NELSON

FOOD & NUTRITION

FOR QCE: UNITS 1–4

written to
the new
Food & Nutrition
senior syllabus

Kirsten McCahon Louise Pamment Kay York

CENGAGE Learning™

This is a legal agreement between the you, (the "Customer") and Cengage Learning Australia Pty Limited (ABN 14 058 280 149) (the "Licensor") which provides the terms and conditions of this non-exclusive licence and the limited warranty for the Product. Use of the Product indicates an acknowledgement that the Customer has read and agreed to be bound by the terms and conditions of this Agreement. If you do not agree to these terms and conditions, return the Product to the place of purchase within 15 days of the date of purchase (with proof of purchase) for a full refund

1. **Licence Grant**
   You do not receive title to the Product. Copyright in the Product (which includes all images, photographs, video, animations, audio, music and text incorporated in the Product, including all of the accompanying printed material) is owned by the Licensor and/or its suppliers and is protected by Australian copyright laws. The Licensor grants you a non-exclusive licence to use the Product subject to the restrictions and terms set out in this Agreement.

2. **A Licence allows you to:**
   Use the Product on your computer. The Customer represents that they shall in no way place the Product in the public domain or in any way compromise our copyright in the Material. You agree to take reasonable steps to protect our copyright.

3. **You may not:**
   Alter, modify, translate, reverse engineer, decompile, or adapt the software or create derivative works based on the Product. Make further copies by any means technological, electronic, digital whatsoever without the written permission of the Licensor. Rent or transfer all or any part of your rights under this Agreement. Remove or alter any copyright or other proprietary notice or label attached to the software.

4. **Termination**
   Any failure to comply with the terms and conditions of this agreement will result in the automatic termination of this licence. Upon termination of this licence for any reason, the Customer must destroy or return to the Licensor all copies of the software and accompanying documentation.

5. **Warranties**
   To the extent permitted by law, the Licensor's liability for any breach of the warranty or any term implied by law into this licence is limited to the lowest cost of replacing the goods, acquiring equivalent goods or having the goods repaired.

NELSON

FOOD & NUTRITION

FOR QCE: UNITS 1–4

written to the new Food & Nutrition senior syllabus

Kirsten McCahon Louise Pamment Kay York

Nelson Food & Nutrition for QCE
1st Edition
Kirsten McCahon
Louise Pamment
Kay York
Consultant: Louise Weihen
ISBN 9780170418560

Publisher: Sam Bonwick
Editor: Carolyn Glascodine
Project editor: Georgia O'Connor
Cover design: Leigh Ashforth (Watershed Design)
Permissions researcher: Flora Smith
Production controller: Christine Fotis
Typesetter: diacriTech, India

Any URLs contained in this publication were checked for currency during the production process. Note, however, that the publisher cannot vouch for the ongoing currency of URLs.

Acknowledgements
Food & Nutrition 2019 v1.1 General Senior Syllabus © Queensland Curriculum and Assessment Authority (QCAA). This syllabus forms part of a new senior assessment and tertiary entrance system in Queensland. Along with other senior Syllabuses, it is still being refined in preparation for implementation in schools from 2019. For the most current syllabus versions and curriculum information please refer to QCAA website http://www.qcaa.qld.edu.au/.

The QCAA's permission does not imply permission to reproduce non-QCAA material. For permission to reproduce the material for which the QCAA owns copyright, please contact the QCAA, PO Box 307, Spring Hill Qld 4004; pushlishing@qcaa.qld.edu.au.

National Library of Australia Cataloguing-in-Publication Data
A catalogue record for this book is available from the National Library of Australia.

Cengage Learning Australia
Level 7, 80 Dorcas Street
South Melbourne, Victoria Australia 3205

Cengage Learning New Zealand
Unit 4B Rosedale Office Park
331 Rosedale Road, Albany, North Shore 0632, NZ

For learning solutions, visit **cengage.com.au**

Printed in China by China Translation & Printing Services.
1 2 3 4 5 6 7 22 21 20 19 18

CONTENTS

CHAPTER 5 DEVELOPING FOOD SOLUTIONS

» How can chemical, functional and nutritional properties and preservation techniques be used to develop vitamin, mineral and protein-based food products?

UNIT 2

CHAPTER 6 CONSUMER FOOD DRIVERS

» Can consumers influence the development of new food products?

CHAPTER 7 SENSORY PROFILING

» Why are the sensory properties of food valuable in developing successful food products?

CHAPTER 8 LABELLING AND FOOD SAFETY

» How does legislation protect consumers?

9780170418560

CHAPTER 9 FOOD FORMULATION FOR CONSUMER MARKETS

» Can changes in food formulations fulfil consumer demands?

UNIT 3

CHAPTER 10 CARBOHYDRATE

» How can the chemical and functional properties of carbohydrate, knowledge of food safety and spoilage, and preservation techniques be used to develop food solutions?

CHAPTER 11 FAT

» How can chemical and functional properties of fat, knowledge of food safety and spoilage, and preservation techniques be used to develop food products?

CHAPTER 12 DEVELOPING FOOD SOLUTIONS

» How can chemical and functional properties of carbohydrate and/or fat, together with preservation techniques, be used to develop food products?

UNIT 4

CHAPTER 13 FORMULATION AND REFORMULATION FOR NUTRITION CONSUMER MARKETS

» What formulation and reformulation opportunities exist for specific nutrition consumer markets?

CHAPTER 14 FOOD DEVELOPMENT PROCESS

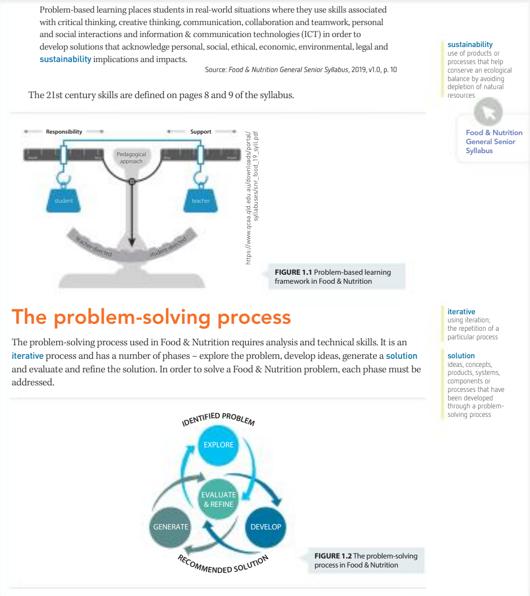
» How can the food development process solve current and future nutrition consumer market problems?

9780170418560

ABOUT THIS BOOK

Nelson Food & Nutrition for QCE has been written specifically for the new Food & Nutrition General Senior Syllabus and is a complete resource for students and teachers.

- Every unit and topic of the syllabus is here, and the headings and activities logically follow the order of the syllabus. Unit opening pages introduce each unit and identify the unit objectives.
- The problem-solving process is introduced in chapter 1 and unpacked further in subsequent chapters.


Problem-based learning places students in real-world situations where they use skills associated with critical thinking, creative thinking, communication, collaboration and teamwork, personal and social interactions and information & communication technologies (ICT) in order to develop solutions that acknowledge personal, social, ethical, economic, environmental, legal and sustainability implications and impacts.

Source: *Food & Nutrition General Senior Syllabus*, 2019, v1.0, p. 10

The 21st century skills are defined on pages 8 and 9 of the syllabus.

sustainability use of products or processes that help conserve an ecological balance by avoiding depletion of natural resources

Food & Nutrition General Senior Syllabus

FIGURE 1.1 Problem-based learning framework in Food & Nutrition

The problem-solving process

The problem-solving process used in Food & Nutrition requires analysis and technical skills. It is an iterative process and has a number of phases – explore the problem, develop ideas, generate a solution and evaluate and refine the solution. In order to solve a Food & Nutrition problem, each phase must be addressed.

iterative using iteration, the repetition of a particular process

solution ideas, concepts, products, systems, components or processes that have been developed through a problem-solving process

FIGURE 1.2 The problem-solving process in Food & Nutrition


In this unit, students explore sectors of the food system and the nutrient elements that make up our food (see chapter 1). They explore fundamentals of food science through practical investigation of the nutritional and scientific properties of vitamins, minerals and protein in foods. Students use the Food & Nutrition problem-solving process to build knowledge and develop and test ideas using a range of experimental techniques to create solutions. Students solve problems for consumer markets by defining and analysing the problem, developing ideas, and generating and evaluating a solution.

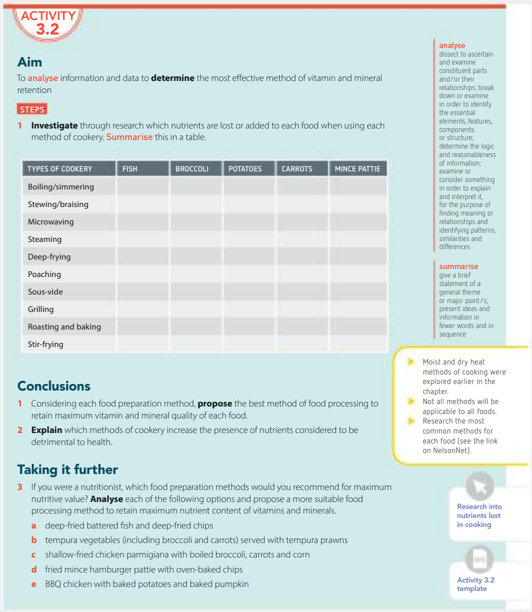
In Topic 1, students identify and understand relevant sectors of the food system and how food is developed, produced, processed, transported, stored and distributed. They become aware of the nutrients found in food, and their functions, sources and recommended values to support health (see chapter 1). In Topic 2, students explore, through experimentation, how processing and preservation techniques affect the bioavailability of vitamins and minerals. Topic 3 provides students with the opportunity to discover, through experimentation, how protein interacts with temperature and physical manipulation to produce nutritional food products. In Topic 4, students have the opportunity to solve a problem related to the formulation of a food solution using the chemical, functional and nutritional properties of vitamins, minerals and protein in foods.

STUDENTS WILL

1. recognise and describe facts and principles related to the nutritional, chemical, functional and sensory properties of vitamins, minerals and protein-based food
2. explain food science ideas and problems related to vitamins, minerals and protein-based food
3. analyse problems, information and data related to the properties and processing of vitamins, minerals and protein-based food
4. determine solution requirements and criteria for vitamin, mineral and protein-based food problems
5. synthesise information and data to develop ideas for vitamin, mineral and protein-based food solutions
6. generate vitamin, mineral or protein-based solutions to provide data to determine the feasibility of the solution
7. evaluate and refine ideas and solutions to make justified recommendations for enhancement of vitamin, mineral or protein-based food solutions
8. make decisions about and use mode-appropriate features, language and conventions for particular purposes and food and nutrition context.

Food & Nutrition 2019 v1.1 General Senior Syllabus, p. 19. © Queensland Curriculum and Assessment Authority (QCAA).

- The experiments and activities follow a consistent and logical structure. Icons indicate when templates and worksheets are available on NelsonNet.


ACTIVITY 3.2

Aim

To analyse information and data to **determine** the most effective method of vitamin and mineral retention

STEPS

1. **Investigate** through research which nutrients are lost or added to each food when using each method of cookery. Summarise this in a table.

TYPES OF COOKERY	FISH	BROCCOLI	POTATOES	CARROTS	MINCE PATTIE
Boiling/simmering					
Stewing/braising					
Microwaving					
Steaming					
Deep-frying					
Poaching					
Sous-vide					
Grilling					
Roasting and baking					
Stir-frying					

Conclusions

1. Considering each food preparation method, **propose** the best method of food processing to retain maximum vitamin and mineral quality of each food.
2. **Explain** which methods of cookery increase the presence of nutrients considered to be detrimental to health.

Taking it further

3. If you were a nutritionist, which food preparation methods would you recommend for maximum nutritive value? **Analyse** each of the following options and propose a more suitable food processing method to retain maximum nutrient content of vitamins and minerals.
   a. deep-fried battered fish and deep-fried chips
   b. tempura vegetables (including broccoli and carrots) served with tempura prawns
   c. shallow-fried chicken parmigiana with boiled broccoli, carrots and corn
   d. fried mince hamburger pattie with oven-baked chips
   e. BBQ chicken with baked potatoes and baked pumpkin

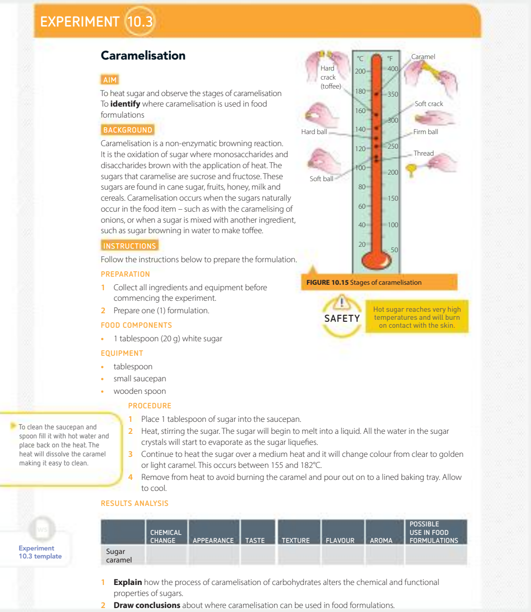
analyse dissect to ascertain and examine constituent parts and/or their relationships; break down or examine in order to identify the essential elements, features, components or structure; determine the logic and reasonableness of information; examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences

summarise give a brief statement of a general theme or major point/s; present ideas and information in fewer words and in sequence

- Moist and dry heat methods of cooking were explored earlier in the chapter.
- Not all methods will be applicable to all foods.
- Research the most common methods for each food (see the link on NelsonNet).

Research into nutrients lost in cooking

Activity 3.2 template


EXPERIMENT 10.3

Caramelisation

AIM

To heat sugar and observe the stages of caramelisation
To **identify** where caramelisation is used in food formulations

BACKGROUND

Caramelisation is a non-enzymatic browning reaction. It is the oxidation of sugar where monosaccharides and disaccharides brown with the application of heat. The sugars that caramelise are sucrose and fructose. These sugars are found in cane sugar, fruits, honey, milk and cereals. Caramelisation occurs when the sugars naturally occur in the food item – such as with the caramelising of onions, or when a sugar is mixed with another ingredient, such as sugar browning in water to make toffee.

INSTRUCTIONS

Follow the instructions below to prepare the formulation.

PREPARATION

1. Collect all ingredients and equipment before commencing the experiment.
2. Prepare one (1) formulation.

FOOD COMPONENTS

- 1 tablespoon (20 g) white sugar

EQUIPMENT

- tablespoon
- small saucepan
- wooden spoon

PROCEDURE

1. Place 1 tablespoon of sugar into the saucepan.
2. Heat, stirring the sugar. The sugar will begin to melt into a liquid. All the water in the sugar crystals will start to evaporate as the sugar liquefies.
3. Continue to heat the sugar over a medium heat and it will change colour from clear to golden or light caramel. This occurs between 155 and 182°C.
4. Remove from heat to avoid burning the caramel and pour out on to a lined baking tray. Allow to cool.

RESULTS ANALYSIS

	CHEMICAL CHANGE	APPEARANCE	TASTE	TEXTURE	FLAVOUR	AROMA	POSSIBLE USE IN FOOD FORMULATIONS
Sugar caramel							

1. **Explain** how the process of caramelisation of carbohydrates alters the chemical and functional properties of sugars.
2. **Draw conclusions** about where caramelisation can be used in food formulations.

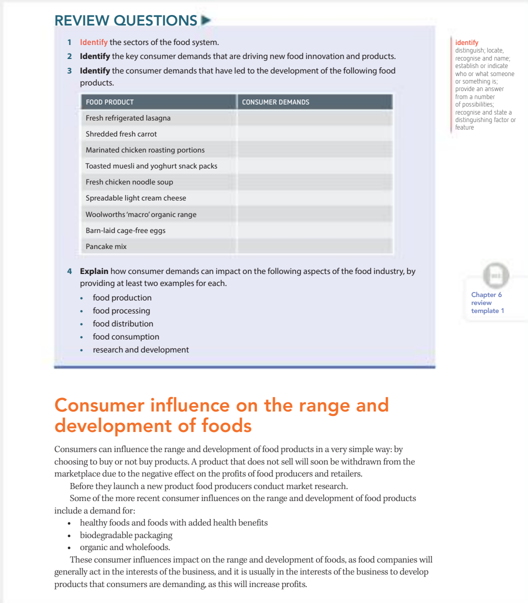
FIGURE 10.15 Stages of caramelisation

SAFETY Hot sugar reaches very high temperatures and will burn on contact with the skin.

To clean the saucepan and spoon fill it with hot water and place back on the heat. The sugar will dissolve the caramel making it easy to clean.

Experiment 10.3 template

- Regular review questions check learning and ensure students fulfil the retrieval and comprehension levels of Marzano & Kendall's New Taxonomy of Educational Objectives. Unit review questions, following the format of the external assessment, are available on NelsonNet.
- Questions and activities feature the relevant cognitive verbs in orange or bold, with the terms defined in the margin glossary when first used in each unit. Definitions are also provided in the margin for key content terms, in blue in the text. A consolidated glossary appears at the front of the book.



REVIEW QUESTIONS ▶

1 Identify the sectors of the food system.
2 **Identify** the key consumer demands that are driving new food innovation and products.
3 **Identify** the consumer demands that have led to the development of the following food products.

FOOD PRODUCT	CONSUMER DEMANDS
Fresh refrigerated lasagna	
Shredded fresh carrot	
Marinated chicken roasting portions	
Toasted muesli and yoghurt snack packs	
Fresh chicken noodle soup	
Spreadable light cream cheese	
Woolworths 'macro' organic range	
Barn-laid cage-free eggs	
Pancake mix	

4 **Explain** how consumer demands can impact on the following aspects of the food industry, by providing at least two examples for each.
- food production
- food processing
- food distribution
- food consumption
- research and development

identify
distinguish; locate, recognise and name; establish or indicate who or what someone or something is; provide an answer from a number of possibilities; recognise and state a distinguishing factor or feature

Chapter 6 review template 1

Consumer influence on the range and development of foods

Consumers can influence the range and development of food products in a very simple way: by choosing to buy or not buy products. A product that does not sell will soon be withdrawn from the marketplace due to the negative effect on the profits of food producers and retailers.

Before they launch a new product food producers conduct market research.

Some of the more recent consumer influences on the range and development of food products include a demand for:
- healthy foods and foods with added health benefits
- biodegradable packaging
- organic and wholefoods.

These consumer influences impact on the range and development of foods, as food companies will generally act in the interests of the business, and it is usually in the interests of the business to develop products that consumers are demanding, as this will increase profits.

NelsonNet

Nelson Food & Nutrition is a premium Cengage title and is fully supported by the NelsonNet platform.

NelsonNetBook

The NelsonNetBook is your digital textbook. Readable online and offline on desktops, laptops and tablets, it reproduces the student text in digital form. With annotations and reviewing tools, and the ability to add and customise your book, NelsonNetBook is accessible immediately via access codes. Please note that any notations made to the NelsonNetBook will expire two years after the access code is activated.

NelsonNet Resources

Access to NelsonNet also provides students with additional web-based materials such as worksheets, videos and bonus recipes.

Weblinks

Students and teachers can link directly to external websites referred to in Nelson Food & Nutrition for QCE Units 1–4 via the free, unprotected weblinks site located at

Weblink

Disclaimer

Please note that complimentary access to NelsonNet and the NelsonNetBook is only available to teachers who use the accompanying student textbook as a core educational resource in their classroom. Contact your Education Consultant for information about access codes and conditions.

9780170418560

ASSESSMENT IN FOOD & NUTRITION

There are two types of assessment throughout the course. The assessment in Year 11 (Units 1 and 2) is formative assessment. The assessment in Year 12 (Units 3 and 4) is summative assessment.

Formative assessment

This assessment is an opportunity to learn how to approach the tasks and receive feedback about your progress in the course of study. The formative assessments will be developed by the school and each objective must be assessed once in the unit of study. There will be no fewer than two assessments in each unit of study and no more than four. The assessment in Year 11 reflects the assessment in Year 12. The assessment is integrated within the unit and part of the notional hours suggested in the syllabus.

Summative assessment

Unit 3 and 4 include summative assessment that will contribute to final levels of achievement and an ATAR (Australian Tertiary Admissions Ranking) score.

Information on the requirements and conditions for assessment tasks is supplied in the syllabus document available on the QCAA school portal or on the QCCA website.

It is important to know the conditions to respond to assessment tasks. The syllabus provides:

- a description of the assessment
- the assessment objectives, which are aligned to the syllabus objectives and the unit objectives
- specifications for the assessment
- contextual stimulus specifications
- conditions of assessment
- the instrument specific marking guide (ISMG). Study the ISMG and refer to the glossary of the syllabus to understand what is required for specific marks. The ISMG is set up according to criteria.

There are two types of summative assessment stipulated in the syllabus:

1 **Examination:** the types of questions in this assessment type are short response and extended response.

2 **Project-folio:** this assessment is based on the problem-solving process. It requires extensive documentation to develop a solution to a food-related problem.

On NelsonNet there is a series of review questions posed for consideration and response. These questions link directly to the syllabus intent and give good practice for examinations.

The Project-folio is a body of work that is carried out over a period of time – up to 15 hours in some units. It is a significant body of work which focuses on a problem-solving process. There is an opportunity to complete a project-folio each unit. Understanding the problem-solving process is paramount to completing a successful folio. Chapter 1 of this book describes problem-based learning in Food & Nutrition in more detail; chapter 5 contains a completed example of the problem-solving process and accompanying activities for students to become familiar with problem-based learning. Chapters 8, 12 and 14 provide content to kick-start the problem-solving process for each unit and refers students back to chapter 5 and to the folio checklist on NelsonNet.

ATAR (Australian Tertiary Admissions Ranking) demonstrates a student's achievement in relation to other students. Now used throughout Australia by tertiary institutions to compare the overall achievement of students

Food & Nutrition Syllabus

Instrument Specific Marking Guide (ISMG) outlines the expectations for the marking of the assessment task

ABOUT THE AUTHORS

Kay York is the current president of HEIA and is Head of Department Home Economics at Park Ridge State High School. Kay regularly delivers professional development in her role as HEIA President and she was on the writing team for the Food & Nutrition General Senior Syllabus.

Kirsten McCahon is a passionate practitioner of education with a focus on organic chemistry. She has over 30 years of experience teaching Home Economics in Queensland schools. Kirsten is the current president of HEIA(Q).

Louise Pamment is an experienced Food Technology, Hospitality and Design and Technology teacher based in New South Wales. She is co-author of Nelson Hospitality Focus HSC and is currently on secondment to the NSW Department of Education.

AUTHOR ACKNOWLEDGEMENTS

Kay York Thank you to Terry for supporting me throughout the process with meals, love and patience. Thank you to my Mother who always believes I can do anything and to my daughter who makes me proud.

Kirsten McCahon The journey of writing this book has been harder than I ever thought and, at the same time, more rewarding than I imagined. None of this would have been possible without the support of my amazingly helpful and tolerant husband Ken for picking up the slack at home and not complaining about late nights, lonely weekends and few holidays. The support of my daughter Jennifer, whose positivity has been invaluable, along with my son David's patience and encouragement over the months, has been a godsend. Thanks to Rosemarie Sciacca, who started me down the writing journey, to Susan Houlahan and Jane Ryan for their continual support, encouragement and a quiet place to write when life was more than hectic. Acknowledgements to Sam Bonwick and the Cengage team for fine-tuning my unpolished writing. Finally, I wish to acknowledge my colleagues and friends in Home Economics for providing the inspiration and collaboration over the past 30 years of teaching.

Louise Pamment Thanks to Joseph for his calming patience, understanding and gentle encouragement as I worked many nights and weekends writing. He also planned and prepared meals to ensure I was sufficiently nourished. Thanks to Kay and Kirsten for allowing me to join the QD adventure to a new curriculum and Sam Bonwick for bringing me into another Cengage project!

The authors and the publisher would also like to thank Bruce D'Arcy, Delia Stecher and Meghann Wear for their considered reviews of the book as it was being developed. Thanks also to Dr Janet Reynolds and Renae Bradbury for their contributions at the early stages of the project.

GLOSSARY

analyse dissect to ascertain and examine constituent parts and/or their relationships; break down or examine in order to identify the essential elements, features, components or structure; determine the logic and reasonableness of information; examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences

categorise place in or assign to a particular class or group; arrange or order by classes or categories; classify, sort out, sort, separate

comment express an opinion, observation or reaction in speech or writing; give a judgment based on a given statement or result of a calculation

compare display recognition of similarities and differences and recognise the significance of these similarities and differences

conduct direct in action or course; manage; organise; carry out

consider think deliberately or carefully about something, typically before making a decision; take something into account when making a judgment; view attentively or scrutinise; reflect on

create bring something into being or existence; produce or evolve from one's own thought or imagination; reorganise or put elements together into a new pattern or structure or to form a coherent or functional whole

decide reach a resolution as a result of consideration; make a choice from a number of alternatives

deduce reach a conclusion that is necessarily true, provided a given set of assumptions is true; arrive at, reach or draw a logical conclusion from reasoning and the information given

define give the meaning of a word, phrase, concept or physical quantity; state meaning and identify or describe qualities

demonstrate prove or make clear by argument, reasoning or evidence, illustrating with practical example; show by example; give a practical exhibition

describe give an account (written or spoken) of a situation, event, pattern or process, or of the characteristics or features of something

design produce a plan, simulation, model or similar; plan, form or conceive in the mind

determine establish, conclude or ascertain after consideration, observation, investigation or calculation; decide or come to a resolution

develop elaborate, expand or enlarge in detail; add detail and fullness to; cause to become more complex or intricate

discuss examine by argument; sift the considerations for and against; debate; talk or write about a topic, including a range of arguments, factors or hypotheses; consider, taking into account different issues and ideas, points for and/or against, and supporting opinions or conclusions with evidence

draw conclusions make a judgment based on reasoning and evidence

evaluate make an appraisal by weighing up or assessing strengths, implications and limitations; make judgements about ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria

examine investigate, inspect or scrutinise; inquire or search into; consider or discuss an argument or concept in a way that uncovers the assumptions and interrelationships of the issue

experiment try out or test new ideas or methods, especially in order to discover or prove something; undertake or perform a scientific procedure to test a hypothesis, make a discovery or demonstrate a known fact

explain make an idea or situation plain or clear by describing it in more detail or revealing relevant facts; give an account; provide additional information

explore look into both closely and broadly; scrutinise; inquire into or discuss something in detail

generate produce; create; bring into existence

hypothesise formulate a supposition to account for known facts or observed occurrences; conjecture, theorise, speculate; especially on uncertain or tentative grounds

identify distinguish; locate, recognise and name; establish or indicate who or what someone or something is; provide an answer from a number of possibilities; recognise and state a distinguishing factor or feature

investigate carry out an examination or formal inquiry in order to establish or obtain facts and reach new conclusions; search, inquire into, interpret and draw conclusions about data and information

justify give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable

make decisions select from available options; weigh up positives and negatives of each option and consider all the alternatives to arrive at a position

propose put forward (e.g. a point of view, idea, argument, suggestion) for consideration or action

recognise identify or recall particular features of information from knowledge; identify that an item, characteristic or quality exists; perceive as existing or true; be aware of or acknowledge

summarise give a brief statement of a general theme or major point/s; present ideas and information in fewer words and in sequence

synthesise combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding

test take measures to check the quality, performance or reliability of something

understand perceive what is meant by something; grasp; be familiar with (e.g. an idea); construct meaning from messages, including oral, written and graphic communication

agronomic related to agronomy, the science of land management for the production of crops

amino acids the building blocks of proteins

antioxidants chemicals approved for the control of oxidation (rancidity) in food products, including butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA) and propyl-gallate

aquafaba the cooking liquid of chickpeas; can be used to replace egg whites for beating to a foam

bioavailability the degree to which nutrients in food are available for absorption and use in the body

brief concise description of a problem that clarifies the need or opportunity to be resolved and may include possible implications and impacts; provides a basis from which students can apply some or all of the stages of the problem-solving process

Bt genes naturally occurring bacteria that produce a protein that is toxic to some insects

carcinogenic a substance or mixture that promotes the growth of cancer

catalyst causing or accelerating a chemical reaction

chronic disease group of diseases that tend to be long-lasting and have persistent effects (Australian National Health and Medical Research Council 2013)

coccidiostats a chemical substance added to animal feed that slows or reduces the population of pathogenic coccidia

consumer any person who uses goods and services

consumer drivers factors influencing consumer demand or expectations for products or services

consumer food market consumer demand for a particular food and nutrition product

consumer rights the legal, social or ethical principles that are according to a legal system or accepted as social conventions

convenience ability of a product to be agreeable to the needs or purpose of the consumer; well-suited with respect to facility or ease in use; favourable, easy, or comfortable for use

criterion (plural, criteria) the property or characteristic by which something is judged or appraised

danger zone the temperature range of 5ºC–60ºC, where foodborne bacteria are most likely to multiply and thrive

degradative the act of degrading; to break down or decompose

denature permanently change the structure of protein; occurs when the bonds holding the helix shape are broken and the strands of the helix separate and unravel; a functional property of protein, useful in food preparation, e.g. whisking eggs or marinating a piece of meat (acid tenderises the meat before cooking)

dietary fibre component of all plant materials, which is indigestible

distribution pathways movement of materials and goods by road, pipeline, air, rail and water

dosa made from a fermented batter of rice and lentil – similar to a pancake or crepe

drip loss deterioration of meat due to the loss of meat juices, which are released from cut sections when stored or thawed

effluent liquid waste or sewage

emulsification the process of making into an emulsion, the suspension of a liquid in another liquid

entomophagy the use of insects as a food source; insectivorous eating habits

excrete the process of eliminating waste and other non-useful materials from the body, through faeces, urine or sweat

feasibility capability of being achieved, accomplished or put into effect; reasonable enough to be believed or accepted; probable; likely of the quality, functionality and reliability of the solution

fermentation changes in food caused by growth of bacteria, yeast or mould; fermented products include alcohol, vinegar and some dairy products

food additives substances added to food that may enhance flavour and appearance or increase shelf life

food formulation putting together the food components in appropriate relationships or structures, according to a formula or recipe

food processing any activity to prepare food for sale, including chopping, cooking, drying, fermenting, heating, pasteurising, thawing and washing, or a combination of these activities (Food Standards Australia New Zealand 2015)

food products processed food sold to consumers

food system the combined actions of people, processes and infrastructure to produce food for a population; includes production, processing, distribution, consumption and research and development, taking into account sustainability, food security and waste management

fortification addition of nutrients that are not naturally present in the food or the addition of amounts greater than those naturally present

functional foods foods or food components to which an existing ingredient or a new ingredient has been added to provide additional benefits, usually for disease prevention or improved health

functional properties the physical and chemical characteristics of foods

HACCP a system that identifies potential biological, chemical and physical hazards in food production and establishes preventative measures for control at these points; a plan outlining this system for a food production process is called a HACCP plan (Hazard Analysis Critical Control Point Australia)

halal of food (especially meat), prepared according to Islamic law

health-conscious individuals who are concerned about their diet and lifestyle

immiscible incapable of being mixed

infrastructure basic structure of the food industry

intensively farmed foods way of producing large amounts of crops or animal products by using chemicals (e.g. antibiotics) and/or contemporary technology

iterative using iteration; the repetition of a particular process

kefir a unique cultured dairy product that is rich in probiotics

kosher 'fit' or 'appropriate' for a Jewish person to eat, according to Jewish laws; used of food and vessels for food ritually proper for use, especially of meat slaughtered in accordance with the law of Moses

ketones the product of the incomplete breakdown of fat when glucose is not available in the cells

lexicon in Food & Nutrition, a source list used to describe the sensory properties of food; similar to a specific technical dictionary

logistics transport and distribution

line extension a product added to the product line

market research collecting information about a section or whole group of the population, in relation to their preferences, characteristics, attitudes, needs, opinions, motivations, behaviour or other relevant attributes

mouthfeel a food product's physical and chemical interaction in the mouth, specifically the texture of the food in the mouth

mycotoxin poisonous chemical compound produced by some fungi

nutrient substance that provides nourishment essential for the maintenance of life and for growth

nutrient-dense foods that are high in nutrients such as vitamins, minerals, complex carbohydrates, lean protein and healthy fat, and generally lower in kilojoules or energy

nutrient reference value a set of recommendations for nutritional intake based on currently available scientific facts (Australian National Health and Medical Research Council 2017)

nutrition intake of food, considered in relation to the body's dietary needs (World Health Organization)

nutrition consumer market market specifically focusing on nutrient content of foods that aim to assist the nutritional status of the consumer, e.g. low salt, low fat and high fibre

nutritive value a simple measure of the nutrient content of a food

organic relating to a type of farming that minimises chemical fertilisers or pesticides, and the produce of such farming

organoleptic the aspects of food that an individual experiences via the senses – sight, smell, hearing, touch and taste

oxidative stress imbalance between the production of free radicals and the ability of the body to detoxify the harmful effects of them

palatability acceptable or agreeable to the palate or taste

pathogen microorganisms, such as bacteria, fungi and viruses which cause disease

physical properties a food's size, shape, colour, volume, viscosity and elasticity

phytochemicals chemical compounds that are produced by plants that have protective or disease-preventive properties

plagiarism the use of someone else's work that you pass off as your own

preservation processing of food to eliminate or control conditions that cause spoilage, e.g. dehydration, canning, freezing, jam making, pickling, ultra-heat treatment

primary data information collected by the individual conducting the research

principles specific types of generalisations that deal with relationships; a proposition that serves as the foundation for a system of belief or behaviour or for a chain of reasoning

probiotics beneficial bacteria that can be introduced to food items such as yoghurt

problem-solving process consists of subject specific problem-solving processes (explore, develop, generate, evaluate and refine) used to iteratively find solutions to difficult or complex problems or situations

product line a range of related products made by a manufacturer

prototype in Food & Nutrition, a trial solution to test an idea to inform further development; demonstrates the interaction of food components in formulations, its purpose is to identify if and how well a solution functions and can be tested by stakeholders

qualitative research gathering information regarding human attitudes and views, which are analysed and devised into data based on interpretation by researchers

quantitative research gathering numerical data via a formal and systematic process

reformulation formulate a mixture of ingredients in a different way; to alter or revise

secondary data information collected by governments or organisations for other research purposes

sensory properties properties that can be identified by organs of sense, e.g. taste, texture, colour and aroma

shear strain produced by pressure in the structure of a substance or liquid, when its layers are laterally shifted in relation to each other; any real fluids (liquids and gases included) moving along solid boundary will incur a shear stress on that boundary

shelf life length of time between packaging and use that a food product remains of acceptable quality to the user

smallgoods small meat products, generally made from secondary cuts, e.g. sausage or salami

solution ideas, concepts, products, systems, components or processes that have been developed through a problem-solving process

sous-vide process in which food is placed in a vacuum sealed, plastic pouch and then placed in a water bath for longer than normal cooking times at a regulated temperature much lower than normally used for cooking: intended to cook the item evenly, ensuring that the inside is properly cooked without overcooking to retain moisture

spent grains leftover malt and adjuncts, by-products of breweries

spore dormant form of some microorganisms that is resistant to environmental factors that could usually cause the death of the microorganism

stakeholder a person or group of people who has an interest in or concern with a particular problem

statutory authority an independent body with the power to enact legislation in a specific area on behalf of the government

striation muscle that is different from smooth muscle, as it has striped dark and light colour across the muscle

sustainability use of products or processes that help conserve an ecological balance by avoiding depletion of natural resources

syneresis separation of liquid from a gel on standing

synthetic chemical substances that are added to foods, that are not derived from a food itself

synthetic meat meat grown in a cell culture instead of inside an animal, is a form of cellular agriculture. Also known as cell-cultured meat, clean meat, vatmeat, lab-grown meat and in-vitro meat

synthesise the process of producing chemical compounds

trans fats fats that occur in animal fats naturally (including dairy), and as a result of processing in commercially prepared, partially hydrogenated margarines and solid cooking fats developed in part to help displace highly saturated animal and vegetable fats used in frying, baking and spreads; may raise blood LDL ('bad') cholesterol levels and at high consumption levels may also reduce HDL ('good') cholesterol levels

transparency policy or practice of making all operations clearly manifest, and of being accountable to the public for all such operations; in relation to consumer rights is the visibility or accessibility of information that a business provides and their business practices

turgor the pressure placed on cell walls or membranes by fluids within the cell; turgor gives food a full, fresh appearance, a firm texture and a crisp mouthfeel

umami a taste characteristic, sometimes referred to as savoury; may be present as glutamate, an amino acid

vegan person who follows a diet that excludes any animal products from their diet, including milk, eggs and honey

vegetarian person who excludes meat (and by-products derived from a slaughtered animal such as gelatine and rennet) and fish from their diet

waste management responsibility for, and control of, disposal of any food substance or food packaging to minimise environmental and health impacts

PROBLEM-BASED LEARNING IN FOOD & NUTRITION

1

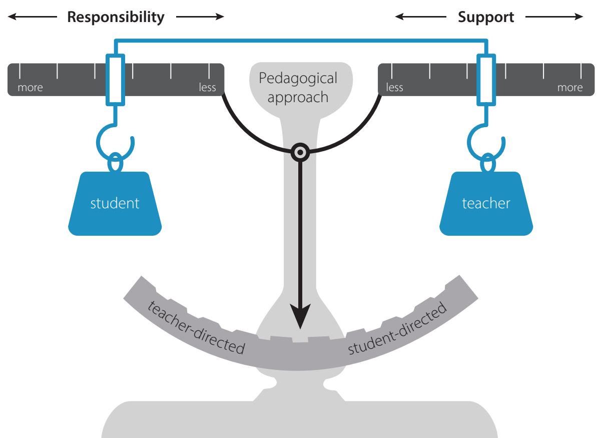
Problem-based learning is the overarching pedagogy of the syllabi in the Technologies learning area.

> Problem-based learning places students in real-world situations where they use skills associated with critical thinking, creative thinking, communication, collaboration and teamwork, personal and social interactions and information & communication technologies (ICT) in order to develop solutions that acknowledge personal, social, ethical, economic, environmental, legal and **sustainability** implications and impacts.
>
> Source: *Food & Nutrition General Senior Syllabus*, 2019, v1.0, p. 10

The 21st century skills are defined on pages 8 and 9 of the syllabus.

sustainability
use of products or processes that help conserve an ecological balance by avoiding depletion of natural resources

Food & Nutrition General Senior Syllabus



https://www.qcaa.qld.edu.au/downloads/portal/syllabuses/snr_food_19_syll.pdf

FIGURE 1.1 Problem-based learning framework in Food & Nutrition

The problem-solving process

The problem-solving process used in Food & Nutrition requires analysis and technical skills. It is an **iterative** process and has a number of phases – explore the problem, develop ideas, generate a **solution** and evaluate and refine the solution. In order to solve a Food & Nutrition problem, each phase must be addressed.

iterative
using iteration; the repetition of a particular process

solution
ideas, concepts, products, systems, components or processes that have been developed through a problem-solving process

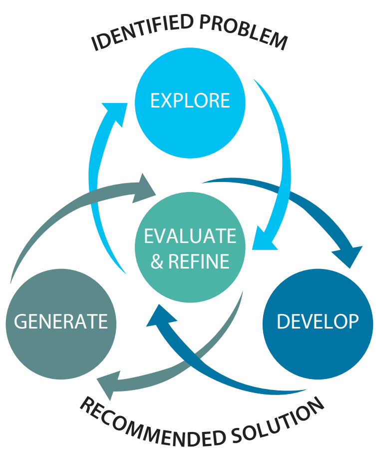


FIGURE 1.2 The problem-solving process in Food & Nutrition

A context is an area of study related to Food & Nutrition. Each of the relevant contexts has its own chapter in this book, and each chapter begins with the facts and principles for each context.

When thinking about a problem suitable for Food & Nutrition consider:

- a need or opportunity that relates to the sectors of the food system
- the needs of identified **stakeholders**
- possible teacher-specified constraints, such as time available, skills, facilities, equipment and legalities
- whether the problem can be solved using the problem-solving process.

stakeholder
a person or group of people who has an interest in or concern with a particular problem

Explore the problem

Recognise and describe facts and principles

In order to explore a Food & Nutrition problem, first recognise the facts about the problem and describe the facts and principles relating to the problem.

FIGURE 1.3 Examples of stakeholders in a Food & Nutrition problem

Explain ideas and problems

During the course of exploring Food & Nutrition problems, ideas and problems need to be explained in a range of contexts. The contexts include the food science of vitamins, minerals and protein in Unit 1; food drivers and emerging trends in Unit 2; food science of carbohydrate and fat in Unit 3; and food solution development for nutrition consumer markets in Unit 4.

Analyse stakeholders' needs

To analyse the needs of relevant stakeholders it is necessary to identify essential features, characteristics and constraints of the problem and from that information identify the people or groups related to the problem. This can be presented in a table, mind map or other graphic organiser – a completed example of Figure 1.3 is provided in chapter 5 on page 127.

The 'essential characteristics' of the problem are those that are absolutely necessary or of critical importance in order to solve the problem. If these characteristics are not identified, it will be difficult to solve the problem.

The characteristics of the problem would include a 'typical feature or quality' that is central to the problem. This could include the physical properties of the particular food nutrient, the preservation technique required and how a food is processed. The constraints of the problem are teacher-specified in Unit 1 of Food & Nutrition. These constraints could include time, economic, physical or sustainability limitations such as equipment, facilities and distance to or from a specific space. The constraints could also be the legal implications of the problem with regard to food laws and regulations.

brief
concise description of a problem that clarifies the need or opportunity to be resolved and may include possible implications and impacts; provides a basis from which students can apply some or all of the stages of the problem-solving process

Develop a brief

After assessing all the information, it is necessary to develop a **brief**.

In Unit 1 the brief is provided by the teacher – an example of a brief is provided in chapter 5 on pages 124–7. The student must develop a brief in Units 2, 3 and 4. A brief will determine the specifications of solution requirements, which include the following:

9780170418560

- Identify stakeholders' needs – these could be specified in the brief or explored through the problem.
- Identify the principles of food science and food safety. Much of the work completed throughout the units is research, and the background section of each experiment contains information relating to the principles of food science and experimenting that can be applied to the specific problem. Research is required to ensure the accuracy of the information.
- Identify food safety information related to the problem. Information about food safety and **HACCP** can be found on page 188. This information can be adapted to suit the problem. Different legislation applies to different food problems and all relevant legislation needs to be considered where it is identified in the problem.
- Identify and carefully examine the essential, characteristics and constraints of the problem. These will be different for each problem so careful examination and further research may be required to identify each one.

In Unit 1 the teacher will prescribe the criteria for the brief. In Units 2, 3 and 4 the student determines the **criteria** and uses them to evaluate ideas and the solution, so the criteria should be referred to throughout the problem-solving process and at the conclusion of the project.

The teacher-specified criteria and self-determined criteria should address:

- solution requirements from the brief
- personal, social, ethical, economic, environmental, legal, sustainable and technological implications of the solution
- the **feasibility** of the solution.

HACCP
a system that identifies potential biological, chemical and physical hazards in food production and establishes preventative measures for control at these points; a plan outlining this system for a food production process is called a HACCP plan (Hazard Analysis Critical Control Point Australia)

criterion (plural, criteria)
the property or characteristic by which something is judged or appraised

feasibility
capability of being achieved, accomplished or put into effect; reasonable enough to be believed or accepted; probable; likely of the quality, functionality and reliability of the solution

Develop ideas

In order to develop ideas, research into the relevant facts for the problem is required. The knowledge and processes can be researched from primary sources and secondary sources.

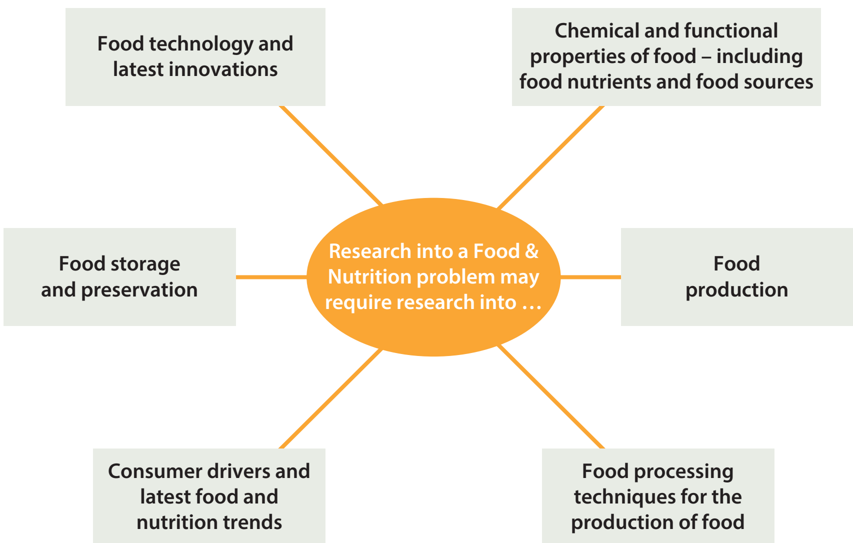


FIGURE 1.4 Areas of research to solve Food & Nutrition problems

Research: primary sources

Data from primary sources includes evidence collected from stakeholders through interviews, surveys and experiments. This material has a direct source and has not been analysed or synthesised into a logical form. Synthesis of the primary data collected into a relevant form is required for use in the process.

Shutterstock.com/ESB Professional

FIGURE 1.5 An interview is an example of a primary source.

How to conduct an interview

1. Decide on the people or stakeholders who will be able to provide good information or have an opinion on the topic. It may be an academic, a community member, a parent or friend.
2. Contact the stakeholder and explain what you are doing and the reasons you are conducting the research. Arrange an interview time.
3. Prepare a list of questions to ask – make sure that the questions will result in the information required.
4. Ask one question at a time and wait for the response. Take notes.
5. Thank the interviewee for their time.

Writing interview questions

- Make the questions open-ended – this will result in better responses and allow the interviewee to answer with their own words.
- Word the questions clearly.
- Avoid value statements.
- Encourage responses using body language.
- Keep the respondent on track.
- Use *who*, *what*, *when*, *where* and *why* as question starters.

Writing a questionnaire

There are many ways to write a questionnaire and many functional tools are available on the Internet. Google has a Forms web app that can be used to create a questionnaire, and websites such as SurveyMonkey are free to use. These programs analyse the responses, making it easy to conduct and analyse a questionnaire. The most difficult part is constructing the questions to gain the required responses to support the Food & Nutrition problem and brief. A valid questionnaire can result in multiple responses that can be analysed. Here is an example:

Questionnaire

Circle the response/s that best describes your behaviour.

1 How often do you eat insects as your primary source of protein?

Never Sometimes Often

2 Where does your largest protein consumption come from?

Animal Plant

3 Do you consume any of the following sources of protein?

Beef Chicken Pork Lamb Lentils Beans

Google Forms

SurveyMonkey

9780170418560

Writing questions for a questionnaire

- Use simple language – explain what you are talking about:
  If there is a worldwide shortage of protein in the future, would you consider eating insects as a source of protein?
- Make questions about one idea. If there are multiple ideas that need to be explored, ask two questions.
  - ☒ **Don't ask**: *How likely would you be to eat a vegetable-based protein-rich diet or an insect-based protein-rich diet?*
  - ☑ **Ask this**: *How likely would you be to eat a vegetable-based protein-rich diet? How likely would you be to eat an insect-based protein-rich diet?*
- Make sure the questions have no bias – do not put your opinion into the question.
  - ☒ **Don't ask**: *I don't think I will ever be able to eat insects. How likely would you be to eat insects?*
  - ☑ **Ask this**: *There is a growing trend in Asian countries to consume insects. How likely would you be to eat insects on a regular basis?*

EXPERIMENTS

Experiments about the chemical and functional properties of food are provided throughout this book. Some Food & Nutrition problems will require experiments to be performed to generate primary data. Many of the experiments in the text will be performed over the course of study and the results may be used in research for the brief. Other experiments may be required to be performed for a specific Food & Nutrition problem or brief.

Procedure for experiments in Food & Nutrition

AIM

What the research is hoping to achieve from the experiment

BACKGROUND

The information about any specific chemical and functional properties of the food is written here. It will save time looking it up to see if the results are in line with the chemical and functional properties.

INSTRUCTIONS

How to carry out the experiment – is there a control sample? What are the variables?

PREPARATION

Prepare one (1) formulation of each, following the instructions for the control procedure.
Prepare one (1) formulation of each of the other variables for analysis.

CONTROL	VARIABLE 1	VARIABLE 2	VARIABLE 3	VARIABLE 4
Produce one batch of the formulation	List any variables that are tested in these boxes. There do not need to be four variables			

FOOD COMPONENT

All the ingredients required to perform the experiment

EQUIPMENT

Any equipment that is needed to be able to perform the experiment

PROCEDURE

How the experiment is performed

RESULTS ANALYSIS

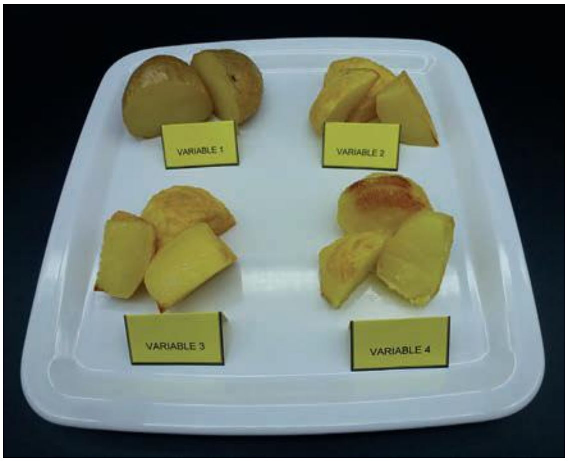
Use the sensory properties and any other headings that are necessary to analyse the results. Tables are a good way to record results.

prototype in Food & Nutrition, a trial solution to test an idea to inform further development; demonstrates the interaction of food components in formulations, its purpose is to identify if and how well a solution functions and can be tested by stakeholders

Taking photographs of experiments

Do not forget to take photographs of the stages in the procedure and the final product.

1. To take a photograph have a plain, light-coloured background, such as a white plate. If there are variables in the formulation make sure that labels are made to identify the different variables.
2. Take a photograph before, during and after the formulation is produced.
3. Some formulations may require that the **prototype** is cut in half and the interior is checked for density, air bubbles or texture. When photographing these take the photograph at an angle to the food.
4. It may be helpful to have a measure, such as a ruler, in the image to give an idea of size.
5. Make sure there is plenty of light on the prototype to show it at its best. Take a couple of photographs from different angles to ensure that the best image is captured. Save these onto the computer for future use and label each image carefully.



Terry McCarten

FIGURE 1.6 Ensure variables are labelled and photographed against a plain, light-coloured background.

RECORD OBSERVATIONS

VARIABLE	APPEARANCE	TASTE	TEXTURE	FLAVOUR	AROMA	POSSIBLE USE IN FOOD FORMULATIONS
	Record observations in a table					

9780170418560

Sensory profiling using physical properties of food

Sensory profiling is used to evaluate a food prototype during the experiments to ascertain the best food formulation. Chapter 7 explores the topic of sensory profiling in more detail; this introduction is provided for experimental analysis. The physical properties of food are used to gauge consumer acceptance and marketability of the food. The sensory profiling of the physical properties of food are listed in the table below.

PROPERTY	DESCRIPTIVE WORDS
Appearance – colour, size, shape, gloss, dullness, transparency	Colour – bright, dull, shiny, light, dark, pale, vibrant, clear, transparent, white, speckled, vivid, glossy, matte Shape – round, square, even, irregular Texture – lumpy, smooth, rough
Taste	Sweet, sour, salty, bitter, umami, spicy, savoury, sharp, tangy, hot
Texture	Mouthfeel – smooth, sharp, soft, crunchy, greasy, juicy, oily, waxy, dry, rough, tender, tough, brittle, sandy, gritty Temperature – warm, hot, cold, freezing, sizzling
Flavour – odour and taste	Pleasant, unpleasant, agreeable, disagreeable, acidic, delicate, rich, bad, good, excellent, strong, weak
Aroma – flavour and aromatics	Strong, weak, aromatic, spicy, burnt, fruity, sweet, rotten, musty

After recording all observations from an experiment, analyse the results to generate a solution. Questions at the end of each experiment prompt students to analyse their results and draw conclusions to determine which products would be suitable for different formulations. Conclusions should be justified using evidence from the experiments or research and analysis that has been carried out in order to support effective decision making on suitable formulations.

Use a spreadsheet to analyse the data – input the data into a spreadsheet and use it to sort the data into a useful format. Apps such as Microsoft Excel and Google Sheets can also be used to construct graphs which are useful for visual representations in the folio.

Research: secondary sources

Shutterstock.com/connel

Shutterstock.com/Dean Drobot

FIGURE 1.7 Secondary sources are sources that have already been published, for example books and information on the Internet.

Secondary sources include information published on the Internet, in books, in newspapers and other media sources. Secondary sources must be referenced.

Secondary research could involve searching for relevant information on latest trends in food product development, new or improved raw materials, components and processing techniques that can be used to address the Food & Nutrition problem. It is important to use an efficient note-taking method, for example a graphic organiser, to make summaries. Using a graphic organiser such as a summary wheel, PMI or concept map for analysis is a good way to decrease the possibility of **plagiarism** as it assists in using dot points from research. Plagiarism must be avoided.

plagiarism the use of someone else's work that you pass off as your own

The Harvard referencing system is a popular method of referencing. Use this or your school's preferred system for in-text referencing, which is required for the folio.

Synthesise information and data

After extensive research there is a lot of primary and secondary data and information to make sense of in order to develop alternative solutions. Synthesis is the term given to making sense of raw data and information.

Determine the solution

Once the data has been synthesised and alternative solutions developed, these can be checked against the specifications in the brief. The solution that best addresses the specifications of the brief is the one that should be generated.

Use a graphic organiser such as a concept map, SWOT analysis, problem/solution, decision-making matrix or information web to synthesise the information and data gathered. See NelsonNet for templates to organise secondary research.

WS

Graphic organiser templates

Generate solutions

Solutions may take different forms. A solution is created to address a specific Food & Nutrition problem. Possible solutions include:

- an additional set of experiments to show a food science principle or process in relation to a specific food problem
- an argument to advocate for or against a solution to a particular food problem
- a prototype.

Test the generated solution to assess its feasibility and record the results. This data could be recorded in a graph or table.

Test the solution

After the solution is created, testing is required in terms of:

- quality
- feasibility
- functionality
- reliability.

The results from the tests must be presented as a graph or table. Evidence of testing must be presented in the folio.

Evaluate and refine

The prescribed or self-determined criteria established earlier in the process are used to make judgements about the feasibility of the solution. Use the data generated through experiments, research or from stakeholders to judge the feasibility of the solution.

The judgements made will determine further refinement of the proposed solution to align with the criteria. After considering the data and judgements about the solution, justified recommendations may be able to be made that will further enhance the solution.

All information needs to be communicated to the specific audience or stakeholder. The information can be presented in the folio in a combination of written and visual forms:

- **Visual:** could be presented in a graph or table; photographs taken during experiments, diagrams, sketches and drawings should be fully annotated to show the thinking throughout the process.
- **Written:** written exploration of the problem including justifications, evaluations and recommendations showing the iterative nature of the problem-solving process. Technical language and writing conventions as well as mode-appropriate features need to be applied to the text. The text needs to consider the purpose or context applied in the brief.

2 THE FOOD SYSTEM

How do consumers access nutritional food?

infrastructure
basic structure of the food industry

food system
the combined actions of people, processes and infrastructure to produce food for a population; includes production, processing, distribution, consumption and research and development, taking into account sustainability, food security and waste management

We all need food to survive, and the people, processes and **infrastructure** throughout the global **food system** all play a role in ensuring that a sufficient supply of safe, quality, affordable and nutritious food is available to consumers.

Sectors of the food system

The food system includes the sectors of:

> production, processing, distribution, consumption and research and development. Waste management, sustainability and food protection are overarching principles that have an impact on all sectors of the food system.

Source: Food & Nutrition 2019 v1.1 General Senior Syllabus (c) Queensland Curriculum and Assessment Authority (QCAA), p.1. This syllabus forms part of a new senior assessment and tertiary entrance system in Queensland. Along with other senior Syllabuses, it is still being refined in preparation for implementation in schools from 2019. For the most current syllabus versions and curriculum information please refer to the QCAA website https://www.qcaa.qld.edu.au/.

Waste management, sustainability and protection are known as the 'principles of the food system' in Food & Nutrition.

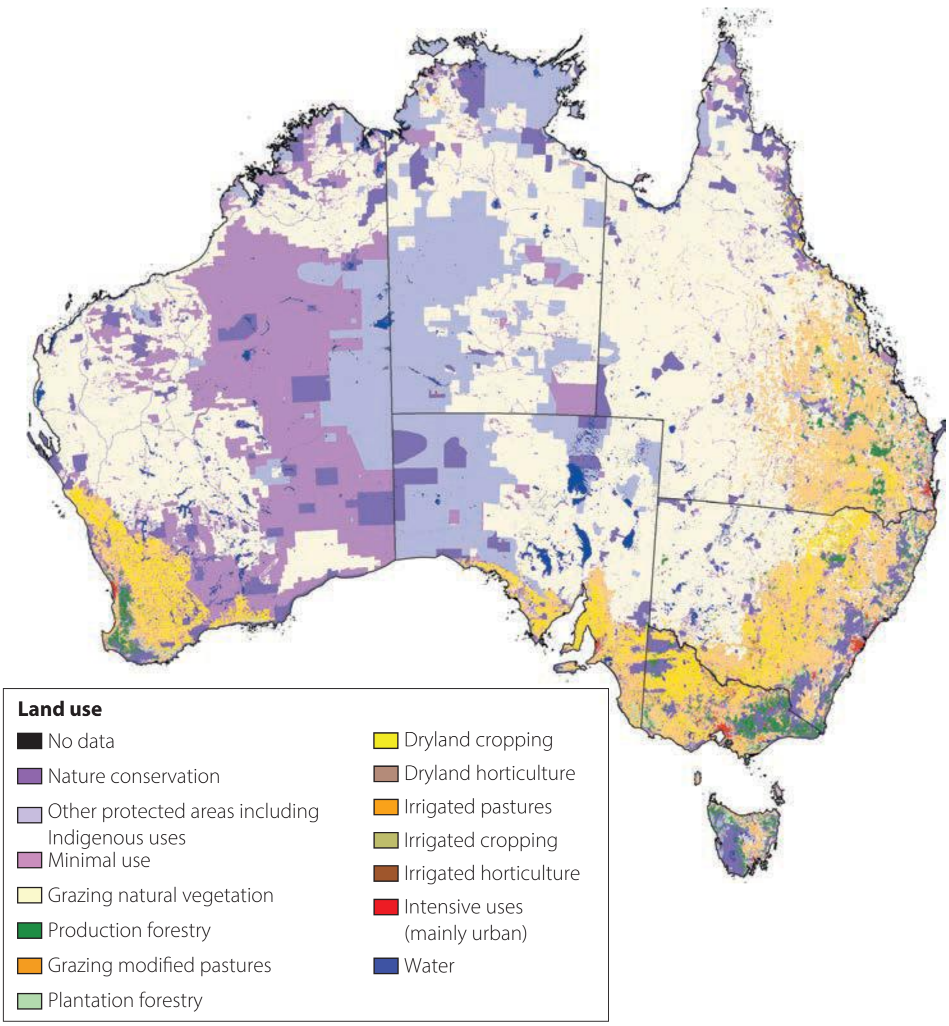
The two topics in the General Food & Nutrition Senior Syllabus related to the food system (Unit 1 Topic 1, 'Introduction to the food system' and Unit 3 Topic 1, 'The food system') have been combined in this chapter of *Nelson Food & Nutrition for QCE*. Year 11 students need to have an understanding of the food system before undertaking the rest of the course, and it is recommended that students revisit the food system at the beginning of Year 12 to consolidate understanding.

FIGURE 2.1 Sectors and principles of the food system

9780170418560

Production

Food production is largely concerned with the activities of the agriculture and fisheries industries. Agriculture involves the nurturing of domesticated animals, or livestock, such as cattle, sheep, pigs, chickens and goats, for meat and dairy products, and the growing and harvesting of plant crops. The fisheries industry is concerned with commercial fishing and aquaculture, which is the controlled farming of fish, shellfish and marine plant species such as kelp and marine algae. Australia has a reputation as a modern, safe, reliable and sustainable producer of food and we are able to export more than half of our agricultural produce. Most of the food we consume is produced domestically – more than 90 per cent of fresh fruits and vegetables, meat, milk and eggs produced in Australia is sold in our supermarkets. Approximately two-thirds of viable land in Australia is used for food production.



Source: Australian Government, Department of Agriculture and Water Resources. Reproduced with permission.

FIGURE 2.2 Land use in Australia

Shutterstock.com/Kartinkin77; Shutterstock.com/Worldpics; Shutterstock.com/Jenoche; Alamy Stock Photo/Chris Putnam

FIGURE 2.3 Stages of meat production

Shutterstock.com/paulinux; Shutterstock.com/Worldpics; Shutterstock.com/135pixels; Shutterstock.com/Tappasan Phurisamrit; Shutterstock.com/Steve Design

FIGURE 2.4 Stages of dairy production

Shutterstock.com/Paul Vinten; Shutterstock.com/Singkham; Shutterstock.com/alexmisu; Shutterstock.com/Subbotina Anna; Shutterstock.com/Tyler Olson

FIGURE 2.5 Stages of plant food production

The CSIRO (Commonwealth Scientific and Industrial Research Organisation) is continually working to solve issues to ensure that the food produced in Australia is healthy, safe and more sustainable.

CSIRO

Processing

Food must often be processed or cooked to make it edible, but some food requires little or no processing if it is to be eaten fresh or raw. Processing can be as simple as harvesting and washing fruit to prepare it for sale, which is an example of primary processing; or processing can involve dramatically altering the physical properties of the food to create a new food product, for example processing apples to make apple sauce, which is known as secondary processing.

Getty Images/Wendy Kirschenbaum/EyeEm

FIGURE 2.6 These apples have been harvested and washed, ready for sale – they have undergone primary processing.

Alamy Stock Photo/Tetra Images

FIGURE 2.7 Apple sauce is an example of the secondary processing of a fruit.

Processing ensures that the food is available and accessible for a larger population and extends the life of the food by destroying or decreasing the growth of microorganisms. The processing of foods is worth the investment because it can increase the value of food. Some foods that are processed are not as nutritionally sound as fresh foods, because additional fat, sugar or other **food additives** are added during food processing.

food additives substances added to food that may enhance flavour and appearance or increase shelf life

Beef: an example of primary processing

Slaughter – The animal is euthanised and the blood is drained ready for processing →
Trimming – The carcass is hung then skinned, and the bone, muscle and fat is cleaned, trimmed and dressed →
Grading – The meat is assessed for colour, tenderness, fat, age, sex and bruising →
Boning – The carcass is cut into different joints and cuts, e.g. rump for beef

Sausages: an example of secondary processing

Mincing – The meat is squeezed through a mincer →
Ingredients – Other ingredients, such as rusk (wheat), seasoning and water, may be added to bind the mince and add bulk →
Additives – Additives for sausages may include preservatives, such as sulphur dioxide and sodium, or flavour enhancers such as yeast →
Filling – The sausage filling is fed into casings, produced from small intestines of pigs or sheep, or manufactured with collagen →
Packaging – The filled casings are trimmed into individual sausages for packaging

FIGURE 2.8 Examples of primary and secondary processing of meat

Milk: an example of primary processing

Separating

The raw milk is heated in a centrifuge and the cream is removed – it can be replaced later

→

Pasteurising

The milk is further heated to 72°C to destroy bacteria

→

Homogenising

Fat is broken up into small particles that do not recombine, to give the milk a consistent texture and taste

Cheddar cheese: an example of secondary processing

Ripening

Bacteria is introduced to the milk, which is cooled to a temperature of 32°C, beginning fermentation

→

Curding

Rennet, an enzyme, is added to form a curd

→

Separating whey and curd

The curd is fermented further, cut and heated to 38°C, to separate it from the whey

→

Draining and texturing

The liquid whey is a by-product and is drained; the curd forms a solid mat

→

Salting and blocking

Salt is added to the curd and it is pressed into blocks of cheese

→

Ageing and packaging

The cheese is stored in cold storage and packaged once the desired age is reached

FIGURE 2.9 Examples of primary and secondary processing of dairy

Wholemeal wheat flour: an example of primary processing

Harvesting

Wheat is harvested

→

Milling

Wheat grains are milled into flour

Bread: an example of secondary processing

Adding ingredients

Yeast and water added to flour

→

Mixing

The flour and other ingredients are mixed together in industrial mixers

→

Dividing

The bread dough is divided into loaves

→

Proving

The dough is left so the gases released by the yeast can make it rise

→

Kneading

The dough is kneaded before being put into individual trays

→

Baking

After further proving the bread is baked in an oven

FIGURE 2.10 Examples of primary and secondary processing of plant foods

9780170418560

Distribution

Distribution includes the transportation, marketing, merchandising and selling of a product.

Transportation

Primary and secondary processed products are transported to retail stores and food services outlets, where they are available to consumers. Consumers expect these products to arrive in perfect condition for their use. Food is distributed internationally using air and sea transport, and domestically using a network of train, road and air transport. Food for consumers is distributed through two main channels – retail and food service. The retail industry distributes food to grocery, convenience and specialised food outlets, while the food service industry distributes food to takeaway and dining restaurants, events or leisure outlets and institutional facilities, such as hospitals, aged care, education and defence facilities.

Getty Images/Image Source

Alamy Stock Photo/Stock Connection Blue

Shutterstock.com/Pierre-Yves Babelon

Shutterstock.com/Nickolay Khoroshkov

FIGURE 2.11 Food can be transported by road, train, sea or air.

Locally grown and produced food is more sustainable. However, food is also imported into Australia from overseas, which is driven by consumer demand. Products may require temperature-controlled transport to ensure freshness, as meat products, fresh produce, frozen foods and fat-based foods will deteriorate quickly if not transported correctly. Regulations set by Food Standards Australia New Zealand (FSANZ) stipulate how food must be transported so it is protected from contamination. Temperature control is used to ensure frozen, refrigerated, dry and hot foods retain their quality and to avoid the growth of bacteria or the formation of toxins. Frozen food must be kept between –30°C and –18°C; refrigerated food must be kept between 0°C and 5°C; dry storage areas must be well ventilated, have controlled humidity levels, and the temperature should not exceed 24°C; hot food must be kept above 60°C. Cold and hot food travelling short distances, such as the distance from a takeaway food outlet to the home of the consumer, may be stored in insulated containers to be kept at the required temperature.

As well as temperature considerations, there are other considerations that need to be taken into account. The vehicle for food distribution should be clean and the journey planned should be the shortest route possible. When the food arrives at its destination it must be unpacked and stored in a temperature-controlled environment or consumed as soon as possible.

FIGURE 2.12 Transportation flowchart for canned vegetables

Marketing, merchandising and selling

In order for consumers to be aware of products and then be able to purchase them, the products must be marketed, merchandised and presented appropriately at the point of sale. The successful marketing and selling of a product is reliant on the marketing mix, that is product, price, promotion and place.

Product

The success of a new product depends greatly on a company having the right product to promote: its product make-up (ingredients and processing methods), the appropriateness and appeal of the packaging, the image associated with the company and its brand name (sometimes referred to as reputation).

Price

The selling price of the product will determine its 'positioning' in the market. Many consumers equate price with quality, but at the same time they are looking for value for money. Setting the right price is important for establishing the correct image for the product.

Promotion

Promotion involves deciding whether and how to inform and educate the consumer about the new product. This may mean media advertising, personal selling sales promotions, sponsorships, packaging and labelling, or a combination of these. In this technological age, promotion follows a new direction through the use (sometimes exclusively) of social media – Facebook, Instagram, Twitter and YouTube. US Greek yoghurt producer Chobani is renowned for its creative use of social media; in addition to posting recipes on its website, Chobani runs a featured blogger series and encourages customers to share ideas. The company aims to respond to every single customer inquiry. Australian company Boost Juice also interacts directly with consumers through social media, running social media contests such as 'What's Your Name Game'.

Place

This involves deciding on the avenues to distribute the product. Some food products, described as 'boutique', may sell only at small specialty shops or delicatessens, while others will be sold widely at supermarkets in all cities and country towns in Australia; and some may be developed solely for export.

Consumption

A consumer is anyone who buys or uses goods and services. Consumers make decisions about purchasing and may be influenced by marketing and advertising. All Australians are consumers.

Consumer trends, such as smaller households, working families and advancing technologies, are driving changes in the sectors of the food system. Consumers are demanding more convenience, which has driven producers to package foods differently, and to consider portion size, versatility and preparation time; and consumers are becoming more discerning about food origins and ethical production.

Australia is an affluent country with an abundance of food available. Australians and people in other affluent countries consume much more food than their bodies need, leading to chronic diseases such as heart disease, high blood pressure, type 2 diabetes and cancers (see chapter 5 for health drivers of food **formulations**). Australians are being urged to align their food consumption with the Australian Guide to Healthy Eating.

Australian Dietary Guidelines

Research and development

Research and development is an essential component of innovation and is carried out by food scientists, technologists and manufacturers to ensure that new products are available for consumers in line with trends in purchasing and consumption. Test kitchens are constantly preparing new food formulations and assessing their **sensory properties** to produce new food products that will be purchased by the discerning consumer. The testing assists with the innovation and development of new products to meet consumer demand. Applied research in scientific or technological fields facilitates future food product development using new or rediscovered ingredients such as **spent grains**, insects and 3D printed food products. World population is rapidly expanding, creating a demand for more food. Research and development is essential to ensure the food industry stays ahead of demand.

Future product development

Innovative or new food products are developed in relation to consumer demand or a perceived gap in the market. Some products are innovative, creative, have new packaging or are new forms of existing **product lines** (reformulated) while others are **line extensions**.

Product strategy development

Market research is carried out for all product line extensions, whether new or reformulated products. The range of products on the market is reviewed to ascertain whether there is a need for a new product. Consumer food consumption trends are analysed to ensure that the new product will meet current or future demands. Consumers are surveyed, and all the results are analysed to decide on the concept or develop the design brief for the new or reformulated product. Prior to a new product being developed, a financial assessment is completed to ensure that the product will be marketable and cost-effective for the producer.

formulations
putting together the food components in appropriate relationships or structures, according to a formula or recipe

sensory properties
properties that can be identified by organs of sense, e.g. appearance, taste, texture, flavour and aroma

spent grains
leftover malt and adjuncts, by-products of breweries

product line
a range of related products made by a manufacturer

line extension
a product added to the product line

market research
collecting information about a section or whole group of the population, in relation to their preferences, characteristics, attitudes, needs, opinions, motivations, behaviour or other relevant attributes

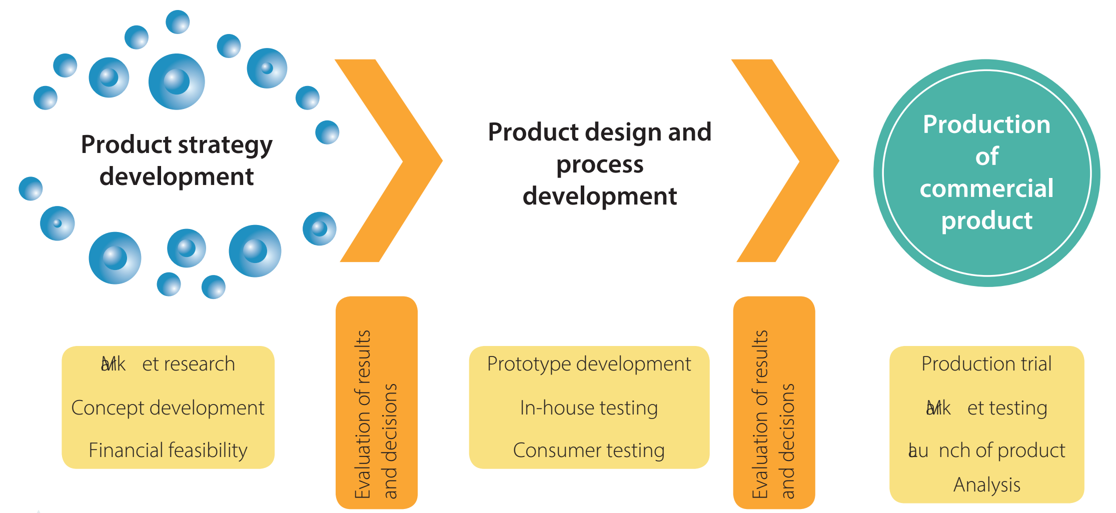


FIGURE 2.13 Food product development

Product design and process development

reformulation formulate a mixture of ingredients in a different way; to alter or revise

A food company develops a prototype which undergoes rigorous testing using a team of in-house food testers to ascertain whether the product will meet the sensory properties required by consumers. The prototype undergoes **reformulation** until the in-house tests find the consumer acceptability suitable to be tested with consumers. External consumers are employed to test the prototype for more research into the product's acceptability. The prototype formulation may be revised to ensure the best possible product. The product must be commercially viable for the food company if it is to be a success.

Production of commercial product

A low-scale commercial run or trial of the product is carried out to test the product in the market. If this is successful, the product is launched by the food company. A launch might involve media advertising, food demonstrators in supermarkets giving out free samples, retail promotions and sponsorship programs. If the product is widely accepted, it will be produced commercially on a large scale. Continued advertising and promotions as well as extended lines of a particularly popular product ensure the longevity of demand. Food product sales are continuously analysed to check market demand and foods are removed from production and sale if they cease to be profitable for the food manufacturer.

REVIEW QUESTIONS ▶

identify distinguish; locate, recognise and name; establish or indicate who or what someone or something is; provide an answer from a number of possibilities; recognise and state a distinguishing factor or feature

1. **Identify** the sectors of the food system.
2. Describe each sector of the food system.

Principles affecting the food system

Sustainability, waste management and protection all affect each sector of the food system. It is important that they are taken into account by producers, processors, retailers and consumers.

Sustainability

The United Nations High Level Task Force on global food and nutrition security (HLTF) defines a sustainable food system as 'a food system that delivers food and nutrition security for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised'. These three dimensions of sustainability – economic, social and environmental – are applied in each sector of the food system and impact on each other. Economic and social sustainability are constrained by environmental limits.

Economic and social sustainability

The food system exists within the economic system of the society in which we live. Australia is a democratic society and capitalism is the overarching economic system in this country and throughout much of the world. As a result, the people and businesses operating within the food system must be able to make a profit from their activities. Economic sustainability within the food system is only possible if the price required for the producers, processors and distributors of food products to make a profit is affordable for the consumers who purchase the food.

Social sustainability includes issues concerning human rights, inequality, health, education, labour and the protection of vulnerable groups. Historically, these issues have been the primary responsibility of governments and charitable organisations, but it is becoming increasingly important for businesses to recognise the impact of their products and help tackle these issues. Within the food system, the food production sector is most significantly affected by a move towards a more socially sustainable future. Food producers have responded by adopting more ethical practices, such as better working conditions and pay for farmers in developing countries under the Fairtrade movement.

ACTIVITY 2.1

Aim

To **identify** and **describe** how the Fairtrade movement contributes to the economic, social and environmental sustainability of the food system

STEPS

1 Read the information below about the Fairtrade movement.

2 Respond to the article by answering the questions that follow.

Alamy Stock Photo/Realimage

FIGURE 2.14 The Fairtrade logo on a chocolate bar

WHAT FAIRTRADE DOES

Fairtrade advocates for better working conditions and improved terms of trade for farmers and workers in developing countries.

It's about supporting the development of thriving farming and worker communities to have more control over their futures, and protecting the environment in which they live and work.

And it's your opportunity to connect with the people who grow the produce that we all depend on.

When consumers purchase products with the Fairtrade Mark, they are supporting farmers and workers as they work to improve their livelihoods and provide better support to their communities. The Fairtrade Mark shows you that the Fairtrade ingredients in the product have been produced by small-scale farmer organisations or plantations that meet internationally agreed Fairtrade social, economic and environmental standards.

FAIRTRADE ®

Fairtrade. Reproduced with permission.

FIGURE 2.15 The Fairtrade logo

The standards include protection of workers' rights and the protection of children, the preservation of the environment, payment of the Fairtrade Minimum Price and an additional Fairtrade Premium to invest in initiatives to support local communities or business development.

Fairtrade benefits small-scale farmers and workers by facilitating links to international markets through the development of supply chains. Small-scale farmers and workers are amongst the most marginalized groups globally and through Fairtrade they can lift themselves out of poverty to maintain their successful livelihoods.

Some products, such as coffee, cocoa and cotton, can only be certified by Fairtrade if they come from small-scale farmer organizations. By working through democratic organizations of small-scale farmers, Fairtrade offers rural communities the stability of income which enables them to plan for the future and invest in developing their organisation.

For some products, such as bananas and tea, Fairtrade can certify plantations (companies that employ large numbers of workers on large areas of land called estates). Standards for large-scale production differ from those for small-scale farmer organisations by focusing on the protection of workers' basic rights; keeping them safe and healthy, allowing them freedom of association and collective bargaining, preventing discrimination and ensuring no bonded or illegal child labour is present. Fairtrade Standards also require employers to pay wages that progress towards living wage benchmarks. Advocating for fair working conditions and worker rights is integral to Fairtrade's mission.

What makes Fairtrade different?

Fairtrade supports farmers and workers in gaining more from trade and through this they are empowered to control their lives. It is an alternative approach that is based on partnership; one between those who grow our food and those that consume it.

FAIRTRADE IS 50 PERCENT OWNED BY PRODUCERS

Fairtrade works with a range of stakeholders but our global system is 50 percent owned by producers representing farmer and worker organisations. With an equal voice, producers have a say in decision-making within our General Assembly and on Fairtrade International's Board of Directors. Through the Board and its committees, they are involved in decisions on overall strategy, use of resources and setting prices, premiums and standards.

FAIRTRADE MINIMUM PRICE

For most Fairtrade goods there is a Fairtrade minimum price which is set to cover the cost of sustainable production for that product in that region. If the market price for that product is higher that our minimum price, then producers should receive the market price. Payment of the minimum price is regularly audited and checked by FLO-Cert. This acts as a vital safety net for farmers and workers and protects them from fluctuations in the market prices of the products they grow for a living. This protection ensures they can have an assured and stable income and plan for their future. Fairtrade is the only certification scheme that offers this unique minimum price protection for farmers.

FAIRTRADE PREMIUM

Over and above the Fairtrade minimum price, the Fairtrade Premium is an additional sum of money which goes into a communal fund for workers and farmers to use – as they see fit – to improve their social, economic and environmental conditions.

Producers determine what is most important to them; whether this is education or healthcare for their children, improving their businesses or building vital infrastructure such as roads and bridges for their community.

Source: Fairtrade. Reproduced with permission.

Conclusions

1 **Identify** how the Fairtrade movement is a) economically, b) socially and c) environmentally sustainable.

2 **Describe** how the Fairtrade movement contributes to sustainability in the food system.

Taking it further

3 **Explain** how the Fairtrade movement impacts on the sectors of the food system.

9780170418560

Environmental sustainability

The food system as a whole requires inputs from the environment, such as land, air, water and energy, and it outputs greenhouse gases that contribute to global warming, pesticides, fertilisers, waste water, packaging and food waste into the environment. Environmental sustainability is about making decisions to protect the environment by conserving an ecological balance that manages the inputs and outputs of the food system and avoids the depletion of natural resources.

Waste management

The purpose of waste management is to limit the environmental and health impacts of the disposal of surplus food products or packaging. The Australian Government Department of the Environment and Energy monitors food waste and has developed a national waste policy that aims to limit waste and apply a universal waste management policy to the food system in Australia.

ACTIVITY 2.2

Aim

To **recognise** and **describe** a waste management policy

STEPS

1 Read the information about the national waste policy.

2 Answer the questions that follow.

FIGURE 2.16 Waste management in Australia

① Supporting efficiency and innovation in agriculture

Key players: Australian Government, state and territory governments, primary producers, academic institutions.

In Australia food that does not make it to the consumer can result from weather, pest and diseases or not meeting market specifications. Some businesses have identified opportunities to use unwanted produce – for example, turning broken or bent carrots into packaged carrot sticks for sale in supermarkets.

② Assessing food ordering, transport and storage practices

Key players: food and grocery retailers, primary producers.

Food and grocery retailers are assessing their supply chains to maximise the shelf life of food and to improve their ordering systems so that the food ordered accurately reflects demand.

Households should consider the food they buy and how they store it. They should only buy what is needed and use 'best before' and 'use by' dates effectively.

③ Using packaging effectively and sustainably

Key players: food processing and manufacturing industries, state and territory governments, Standards Australia, Australian Government.

Effective use of packaging can increase the shelf life of food products but it can also make food waste unsustainable for composting if it is not disposed of separately. The Australian Government partners with other jurisdictions and industry through the Australian Packaging Covenant to improve packaging design and increase the recycling of packaging.

④ Encouraging partnerships between food and grocery retailers and charitable organisations

Key players: food and grocery retailers, food rescue organisations.

Major food and grocery retailers in Australia have partnered with food recovery organisations and committed to reducing the amount of food waste that goes to landfill. This means retailers can meet their food waste reduction goals and also help charities to alleviate poverty and reduce food insecurity.

⑤ Conducting household education and community initiatives

Key players: state and territory governments, local governments, not-for-profit organisations.

A number of state and territory governments have invested in public education campaigns to reduce food waste. Some local councils are also encouraging home composting by providing their residents with home compost bins or offering a rebate on composting equipment.

⑥ Diverting food waste from the commercial food sector

Key players: state and territory governments, commercial food sector, academic institutions, not-for-profit organisations.

Queensland, Western Australia and South Australia have piloted programs to turn food waste from commercial kitchens into compost or fertiliser. Businesses save money because they no longer have to pay landfill fees. Tools for businesses to self-assess their food waste practices have also been developed, including the Royal Melbourne Institute of Technology's DIRECT, the 'Dynamic Resource Efficiency Calculation Tool'.

7 Investing in alternative treatment technology and infrastructure

Key players: state and territory governments, private sector, Australian Government.

A number of states are upgrading their waste treatment infrastructure, particularly for organic waste. For example, in May 2017 a large scale biodigester was opened in Western Australia to treat food waste, generate electricity and produce compost for agricultural uses. These investments are often funded through landfill levies.

8 Finding incentives for alternatives to disposing of food waste in landfill

Key players: state and territory governments, waste management sector, private sector.

Because landfill is relatively cheap in Australia compared to other parts of the world, it can be difficult to make alternative food waste treatment technologies cost effective. To address this problem, most states and territories have introduced levies or fees to dispose of organic waste to landfill. This makes alternative treatment methods such as biodigestion and composting more cost effective options for businesses.

9 Creating value from food waste

Key players: academic institutions, Australian Government research institutions, private sector.

A number of research and development activities are taking place to find the best value uses for food waste. Research organisations, including CSIRO Agriculture and Food, are supporting the development and commercialisation of new bio-products.

10 Standardising data to measure food waste and track its reduction

Key players: waste management sector, state and territory governments, private sector, Australian Government.

Standardising waste data will allow more consistency between the states and territories and is supported by the food industry. The Australian Government can assess where national standards will make a difference – for example, where standards can be used to reduce the costs associated with meeting different state and territory requirements.

Source: Department of Environment and Energy, environment.gov.au,

Conclusions

1 **Identify** how Australians can reduce food waste. **Define** the government role in food waste reduction.

2 **Consider** how you as an individual contribute to food waste reduction.

define
give the meaning of a word, phrase, concept or physical quantity; state meaning and identify or describe qualities

consider
think deliberately or carefully about something, typically before making a decision; take something into account when making a judgment; view attentively or scrutinise; reflect

Protection

Food protection is ensuring that the food supplied to consumers is safe to eat. Protection encompasses not only the natural microorganisms that could cause food to be unsafe for consumption, but the errors or failures in the food system, such as the deliberate tampering with food to make it unsafe.

Individuals preparing food need to be aware of the preparation and storage rules that apply to food to prevent food poisoning. There are many preventable cases of food poisoning that occur in Australia each year. Following simple procedures, such as washing hands, preparing food separately so as not to cause cross-contamination and storing food correctly, will go a long way towards preventing these cases.

The Australian public is protected by a series of Acts, guides, rules and regulations that are enforced across the food industry. These protections are designed to prevent contamination by foodborne illnesses, such as gastroenteritis, non-gastrointestinal illnesses, and contamination by foreign materials such as string, plastic and glass or chemicals, including additives and pesticides, during production, processing, distribution and storage.

Federal, state and local protection

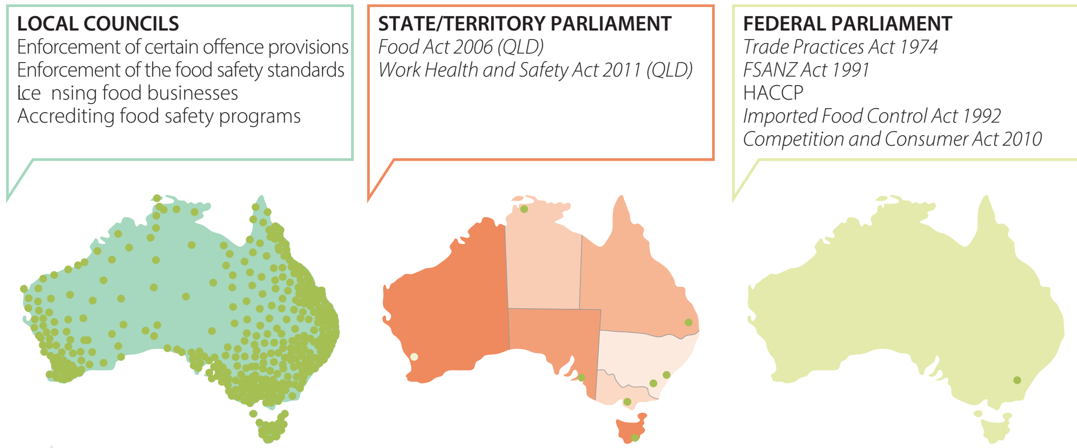


FIGURE 2.17 Food protection legislation at local, state and federal levels

At a Federal level, Food Standards Australia New Zealand (FSANZ) is responsible for regulating the Australia New Zealand Food Standards Code, which is the overarching standard for food safety in Australia.

FSANZ

At a state level the *Food Act 2006 (QLD)* requires that food sold in Queensland is safe and suitable for human consumption, and meets all standards set out in the Food Standards Code. Food safety in Queensland is a joint responsibility of QLD Health and local government.

At a local level, Environmental Health Officers are employed by local councils responsible for food business registration, monitoring compliance, providing education and advice, and they take enforcement action when needed.

Some city councils have a coding system to ensure that it is clear to consumers which businesses are safe places to eat. The Brisbane City Council has a safety star rating for all food premises. The food safety star rating system is enforced by Environmental Health Officers who in 2016 issued more than 400 fines to local businesses. There are more food businesses operating in Brisbane now and the council does not tolerate unsafe food practices. Non-compliant businesses are shut down until the safety breach is rectified. Each business inspected is issued a food safety star rating. Other councils in Queensland also inspect and issue food safety star ratings. These ratings can be displayed on the window or in an area visible by customers.

FIGURE 2.18 Food safety star ratings, such as Eat Safe Brisbane, help protect and inform consumers

HACCP

HACCP, which stands for Hazard Analysis and Critical Control Point, is a safety system to ensure that food is safe for human consumption. HACCP provides a formal method for businesses to manage the safety of food as it progresses through the different stages of production.

The HACCP principles enable food producers, manufactures and retailers to:

- check every stage of production and identify hazards that could occur
- note where the hazards pose a high risk
- take steps to prevent, remove and reduce hazards
- monitor the control points to ensure adequate measures are taken to ensure food safety
- monitor where serious problems occur and take steps to address the problem
- use documentation to demonstrate all steps in the process.

Food – a chemically complex mixture of substances

'Food' is the word used to describe a chemically complex mixture of substances that organisms consume to maintain life. Nutrients are the substances in food that are used by the body for growth, maintenance and repair, and food is mostly composed of these substances. Small amounts of other substances, such as fibre, phytochemicals and pigments, which affect the properties of food and can be beneficial, neutral or harmful to the human body, make up the rest of the chemical composition of food.

Nutrients

Nutrients can be split into macronutrients and micronutrients. The macronutrients of protein, carbohydrate, fat and water make up around 97 per cent of a food's mass, and, with the exception of water, provide the body with the energy to live. Water may not provide the body with energy, but it is classified as a macronutrient because it makes up such a large portion of the chemical composition of food (fruits and vegetables can be up to 96 per cent water), and it is of vital importance to many functions of the human body. Vitamins and minerals are micronutrients, which are consumed in such small amounts they are measured in micrograms rather than grams. Vitamins and minerals do not provide the body with energy, but they perform important and specific functions in the human body, including facilitating the release of energy from protein, carbohydrate and fat.

The chemical and physical properties of foods cause them to react differently during food preparation when heat, cold, acids or alkalis are applied. Changes in food often increase the palatability of the food, while other changes and time may cause food to be inedible.

Protein

Protein is the nutrient responsible for growth and repair of the body. Proteins come from both animal and plant sources. Animal sources of protein include meat and dairy; and plant sources include soy, legumes and nuts.

Carbohydrate

Carbohydrate is a nutrient consisting of carbon, hydrogen and oxygen. Carbohydrate provides heat and energy for the body to function. Complex carbohydrate-based foods contain starch and include cereals, pasta, bread and potatoes, while simple carbohydrates include sugar found in sweets and desserts.

Fat

Fat is a concentrated source of energy for the body and consists of chains of fatty acids and glycerol, made up of carbon, hydrogen and oxygen. Fat can be classified as saturated and unsaturated. Food sources of saturated fat include animal fat and coconut oil. Food sources of unsaturated fat include vegetable oils.

Vitamins

Vitamins are nutrients that are essential for specific functions in the body. Each of the 13 different vitamins has its own specific role in the human body and vitamins are grouped according to whether they are water or fat soluble. The fat-soluble vitamins discussed in the course of Food & Nutrition are vitamins A, D, E and K, and the water-soluble vitamins discussed are vitamins B1, B2, B3 and C. Vitamins are complex organic compounds and are easily destroyed by heat, light and chemicals.

Minerals

Minerals have the simplest chemical structure of all the nutrients. Each mineral is itself a chemical element, so it not made up of atoms from other elements. This means minerals, while they can be broken down into single atoms, retain the same chemical composition. Minerals and water are known as inorganic nutrients because they do not contain carbon. There are 16 minerals currently known to be essential to human nutrition, but only calcium, sodium and iron are studied in depth in Food & Nutrition.

Water

Water is an essential nutrient for the body, made up of hydrogen and oxygen with the chemical formula H_2O. It is required by the body every day and makes up 50 to 80 per cent of the body mass, depending on age, gender, weight and health. The body requires water for all cells, organs and for tissue functioning. Water regulates body temperature and maintains other bodily functions, such as digestion, absorption, creation of saliva and transportation of other nutrients. Humans lose water from the body through breathing, sweating and digestion, and require fluids and foods with a high water content to rehydrate.

The recommended intake of water ranges from 2.3 litres to 2.6 litres per day.

Under-consumption of water results in thirst and a dry mouth. If water is not ingested, the symptoms can worsen, resulting in headache, constipation, dizziness, mood changes and muscle cramps. Long-term effects of dehydration may include gaining weight, as it slows the metabolism, resulting in fatigue, kidney failure, heat injury and eventually death.

Excess water intake can cause hyponatremia, but it is rare; the body self-regulates water consumption so there is little incidence of over-consumption.

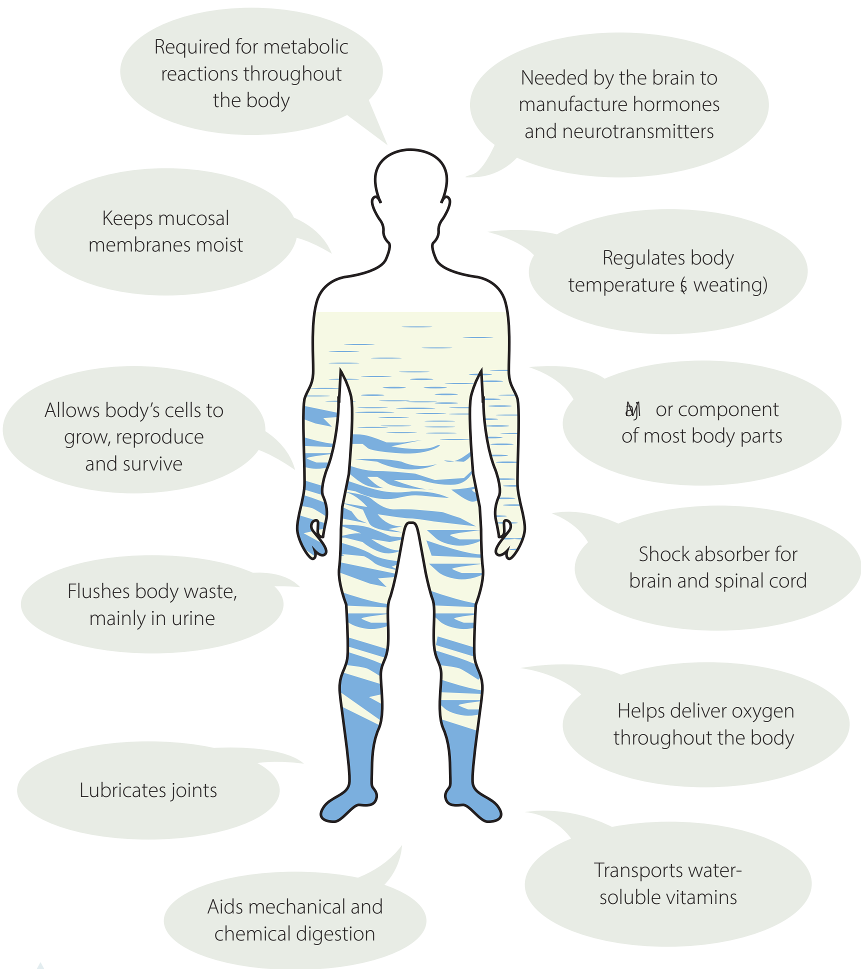


FIGURE 2.19 Functions of water in the body

Interrelationships between nutrients

Combinations of various foods will either enhance or inhibit the absorption of particular nutrients. In some cases, one nutrient depends on another for it to be absorbed or to perform a task. So, a balanced diet, including a variety of foods from many sources, is essential to overall good health. Here are some examples of how certain nutrients work when consumed together.

Iron and vitamin C

The body's ability to absorb iron can be increased by approximately 30 per cent by consuming vitamin C (also known as ascorbic acid) at the same time. Iron and vitamin C work together in the synthesis of red blood cells, as iron is a vital part of haemoglobin, found in red blood cells, and vitamin C is essential for the integrity of the blood vessels. So, when eating iron-rich foods it is best to consume foods that are rich in vitamin C, like citrus fruits or greens, at the same time. While vitamin C greatly increases iron absorption, this is true only when consuming iron-rich foods, such as red meat, green leafy vegetables or whole grains. There are no proven benefits to taking multivitamin or mineral supplements. Another option is to take pure, pharmaceutical-grade ascorbic acid, which comes in a powder, with a meal containing iron-rich foods.

▶ The relevant facts and principles about each nutrient studied in Food & Nutrition, including the functions, classification, nutrient reference value (NRV), food sources and health impacts of over- and under-consumption are found at the beginning of the chapter related to each nutrient, as indicated in Table 2.1.

Calcium and vitamin D

Vitamin D promotes the absorption of calcium. Without vitamin D we cannot make use of the calcium in food, resulting in weak bones and teeth. Vitamin D can be synthesised in the skin when exposed to ultraviolet (UV) light from the sun, or can be supplied in the diet from foods such as fish oils. Consuming fish and dairy foods at the same time helps the body absorb the optimum amount of these micronutrients.

During the four units of this course, all the nutrients and their chemical, physical and functional properties will be explored in detail in order to produce viable and innovative food solutions in response to food and nutrition problems.

Table 2.1 Summary of classifications of nutrients

NUTRIENT	CHAPTER IN THIS BOOK
Vitamins Fat soluble, including vitamins A, D, E and K Water soluble, including vitamins B1 (thiamine), B2 (riboflavin), B3 (niacin) and vitamin C	Chapter 3, p. 35
Minerals Including calcium, sodium and iron	Chapter 3, p. 37
Protein	Chapter 4, p. 70
Carbohydrate	Chapter 10, pp. 230–2
Fat	Chapter 11, pp. 274–6
Water	Chapter 2, p. 27

Health benefits of different food models

The types of food chosen by consumers to eat is dependent on the availability of food within the food system. With a large variety of raw and processed foods available, food choices become difficult for consumers. Education about good food choices is paramount to ensure that consumers choose foods that will benefit their health and wellbeing. How we produce, process, distribute and consume food correlates with health problems related to over- and under-consumption of food.

The Australian Government has developed health policies to ensure consumers are following the Australian Dietary Guidelines. The Australian Guide to Healthy Eating is a food selection guide which visually represents the proportion of the five food groups recommended for consumption each day in the Australian Dietary Guidelines.

Australian Dietary Guidelines

The Aboriginal and Torres Strait Islander Guide to Healthy Eating was adapted from the Australian Guide to Healthy Eating. It was developed after consultation with many stakeholders who believed that a targeted approach would improve the health of the Indigenous people of Australia.

State governments also have their own campaigns. For example, the Queensland Government has introduced a series of materials to educate Queenslanders about the benefits of healthier living as part of the 'Healthier. Happier.' campaign. This campaign, which has a website and series of advertisements to educate consumers, aims to change the habits of Queenslanders so that Queensland becomes the healthiest state.

Queensland Government Healthier. Happier.

The Smart Choices traffic light system has been developed by the Queensland Government to communicate to school students in Queensland the recommendations in the Australian Dietary Guidelines and Australian Guide to Healthy Eating.

9780170418560

Australian Guide to Healthy Eating

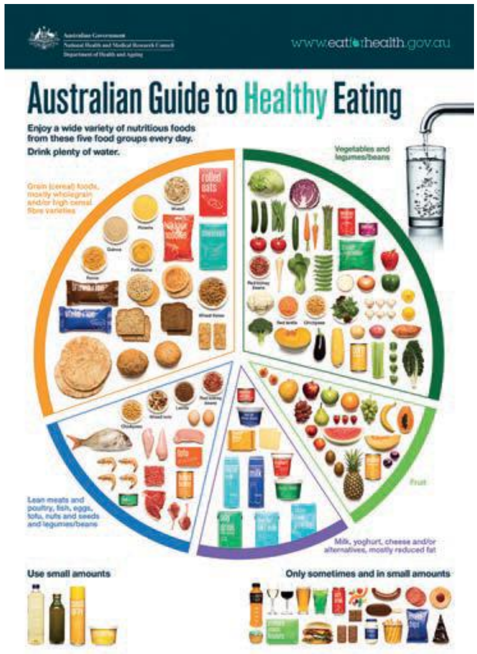


FIGURE 2.20 Australian Guide to Healthy Eating

Australian Guide to Healthy Eating

ACTIVITY 2.3

Aim

To **investigate** the Australian Guide to Healthy Eating

investigate carry out an examination or formal inquiry in order to establish or obtain facts and reach new conclusions; search, inquire into, interpret and draw conclusions about data and information

STEPS

Refer to the Australian Guide to Healthy Eating and answer the questions below.

Conclusions

1 a **Identify** the recommended number of serves of i) lean meat, ii) poultry, iii) fish, iv) milk and milk alternative food groups for adolescents aged between 14 and 18 years.

   b **Explain** the reasons for these recommendations.

2 a **Identify** the number of serves of i) vegetables, ii) legumes and iii) fruit for adolescents aged 14 to 18 years.

   b **Explain** the reasons for these recommendations, referring to the health of Australians.

3 a **Identify** the recommended number of serves of grain foods for adolescents aged 14 to 18 years.

   b **Explain** the reasons for this recommendation.

4 Refer to the 'Use small amounts' and the 'Only sometimes and in small amounts' foods.

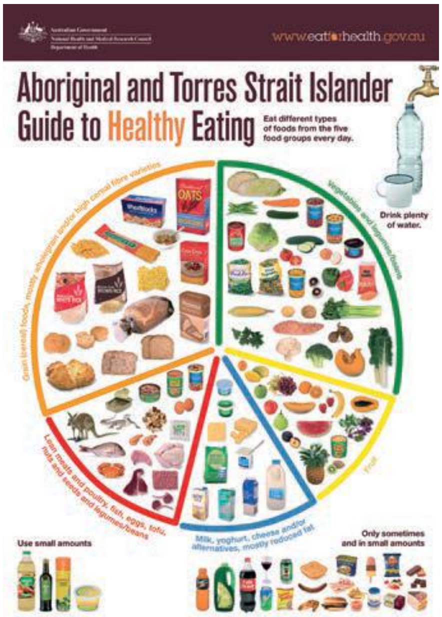
   a **Identify** the foods in 'Use small amounts' and 'Only sometimes and in small amounts' foods.

   b **Identify** whether the foods included in these groups are predominantly fat or carbohydrate-based foods.

   c **Justify** their positioning in the guide and **explain** why their intake should be limited.

justify give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable

Aboriginal and Torres Strait Islander Guide to Healthy Eating



Aboriginal and Torres Strait Islander Guide to Healthy Eating

FIGURE 2.21 Aboriginal and Torres Strait Islander Guide to Healthy Eating

ACTIVITY 2.4

Aim

To **investigate** the Aboriginal and Torres Strait Islander Guide to Healthy Eating

STEPS

Refer to the Aboriginal and Torres Strait Islander Guide to Healthy Eating and answer the questions that follow.

Conclusions

compare display recognition of similarities and differences and recognise the significance of these similarities and differences

1. **Compare** the recommendations of the guide for the carbohydrate and fat-based foods between the Australian Guide to Healthy Eating and the Aboriginal and Torres Strait Islander Guide to Healthy Eating.
2. **Explain** why there might be a difference in the guides.
3. **Identify** the serving amounts of each group for Indigenous adolescents aged between 14 and 18 years.
4. **Explain** the reasons why these recommendations are made to Indigenous Australians.
5. **Explain** how these guides assist consumers to eat a healthy diet.

9780170418560

Smart Choices

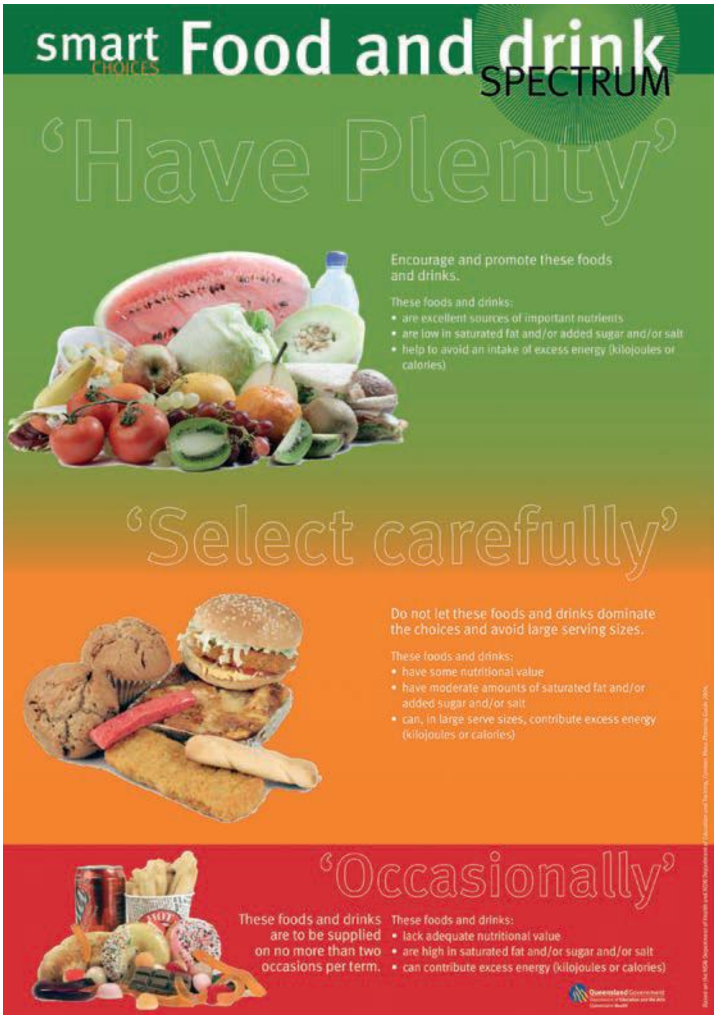


FIGURE 2.22 Smart Choices guide

Smart Choices

ACTIVITY 2.5

Aim

To **investigate** the Smart Choices guide

STEPS

Refer to the Smart Choices guide and answer the questions that follow.

Conclusions

1 **Identify** where a) lean meat, b) poultry and fish, c) pulses and lentils, and d) milk and milk alternatives are located in the Smart Choices guide.

2 **Explain** why a) lean meat, b) poultry and fish, c) pulses and lentils, and d) milk and milk alternatives are located in that section of the Smart Choices guide.

REVIEW QUESTIONS ▶

discuss
examine by argument; sift the considerations for and against; debate; talk or write about a topic, including a range of arguments, factors or hypotheses; consider, taking into account different issues and ideas, points for and/or against, and supporting opinions or conclusions with evidence

1 **Identify** the six food nutrients.
2 **Identify** a function for each food nutrient.
3 **Explain** why the following statement is correct: 'Food is a chemically complex mixture of substances'.
4 **Compare** the food models and identify the recommended serves of each food group according to the food model.
5 **Identify** the health benefits for Australians of implementing the recommendations on the food models of the Australian Guide to Healthy Eating and the Smart Choices policy.
6 **Discuss** whether the policies implemented by the government have had a positive impact on the health of Australians.

Mind mapping template

Mind mapping tools

How do consumers access nutritional food?

Create a mind map of information to help answer the guiding question. Use the supplied template or develop your own mind map. You may find it useful to use online tools such as Bubbl.us, Canva, Coggle, MindMup, iMindQ.

UNIT 1 FOOD SCIENCE OF VITAMINS, MINERALS AND PROTEIN

In this unit, students explore sectors of the food system and the nutrient elements that make up our food (see chapter 1). They explore fundamentals of food science through practical investigation of the nutritional and scientific properties of vitamins, minerals and protein in foods. Students use the Food & Nutrition problem-solving process to build knowledge and develop and test ideas using a range of experimental techniques to create solutions. Students solve problems for consumer markets by defining and analysing the problem, developing ideas, and generating and evaluating a solution.

In Topic 1, students identify and understand relevant sectors of the food system and how food is developed, produced, processed, transported, stored and distributed. They become aware of the nutrients found in food, and their functions, sources and recommended values to support health (see chapter 1). In Topic 2, students explore, through experimentation, how processing and preservation techniques affect the bioavailability of vitamins and minerals. Topic 3 provides students with the opportunity to discover, through experimentation, how protein interacts with temperature and physical manipulation to produce nutritional food products. In Topic 4, students have the opportunity to solve a problem related to the formulation of a food solution using the chemical, functional and nutritional properties of vitamins, minerals and protein in foods.

STUDENTS WILL

1. recognise and describe facts and principles related to the nutritional, chemical, functional and sensory properties of vitamins, minerals and protein-based food
2. explain food science ideas and problems related to vitamins, minerals and protein-based food
3. analyse problems, information and data related to the properties and processing of vitamins, minerals and protein-based food
4. determine solution requirements and criteria for vitamin, mineral and protein-based food problems
5. synthesise information and data to develop ideas for vitamin, mineral and protein-based food solutions
6. generate vitamin, mineral or protein-based solutions to provide data to determine the feasibility of the solution
7. evaluate and refine ideas and solutions to make justified recommendations for enhancement of vitamin, mineral or protein-based food solutions
8. make decisions about and use mode-appropriate features, language and conventions for particular purposes and food and nutrition context.

Food & Nutrition 2019 v1.1 General Senior Syllabus, p. 19.

Shutterstock.com/StudioPhotoDFlorez, TheFarAwayKingdom, Africa Studio

3 VITAMINS AND MINERALS

How can food processing and preservation alter the bioavailability of vitamins and minerals?

Foods rich in vitamins and minerals are essential for human life, health and wellbeing, and are called **nutrient-dense** foods. The most nutrient-dense natural foods include vegetables, fruit, grains, fish and lean meats. This chapter examines the availability of vitamins and minerals naturally existing in foods and how processing can change their **bioavailability**. The chapter also examines techniques to retain and enhance supply of vitamins and minerals to people around the world.

nutrient-dense foods that are high in nutrients such as vitamins, minerals, complex carbohydrates, lean protein and healthy fat, and generally lower in kilojoules or energy

bioavailability the degree to which nutrients in food are available for absorption and use in the body

Shutterstock.com/margouillat photo

FIGURE 3.1 Nutrient-dense foods include vegetables, fruit, grains, fish and lean meats.

Facts and principles about vitamins and minerals

Vitamins

Vitamins are nutrients that are essential for many functions in the body. There are two categories of vitamins:

- **fat-soluble:** found in foods near or in fat. Examples of fat-soluble vitamins include vitamins A, D, E and K
- **water-soluble:** found in foods near or in water. Examples of water-soluble vitamins include B vitamins – B1 (thiamine), B2 (riboflavin) and B3 (niacin) – and vitamin C.

Fat-soluble vitamins

Fat-soluble vitamins dissolve in fat and are absorbed into the blood stream. They are stored in the liver and fatty tissue for an extended period, so the body does not need to consume these vitamins every day. Excess amounts of these vitamins can accumulate in the body over time and lead to toxicity and damage to organs. It is important to eat a balanced diet, rich in a range of vitamins and minerals.

Table 3.1 Fat-soluble vitamins

NUTRIENT	FUNCTIONS	NUTRIENT REFERENCE VALUE (NRV)		FOOD SOURCES	HEALTH IMPACTS OF OVER- OR UNDER-CONSUMPTION
Vitamin A – a common dietary form of vitamin A is retinol	Helps maintain: • normal vision • body growth • immune function • reproductive health	AGE	RDI (μG, AS RETINOL EQUIVALENTS)	• fish liver oil • beef liver • liverwurst • butter • egg yolk • yellow vegetables	Over – • toxicity is rare and caused by excess doses of supplements • liver disease • hypervitaminosis A
		Boys 14–18	900		Under – • dry eyes • blindness • hair loss • skin problems
		Girls 14–18	700		
		Men 19–30	900		
		Women 19–30	700		
Vitamin D – produced in the skin from exposure to sunlight	Good for: • bone health • regulating the immune system	AGE	RDA (MCG)	• fish liver oil • mushrooms • salmon • egg yolk • meat fat	Over – • toxicity is rare and caused by excess doses of supplements • hypercalcemia – excess calcium in the blood
		9+	15		Under – • lowered immune function • slow wound healing • in adults – osteomalacia (soft and brittle bones, weak muscles) • in children – rickets
Vitamin E alpha-tocopherol makes up 90% of this vitamin in the blood	Acts as an antioxidant – protects fatty acids from oxidation	AGE	RDA AI (MG, AS A-TOCOPHEROL EQUIVALENTS)	• wheat germ oil • sunflower oil and seeds • almonds • hazelnuts • avocado • peanut butter • margarine • fatty fish	Over – • toxicity is rare and caused by excess doses of supplements • high doses lead to **oxidative stress**
		Male 14+	10		Under – very rare and not found in healthy people
		Girls 14–18	8		
		Women 19+	7		
Vitamin K	• assists with clotting of blood • supports bone health • assists with prevention of calcification of blood vessels	AGE	AI (MCG)	• parsley • kale • spinach • brussels sprouts • lettuce • egg yolk • butter • liver	Over – no known symptoms
		14–18	75		Under – blood doesn't clot
		Men 18+	120		
		Women 18+	90		

Source: Nutrient Reference Values for Australia and New Zealand, Ministry of Health, www.nrv.gov.au, accessed 8 March 2018. Based on material National Health and Medical Research Council. Released under a CC BY 4.0 AU licence.

μg/day – metric measurement microgram – one millionth of a gram/day
RDI – Recommended Dietary Intake
RDA – Recommended Dietary Allowance
AI – Adequate Intake
mcg – micrograms
mg – milligrams

nutrient reference value
a set of recommendations for nutritional intake based on currently available scientific facts (Australian National Health and Medical Research Council 2017)

oxidative stress
imbalance between the production of free radicals and the ability of the body to detoxify the harmful effects of them

NRVs

excrete
the process of eliminating waste and other non-useful materials from the body, through faeces, urine or sweat

Water-soluble vitamins

Water-soluble vitamins dissolve in water and are not stored in the body. They are **excreted** from the body in urine, so we need a constant daily supply in our diet. These vitamins can be destroyed by heat and can dissolve in cooking water, so it is important to be careful when preparing and cooking foods containing water-soluble vitamins.

Table 3.2 Water-soluble vitamins

NUTRIENT	FUNCTIONS	NUTRIENT REFERENCE VALUE (NRV)		FOOD SOURCES	HEALTH IMPACTS OF OVER – OR UNDER – CONSUMPTION OF NUTRIENT
		AGE	RDI (MG)		
Vitamin B1 – thiamine	• assists with carbohydrate metabolism to supply energy to the tissue • processes fat and alcohol in the body • important for nerves to function properly	Male 14+ Female 14+	1.2 1.1	• pork • other meat • fish • potatoes • beans • nuts • wheat • whole grains (wheat, oats, rice) • occurs in most fruits and vegetables	Over – no adverse effect as it is excreted from the body in urine Under – very uncommon; two conditions (beriberi occasionally seen in alcoholics and Wernicke-Korsakoff syndrome)
Vitamin B2 – riboflavin	• important for the growth and production of red blood cells • helps vision and skin health	Male 14–70 Female 14–70	1.3 1.1	• whole grains • cereals • milk • eggs • green leafy vegetables	Over – no adverse effect as it is excreted from the body in urine Under – rare and usually with other vitamin B deficiencies ariboflavinosis
Vitamin B3 – niacin – the amino acid tryptophan is converted into niacin in the body; niacin is more heat stable and little is lost in cooking	• assists the body to convert carbohydrate, fat and alcohol into energy • maintains skin health • supports the nervous and digestive systems	Male 14–70 Female 14–70	16 14	• meats, fish, poultry, milk, eggs, whole grains, nuts • mushrooms	Over – extra-large doses affect the nervous system – itching, flushing, nausea and potential liver damage Under – pellagra associated with digestive problem where the body does not absorb enough; symptoms include dementia, diarrhea and dermatitis
Vitamin C – ascorbic acid	• protects lipids in human plasma against oxidative damage • aids in the absorption of iron and copper	Male 14–18 Female 14–18 Male 19–70 Female 19–70	40 40 45 45	• blackcurrants • guava • citrus fruits • kiwifruit • broccoli • sprouts	Over – take no more than 1000 mg/day as gastrointestinal effects are seen; less than that no adverse effect as it is excreted from the body in urine Under – rare; however may result in a disease called scurvy, causing a loss of collagen strength resulting in loose teeth, bleeding and swollen gums and poor wound healing

Source: Nutrient Reference Values for Australia and New Zealand, Ministry of Health, www.nrv.gov.au, accessed 8 March 2018. Based on material National Health and Medical Research Council. Released under a CC BY 4.0 AU licence.

9780170418560

Minerals

Minerals are chemical elements in food that are essential for good health. Calcium, sodium and iron are the three significant minerals studied throughout this course. Other important minerals include phosphorus, potassium, magnesium, sulphur, zinc, iodine, chlorine, cobalt, manganese, molybdenum and selenium.

Table 3.3 Minerals

NUTRIENT	FUNCTIONS	NUTRIENT REFERENCE VALUE (NRV)		FOOD SOURCES	HEALTH IMPACTS OF OVER- OR UNDER-CONSUMPTION OF NUTRIENT
		AGE	RDI (MG)		
Calcium	Calcium and vitamin D are required in the diet, along with exercise, to reduce the incidence of bone density loss. Essential for the building and maintaining of bones and teeth in the body which supports the skeletal system. About 99% of the calcium in the body is found in the bones. The remainder of the calcium in the body is used for blood clotting, stabilising blood pressure, regulation of heart function and muscle functioning, contributing to normal brain functioning and communicating essential information among cells	All 1–3 years All 4–8 years All 9–11 All 12–18 Female 19–50 Female 51+ Male 19–70 Male 70+	500 700 1000 1300 1000 1300 1000 1300	• dairy products • eggs • fish with edible bones – salmon and sardines • green leafy vegetables • nuts and seeds	Over – an excess of calcium in the diet increases the calcium in the urine. Urinary calcium rises and increases the risk of kidney stones. Toxic when given in high doses as an antacid, causing hypercalcemia Under – insufficient calcium in a child's diet will result in a disease called rickets which causes the legs to bow as they cannot support the weight of the growing body. Calcium is deposited in the bones and when it is in short supply the body takes it from the bones for other functions. If this occurs the bone density or strength is reduced, resulting in osteoporosis, which is characterised by brittle bones
		AGE	RDI (MG)		
Sodium	Has an essential role in the maintenance of extracellular fluid and cellular membrane potential. The balance of water in and around the cells is important for muscle and nerve functioning. About 90% of sodium intake is excreted in the urine	Male 14–70 Female 14–70		• sodium chloride or salt in processed foods such as cereal products, snack foods • small amounts from food additives such as sodium phosphate, sodium bicarbonate and sodium benzoate	Over – can result in high blood pressure (hypertension) which could lead to stroke, myocardial infarction and chronic kidney disease Under – can cause muscle cramps, nausea, vomiting and dizziness. Not enough sodium in the blood is known as hyponatremia

(*Continued*)

Table 3.3 Minerals (*Continued*)

NUTRIENT	FUNCTIONS	NUTRIENT REFERENCE VALUE (NRV)		FOOD SOURCES	HEALTH IMPACTS OF OVER- OR UNDER-CONSUMPTION OF NUTRIENT
		AGE	RDI (MG)		
Iron	Found in every cell in the body. Eating vitamin C with a meal increases the absorption of iron from food. Essential for the formation of haemoglobin in the blood, which is responsible for transporting the oxygen from the lungs to tissues around the body cells. 2/3 of the iron in the body is found in haemoglobin circulating in the blood. The remaining iron is stored in the liver and muscles and is easily metabolised for use by the body. More iron is required in periods of rapid growth such as early childhood and adolescence and during pregnancy	Male 14–18 Male 19+ Female 14–18 Female 19–50 Female 51+	11 8 15 18 8	• haem iron is found in animal foods and is the best source of iron as it is more readily absorbed by the body – red meat, pork, lamb, kangaroo and poultry, offal such as liver and kidney, fish and shellfish such as salmon, sardines and tuna. • non-haem iron is found in vegetable foods – nuts, green leafy vegetables, whole grain products, dried fruit such as raisins and apricots, dark chocolate	Over – an upper limit of 20 mg is set for iron consumption. Too much iron is toxic and symptoms can range from gastrointestinal irritation to systemic toxicity. An inherited condition known as haemochromatosis causes 0.5% of the population to overload iron amounts. Supplements need to be avoided by this portion of the population. It is only diagnosed when symptoms are present Under – a deficiency of iron in the body will cause a lack of energy and tiredness. It can occur with inadequate intake of iron in the diet and stores in the body. It can also occur when there is insufficient production of red blood cells in the body. This condition is known as anaemia. The symptoms include palpitations, shortness of breath, dizziness and light-headedness. Poor concentration is a symptom of iron deficiency

Source: Nutrient Reference Values for Australia and New Zealand, Ministry of Health, www.nrv.gov.au, accessed 8 March 2018. Based on material National Health and Medical Research Council. Released under a CC BY 4.0 AU licence.

define
give the meaning of a word, phrase, concept or physical quantity; state meaning and identify or describe qualities

describe
give an account (written or spoken) of a situation, event, pattern or process, or of the characteristics or features of something

REVIEW QUESTIONS ▶

1 **Define** fat-soluble and water-soluble vitamins and minerals, and provide examples of each.
2 **Describe** the main functions of the following vitamins and minerals in the body:
   a vitamin A
   b vitamin C
   c iron
   d calcium

9780170418560

3 **Defin** the following terms in your own words:
   a nutrient-dense
   b bioavailability
4 Explain why over-consumption of fat-soluble vitamins can be a concern. Provide examples of health impacts of over- and under-consumption of a range of vitamin and minerals.
5 Propose foods to add to the diet if a person has the following conditions:
   a anaemia
   b scurvy
   c osteoporosis
   d beriberi
   e hypertension

explain
make an idea or situation plain or clear by describing it in more detail or revealing relevant facts; give an account; provide additional information

propose
put forward (e.g. a point of view, idea, argument, suggestion) for consideration or action

Production

Meat and dairy (see chapter 4) and grains (see chapter 10) cannot be consumed raw at the place of production. We cannot pick up a chicken or a kernel of wheat and eat either of them safely or enjoyably – they must first be processed or cooked. However, many fruits and vegetables can be consumed raw and after processing or cooking. An orange can be picked from the tree, peeled and eaten immediately; it can be squeezed for its juice, or it can be boiled in water and added to a flourless orange cake.

FIGURE 3.2 An orange can be eaten raw, processed or cooked.

Processing

Most food is processed in some way prior to being sold to consumers. Most fruits and vegetables have a high water content and start to deteriorate after harvesting, usually leading to food spoilage. Food spoilage is discussed in more detail on page 55. For fruit and vegetables to be sold in their optimum range, at least one of the following processes will usually take place:

- **Cleaning and washing:** removing foreign materials such as twigs, soil, insects, fertilisers and pesticides. Washing is usually undertaken in chlorinated water, in rotary drums, for example washing of apples, pears and potatoes; or in wire cylinders, for example washing of lettuce and spinach.

- **Blanching:** fresh fruit or vegetables are placed in water between 91°C and 99°C for 1–10 minutes. Blanching inactivates the enzymes that cause ripening and food spoilage, and can kill microorganisms.
- **Curing:** food is held between 25°C and 32°C to dry the surface of the food items, usually with the addition of salt, nitrites, nitrates or sugar to draw moisture out and prevent bacterial spoilage. Root vegetables and tubers can be cured to extend shelf life. Curing can also help to protect vegetables with surface scratches or dents.
- **Chemical preservatives:** chemical preservatives can be applied to prevent damage by insects or to control enzymatic activity.
- **Control of temperature:** used to reduce further ripening and spoilage of fruit and vegetables.
- **Regulating humidity:** used to retain freshness and reduce further deterioration.
- **Packaging:** fruit and vegetables are packaged to maintain optimum appearance and marketability. Sulphites are often added to maintain appearance.

Processing can help to retain vitamins and minerals and keep fresh fruit and vegetables in optimum condition. Cooking of food products can help to improve their digestibility and **palatability**. This increases bioavailability as food products are more appealing, accessible and desirable. For example, slow cooking tough meat will make the meat more palatable for human consumption. Soaking legumes overnight enables them to become usable for various food products, thus improving the availability of their vitamins and minerals.

palatability acceptable or agreeable to the palate or taste

However, some processing and cooking of food items can deplete the vitamins and minerals available in the food product. For example, during the processing of bran or other cereals, the fibrous husk is usually removed. The husk contains dietary fibre, B-group vitamins and some minerals, all of which are lost after milling. Heating also destroys some water-soluble vitamins such as vitamin C.

Effect of cooking methods on vitamins and minerals

Cooking can make food more flavoursome and palatable and increase the sensory properties that consumers demand. Cooking plant food can break down the cell walls that would otherwise be indigestible, and it destroys harmful microorganisms and bacteria. In some cases, the bioavailability of nutrients in the raw product is increased through cooking. For example, more phytochemicals produced by plants, such as lycopene in tomatoes, are available after cooking.

There are 12 basic methods of cookery:

- boiling
- stewing
- microwaving
- steaming
- grilling
- roasting
- stir-frying
- braising
- deep-frying
- baking
- **sous-vide**
- poaching.

sous-vide process in which food is placed in a vacuum sealed, plastic pouch and then placed in a water bath for longer than normal cooking times at a regulated temperature much lower than normally used for cooking: intended to cook the item evenly, ensuring that the inside is properly cooked without overcooking to retain moisture

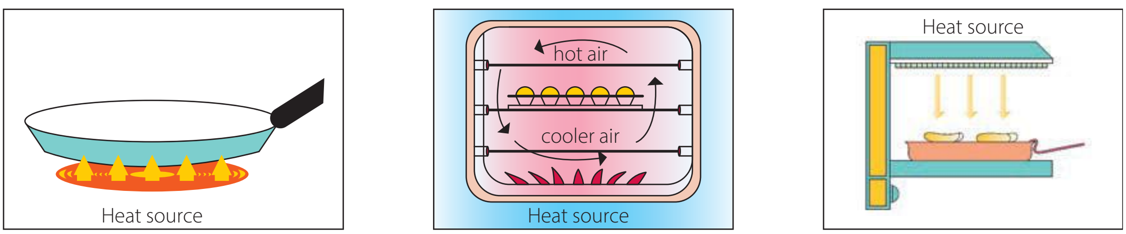


FIGURE 3.3 The three types of heat transference are conduction, convection and radiation. Stir-frying is an example of conduction; baking is an example of convection; and grilling is an example of radiation.

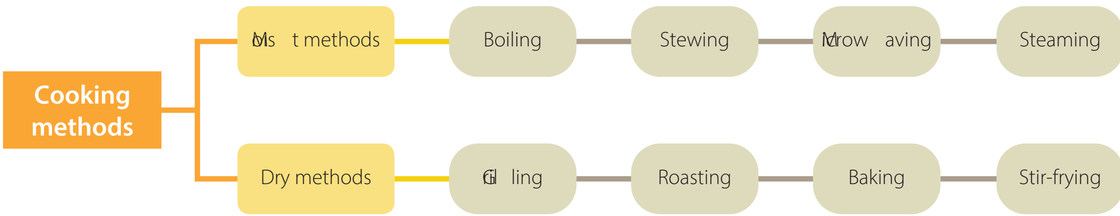


FIGURE 3.4 Cooking methods using moist and dry heat

ACTIVITY 3.1

Aim

To **investigate** and explain how moist and dry heat cookery methods can affect the retention of vitamins and minerals

investigate
carry out an examination or formal inquiry in order to establish or obtain facts and reach new conclusions; search, inquire into, interpret and draw conclusions about data and information

STEPS

In groups or individually, prepare a short presentation on one method of cookery:

- boiling
- stewing
- microwaving
- steaming
- grilling
- roasting
- stir-frying
- braising
- deep-frying
- baking
- sous-vide
- poaching.

1 **Explain** the method of cookery.

2 **Investigate** through research how each method affects the retention of vitamins and minerals of a range of food items.

3 Outline the effect of the cooking method on the sensory properties. If you are unsure of the meaning of any of the sensory properties go to chapter 7, page 169 for more information:
   - appearance
   - texture
   - taste
   - flavour and aroma

4 Present your findings to the class individually or as a group.

Conclusions

1 **Determine** which methods retain the maximum vitamins and minerals in fresh fruit and vegetables and which methods of cookery will lose key vitamins and minerals.

determine
establish, conclude or ascertain after consideration, observation, investigation or calculation; decide or come to a resolution

Taking it further

2 The sensory properties also affect the appeal of food to consumers. Which methods of cookery are most popular in fast food items? **Explain** why these are the most appealing.

3 **Consider** the cooking methods that are best for nutrient retention.

consider
think deliberately or carefully about something, typically before making a decision; take something into account when making a judgment; view attentively or scrutinise; reflect on

Extension of shelf life through distribution pathways

Much of the food that is produced in Australia is grown in agricultural communities, usually in rural and remote locations. The raw produce is then transported to a food producer or distributer before it makes its way to a retailer for sale to the consumer. This means that food may be produced a long way from where it is purchased, often weeks, months or years before it is purchased and eaten by a consumer!

nutritive value a simple measure of the nutrient content of a food

For example, bananas or pineapple grown in Queensland might be transported all the way to Tasmania for purchase in a supermarket in Hobart. Some foods are even grown overseas and imported into Australia for consumption, increasing the time needed to maintain quality of appearance, texture, flavour and **nutritive value**. Various **distribution pathways** are used for transport and movement of food products. Each pathway must meet the needs of the food item, or the food item must be processed and packaged in a way that is suitable for the distribution method. For example, if frozen or refrigerated products are transported, they must be held at the correct temperature. When importing food items, canned or shelf stable items are easier to import due to the extended transport time that is involved.

distribution pathways movement of materials and goods by road, pipeline, air, rail and water

In Australia, much of the food supply is transported by truck, as it is a reliable and efficient method to transport goods between the food processor and the food retailer, and the atmosphere inside the truck can be controlled. Road transport via truck also means that food is able to be delivered to rural and remote communities. Rail transport is also used; however, this makes up a smaller proportion of the food distribution pathway as rail locations are limited and food still needs to be transported to specific locations via truck upon arrival.

Shipping is the main mode of transport for imported foods, provided they have a long shelf life and can be kept stable throughout the journey. Air transport is used for imported products that have a shorter shelf life; however, it is the most expensive mode of transport for importing food items and adds to the cost for the consumer.

Effective packaging and storage during transportation is important to maintain the quality and appearance of food items. Nutrient-dense food items such as fruit and vegetables spoil quickly, so good planning and packaging is essential to maintain quality, freshness and nutritive value. Efficient **logistics** systems and record keeping help to avoid food wastage and spoilage in Australia's distribution pathways.

logistics transport and distribution

After processing, there are three main methods of food distribution, known as distribution channels. The three distribution channels may use different distribution pathways, that is, road, rail, air and water, and sometimes a combination of different distribution pathways.

- **Direct to consumer:** food manufacturer sells directly to the consumer such as at a bakery or farmers markets
- **Selling through retailers:** food manufacturer sells to a retailer such as an Independent Grocer (IGA) or small or large grocery store who sell it to the consumer
- **Selling through a wholesaler:** food manufacturer sells to a wholesaler, who then sells to a retailer and then to the consumer. For example, PFD is a wholesaler that stocks many different products, and a retailer or hospitality business may purchase different products for delivery through a single wholesaler, which saves them time and effort shopping at different stores. This channel may utilise different pathways; for example, foods are imported via water into Australia by the wholesaler. The wholesaler delivers the food items to far North Queensland by rail and then truck to the retailer.

When considering the logistics of transport, manufacturers, wholesalers and retailers must consider the food items and select methods, processing and transportation that will allow food products enough shelf life to reach the consumer in a safe way and still of an acceptable quality.

9780170418560

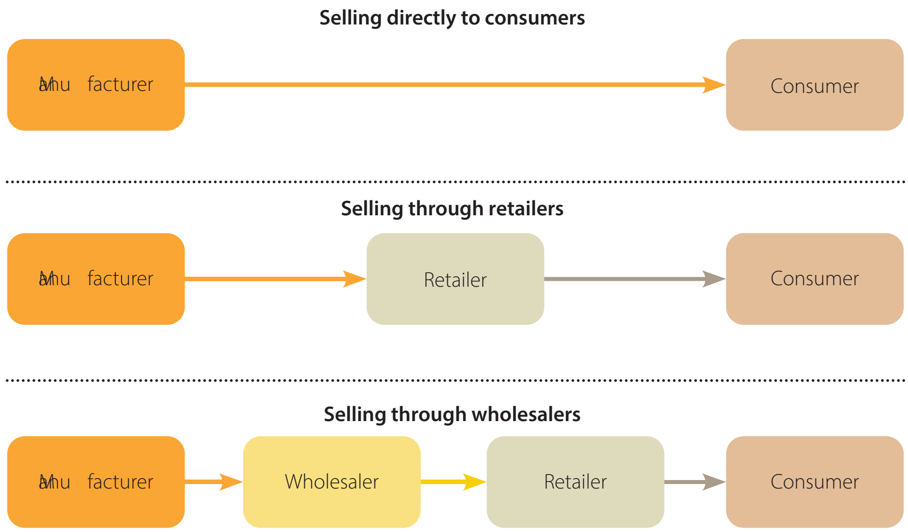


FIGURE 3.5 The main food distribution channels. Different distribution pathways may be used within the one channel.

Reasons for processing foods

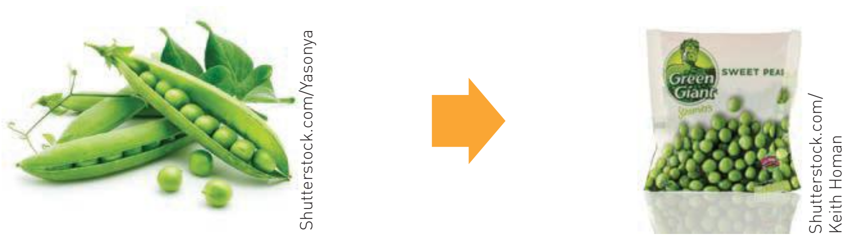
food processing any activity to prepare food for sale, including chopping, cooking, drying, fermenting, heating, pasteurising, thawing and washing, or a combination of these activities (Food Standards Australia New Zealand 2015)

Food processing occurs not only to extend the shelf life of food but also to halt loss of nutritional value and therefore increase the bioavailability of nutrients. For the consumer, the benefits and reasons for food processing include:

- **Convenience:** food processing allows consumers to access a wide range of foods simply and easily, often from just one supermarket. Foods can be processed into convenient packaging, so they can be transported home easily. Most Australians live in cities that are far away from the production of food. Food processing ensures that the food reaches the consumer safely, can be prepared easily and is readily available. There are many processed foods on the shelf for convenience, from bottled pasta sauces to dried soup mix to frozen meals.
- **Cost:** fresh fruit and vegetables can be expensive, and can spoil quickly once purchased. This means wasted food and money. Out-of-season produce is even more expensive, as there are smaller quantities available or the product is imported from another country. Produce can be purchased and processed when it is cheap but sold all year round. Canned or bottled produce can also use cheaper fruits and vegetables that may have been purchased at a cheaper price due to imperfections or blemishes.
- **Access to nutrients:** food processing can be designed to retain maximum vitamins and minerals. This can reduce nutrient loss after processing and increase the value of processed products. For example, vitamin C content has been found higher in frozen corn, green beans and blueberries.
- **Minimise seasonality:** waste can be minimised and foods become available out of season through food processing. For example, berries that may only be available seasonally can be purchased frozen for year-round inclusion in diets and recipes.
- **Minimise pathogen growth cycles:** food processing can ensure that fresh food is safe to eat, particularly perishable items such as dairy and meat. Milk is processed using heat to kill pathogens and provide a safer product to consumers that will last longer before spoiling.

pathogen microorganisms, such as bacteria, fungi and viruses which cause disease

Food processing also occurs due to consumer demand for specific characteristics in food products. Food drivers are discussed in chapter 6.



Convenience
Peas grow in pods; if purchased fresh, consumers need to wash and shell their own peas then store and use them before they spoil. Frozen peas are conveniently located in the freezer for use anytime.

Cost
Peas deteriorate quickly. Freezing means they can be mass produced and sold at a cheaper price due to reduced wastage of fresh product.

Access to nutrients
Peas are 'snap' frozen very quickly after harvest so they retain their nutrient value.

Minimisation of seasonality
Pea plants are sensitive to heat. Peas are best grown at 7–26°C. Fresh peas will last 2–3 days in their pods and 3–5 days in the fridge. Freezing peas can make them conveniently available 12 months of the year with minimal nutrient loss.

Pathogen growth cycles
Freezing dramatically halts bacterial and pathogen growth, meaning food is safe to eat.

FIGURE 3.6 Example of the benefits of and reasons for food processing: peas

Food processing techniques

Food processing techniques are applied to many food products after they leave the farm. Some techniques discussed earlier, such as cleaning, control of temperature and packaging are applied to keep produce fresh for consumption or for further processing.

Food processing techniques are then applied to food items for a range of reasons, as discussed above.

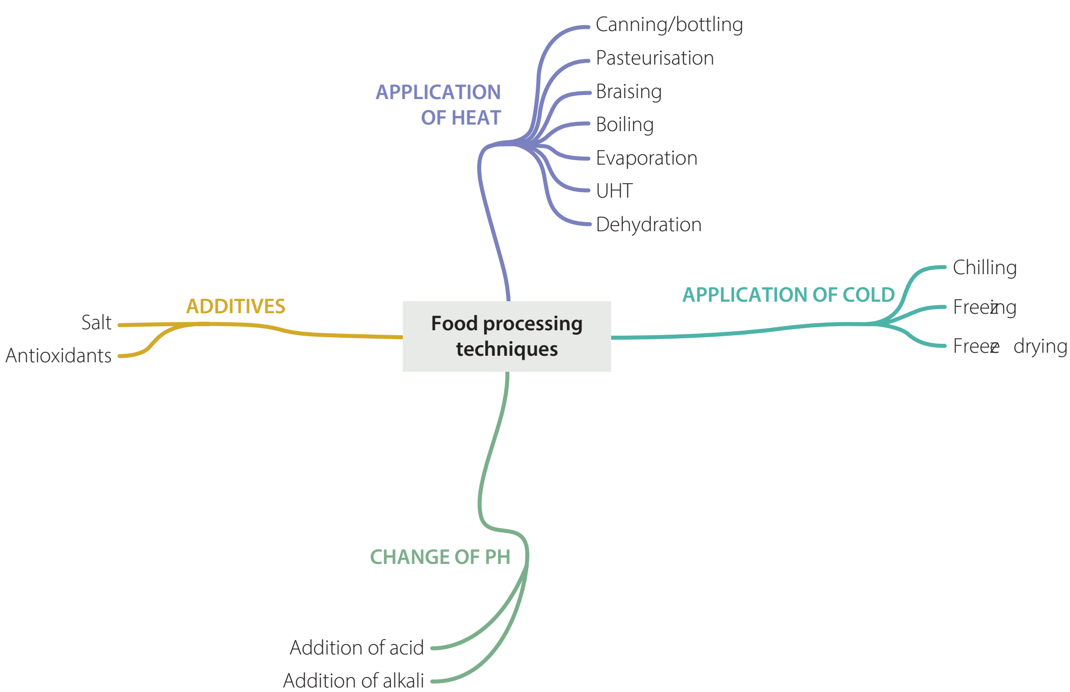


FIGURE 3.7 Food processing techniques used to control accessibility and the consumability of food sources

Food processing techniques are used to control the accessibility and consumability of food products. Multiple hurdles are often used to control microbial growth, extend product shelf life and increase food safety and availability. For example, UHT milk is heat-treated, then sealed in airtight, sterile packaging. Once the packaging is opened and oxygen is introduced, the UHT milk must be stored in the refrigerator (another hurdle) to prolong its life after opening, as oxygen is now available and the milk will spoil much quicker. The table below outlines different processing techniques and typical foods associated with each technique.

Table 3.4 Food processing techniques

	PROCESSING TECHNIQUE	TYPICAL FOODS
Application of cold	**Chilling** • slows the rate of ripening of vegetables and fruit • slows the development of any rot • air can also be modified by reducing oxygen, increasing carbon dioxide levels to slow ripening of foods like apples • does not kill microorganisms or deactivate enzymes • suitable for short-term storage	• most fruits and vegetables, particularly those with a high water content • perishable food items
	Freezing • uses low temperature and reduction of water activity (due to freezing water content into ice) • microorganisms and enzymes are inhibited, but not killed • slows oxidation reactions • pre-treating of some food products is necessary prior to freezing, e.g. blanching to destroy enzymes and microorganisms, preserving vitamins and enhancing colour • items are packaged carefully • freezing must take place quickly, to help maintain cell structure	• peas, beans, corn, cauliflower, broccoli, potato, berries, mango • perishable food items
	Freeze-drying • frozen food is dried using sublimation under a vacuum (ice turning directly to water vapour without becoming liquid first) • food retains volume, but is porous in texture • products need to be dried to approximately 5% moisture content, to inhibit mould and bacterial growth	• peas, apples, bananas, kiwifruit • fruit juice, fruit for breakfast cereal • vegetables for ration packs
Application of heat	**Blanching** • rapid heating in boiling water followed by rapid cooling in cold water • leaching occurs	tomato, beans, cauliflower, broccoli, carrot, almonds, peas, potato, corn, brussels sprouts
	Boiling • uses convection to heat water to 100°C, until rapid bubbling movement of liquid • holding food at 100°C for a few minutes will kill enzymes and destroy most bacteria	• corncobs, potato, peas, carrots, celery, beans and lentils. • not suitable for leafy salad vegetables
	Braising food seared in fat/oil to create browning, then partially covered in liquid with tight fitting lid slowly cooking until food is tender	carrots, onion, celery, potato, mushroom, olives, parsnip
	Evaporation • also known as drying or curing, reduces the water level, delaying microbial growth and enzymatic action • temperature of food is raised to 100°C, until the correct concentration is achieved • causes decrease in the weight of food and intensifies the nutrient content	milk, tomatoes, apples, banana, mango, grapes, plums, berries
	Pasteurisation • heating food item to 72°C for 15 seconds and then rapidly cooling • slows growth of microorganisms, but does not completely sterilise food	• milk, fruit juice • irradiation – used for fruit and vegetables, spices, nuts and legumes

(*Continued*)

Table 3.4 Food processing techniques (*Continued*)

	PROCESSING TECHNIQUE	TYPICAL FOODS
Application of heat	**Canning and bottling** • sealing cooked food in sterile bottles and cans • the container is boiled, which kills or weakens bacteria and ensures no contamination from the container • foods are cooked for various lengths of time according to their nutrient make-up	beetroot, corn, peas, pineapple, tomato, peach, pair, pickles, chickpeas, lentils, cabbage, lemons
	Ultra-high temperature (UHT) • UHT is a pasteurisation process where food is heated to 138°C for 2 seconds • usually undertaken in a sterile environment	milk and dairy products, such as cream, custard, fat, soy and coconut milk, fruit juice
Change of pH	**Adding acid** • most microorganisms grow best at pH values around 7.0; by adding a weak acid to low acid foods, the pH is lowered, stopping the growth of bacterial microbes • sodium lactate, ethanol alcohol, vinegar or lemon juice are examples of acids that can be added	onions, pickles, apples, broccoli, avocado
	Adding alkali • sulphites are commonly used as an additive to increase the pH value of foods • inhibits enzymatic and Maillard reaction – prevents browning	dried fruit and vegetables, sausages, wine, cordials
Additives	**Salt** • addition of salt reduces the water activity (a_w) of foods, as sodium and chloride ions bind to water • salt is not solely used to preserve foods, but used in conjunction with other processes • salt plays a vital role in fermenting of foods, by allowing the growth of salt tolerant beneficial organisms while inhibiting the growth of spoilage bacteria	• onions, olives, pickles, cauliflower, peas, capsicum • meat for jerky
	Antioxidants • can be added to extend the shelf life of some food items and prevent wastage • browning of cut fruit can be avoided by adding antioxidants • unsaturated fats are susceptible to oxidation, causing them to go rancid • common antioxidants in food include ascorbic acid, tocopherols, as well as other synthetic antioxidants	

Consumption

Food processing, whether it is at a commercial level or preparation and preservation techniques at a domestic level, entails the manipulation of a food's temperature and use of chemicals to prolong shelf life. The resulting product allows consumers to enjoy the food out of season and also prolongs the shelf life, increasing food accessibility around the world.

9780170418560

EXPERIMENT 3.1

Vitamin C in frozen, dehydrated, fresh and canned peas

AIM

To investigate the effects of physical manipulation, temperature and chemicals on vitamin C in fruits and vegetables

BACKGROUND

SAFETY

Iodine solution is poisonous.

The chemical name for vitamin C is ascorbic acid. When iodine and ascorbic acid are combined in solution, a chemical reaction takes place. In this chemical reaction, the ascorbic acid molecule loses electrons, which are transferred to the iodine molecule. Chemists call this type of reaction an oxidation/reduction reaction (or redox reaction for short). The molecule that loses electrons is oxidized ... and the molecule that accepts the electrons is reduced.

So how can you use the iodine-ascorbic acid reaction to determine the amount of ascorbic acid (vitamin C)? If you start with a known concentration of iodine, and carefully measure the amount of the iodine solution that you add, you can calculate how much ascorbic acid was present. How do you know when the iodine-ascorbic acid reaction is complete? You add an indicator to the solution. In this case, the indicator is soluble starch. When iodine reacts with starch, it turns the solution a blue-black colour. If ascorbic acid is present in the solution, iodine will react with it, and not with the starch, so the solution will not change colour. However, once all the ascorbic acid has been oxidized, added iodine will be free to react with the starch, producing a distinct colour change.

Source: Science Buddies. Reproduced with permission.

Nutrient-dense fruits and vegetables are processed to extend their shelf life, make food more appealing, increase nutrient availability and be convenient for consumers to purchase.

INSTRUCTIONS

1 Set up an area to work with chemicals that will not contaminate other food preparation surfaces. Ensure that clothes are covered and non-porous gloves and eye protection is used.

2 Carry out this experiment on the five samples listed below. Purchase peas from the local supermarket.

3 Look at each option being tested (see table below) and choose the option you feel will be highest in vitamin C levels. Note this as a prediction to refer to at the end of the experiment.

- Accuracy in measuring of all substances is essential to achieve an accurate outcome.
- The samples are tested twice for accuracy and for later results analysis.

PREPARATION

CONTROL	VARIABLE 1	VARIABLE 2	VARIABLE 3	VARIABLE 4
Prepare a sample of liquid vitamin C tablet	Fresh peas	Frozen peas, defrosted	Dehydrated peas, soaked as per packaging instructions	Canned peas, drained

FOOD COMPONENTS

- 2 g corn starch + 1 cup warm water
- 1 effervescent vitamin C tablet
- ¼ cup fresh peas

- ¼ cup frozen peas (defrosted)
- ¼ cup dehydrated peas (reconstituted)
- ¼ cup canned peas (drained)

EQUIPMENT

- scales
- small measuring jug
- stirrer
- fork or food processor
- strainer or cheese cloth
- 1-litre measuring jug
- syringe
- eye dropper
- plastic or glass cups
- marker
- hot plate
- saucepan
- wooden spoon

PROCEDURE

1. Measure 2 g of starch and mix with warm water in a flask/cup.
2. Pour into saucepan and boil for 5 minutes.
3. Set aside to cool. This is the starch solution to be used.
4. Dissolve the vitamin C tablet in the jug with 1 litre of water.
5. Mash/process each pea sample and mix with 100 mL of water at room temperature and stir well.
6. Strain to remove as much pulp of each sample.
7. Accurately measure 50 mL of the control and each variable, placing each in a marked flask/cup.
8. Add 5 mL of starch solution to each flask/cup, stirring well.
9. To each flask/cup add drop by drop of the iodine solution, stirring constantly until you notice a colour change to bluey brown.
10. Note the number of drops in the results table.
11. Repeat steps 5 to 9 and record the results so that all results can be averaged later.

compare display recognition of similarities and differences and recognise the significance of these similarities and differences

draw conclusions make a judgment based on reasoning and evidence

RESULTS ANALYSIS

After preparation of the control and each variable sample, draw a table or use the worksheet for this experiment and record your results for each test, repeat and record the results again.

> Note that the more iodine added to the liquid and starch solution, the greater the potency or concentration of vitamin C in the sample.

1. **Compare** the amount or potency of vitamin C control and variables 1, 2, 3 and 4.
2. Create a graph that represents the level of vitamin C potency for each sample.
3. Prepare a report addressing the following:
   a. **Draw conclusions** about the effect physical manipulation, temperature and chemicals have on the vitamin C levels in fruits and vegetables.
   b. Was the original prediction accurate? **Explain** the reason behind the prediction and use the data to explain or disprove this.
   c. Using knowledge of food labels, check the ingredients lists for possible fortification (addition of vitamin C/ascorbic acid) of the test sample. How would addition of vitamin C impact on the results in terms of natural bioavailability?
   d. As a concluding statement, use knowledge of the scientific principles of food processing to **decide** on the best product for consumption in terms of bioavailability.

ACTIVITY
3.2

Aim

To analyse information and data to **determine** the most effective method of vitamin and mineral retention

STEPS

1 **Investigate** through research which nutrients are lost or added to each food when using each method of cookery. Summarise this in a table.

TYPES OF COOKERY	FISH	BROCCOLI	POTATOES	CARROTS	MINCE PATTIE
Boiling/simmering					
Stewing/braising					
Microwaving					
Steaming					
Deep-frying					
Poaching					
Sous-vide					
Grilling					
Roasting and baking					
Stir-frying					

Conclusions

1 Considering each food preparation method, **propose** the best method of food processing to retain maximum vitamin and mineral quality of each food.

2 **Explain** which methods of cookery increase the presence of nutrients considered to be detrimental to health.

Taking it further

3 If you were a nutritionist, which food preparation methods would you recommend for maximum nutritive value? **Analyse** each of the following options and propose a more suitable food processing method to retain maximum nutrient content of vitamins and minerals.

a deep-fried battered fish and deep-fried chips

b tempura vegetables (including broccoli and carrots) served with tempura prawns

c shallow-fried chicken parmigiana with boiled broccoli, carrots and corn

d fried mince hamburger pattie with oven-baked chips

e BBQ chicken with baked potatoes and baked pumpkin

analyse
dissect to ascertain and examine constituent parts and/or their relationships; break down or examine in order to identify the essential elements, features, components or structure; determine the logic and reasonableness of information; examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences

summarise
give a brief statement of a general theme or major point/s; present ideas and information in fewer words and in sequence

- Moist and dry heat methods of cooking were explored earlier in the chapter.
- Not all methods will be applicable to all foods.
- Research the most common methods for each food (see the link on NelsonNet).

Research into nutrients lost in cooking

WS

Activity 3.2 template

Maximum retention and bioavailability of foods rich in vitamins and minerals

As discussed, food preservation and preparation techniques affect the retention of vitamins and minerals in food products. Foods products can be prepared using various techniques. Preparation of food will affect the bioavailability of the nutrients. Some nutrients become more readily available for use in the body after processing and preparation, whereas other nutrients are destroyed or decreased by processing and preparation.

Research and development

Research and development of innovative food products is growing in demand. As the population grows, incomes continue to rise and lifestyles change. Social, environmental and ethical concerns also bring about change and demand in food processing. Food businesses, like any other business, also strive to survive, make money and increase profits, which also fuels the research and development of innovative food products.

Newer developments in food products and technology include genetic modification, which can provide greater bioavailability of vitamins and nutrients in our food supply. New genetic species can be developed, which are often richer in nutrients or are less susceptible to pests, providing a more stable and nutrient-rich food supply for human survival. In developing countries, nutrient-rich food sources are of great importance to increase the standard of living and improve normal growth and development within the country.

Golden rice and genetically modified bananas are two examples of innovative vitamin and mineral food sources.

ACTIVITY 3.3

Aim

To research the development of golden rice to determine its health implications

Reuters Pictures/Erik de Castror

Golden Rice Humanitarian Board: www.goldenrice.org

FIGURE 3.8 A comparison of white, golden rice and golden rice 2

BACKGROUND

Golden rice is a genetically modified rice grain that has been modified to produce beta (β)-carotene, the predominant form of provitamin A. Consuming provitamin A allows the body to convert it to active vitamin A once in the body. Golden rice was developed to help with vitamin A underconsumption. Infants, young children and pregnant woman appear to be at greatest risk of vitamin A underconsumption, usually in developing countries.

Fortification is where a specific micronutrient is deliberately increased in a food to improve the nutritional quality of the food supply, and thus provide a public health benefit. Biofortification is where the nutritional quality of crops is enhanced or increased through **agronomic** practices, conventional plant breeding or modern biotechnology.

This is different from conventional fortification, as biofortification aims to increase the nutrient levels of the crop during growth, rather than after, during processing. Biofortification of crops is beneficial in developing countries or where conventional fortification processes may not reach the entire population. It also eliminates the need for fortification and additives during processing and can directly reach subsistence communities. It is potentially more cost-effective.

agronomic
related to agronomy, the science of land management for the production of crops

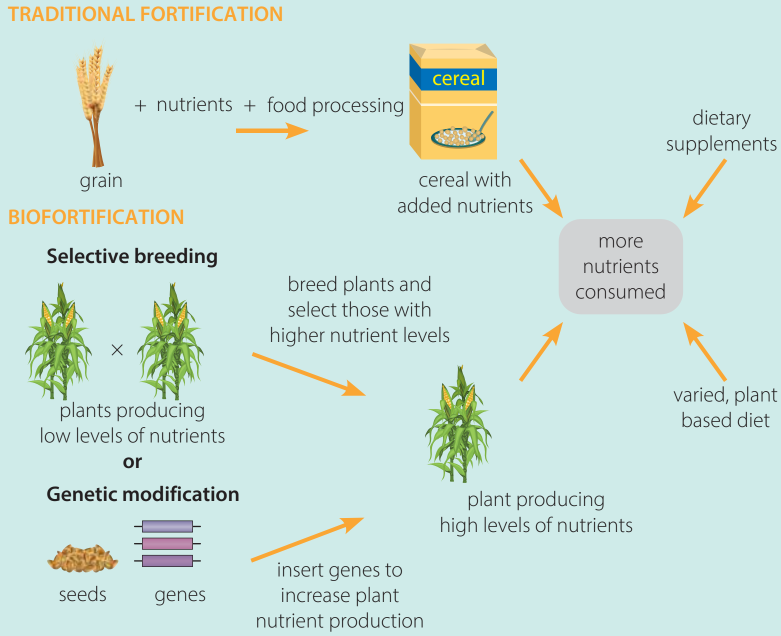


FIGURE 3.9 Could biofortification help to eliminate some of the world's deficiency problems?

STEPS

1 Research vitamin A underconsumption:
   a What are the symptoms associated with vitamin A underconsumption?
   b Which countries/populations are most at risk of vitamin A deficiency or have high incidence of vitamin A deficiency?
   c Research the global incidence of vitamin A underconsumption. Provide some statistics on the incidence around the world, including mortality rates.
2 Research the development of golden rice:
   a Outline the development of golden rice.
   b Outline how golden rice 2 was produced, including what plant genes were inserted into the rice.
3 **Investigate** the impact golden rice can have on health.
4 Outline the positive and negative aspects of the development and use of golden rice.

Golden rice

Golden rice 2

Health impacts of golden rice

Biofortification

deduce
reach a conclusion that is necessarily true provided a given set of assumptions is true; arrive at, reach or draw a logical conclusion from reasoning and the information given

Golden rice in Australia

Sweet potato

Conclusions

1 Biofortification vs. conventional (added) fortification:
   a **Explain** how golden rice is an example of biofortification, not added fortification.
   b **Describe** the benefits of biofortification.
   c **Explain** why rice is a good choice for vitamin A biofortification. **Deduce** why rice was selected to combat this deficiency. In your answer, refer to the specific countries that are targeted for inclusion of golden rice.

Taking it further

2 Use of golden rice in Australia: **Investigate** whether golden rice is permitted in Australia, under FSANZ. What is the current application status? What is permitted in Australia? What are the general rules for use?

3 Other biofortification: Research the development of orange-fleshed sweet potato (OFSP) to combat vitamin A underconsumption in African countries. How was it developed? What biofortification techniques were used?

ACTIVITY 3.4

Aim

To research the health implications of the development of genetically modified bananas

BACKGROUND

Several genetic research and production programs for bananas exist in varying stages of development across the world, with the aim to increase bioavailability of nutrients in bananas, as well as provide bananas that are resistant to disease. Bananas are considered a staple food in many countries, but are often low in nutrients, particularly the cooking variety of banana used in many developing countries.


Shutterstock.com/Travel Stock

FIGURE 3.10 Bananas are a staple food in Uganda.

Provitamin A is found in the banana species 'Asupina', however this banana variety is not suitable for the growing conditions and yield expectations in countries such as Uganda and other East African countries. Genetic modification and testing of the 'Cavendish' banana have been undertaken in Queensland, with genes taken from the Asupina variety.

Food supplements and more conventional fortification have been trialled in African countries where diet is lacking in micronutrients, such as vitamins and minerals. There are varying degrees of success with foreign supplements, as sometimes the population views the supplements suspiciously, refusing to consume them, or they do not reach all of the population.

Banana21 is a collaborative project, funded by the Bill & Melinda Gates Foundation. The project is aimed at improving the levels of provitamin A and iron in the fruit of the staple food of Uganda, the East African Highland banana. Since its inception, the banana21 project has been expanded to include disease resistance and drought tolerance and a number of other funding sources and collaborators have joined the project.

STEPS

1 Outline the development of the golden banana.

2 The golden banana and banana21 were developed for Uganda. Outline the main reasons for the development of the GM banana for use in Uganda.

3 Research the field trials that have taken place in Queensland and Uganda. How successful have they been? What conclusions have they come to?

4 What are the potential health implications of the golden banana?

Conclusions

1 Who would own the patent or seeds of the GM banana that is being developed? **Discuss** the ethics surrounding the development of GM foods.

2 There is debate surrounding the development of GM foods and uses around the world. **Discuss** the positive and negative aspects of developing GM foods. In your answer, include the health implications for developing countries.

Taking it further

3 a Research the other genetic modifications that are occurring in bananas, including:
- disease resistance
- drought resistance
- iron fortification.

b Write a short report on each development to include:
- the reason for the genetic modification
- current research and developments
- health implications.

discuss
examine by argument; sift the considerations for and against; debate; talk or write about a topic, including a range of arguments, factors or hypotheses; consider, taking into account different issues and ideas, points for and/or against, and supporting opinions or conclusions with evidence

GM bananas

Waste management and sustainability

In Australia, food waste tends to occur from oversupply of fresh fruit and vegetables to retailers as well as individual households purchasing and not using fresh produce prior to expiration. In Australia distribution and logistics pathways are well established, resulting in minimal waste due to spoilage during transport.

The sensory properties of fresh food items are highly regarded, and fresh products that appear different or imperfect are not selected. As a result, the specifications that many large supermarkets put in place mean that growers are discarding 20–40 per cent of all produce because it does not meet the appearance requirements for sale in a retail environment. Much of the discarded produce is perfectly fine for consumption, it may just be a different shape, have bruises or spots that are seen as imperfections. Waste of this produce is also a waste of other resources such as labour, water, nutrients, chemicals and soil.

Another part of food wastage in Australia is within the household. Food is readily available to Australian households and discarding fresh produce that is slightly unappealing is not considered important to many Australian householders. Food that is improperly stored in households will also perish quicker, resulting in food wastage.

In developing countries, food spoilage and waste of fresh fruit and vegetable products is commonly due to the distribution pathways, processing facilities and handling post harvesting. Increasing transportation distance (sometimes referred to as 'food miles') can decrease nutrient density and cause some food to spoil. Smaller communities in villages may have local markets for distribution of produce; however, this limits the community to the food products that are produced locally. Sale of fresh fruit and vegetables from farming communities must be transported to larger cities. Without organised, systematic and stable transportation pathways, food can spoil before reaching the marketplace.

sustainability use of products or processes that help conserve an ecological balance by avoiding depletion of natural resources

In both developing and developed countries, there are methods and practices that can be adopted to minimise food wastage and assist with **sustainability**.

Extending a food item's shelf life through processing methods will improve its availability and can ensure consumption prior to spoilage. Food processing methods are outlined earlier in this chapter, see pages 44–46 for more information. Other ways to reduce waste of fresh produce include:

- using correct storage methods to ensure fresh products remain in optimum condition for as long as possible. Read about storage of perishable, semi-perishable and non-perishable food items on pages 66–68
- repurposing off-cuts or by-products of processing into other products, for example, using vegetable off-cuts to produce vegetable stock, using broccoli and cauilfower stems for frozen vegetables, using coffee cherry husks (usually discarded) to produce cascara tea, which is high in caffeine but with a fruity flavour
- repurposing waste fruit and vegetables, for example, selling 'odd' fruit and vegetables at a cheaper price, using undesirable tomatoes to produce canned tomato products such as tomato paste, diced canned tomatoes or tomato sauce, using misfit fruit and vegetables to produce juice or other food products, using waste stems, leaves, skin and seeds for animal feed products.

Innovation in repurposing food waste

iStock/Getty Images Plus/Sopone Nawoot

FIGURE 3.11 Cascara tea uses the by-product of coffee production to form another product.

Mark Fergus Photography

FIGURE 3.12 Coles mixed vegetables includes broccoli core and cauliflower core, which are the off-cuts from other frozen vegetables that use the broccoli and cauliflower heads.

Source: Snact. Reproduced with permission.

FIGURE 3.13 Snact aims to tackle food waste by using misfit fruits from wholesale markets to create products, such as these fruit bars.

9780170418560

At a household level, waste can be reduced by the correct storage of fruits and vegetables, using all the food where possible and composting. The following are some simple tips that you can use to preserve the nutrient density of fruit and vegetables.

- Store food in the appropriate way. Keep foods cold in an airtight container in the refrigerator.
- Keep root vegetables like potatoes in a cool, dry and dark place.
- Try washing or scrubbing fruit and vegetables rather than peeling them.
- Use all the outer leaves of leaf vegetables first so they don't wilt.
- Use fresh vegetables where possible.
- Purchase only what you need to avoid wastage.
- If you buy in bulk, have a meal plan that will use all the produce over a week.
- Microwave, steam, grill or roast vegetables to retain their nutrients.
- If you boil fruit or vegetables, save or use that water for soup or sauces; it will be full of nutrients that have leached out of the food.
- Cook these foods quickly.

REVIEW QUESTIONS ▶

1 **Describe** where food waste is likely to occur in:
   a developing countries
   b developed countries.
2 **Defin** 'sustainability'. **Explain** how transportation and storage of food products help to improve sustainability and waste management.
3 **Describe** methods to reduce waste. Provide examples of each.
4 'There is enough food in the world to feed everyone' is a claim that is often made when considering the amount of food that is produced by the world. **Explain** how waste in developing countries could be reduced.

Food protection

Food Standards Australia New Zealand (FSANZ) has developed standards to maintain the integrity and safety of food production. These standards apply to growing, manufacturing, producing, collecting, extracting, processing, storing, transporting, delivering, preparing, treating, preserving, packing, cooking, thawing, serving and displaying of food. The standards aim to keep foods suitable for human consumption. When a food is considered 'not suitable' it could potentially harm people due to food spoilage. FSANZ defines food as not suitable when it:

- is damaged, deteriorated or perished to an extent that affects its reasonable intended use
- contains any damaged, deteriorated or perished substance that affects its reasonable intended use
- is the product of a diseased animal or an animal that has died other than by slaughter, and has not been declared by or under another Act to be safe for human consumption
- contains a biological or chemical agent, or other matter or substance, that is foreign to the nature of the food.

Compliance by all aspects of the food industry is essential for success of and confidence in these standards. The standards are in place to reduce the incidence of foodborne illnesses due to food spoilage.

FSANZ

Factors causing food spoilage

Food spoilage occurs when the quality of a food product deteriorates. Food spoilage is usually the result of the activity of yeasts, moulds and enzymes, and will result in undesirable physical and sensory properties, making the food item unacceptable to consume. Generally, the smell, look and feel of the item has deteriorated and you can see it, taste it or smell it. Food spoilage will naturally occur in all fresh items over time.

Food spoilage can also occur as a result of physical injury to the fresh item. Bruising, pressure freezing, drying and radiation, or damage from insects can speed up food spoilage.

Food spoilage can also occur through introduced means, during food transport, storage, production or handling. Improper storage, inadequate processing or poor hygiene practices can also cause biological, chemical or physical changes in the food product, resulting in food spoilage.

Biological changes

Biological changes relate to the action of microorganisms which are found in soil, water and air, plant pathogens and other environmental sources on food. Food affected by bacteria, yeast and moulds give off heat and gas because of chemical breakdown. This process is known as fermentation and occurs in alcohol, vinegar and some dairy products.

Bacteria

Bacteria are microscopic cells not seen by the human eye. The three main types of bacteria are named after their shapes:

- bacilli which are long thin rods
- cocci which are spheres/balls
- spirilli which are spiral.

In fruits and vegetables, the main signs of food spoilage are change of colour, texture, smell or taste. Some bacteria can form a protective layer of spores over their own surface, keeping the bacteria alive until optimum growth conditions allow them to multiply rapidly. Spores can withstand high cooking temperatures and dry conditions, surviving to then reproduce once conditions become favourable. Spore development makes food unsuitable for consumption. Lactobacillus is one bacteria found in plant foods; it produces lactic acid from breaking down carbohydrates.

Yeasts

Yeasts are single cells that are oval, spherical or elongated in shape and reproduce asexually by budding. They are larger in size than bacteria. Yeast can be used in food production, such as leavening bread. However, yeast can also cause undesirable food spoilage, producing an 'off' flavour. Yeasts are more tolerant to cold than heat and can be easily destroyed by heating.

BACTERIAL SHAPES

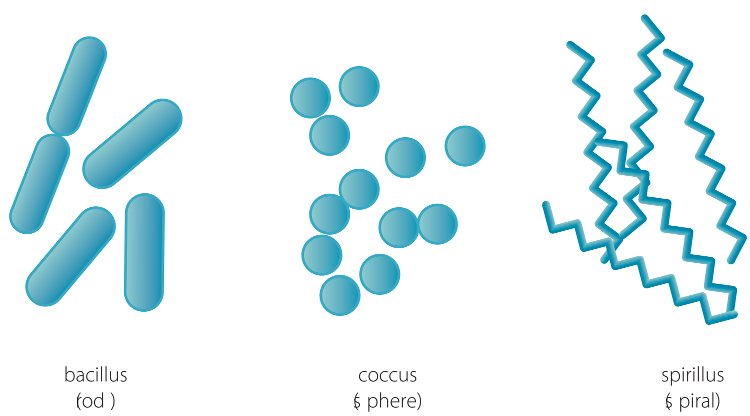


FIGURE 3.14 Different bacterial shapes

Moulds

Moulds are multicellular microorganisms composed of many filaments, known as hyphae, which form clusters and reproduce, creating spores that are spread through the air. One very common and useful mould is penicillium, which is blue green in colour. Moulds can be used during food production, such as cheese production, but can also cause food spoilage.

Shutterstock.com/Luca Lorenzelli

Shutterstock.com/Marcel Jancovic

FIGURE 3.15 Mould on strawberries and oranges can cause food spoilage and waste.

Chemical changes

The production of an odour and colour is key to noticing that a chemical change has occurred in fruit or vegetables.

Oxidation

Enzymic action can cause oxidation, which discolours the exposed surface of the food and causes vitamin loss and 'off' flavours. Enzymes can be inactivated by heat and radiation processes.

Ripening

Ripening occurs as starch is converted to sugar and the fruit becomes sweeter. Skin-colour change of fruit and vegetables is representative of the ripening process and skin will eventually go dark brown when the food is unsuitable to eat. This is a natural process. Some foods can still be consumed once very ripe; for example, once bananas are past their optimum ripeness to eat as fresh fruit, they can be mashed and used in cooking.

Physical changes

Physical changes are caused by exposure to light, water or oxygen and are generally easy to detect as appearance is key. Surface damage such as bruising, freezer burn or cuts can cause further deterioration of food items.

Evaporation

Water content is important for maintaining the nutritional value of fruit and vegetables. If stored in a cool environment, water loss will be reduced, also reducing food spoilage. Water is lost from the surface of the skin, which can also cause loss of nutrients.

Discolouration

Discolouration of fresh products will indicate natural ripening or other food spoilage, such as mould on oranges. Discolouration will also occur where there is damage to fresh products such as bruises or cuts. Freezer burn or exposure to oxygen will cause discolouration in red meat.

Wilting

Wilting is caused by exposure to air and the drying of the surface of the fruit or vegetable. Green leafy vegetables and fresh herbs wilt easily if not stored correctly.

Preservation processes

Food preservation is essential to reduce the waste of produce and create a food safe environment allowing an extended shelf life.

EXPERIMENT 3.2

Using salt to cure lemons

understand perceive what is meant by something; grasp; be familiar with (e.g. an idea); construct meaning from messages, including oral, written and graphic communication

AIM

To **understand** and **explain** the preservation process of curing, using salt to cure lemons

BACKGROUND

Physical manipulation of lemons for preservation

Salting (or pickling) is a preservation technique that changes the pH of the fruit and slows its deterioration. Once preserved, the lemons are washed to eliminate the salty taste, and both the pulp and rind can be used to flavour dishes.

INSTRUCTIONS

1 Set up an area to work with chemicals that will not contaminate other food preparation surfaces.
2 Prepare one (1) portion of each food formulation and store it appropriately. Each technique will be examined for changes in the vitamin and mineral content.

PREPARATION

CONTROL	VARIABLE 1	VARIABLE 2
Use a fresh lemon to store next to your salted lemon jar	Salted lemon in jar following the procedure described	Fresh lemon purchased just before the sensory analysis

FOOD COMPONENTS

- 5 lemons (more lemons may be needed for extra juice)
- 1 lemon for control
- ¼ cup salt, more if desired
- 1 bay leaf
- 4 black peppercorns

EQUIPMENT

- paper towel
- shallow bowl
- chopping board
- 2 sterile 300–500 mL mason jars
- sharp knife
- 1 fresh lemon purchased 30 days after the experiment

9780170418560

PROCEDURE

1 Wash all lemons and dry with paper towel.
2 Place 1 lemon on dry paper towel and store where the salted lemon will be stored. This is the control lemon.
3 Quarter the other lemons from the top to within 1.5 cm of the bottom.
4 Sprinkle salt on the exposed flesh, then reform the fruit in its original shape.
5 Place 1 tablespoon of salt in the bottom of each mason jar.
6 Pack half the lemons in one jar and half in the other. Push them down, adding more salt, and the bay leaf and peppercorns between layers.
7 Press the lemons down to release their juices.
8 If the juice released from the squashed fruit does not cover them, add more freshly squeezed lemon juice.
9 Seal the jars and place in a warm place for 30 days to let ripening occur.
10 After 30 days open the sealed container and examine the lemons using a sensory analysis to compare the preserved lemon to the fresh lemon.

RESULTS ANALYSIS

1 Draw tables like the ones that follow, or use the templates for this experiment on NelsonNet.
   a Table 1: Record your results every 2–3 days. Record any changes that you see taking place in each sample (see example in the table).
   b Table 2: Record your sensory observations at end of experiment.

SAFETY

You will need to discard your control sample if spores develop.

Please use gloves and a mask to dispose of the lemon and paper in composting area.

WS Experiment 3.3 template 1

CHECKING DATE	CHANGES VISIBLE IN CONTROL SAMPLE	CHANGES VISIBLE IN VARIABLE 1 SAMPLE
25/4	*Slight discoloration of skin, lemon appears to have shrunk in size*	*Skin of lemon looks less firm*

WS Experiment 3.3 template 2

SENSORY PROPERTY	VARIABLE 1	VARIABLE 2
Appearance		
Taste		
Flavour and aroma		
Texture		

2 Prepare a report addressing the following:
   a **Analyse** the data in Table 1 and **draw a conclusion** (referring to data from the experiment) about the success of preserving lemons using salt as an extension of shelf life.
   b **Analyse** the information collected in Table 2 and **comment** on each sample in terms of the sensory properties.

comment express an opinion, observation or reaction in speech or writing; give a judgment based on a given statement or result of a calculation

EXPERIMENT 3.3

Preserving fruit and vegetables through dehydration (drying)

AIM

To **understand** and **explain** the preservation process of dehydrating (drying), using fruit and vegetables

BACKGROUND

Removal of water by evaporation

Dehydration or drying food is the process of removing water or moisture, making the food item smaller and lighter. Drying or dehydrating food is one of the oldest methods to preserve food, with various methods used in the past to dry food items. Drying food was a method to preserve food before refrigerators were available. Using this method, extra food was able to be preserved for months, providing life-sustaining food that could be available for longer periods of time.

Dehydrated food is still used today. Dehydrated foods are ideal for camping, hiking or backpacking as they are light and do not require refrigeration. They are also used in army ration packs due to the long shelf-life. Other dried foods have become popular to eat in the home, such as dried fruits, coconut, fish or seaweed.

Foods are spoiled through microorganisms or enzymatic reactions. Bacteria, yeast and moulds must have a level of moisture content to grow and spoil food items. Removal of moisture slows down enzymatic reactions and can help prevent spoilage by microorganisms, prolonging the shelf life. These days, the characteristics of dried foods are also desirable.

To successfully dry food at home, the following aspects should be considered:

- Dry air – to absorb the moisture that is released
- Heat – enough to force out moisture without cooking or destroying the texture of the food item, generally around 60°C
- Air movement – to remove moisture

Foods can be dried in the home using three main methods:

1. Sun drying – warm das of at least 29°C (or higher) with low humidity. Only recommended for drying fruits, must consider insect control and how many days will be required
2. Oven drying
3. Food dehydrator – electric dehydrators are cost efficient and take less time than the oven to dry foods

INSTRUCTIONS

1. For the ease of use and control of microorganisms, use a dehydrator/drying cabinet for this experiment. If using an oven, do not leave it unattended.
2. Drying times are for the food to be a 'leather' product, crisp food will take longer to dry.
3. Set up an area where you can work that will not contaminate other food preparation surfaces.
4. One portion of each food formulation will be prepared and stored appropriately before tasting. Group work will reduce the time factor for this experiment.
5. Each technique will be examined for changes in the nutritional value, shelf life and sensory properties.

PREPARATION

CONTROL	VARIABLE 1
250 g sample of each fruit and vegetable stored hygienically for the duration of the experiment	250 g sample of each fruit and vegetable prepared as per the method

FOOD COMPONENTS

- 500 g seedless grapes and apple or banana
- 500 g onions and mushrooms

9780170418560

- 1 bunch fresh herbs, e.g. parsley
- if dipping to prevent oxidation, lemon or lime juice will be required for the apples/bananas

EQUIPMENT

- paper towel
- 4 chopping boards
- 4 knives
- gloves
- tongs
- if blanching or steaming, a pot with a strainer is needed
- if dipping, a juicer, strainer and bowl is needed
- air dehydrator or oven

PROCEDURE

1. Rinse fruits and vegetables under cold running water and cut away bruised and fibrous portions (onion/banana skin). Remove seeds, stems and/or pits.
2. Store 250 g of each food safely for results analysis – this will be the control sample.
3. Slice apple or banana into 0.6-cm thick slices for leather or 0.3-cm for crisps, then complete one of the following processes:
   - dipping: juice lemon/lime, strain and pour into a deep bowl **or**
   - steaming/blanching: bring water to the boil and cook for 3–5 minutes.
4. Lay each piece of food on paper towel.
5. The parsley or other herbs can be dried whole or roughly chopped. The stems can be used if chopped finely.
6. Slice onion and mushrooms, lay out separately on paper towel and pat dry.
7. The grapes will be dried whole and will take the longest time.
8. Arrange food on drying racks and dry. Follow the times listed below as a guide to your degree of doneness.
9. When you have achieved your leather or crisp state for each food, remove from the dehydrator and reweigh.
10. Record results.
11. Safely store for tasting.

Grape	12–20 hours
Apple	6–12 hours
Banana	8–10 hours
Onion	3–6 hours
Mushroom	8–10 hours
Parsley	1–2 hours

FOOD	WEIGHT AT BEGINNING AND END	LIST CHANGES THAT OCCURRED DURING PROCESSING
Grape	250 g	
Apple	250 g	
Banana	250 g	
Onion	250 g	
Mushroom	250 g	
Parsley	250 g	

SENSORY PROPERTY	CONTROL	VARIABLE 1
Appearance		
Taste		
Flavour and aroma		
Texture		

WS Experiment 3.4 template 1

WS Experiment 3.4 template 2

RESULTS ANALYSIS

1 After preparation of the sample, draw tables like the ones on page 61 or use the templates for this experiment on NelsonNet and record the results.
   a Table 1: Record the weights of the foods.
   b Table 2: Record sensory observations for each fruit or vegetable.
2 Prepare a report, addressing the following:
   a **Analyse** the data in Table 1. Graph the reduction of weight (grams) when using drying/dehydration.
   b **Draw conclusions** (citing supporting results data from your analysis) about the success of drying/dehydration for extending shelf life.
   c **Analyse** the information collected in Table 2 and **comment** on each sample in terms of sensory properties.

EXPERIMENT 3.4

Pickling onions and sauerkraut

AIM

To **understand** and explain the preservation process of pickling, using onions and sauerkraut

BACKGROUND

Fermentation of fruits and vegetables is a preservation method used due to the simplicity of the process. There is no need for sophisticated equipment; pickled produce, German sauerkraut to Korean kimchi, and wine are examples of this process. The good bacteria that exists on the surface of food generates fermentation.

INSTRUCTIONS

1 Set up an area that will not contaminate other food preparation surfaces.
2 Prepare one (1) portion of each food formulation and store it appropriately before tasting. Note that group work will reduce the time required for this experiment.
3 Each technique will be examined for changes in the nutritional value, shelf life and sensory properties.

SAFETY

It essential that all equipment is sterile of this experiment, and that hands are clean and gloves used to prevent contamination or growth of unwanted bacteria.

PREPARATION – SAUERKRAUT

VARIABLE 1	VARIABLE 2	VARIABLE 3
Cabbage stored in cool, dark, dry place	Cabbage stored in refrigerator	Flavouring added to cabbage, cabbage stored in refrigerator

FOOD COMPONENTS

- ¾ large head of cabbage
- 3 × ½ tablespoon pickling or kosher salt
- ½ tablespoon salt and 250 mL water, if needed for the brining solution

9780170418560

- ½ teaspoon ground black pepper
- 1 teaspoon garlic minced

EQUIPMENT

- 3 × 1-litre bottle with metal lids (suitable for preserving) or 3 food-grade plastic containers with lids
- paper towel
- 3 large glass or ceramic bowls
- gloves
- measuring spoons
- tongs or wooden spoon
- for brine: measuring jug and spoon
- for chopping cabbage: shred in a food processor or mandolin, grate with grater or finely chop using knife and board

PROCEDURE

1. Remove the outer leaves of the cabbage and divide into three pieces.
2. Shred cabbage and place in bowl, add salt and mix. This can be done with gloved or clean hands.
3. To variable 3, add pepper and garlic and mix.
4. Sterilise the jars and place on bench next to bowls.
5. Use hands to squeeze as much juice as possible out of the cabbage, juice to remain in the bowl.
6. Place squeezed cabbage into jar.
7. Pour the remaining liquid over the top so that the cabbage is completely covered.
8. If not completely covered, make up brine solution using 250 mL of cold water and 1 teaspoon of salt and stir liquid (salt does not need to be dissolved).
9. Top up jar so that cabbage is completely covered, and seal jars.
10. Place all three jars in a warm place for 2–3 days, checking that all the cabbage is still completely covered.
11. After this time, safely store each variable as per the experiment instructions.
12. Taste these samples after 10 days.
13. Record your results.

Samples can be stored for up to 6 months unopened. Once the jars have been opened they can be stored in the refrigerator for up to 1 month.

RESULTS ANALYSIS

After preparing the samples, draw the table that follows or use the template on NelsonNet and record your sensory observations.

SENSORY PROPERTY	VARIABLE 1	VARIABLE 2	VARIABLE 3
Appearance			
Taste			
Flavour and aroma			
Texture			

WS Experiment 3.5 template 1

PREPARATION – ONIONS

CONTROL	VARIABLE 1	VARIABLE 2
Fresh onion purchased at the same time as the variables	Pickled onion – plain	Pickled onion – flavoured

FOOD COMPONENTS

- 3 large white or red onions
- 3 × 500 mL boiling water
- 3 × 1½ teaspoons pickling or kosher salt
- 3 × ¾ cup wine vinegar
- 3 × ¾ cup hot water
- ½ teaspoon whole black peppercorns
- ½ teaspoon other herb or spice

EQUIPMENT

- 3 × 500 mL glass bottles with metal lids (suitable for preserving)
- 3 large glass or ceramic bowls
- 3 sieves
- gloves
- measuring spoons
- measuring jug
- tongs or wooden spoon
- chopping onion: shred in a food processor or mandolin, grate with grater or finely chop using knife and board.

PROCEDURE

1. Top and tail onions, then remove tough outer skin.
2. Slice into thin rings and place in bowl.
3. Boil 2 cups of water and pour over onions, let rest for 10 minutes. This destroys any microorganisms present.
4. Sterilise the jars and place on bench next to bowls.
5. Drain onions and place into clean jars.
6. Add flavours to variable 2. In each bowl mix the salt with hot water then add the wine vinegar.
7. Pour the liquid over the onions and refrigerate for 1 hour.
8. You can taste these samples after 1 hour, but they can be stored for up to 7 days when opened.
9. Record your results.

Unopened jars can be stored in the refrigerator for up to 1 month.

RESULTS ANALYSIS

After preparing the samples, draw the table below or use the worksheet on the website accompanying this book and record your sensory observations.

WS
Experiment 3.5 template 2

SENSORY PROPERTY	CONTROL	VARIABLE 1	VARIABLE 2
Appearance			
Taste			
Flavour and aroma			
Texture			

Analyse the information in the results table. **Comment on each sample in terms of the sensory properties and draw a conclusion** (citing supporting results from the analysis) about the success of pickling as an extension of shelf life.

9780170418560

EXPERIMENT 3.5

AIM

To **understand** and **explain** the preservation process of freezing, using vegetables

BACKGROUND

Changing temperature of food

Water makes up over 90 percent of the weight of most fruits and vegetables. This water and other chemical substances are held within the rigid cell walls which give support structure, and texture to the fruit or vegetable. Freezing fruits and vegetables consists of freezing the water contained in the plant cells. When the water freezes, it expands, and the ice crystals cause the cell walls to rupture. Consequently, the texture of the produce, when thawed, will be much softer than it was when raw. This texture difference is especially noticeable in products which are usually consumed raw. For example, when a frozen tomato is thawed, it becomes mushy and watery.

Enzymes in vegetables are inactivated by the blanching process. Blanching is the exposure of the vegetables to boiling water or steam for a brief period. The vegetable must then be rapidly cooled in ice water to prevent it from cooking. Contrary to statements in some publications on home freezing, in most cases blanching is essential for producing quality frozen vegetables. Blanching also helps to destroy microorganisms on the surface of the vegetable and to make some vegetables, such as broccoli and spinach, more compact.

Source: University of Minnesota Extension. Reproduced with permission.

INSTRUCTIONS

1. Set up an area where you can work that will not contaminate other food preparation surfaces.
2. You will be required to prepare one (1) portion of each food formulation and store it appropriately before tasting; group work will reduce the time factor for this experiment.
3. Each technique will be examined for changes in the nutritional value, shelf life and sensory properties.

PREPARATION

CONTROL 1	CONTROL 2	VARIABLE 1	VARIABLE 2
Fresh carrot cut in circles 0.5 cm thick	Fresh broccoli cut into florets 3 cm in diameter	Blanched then tray packed, open frozen carrots	Steamed then tray packed, open frozen broccoli

FOOD COMPONENTS

- 2 × 2 large carrots
- 2 similar size heads of broccoli
- hot water
- cold water
- 500 g ice cubes

EQUIPMENT

- 2 food-grade plastic containers with lids for long-term storage
- paper towel
- 2 chopping boards
- 2 sharp knives
- large saucepan
- slotted spoon or strainer
- 2 timers
- microwave steamer with lid

- 2 large glass or ceramic bowls
- gloves (optional)
- tongs or wooden spoon
- for brine: measuring jug and spoon

PROCEDURE

1. Wash both carrots and broccoli, place on paper towel and dry.
2. Top and tail the carrot then cut into rounds 0.5 cm thick.
3. Cut broccoli into florets 3 cm in diameter. Cut stems into pieces 0.5 cm thick.
4. From here divide each of your vegetable piles in half.
5. Place half into airtight containers and put into refrigerator for tasting.
6. Fill each bowl ⅔ full of cold water. Add 250 g ice to each bowl and set aside for rapid cooling of steamed and blanched vegetables.
7. Boil water for carrots, add carrots to water and boil rapidly for 5 minutes. Remove from water and place straight into the ice bath.
8. Place the broccoli into steamer, cover and steam for 5 minutes.
9. Remove the broccoli from the steamer and place straight into the ice bath.
10. After 5 minutes drain each of the vegetables and place on trays lined with baking paper. Note that each piece of vegetable needs to be surrounded by air.
11. After this time safely store each variable as per the experiment instructions.
12. You can taste these samples after 10 days, but they can be stored for up to 6 months unopened.
13. Record your results.

RESULTS ANALYSIS

After preparing the samples, draw the table below or use the template on NelsonNet and record your sensory observations.

SENSORY PROPERTY	VARIABLE 1	VARIABLE 2
Appearance		
Taste		
Flavour and aroma		
Texture		

WS Experiment 3.6 template

Analyse the information in the results table. **Comment on each sample in terms of the sensory properties and draw a conclusion** (citing supporting results from the analysis) about the success of freezing as a preservation process.

Perishable foods

Some foods are more susceptible to food spoilage than others. These are known as perishable foods. These foods have a high water content and will deteriorate rapidly, causing food spoilage. Perishable foods include meats, fish, poultry, milk, milk products, eggs, plus some fruits and vegetables. These foods need to be refrigerated at less than 4°C or frozen below −18°C). Low temperatures slow down enzymatic or chemical changes and slow the growth of microorganisms in the food. Perishable foods generally have a shelf life of less than two weeks.

FIGURE 3.16 Examples of perishable foods, which should be refrigerated or frozen to extend shelf life

Semi-perishable foods

Semi-perishable foods are foods that will spoil but can last several weeks or may even last several months. Semi-perishable foods last longer than perishable foods due to lower water content. Examples of semi-perishable foods include some fruit, vegetables, nuts, breads and cakes. If stored in a cool dark place their deterioration is slowed and they can remain unspoiled for several weeks. Some semi-perishable foods require refrigeration, depending on the climate. A hot climate and other conditions may mean refrigeration is required for some fruit and vegetables that would otherwise not require refrigeration. Refrigeration can also be used to halt ripening of certain fruit, such as avocados.

FIGURE 3.17 Examples of semi-perishable foods, which generally do not require refrigeration

Non-perishable foods

Non-perishable foods are quite stable due to their very low water content. Non-perishable foods include flour, sugar, dried beans or fruits, canned products, pasta, noodles and dried herbs and spices. They can be stored in airtight containers in a cool, dark place and have a shelf life of months, or sometimes years. These foods, along with canned or irradiated products, will only begin to deteriorate once opened. Refrigeration is recommended for some non-perishable products after opening – they are then considered perishable items.

Shutterstock.com/Foxys Forest Manufacture

FIGURE 3.18 Examples of non-perishable foods, which do not require refrigeration

Food protection – a comparison

Extending the shelf life of all food is a goal for more sustainable food consumption. Processing foods can change not only the shelf life but nutritive value and sensory properties of each food. Vegetables are an example of fresh produce that can be purchased in several different ways to extend their shelf life and for added convenience.

ACTIVITY 3.5

Aim

To **compare** the nutritive value of peas using different processing techniques

STEPS

1 Obtain the following types of peas:
   - frozen peas
   - canned peas
   - fresh peas
   - dehydrated peas
2 Compare the labels of the canned, frozen and dehydrated peas for nutritional information. It is easiest to compare products using the nutrition panel, and the 'quantity per 100 g' column. This means that you are comparing the same amount, and values are comparative. Information for fresh peas can be sourced via research.

9780170418560

3 Draw a table like the one below or use the template in NelsonNet. Examine each label for differences in nutrient content and record the results in the table:

NUTRIENT CONTENT PER 100 g OF PRODUCT	FROZEN PEAS	CANNED PEAS	DEHYDRATED PEAS	FRESH PEAS
Total fat (grams)				
Saturated fat (grams)				
Total carbohydrate (grams)				
Sugar (grams)				
Protein (grams)				
Dietary fibre (if applicable)				
Sodium (mg)				

Activity 3.5 template 1

Conclusions

1 **Analyse** the data in the table above, highlighting any significant differences in nutrient content.

2 **Explain** how the processing method could produce the results for significant differences in nutritional value.

3 Use ½ cup samples of fresh, frozen, canned and dehydrated peas to complete the following taste testing using sensory evaluation descriptions.

SENSORY PROPERTY	FROZEN PEAS	CANNED PEAS	DEHYDRATED PEAS	FRESH PEAS
Appearance				
Taste				
Flavour and aroma				
Texture				

Activity 3.5 template 2

4 Rate each product on a scale of 1–5 (1 being best) on the following:

a overall nutrient retention

b overall sensory properties

c shelf life of the product

Note that the dehydrated peas will need to be rehydrated before tasting.

Taking it further

5 Research the nutrient differences in fresh, canned, frozen and dehydrated peas or another fruit or vegetable product in terms of vitamin and mineral retention. Make a judgement about the best food processing method for peas, in terms of nutrient retention.

How can food processing and preservation alter the bioavailability of vitamins and minerals?

Create a mind map of information to help answer the guiding question. Use the supplied template or develop your own mind map. You may find it useful to use online tools such as Bubbl.us, Canva, Coggle, MindMup, iMindQ.

Mind mapping template

Mind mapping tools

4 PROTEIN

» How can chemical and functional properties of protein and knowledge of food safety and spoilage and preservation techniques be used to develop protein-based foods?

Protein-based foods are essential for human survival, providing growth and repair of body tissue as well as energy. Demand for protein is increasing globally, as the world population continues to grow and the middle class expands. Protein-based foods have a limited shelf life and require specific processing and storage to extend their shelf life. In this chapter, the chemical and physical properties of proteins are explored through experimentation to understand how handling, storage, production and preservation for safe consumption produce nutritional food products.

Facts and principles about protein

Protein is a macronutrient required for the structure, function and regulation of the tissue and organs. It is predominantly sourced from animal products though it is also found in vegetable sources such as nuts and legumes.

Table 4.1 Protein

FUNCTIONS	NUTRIENT REFERENCE VALUE (NRV)		FOOD SOURCES	HEALTH IMPACTS OF OVER- OR UNDER-CONSUMPTION OF NUTRIENT
	Age	RDI		
• Builds, strengthens and maintains body tissues • Repairs body tissue • Regulates body processes • Provides energy	Girls 14–18	45 g	**Animal proteins** • meat – beef, fish, chicken, lamb, pork, rabbit • fish and seafood • eggs • dairy products • insects **Plant protein** legumes (beans and pulses), nuts, seeds, grains **Alternative proteins** bacteria, mycoprotein, microalgae and synthetic protein	Over – evidence supports that it is related to upper digestive tract and kidney cancer. It is thought to be linked to cancer, renal disease, coronary artery disease and osteoporosis, however the evidence is not conclusive
	Boys 14–18	65 g		
	Women 19–70	46 g		
	Men 19–70	64 g		Under – impaired immune function and growth (uncommon in Australia)

Source: Nutrient Reference Values for Australia and New Zealand, Ministry of Health, www.nrv.gov.au, accessed 8 March 2018. Based on material National Health and Medical Research Council. Released under a CC BY 4.0 AU licence.

Production

Protein production has traditionally been land- or ocean-based, using the earth or oceans to provide nutrients for animals and plants alike. The increasing demand around the world for quality protein, in particular animal-based protein, is expected to have a negative impact on the environment.

9780170418560

The demand for increased protein production will continue to rise as socio-demographics change (such as rising incomes and better education), the population continues to grow, and the average age of the population continues to rise. Much of the increased demand for animal-based protein products is from developing countries, where economic development and increased urbanisation are causing major transitions in the low- and middle-income populations.

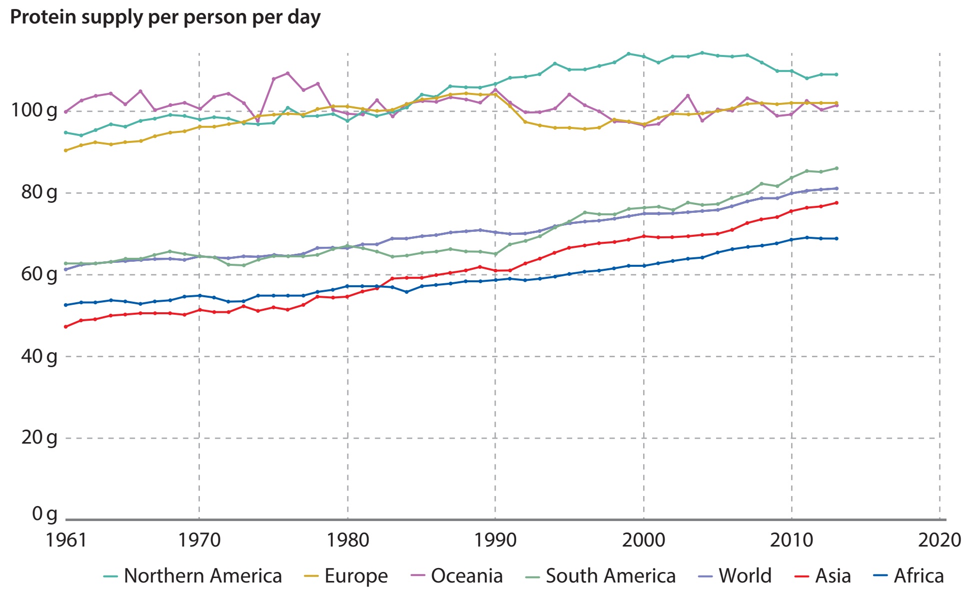
Increased demand for protein production has raised questions about environmental sustainability, including:

- increased greenhouse gas emissions if the supply of animal-based protein grows
- more land and water required for production of animal-based protein
- more land required to grow the animal feed for animal-based protein
- health concerns surrounding over-consumption of protein, particularly when it includes saturated fatty acids and processed meats
- ethical concerns surrounding animal production and treatment.

However, some of this increase in demand may be offset by a slowing or stabilising in the demand for animal protein in developed countries. Slowing demand in developed countries is attributed to increased awareness of the impact on the environment and on health of protein production and consumption. Ethical concerns surrounding animal welfare are also attributed.

Improvements in technology and innovation are opening new possibilities to produce protein in different ways. Improvements in the food system are helping to limit soil contamination, reduce water use and reduce air pollution, while making best use of diminishing world resources.

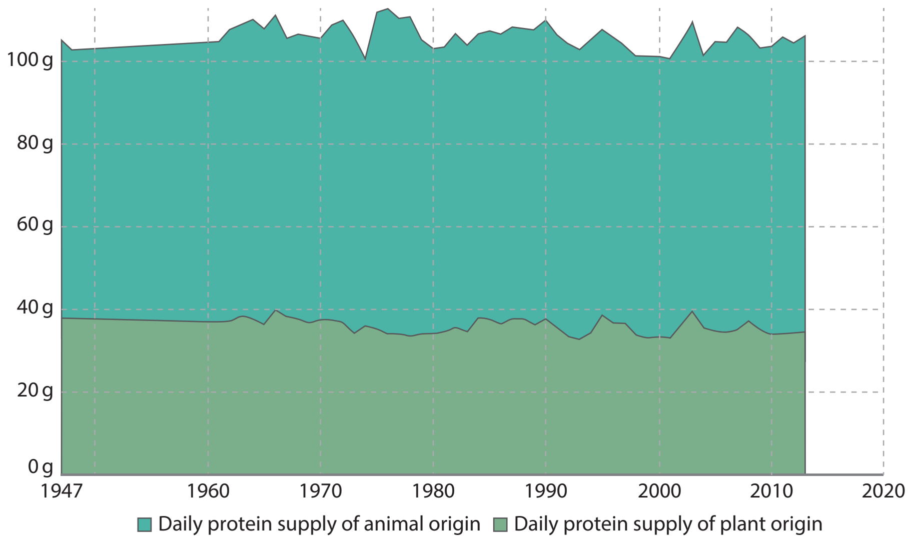
The UN projects global population growth to reach 11.2 billion by 2100. This is an 80 per cent increase from the year 2000. Projections are that animal-derived protein demand will double by 2050! This causes concerns about sustainability and food security.



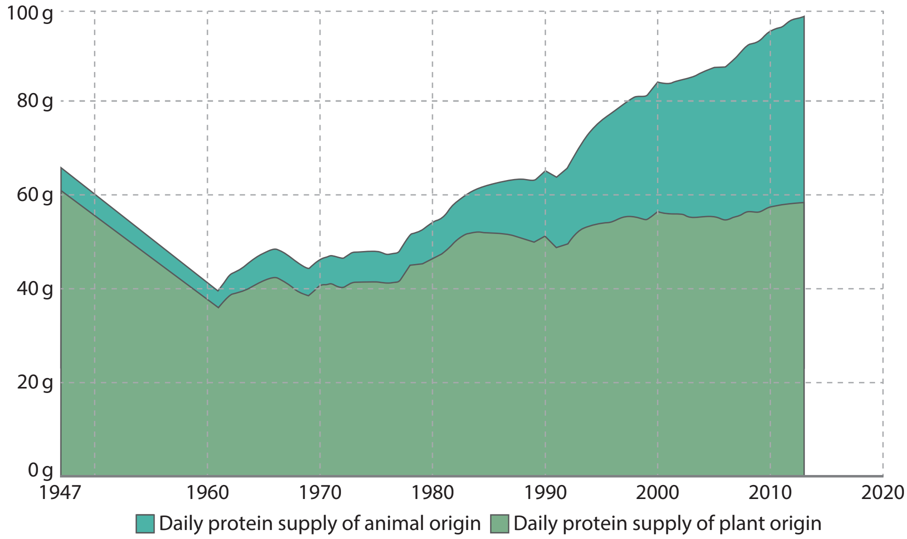
Source: Adapted from Max Rosa and Hannah Ritchie, Our World in Data, accessed 8 March 2018. Released under a Creative Commons, Attribution-Sharealike licence.

FIGURE 4.1 Steady protein supply can be seen in developed regions such as North America, Europe and Oceania, whereas a steady increase is seen in developing continents such as Africa, Asia and South America.

Daily protein supply from animal-based and plant-based foods, Australia



Daily protein supply from animal-based and plant-based foods, China



Source: Adapted from Max Rosa and Hannah Ritchie, Our World in Data, accessed 8 March 2018. Released under a Creative Commons, Attribution-Sharealike licence.

FIGURE 4.2 Australia's breakdown of plant and animal-based protein consumption has been steady over many years, but in China an increasing amount of animal-based protein in the daily protein supply is evident.

Food sources of protein

Food sources of protein are animal-based and include meat, dairy and eggs; and plant-based protein such as legumes (pulses and beans), nuts and grains.

Animal-protein-based foods are generally high in protein (grams per 100 grams).

9780170418560

Plant-protein-based foods can also be rich in protein. Increased knowledge of nutrition, better informed consumers and ethical concerns surrounding treatment of animals is driving some consumers to adopt a **vegetarian** or **vegan** lifestyle and increasing the consumption of plant-based protein in developed countries.

vegetarian
person who excludes meat (and by-products derived from a slaughtered animal such as gelatine and rennet) and fish from their diet

vegan
person who follows a diet that excludes any animal products from their diet, including milk, eggs and honey

Table 4.2 Amount of protein in 100 g of animal-protein-based foods

	FOOD (PER 100 g)	PROTEIN AMOUNT (g)
Meat	chicken breast (grilled without skin)	32.0
	pork chop (lean grilled)	31.6
	beef steak (lean grilled)	31.0
	lamb chop (lean grilled)	29.2
Fish	salmon (grilled)	24.2
	tuna (canned in brine)	23.5
	mackerel (grilled)	20.8
	cod (grilled)	20.8
Seafood	prawns	22.6
	mussels	16.7
	crabsticks	10.0
Eggs	chicken eggs	12.5
Dairy	cheddar cheese	25.4
	cottage cheese	12.6
	whole milk yoghurt	5.7
	lite milk	3.4
	whole milk	3.3

Shutterstock.com/Africa Studio

FIGURE 4.3 Some examples of animal-protein-based foods with high biological value

Shutterstock.com/Tara Grace

FIGURE 4.4 Plant-based protein foods are varied and important in all diets; variety is particularly important in vegetarian or vegan diets.

Table 4.3 Amount of protein in 100 g of plant-protein-based foods

	FOOD (PER 100g)	PROTEIN AMOUNT (g)
Pulses	chickpeas (cooked)	8.4
	red lentils (cooked)	7.6
Beans	tofu (soybean steamed)	8.1
	kidney beans (cooked)	6.9
	baked beans	5.2
Grains	wheat flour (brown)	12.6
	buckwheat (raw)	11.7
	rolled oats (raw)	11.0
	bread (brown)	7.9
	bread (white)	7.9
	pasta (fresh cooked)	6.6
	rice (easy cook boiled)	2.6
Nuts	peanuts	24.7
	almonds	21.1
	cashews	18.0
	walnuts	14.7
	hazelnuts	14.1
Seeds	sunflower seeds	21.0
	pumpkin seeds (pepitas)	19.0
	chia seeds	17.0
	quinoa (raw)	13.1

Amino acids

amino acids the building blocks of proteins

Protein is composed of **amino acids**, which are the building blocks of proteins. Amino acids are molecules of carbon, hydrogen, oxygen and nitrogen. Some amino acids also contain sulphur and phosphorus. There are 22 different amino acids.

Amino acids share the same basic structure:

- central carbon with hydrogen (H) atom
- a carboxyl group (COOH)
- an amino group (NH_2)
- a side or radical group, which is different for each amino acid and is what determines the 22 variations and chemical properties.

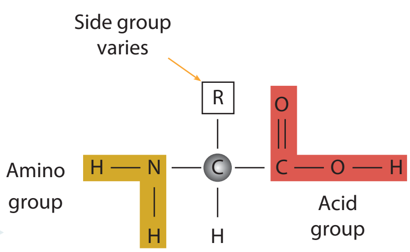
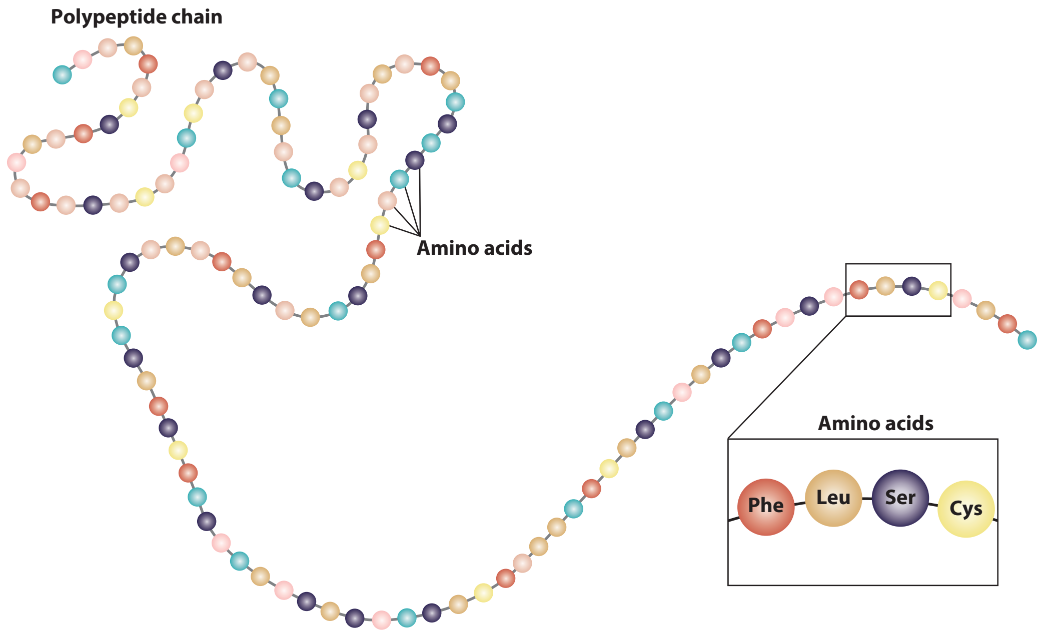


FIGURE 4.5 Amino acid structure

The 22 amino acids can join in various ways to form proteins. The join between the amino acids is called a peptide bond. Chains of amino acids are called polypeptides, also referred to as proteins. The polypeptides or proteins form two distinct shapes, globe-shaped (round) or fibrous shaped (elongated or long). The shape of the protein is important, as it will affect the functional properties of the protein.

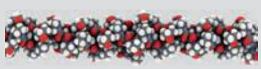
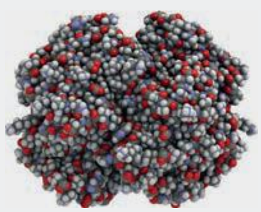


Amino acids

Ala: alanine	Glu: glutamic acid	Leu: leucine	Ser: serine
Arg: arginine	Gln: glutamine	Lys: lysine	Thr: threonine
Asn: asparagine	Gly: glycine	Met: methionine	Trp: tryptophan
Asp: aspartic acid	His: histidine	Phe: phenylalanine	Tyr: tyrosine
Cys: cysteine	Hyp: hydroxyproline	Pro: proline	Val: valine
Cys2: cystine	Ile: isoleucine		

FIGURE 4.6 Amino acids join together with peptide bonds to form polypeptide chains.

Table 4.4 Protein structures and food sources

STRUCTURE OF PROTEIN	PROTEIN NAME	FOOD SOURCE
Elongated (fibrous)  Shutterstock.com/molekuul_bet	collagen	connective tissue of meat, poultry, seafood
	myosin	muscle tissue of meat, poultry, seafood
	elastin	muscle tissue of meat, poultry, seafood
	gluten	wheat
	globulin	legumes, pulses and soybeans
Globe-shaped (globular)  Shutterstock.com/molekuul_be	caseinogen	milk curd (solids)
	lactalbumin	milk whey (liquid)
	lactoglobulin	milk whey (liquid)
	ovalbumin	egg white
	lipovitellin	egg yolk
	mucin	egg white

synthesise the process of producing chemical compounds

Of the 22 amino acids that humans need, the body can synthesise 14 in adulthood and 13 in infancy. This means there are eight amino acids (or nine in infancy) that the body cannot **synthesise** or produce. These eight amino acids must be consumed through the diet and are known as the essential amino acids.

Table 4.5 Amino acids

ESSENTIAL AMINO ACIDS	NON-ESSENTIAL AMINO ACIDS
isoleucine	alanine
leucine	arginine
lysine	asparagine
methionine	aspartic acid
phenylalanine	cysteine
threonine	cystine
tryptophan	glutamic acid
valine	glutamine
histidine (in infancy)	glycine
	hydroxyproline
	proline
	serine
	tyrosine
	histidine (in adulthood)

Animal protein contains all essential amino acids. Foods that contain all essential amino acids are known as complete proteins, and are said to have high biological value (HBV). Animal foods such as red meat, eggs, fish, poultry, milk and cheese are all considered complete proteins. Soybeans, buckwheat and quinoa are the only plant-protein-based foods that are considered complete.

If the protein lacks one or more essential amino acids, then it is said to be an incomplete protein and to have low biological value (LBV). Plant-based incomplete protein includes legumes, nuts, cereals and some vegetables. However, vegetarian diets that are varied still contain all amino acids and protein required for good health.

The quality of protein can be measured in various other ways. The aim of measuring the quality of protein is to determine the capacity of protein sources to meet the body's protein and essential amino-nitrogen requirements. This means satisfying the metabolic needs for amino acids and nitrogen. Over the years, various methods to determine protein quality have been used and reviewed by the food science community. The PDCAAS (Protein Digestibility Corrected Amino Acid Score) method was accepted for many years as the method to determine protein quality. Part of the criticism of this method was that the protein-based food was treated as a whole, not as individual amino acids. This sometimes results in overestimation of protein quality of poorly digestible proteins in supplemented foods or protein supplements and over-credits protein-based foods containing anti-nutritional components. It also does not take into account the bioavailability of individual amino acids.

An expert FAO consultation panel recommended in 2011: 'It is thus recommended that dietary amino acids be treated as individual nutrients and that wherever possible data for digestible or bioavailable amino acids be given in food tables on an individual amino acid basis.'

9780170418560

The FAO consultation panel recommended the digestible indispensable amino acid score (DIAAS) as the method to determine protein quality. The term 'bioavailability' encompasses three properties of foods that can alter the proportion of an amino acid that can be utilised. These are:

1 digestibility, which describes the net absorption of an amino acid
2 chemical integrity, which describes the proportion of the amino acid that, if absorbed, is in a utilisable form
3 freedom from interference in metabolism resulting from the presence in the food of substances that limit the utilisation of the amino acid.

Of these properties, the greatest reason for variation in bioavailability is usually digestibility.

REVIEW QUESTIONS ▶

1 **Summarise** the main functions protein plays in the body.
2 Identify the different types of animal- and plant-protein-based foods.
3 **Identify** the foods someone who identifies as a vegan does not eat. **Explain** how this diet may differ from a vegetarian diet.
4 **Outline** the factors that are contributing to the increased demand in protein around the world.
5 **Explain** the concerns surrounding increased production and consumption of animal-protein-based foods.
6 **Describe** the basic structure of an amino acid.
7 **Identify** the essential amino acids. **Explain** why they are considered essential.
8 When analysing the quality of protein, the FAO recommended using the DIAAS method. Briefly **describe** this method and what is meant by bioavailability in this context.

identify
distinguish; locate, recognise and name; establish or indicate who or what someone or something is; provide an answer from a number of possibilities; recognise and state a distinguishing factor or feature

Processing

Processing and cooking of both animal- and plant-protein-based foods occurs after slaughter or harvesting to improve palatability and prolong shelf life.

Processing and cooking techniques include:

- canning
- dehydration
- change of pH, e.g. addition of acid or alkali
- additives, e.g. salt or antioxidants
- physical manipulation, e.g. tenderisation, aeration
- application of heat, e.g. grilling, roasting, poaching, braising and frying.

Processing techniques

Food processing techniques are used to extend the shelf life and improve palatability of protein-based foods. Caution is essential as improper handling and storage of protein-based foods will cause biological deterioration. Food Standards Australia New Zealand (FSANZ) has rigid guidelines for Australian food processors to follow, with rigorous training and testing schedules in place to avoid foodborne illnesses. Food products that are processed outside Australia may not follow the same strict processing measures.

Canning

Many foods are canned to preserve them, so they can be used later. Canning is also popular as it is safe, inexpensive, relatively simple and offers convenience to consumers. The food is heated under steam pressure to temperatures of 116°C to 121°C to destroy microorganisms that cause food spoilage. The sensory qualities of the protein-based foods are altered by breaking links between amino acids, making the food less rigid, and smoother. Protein-based foods that are canned include meat, seafood, chicken and legumes. Foods are chosen at peak freshness to be preserved by canning. Seafood is usually packed after being boned or shelled; the bones of some fish such as salmon are softened (and made edible) by cooking. Meats are usually cooked before canning to soften the flesh, and then canned in flavoured sauces or dishes to mask flavour change, which can add value for the customer.

ACTIVITY 4.1

Aim

To **investigate** the process of canning fish

The canning process

STEPS

1. Watch the first part of the video on NelsonNet, showing the canning process for sardines, or conduct your own research to find a video that demonstrates the canning process.
2. Take notes during the video, noting the various steps in the canning process.
3. Prepare your notes in a flow chart that clearly identifies the steps in canning the food item.

Conclusions

1. **Describe** the safety and hygiene measures that are undertaken to ensure a safe food product.
2. **Explain** how the process improves the palatability of the raw sardines.

Taking it further

3. **Investigate** the canning of tuna, meat or beans. Are there differences in the canning process?

Dehydration

Dehydration is the process of removing moisture from food. It can be completed using a dehydrator, oven, indoor or air drying, sun or a microwave oven. Dehydration prolongs shelf life as moisture is removed from the food product, to a point that microorganisms cannot reproduce and cause the food to spoil. Meats such as beef, lamb and venison, and seafood and legumes can be dehydrated with very little change in nutrient value. However, water-soluble B-group vitamins will be lost. Lean meat is best suited to dehydration, as fat present in dehydrated meat will continue to go rancid after dehydration. Meat that is dehydrated shrinks in size, the colour darkens and the texture changes from soft to hard. Dehydrated meat has a longer shelf life and does not need to be refrigerated.

Shutterstock.com/HandmadePictures

FIGURE 4.7 Dried meat is darker in colour and can be stored outside of the refrigerator.

Change of pH through the addition of acid and alkali

All foods can be placed on the pH scale, which shows how acid or alkaline a food is. The pH scale starts at 0, for highly acidic, and ends at 14, for highly alkaline. The midpoint of the pH scale is 7 and substances with a pH of 7 are said to be neutral – water is an example of a pH neutral substance. Most foods have a pH of between 2 and 8; therefore, far more foods are acidic than alkaline. Both acidic and alkaline foods are useful in food processing.

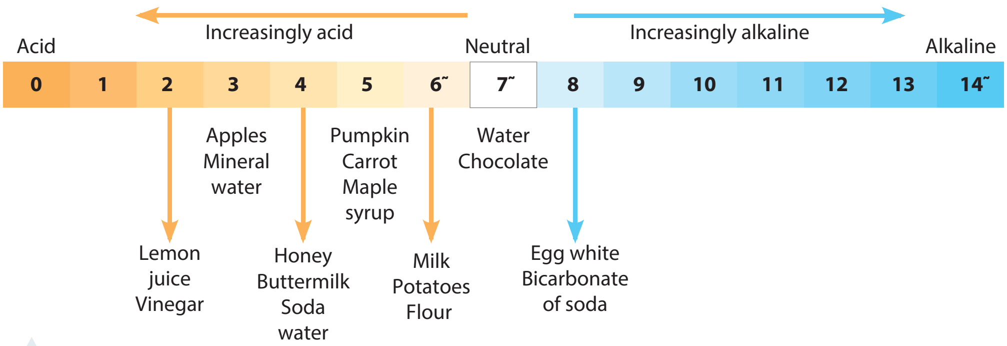


FIGURE 4.8 The pH scale

Addition of acid

Changing the pH of protein foods through the addition of acid will create an environment that slows the growth of microorganisms, preserving the food and extending the shelf life. The chemical and physical properties of the protein will be changed through the addition of acid. Both natural and **synthetic** acids are added to protein-based foods.

The following are examples of acids that can be added to protein-based foods to enhance palatability or help extend shelf life:

- vinegar (acetic acid)
- lemon juice (citric acid)
- soda water (carbonic acid).

Acid **denatures** protein and is commonly added to raw seafood protein items. Many seafoods do not contain connective tissue, which helps the denaturation process and gives a firmer, cooked texture and taste.

Marinades are another example of the addition of acid. Acids used for marinades include vinegar, citrus, such as lemon or lime juice, and tomatoes. The acid in the marinade denatures the surface of the protein-based food. This helps to tenderise the meat through the denaturation of protein and the meat absorbs flavour from the marinade. As a result, the meat is easier to chew and digest; it is also more palatable due to the added flavour.

When egg whites are beaten into a foam, air particles are produced between the protein molecules of the egg white. Addition of acid to an egg white foam increases the stability of protein molecules, reducing the chance of overbeating which causes lumps and loss of water due to collapse of the foam. Common acids added to egg white foam include cream of tartar, lemon juice or vinegar.

Other examples of adding acid to protein-based foods include the addition of acid to produce cheese such as paneer and ricotta. The acid and heat coagulate the proteins, forming the cheese. These cheeses do not melt when heat is applied later.

synthetic
chemical substances that are added to foods, that are not derived from a food itself

denature
permanently change the structure of protein; occurs when the bonds holding the helix shape are broken and the strands of the helix separate and unravel; a functional property of protein, useful in food preparation, e.g. whisking eggs or marinating a piece of meat (acid tenderises the meat before cooking)

Addition of alkali

Changing pH through the addition of alkali can also improve palatability of protein-based foods. Sodium bicarbonate (baking soda), which has a pH of 9, is commonly used.

Egg white has a pH of 7.5–8.5; it can also be used to improve palatability of food.

In Chinese cookery, a process known as 'velveting' is used to improve the texture of cooked meat and results in a more tender and juicy meat. Velveting involves marinating small pieces of meat in a solution of egg white, cornstarch and Chinese rice wine for at least 30 minutes prior to blanching or deep-frying.

Mark Fergus Photography

FIGURE 4.9 Velveting, an example of adding alkali to protein-based foods to improve texture

Additives

Food additives play an important role in maintaining the quality and characteristics of foods. They keep food safe, wholesome and appealing, from the farm to our plates. Careful regulation of additives means that consumers can have confidence in the Australian food system.

Additives used for protein-based food include salt, sugar and antioxidants.

Salt

Salt (sodium chloride) is added to protein-based foods to inhibit the growth of undesirable microorganisms. The salt draws the water from the cells of the food and therefore decreases the available water (a_w) for the growth of microorganisms. There are two basic methods of salting food:

1. **Dry salting:** the curing salt mix is directly applied to the surface of the meat. The meat is sealed tightly in plastic, then refrigerated to cure it. The excess salt is removed by rinsing the food, and then it is cooked to taste. This process is most suitable for ham, bacon and small cuts of meat.
2. **Brine curing:** salt and water are combined to create a brine solution. The brine can be pumped into the meat or used as a soaking bath. Refrigeration is required for the duration of the cure. The cured meat is cooked after the curing process takes place. Hams and larger pieces of meat can be cured in less time if a combination of these processing techniques is used. The use of this technique adds flavour and creates interesting colours after heat treatment, such as the pink or red colour in ham and bacon.

Sugar

Sugar is added to protein-based foods to sweeten the food and enhance its flavour. Sugar increases the temperature of coagulation in an egg mixture. Sugar will bind to the water molecules in the protein-based foods, such as egg mixture, delaying the coagulation of protein. This is seen in products like custards and curds, resulting in a firm, light texture.

Antioxidants

antioxidants chemicals approved for the control of oxidation (rancidity) in food products, including butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA) and propyl gallate

Addition of **antioxidants** to protein-based foods inhibits the rate of oxidation. Oxidation leads to the breakdown of foods. Antioxidants are often added to meat products to delay the development of 'off' flavours and to improve the flesh colour, flavour and appearance of meat. There are two types of antioxidants:

1. **Synthetic:** synthetic antioxidants are those that have been produced artificially. Examples of synthetic antioxidants include:
   - BHA – Butylated hydroxyanisole
   - BHT – Butylated hydroxytoluene

- PG – Propyl gallate
- TBHQ – tert-butylhydroquinone

2 **Natural:** natural antioxidants are found naturally in food. Examples of natural antioxidants include curry, green tea, rosemary, salt, peony root and cocoa leaf extract. Consumer demand for use of natural antioxidants in processing and preserving food has led to extensive research and development in this area. Reformulation of existing products has occurred to create new, healthier products.

Industry studies indicate that synthetic antioxidants have been identified as toxicological and carcinogenic agents.

carcinogenic
a substance or mixture that promotes the growth of cancer

Physical manipulation

Physical manipulation of protein involves manual or mechanical procedures that are applied to the food item. Two processes of physical manipulation of proteins are tenderisation and aeration.

Tenderisation

Meat texture is directly related to the size of muscle fibre and the amount of connective tissue present in the cut of meat. Large areas of connective tissue or muscle bundles can be tough, particularly if cooked quickly, making it difficult to digest. As consumers demand high quality protein that is palatable, tenderisation processes are used to break down protein and regulate the tenderness of meat products. The following are tenderising techniques:

1 Naturally occurring enzymes such as Papain from papaya and Bromelain from pineapple plants contain proteolytic enzymes, which break connective tissues in muscle mass, by denaturing or breaking amino acid bonds. This is similar to partial digestion in the human body, and can help to tenderise meat products prior to cooking.

2 Physical manipulation of muscle tissue can tenderise meat, making fibres softer and easier to chew. This can be achieved through use of a meat mallet, pounder or a blade tenderiser. An industrial style tenderiser will have needles or blades that pierce the meat. This technique makes tough cuts of meat more palatable and tender.

Shutterstock.com/Gavran333

FIGURE 4.10 A meat mallet is an easy way to tenderise meat prior to cooking.

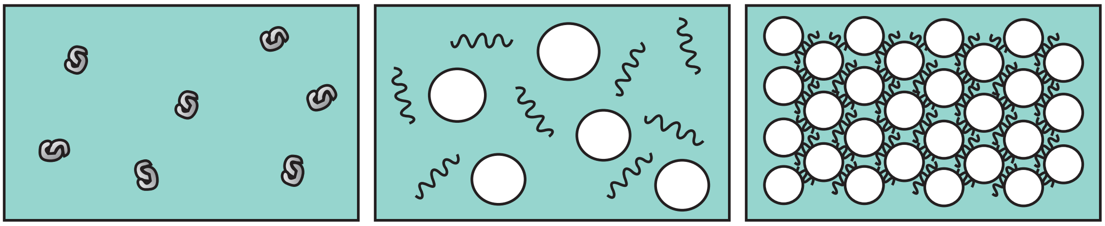
Skyfood Equipment LCC. Reproduced with permission.

FIGURE 4.11 Industrial-style meat tenderiser, used to tenderise meat for mass production

Aeration

The physical agitation of egg white protein causes the protein molecules to denature or unfold. The protein molecules align themselves between the air and the water, encapsulating the air and forming bubbles. The more agitation in the form of beating, the more bubbles are formed and the finer and more even the bubbles become. Egg whites can foam up to six times their original volume. However, it is possible to overbeat an egg white foam, causing it to deflate and dry out. Egg white foams are not stable and will lose aeration and return to a liquid state unless a stabilising ingredient such as sugar is incorporated. If sugar is added before foaming or added too quickly, it can lessen the foaming effect. Eggs foam better at room temperature and when they are fresh. It should be noted that even a small amount of fat can stop the egg white foam from forming as it will bond with protein molecules instead of protein molecules bonding together. For this reason, care should be taken when separating egg whites from yolks, as any yolk in the white can stop the foam from forming. The bowl and beating equipment should also be clean and free from any fat that may be present from previous use.

Aeration of egg white protein will enable different textures to be achieved in food products, increasing the variety of products that can be produced from eggs.



Raw egg white:
90% water and almost 10% protein

When whipped a little:
large air bubbles are mixed into the egg white and the proteins are denatured

When foam is complete:
denatured proteins are oriented around smaller air bubbles

FIGURE 4.12 Egg foam formation

Effect of cooking methods on protein

Cooking or the application of heat to protein-based foods is used to increase the palatability of the food. The heat coagulates the proteins, altering the sensory properties of the food, including the flavour, texture and colour. Cooking will also extend shelf life, due to killing or reducing food-poisoning bacteria to a safe level.

The process for applying heat to protein-based food items determines the final sensory properties of the food. Grilling, roasting, poaching, braising and frying are examples of heat methods that can be applied to protein items. The application of heat and cooking methods for protein are outlined in Table 4.6 (pages 98–99).

EXPERIMENT 4.1

Denaturation

AIM

To **investigate** foam formation and stability by dispersing gas in an animal-protein molecule matrix

BACKGROUND

Egg white foams when agitated

The protein albumen is denatured as it stretches, forming a thin film where the albumen traps the pockets of air to form a foam. Egg white foams are used in food formulations to add lightness in texture and contribute to leavening. They are used in foods such as meringues, pavlova, sponge cakes and fluffy omelettes.

9780170418560

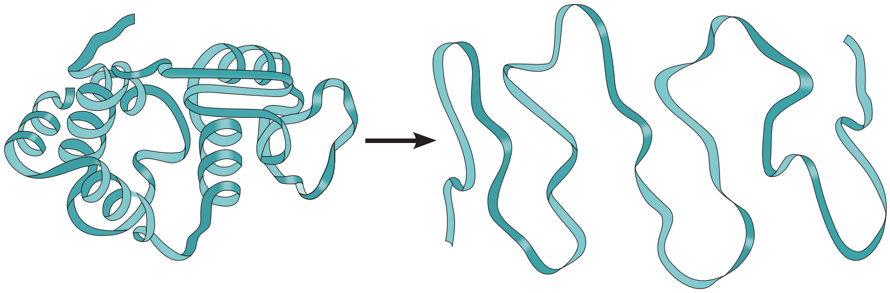


FIGURE 4.13 Normal active protein and denatured protein structure

- Overbeating causes the albumen to become thin and less elastic, and after cooking the air expands and breaks the cell walls.
- Impurities in the egg foam will prevent foaming. Small amounts of fat (from egg yolk as well as oils) and water prevent foaming. It is important to use clean, dry equipment to foam eggs.
- Addition of acid (cream of tartar) to egg white foams will make the foam more stable but increases beating time. The acid helps to denature the protein and also neutralises the charges on the proteins, which makes them more likely to come together and form a network around the air bubbles.
- Sugar can be added at the soft peak point. This can help to stabilise the mixture.
- The addition of salt will increase the stability of the foam and increase beating time.

INSTRUCTIONS

PREPARATION

Prepare one (1) formulation of meringue, following the instructions for the control procedure.
Prepare one (1) formulation of each variable.

CONTROL	VARIABLE 1	VARIABLE 2	VARIABLE 3
Produce one formulation of each meringue following the procedure	Add the sugar at the beginning of the beating procedure	Add twice the cream of tartar and follow the procedure	Add a drop of egg yolk to the control formulation

FOOD COMPONENTS

- 2 egg whites, at room temperature
- a pinch of salt
- ⅛ teaspoon cream of tartar
- ½ cup castor sugar
- ¼ teaspoon vanilla extract

EQUIPMENT

- baking paper
- tray
- bowl (stainless steel or glass)
- timer
- electric mixer
- measuring cup and spoon
- spatula

PROCEDURE

1. Place baking paper onto a tray ready for the meringues.
2. Separate the eggs, placing the egg whites into a clean, dry bowl.
3. Start the timer and use an electric beater to beat the egg whites and salt until soft peaks form. Record the time taken.
4. Gradually add the cream of tartar and then the sugar, beating well between each addition. Beat for 3 minutes on high until firm peaks form, then add the vanilla. Record the time taken.
5. Use the control formulation for coagulation experiment 1 immediately.

RESULTS ANALYSIS

1. **Compare** the quality and stability of the foam after each batch, prior to baking.
   a. quality of foam – beating time
   b. stability of the foam
   c. appearance
   d. texture
2. Prepare a report addressing the following:
   a. **Draw conclusions** about the best food formulation to produce egg-based meringues by denaturation of the protein. Use your knowledge of scientific principles of denaturation of protein to explain how the chosen formulation produced the best foam and sensory properties.
   b. Use your knowledge of scientific principles of denaturation to **explain** why the other formulations did not produce a good result.

EXPERIMENT 4.2

aquafaba the cooking liquid of chickpeas; can be used to replace egg whites for beating to a foam

emulsification the process of making into an emulsion, the suspension of a liquid in another liquid

Denaturation

AIM

To **investigate** foam formation and stability in chickpea water (**aquafaba**)

BACKGROUND

Aquafaba, or bean water, is a relatively new discovery and is said to have revolutionised the vegan world. It has a structure that is able to perform many of the properties of eggs, such as foaming, binding and **emulsification**. Aquafaba contains proteins and carbohydrates that have seeped into the water during the cooking process. It can be used as a substitute for egg whites in various food formulations. The proteins in aquafaba unfold as it is beaten and this allows the protein molecules to attract other protein molecules. The denatured proteins bond together, creating a foam and holding the air molecules in place.

- Beating of aquafaba requires a long time to denature the proteins and create a foam, forming a thick film around the air bubbles.
- Impurities added to the aquafaba will prevent foaming. Small amounts of fat or water will prevent foaming. It is important to use clean, dry equipment to foam aquafaba.
- The addition of acid is not required; however, it is thought to add stability and firm up the peaks of the foam.
- The addition of sugar stabilises the foam and stops it from deflating. Sugar is added to the foam after it is beaten to firm peaks, as sugar will delay the formation of the foam if added too early.
- The addition of salt to aquafaba is unnecessary as most tins of chickpeas already contain sodium.

INSTRUCTIONS

PREPARATION

1 Prepare one (1) formulation of meringue following the instructions for the control procedure.
2 Prepare one (1) formulation of each of the other variables for analysis.

CONTROL	VARIABLE 1	VARIABLE 2	VARIABLE 3
Produce one formulation of each meringue following the procedure	Add the sugar at the beginning of the beating procedure	Add twice the cream of tartar and follow the procedure	Add a drop of egg yolk to the control formulation

FOOD COMPONENTS

- 1 can chickpeas (low sodium is recommended)
- 1 teaspoon cream of tartar
- 1 teaspoon vanilla
- 120 g castor sugar

EQUIPMENT

- baking paper
- tray
- bowl (stainless steel or glass)
- measuring jug, cup and spoon
- electric mixer
- timer
- spatula

PROCEDURE

1 Place baking paper onto a tray ready for the meringues.
2 Drain the chickpeas and retain the liquid – aquafaba. Measure the liquid.
3 Measure out an equal weight to the aquafaba of castor sugar in a separate measuring cup.
4 Pour the aquafaba into a large, clean, dry bowl and add the cream of tartar.
5 Start the timer and beat with the electric mixer until it begins to foam. Record the time taken.
6 Continue beating until aquafaba is foamy and glossy. This may take about 20 minutes. The mixture should not move in the bowl when the bowl is held upside down. Record the time taken.
7 Add the vanilla and slowly add the sugar while still beating. The mixture will thicken and must hold soft peaks. Record the time.
8 Use the control formulation immediately.

RESULTS ANALYSIS

1 **Compare** the quality and stability of the foam after each batch, prior to baking.
   a quality of foam – beating time
   b stability of the foam
   c appearance
   d texture
2 Prepare a report addressing the following:
   a **Draw conclusions** about the best food formulation to produce aquafaba meringues by denaturation of the protein. Use your knowledge of scientific principles of denaturation of protein to explain how the chosen formulation produced the best foam and sensory properties.
   b Use your knowledge of scientific principles of denaturation to **explain** why the other formulations did not produce a good result.

EXPERIMENT 4.3

Coagulation of egg white and aquafaba foam


Terry McCarten

FIGURE 4.14 Coagulation of aquafaba

AIM

To **determine** optimum conditions to complete foam coagulation with desirable sensory properties when making meringues from animal (egg white) and plant (chickpea water – aquafaba) proteins

BACKGROUND

Coagulation occurs after denaturation

When foams for meringues are created using egg whites or aquafaba, denaturation of the protein occurs due to the physical agitation by beating or whisking. As beating continues, the proteins also start to coagulate. During this stage, acid can be used to slow coagulation and allow more air to be beaten into the foam.

Once the foam is stable and has optimum volume, coagulation is completed by heating the meringue foam at a low temperature. The air bubbles expand, the water evaporates and the proteins coagulate at an even rate throughout the meringue. The temperature and baking time is very important:

- The oven temperature needs to be hot enough (e.g. 120°C) to set the outside. The temperature needs to be immediately reduced to a lower temperature (e.g. 90°C) to allow the insides to dry out.
- If the temperature is too high the proteins set before the water inside has time to evaporate. The water dissolves the sugar to form syrupy beads on the surface, causing the centres to be sticky and chewy.
- Meringues are 'dried out' in the oven rather than cooked so leaving them in the oven until the oven is completely cool is recommended.

INSTRUCTIONS

PREPARATION

CONTROL	VARIABLE 1	VARIABLE 2	VARIABLE 3
Bake as per procedure	Remove from oven as soon as the cooking time is completed	Increase the oven temperature to 180°C. Bake until light golden	Leave out of oven for 15 minutes then bake as per procedure

9780170418560

PROCEDURE

1 Preheat the oven to 120°C.
2 Use teaspoons and a spatula to spoon the meringue mixture well-spaced onto the baking tray.
3 Reduce the oven temperature to 90°C and bake for 1 hour and 30 minutes. Turn off the oven and allow to cool overnight.

RESULTS ANALYSIS

1 After baking the control batch, **compare** the sensory properties:
   a quality of baked product – setting quality
   b appearance – colour and shape
   c flavour – this is a combination of taste and aroma, as well as **mouthfeel** experience – the whole sensory experience when eating the product.
   d texture – sensory properties.
2 Prepare a report addressing the following:
   a **Draw conclusions** about the best application of heat to produce egg-based and aquafaba meringues with desirable sensory properties. Use your knowledge of scientific principles of coagulation of protein to explain how the chosen variable produced the best meringue.
   b Use your knowledge of scientific principles of coagulation to **explain** why the other heat applications did not produce a good result.

mouthfeel
a food product's physical and chemical interaction in the mouth, specifically the texture of the food in the mouth

EXPERIMENT 4.4

Effect of an acid as a coagulation method

AIM

To **determine** optimum conditions for coagulation of protein molecules in milk, using acid, when producing formulations for cottage cheese and ricotta with desirable sensory properties

BACKGROUND

Acids are used to coagulate protein-based foods. The protein molecule casein is coagulated from milk using an acid, which will form cottage cheese. By using lemon juice, ricotta can be produced.

Lowering the pH of milk causes the milk proteins, such as casein, to unwind and unfold, causing the protein to denature. The unwound proteins clump together to cause a curdled appearance.

Acids such as vinegar (acetic acid) and citric acid (lemon juice) are used in milk to create different cheeses.

INSTRUCTIONS – COTTAGE CHEESE

PREPARATION

Prepare one (1) formulation following the instructions for the control procedure.

FOOD COMPONENTS

- 500 mL skim milk
- 15 mL vinegar
- a pinch of salt

EQUIPMENT

- measuring jug
- saucepan
- food-grade thermometer
- colander
- cheesecloth or paper towels
- large bowl

PROCEDURE

1. Heat the milk in a saucepan to 88°C. If you do not have a thermometer, heat until just before the milk begins to simmer, then take off the heat.
2. Add the vinegar.
3. Allow the mixture to cool.
4. Line a colander with cheesecloth or paper towel. Place the colander over a large bowl. Pour the curd mixture into the colander.
5. Put the curds into a bowl and add salt to taste.

RESULTS ANALYSIS

Record the sensory properties and food structure of the control curd:

- a quality of curd – setting quality
- b texture – mouthfeel
- c appearance – colour and shape of curd
- d flavour – a combination of the taste and aroma as well as mouthfeel experience – the whole sensory experience when eating the product.

INSTRUCTIONS – RICOTTA

PREPARATION

Prepare one (1) formulation following the instructions for the control procedure.

FOOD COMPONENTS

- 1 cup whole milk
- 1 tablespoon strained freshly squeezed lemon juice
- ⅛ tsp salt

EQUIPMENT

- measuring jug
- saucepan
- colander
- cheesecloth or paper towels
- large bowl

PROCEDURE

1. Place milk in a saucepan (high heat) and bring to the boil.
2. Remove from heat and stir in lemon juice and salt. Let stand, without stirring for approximately 10 minutes until small curds form.
3. Line a colander with cheesecloth or paper towel – two layers. Place the colander over a large bowl.
4. Pour the curd mixture into the colander in small amounts, allowing the liquid to drain between each addition.

9780170418560

5 Stand for 20 to 30 minutes to allow the whey to drain from the cheese. The more whey that drains, the thicker the ricotta cheese will be.
6 The ricotta will keep for up to a week in the refrigerator. The whey can be used and will keep for up to 4 days.

RESULTS ANALYSIS

Record the sensory properties and food structure of the curd:

a quality of curd – setting quality
b texture – mouthfeel
c appearance – colour and shape of curd
d flavour – a combination of the taste and aroma as well as mouthfeel experience – the whole sensory experience when eating the product.

EXPERIMENT 4.5

Effect of enzymes as a coagulation method

AIM

To **determine** optimum conditions for coagulation of protein molecules in milk using enzymes when producing formulations

BACKGROUND

Enzymes are used to coagulate milk to produce curds and whey. The proteolytic enzyme, renin, coagulates the protein in milk – casein. Renin is an enzyme synthesised by cells in the stomach. The role of renin in the stomach is to curdle or coagulate milk. The protein casein coagulates to form a soft curd and is high in calcium and easy to digest. It is used as a dessert.

- Effect of temperature – the best temperature for formation of the curd is 37°C. With a lower temperature, the reaction is very slow and if the temperature is too high the renin is denatured and made inactive.
- Milk composition – whole milk is more effective than fat-reduced milk.

INSTRUCTIONS – JUNKET

PREPARATION

Prepare one (1) formulation of following the instructions for the control procedure.

FOOD COMPONENTS

- 500 mL fresh milk (long-life milk is not suitable)
- 1 junket tablet for plain junket (or 2 junket tablets for flavoured junket)
- 1 tablespoon cold water
- 2 tablespoons castor sugar
- nutmeg, if desired

EQUIPMENT

- saucepan
- food-grade thermometer
- spoon
- measuring jug
- dessert bowls
- roasting pan for water bath

PROCEDURE

1. Warm fresh milk and sugar gently to lukewarm (e.g. 37°C). If you overheat the milk, allow it to cool to 37°C.
2. Dissolve the junket tablets in cold water. Stir the dissolved junket tablets into the milk quickly (do not over-stir) and pour into dessert bowls.
3. Stand the bowls in a warm water bath to allow the junket to set. This will take approximately 15 minutes.
4. Once set, put the bowls into the refrigerator to chill. Sprinkle with nutmeg if desired.

RESULTS ANALYSIS

Record the sensory properties and food structure of the curd:

- a quality of curd – setting quality
- b texture – mouthfeel
- c appearance – colour and shape of curd
- d flavour – a combination of the taste and aroma as well as mouthfeel experience – the whole sensory experience when eating the product.

EXPERIMENT 4.6

Effect of salt as a coagulation method

AIM

To **determine** optimum conditions for coagulation of protein molecules in soy milk using salt when producing formulations for tofu

BACKGROUND

Soy protein can be made into milk and coagulated using salt. There are a variety of salts that can be used for this purpose. Magnesium sulphate (Epsom salts), magnesium chloride (nigari) and calcium sulphate (gypsum). Most supermarkets sell Epsom salts. Soybean proteins are called globulins and are soluble in salts. A bond is caused by the magnesium ions being attracted to the protein molecules, causing the proteins to coagulate.

The softness of the curd is dependent on the quantity of water in the tofu.

The by-product is okara. Okara can be used in vegan food formulation to make muffins, crackers and okara chocolate pudding pie.

9780170418560

INSTRUCTIONS – CONTROL

PREPARATION

Prepare one (1) formulation following the instructions for the control procedure.

FOOD COMPONENTS

- 1 cup dry soybeans (or use 1 litre of processed soy milk and start at step 7)
- 14 g Epsom salts (or 2 teaspoons if using processed soy milk)
- 4 cups water (no water if using processed soy milk)

EQUIPMENT

- colander
- food processor or blender
- 2 large saucepans
- strainer or sieve
- mesh bag or layers of cheesecloth
- food-grade thermometer

PROCEDURE

1. Soak soybeans in water overnight in the refrigerator.
2. Wash the soaked beans using a colander and remove any discoloured beans.
3. Add half the soaked beans to the blender or food processor and add enough water to cover the beans. Blend. Repeat with remaining beans.
4. Add the processed beans to a large saucepan with 4 cups of water.
5. Bring to the boil and simmer for about 20 minutes. The mixture will foam up so do not let it boil over.
6. Strain the milk into the second saucepan, pressing out as much of the milk as possible. The liquid is soy milk while the solids are known as okara.
7. Place the saucepan on the stove and heat the soy milk to 82°C.
8. Dissolve the Epsom salts in ½ cup of warm water.
9. Remove soy milk from heat and very gently stir the salt-water mixture into the soy milk. Too much stirring will stop the coagulation from occurring. The curds will separate in about 5 to 10 minutes.
10. Line the colander with a mesh bag or cheesecloth. Use the strainer or sieve to remove the curds from the saucepan and pour them into the mesh bag. Press down with a plate and a heavy item.
11. Leave for 20 minutes. The solid in the mesh bag is the tofu. There will be soy milk, okara and tofu. Store the tofu covered in fresh water in the refrigerator. Change the water every day and it will keep for a week.

RESULTS ANALYSIS

Record the sensory properties and food structure of the curd:

a. quality of curd – setting quality
b. texture – mouthfeel
c. appearance – colour and shape of curd
d. flavour – a combination of the taste and aroma as well as mouthfeel experience – the whole sensory experience when eating the product.

EXPERIMENT 4.7

Effect of heat as a coagulation method

AIM

To **determine** optimum conditions for coagulation of protein molecules in raw egg, using heat when producing formulations

BACKGROUND

Heat is used to coagulate protein-based foods. Raw egg coagulates when heat is applied. Eggs are used in many food formulations such as meringue, custard, frittata and quiche formulations. The mixture of eggs, milk and sometimes sugar is the key for the sensory properties of these formulations.

- When mixtures containing eggs and milk are heated the proteins in the egg yolk begin to unwind.
- Addition of sugar to a mixture gives the proteins more time to interact with the minerals, forming connections and becoming thicker. The unwinding process is slowed down by the water in the milk and the sugar.
- Temperature needs to increase slowly to ensure that the correct texture is achieved. The result is a smooth and fine formulation of egg proteins in custards, quiche and frittatas.
- Frittata and quiche – the difference between a frittata and a quiche is that a frittata is cooked on the stove and cooking may be finished up in the oven or under a grill. A quiche is baked in the oven and usually has pastry. The food formulations are similar. In the formulations for quiche and frittata the egg proteins unwind and form a bond, trapping milk and cream in a soft gel.

Investigation will be carried out to determine how each formulation affects sensory properties.

INSTRUCTIONS – BAKED EGG CUSTARD

PREPARATION

Prepare one (1) formulation of baked egg custard, following the instructions for the control procedure.

FOOD COMPONENTS

- 1 egg and 1 egg yolk
- ½ teaspoon vanilla extract
- 200 mL cream (or use half milk, half cream)
- 20 g castor sugar
- nutmeg to dust

EQUIPMENT

- bowl
- fork
- saucepan
- sieve
- baking dish
- roasting pan for water bath

PROCEDURE

1. Preheat the oven to 170°C.
2. Add the whole egg, egg yolk and vanilla to a bowl and beat together with a fork.
3. Put the cream and sugar in the saucepan and heat to just below boiling point. Stir to dissolve the sugar.
4. Add the cream mixture to the eggs stirring all the time.
5. Strain through a sieve.
6. Pour the mixture into a baking dish and stand the baking dish in the roasting pan. Add hot water to the roasting pan until it is half way to the top of the baking dish.

9780170418560

7 Lightly dust with nutmeg if desired.
8 Bake in 170°C oven for 20 to 30 minutes or until the custard is set to a soft curd.

RESULTS ANALYSIS

Record the sensory properties and food structure of the curd:

a quality of curd – setting quality
b texture – mouthfeel
c appearance – colour and shape of curd
d flavour – a combination of the taste and aroma as well as mouthfeel experience – the whole sensory experience when eating the product.

INSTRUCTIONS – EGG CUSTARD OR CRÈME ANGLAISE

PREPARATION

Prepare one (1) formulation following the instructions for the control procedure.

FOOD COMPONENTS

- 100 mL cream
- 100 mL milk
- ½ teaspoon vanilla extract (or 6-cm piece of vanilla pod)
- 2 egg yolks
- 40 g castor sugar

EQUIPMENT

- saucepan
- bowl
- whisk
- measuring jug and spoons
- sieve

PROCEDURE

1 Place cream and milk in the saucepan.
2 Add vanilla extract or scrape seeds from vanilla pod and add seeds and pod.
3 Heat until the mixture begins to simmer and remove from heat. Remove the vanilla pod if used.
4 Whisk the egg yolks and sugar in a bowl until light in colour.
5 Pour hot milk into the yolk mixture, whisking all the time.
6 Pour the custard into the saucepan and stir over a low heat until the custard thickens (about 5 minutes). The back of the spoon should be coated with a layer of custard.
7 Pour the custard through the sieve to strain, cover and refrigerate.

RESULTS ANALYSIS

Record the sensory properties and food structure of the control curd:

a quality of curd – setting quality
b texture – mouthfeel
c appearance – colour and shape of curd
d flavour – a combination of the taste and aroma as well as mouthfeel experience – the whole sensory experience when eating the product.

INSTRUCTIONS – FRITTATA

PREPARATION

Prepare one (1) formulation following the instructions for the control procedure.

FOOD COMPONENTS

- 1 tablespoon olive oil
- 1 spring onion, finely sliced
- 2 tablespoons frozen peas, thawed
- ½ zucchini, grated
- 1 slice ham, diced
- 2 eggs
- 50 g feta cheese

EQUIPMENT

- sharp knife
- chopping board
- grater
- bowls
- measuring spoon
- heavy frying pan
- fork

PROCEDURE

1. Heat olive oil in a heavy frying pan. Add the spring onion, peas, zucchini and ham and cook for 4 minutes. Spread the mixture evenly across the base of the pan.
2. Lightly beat the eggs together in a bowl and add crumbled feta. Pour over the spring onion mixture in the pan.
3. Cook on the stove over low to medium heat until the mixture comes away from the sides, being careful not to burn the bottom.
4. Place under grill or in the oven and cook until the egg mixture is set. Allow to cool a little and turn out onto a plate.

RESULTS ANALYSIS

Record the sensory properties and food structure of the curd:

a. quality of curd – setting quality
b. texture – mouthfeel
c. appearance – colour and shape of curd
d. flavour – a combination of the taste and aroma as well as mouthfeel experience – the whole sensory experience when eating the product.

INSTRUCTIONS – QUICHE

PREPARATION

Prepare one (1) formulation following the instructions for the control procedure.

FOOD COMPONENTS

- 1 pre-made or purchased shortcrust pastry shell
- 1 spring onion, finely sliced
- 2 tablespoons frozen peas, thawed
- ½ zucchini, grated
- 1 slice ham, diced
- 2 eggs
- 50 g feta cheese
- 1 tablespoon olive oil

9780170418560

EQUIPMENT

- bowl
- sharp knife
- grater
- fork
- measuring spoon

PROCEDURE

1 Spread the spring onion, peas, zucchini and ham evenly across the base of the pastry shell.
2 Beat the eggs together and add crumbled feta. Pour over the spring onion mixture in the pastry.
3 Bake in the oven for 20 minutes or until the egg mixture is coagulated and set.

RESULTS ANALYSIS

Record the sensory properties and food structure of the curd:

a quality of curd – setting quality
b texture – mouthfeel
c appearance – colour and shape of curd
d flavour – a combination of the taste and aroma as well as mouthfeel experience – the whole sensory experience when eating the product.

CONCLUSIONS

1 Using the observations from each of the food formulations for coagulation of protein **analyse** the results in your report:

a **Identify** the different coagulation methods for coagulating protein-based foods.
b From your observations, **describe** the different methods of coagulation and explain the resulting sensory properties of each food.
c **Explain** how different coagulation methods affect food structure.
d **Draw conclusions** about the correct use of protein coagulation methods for specific food formulations.

TAKING IT FURTHER

2 **Analyse** the information and data from the food science experimentation to **explain** the difference between denaturation and coagulation.

Consumption

Various processing and cooking techniques are required before animal-protein-based foods can be consumed. Different parts or cuts of meat require different cookery techniques, so the protein can be consumed, and for acceptable palatability. For example, cuts of meat that are tougher require slower cooking techniques to soften the meat for consumption. The physical characteristics of meat will determine the most suitable cooking techniques.

The flesh or the muscular tissue of the animal is composed of fine fibres, which are not visible to the naked eye. The fibre is elongated with **striations**, and they differ in length.

striation
muscle that is different from smooth muscle, as it has striped dark and light colour across the muscle

The length of the fibres depends on their function in the animal's body, the age of the animal and the amount of activity the animal has had in its life. The muscle fibres are shorter when the animal is younger or in parts of the body where the muscle is not used for exercise.

If the cut of meat contains a high amount of connective tissue, then it will be tougher when cooked. The cuts of meat that will have a high amount of connective tissue are usually from those parts of the animal that are used most, for example, legs, shoulders, neck and forequarters. The more tender cuts of meat are those that are from parts of the body that are used less often, such as the ribs and back of the animal.

Tougher cuts of meat are most suited to cookery in or surrounded by liquid. This allows the connective tissue when heated to become tender, as the collagen chemically changes to become gelatine (a jelly-like substance when cool). Longer cooking times are essential for the tenderisation process to occur, allowing the meat to soften. The moist heat cookery methods include braising and stewing.

The tender cuts of meat, which have less connective tissue and smaller muscle fibre cells, can be cooked more quickly, such as with dry heat, grilling/barbecuing and frying. These cuts of meat are also easier to chew due to the short length of muscle cell fibres. Tender cuts of meat are usually more expensive to purchase, but are suitable for quick cooking and busier lifestyles.

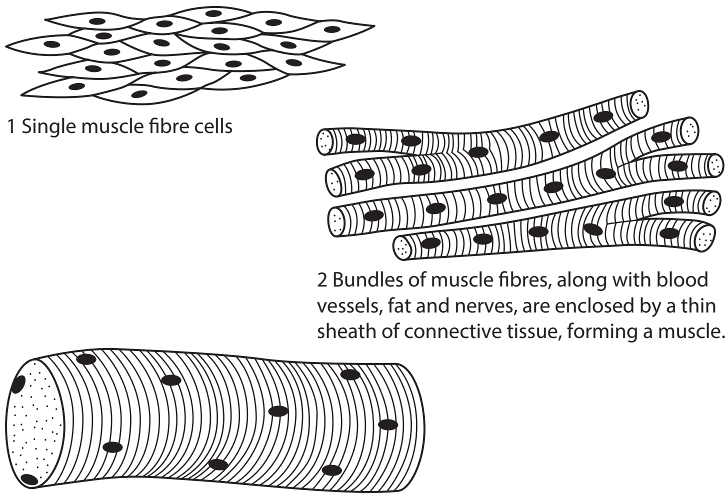


FIGURE 4.15 Structure of muscle fibres and connective tissue

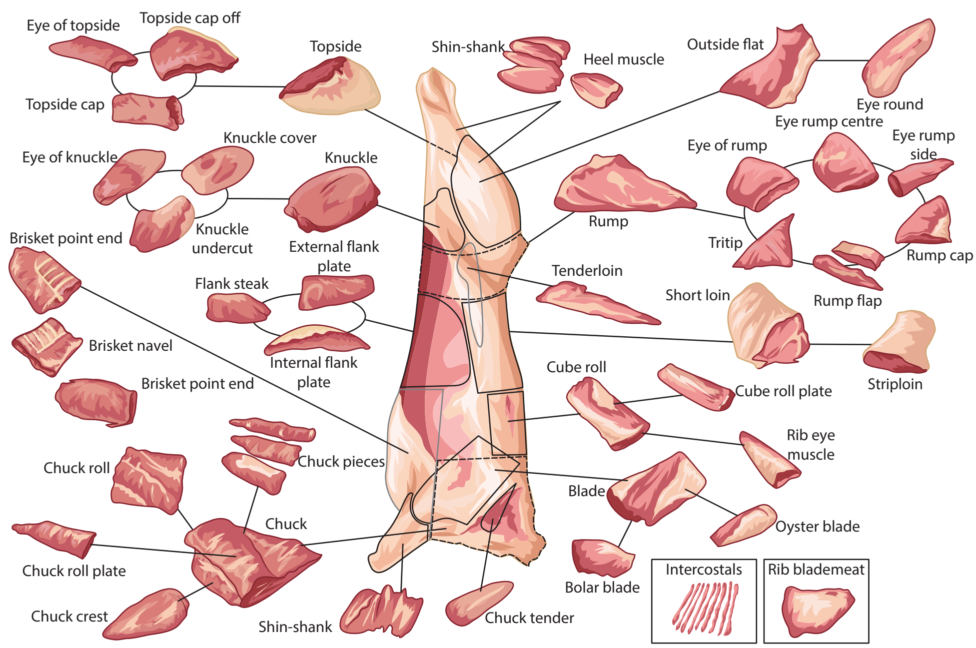


FIGURE 4.16 Australian standard cuts of beef

9780170418560

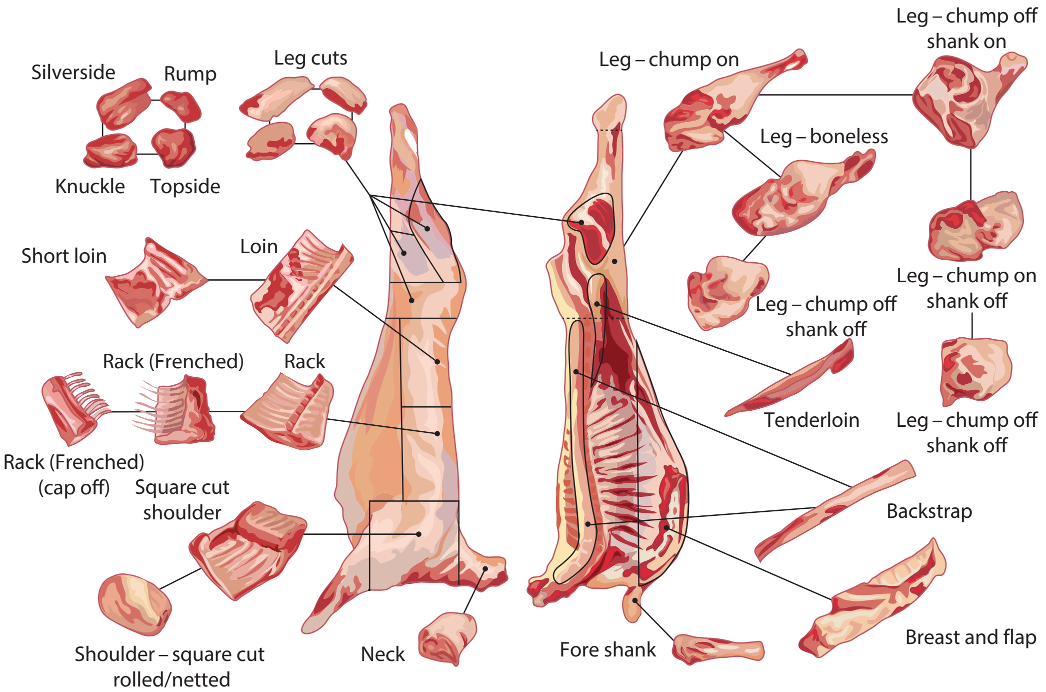


FIGURE 4.17 Australian standard cuts of lamb

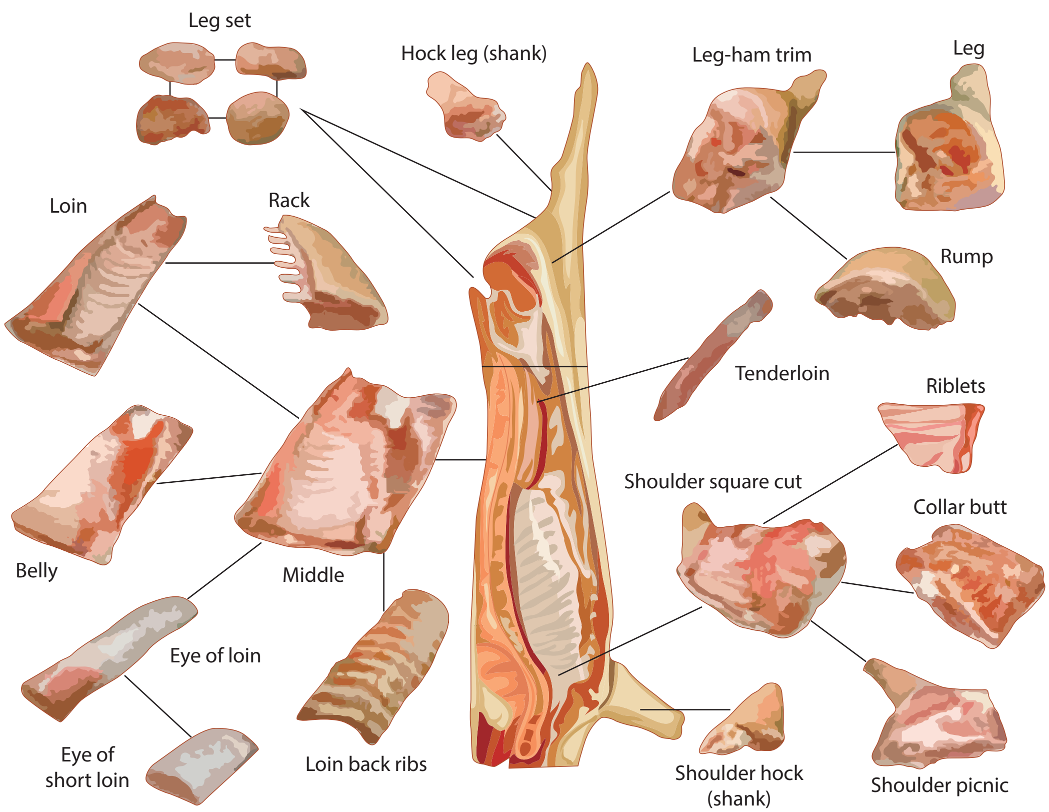
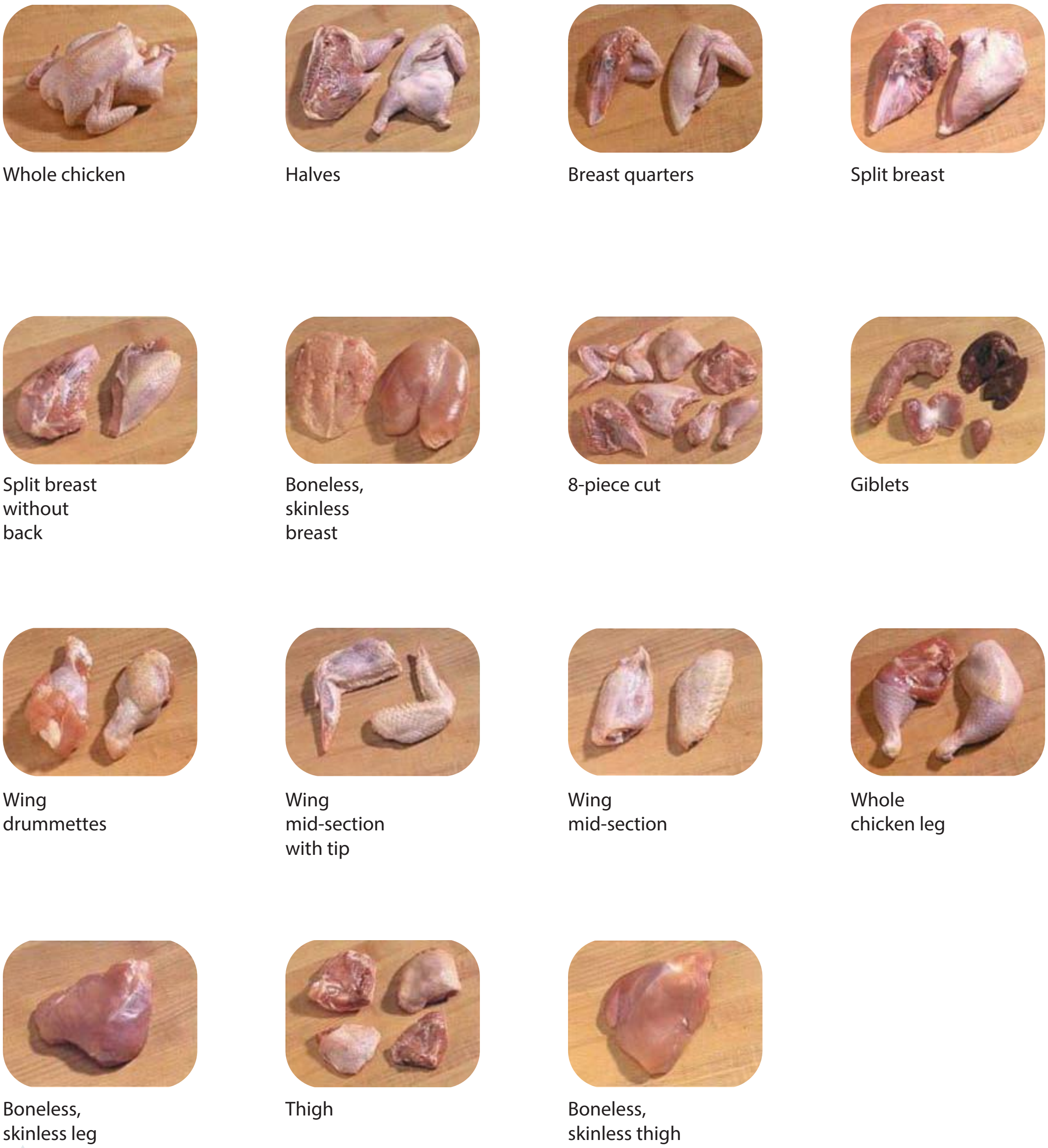


FIGURE 4.18 Australian standard cuts of pork



Australian Chicken Meat Federation

FIGURE 4.19 Australian standard cuts of poultry

REVIEW QUESTIONS ▶

1 **Summarise** the difference between tough cuts and tender cuts of meat.

2 **Identify** the suitable cooking techniques for tough cuts. **Explain** why these methods are required to improve palatability.

3 **Explain** why tender cuts of meat are more expensive.

9780170418560

Table 4.6 Cooking techniques

METHOD	COOKING TECHNIQUE	EXAMPLE IMAGE	SUITABLE PROTEIN-BASED FOODS
Dry heat	**Grilling** • Dry heat is applied directly to the food • The flavour is developed by fast cooking • The protein-based food is grilled to various stages of doneness, ranging from blue to well done depending on the cut of meat and the preferred option of the consumer	 Alamy Stock Photo/Rob Crandal	Tender cuts, such as rib eye, T-bone, porterhouse, chicken breast or thigh, lamb steak and chops
	Roasting • The protein-based food is placed onto a tray and heat is applied using convection in the oven • This process is used for large pieces of protein-based foods • The oven temperature can be set and the food is cooked at that temperature for a long period of time • The food browns and the flavours are enhanced in the oven	 Shutterstock.com/Joe Gough	• Larger cuts of meat – joints of beef, lamb, pork, whole chicken • Nuts and seeds
	Frying The protein-based food is placed in a frying pan with some oil and fried on a medium to high heat to various stages of doneness, ranging from blue to well done, depending on the cut of meat and the preferred option of the consumer	 Alamy Stock Photo/Image Source	Tender cuts such as rib eye, T-bone, porterhouse, chicken breast or thigh, lamb steak and chops
Moist heat	**Poaching** • Moist heat in the form of water is used to cook the food • Low temperatures (71°C to 80°C) are used to cook foods such as eggs and fish gently • There should be no simmering or boiling in this method	 Shutterstock.com/Tobias1900	Delicate foods – fish, eggs
Combination	**Braising** • The food is dry-fried or sautéed to caramelise the surface and improve the flavour • Stock and other flavours are added and the food is either simmered on the stove top or in the oven until it becomes tender	 Shutterstock.com/casanisa	• Tougher cuts of meat – blade, round, skirt, flank • Beans
	Sous-vide • Food is vacuum-sealed in plastic or placed into a sealed bag • The package is placed in a water bath to heat to a pre-set temperature	 Shutterstock.com/FotoCuisinette	Meat, chicken, eggs

EXPERIMENT 4.8

Using the Maillard reaction in the preparation of protein-based foods

AIM

demonstrate prove or make clear by argument, reasoning or evidence, illustrating with practical example; show by example; give a practical exhibition

To **demonstrate** the effect of the Maillard reaction on protein and its effect on sensory properties of meat using differing cookery techniques

BACKGROUND

The Maillard reaction is named after Louis-Camille Maillard, the chemist who first described the reaction in 1912. The process was noted to be of importance in cooking for the way it affected the colour, flavour and aroma in the cooking of meat.

The Maillard reaction is a non-enzymatic reaction that occurs during cooking of muscle tissues at temperatures above 120°C. The result is a crusty brown surface. The long chain of amino acids, particularly lysine and proline, destabilise or denature in the presence of carbohydrate sugars, such as glucose, which are stored in muscle fibre cells. For the reaction to occur in meat, it must be dry on the surface and make firm contact with the heated surface to quickly destabilise the amino acid chains. The higher the temperature, the greater the change that occurs on the surface of the protein that is directly exposed to the heat.

The speed of denaturation is directly related to the temperature. Molecules vibrate faster at higher heat, and the hydrogen bonds holding the amino acids together will weaken and break faster.

Figure 4.21 below indicates the temperature at which the Maillard reaction will start and progress, and the types of heat source that will allow the reaction to occur. This experiment will examine the techniques of frying, baking, roasting, grilling and stewing.

Caution is advised when experimenting with the Maillard reaction, as the result of very high heat leads to deterioration of the quality of the protein, and results in black charred, carbon-dense molecules which are carcinogenic.

The Maillard reaction also occurs naturally at room temperature, but before this can be seen the food will have spoiled.

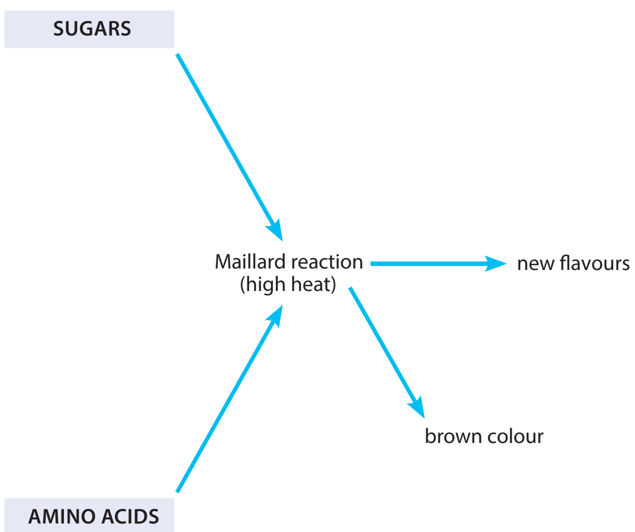


FIGURE 4.20 Molecular model showing how the Maillard reaction occurs

9780170418560

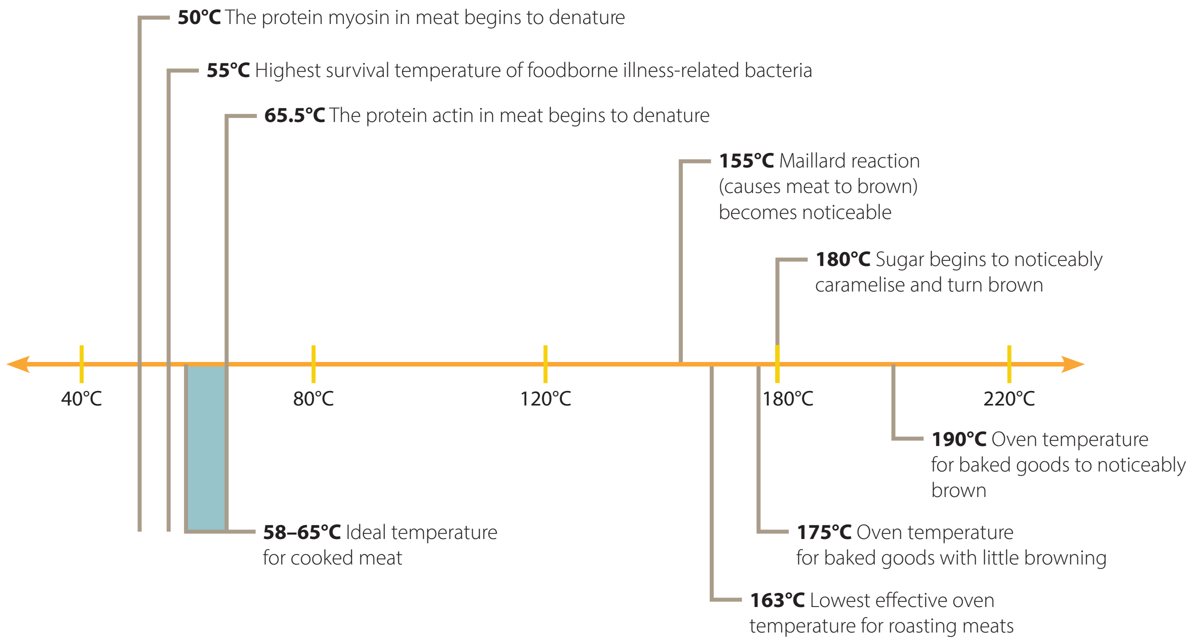


FIGURE 4.21 Temperatures for common reactions in food (above the line) and heat sources (below the line)

INSTRUCTIONS – FRYING (DRY)

1. This experiment could be done with any type of lean meat (red meat will give the best visual results), or tofu.
2. You will be required to prepare one portion of each control and variable and store it appropriately before tasting. (Note that group work will reduce the time required for this experiment.)
3. Each food (control) will be examined for changes in the sensory properties.

PREPARATION

Prepare one steak for the control procedure.

CONTROL	VARIABLE 1	VARIABLE 2	VARIABLE 3
Temperature of pan required: 130°C	Temperature of pan required: 100°C	Temperature of pan required: 180°C	Temperature of pan required: 220°C

FOOD COMPONENTS

- 4 × 200 g piece of rump steak, fat removed

EQUIPMENT

- electronic scales
- sharp knife
- chopping board
- paper towel
- electric frying pan with temperature control
- tongs
- timer

PROCEDURE

1 Weigh and cut meat into correct portions.
2 Leave meat at room temperature for 20 minutes.
3 Use paper towel to remove any moisture from the surface of the steak.
4 Preheat each pan to the set temperature as per the temperature control for the pan (leave each setting 1 minute to bring pan to the correct temperature).
5 Place each sample into the hot pan. Turn it with care every 15–20 seconds, for a total of 2 minutes.
6 Remove from pan and let rest for 5 minutes.
7 Cut the steak into pieces, noting appearance, aroma, flavour and texture.

RESULTS ANALYSIS

1 After preparing the samples draw a table or use the template on NelsonNet to record the results.

WS Experiment 4.8 template 1

SENSORY PROPERTY	CONTROL	VARIABLE 1	VARIABLE 2
Appearance			
Taste			
Flavour and aroma			
Texture			

INSTRUCTIONS – GRILLING

1 An oven or benchtop grill is suitable for this experiment.
2 This experiment could be done with any types of lean meat (red meat will give the best visual results) or tofu.
3 Set up an area where you can work without contaminating food preparation surfaces.
4 You will be required to prepare one portion of each control and variable and store it appropriately before tasting. (Note that group work will reduce the time required for this experiment.)
5 Each food (control) will be examined for changes in the sensory properties.

PREPARATION

Prepare one steak for the control procedure.

CONTROL (AS THE CONTROL ABOVE)	VARIABLE 1	VARIABLE 2
Temperature of grill required: 130°C	Temperature of grill required: 165°C cooked for 4 minutes	Temperature of grill required: 165°C cooked for 8 minutes

FOOD COMPONENTS

- 3 × 200 g piece of rump steak, fat removed

EQUIPMENT

- electronic scales
- sharp knife
- chopping board
- paper towel
- grill with temperature control
- tongs
- timer

9780170418560

PROCEDURE

1. Weigh and cut meat into correct portions.
2. Leave meat at room temperature for 20 minutes.
3. Use paper towel to remove any moisture from the surface of the steak.
4. Preheat the grill to the set temperature.
5. Place each sample into the hot grill; turn once at the half-time point.
6. Remove from grill and let rest for 5 minutes.
7. Cut the steak into pieces, noting appearance, aroma, flavour and texture.

RESULTS ANALYSIS

After preparation of the samples draw a table or use the template in NelsonNet to record the results.

SENSORY PROPERTY	CONTROL	VARIABLE 1	VARIABLE 2
Appearance			
Taste			
Flavour and aroma			
Texture			

WS Experiment 4.8 template 2

INSTRUCTIONS – ROASTING

1. This experiment could be done with any type of lean meat (red meat will give the best visual results), or tofu.
2. You will be required to prepare one portion of each control and variable and store it appropriately before tasting. (Note that group work will reduce the time required for this experiment.)
3. Each food (control) will be examined for changes in the sensory properties.

PREPARATION

Prepare one steak for the control procedure.

CONTROL (AS THE CONTROL ABOVE)	VARIABLE 1	VARIABLE 2
Temperature of pan required: 130°C	Temperature of oven required: 160°C, cooked for 12 minutes	Temperature of oven required: 165°C, cooked for 25 minutes

FOOD COMPONENTS

- 3 × 200 g piece of rump steak, fat removed

EQUIPMENT

- electronic scales
- sharp knife
- oven
- baking tray (at least 2 cm deep)
- tongs
- paper towel
- chopping board
- timer

PROCEDURE

1. Weigh and cut meat into correct portions.
2. Leave meat at room temperature for 20 minutes.

3 Use paper towel to remove any moisture from the surface of the steak.
4 Preheat oven to the set temperature.
5 Place each sample into the hot oven; turn once at the half-time point.
6 Remove from oven and let rest for 5 minutes.
7 Cut the steak into pieces, noting appearance, aroma, flavour and texture.

WS
Experiment 4.8 template 3

RESULTS ANALYSIS

After preparation of the samples draw a table or use the online template on NelsonNet to record the results.

SENSORY PROPERTY	CONTROL	VARIABLE 1	VARIABLE 2
Appearance			
Taste			
Flavour and aroma			
Texture			

INSTRUCTIONS – STEWING

1 You will be required to prepare one portion of each control and variable and store it appropriately before tasting. (Note that group work will reduce the time factor for this experiment.)
2 Each food (control) will be examined for changes in the sensory properties.

PREPARATION

Prepare one steak for the control procedure.

FOOD COMPONENTS

- 4 × 200 g piece of rump steak, fat removed
- 3 × 20 mL oil
- 3 × 20 gflour
- 4 × 1½ cups water

CONTROL	VARIABLE 1	VARIABLE 2	VARIABLE 3
• Temperature of pan for browning is 130°C and for simmering as required, cooked for 12 minutes • Meat used in 1 piece • Meat and water only in saucepan	• Temperature of pan for browning is 130°C and simmering as required, cooked for 12 minutes • Meat used in 1 piece • Meat rolled in flour before browning	• Temperature of pan for browning is 130°C and simmering as required, cooked for 12 minutes • Meat cut into pieces and rolled in flour before browning	• Temperature of pan for browning is 130°C and simmering as required, cooked for 30 minutes • Meat used in 1 piece • Meat rolled in flour before browning

EQUIPMENT

- electronic scales
- sharp knife
- chopping board
- paper towel
- hot plate with accurate temperature control
- 4 small saucepans with lids
- tongs
- timer

9780170418560

PROCEDURE

1 Weigh and cut meat into correct portions.
2 Leave meat at room temperature for 20 minutes.
3 Use paper towel to remove any moisture from the surface of the steak.
4 Prepare control and each variation as per above box.
5 To brown each sample, place oil in each saucepan and heat to 130°C.
6 Add meat and stir for 3 minutes. This should be enough time to brown all sides of the meat.
7 Remove from heat and add water.
8 Lower heat to 100°C.
9 Stir, place lid on saucepan and return to the heat for the required times (above).
10 Remove from pan and rest for 5 minutes.
11 Cut the steak into pieces, noting appearance, aroma, flavour and texture.

WS Experiment 4.8 template 4

RESULTS ANALYSIS

After preparing the samples draw a table or use the template on NelsonNet to record the results.

CONCLUSIONS

Prepare a report addressing the following:

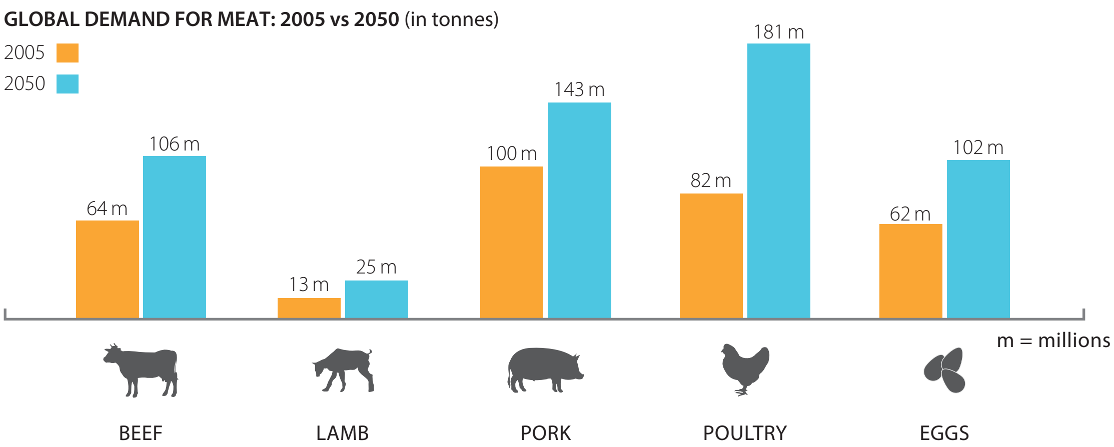
1 **Explain** the Maillard reaction in your own words, using the terms amino acid, hydrogen bond, temperature and time.
2 **Analyse** the data collected in terms of the sensory properties. **Discuss** as a class the answers to the following (as individual taste and preference can vary) and then **summarise** the sensory preferences with the following questions:
   a Outline the cookery methods and variables that were most successful for taste (there may be more than one). **Describe** the taste that is most desired.
   b Which cookery methods and variables produced meat with the most appealing texture? **Describe** the texture of meat that is most desired and explain why this texture is so.
   c Which cookery methods and variables produced the most flavoursome product? **Propose** an explanation for this result. Was there a difference in opinion? Is flavour subjective or objective?
   d Which cookery method and variable was the most successful for colour and appearance? **Explain** the colour and appearance that would be considered most appealing.

Research and development

Innovative protein-based products

As the world population continues to grow, research and development into innovative protein-based products is increasingly important. Consumption of protein is essential for human growth and repair, and the demand for both animal-protein-and plant-protein-based foods will continue to grow. The demand for animal-protein-based foods appears to be increasing at a faster pace as the world's population of middle class grows, which is changing their socioeconomic status, education and money available to spend on food.

Producing greater amounts of animal protein will add to greenhouse gas emissions and other environmental pressures, such as land degradation for grazing as well as land use for producing animal feed. This has led to the development of alternative protein products and research and development in this area. Alternative protein sources that are currently being explored include cultured meat, new soya products, insects, 3D printing of meat, genetically modified protein, fortification and function foods and bush food protein sources. These alternative protein-based products to fulfil consumers' future protein requirements will be discussed in detail in chapter 6.



Source: Based on Food and Agriculture Organization of the United Nations, ESA Working Paper No 12-3, p. 131.

FIGURE 4.22 Global demand for meat is expected to rise dramatically by 2050.

ACTIVITY 4.2

Innovative protein products

Aim

To research the development of synthetic meat products

BACKGROUND

Synthetic or cultured meat is also known as 'in vitro' meat, hydroponic meat, test-tube meat, vat-grown meat and victimless meat. Mark Post and Jean F. Hocquette are leaders in this field of research and development. This technology is surrounded by controversy as people have varying and, at times, extreme views about consumption of something currently considered unnatural.

STEPS

1 Research the process of creating synthetic meat. Write down the procedure. Using technology of your choice, develop this into a flow chart that explains the process of developing synthetic meat.

2 Research current opinions relating to the positive and negative opinions surrounding the development of synthetic meat. In your research, use a variety of terms, such as 'synthetic meat', 'in vitro meat', 'clean meat' or 'lab meat', to find different information. Make a list of the positive and negative opinions surrounding the development and use of synthetic meat.

Synthetic meat

Conclusions

1 **Explain** the advantages and disadvantages of synthetic meat development and use in terms of:
   a global sources of protein
   b a sustainable food resource
   c an acceptable protein substitute for consumers.

2 **Explain** the impediments or difficulties that companies will face producing and selling synthetic meat to consumers.

Taking it further

3 Are there communities in the world that would benefit from the production of synthetic meat? **Explain** the potential benefits around the world of synthetic meat production.

ACTIVITY
4.3

New soya products

Aim

To research the development of new soya products

BACKGROUND

Soy protein provides a complete amino acid profile and is of high biological value. These protein properties, along with the fact that soy is a plant-based protein, make it an appealing protein source. As a result, further research and development into soy protein products has occurred. Traditionally, whole soybeans, soy milks, tofu, tempeh and miso have been highly regarded and purchased soya products.

In more recent years, market innovation, research and development has led to modern food development of soy protein isolates and concentrates.

STEPS

1 Research the development of soy protein isolates.
   a **Summarise** the process to produce soy protein isolates.
   b **Identify** the uses of soy protein isolates.
   c **Describe** the nutritional profile of soy protein isolates.
2 Research the development of soy protein concentrate.
   a **Summarise** the process to produce soy protein concentrate.
   b **Identify** the uses of soy protein concentrate.
   c **Describe** the nutritional profile of soy protein concentrate.

Conclusions

1 **Explain** the advantages and disadvantages of soy protein isolates and concentrate. In your answer, consider the following:
   - global ramifications of soy protein as a protein addition to diets
   - sustainability of this as a protein source
   - acceptability of this protein source to consumers.

Taking it further

2 Research other innovative soya products or existing soya products on the market that are popular.

Waste management and sustainability

Foods that are protein-based, particularly from animal sources, are often considered to be unsustainable and high in waste products. One way to decrease waste from animal-based food processing is to repurpose leftover products into other useful products. Value-added products are products with features added to the baseline product that are valued by the customer. In the meat industry, for example, meat patties are produced from meat offcuts and flavourings are added, creating a value-added product that consumers will purchase due to convenience and ease of use. Secondary products, such as sausages or pies, are made from the organs and offcuts after prime cuts have been removed.

waste management responsibility for, and control of, disposal of any food substance or food packaging to minimise environmental and health impacts

effluent liquid waste or sewage

smallgoods small meat products, generally made from secondary cuts, e.g. sausage or salami

As industry and the public become more conscious of animal welfare, the environment and workplace health and safety, more effort and planning is taking place in **waste management** and sustainability. Waste management in animal production involves storage and processing of solid wastes, management of odour, dust and flies, liquid wastes and utilisation of manure, compost and **effluent**.

Secondary meat products

Primary meat processing is the slaughtering and dressing of the animal. Anyone who handles the meat after this is known as a secondary processor. Secondary processors include retail butchers and **smallgoods** processors, who create their own products which enhance or value-add to the primary meat products.

Butchers value add by breaking carcasses down into the various cuts of meat, pictured earlier in this chapter. Value adding permits the less desirable cuts of meat to be made into cheaper but popular sources of protein. Butchers can charge the customer more if the meat has been further processed for ease of use; for example, lamb shanks that are 'french trimmed' or pre-marinated meat offer the customer convenience and ease of use.


iStock/Getty Images Plus/Isaac74

FIGURE 4.23 Butchers can value add to meat products through additional preparation such as portioning, marinating, trimming and trussing.

Table 4.7 Secondary meat products

NAME OF SECONDARY MEAT PRODUCT OR VALUE-ADDED PRODUCT	METHOD OF VALUE ADDING	COMPOSITION WITH EMPHASIS ON PROTEIN
Mince	• Raw meat ground to break the connective tissue (tenderise) of tougher prime cuts such as shoulder and flank • Butcher mince containing trimmings from other prime cuts • Legally, mince cannot contain preservatives	• Categorised according to the percentage of fat and expressed in fat g per 100 g • Fat is visible as white flecks • Low fat = 3 g per 100 g fat • Lean mince = 10 g per 100 g fat • Fat adds flavour and texture but decreases the amount of protein in mince

(Continued)

9780170418560

Table 4.7 Secondary meat products (*Continued*)

NAME OF SECONDARY MEAT PRODUCT OR VALUE-ADDED PRODUCT	METHOD OF VALUE ADDING	COMPOSITION WITH EMPHASIS ON PROTEIN
Flavoured sausages	• Processed meat that is minced, chopped or diced meat, which may be combined with other foods or flavourings • Processed meat is then encased into individual units of varying sizes • Made from trimmings and offcuts of prime cuts • Some butchers add sausage meal (usually made from wheat or rice flour) • Water is added for weight and texture	• Meat product containing no less than 300 g per kg (30%) meat, where meat is used in combination with other ingredients or additives • Choose sausages that have a higher percentage of meat • Australian Food Standards require the percentage of meat to be listed on packaging • Additives include sulphur dioxide and sodium and potassium sulphites, which should be less than 500 mg per kg of meat
Pies	Processed meat that is minced, chopped or diced, which may be combined with other food such as starches or vegetables and encased in pastry	• Must contain no less than 250 g per kg of meat flesh (25%) • Meat flesh includes the skeletal muscle of any slaughtered animal as well as any attached animal rind, fat, connective tissue, nerve, blood and blood vessels
SMALLGOODS		
Bacon	• Animal source: pork (pig) • Cured by injecting with brine (salt and water predominantly), soaking in pickle, then drying and smoking before chilling and slicing • Bacon is generally cooked to kill pathogens before consumption	• Protein value does not change from prime cuts, but texture and flavour are altered • Caution: consumption of bacon should be in moderation, due to the high sodium (salt) content
Roast meats	Cuts and joints of meat are injected with salt, soluble seasonings and vegetable protein; cooked then chilled, sliced and sold for sandwich making	• Used in the catering section as a more chemically stable product • Texture and flavour are different to the prime cut
Pâté, liverwursts, and terrines	• An emulsion of cooked, cooled and packaged meat or offal • Gelatine or a garnish (e.g. pepper) can be added to the top.  Shutterstock.com/bitt24	• Connective tissue is broken down in the formation of the emulsion, creating a very smooth texture • A strong flavour is evident due to the offal used to create these products Caution: Nitrite is added to some goods to produce a red colour

(*Continued*)

Table 4.7 Secondary meat products (*Continued*)

NAME OF SECONDARY MEAT PRODUCT OR VALUE-ADDED PRODUCT	METHOD OF VALUE ADDING	COMPOSITION WITH EMPHASIS ON PROTEIN
Dried meats	• Meat flesh is used to produce dried jerky • Most dried meat is produced by salting under refrigeration and usually drying at a moderate temperature (55°C to 65°C) • Shelf life is extended and dried meats do not require refrigeration • Current trends in jerky processing include the flavouring of meat before drying  Shutterstock.com/Binh Thanh Bu	• Must contain at least 160 g per kg fat-free meat flesh • Moisture content of dried meat is less than 85% Caution: added nitrites of up to 125 mg per kg and sorbates up to 1500 mg per kg
Slow-cured meats	• Mostly prepared from deboned legs, with the pH > 6 • The meat undergoes a dry salting process, and is then dried at a low temperature (between 10 and 15°C) and humidity between 75 and 85%  Shutterstock.com/casanisa	Prosciutto is made from a prime cut of meat with composition change being from salting and drying, creating changes in texture and taste

(*Continued*)

9780170418560

Table 4.7 Secondary meat products (*Continued*)

NAME OF SECONDARY MEAT PRODUCT OR VALUE-ADDED PRODUCT	METHOD OF VALUE ADDING	COMPOSITION WITH EMPHASIS ON PROTEIN
Gelatine	• Made by the partial hydrolysis (breaking the peptide bonds of larger amino acid bonds into smaller chains of amino acids in a limited amount of water) of collagen from skin, bones and white connective tissue of animals • Most common sources are cattle cowhide splits, bones, pork skin, chicken and fish skin • Dried for use	• The quality of gelatine across the world is graded by the amount of protein it contains. By law, in Australia gelatine powder must contain 98% protein • Proline and glycine are the major components of gelatine
Animal feed	• Bone meal is a by-product of the rendering industry and is created to improve the amino acid/ protein content in animal feed • Rendering is to 'clarify or purify by melting', heat is used to remove the fat, kill bacteria and other microorganisms in the food • The materials used include fat trim, meat, viscera, bone, blood and feathers (which can make up between 33 and 43 % by weight of the live animal)	• Meat and bone meal contains approx. 50% crude protein • Feather meal contains approx. 89% crude protein • Poultry meal contains approx. 81% crude protein • The process allows for denaturation of protein, which also makes it more digestible • Caution must be used when considering the supplementation of bone meal in animal feed as significant biosecurity risks exist if the rendering is not done at temperatures between 115°C and 145°C • Salmonella and bovine spongiform encephalopathy (BSE) are the major biohazards associated with feed not rendered properly
Fertilisers	• Bone meal as a fertiliser consists of animal bones which have been cleaned of residue, sterilised to kill microorganisms, then dried and crushed into different-sized powders • It is used on plants as a slow release fertiliser; as a concentrated source of nutrients, it should be used in small quantities	• The fertiliser is primarily used for its protein rather than its nitrogen content which = 13.25%, phosphorus content = 1.0%, potassium content = 0.6% • Australia has rigid testing for the presence of microorganisms in fertilisers, so the biosecurity risk for using these animal products on garden plants is minimal  Alamy Stock Photo/Andrea Jones Images

ACTIVITY 4.4

Developing new red meat products

Aim

To **investigate** innovation and trends in methods of repurposing meat products

Value chain benefits

Greater use of secondary cuts and increased value of these cuts, and the development of new markets for Australian red meat.

Food for the future

Increasing sales of red meat around the globe is no longer as simple as promoting steaks and chops; it's about providing innovations that deliver value and choices. This means developing new value-added beef, goat and lamb products that are demand driven opportunities that consider:

- novel science and technology platforms and tools
- increasing the value of secondary cuts and carcass utilisation
- insights for new red meat occasions and usages
- new value chain/business model design.

Trending now

The face of the food industry is rapidly changing. Impacts are being felt as a result of:

- increasing globalisation
- an ageing population
- a move away from traditional meals eaten in the home to snacking and dining out
- the growth of the foodservice sector, including conference and convention catering, airlines, retirement and medical facilities and quick service restaurants
- economic growth and the westernisation of China and Indonesia and their interest in consuming more protein
- advancements in technologies.

Underpinning these factors is the need to identify trends and insights for these growth opportunities and to develop capabilities in new product and process developments and business model solutions. Recent consumer attitudinal research confirms more red meat would be consumed if it met purchaser requirements of convenience, enjoyable eating experiences, value for money and nutrition.

Investment has been [made] in creating products for developing markets, new meat processing technologies, developing capability within the industry (by educating butchers, foodservice and processing partners) and researching the forces impacting the market.

Serving it up

Here are examples of product innovation outcomes from the investment:

- **High pressure processing (HPP):** This process uses pressure and water to surround the sealed meat product to significantly extend shelf life and, when used in combination with high temperature, is ideal for secondary cuts to produce a tender dish similar to sous vide/slow-cooked dishes (but in 15 minutes rather than 6 hours). Benefits are increased shelf life, reduced waste, less reliance on preservatives, greater use of secondary cuts and increased value.

- **High moisture extrusion cooked (HMEC):** Using an extrusion process already applied to pasta and snack foods, this involves 'creating' a meat product with great texture and fibres made from lean trimmings, ideal for pizza toppings, sandwiches and rolls and a range of foodservice uses. Benefits are increased versatility for products created from secondary cuts that traditionally are minced to create more opportunities for use of red meat.
- **Commercial partnerships:** MLA has supported the development of products for particular markets including Sizzle steak (using Thin Slice Technology), Sausages (using very fast chilled NuMeat technology), Sous Vide cooked Rib fillet (using SmartShape™ technology), Pulled meats (using cook-shredding processes) and a range of meat based toddler and baby food products.

Source: MLA Donor Company, accessed 8 March 2018. Reproduced with permission.

STEPS

1 **Investigate** the development of new red meat products from Meat & Livestock Australia (MLA), by reading the case study and watching the two videos at the links provided on NelsonNet:

Meat & Livestock – high pressure processing

Meat & Livestock – extruded meat products

2 **Summarise** the innovative products that MLA is developing for red meat secondary products.

3 **Describe** the value of high pressure processing.

4 **Describe** the value in extruded meat products. **Explain** how this uses secondary meat cuts and reduces wastage.

Conclusions

1 **Discuss** how using secondary cuts of meat for products such as extruded meat or meat pies can improve wastage and address current sustainability concerns surrounding animal production.

Taking it further

2 **Investigate** developments in other secondary meat products, such as pork or chicken, for new innovations to reduce waste.

HPP

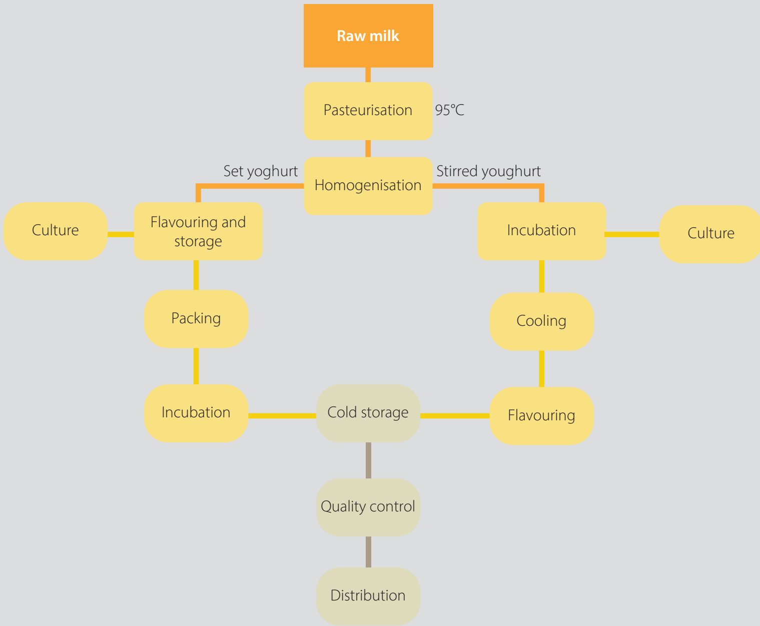
HMEC

Secondary milk products

Similar to the meat industry, the dairy industry can use protein waste products from its primary production of milk to consumers, to produce valued-added secondary products.

On the next two pages is a table that outlines the composition of some more popular secondary dairy products.

Table 4.8 Secondary dairy products

NAME OF SECONDARY DAIRY PRODUCT OR VALUE-ADDED PRODUCT	METHOD OF VALUE ADDING	COMPOSITION WITH EMPHASIS ON PROTEIN
Yoghurt	• Preserves milk by using live probiotic bacteria which denatures the lactic acid protein, producing a soft curd with a rich, tangy texture • Probiotic bacteria most commonly used are *Lactobacillus bulgaricus* and *Streptococcus thermophilus* • The milk mixture is pasteurised at 85°C for 30 minutes. This high heat treatment denatures the whey proteins, allowing the formation of a more stable gel, which prevents separation of the water during storage and reduces the number of spoilage organisms in the milk • This provides a better environment for the starter cultures to grow. Most yoghurts are either stirred or pot set for food safety	• Must contain 5–7% protein • The protein in milk is denatured, producing flavour, aroma and textural differences  **FIGURE 4.24** Yoghurt production
Probiotic drinks	• The human microbiome consists of several hundred types of bacteria which have an essential role in the digestion of food and normal immune system function • Probiotics are living organisms such as bacteria, yeast and fungi that are added to milk for fermentation to occur • When consumed they refurbish the gut microbes essential for good health • A probiotic drink known as kefir is made from milk, kefir grains or a powdered culture starter which, when added to milk, attacks the lactic acid for rapid multiplication of bacteria. Kefir grains consist of bacteria/yeast mixture clumped together with casein (milk proteins) and complex sugars • Kefir grains contain more species of bacteria than those found in yoghurt, making probiotic drinks a more concentrated source of microorganisms	• The most common probiotics used in drinks in Australia are *lactobacillus* and *Bifidobacterium* bacteria as they can pass through the stomach without being destroyed • Lactic acid bacteria attack the cell wall, denaturing the protein, thus aiding in digestion of the protein in the body • The texture and aroma of the dairy product is altered  Shutterstock.com/joannawnuk

(*Continued*)

9780170418560

Table 4.8 Secondary dairy products(*Continued*)

NAME OF SECONDARY DAIRY PRODUCT OR VALUE-ADDED PRODUCT	METHOD OF VALUE ADDING	COMPOSITION WITH EMPHASIS ON PROTEIN
Whey protein	• Whey protein is a by-product of cheesemaking that was previously discarded • This is the raw material for the purified whey that athletes can use to build muscle • Protein powders are made from whey powder	• As a liquid, whey consists of about 1% protein, 5% lactose, 0.6% minerals, 0.2% fat and 93% water • The whey powder has been processed to remove fat, minerals, lactose and water and contains the highest biological value of all protein-based foods, at 95% • The main protein in whey powder is beta-lactoglobulin

Food protection

The short shelf life of animal-protein-based foods can come from multiplication of pre-existing bacteria and enzymes from the living animal before butchery, plus unsafe handling and storage during production and processing. The quantity of fat or oil in the food also increases the chances of spoilage before it reaches the consumer for preparation and consumption. Reducing the chances of spoilage is essential for waste management of protein-based foods.

Table 4.9 Types of spoilage

	OCCURS DURING PRODUCTION	OCCURS AFTER PRODUCTION
Biological	bacteria, yeast and moulds if food is undercooked or improperly processed	growth of bacteria, yeasts or moulds through improper storage or handling
Chemical	• Oxidation due to improper processing • Naturally occurring chemicals or toxins • Incorrect use of food additives • Allergens not declared on packages, accidentally used	• Accidental contamination with cleaning chemicals • Oxidation through improper storage or handling
Physical	• Foreign objects – accidentally added in production chain • Natural components of food incorrectly removed or lack of processes to remove, e.g. shells or bones	• **Drip loss** or **syneresis** through improper storage • The addition of foreign objects through improper storage or handling

drip loss
deterioration of meat due to the loss of meat juices, which are released from cut sections when stored or thawed

syneresis
separation of liquid from a gel on standing

Biological changes

Bacteria

Bacteria require warmth, food and water (A_W: water availability) to produce. The amino acids in protein-based foods are an excellent food source for bacteria. Microorganisms colonise on protein-based foods, break it down, and leave behind toxins. Bacteria and associated toxins are responsible for both food spoilage and foodborne illnesses, which can be harmful to health. Over time there will be some evidence of bacterial changes in protein-based foods, although most bacterial contamination will remain undetectable.

If left to grow, some bacteria will induce food spoilage. These include:

- *Pseudomonas*
- *Acinetobacter*
- *Moraxella.*

Bacteria commonly found in protein-based foods which cause illness include:

- *E. coli* in raw meats
- *listeria* in soft cheese, pâté, incorrectly prepared meats and unpasteurised milk
- *Salmonella* in raw or undercooked poultry and eggs via cracked shells
- *campylobacter* from raw and undercooked poultry and unpasteurised milk.

Yeast

Yeasts are a type of fungi present in the air and on many surfaces. The primary food source of yeasts is sugar and starch. Protein-based foods generally do not contain adequate levels of sugar for yeast to grow. As a result, yeasts are not considered a common spoiling agent in protein-based foods; the exceptions are processed meats such as salami and ham, which are cured in sugar solutions.

Moulds

Moulds are another type of fungi that will grow in moist and warm conditions. Moulds multiply by producing spores that can enter the air and be transported to another site on the meat, seeding to create another mould growth cycle. When moulds grow on foods a 'bloom' or furry growth will be visible to the human eye. Mould is hazardous to health as the reproduction process creates toxins that can make people sick. In the absence of preservation methods such as refrigeration, mould will often be the first visible sign of food spoilage.

All types of cheeses, dairy products and tofu are susceptible to mould growth. Mould will continue to grow and develop in the refrigerator once the product is opened. As mould cannot grow in the absence of oxygen, vacuum sealing is very successful at preventing mould in protein-based foods.

Chemical changes

As food appears to the human eye in either a solid or liquid form, it is often difficult for people to understand the molecular changes that take place, which cannot be seen. As chemical reactions occur at a cellular level, often visual and aromatic variations are the only result evident for individuals to gauge change or protein spoilage and should be examined more closely.

Oxidation

Oxidation refers to change in a food because it is exposed to oxygen. In protein-based foods, amino acids and fat (oil) will denature, and be a major contributor in spoilage in protein-based foods, often causing changes in smell, texture and taste. During handling or freezing of protein-based food, cells expand, burst and expose amino acids for oxygenation. This is the primary cause of deterioration during frozen storage of protein-based foods. In red meats, myoglobin will change to metmyoglobin, causing the red meat to 'fade' or brown when exposed to oxygen. The process of vacuum-sealing can prevent this browning oxidation.

Enzymatic reactions

Enzymatic reactions in protein-based foods will result in cell breakdown and cause odour development. The enzyme protease is produced by proteolytic bacteria which live on the surface of meats. It denatures the connective tissue between the muscle fibres, allowing bacteria to penetrate. The action of proteolytic bacteria produces putrescine and cadaverine, which are two compounds responsible for rotten smells. Caution is advised here as the consumption of protein-based foods affected by enzymatic reactions will be harmful to the human body. These foods need to be disposed of immediately and in a safe manner.

Physical changes

Physical changes can often be observed by the human eye and involve the introduction or removal of substances to and from the food item.

Evaporation

Water evaporation can easily occur in foods not stored correctly. Over time foods can dry out, impacting their flavour and texture. While drying will slow microbial growth, the sensory properties of the food will also be affected. Salt can be used to dehydrate cells by removing the water molecules so other chemical reactions cannot occur.

Drip loss

A red liquid solution containing amino acids will drip from cut meats once butchered. The severity of drip loss is related to the cut of meat; for example, a fillet will drip more than a roast piece with the bone intact. Too much drip loss is considered a disadvantage as it produces inferior quality meat with less protein. Rapid chilling will prevent drip loss.

Separation

Syneresis, or 'water seepage' is common in ageing yoghurts, gels and soft cheeses. Separation of the protein bond structures can occur because of bacteria activity. Syneresis can be detected by the pooling of liquid on the surface of the food product and increases with the age of the product. Syneresis in protein products does not indicate that the product is unsuitable for consumption. Gums are often added to gels or yoghurt to counteract this problem, as the gum adds to the water-holding properties of the gel or yoghurt.

Deterioration of protein-based foods

The composition of protein-based foods differs greatly, especially between animal and vegetable protein sources. Chemical composition and physical structure of animal-protein products will have an increased rate of deterioration and food safety risk. As red meat, poultry, fish, seafood and dairy products have the highest biological value, changes will occur at a faster rate than most other foods.

The deterioration of protein-based foods will also be affected by:

- the environment from which food was obtained
- the microbial load of the food in its raw or unprocessed state
- handling and processing sanitation
- the effectiveness of the packaging, handling and storage conditions in restricting microbial growth.

Deterioration in fish and seafood

- In fish, the flesh is arranged in layers of short muscle fibres, which is why fish can be eaten raw (provided it is fresh) with no concern for chewiness.
- The lack of connective tissue in fish contributes to its ease of spoilage as microbes can easily penetrate. Certain types of fish are prone to 'gaping' which can look like holes or tears in the fillet. Gaping is a form of tissue separation.
- Moreton Bay bugs will only keep for a maximum of 48 hours refrigerated. Bugs, which are a type of lobster, deteriorate immediately and it is common for restaurants to keep them alive until an order is placed. If left, the tail meat will disintegrate almost completely into water or fluid due to the action of proteolytic enzymes.
- Preservation methods for seafood and crustaceans have evolved to prevent rapid deterioration. For example, prawns are often caught, cooked and frozen at sea, ready for distribution.

Deterioration in red meat and poultry

- Tight connective tissue in red meats especially are not as easy for microbes to penetrate.
- Ground meat (e.g. burger patties and mince) or porous organ meats are at greater risk of contamination as the connective tissue has been broken down and air pockets allow for easy exposure to oxygen and conditions leading to spoilage.
- In chicken, darker meats (chicken legs, which have more fat and flavour) spoil faster than the breast due to higher levels of myoglobin. The myoglobin oxidises as a result of polyunsaturated fatty acids.
- Whole pieces of meat (e.g. a whole chicken with the skin on) can prevent the flesh from initial deterioration. Sliced or portioned meat has a greater surface area on which food spoilage can occur.
- Wrapping meats can encourage the surface growth of bacteria and conditions for spoilage; however, unwrapped meats will dry and impact texture even though the drying stalls microbial growth.

Deterioration in dairy products

- Pasteurisation kills most bacteria, yeasts and moulds present at production, although pasteurised milk and dairy products will continue to deteriorate.
- Cheese will spoil with surface mould but many cheeses do not have available water for bacterial spoilage.
- UHT milks (including soy) are sterile until opened and then will deteriorate at the same rate as fresh milk.

Deterioration in eggs

- Eggs have inbuilt shell and membrane barriers to prevent spoilage.
- Eggshells can easily transfer bacteria, and cracks in the shell can harbor bacteria that cause foodborne illness.
- While eggs can be kept at room temperature, refrigerating eggs will significantly decrease deterioration.

Perishable protein-based foods

danger zone the temperature range of 5°C–60°C, where foodborne bacteria are most likely to multiply and thrive

Most protein-based foods are highly perishable and require chilling or some other form of preservation to prevent them spoiling in a very short time. Perishable foods must be kept within safe temperatures, out of the temperature **danger zone** wherever possible. A room temperature steak left on the bench in 30°C heat (common in Queensland) would be considered unsafe for consumption after 2 hours. The thermometer shown below is a simple visual representation commonly used by consumers to prompt safe storage of food.

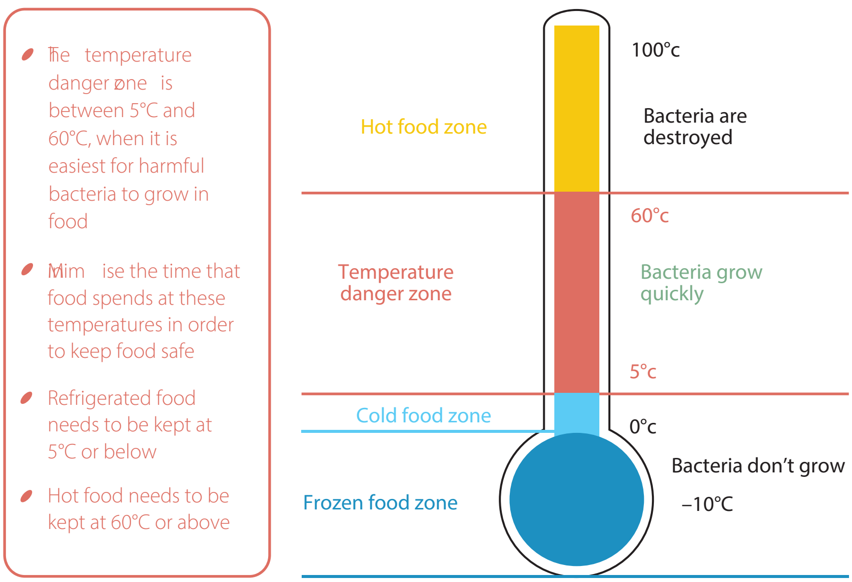


FIGURE 4.25 Minimise the time that perishable foods spend in the temperature danger zone.

Appropriate storage of protein-based foods

The on the next page is an indication of expected shelf life of raw and cooked foods if stored sealed in a refrigerator. Uncooked seafood, meat, liver, kidneys and poultry must be stored in the coldest part of the refrigerator as they contain high quantities of bacteria which can grow and produce food-poisoning microorganisms. The recommended safe temperature for these foods is 0–3°C.

Table 4.10 Shelf life of protein-based foods

PROTEIN-BASED FOODS/ANIMAL SOURCES	EXPECTED SHELF LIFE IN THE HOME REFRIGERATOR (UNOPENED)
Seafood	3 days
Crustaceans and molluscs	2 days
Meat	3–5 days
Minced meat and offal	2–3 days
Cured meat	2–3 weeks
Poultry	3 days
Milk	5–7 days
Cheese	variable (1–3 months)
Soft cheese (camembert, brie)	2–3 weeks
Cottage, ricotta, cream cheese	10 days
Eggs	3–6 weeks

Storing protein-based foods

Freezing is a popular process for protein-based food storage in a domestic kitchen. Low temperatures are used to freeze water in the cells, slowing bacterial action.

Freezing milk and meat products can change the sensory properties of these protein-based foods.

EXPERIMENT 4.9

Sensory properties of fish

AIM

To **determine** the sensory properties of cured and smoked fish

BACKGROUND

Curing (through salting) and smoking fish are two methods to extend the shelf life of fish. Fish is of high biological value, and spoils very easily. Refer to page 80 for more information on salting as a preservation process.

There are two methods for smoking – hot smoking and cold smoking. Hot smoking will cook the seafood, but only partially preserves it. Cold smoking is a preservation process, but does not cook the fish. Cold smoking can be applied by using smoke with the heat removed or with a liquid containing the same chemicals as those in the smoke.

INSTRUCTIONS

1 Note that the fish species (cod) is not important, but it is preferable to have the same fish for all three portions.
2 Prepare one portion of each variable and store it appropriately before tasting. (Note that group work will reduce the time required for this experiment.)
3 Each food (control) will be examined for changes in the sensory properties.

PREPARATION

CONTROL 1	VARIABLE 1	VARIABLE 2
Fresh fish 100 g	Cured fish 100 g	Smoked fish 100 g

FOOD COMPONENTS

- 100 g fresh fish fillet (e.g. salmon, trout, snapper)
- 100 g cured fish (e.g. salmon, trout, snapper)
- 100 g smoked fish (e.g. salmon, trout, snapper)

EQUIPMENT

- scales
- large tasting board
- sharp knife
- non-stick frying pan
- egg flip
- magnifying glass or digital microscope

PROCEDURE

1 Dry-fry fish fillet portions in pan.
2 Remove from pan to cool.
3 Prepare portions of cured and smoked fish for tasting.
4 Complete taste testing. You can magnify each sample to better see the physical and textural changes from each food process.

RESULTS ANALYSIS

After tasting the samples, draw a table or use the template on NelsonNet for this experiment and record your results:

Experiment 4.9 template

SENSORY PROPERTY	CONTROL	VARIABLE 1	VARIABLE 2
Appearance			
Taste			
Flavour and aroma			
Texture			

9780170418560

EXPERIMENT 4.10

Sensory properties of thawed meat and milk products

AIM

To **determine** the sensory properties of meat and milk products after freezing and thawing to ascertain the impact of freezing as a method of food protection

BACKGROUND

Freezing as a processing technique can offer protection to protein-based food items and prolong shelf life. Examine a variety of foods for changes in the sensory properties as a result of the chemical and physical changes to amino acids and protein structure after freezing.

INSTRUCTIONS – THAWED MEAT

1. Measure and freeze both beef and chicken variables for at least 48 hours before thawing and using for the experiment.
2. Prepare one portion of each variable and store it appropriately before tasting. (Note that group work will reduce the time required for this experiment.)
3. Each food (control) will be examined for changes in the sensory properties.

PREPARATION

CONTROL 1	CONTROL 2	VARIABLE 1	VARIABLE 2
Fresh beef 100 g	Fresh chicken 100 g	Frozen beef 100 g	Frozen chicken 100 g

FOOD COMPONENTS

- 200 g beef steak
- 200 g boneless chicken

EQUIPMENT

- 2 food-grade plastic containers with lids for freezing meat
- plastic wrap
- 4 tasting boards/plates
- sharp knife
- non-stick frying pan
- egg flip
- timer
- scales
- magnifying glass or digital microscope

PROCEDURE

1. Divide both chicken and beef steak into 100 g pieces.
2. Wrap one portion of chicken and beef separately in plastic wrap. Freeze each portion of beef and chicken for 48 hours.
3. Place into coldest part of freezer for 48 hours.
4. Thaw frozen portions in microwave.
5. Examine the meat before cooking for any visual changes in the frozen meat samples.
6. Pan-fry all portions using the same cooking times and conditions.
7. Remove from pan and allow to rest for 5 minutes.
8. Observe any differences between frozen and fresh samples.
9. Complete a sensory taste analysis.
10. Record your results.

RESULTS ANALYSIS

After tasting the samples draw a table like the one below or use the template on NelsonNet and record your results.

SENSORY PROPERTY	CONTROL 1	CONTROL 2	VARIABLE 1	VARIABLE 2
Appearance				
Taste				
Flavour and aroma				
Texture				

INSTRUCTIONS – MILK PRODUCTS

PREPARATION

CONTROL 1	CONTROL 2	VARIABLE 1	VARIABLE 2
Fresh full-cream milk 150 mL	Fresh yoghurt 150 mL	Frozen full-cream milk 150 g	Frozen yoghurt 150 g

FOOD COMPONENTS

- 300 mL full-cream milk
- 300 mL yoghurt (flavour and fat content do not matter)

EQUIPMENT

- measuring jug
- 4 food-grade plastic containers with lids for freezing
- spoons
- scales
- magnifying glass or digital microscope

PROCEDURE

WS Experiment 4.10 templates

1. Measure 2 × 150 mL portions of milk.
2. Measure 2 × 150 mL portions of yoghurt.
3. Freeze one portion of milk and one of yoghurt for 48 hours.
4. Refrigerate the other portions of milk and yoghurt.
5. Thaw frozen portions in microwave or for 24 hours in refrigerator.
6. Complete a sensory taste analysis.
7. Record your results.

RESULTS ANALYSIS

After tasting the samples, draw a table like the one below or use the template on NelsonNet and record your sensory observations.

SENSORY PROPERTY	CONTROL 1	CONTROL 2	VARIABLE 1	VARIABLE 2
Appearance				
Taste				
Flavour and aroma				
Texture				

1. Was there a noticeable difference between the thawed and fresh meats? **Determine** the value of using this as a food protection and preservation process.
2. Was there a noticeable difference between the thawed and fresh dairy products? **Consider** whether this a method suitable for food protection and preservation.

9780170418560

ACTIVITY 4.5

Aim

To **compare** the nutritive value, sensory properties and shelf life of fresh, frozen, dehydrated and canned meat

STEPS

1 Select a meat source that can be purchased fresh, frozen, dehydrated (jerky) and canned, such as beef.

2 As a team or individually, design a sensory test to compare the sensory properties of each meat type. This may be a table with different aspects of the meat samples to compare or a set of questions about sensory properties that you and the group have decided to compare.

3 Prepare the meat samples and conduct the sensory analysis. Record the results.

4 Compare the shelf life of each item, noting the storage requirements and approximate timeframe for storage.

5 Record the nutritive value of each meat sample in terms of:

- a ingredients and additives
- b energy
- c protein
- d fat
- e carbohydrate.

When designing the test, think about how each sample will be tested for the best results, e.g. heat the canned meat, prepare the fresh meat as a stew similar to the canned meat and serve hot.

Conclusions

1 Which meat item was considered the most appealing in terms of sensory properties? **Explain** why. Was this the same for all group members or did it vary depending on individual tastes?

2 Which meat item can be stored the longest? **Consider** whether the longest shelf life is an important factor to take into account when eating at home, or will consumers compromise on shelf life for fresher products?

Taking it further

3 Can you see value and use for each meat item, even though they have all been processed and stored differently? For each meat sample, **propose** two situations where it would be the best option to choose. For example, fresh meat may be best for a lunch BBQ.

How can chemical and functional properties of protein and knowledge of food safety and spoilage, and preservation techniques be used to develop protein-based foods?

Create a mind map of information to help answer the guiding question. Use the supplied template or develop your own mind map. You may find it useful to use online tools such as Bubbl.us, Canva, Coggle, MindMup, iMindQ.

WS Mind mapping template

Mind mapping tools

5 DEVELOPING FOOD SOLUTIONS

» How can chemical, functional and nutritional properties and preservation techniques be used to develop vitamin, mineral and protein-based food products?

In this chapter, a brief is explored to demonstrate how the problem-solving process can be applied to develop food solutions and, in turn, answer the guiding questions related to the development of food solutions at the end of each iteration of the problem-solving process.

Problem-based learning

In the preceding chapters, the following concepts were explored:

- the sectors and principles of the food system
- processing and preservation techniques of vitamins and minerals
- how proteins behave and how they can be manipulated.

Chapter 1 of this book introduces the problem-solving process in Food & Nutrition and this chapter builds on that knowledge. A sample brief and criteria are provided, with activities, to explore the problem-solving process, showing how each step can be undertaken.

In this unit, the teacher will provide a brief along with the criteria to work through the problem-solving process. This will form part of the assessment of this unit.

In Units 2, 3 and 4, a scenario will be provided, and students will develop their own brief and criteria.

Food problem example

Explore the problem and develop your brief. The work you have done in topics 1–3 will help you to recognise and describe facts and principles about protein-based food problems.

Problem stimulus

Neptune's Seafood Company wants to establish a line extension to sell to inland Australian residents who would otherwise not eat seafood products. The line extension must be able to be frozen and thawed and have sensory properties acceptable to consumers. It must be high in protein, specifically seafood, and use the chemical and functional properties of protein in its production.

Explore the brief

Explore the problem and brief to identify the stakeholders, constraints, food science principles and chemical and functional properties of protein-based foods. The work you have done in topics 1–3 will help you to recognise and describe facts and principles about vitamin, mineral and protein-based food problems.

In the first instance, students will explore the problem by responding to the brief (in this case, the Neptune's Seafood Company brief). Exploring the problem means examining the stakeholders, principles of food science, food safety and legislation as well as considering the essential characteristics and constraints of the brief.

Respond to the brief

Stakeholders

Stakeholders must be identified. They can be presented in a table, mind map or other graphic organiser.

Principles of food science, food safety and legislation

Responding to the brief in terms of the principles of food science, food safety and legislation will help to determine the specifications of the solution. Exploring the principles prior to developing ideas will help to focus the research and development of the food prototype, and should be included when determining the specifications of the final prototype. Some examples are given on what would be considered in the Neptune's brief. In other briefs, it will be necessary to look at the specific food science, safety and legislation principles. The background section of each experiment in this book contains information relating to the principles of food science and experimenting that can be applied to specific problems.

Respond to the brief

Essential characteristics and constraints

The essential characteristics and constraints are identified in the brief. These need to be considered and explored. In Units 2–4 students are required to create their own essential features, characteristics and constraints for consideration.

Brief

Develop a prototype that uses seafood. The prototype must be suitable for inland consumers as they cannot access a range of fresh produce. These consumers would prefer a variety of products that can be transported frozen and are acceptable after preparation.

Essential characteristics and constraints

- The prototype must include seafood and other protein-based food components
- Must be able to be frozen and storage and transport must be considered.
- Must be saleable in retail locations.
- You will have 15 hours to follow the four phases of the Food & Nutrition problem-solving process.

Seafood can be used for a variety of food products. Fish cakes, mornays, crepes, pies, pizza and pasta dishes are among the variety available on the market. The chemical and functional properties of protein must be applied when developing prototypes for the brief.

- The prototype should be acceptable to consumers after being frozen and reheated following preparation instructions.
- The prototype can include other protein-based food components.

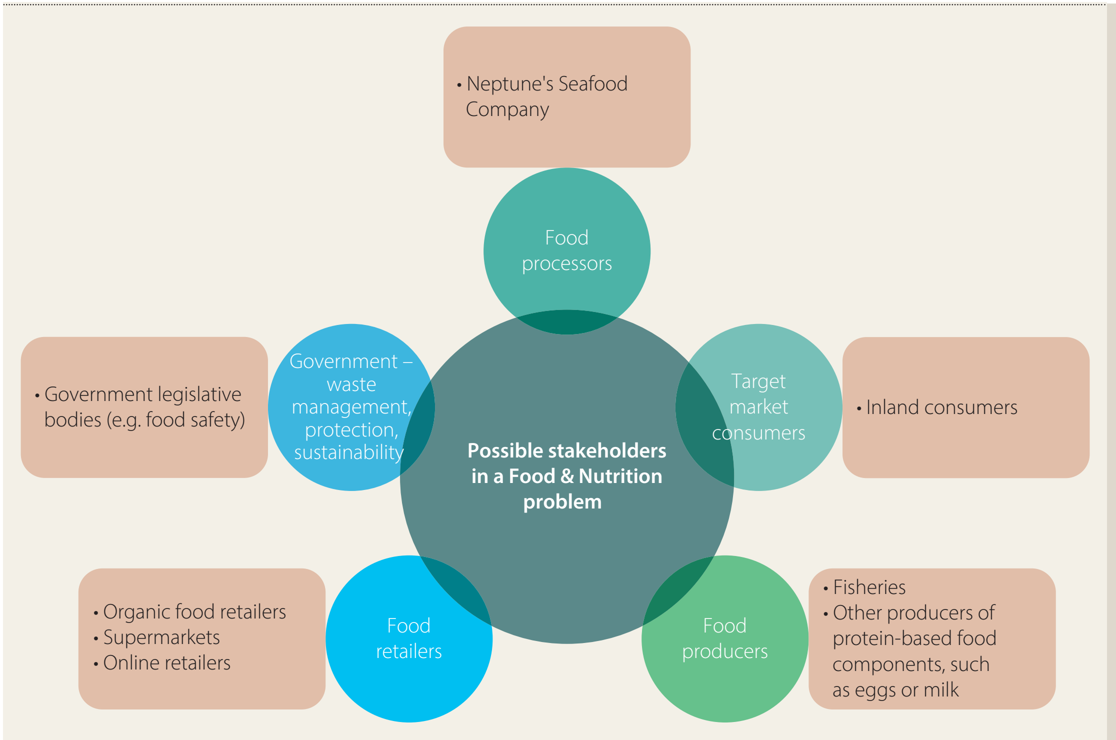
Specifications

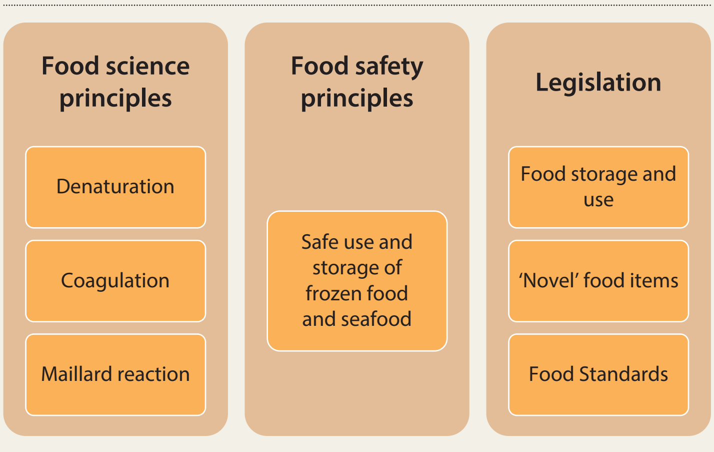
- Solution must contain seafood.
- Solution must provide a different seafood product to others that are available.
- Sensory testing of the prototype must be acceptable when prepared after purchase.

Criteria

CRITERIA	REQUIREMENTS
Appearance	Food product has an appealing appearance
Taste	Taste is acceptable to a range of consumer groups
Texture	Texture is acceptable when prepared after purchase
Sensory testing	Product is tested and accepted by the targeted consumer group or groups, as evidenced through sensory testing
Prototype food components	Must contain a majority of seafood with other protein-based food components
Storage and shelf life	Must have a storage life of at least 3 days (can be in the refrigerator if required)
Point of difference to other products already available	Different to other product lines available in store

9780170418560


• Neptune's Seafood Company
Food processors
• Government legislative bodies (e.g. food safety)
Government – waste management, protection, sustainability
Possible stakeholders in a Food & Nutrition problem
Target market consumers
• Inland consumers
• Organic food retailers
• Supermarkets
• Online retailers
Food retailers
Food producers
• Fisheries
• Other producers of protein-based food components, such as eggs or milk


Food science principles
Denaturation
Coagulation
Maillard reaction
Food safety principles
Safe use and storage of frozen food and seafood
Legislation
Food storage and use
'Novel' food items
Food Standards

ACTIVITY 5.1

Aim

To **determine** the specifications of the protein-based food solution to the brief by considering the following:

- stakeholder needs
- principles of food science, food safety and legislation
- essential features, characteristics and constraints of the problem.

Once these are considered, a summary should be included in the folio. This may be presented in graphical format.

STEPS

1 Refer to the list of stakeholders for this scenario (page 127). **Identify** opportunities, threats and needs in each stakeholder category. Some stakeholders in the scenario may not have a vested interest but should still be considered. For example, other frozen seafood manufacturers may not want this product to be used as it is a direct alternative to their product, so they are still considered a stakeholder.

2 a **Consider** the food science, food safety and legislation that will impact on the development of a frozen seafood product.

b **Consider** the standard uses and properties of proteins and processes used to produce different seafood products.

3 Using mind mapping techniques, **consider** the essential characteristics and constraints of the problem.

WS Activity 5.1 template

Conclusions

1 **Summarise** how the key stakeholder needs will be considered in the creation of a solution for this scenario. Write this up as a practice for your assessment task.

2 **Identify** how the principles of food science, food safety and legislation might impact on the development of this prototype. Provide a summary of the considerations.

3 **Identify** the essential characteristics and constraints from the mind mapping exercise. Write these in a summary.

Consider prescribed criteria

In this example, a prescribed list of criteria is supplied in the Neptune's brief on page 126. In addition to the prescribed criteria, the brief must be considered in terms of the personal, social, ethical, economic, environmental, legal, sustainable and technological implications of the food solution. The feasibility, quality and reliability of the solution should also be considered.

9780170418560

ACTIVITY 5.2

Aim

To **consider** the prescribed criteria (in the brief on page 126) and each criterion's impact on the solution

STEPS

1 **Consider** the brief specifications by listing each criterion, then consider the requirements for each one. **Summarise** how this will impact on your development of a food solution. This can be in dot point form.

2 For the prescribed criteria, **decide** on the impact or implication each will have on the possible solution. Some solution requirements may fit into more than one of these categories. Explain how each will be considered in the final food solution.

Note that the brief specifications and requirements are already provided in this example. Students need to consider how each requirement will impact on their food solution.

CRITERIA	REQUIREMENTS	IMPACT	IMPLICATION
Feasibility of the quality	Prototype is quality, accepted by consumers		
Functionality	Can be used by a variety of consumers		
Reliability of the solution	Is in constant supply, easy to prepare after purchase		
Solution requirements	• Uses seafood and other protein-based food components • Different to other frozen seafood products available • Follows the principles of chemical and functional properties of protein in relation to the food components • Able to be frozen, stored and prepared after purchase • 15 hours to use the problem-solving process		
Personal, social, ethical, economic, environmental, legal, sustainable and technological impacts	• Sustainable – use product that would otherwise go to waste • Personal – acceptable to the consumer – appearance, taste, texture, flavour and aroma • More seafood eaten by inland consumers, more variety in the diet of consumers		

decide reach a resolution as a result of consideration; make a choice from a number of alternatives

3 a Consider the feasibility of the quality, functionality and reliability of the solution. Based on research and experimentation already undertaken in relation to seafood, is this solution capable of being achieved?

b **Comment** on each in the table like the one below or use the template in NelsonNet. Where there is doubt or risk, or it may not be feasible, these should be listed too and all options **explored**.

Quality	
Functionality	
Reliability	

explore look into both closely and broadly; scrutinise; inquire into or discuss something in detail

WS Activity 5.2 template

Develop ideas

Research the knowledge and processes required from primary sources -conduct interviews with relevant stakeholders → **Experiment** with chemical and functional properties to gather primary source data → **Research** the latest trends, raw materials, components and processing techniques from secondary sources → **Synthesise** information and data to develop ideas for alternative solutions → **Determine** which solution best meets the specifications of the brief

FIGURE 5.1 Development of ideas in Food & Nutrition

As outlined in chapter 1, possible solutions to problems in Food & Nutrition include:

- an argument to advocate for or against a solution
- a set of experiments to show a food science principle or process
- a prototype.

In the Neptune's brief, a set of experiments or a prototype would be the most appropriate solutions. Possible ideas could include:

- Seafood patties, smoked seafood with different flavourings, seafood stock for use in other food products
- Seafood mornay
- Seafood quiche

ACTIVITY 5.3

Aim

To **conduct** primary research to determine options for using seafood to develop a frozen food for inland consumers.

conduct direct in action or course; manage; organise; carry out

STEPS

1 Construct a questionnaire for consumers to determine which seafood products could be used. Check chapter 1, pages 4–5 for tips on writing questionnaires. The questionnaire can be prepared in a Word document or using an online platform, such as Microsoft Forms, Google Forms, SurveyMonkey or another survey platform.

2 Survey 10 consumers who are the target market for this product:

   a Consumers from inland communities

   b Consumers who use frozen prepared products

   c Consumers who eat seafood or seafood products

3 **Analyse** and present the results of your survey.

4 **Perform** an experiment to test the following:

   a Which seafoods are available and could be used to develop frozen prototypes?

   b Which seafood has better sensory testing results when cooked, frozen and reheated?

9780170418560

Conclusions

1 **Identify** other primary data research methods you could use for this project.

2 **Discuss** why a questionnaire might be useful to gather primary data instead of interviews or a focus group.

3 **Explain** what information related to seafood preparation and storage may be found through secondary research.

Taking it further

4 From the primary research for the Neptune's brief, what conclusions can be drawn? What information and data would be used to **develop** ideas for this brief?

develop
elaborate, expand or enlarge in detail; add detail and fullness to; cause to become more complex or intricate

Generate solutions

Create the solution

The solution that best meets the specifications of the brief following research and the synthesis of the information and data is created. In the aquafaba brief, creating the solution involves:

- determining the food formulation for the final product
- determining the target market
- determining instructions for final preparation after purchase.

Evidence of the solution must be presented in the folio.

In the folio, evidence of primary and secondary research is required as well as the conclusions or information gained from this research.

Think about how this can be presented with images and concise conclusions drawn from the research.

Test the solution

After the solution has been created, testing is required on the following:

- quality
- functionality
- reliability.

The results from the tests must be presented in graphical or tabular form. Evidence of testing must be presented in the folio.

ACTIVITY 5.4

Aim

To **determine** how the Neptune's brief could be tested for quality, functionality and reliability

STEPS

The fish patties idea is determined to best meet the specifications for the Neptune's brief. It will be sold in supermarkets or online for inland consumers.

Propose at least three ways that testing could occur, along with data that would be collected from the testing.

TESTING	METHODS	DATA COLLECTED
Quality		
Functionality		
Reliability		

Conclusions

1 **Analyse** why testing of the final solution is important in terms of quality, functionality and reliability.
2 **Identify** the risks to a food company if this testing is not carried out.

Evaluate and refine the solution

In this stage, evidence of evaluation of the solution is required in the folio. Solutions do not need to be perfect, so an evaluation can be honest and reflect where future enhancements would occur. A perfect solution will be unlikely due to the short time frame; however, recommendations can be included in the folio for future development.

Make judgements

The final solution now needs to be evaluated against the criteria and data. For example, in the case of the aquafaba brief, the final solution of checkspace fish patties would be judged against the criteria and data. It is suggested that each criterion is compared against the final solution, along with the data generated from the research and the testing, to determine the feasibility of the solution.

In the brief, the following would be prepared and then judgements against each criterion recorded. Some questions to ask when determining the judgement:

- Does the solution meet the specification? Why or why not?
- What could be changed to make the solution fit the criteria?
- Have some criteria been prioritised over others? If so, what is the reason for this? Is it justifiable?

CRITERIA	JUDGEMENTS
Specifications	
Prototype is quality, accepted by consumers	
Can be used by a variety of consumers	
Is in constant supply, easy to prepare after purchase	
Uses seafood and other protein-based food components	
Different to other frozen seafood products available follows the principles of chemical and functional properties of protein in relation to the food components	
Able to be frozen, stored and prepared after purchase	
15 hours to use the problem-solving process	
Sustainable – use product that would otherwise go to waste	
Personal – acceptable to the consumer – appearance, taste, texture, flavour and aroma	
More seafood eaten by inland consumers, more variety in the diet of consumers	

Refine ideas

Refining ideas and the proposed solution involves evidence of evaluation that has occurred through the iterative design process, and evidence of how ideas have been refined. A set system can be used to indicate throughout the folio where evaluation and refining of ideas has occurred, as this is not something that should only be presented at the end of the problem-solving process. For example, highlight sections where ideas are refined using a coloured box or highlighted text in the folio. Any evidence of development or improvements on an idea can be highlighted as evidence of refining ideas to the proposed solution.

Make recommendations

From the judgements made in relation to the criteria, make recommendations about future enhancements to the product. Some questions to think about when making recommendations:

- How completely were the criteria met?
- How close is the solution to meeting the brief?
- Was the correct target market reached? If not, propose changes that might better suit the target market.
- Was there any issue with food safety?
- Were there any issues in relation to legislation or labelling laws?
- Will the solution be viable?
- Did the solution produce the standard of quality required?
- Did the solution produce the functionality that was required?
- Was the solution based on the research and data?
- Was there enough evidence to support the proposed solution?
- Did the prototype and sensory testing reveal any changes that need to be made?
- Is there any issue with costs?
- What will stakeholders think about the solution?

When answering these questions, think about what recommendations could be made to enhance the solution. This will need to be presented in the folio. Think also about the stakeholders in presenting recommendations and structure the recommendations in a convincing way, based on research, data or tests – don't just make up recommendations!

Further brief ideas

- Egg custard is traditionally produced by a large company for their Christmas food line. The custard recipe uses only egg yolks. The company is worried about the perception that lots of egg white is thrown away and wasted. To be more sustainable the company wants to devise a prototype using egg white that is acceptable to consumers, makes the most of the functional properties of the egg protein and is able to be stored at room temperature.
- An inner-city childcare centre is concerned that some children are not receiving sufficient protein in their diet at home. Since the centre provides snacks and lunch to all the children in their care the director has asked that a solution be found to this problem. Devise and test a prototype protein-based lunch food for the children that will have suitable sensory properties and be acceptable by the children in the centre. The prototype must be able to be prepared in a standard kitchen, different to current snack and lunch foods served and in multiple quantities. Stimulus showing commercially available lunch foods could support this brief.
- Quinoa is becoming popular in the trendy restaurants and cafés in the area. It has limited consumer acceptability but is high in protein and not as expensive as meat protein. Quinoa is considered a superfood, and the price of quinoa has recently stabilised. Devise a prototype to include in the product range for the company, making sure that the prototype is high in protein, has acceptable sensory properties for consumers.

WS
Unit 1 review

UNIT 2 FOOD DRIVERS AND EMERGING TRENDS

In Unit 2, students explore the factors that determine what food solutions will be developed and made ready for marketing and consumption. These factors include consumer drivers and quality control standards, including food safety and labelling legislation. Students use the Food & Nutrition problem-solving process to build knowledge and skills that they can use to develop ideas related to consumer food drivers, sensory profiling and labelling legislation. Students will solve problems for consumer markets by defining and analysing the problem, developing ideas and generating and evaluating a solution.

In Topic 1, students evaluate traditional consumer drivers and their impact on the development of alternative food solutions to fulfil the future protein demands of consumers. In Topic 2, students explain sensory profiling and analyse the impact of physical properties on consumer choice. In Topic 3, students analyse current labelling legislation and its relevance to consumer rights and the need for transparency in the food industry. In Topic 4, students have the opportunity to solve a problem related to developing a protein food solution in response to consumer drivers.

STUDENTS WILL

1. recognise and describe facts and principles about food systems, consumer demand, food safety and labelling
2. explain ideas and problems related to current and emerging consumer food markets
3. analyse problems, information and data related to current and emerging consumer food markets
4. determine solution requirements and criteria for specific consumer food market problems
5. synthesise information and data to develop ideas for solutions related to consumer food market problems
6. generate consumer market solutions to provide data to determine the feasibility of the solution
7. evaluate and refine ideas and solutions to make justified recommendations for enhancement of consumer food market solutions
8. make decisions about and use mode-appropriate features, language and conventions for particular purposes and food and nutrition contexts.

Food & Nutrition 2019 v1.1 General Senior Syllabus, p. 26.

Shutterstock.com/Africa Studio, Gepardu

CONSUMER FOOD DRIVERS 6

» Can consumers influence the development of new food products?

For new food products to be successful, consumers must be willing to purchase them, but how far does consumer influence extend? Throughout this chapter, consider the positive or negative influences that consumers may have on the development of alternative protein products in the future.

Sectors of the food system and consumer demand

The sectors of the food system (discussed in detail in chapter 1) include production, processing, distribution, consumption and research and development. Waste management, sustainability and food protection are also components of the food system and must be considered in all sectors. Each sector forms an important part of the Australian economy, through employment, business and service opportunities. Food production and processing are particularly important to the economy of regional Australia.

Each sector of the Australian food system is subject to changing trends and consumer demands at home and overseas. Exports of Australian food and agribusiness products have steadily grown over the past 10 years and Australia now exports over half of its agricultural produce. As trends and consumer demands change, at home and within the countries to which Australia exports goods, the sectors of the food system must adapt and respond to ensure sustainability into the future.

FIGURE 6.1 How is each sector of the food system influenced by consumers?

Consumer demand

The consumer market in relation to food has changed drastically in recent years. The demands of the modern Australian consumer can have both positive and negative effects on the food industry, presenting food businesses with many opportunities, but also frequent threats or risks. Some of the emerging consumer trends and demands in relation to food are described below.

More knowledgeable consumers

Consumers today are more connected and better informed than in any previous generation. As a result, consumers are more demanding than ever before, and this demand is driving the food industry towards new, innovative methods and higher standards of operating. It has also led to increased transparency, as companies can easily suffer a loss of reputation when stories of unethical practices and food safety issues are posted, shared and go viral. However, vast, easy access to information does not always mean the information is high-quality and factual. Information can be based on myths and opinions, rather than facts; surveys can present biased views and marketers and personalities pushing a particular agenda can easily reach consumers on social media or other platforms. As a result, consumers need to think critically when viewing, reading and sharing information online.

The increased accessibility of information to consumers has led to increased awareness across a range of food issues relating to processing methods, country of origin, nutritional requirements, food safety, use of chemicals in production, packaging, food waste and sustainability. The list is constantly expanding as social media and the Internet allow any and every topic to be shared widely and freely explored by Australian consumers.

Natural, organic and nutritious locally sourced food

Consumers are developing more health and environmentally conscious attitudes and the demand for natural, organic, local and nutritious produce has increased dramatically. The food industry is responding to these demands. The trend towards locally sourced produce is very popular in the food service and catering sector (hospitality) as cafes and restaurants become increasingly aware and conscious of where their raw produce is sourced. Australians want to know where their food is grown and produced, and the Australian Government has supported this consumer demand by implementing new country of origin labelling legislation.

The consumer demand for less processing and more 'natural' products is sometimes in conflict with current legislation designed to protect consumers. For example, the demand for raw or unpasteurised milk has grown, even though raw milk products are 150 times more likely to cause health issues. Australia has maintained strict legislation that makes it illegal to sell unpasteurised milk. However, consumer demand for unpasteurised cow's milk has spurred producers to investigate solutions to meet Australia's high safety standards without pasteurisation. Made by Cow, a business in New South Wales, has gained approval to sell fresh milk that has undergone a process known as high pressure processing (HPP) to make it safe for human consumption.

ACTIVITY 6.1

Aim

To **recognise** how consumer demands have influenced milk processing in Australia

recognise
identify or recall particular features of information from knowledge; identify that an item, characteristic or quality exists; perceive as existing or true; be aware of or acknowledge

MADE BY COW

The closest thing to raw milk that consumers can legally purchase was released to the market in 2016, which caused some controversy since it is illegal to sell 'raw' milk in Australia. The NSW Food Authority was quick to respond, stating that the milk was a 'highly processed' and safe product. Marketing aside, the product is still a breakthrough in the milk industry.

Made by Cow has, for the first time ever, been given permission to bottle and sell milk that has not been heat processed. The NSW start-up company uses high water pressure, rather than heat, to kill harmful bacteria in milk. Company founder, Mr Saxon Joye, believes that this is the first place in the world that HPP has been used for commercial milk.

HPP is used in Australia for other food products such as fruit juices, the first in Australia being commercially sold as Preshafruit. Preshafruit was developed in conjunction with the CSIRO and is marketed as cold-pressed juice.

Mr Joye also commented that the HPP use with milk allows people to enjoy the natural, tasty and nutritious goodness of raw milk, without using heat, pasteurisation or homogenisation.

Made by Cow spent two years getting approval from the NSW Food Authority to sell this type of milk. The Authority said it approved HPP as an alternative to heat for killing harmful bacteria, but it did not endorse any products.

A CSIRO microbiologist has claimed there is 'no evidence' of any substantial health benefits to processing milk in this way, although she has agreed that the milk would be more likely to appeal to consumers wanting a more 'natural' product.

Made by Cow milk will retail at a cost much higher than all other milks on the market, due to higher production costs. The start-up company also sources the milk from a single Jersey herd from a farm near Berry in the NSW south-coast region, which the company will also use for marketing purposes, stating that the milk comes from a high-quality dairy, with good management and hygienic milking practices.

Made by Cow

FIGURE 6.2 What constitutes 'raw'? Bottled raw milk is placed into vessels and then subjected to extreme pressure to kill harmful bacteria.

explain
make an idea or situation plain or clear by describing it in more detail or revealing relevant facts; give an account; provide additional information

discuss
examine by argument; sift the considerations for and against; debate; talk or write about a topic, including a range of arguments, factors or hypotheses; consider, taking into account different issues and ideas, points for and/or against, and supporting opinions or conclusions with evidence

summarise
give a brief statement of a general theme or major point/s; present ideas and information in fewer words and in sequence

Once the milk is sourced, it is transported to a bottling station and then transported to the treatment facility. Here the bottles are placed into baskets in a high-pressure water chamber for several minutes. The pressure is equivalent to being 60 kilometres below the ocean surface! Made by Cow claims that the enormous pressure kills harmful bacteria, with less damage to the original product than heat treatment, including less damage to vitamins and the molecules responsible for flavour and colour.

HPP can also extend the shelf life of milk, because it is treated in its packaging rather than after it has been packaged. This means there is less chance of other contaminants entering the milk. The Made by Cow product has a shelf life of 21 days.

Conclusions

1 What is high pressure processing and how does it make milk safe to drink?
2 **Explain** the consumer drivers that have influenced the development of this product.
3 Some consumers are demanding the ability to purchase raw milk. Should legislation change to cope with consumer demand? **Discuss** the positive and negative impacts of changing the legislation to allow this.

Taking it further

4 Think about another food product that has been developed due to consumer demand. **Summarise** the food product and **explain** how consumer demand has influenced its development.

Ready-to-eat food

In the busy families of the 21st century, fewer meals are being prepared at home and convenient, read-to-eat products have grown in popularity, creating a whole new market segment. This provides new opportunities for food production, but introduces threats related to food safety as ready-to-eat foods are the most affected by food recalls. In the past, most ready-to-eat food was frozen or sold on supermarket shelves as stir-through sauces and easy-to-prepare packets. Now consumers are demanding ready-to-eat foods that are fresher, healthier and with fewer additives. This comes with more challenges as food safety aspects of ready-to-eat products that are fresh (not frozen, canned, bottled, processed) are harder to manage. These foods require refrigeration and have much shorter shelf lives. Food producers need to pay attention to every detail to avoid foodborne illness. Food wastage in this type of production is therefore higher as food spoils quickly, and if not purchased within the timeframe, will need to be disposed of.

Ageing population

Australia's ageing population is at greater risk of foodborne illness. As the ageing population grows in size, demand for nutritious and quality food products for the elderly grows. Consumer demands in relation to the elderly include catering to different nutrition requirements, such as the need for more dietary fibre, easy-to-open packaging and an increased focus on food safety.

REVIEW QUESTIONS ▶

1 Identify the sectors of the food system.

2 **Identify** the key consumer demands that are driving new food innovation and products.

3 **Identify** the consumer demands that have led to the development of the following food products.

FOOD PRODUCT	CONSUMER DEMANDS
Fresh refrigerated lasagna	
Shredded fresh carrot	
Marinated chicken roasting portions	
Toasted muesli and yoghurt snack packs	
Fresh chicken noodle soup	
Spreadable light cream cheese	
Woolworths 'macro' organic range	
Barn-laid cage-free eggs	
Pancake mix	

4 **Explain** how consumer demands can impact on the following aspects of the food industry, by providing at least two examples for each.

- food production
- food processing
- food distribution
- food consumption
- research and development

identify
distinguish; locate, recognise and name; establish or indicate who or what someone or something is; provide an answer from a number of possibilities; recognise and state a distinguishing factor or feature

WS Chapter 6 review template 1

Consumer influence on the range and development of foods

Consumers can influence the range and development of food products in a very simple way: by choosing to buy or not buy products. A product that does not sell will soon be withdrawn from the marketplace due to the negative effect on the profits of food producers and retailers.

Before they launch a new product food producers conduct market research.

Some of the more recent consumer influences on the range and development of food products include a demand for:

- healthy foods and foods with added health benefits
- biodegradable packaging
- organic and wholefoods.

These consumer influences impact on the range and development of foods, as food companies will generally act in the interests of the business, and it is usually in the interests of the business to develop products that consumers are demanding, as this will increase profits.

halal
of food (especially meat), prepared according to Islamic law

organic
relating to a type of farming that minimises chemical fertilisers or pesticides, and the produce of such farming

kosher
'fit' or 'appropriate' for a Jewish person to eat, according to Jewish laws; used of food and vessels for food ritually proper for use, especially of meat slaughtered in accordance with the law of Moses

Businesses in the food industry need flexibility to survive. Flexibility means that product supply can match consumer trends such as being healthier, eating wholefoods as well as convenience and value for money. This is known as a dynamic industry, as it is highly driven by consumer demands. As the population changes, the demands also change. Australia is an ethnically and culturally diverse nation and this is reflected in the demand for culturally diverse products, including foods with specific attributes such as **halal**, **kosher** or **organic** food items, which has also increased the need for food certification systems and standards.

Our food industry is also internationally focused, with exports to over 200 markets across the world. The flexible and dynamic nature of our food industry is therefore also attributed to consumer demand and influences from all over the world. The food industry has developed new food processing techniques, packaging technologies and innovative food products. This has kept Australia at the forefront of the food industry worldwide and Australia's food industry has a global reputation for producing high-quality raw materials and an excellent safety and hygiene record. It is an environment that encourages creativity, innovation and collaboration and Australia is well-placed for investment in our food industry.

ACTIVITY 6.2

Aim

analyse
examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences

To **analyse** the impact of consumer-driven market trends on the range and development of food products

STEPS

1 Visit your local supermarket or an online supermarket shopping site.
2 Pick a food item from each category and **identify** the related consumer market trend.
3 Draw and complete a table like the one below or use the template on NelsonNet.

CATEGORY	FOOD ITEM	CONSUMER MARKET TRENDS
Fresh fruit		
Fresh fish		
Frozen convenience product		
Deli product		
Fresh dairy product		
Fresh bakery item		
Bottled product		
Canned item		
Frozen dessert		
Frozen vegetables		
Fresh meat product		

WS Activity 6.2 template

Conclusions

determine
establish, conclude or ascertain after consideration, observation, investigation or calculation; decide or come to a resolution

1 Make a list of consumer market trends identified from the research into supermarket food products.
2 **Determine** the relationship between consumer market trends and food product development.

3 **Determine** the impact consumers have on food product development from the examples you have found.

4 Evaluate the importance of food producers conducting market research so they can determine consumer trends prior to food product development.

Taking it further

5 Using your responses to the questions above, **analyse** the impact of consumer-driven market trends on the range and development of foods, making clear the relationship between consumer market trends and food product development. In your response, include relevant examples to illustrate each relationship. Present the analysis in a report.

evaluate
make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria

Traditional consumer food drivers

Traditional consumer drivers have a direct impact on purchasing decisions made by consumers.

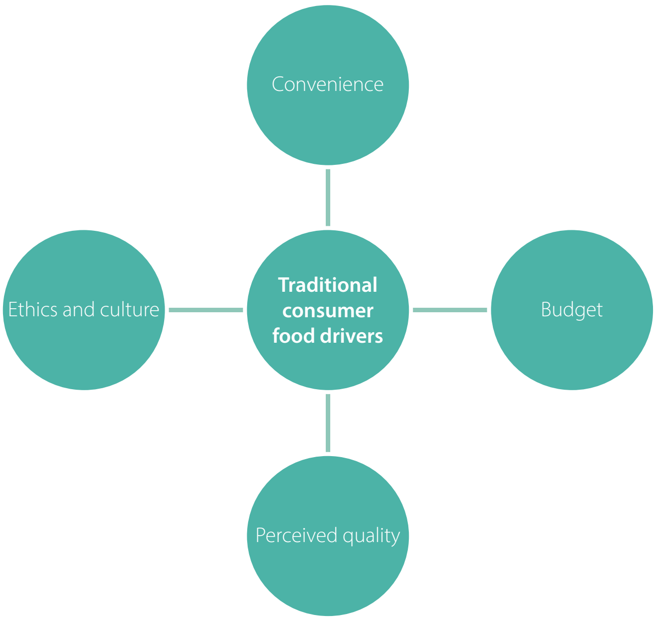


FIGURE 6.3 Traditional consumer food drivers

Convenience

Convenience is a key consumer driver of food products. Convenience products are products that are pre-prepared in some way and they are widely available in supermarkets. Convenience can be measured in several different ways, including time and effort spent on the tasks shown in the diagram that follows.

In the modern world, many people are faced with work–life balance problems, lack of time, meal fragmentation (where different family members eat the same meal at different times or different meals at different times), fewer cooking skills and an increased desire for leisure time. This results in more convenience-food products, often value-added, but usually at an additional cost to the consumer.

① Deciding what to buy and cook

includes making shopping lists, consulting recipes, consulting and considering family members

↓

② Accessing food

includes buying food at supermarkets, online shopping, shopping at specialist stores, shopping at food markets (decisions, and time and effort spent on shopping will depend on whether shops are in the local area, and available transport)

↓

③ Storing food

includes buying food in packaging that can be easily stored in the home, breaking down bulk buys into portions that are storable

↓

④ Preparing food

includes chopping, peeling, washing, measuring, mixing and combining ingredients; cooking

↓

⑤ Consuming food

includes portioning, serving, ease of consumption of foods that can be microwaved directly in the packaging they are purchased in, muesli and yoghurt that can be consumed on the go, pre-cut fruit that can easily be consumed as a snack, trail mix that is premixed and sometimes even pre-portioned

FIGURE 6.4 Consumer convenience can be related to different aspects of the consumer experience.

Studies have shown that the majority of consumers spend no more than 30 minutes each night cooking dinner. Partially prepared or fully prepared meals are contributing more and more to the average Australian meal that is prepared in the home. However, consumers are also demanding quality convenience products. Many consumers want fresh, high-quality products that are easy to prepare and do not compromise nutritional content.

The rise of convenient, value-added products has helped people to prepare high-quality meals in the home. For example, pre-washed and packed mixed lettuce is common in most supermarkets, as well as easy-to-produce salad kits.

Consumers have also opened new markets for companies such as HelloFresh, Tastebox or Marley Spoon, where all the ingredients and recipes are delivered fresh to your door, cutting out decision making, shopping time and food waste.

Home-delivered meals can also be ordered through other services such as Dinner Ladies, youfoodz and Gourmet Dinner Service, where home-cooked meals are delivered to the consumer's door and just require reheating.

People now have busier lives and are often too tired to cook dinner or even leave the house to get takeaway, which has enabled new food delivery services, such as Menulog, Deliveroo, UberEats and Foodora, to gain in popularity around Australia. Food delivery apps have increased substantially, which means that consumers can now order over 130 different cuisines through their devices. This is a large shift from the traditional pizza that dominated the home food delivery market for many years. According to News Corp Australia Network, 'A recent study by YouGov found that almost half of all Australians had ordered food online and most would do it again' (Jennifer Dudley-Nicholson, 11 June 2016). A recent app update to Menulog allows consumers the convenience of reordering their favourite items in just two taps.

FIGURE 6.5 Convenient, value-added products such as pre-washed and mixed salad leaves are growing in popularity.

ACTIVITY 6.3

Aim

To **investigate** how convenience is influencing consumer purchasing decisions

investigate carry out an examination or formal inquiry in order to establish or obtain facts and reach new conclusions; search, inquire into, interpret and draw conclusions about data and information

CONVENIENCE DRIVING CONSUMERS TO BUY VEGETABLES IN NEW WAYS

Australian consumers are exploring new frontiers in grocery shopping, with one in eight Australians purchasing vegetables online, according to the latest findings from the ongoing consumer research study of Project Harvest.

The study, which is being undertaken by vegetable and potato growers' representative body AusVeg, also found that the convenience of online shopping was winning Australians over, with the majority of consumers who shop online saying that the ease with which they can buy online was a key driver.

Project Harvest is a joint initiative funded through Horticulture Innovation Australia (HIA) by the National Vegetable Levy with matched funds from the Commonwealth government.

'When asked their reasons for buying vegetables online, the overwhelming majority of consumers listed "convenience",' said Kurt Hermann, AusVeg Assistant Manager – Industry Development.

'Buying Australian' important

Mr Hermann said the research had also found that Australians continued to support buying Australian products, and that online shopping was 'a part of this strategy, with respondents' comments suggesting that consumers make a link between buying online and supporting local growers'.

Convenience also driving growth of prepared vegetables

The study has also found that convenience was driving other changes to the way Australians buy vegetables.

'With time becoming a precious commodity, we've found that Australians are looking for quicker and simpler ways of getting vegetables into their diet,' Mr Hermann said.

Mr Hermann said this could take the form of online shopping, as shown by the 33 per cent of online shoppers who said they bought vegetables online at least once a fortnight. However, he said 'it can also take the form of buying pre-cut and pre-packaged produce in-store'.

'In celery consumption, for example, research shows that 40 per cent of consumers are buying pre-packaged celery, be that half-celery, celery stalks, or celery hearts,' Mr Hermann said. 'This wave of data also shows an increase in purchases of trays of zucchini, from 11 per cent of consumers in August to 18 per cent of consumers in December,' he said.

'We're encouraged by signs that Australians are finding ways to keep their diets healthy and nutritious even as they deal with increasing demands on their time,' Mr Hermann said. 'All Australians should be enjoying the health and wellbeing benefits that a vegetable-rich diet can provide, and as this research shows, they can take advantage of a range of convenient options to make this happen,' he said.

Source: Australian Food News, ausfoodnews.com.au, accessed 8 March 2018. Reproduced with permission.

Conclusions

justify give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable

1. **Summarise** the findings of the consumer research project.
2. **Identify** other supermarket products that are driven by convenience.
3. If convenience products such as pre-cut celery are more expensive, **justify** why consumer spending on these types of products is increasing.
4. **Explain** how traditional food drivers, including convenience, influence consumer purchasing decisions.

Budget

In a recent survey by global independent market research company Ipsos, taste, everyday price promotions and discounts were the top three considerations of consumers surveyed in relation to food purchasing decisions. The amount of money that a consumer sets aside for their food budget is therefore a key driver in consumer purchasing decisions. Consumers may make purchasing decisions based on the amount of money they have available and the perceived quality of what they are getting for their money. For lower income consumers, the food budget is often where they can save money; other key expenses such as rent, electricity and water cannot be altered month to month, unlike the amount of money that is spent on food. Food spending can therefore fluctuate depending on the amount of money available to the consumer. Another consideration of some consumers is value of food. Some consumers see food as simply fuel to continue to live, while others place much more value on food and will probably allocate a greater proportion of their household budget to food products.

In the same Ipsos survey, it was noted that:

- 55 per cent of consumers don't care whether the groceries they buy are private labelled (supermarket brands) or premium branded (foods from the manufacturer)
- 11 per cent prefer to buy supermarket brands.

This means that 66 per cent of consumers were happy to have the generic or private brand over premium brands. This indicates a trend toward cheaper alternatives and less brand power.

9780170418560

Budget and food costs are also associated with physical location. A survey in 2014 called the Healthy Food Access Basket measured the cost and availability of a standard basket of healthy food items in Queensland. On average, across all household sizes, the cost of the basket in very remote stores was 26 per cent more than compared to major city stores. Rural and remote spending on food is higher, although this may be offset by cheaper housing and rentals in rural and remote locations.

Other factors can contribute to the cost of food, such as drought, fire, disease and pests. When environmental factors wipe out crops, this can affect the price of fresh produce and have a flow-on effect to many other sectors of the food industry. For example, in 2011 Cyclone Yasi destroyed much of Australia's banana crop, causing the price of bananas to skyrocket to $15/kg. In times like these, many consumers are not prepared to pay such a high price for bananas and will opt for different food products during this period.

Food products also go through trends. The price of quinoa has fallen dramatically over the past four years. The price of quinoa peaked in 2013, at approximately $350 per quintal (48.5 kg). The 2017 rate for quinoa was just $110 per quintal. The price prior to 2013 remained steady until around 2007 when prices started to dramatically rise. Quinoa is a perfect example of how marketing and trends can dramatically affect food prices.

Perceived quality

Perceived quality of food items will influence what consumers are willing to pay. Quantity, quality and price are all factors that a consumer will consider when purchasing food items, and are therefore drivers of consumer purchasing decisions. Consumers are influenced by marketing and promotions of food products, including the perceived quality of food items. Consumers are also influenced by the amount of money they are prepared to pay for items versus their perceived quality. Premium brands, organic produce, groceries with added functional properties or 'health' foods are likely to attract higher prices, with the perceived benefit of the functional, health or organic food item warranting a higher price.

Price vs. quantity

The price of food items relates directly to the quantity of the food item that is purchased. In general, if the quantity is higher, then the food is more expensive. However, when the unit price is calculated, it is often cheaper to purchase a larger quantity of the food item, rendering the unit price cheaper than the smaller quantity. In Australia, big supermarkets and online grocery retailers must display the unit price and the unit of measurement on the grocery item alongside its selling price. The unit pricing system allows consumers to compare prices when purchasing items. Unit prices will appear as per litre, kilogram, 100 grams, 10 grams or per item, depending on the type of product.

Unit pricing can help consumers save money. The Australian Competition and Consumer Commission has the following tips to save money using unit pricing:

1. Compare the unit price of different sizes of the same brand's product, as well as products from different brands of the same product.
2. Look out for special offers which might temporarily have the lowest unit price – but not always.
3. The unit price of large packs is often lower than small or medium size packs. But avoid buying a bigger pack if it's likely to go to waste.
4. If a product is available loose or pre-packaged, check the unit price of both.
5. Compare unit prices in different parts of the supermarket. The same product may be sold in different sections, for example, cheese, meats, seafood, nuts, fruit and vegetables.

Source: ACCC Australian Competition & Consumer Commission, www.accc.gov.au, accessed 7 April 2018.

Mark Fergus Photography

FIGURE 6.6 Unit pricing per 100g allows consumers to easily compare the cost of different items.

Nutritional properties

The nutritional properties of food items can influence consumer purchasing decisions. This includes actual nutritional qualities and perceived nutritional qualities, where consumers may assume that a particular item is 'healthier' than another, or where products are marketed in a specific way.

Health claims such as '99 percent fat free', 'reduced fat', 'high in fibre', 'source of whole grain' can be misleading and give false impressions, but can influence consumers' purchasing decisions. For example, if a packet of lollies claims to be 99 per cent fat free, this can give a false impression that they are somehow better than lollies that do not contain this label, when in reality few lollies will have fat in them; they are all generally high in sugar.

Other health or nutrition related properties that may influence consumers to purchase particular products include functional foods, which are foods designed to promote different aspects of health. Examples of these products include yoghurts that have added live cultures or foods that are fortified with vitamins or other nutrients, such as bread with folic acid and iodine. Some food items have mandatory fortification standards that Food Standards Australia New Zealand (FSANZ) has set, as well as some voluntary standards not mandated by FSANZ. Mandatory fortification of foods is in place to address health concerns where serious problems arise from a deficiency. For instance, folic acid is added to wheat flour when making bread, to address and further reduce the incidence of neural tube defects in unborn infants.

Freshness and sensory properties

The freshness and sensory properties of fresh produce can influence purchasing decisions. Consumers use sensory evaluation to decide which fresh produce to purchase, and make judgements based on:

- overall physical appearance: general colour, shape, **turgor** and amount of fat
- smell or aroma: the smell of fresh fruit can indicate ripeness
- unwanted extras: garnishes, additional liquid, blemishes
- anticipated taste
- texture: the firmness of fresh fruit can indicate ripeness.

Read more about sensory properties on page 168.

turgor
the pressure placed on cell walls or membranes by fluids within the cell; turgor gives food a full, fresh appearance, a firm texture and a crisp mouthfeel

ACTIVITY 6.4

Aim

To **investigate** how sensory properties and food freshness affect purchasing decisions

STEPS

1 **Investigate** the general sensory properties and features consumers look for when purchasing the following products.

2 Present your findings in a table like the one below or use the template on NelsonNet.

FOOD PRODUCT	SENSORY PROPERTIES (INCLUDE APPEARANCE, TASTE, FLAVOUR AND AROMA, AND TEXTURE)
Fresh red meat	
Fresh chicken	
Fresh fish	
Fresh fruit	
Frozen vegetables	
Canned products	
Packaged items	

WS Activity 6.4 template

Conclusions

1 **Identify** the most desirable characteristics of fresh meat.

2 **Identify** the most influential characteristic (appearance, taste, flavour and aroma or texture) when consumers are purchasing fresh fruit. Give reasons for your choice.

3 **Explain** how sensory properties of fresh products affect consumer purchasing decisions.

4 **Explain** how the appearance of packaged products affects consumer purchasing decisions.

Taking it further

5 **Analyse** the influence sensory properties and consumer purchasing decisions can have on food waste from supermarkets.

Ethics and culture

Ethics relate to the moral principles that govern an individual's behaviour and can influence purchasing decisions. Culture relates to the ideas, customs and social behaviours of a group of people or a part of society.

Examples of how ethical and cultural drivers can influence consumer purchasing decisions are included in the table below.

Table 6.1 How ethical and cultural drivers can influence consumer purchasing decisions

ETHICAL / CULTURAL DRIVERS	CONSUMER CONCERNS	EXAMPLES
Animal welfare	Consumers want information and reassurance about animal welfare	Free-range eggs are increasing in popularity as consumers choose products that take animal welfare into account in their production
Sustainability in production and environmental stewardship	Consumers want to be informed about long-term sustainability and environmental stewardship, including how and where their food is grown and processed. Sustainability also relates to the use of resources during production and processing. Water usage, forest sustainability, climate change, ecological farming including prevention of soil erosion, reduced carbon emissions, use of biofuels	Sustainable fishing including aquaculture breeding, grass-fed or free-range products
Organic production	Consumer demand for organic produce has continued to increase, with many more consumers wanting products that are free from synthetic sprays, chemicals and growth regulators. Organic food items are seen as a healthier alternative due to production in a natural way	Organic fruit and vegetables, organic chicken, organic beef
Food waste	Food waste has become an ethical and moral dilemma facing developed countries. It is estimated that Australians throw out $8–10 billion of food every year. OzHarvest is fighting against food waste in Australia, to redirect food that is still edible to people who need it	Buying 'ugly' fresh fruit at supermarkets, buying less food, rescuing food that can still be eaten but may be past the official use-by date
Genetically modified foods	Genetic modification can affect consumer purchasing decisions, depending on their moral and ethical stance on genetic modification, and their beliefs surrounding scientists 'interfering' with nature. However, genetic modification can also result in desirable characteristics in food items, that may attract some consumers and can help to increase the world's food supply, increase food security and reduce famine in countries where food is scarce or expensive	Avoiding purchasing GM foods
Fair trading practices	Fair trade products are about stable prices, decent working conditions for all workers and empowering farmers and workers around the world. Research shows that consumers in Australia are more likely to purchase a product that supports someone in need over a product that does not have a charitable aspect, as long as the price and quality between the two were similar	Fair trade coffee, fair trade chocolate, fair trade tea
Packaging and landfill, particularly over-packaging	Environmental concerns over packaging, particularly over-packaging, have resulted in consumers who are making purchasing decisions based on packaging	Buying in bulk to reduce packaging, purchasing foods in packaging that is recyclable
Country of origin and production	Consumers want to make informed decisions, and want to know where products were grown, manufactured and packed	Australia has introduced new country of origin labelling laws to make it clearer where products are grown, manufactured or packed

OzHarvest

(*Continued*)

Table 6.1 How ethical and cultural drivers can influence consumer purchasing decisions *(Continued)*

ETHICAL / CULTURAL DRIVERS	CONSUMER CONCERNS	EXAMPLES
Media and advertising ethics, such as direct marketing to children	Ethics relating to media and advertising are contested in Australia; although the main role of advertising is to sell a product, advertising is not always considered ethically acceptable. Marketing of products that are considered 'junk food', as well as marketing to children, are raised as ethical questions. Media and advertising can influence consumer purchasing decisions, not always in a positive way. Advertising companies are successful if their advertising campaigns are successful, although in reality this may mean more junk food sold to children or more fast food purchased by consumers. Ethical considerations surrounding this may influence some consumers to avoid certain companies or products in 'protest' of their media and advertising tactics. Consumers have also forced changes in the codes of practice that exist surrounding food advertising in Australia	Families boycotting certain products for advertising to children
Cultural sensitivity	People are connected to their cultural group through similar food patterns and beliefs. The ingredients, methods and food customs can all be used to link cultural groups together. No matter where you are in the world, food is an important part of any traditional celebration. Different countries use food in different ways and it can be used to celebrate special occasions such as birthdays, New Year, weddings and religious occasions. Culture plays an important part in food selection, and what we grew up with often shapes attitudes to and beliefs about food as well as food habits. Culture may also include various rules and customs surrounding what should or should not be eaten	Jewish faith would dictate that food eaten must be kosher, which will influence the types of products that Jewish people will purchase

ACTIVITY 6.5

Aim

To **investigate** how traditional consumer food drivers influence consumer purchasing decisions when buying groceries

STEPS

1. Write a short questionnaire (could be completed as a class) to **determine** what traditional consumer food drivers influence purchasing decisions when purchasing groceries. Include questions that refer to:
   - convenience
   - budget
   - price vs. quantity
   - nutritional properties
   - sensory characteristics
   - ethics
   - culture.
2. Conduct the survey with up to 20 people who do grocery shopping for themselves or their family. The survey could be designed for easy collection using SurveyMonkey, Google Forms or Microsoft forms.
3. Collate the survey information.

Refer back to the previous pages to determine what questions to ask under each category. Remember, the questionnaire should be designed to determine which drivers influence consumers when purchasing groceries.

generate
produce; create; bring into existence

synthesise
combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding

Conclusions

1 **Identify** the highest ranking traditional drivers that influenced purchasing decisions.
2 **Summarise** the conclusions you can draw from the survey results.

Taking it further

3 **Generate** ideas on how food companies can use purchasing decisions to their advantage. **Synthesise** new food product ideas that address the consumer drivers and would encourage consumer purchasing of the food product.

REVIEW QUESTIONS ▶

define
give the meaning of a word, phrase, concept or physical quantity; state meaning and identify or describe qualities

describe
give an account (written or spoken) of a situation, event, pattern or process, or of the characteristics or features of something

1 **Summarise** how budget can drive consumer purchasing decisions.
2 Perceived quality can influence what consumers are willing to pay for different food items. **Explain** how price versus quantity can influence consumer spending.
3 Nutritional properties, including nutritional claims on packaging, can influence consumer purchasing decisions. **Identify** three examples of nutritional claims on packaging and explain how they can influence consumers to purchase products.
4 **Define** 'ethical' and provide three examples of ethical considerations consumers may have that affect purchasing decisions.
5 **Describe** how cultural sensitivities and differences can affect purchasing decisions and provide two different examples.
6 According to OzHarvest, Australians throw out $8–10 billion of food every year, which equates to every Australian household throwing out $1036 worth of groceries each year. **Discuss** how this is an ethical concern in today's society.

Fulfilling future consumer protein requirements

As the global population continues to expand, the need for protein increases with it. The desire for protein increases further as countries get richer and people have more money to buy protein-based foods. This is currently being seen throughout Asia, as the middle class grows. The increased demand puts pressure on traditional sources of protein, particularly animal protein; therefore, alternative protein sources will play an important role in meeting future global demand. Before introducing alternative food products, food manufacturers need to consider consumer attitudes, values and concerns, as well as the broader governmental and environmental climate, such as the state of the economy and introduction of new legislation, and the technological environment, including new and emerging technologies.

Genetically modified foods

Genetically modified foods are foods that have been processed from organisms (plants, animals or microorganisms) in which genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination. The definition of genetic modification of food items, novel DNA and novel protein is provided in Standard 1.5.2 of the Food Standards Code.

9780170418560

Novel DNA and novel protein is DNA or protein that has a different structure to the original item because of the use of gene technology. Genetically modified food is food that is produced using gene technology and contains novel DNV or protein or is listed in Section S26-3 of the standard.

In Australia, GM food is only available in the form of crops such as soybean, corn, cotton and canola.

Transparency of industry

In Australia, the issue of **transparency** in GM foods is tackled through the GMO (Genetically Modified Organism) record. The purpose of the GMO record is to provide the Australian public with access to information about GMOs in Australia. Australia was one of the first countries to make this information publicly available. A company must declare if it has a 'dealing' with a GMO. 'Dealings' with a GMO include conducting experiments with GMOs, breeding GMOs, importing GMOs, growing or raising GMOs and disposing of them.

transparency
policy or practice of making all operations clearly manifest, and of being accountable to the public for all such operations

ACTIVITY 6.6

Aim

To **investigate** how the CSIRO has produced genetically modified cowpeas

INSECT PROTECTED COWPEAS

Cowpeas are an important food crop in Sub-Saharan Africa but yields are often reduced by more than 80 per cent due to pests and diseases. We are part of a global project to improve cowpea production in Africa and are making progress towards incorporating 'built-in' insect pest protection that could help to reduce food shortages in the region.

The challenge – Increasing food security for Sub-Saharan African farmers

Cowpeas are a staple food and an important source of protein for more than 200 million people in Sub-Saharan Africa. They are mostly grown in West Africa on an area of more than 7 million hectares.

Cowpeas have been used in this part of the world for millennia. They are regarded as drought tolerant and can cope with poor soils, making them highly adapted to the region.

One additional advantage of cowpeas is that the leaves and green pods can be eaten before crop maturity. This provides an important food source before mature grain is harvested – acting as a food bridge during the 'hunger gap' between harvests.

Our response – Protecting African cowpeas from insect pests

We are combating one of the major pests that affect cowpeas – the legume pod borer.

Legume pod borers deposit eggs on the flower buds of cowpea. When the larvae emerge they damage the flowers, young pods and seeds, drastically reducing yield.

Using insecticides has not proven to be a viable approach. They are expensive and their safe handling and use requires equipment and expertise that is not readily available to small-scale farmers in Sub-Saharan Africa.

One option to address these pests is to develop cowpea varieties with their own 'built-in' protection against the pod borer.

Researchers in Africa have been looking for pest resistance in extensive collections of cowpeas and related species, but useful levels of protection have not been found.

As a result, CSIRO was approached by the Network for Genetic Improvement of Cowpeas for Africa and the African Agricultural Technology Foundation (AATF) to develop a system for genetically engineering cowpeas, which is a basic requirement to introduce new genes for insect protection.

Bt genes naturally occurring bacteria that produce a protein that is toxic to some insects

Similar to cotton, where **Bt** genes are providing resistance to cotton's number one pest – *Helicoverpa*, we are using a Bt gene in cowpeas to protect against pod-borers.

The Bt gene causes the plant to produce a protein that selectively affects certain insect pests including the pod borer without affecting others, including beneficial insects.

The results – Successful glasshouse and field trials of resistant cowpeas

Significant progress has been made toward the ultimate aim of incorporating one or more Bt genes into cowpeas to provide a long term plan for robust protection.

The team has been able to develop several pod borer resistant cowpea lines, each producing different amounts of the Bt protein.

Trials have been carried out in greenhouses at our Black Mountain site in Canberra.

In the lab the research team found that there was 100 per cent mortality of the pod borer caterpillars after feeding on flower buds of cowpea containing the Bt gene.

Field trials to test agronomic performance and insect resistance have been carried out in Puerto Rico, Nigeria, Burkina Faso and Ghana and more are planned for Malawi in Southern Africa.

Initial field results were very promising. Selected cowpea lines were fully protected in both Nigeria and Burkina Faso over several years. Currently, the plant breeders are introgressing the Bt gene into farmer-preferred lines and are evaluating their acceptability and suitability for local environments.

Transferring the benefits to Africa

Regulatory requirements will need to be met before the insect-resistant cowpeas are considered for general release in Africa. Besides developing improved breeding material, CSIRO also aims to transfer knowledge of the technology to Africa.

Several African stakeholders including regulators have visited the Canberra based group already and have benefited from their experience by establishing protocols based on what they learned in Australia. This research is supported by the African Agricultural Technology Foundation and grants from USAID and the Rockefeller Foundation.

Source: CSIRO. Reproduced with permission.

9780170418560

FIGURE 6.7 Pod borer moths lay their eggs on the cowpea plants, drastically reducing the yield when caterpillars emerge and feed on the plant.

FIGURE 6.8 Field trials in Ghana to test the new pod borer resistant cowpea plant

Conclusions

1 **Summarise** the importance of cowpeas in Africa.
2 **Identify** the existing advantages of the cowpea crop.
3 **Analyse** the research and development that the CSIRO has carried out and **explain** what has been developed to address the current problem.
4 **Explain** which consumer food driver impacted on the development of the GM food.
5 **Identify** how GM foods are transparent in Australia. What has the CSIRO also implemented for transparency in the development of this GM food?
6 **Discuss** the value of genetically modified crops, taking into consideration both positive and negative aspects of GM crops.

Organic food compared with intensively farmed food

Intensively farmed foods have come under much scrutiny as information about intensive farming techniques becomes more widely available. Food producers need to be transparent and upfront as consumers are questioning intensively farmed foods. Consumer demand for organic food has grown exponentially. In 2016, it was reported that the organic food sector grew 17 per cent in five years. The cost of organic produce is still high, but as more farmers convert to organic methods, the cost is predicted to fall with competition in this sector increasing. It is predicted that the organic food industry will rise from the current worth of $919 million to $1.2 billion in 2020.

intensively farmed foods
way of producing large amounts of crops or animal products by using chemicals (e.g. antibiotics) and/or contemporary technology

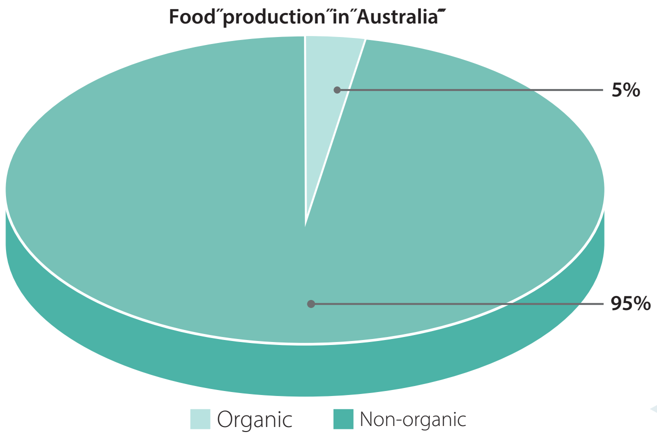


FIGURE 6.9 Food in Australia

Australia has the largest area of organic farmland in the world, covering more than 22 million hectares, with more being added every year, but organic food accounts for only 5 per cent of Australia's total food production by volume.

The rising demand for organic products is partly due to health and ethical concerns over animal welfare. The industry is also fuelled by consumers with higher incomes who can afford to purchase organic products. However, the lengthy process to convert to organic farming plus the certification processes means organic farming cannot grow as quickly as consumer demand. Reducing the conversion times may help the overall growth and outlook of the industry. Organic protein trends include the foods listed below.

Fish

Most nutritionists would agree that fish is healthy. However, not all fish are equal, and the health of fish is determined by their origin. Farmed fish are not fed a natural diet and therefore do not always produce the desirable nutritious characteristics that wild fish are known for, including the desirable omega-3s. Added to this is the 'collateral damage' that fish farms can cause on waterways – concentrated fish excrement in one location and excess feed settling on the ocean floor can negatively affect oxygen water levels and lead to fish deaths in the natural environment. Ethically, the number of fish that die along with the welfare of the animal during breeding is enough for some consumers to turn to natural or organic fish. Wild fish are seen as the organic option; although fishing in this way additionally raises questions of sustainability, the fish are considered natural living creatures for their life.

iStock/Getty Images Plus/ThamKC

FIGURE 6.10 Wild salmon (left) vs. farmed salmon (right). To prevent this difference in colour, farmed salmon are fed chemically synthesised astaxanthin, which is the pigment that wild salmon consume from algae and seaweeds, as consumers expect 'red' salmon.

Quinoa

Quinoa is a complete protein. It has twice the protein content of rice or barley and is considered a 'pseudocereal' as it is technically a seed. In recent years, quinoa has been promoted as a superfood due to its high nutrient content, including high protein content, minerals and B-vitamins. Quinoa has been a staple crop grown and consumed in South America for many years. Quinoa is technically gluten free, although processing is often performed in areas where other grains are processed, which can lead to gluten contamination. Organic quinoa is widely available in Australia. The worldwide price of quinoa increased significantly as it became popular in Western countries, but it has recently fallen due to increased production around the world.

Shutterstock.com/Elena Schweitze

Shutterstock.com/Losangela

FIGURE 6.11 Superfood organic quinoa has grown in popularity around the world.

Eggs

Eggs are an excellent source of protein as well as thiamine, riboflavin, pantothenic acid, folic acids, vitamin B12, biotin, vitamin D, vitamin E and phosphorus. Whole eggs are more nutrient dense than egg white alone, since the yolk contains most of the vitamins, minerals, antioxidants and omega-fatty acids. Organic eggs should not be confused with free-range eggs. Under the most recent legislation, 'free range' can appear on the label for eggs if the chickens have had meaningful and regular access to an outdoor range during daylight hours, are able to roam and forage on the outdoor range and have a stocking density of 10 000 hens or less; certified organic eggs are free from artificial chemicals, antibiotics and their production methods are humane. Organic eggs provide more nutrients and fewer toxins than conventionally produced eggs, but their yolks may be paler than other eggs due to the lack of artificial colour in organic poultry feed.

Milk

Demand for organic milk in Australia is growing, with milk processors offering dairy farmers premium prices to convert to organic dairy production. Organic milk must be from certified organic dairy farms and be processed at certified organic facilities. Organic milk is almost always more expensive than non-organic milk. Production costs are higher as milk is produced without pesticides and with higher standards of animal welfare. Many organic milk brands are produced by smaller dairies.

Other dairy products

Organic dairy products, including cheeses and yoghurts, are good sources of protein. Several manufacturers now produce organic dairy products, using the milk from certified organic dairy farms, processed at certified organic facilities around Australia.

Chicken

coccidiostats a chemical substance added to animal feed that slows or reduces the population of pathogenic coccidia

Chicken is a good source of complete protein, containing all the essential amino acids. Organic certification ensures that the chickens are raised in humane conditions, fed an organic nutrient-rich diet and without the use of antibiotics, hormones or **coccidiostats**. Conventionally farmed chickens are intensively raised and ready for consumption after as little as 32 days. Organically farmed chickens are raised more slowly, taking up to 60 days, which adds to the increased price tag for organic chicken. Certified organic poultry is the only way to guarantee the chicken is 100 per cent antibiotic free. Antibiotics are fed to conventional chickens to prevent disease and accelerate weight gain. Many consumers incorrectly assume that 'free range' is the same as organic. Free range chickens can still be treated with therapeutic antibiotics and their feed is not free of chemicals, herbicides and fertilisers.

Beef

Beef is another source of complete protein and it also has iron and zinc. Organic beef must be certified and display the certification on the label. Organic beef is raised on organic farms, with the animal grazing on chemical-free pasture (no artificial pesticides, herbicides or fungicides), with no GMOs, no animal by-products, no antibiotics or growth hormone and ethical treatment of animals. In Australia, we have an abundance of natural grazing land which means organic beef farming is easier. Organic beef is not to be confused with grass-fed beef. Grass-fed beef also requires a certification, but does not meet all the requirements for organic certification.

Lentils

Lentils are not a complete protein, but are still a good source of amino acids, carbohydrates and fibre. When combined with other grains they form a complete protein. Lentils can be filling and are easier to digest than larger beans. Organic lentils are readily available in supermarkets and health food stores.

Tempeh

Made from fermented soy, tempeh is a source of protein for vegans (provided they have no soy sensitivity). Organic tempeh means no genetic modification. Soy protein is comparable in digestibility to other high-quality protein sources.

Spirulina

Spirulina is a biomass of cyanobacteria, which are blue-green algae. It is approximately 57 per cent per cent protein and used in various forms. The protein in spirulina is 85–95 per cent digestible, since it has no cellulose in its cell walls. Organic spirulina is generally available as capsules or tablets, or in a powdered form. Spirulina is classified as a dietary supplement and, like quinoa, is promoted as a superfood.

REVIEW QUESTIONS ▶

1 **Identify** the traditional consumer food drivers (see pages 141–3) that impact on increasing demand for organically farmed foods.
2 **Analyse** which traditional consumer food drivers are impacting on intensively farmed protein-based.
3 In a table like the one below or using the template on NelsonNet, **identify** which consumer food driver(s) are attributed to the development of each of the following popular protein-based foods.

9780170418560

PROTEIN ITEM	CONSUMER FOOD DRIVERS
Organic fish	
Farmed fish	
Organic quinoa	
Organic eggs	
Free range eggs	
Organic milk	
Organic chicken	
Farmed chicken	
Organic beef	
Organic legumes such as lentils	
Organic spirulina	

WS Chapter 6 review template 2

Fortification and functional foods

Fortification and **functional foods** are the food industry's response to consumer demand for healthier food choices or, in some cases, directives from the government. Functional and fortified foods contain extra health benefits, which exist naturally or may be added during manufacture. Fortified foods have had nutrients added to the food to increase or supplement the original levels; for example, salt is often fortified with iodine and bread is fortified with fibre and folate. Functional foods are categorised into three main groups: foods that contain natural substances that are preventative or curative, modified processed foods and foods containing active non-nutrients.

fortification
addition of nutrients that are not naturally present in the food or the addition of amounts greater than those naturally present

functional foods
foods or food components to which an existing ingredient or a new ingredient has been added to provide additional benefits, usually for disease prevention or improved health

Foods containing natural substances that are preventative or curative

Fruits, vegetables, high-fibre cereals, grains, fermented foods, oily fish and dairy products with added bacteria all fall into this category. For example, oily fish such as salmon, tuna and trout contain two of the most crucial omega-3 fatty acids: eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). These two fatty acids can help to lower blood pressure, slow the development of plaque in the arteries, and reduce the likelihood of heart attack and stroke. Foods containing probiotics is another example of a functional food item. **Probiotics** in yoghurt promote healthy digestive function, can aid in improving intestinal health, preventing the common cold, help with irritable bowel syndrome symptoms and crowd out harmful bacteria. Other fermented products with beneficial probiotics include fermented dairy products such as **kefir**, sauerkraut and kimchi.

probiotics
beneficial bacteria that can be introduced to food items such as yoghurt

kefir
a unique cultured dairy product that is rich in probiotics

Modified processed foods

Modified processed foods are manufactured by altering the original food products through the addition or removal of certain nutrients. Fat-reduced foods, for example, are modified by the removal of fat content. Removal of fat in dairy products such as milk, cheese and yoghurt can help lower the risk of obesity as well as the risk of diabetes, high cholesterol and high blood pressure.

Nutritionally enriched foods have had nutrients replaced that may have been lost during processing. For example, during wheat flour processing, several B vitamins such as folic acid, riboflavin, niacin and thiamine, and iron are lost. The flour is then enriched when those nutrients are added back in after processing. The B group vitamins are important for helping our bodies convert food to fuel for energy, known as metabolism, correct nerve functioning and muscle development.

phytochemicals chemical compounds that are produced by plants that have protective or disease-preventive properties

Foods containing active non-nutrients

These foods are considered to enhance the functioning of the body. They include **phytochemicals**, probiotics and fibre. Food manufacturers are producing these foods for the added benefits that are imparted to the consumer. Fibre is classified as an active non-nutrient as it is not digested and metabolised like other carbohydrates. Thousands of different phytochemicals have been identified and grouped according to their chemical characteristics. Phytosterols, terpines, organosulphur compounds and phenols are the main groupings. The phytochemicals found in fruits and vegetables can be identified by their colour.

Table 6.2 Phytochemicals found in fruits and vegetables of different colours

YELLOW AND ORANGE	RED	BLUE AND PURPLE	GREEN	BROWN AND WHITE
carotenoids (beta-carotene, lutein)	lycopene	anthocyanins	carotenoids (beta-carotene and lutein)	flavonoids (flavonols)
	anthocyanins	flavonoids (flavonols)	isothiocyanates	fructans
	flavonoids (flavonols)		saponins	allyl sulphides
	saponins		flavonoids (flavones and flavonols)	isothiocyanates
			fructans	saponins

FIGURE 6.12 The food rainbow

Give Colour a Spin

Labelling of functional foods

The formulation and advertising of functional foods in Australia is heavily regulated. FSANZ mandates five steps for advertising and labelling functional foods in Australia:

1 Determine whether your functional food is a 'food' or a 'therapeutic good'.
2 Make sure that the formulation of the food follows the Food Standards Code.

9780170418560

3 Avoid making therapeutic claims.
4 Ensure that any nutrition content or health claims included on food labels or in food advertising comply with *Standard 1.2.7 – Nutrition, health and related claims.*
5 Ensure all claims made with respect to the functional food comply with the Australian Consumer Law.

ACTIVITY 6.7

Aim

To **investigate** different food items that have added or removed ingredients

STEPS

1 **Identify** which category the following functional foods fall under:
- breads with extra fibre, DHA (docosahexaenoic acid), phytoestrogens or hi-maize
- cereals supplemented with additional folate, minerals and vitamins
- eggs containing omega-3 fatty acids
- milks enriched with calcium and iron
- yoghurts containing bacterial cultures
- margarines/ spreads with plant sterols
- fruit juices enriched with calcium and iron.

2 **Investigate** 10 food items where ingredients have been added or removed from the food item. Draw a table like the one below or use the template on NelsonNet. List the 10 items, ingredients added/removed and the benefit to the consumer of each, and which consumer food driver impacted on the development of the product.

FOOD ITEM	ADDED / REMOVED INGREDIENTS	BENEFITS TO CONSUMER	FOOD DRIVERS THAT IMPACTED ITS DEVELOPMENT

WS Activity 6.7 template

Conclusions

1 Have consumer food drivers impacted on the development of fortified or functional foods? Clearly **explain** the relationship between traditional food drivers and fortified or functional food products.

Taking it further

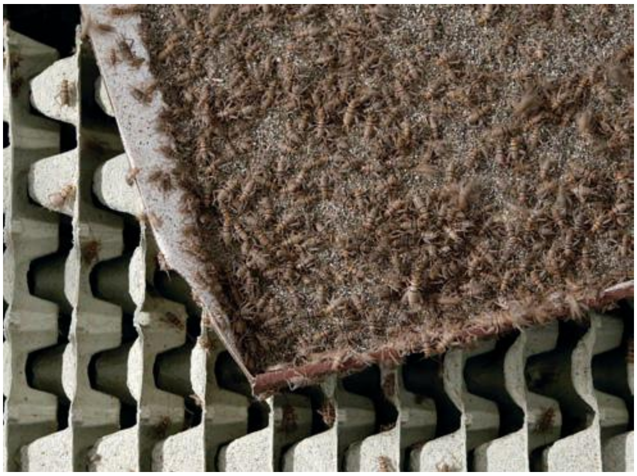
2 **Investigate** mandatory fortification in Australia. Make a list of foods where there is mandatory fortification and list the reason for each.
3 **Analyse** the use of mandatory fortification by the government. What is the purpose of mandatory fortification? Do you agree or disagree with mandatory fortification? Provide reasons for and against.

Entomophagy

entomophagy use of insects as a food source; insectivorous eating habits

Entomophagy is the use of insects as a food source. In 2017, the CSIRO published *The Food and Agribusiness Roadmap: unlocking value-added growth opportunities for Australia*. In this report, the CSIRO identified that the global edible insect market is expected to grow from US$34 million in 2015 to over US$520 million by 2023, powered largely by the growth of Asia's middle class and the subsequent increase in demand for sustainable protein-based foods. The CSIRO has identified sustainable solutions could be insect-based ingredients (e.g. flours), snacks and animal feed that utilise crickets, meal worms, locusts and ants.

Insects offer a sustainable and economic source of protein for humans and animals, with comparatively lower greenhouse gas emissions and lower costs. In 2015, beetles dominated worldwide demand of insects. Key consumption of insects in 2015 was whole or in a powder form for flour, protein bars and other snacks. Insects were also heavily used for animal feed, particularly black solider fly larvae and maggots for feeding in the aquaculture industry. Grasshoppers, beetles, crickets, cockroaches, termites, flies, wasps, bees and ants are food sources for poultry. It is estimated that 1 hectare of land could produce over 150 tons of insect protein per year. Insects have lower emissions and consume less water and natural resources when compared with beef and pork farming.



Reuters Pictures/Francois Lenoir

FIGURE 6.13 Cricket farming is inexpensive and environmentally friendly.

ACTIVITY 6.8

Edible bug shop

Aim

To **investigate** current edible insects sold in Australia

STEPS

1 **Identify** and make a list of current insects that are available for human consumption and those that are available for animal feed.

2 **Investigate** the benefits of human consumption of insects and insects for animal feed.

3 Create a marketing campaign to persuade people that eating insects is the protein of the future!

create bring something into being or existence; produce or evolve from one's own thought or imagination; reorganise or put elements together into a new pattern or structure or to form a coherent or functional whole

Conclusions

1 Traditional consumer drivers may have a negative impact on the development of the edible insect industry. **Identify** which traditional drivers may hinder the development of this industry.

2 Using traditional consumer drivers, **analyse** how edible insects could be marketed to consumers to increase consumption of the edible insect market.

Synthetic protein

Synthetic meat is grown in a cell culture in a laboratory instead of growing the animal itself. It is sometimes referred to as 'cellular agriculture'. The first cultured meat patty was eaten at a press conference in London in 2013, and it was hailed as the world's most expensive hamburger. The meat strands were grown over a three-month period and the burger was advertised as costing US$330 000 to produce. Around 3000 muscle strips, each the size of a grain of rice were grown individually to create the meat patty.

Synthetic or in-vitro meat is now being experimented with more widely, including clean chicken or poultry meat. Some have argued that the biggest hurdle will be convincing people to eat meat grown in a laboratory.

synthetic meat meat grown in a cell culture instead of inside an animal, is a form of cellular agriculture. Also known as cell-cultured meat, clean meat, vatmeat, lab-grown meat and in-vitro meat

ACTIVITY 6.9

Aim

To **analyse** how traditional consumer drivers will impact on the development, safety and ethics of lab-grown meat

STEPS

1. Lab-grown meat, synthetic meat and cellular agriculture could be a sustainable way to produce and consume meat into the future. Research and **summarise** in a one-page report the latest research and development in lab-grown meat, including new technologies, what meat is being grown and current taste test results.
2. **Analyse** the impact on the environment, resources and the ethical considerations of lab-grown meat, including positive and negative perceptions by consumers. Check the links on NelsonNet for inspiration.

Alamy Stock Photo/tilialucida

FIGURE 6.14 Will lab-grown meat one day be the norm? Will consumers accept lab-grown meat as a suitable protein alternative?

Lab-grown meat

Conclusions

1. What conclusions can you draw from the current research and development into lab-grown meat?
2. **Analyse** the potential receptiveness of consumers to lab-grown meat. In your answer consider why some consumer groups may be more open to the concept than others.

consider think deliberately or carefully about something, typically before making a decision; take something into account when making a judgment; view attentively or scrutinise; reflect on

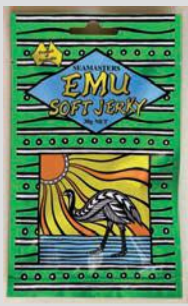
Taking it further

3. Think 50 years into the future. Lab-grown meat is commonly available and eaten in Australian households. What consumer drivers do you believe would have led to this reality?

Bush food protein sources

There is an abundance of bush food protein sources. The table below outlines some of the key bush food protein sources:

Table 6.3 Bush food protein sources

BUSH FOOD	DESCRIPTION	PICTURE
Kangaroo	• Unique to Australia • Lean, inexpensive, quick and easy to cook • High-quality protein, very low in fat • Rich source of iron, zinc and several B-vitamins – riboflavin, niacin, vitamins B6, vitamin B12 • Harvesting is strictly controlled by the *Environment Protection and Biodiversity Conservation Act 1999*, mostly in NSW and QLD • They are free-range animals, not farmed but 'harvested' in the wild by licensed hunters • Easy to BBQ, best served medium rare or rare because with virtually no fat it can dry out and become very tough if overcooked	 Alamy Stock Photo/E.J.Westmacott
Crocodile	• Contains almost double the amount of protein as chicken • 100g serving of stewed crocodile meat contains as much as 46 g of protein • Tail meat that is white and tender is considered the best part of the animal	 Naturally Wild Produce
Other animals	• Emu meat is known to be higher in protein, vitamin C, and protein than beef and low in fat • Goannas offer oily white meat that tastes like chicken	 Alamy Stock Photo/Neil Setchfield
Wattleseed	• Traditionally ground to make a flour • Can survive tough weather conditions as it has a hard husk that protects the seed during long periods of dormancy on the ground • Valuable source of protein and carbohydrate • High concentrations of potassium, calcium, iron and zinc	 Shutterstock.com/Jaletan
Quandong	• Quandong is a bright scarlet fruit, about 2 cm in diameter and containing one nut / kernel • It can be eaten fresh or dried • The fruit is somewhat tart, but highly nutritious and contains twice the vitamin C of orange • 25 per cent protein, 70 per cent complex oils	 Shutterstock.com/mastersky

(*Continued*)

9780170418560

Table 6.3 Bush food protein sources (*Continued*)

BUSH FOOD	DESCRIPTION	PICTURE
Bunya nut	• Native to South-Eastern Queensland • The bunya nut tree is a huge tree that only bears nuts after the tree is around 100 years old. It then only produces a crop every 2–3 years • Bunya pine cones weigh 5–10 kg and contain 30–100 nuts • During fruiting season (December to March) the cones drop off the trees, sometimes from great heights and can be dangerous to people below • Bunya nuts are 40 per cent complex carbohydrate and approximately 9 per cent protein	 Alamy Stock Photo/Clearviewimages RF
Kurrajong seed	• Kurrajong seeds are grown on an inland tree • The pods contain sulphur-yellow seeds that are high in protein • The seeds have a nutty taste after roasting	 Shutterstock.com/kezz
Witchetty grubs	• Contain 15 per cent protein and 20 per cent fat, high in energy, making them an ideal survival food • Rich in vitamin B1, potassium, magnesium and zinc	 Getty Images/Photolibrary/David Kirkland

ACTIVITY 6.10

Aim

To **investigate** grubs for future generations

GRUB FOR FUTURE GENERATIONS

An Australian first study hopes to identify dozens of different edible larvae commonly found on the Aboriginal bush tucker menu.

For thousands of years, Aboriginal and Torres Strait Islander people have enjoyed a smorgasbord of larvae, but only the "witchetty grub" has been formally classified as edible.

'The larvae of moths and beetles that live in plant roots or tree trunks are among the most popular foods enjoyed by Indigenous Australians,' La Trobe University PhD candidate Conrad Bilney said.

'They're widely known as witchetty grubs or bardi grubs, but Indigenous Australians believe there are up to 30 different edible larvae in Australia.'

Mr Bilney, with the support of La Trobe supervisors Dr Susan Lawler, Dr Michael Shackleton and Dr Alan Yen, began his research in 2014 to locate and identify edible grubs known to Indigenous Australians. He has been supported financially through the Office of Indigenous

Getty Images/Tobias Titz

FIGURE 6.15 Grubs for future generations?

Strategy & Education, Executive Director Professor Mark Rose, and by Dr Pettina Love, Indigenous Student Services Officer at the Wodonga Campus.

With the help of Traditional Owners, he has since collected more than 200 larvae from across Victoria, Western Australia and the Northern Territory.

'Traditional Owners helped us to identify the grubs they eat, and from there we preserved them and took them to the laboratory to extract and sequence their DNA,' Mr Bilney said.

'We're now in the midst of matching the grubs' DNA to insects, and believe most of the grubs belong to certain families of moths or beetles.'

Mr Bilney, a Kokotha man from South Australia, said the research was important to not only retain Aboriginal knowledge, but to ensure the future management of these nutritionally rich edible larvae.

'These grubs are not only delicious, but an incredibly important source of nutrition for Indigenous Australians who live in desert areas, where energy-rich foods are scarce. They are packed full of fat and protein.'

'I hope my study will pave the way forward for further research. We need to learn more about where these grubs live and when they hatch, so we can tailor conservation efforts.'

Source: La Trobe university, www.latrobe.edu.au, accessed 8 march 2018. Reproduced with permission.

Conclusions

1 **Summarise** the benefits of identifying traditional protein-based food sources.

2 **Describe** the project that is currently being undertaken to identify the different types of edible larvae. What are the specific benefits of this project?

3 **Analyse** how traditional consumer drivers could positively or negatively impact on the popularity of bush foods and increase the production of bush foods.

REVIEW QUESTIONS ▶

In a table like the one below, or using the template on NelsonNet, **summarise** the impact traditional consumer drivers have on the development, safety and ethics of alternative food products to fulfil future protein requirements.

a Provide examples of each alternative protein-based product.

b **Identify** the impact of relevant consumer drivers on each alternative protein.

ALTERNATIVE PROTEIN PRODUCTS	PROTEINS EXAMPLES	IMPACT OF TRADITIONAL FOOD DRIVERS
Genetically modified foods		
Organic foods		
Fortification and functional foods		
Entomophagy		
Synthetic protein		
Bush foods		

WS Chapter 6 review template 3

Consumer purchasing trends

Primary data and secondary data are both valuable and valid forms of data collection that are used to determine consumer purchasing trends.

primary data
information collected by the individual conducting the research

secondary data
information collected by governments or organisations for other research purposes

Primary data

Primary market research and data collection is done by the business or company with the intention of gathering information that can be used to improve the products, services or functions of the business. It is done from the beginning, without using information available through other sources. The data can be gathered through qualitative or quantitative research methods. It is the most common type of data collection for market research as it can be designed to directly gather the specific information required.

qualitative research
gathering information regarding human attitudes and views, which are analysed and devised into data based on interpretation by researchers

quantitative research
gathering numerical data via a formal and systematic process

The most commonly used primary market research methods are:

- focus groups
- questionnaires
- observation
- trials and experimentation
- in-depth interviews.

Secondary data

Secondary market research and data collection is a technique that does not gather information from the beginning or directly from the source, rather it relies on already available information from multiple sources. The data is collected by other people (within or outside of the organisation) and is available for free to individuals or at a cost to other businesses. It may include government data, inter-office data, media articles and data on websites. Secondary data collection can be used to get an initial understanding of the current market trends or a particular market segment. Secondary data examples include:

- existing market research statistics and surveys, e.g. the Census
- information available on the Internet
- existing data from within the business, e.g. customer database, stock lists, annual reports, financial data
- information from other agencies such as local councils, industry bodies and libraries.

Primary research gives the business control over the questions and information that is gathered. Primary research can be very valuable; however, it is more labour intensive, time-consuming and costly than secondary research. Some businesses may choose to use secondary research first to see what data already exists, and then design specific primary research to address the company's needs. One of the benefits of doing secondary market research is that it is mostly free and takes a lot less time. However, a drawback of using secondary data is that it may not provide you with the exact information you require and it can be misunderstood if it was collected for a different purpose. Secondary data also needs to be checked for validity, reliability, relevance and currency. Markets can change quickly and what may be an upward consumer trend according to the secondary data, may actually be out of date, and the trend is no longer the same.

Quantitative and qualitative research

Quantitative and qualitative research methods define the type of information that is gathered. It is important to know how research was conducted so that when you read reports or statistics you can understand how they were collated.

Quantitative research involves gathering numerical data. The word *quantitative* comes from the word *quantity*, meaning it can be expressed in terms of a quantity. Quantitative research produces a lot of data and statistics and is useful as an overview of demographics and market trends.

Quantitative data can include:

- sales numbers
- survey results from customers
- financial trends
- industry product sales numbers
- market size
- customer demographics, such as age and gender
- prices.

Qualitative research gathers views and attitudes. The word *qualitative* comes from the word *quality*. Qualitative research can help to provide a better understanding of customer needs, interests and habits. Collecting and analysing qualitative data can take longer as it requires some interpretation and categorisation of responses. Qualitative research can include:

- formal and informal conversations with customers or industry
- focus groups to find out feelings and attitudes toward different services, products or ideas
- visits and reviews of products currently on the market.

ACTIVITY 6.11

Aim

To **investigate** consumer purchasing trends in relation to the protein market

STEPS

To **investigate** consumer purchasing trends in relation to one of the following protein markets:

a Plant-based protein consumption such as pulses, nuts, beans, seeds

b Alternative protein such as microalgae, bacteria or synthetic protein (such as lab-grown meat)

c Sustainable animal protein such as kangaroo meat or sustainable fisheries

Consumer purchasing trends

Conclusions

From your research, **analyse** the following:

a Key consumer drivers in the food industry in relation to the protein market investigated

b Key trends and statistics in protein consumption

c Three needs or opportunities in the current protein market

Food sustainability and ethical practices

Food choices can have a huge impact on our carbon footprint and greenhouse gas emissions. Food is fundamental to our lives; however, the amount of food production and waste is of growing concern. Finding solutions for food sustainability is key to reducing our impact on the environment and ensuring that food will be available for generations to come.

The term ethical relates to the moral principles within a specified group or field. With information much more freely available, the ethics relating to the food industry and the practices that are undertaken often come under scrutiny.

9780170418560

ACTIVITY 6.12

Aim

To **investigate** the terms 'food sustainability' and 'ethical practices' in relation to protein markets and the food industry

STEPS

Complete the investigation using the supplied scaffold (points a–f below). Check the links available on NelsonNet for inspiration.

a **Investigate** the term 'food sustainability' and 'ethical practices' in the food industry. Develop a definition for each term.

b Identify sustainability issues in relation to protein production and consumption.

c How do food sustainability issues relate to consumer decisions about protein consumption? In your answer, refer to the specific protein-based items and sustainability issues identified in question b.

d Identify ethical issues in relation to protein-based production and consumption.

e How do ethical issues impact on consumer decisions about protein consumption? In your answer, refer to specific ethical issues identified in question c.

f 'Sustainable protein' has become a popular term. **Investigate** the term 'sustainable protein'. Identify two 'sustainable protein' initiatives and **describe** how each can be related to consumer decisions regarding protein consumption.

Sustainability and ethical practices

Can consumers influence the development of new food products?

Create a mind map of information to help answer the guiding questions. Use the supplied template or develop your own mind map. You may find it useful to use online tools such as Bubbl.us, Canva, Coggle, MindMup, iMindQ.

WS Mind mapping template

Mind mapping tools

7 SENSORY PROFILING

Why are the sensory properties of food valuable in developing successful food products?

The sensory properties that food products possess play a critical role in consumer selection. If the sensory properties are not appealing to consumers, they will probably not purchase the product (or not purchase it a second time). This chapter examines sensory profiling for consumer acceptance of food products. This will include different methods of sensory profiling, analysing food products in terms of sensory properties and their impact on consumer choice.

Food choices are strongly influenced by our senses – sight, smell, hearing, touch and taste. Sensory profiling, also known as 'sensory analysis', is essential in the development of all new food products. Sensory analysis can help to inform:

- marketing – development of product concepts and for benchmarking
- research and development – used for optimising the formulation and processes
- quality – to inform quality of raw ingredients and supply of the finished product.

Uses of sensory profiling

organoleptic the aspects of food that an individual experiences via the senses – sight, smell, hearing, touch and taste

During sensory profiling, a panel of people highlights and describes the **organoleptic** properties of the food product.

Sensory profiling can be used for:

- evaluating the quality of a new product or improving the quality of an existing product, e.g. sales are low and the company wants to know why and what can be done to improve the product
- checking that a food product meets the original brief, e.g. if the brief was to produce a product that has the same taste with half the sugar, does it meet the brief?
- analysing a food prototype for improvements and changes, e.g. a new product is partway through the design process; sensory profiling can be used to check whether further changes are needed
- gauging consumer response to a product and its acceptability, e.g. will consumers purchase tomato sauce that is green?

Sensory profiling may also be used when:

- providing input for decision making, i.e. product development
- determining the market value of a product, i.e. price. What price would a consumer be willing to pay for the food item?
- informing if an ingredient substitution could take place, e.g. a new formulation that may save money. Does the new ingredient change the product? Can consumers taste it?
- comparing product(s) with a competitor's product, i.e. finding out if consumers can taste the difference between two products.

Sensory profiling can fail or produce incorrect results if the wrong objective is set, the wrong participants are chosen, or the wrong questions are asked. It can also produce ineffective results if there is bias, the sensory profiling lacks rigour or control, or the tests were conducted in the wrong environment. Careful consideration of all factors is important prior to sensory testing to maximise the efficiency of the results produced.

9780170418560

REVIEW QUESTIONS ▶

1 **Defin** sensory profiling.
2 **Identify** reasons for the use of sensory profiling.
3 **Defin** the term 'food prototype'.
4 **Describe** how sensory profiling could be used during food prototyping.

The physical properties of food

The physical properties of food products will determine consumer acceptance and affect the decision to purchase a food product. Food manufacturers go to great lengths to ensure that the physical properties of the food product are appealing to the target market, as consumer acceptance will determine the success or failure of a food product.

Appearance

The first impression that we often have about food is based on the appearance of the item, and whether we think that it looks like we will enjoy it. Appearance is therefore an extremely important part of consumer acceptance of both raw and processed food products. About 55 per cent of our decision is based on visual appearance. We select foods that look good to us, such as bright and shiny fruit, without cuts or bruises.

Appearance of fresh produce may include any of the following attributes:

- size or volume
- colour
- weight
- shape
- texture, including viscosity and elasticity
- brightness
- packaging
- lack of bruising or cuts
- amount of visible fat
- signs of oxidation (if any).

Food producers and retailers know the appearance consumers are looking for and work hard to ensure that fresh fruit and vegetables have a desirable appearance, for example, that products are an even and desirable size and of the optimal colour. In relation to fresh fish and meat, the amount of visible fat could be a consideration along with the colour of the meat.

Packaged products should have no visible damage to the package and should be appropriately sized and labelled. Most packaging is produced by the marketing team of the food producer and is designed to entice consumers to buy the product. Marketing teams carefully select appropriate images and words that give the impression they are seeking. For example, a lush green countryside gives the impression that the product is more natural. The size of the packaging may also entice consumers to purchase one product rather than another, even though the net weight is the same.

Mark Fergus Photography

FIGURE 7.1 Packaging is carefully designed to maximise the perception of the product to the consumer.

Shuttertock.com/s-ts

FIGURE 7.2 Green pastures or nature images can give the impression of a more natural product.

Mark Fergus Photography

FIGURE 7.3 Grey meat may look unappealing, but it can be perfectly safe to eat. Mince undergoes several colour changes during its shelf life. The brown-grey colour does not indicate it is stale, old or unsafe to eat.

Taste

umami
a taste characteristic, sometimes referred to as savoury; may be present as glutamate, an amino acid

Taste of a food item can be described in terms of sour, salty, bitter, sweet and **umami**. The tastes of sour, salty, sweet and bitter have been commonly written about and most people can pick the difference between these tastes. Umami has been more recently identified as an additional flavour that we enjoy. Umami is loosely translated from Japanese to mean 'pleasant savoury taste' and refers to a savoury taste that exists particularly in mushrooms, asparagus, tomatoes, cheese and meat. Glutamate, an amino acid, was pinpointed as the source of the savoury wonder and it was then produced artificially in what we know as monosodium glutamate (MSG), a flavour enhancer.

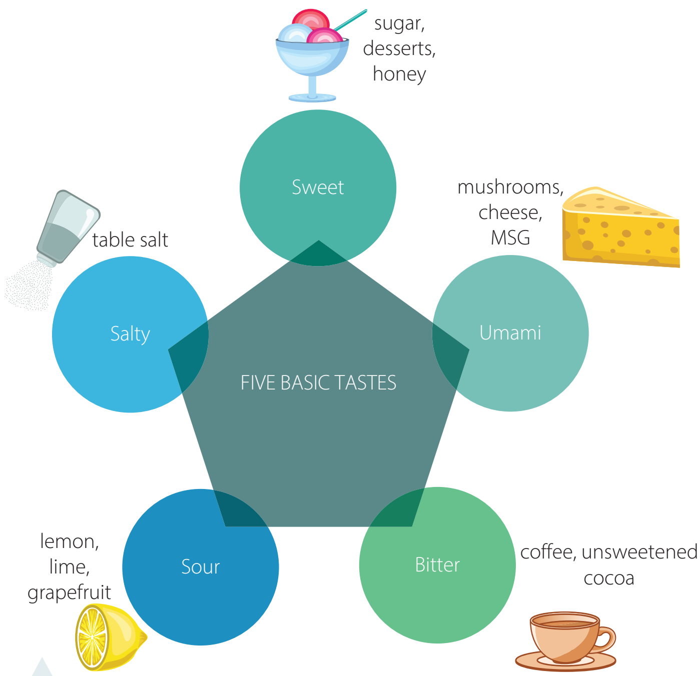


FIGURE 7.4 The five basic tastes

9780170418560

Flavour and aroma

Flavour is considered the total impression that we get from eating a food product, including the taste and aroma as perceived through the mouth, throat and nose, as well as the appearance and sound of the product. For example, an apple may look shiny and bright to eat, but when eating the apple, if the taste, aroma and sound are not all giving a positive impression, then the overall flavour of the apple will be compromised. Our ability to detect flavour starts before the food is placed into the mouth. The aromas that are given off by the food are detected by the olfactory cells in the nose and they create an expectation and impression in the brain. Next time you eat a piece of chocolate or a piece of fruit, hold the food item up to your nose and inhale the aroma of the food, observing the impression and expectation your brain gives you simply by smelling the food. This can add to the overall flavour and experience of eating the food product.

Once the food is placed into the mouth, the flavour chemicals are dissolved by the saliva present in the mouth. The nerve endings detect the temperature of the food and temperature can also affect how well we can taste – colder ice cream tastes pleasant but melted ice cream tastes much sweeter; ham tastes saltier when it is cold but less salty when warm.

The olfactory receptors play a large role in the flavour of food, which is why food often tastes bland or loses its flavour when we have a cold. When we smell a food before eating it the aroma is detected by orthonasal olfaction, directly through the nasal cavity. For example, when smelling a mango or rockmelon before purchasing it we are using orthonasal olfaction.

Once food is placed in the mouth and we chew, the odour molecules have a back entrance to our olfactory receptors, known as retronasal olfaction. When we have a cold, we can still distinguish taste, such as the sweetness in foods, and texture, such as how firm or crunchy a food product is, but we may find it difficult distinguishing between foods that are sweet and have the same texture.

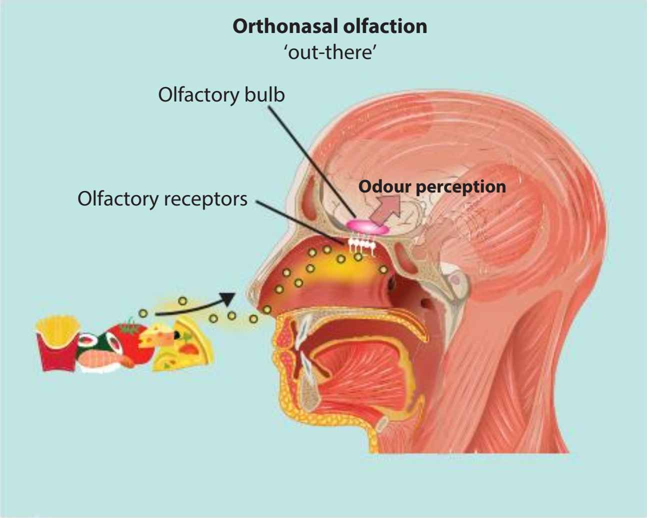


FIGURE 7.5 Orthonasal olfaction is what your nose can smell or perceive prior to food entering the mouth.

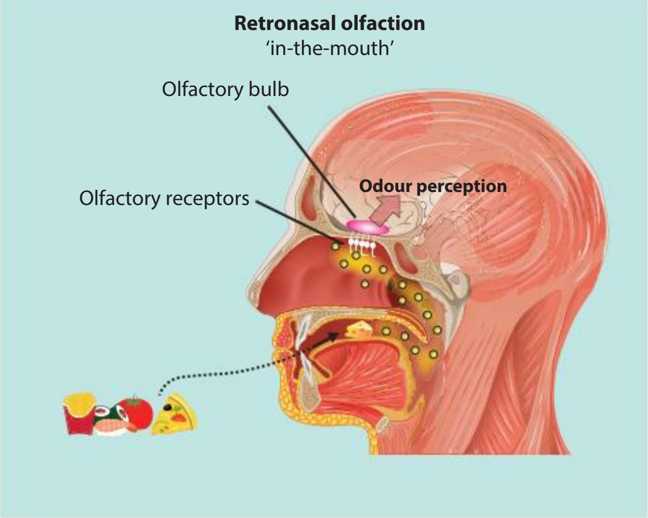


FIGURE 7.6 Retronasal olfaction is when food consumed contributes to the overall flavour of the food item.

ACTIVITY
7.1

Aim

To **describe** the physical properties that determine consumer acceptance of raw and processed foods, through retronasal olfaction

STEPS

1 Prepare some foods for testing that have similar texture and taste, for example:
- apple and pineapple
- ripe mashed mango and mashed banana
- carrot slices, potato slices, apple slices (similar size and shape)
- different flavours of baby food
- different flavours of lollies, e.g. fruit-flavoured jelly beans or snakes or something similar.

2 Form pairs – one person is the taster and the other administers the test. The taster should not see the foods that are going to be tasted.
  a Have the taster place a blindfold on and pinch their nose.
  b Their partner will then give the taster one of the foods to taste and record the actual flavour, then what the taster thinks the flavour is.
  c Repeat with as many examples as desired.
  d Have the taster test without the pinched nose (still blindfolded) and compare the difference.
  e The pairs can swap roles and the other person completes the test.

Conclusions

1 What were the findings from this activity? Could the taster always pick the flavour or was it difficult?
2 **Explain** the survey results based on the diagram on retronasal olfaction on page 171.

ACTIVITY
7.2

Aim

To use your orthonasal olfaction to sense and **describe** the aroma of different food items

STEPS

1 Set up different cups containing foods to be tested, covered with cheesecloth or gauze so the food cannot be seen. Examples could include:
- freshly ground coffee beans
- chocolate chips
- orange peel
- tea leaves
- parmesan cheese
- freshly chopped garlic
- chopped vegetables such as onion, carrot, potato
- chopped fruit such as orange, pineapple, apple, strawberry
- spices such as cinnamon, cumin, rosemary, oregano
- bread.

2 Label each cup with a number.
3 Each tester smells the contents of the cup, without lifting the cover, and records their response in a table.
4 Reveal the contents of each cup after everyone has guessed through their orthonasal olfactory.

compare
display recognition of similarities and differences and recognise the significance of these similarities and differences

Conclusions

1 **Compare** the smells that both people detected correctly. Which were most often incorrect?
2 **Hypothesise** why the incorrect ones could not be detected.
3 **Describe** how smell can be used to determine consumer acceptance of food products.

hypothesise
formulate a supposition to account for known facts or observed occurrences; conjecture, theorise, speculate; especially on uncertain or tentative grounds

Taking it further

4 Does smell have an impact on consumer purchasing decisions? Give examples where smell might contribute to consumer acceptance of food products and **explain** how this could then impact on the raw products that are purchased for retail sale.

Texture and mouthfeel

We often select fresh fruit and vegetables based on the texture and feel of the food. A typical example is purchasing avocado: we feel the avocado for an indication of how ripe it is and how soon it could be used.

When we look at food before eating it, our brain creates an expectation of the texture and mouthfeel of the food. Typically, deep-fried foods are expected to have a firm, crispy coating. If a deep-fried food is soft and soggy, the consumer may have a negative reaction, as this is not what they were expecting. Texture can also indicate the quality of the food. For example, when cutting celery, if the texture is floppy and soft, this may indicate it has lost turgor and is no longer at its optimum. Turgor gives food a full, fresh appearance, a firm texture and a crisp mouthfeel. If milk has a different texture, for instance if it is lumpy, this may indicate it has spoiled or something has been added, such as acid, to cause lumps.

Mouthfeel is how the food feels in our mouth, against our skin and on our tongue. The mouthfeel of crisp celery and the mouthfeel of a soft-boiled egg are very different. Mouthfeel is determined by the texture, amount of liquid and air in the product and the fat content. Some descriptive words for mouthfeel include light, airy, smooth, creamy, rough, crunchy, spongy, stringy. The mouthfeel produced by texture can also be a reason that a consumer may dislike a food; for example, the texture of oysters may turn some people off and the smell of brie or blue cheese might be what a consumer most dislikes about strong cheeses.

Describing food

Table 7.1 Describing food

SENSE	CHARACTERISTIC	EXAMPLES OF DESCRIPTIVE WORDS
Sight	Appearance – colour, size, shape, gloss, dullness, transparency	• colour – bright, dull, shiny, light, dark, pale, vibrant, clear, transparent, white, speckled, vivid, glossy, matte • shape – round, square, even, irregular • texture – lumpy, smooth, rough
Smell	Aroma – flavour and aromatics	strong, weak, spicy, burnt, fruity, sweet, rotten, musty
Taste	Flavour – odour and taste	sweet, sour, salty, bitter, umami, spicy, savoury, sharp, tangy, hot
Hearing	Sound – quality and intensity	crisp, crunching, fizzing, crackling, popping, dull, sizzling, bubbling
Touch	Texture and mouthfeel	smooth, sharp, soft, crunchy, greasy, juicy, oily, waxy, dry, rough, tender, tough, brittle, sandy, gritty temperature – warm, hot, cold, freezing, sizzling

categorise place in or assign to a particular class or group; arrange or order by classes or categories; classify, sort out, sort, separate

REVIEW QUESTIONS ▶

1 **Categorise** words used to describe the physical properties of food with regard to consumer acceptance by completing a table like the one below (available on NelsonNet). Use the words in Table 7.1 and add some of your own.

ITEM	APPEARANCE	AROMA	FLAVOUR	NOISE	TEXTURE
Salt and vinegar chips					
Fresh apple slices					
Baked meat pie					
Chocolate mud cake					
Spicy curry					
Cereal – cornflakes					
Vegemite					
Tomato sauce					

WS Chapter 7 review template 1

2 If consumers purchase the above products and they do not get what they are expecting, what will the consequence be?

3 **Analyse** the importance of food manufacturers considering the sensory properties of the food product.

4 Identify the physical properties that determine the acceptance of each food item, using a table similar to the following.

FOOD ITEM	ACCEPTABLE PHYSICAL PROPERTIES
Avocado	
Banana	
Fresh raw beef mince	
Fresh seafood	
Loaf of bread	

WS Chapter 7 review template 2

Methods of sensory profiling

Sensory profiling is conducted when developing food products to research consumer acceptance of new food products. Sensory profiling can take place in many ways, with both expert tasters as well as general consumers from the target market. Sometimes food producers will carry out their own sensory profiling and testing, although in most cases they will use a specialised market research company to conduct sensory profiling. The results from the sensory profiling provide feedback to the manufacturer on consumer preferences and can help to identify changes or modifications that are needed in the product. This helps to lower the risk of wasted money, time and effort in developing, producing and marketing a new food product that consumers do not like.

Descriptive sensory profiling

Descriptive sensory profiling is used to determine if a specific consumer group likes or prefers a particular food product.

Ranking test

A ranking test is where panellists are given two or more samples of a product and then rank them in order of preference. They are usually asked to assess a particular characteristic of the sample, such as its aroma, and they rank each according to a scale from ‘very much’ to ‘not at all’.

Paired preference test

The paired preference test is where panellists are given two samples and asked to choose which one they prefer. The two samples appear to be the same and the consumer is asked to compare a characteristic, which may be the texture or the colour.

Likeability test

The likeability test is where panellists taste a sample and score it on a hedonic scale. The hedonic scale ranges from ‘dislike extremely’ to ‘like extremely’ and can have up to nine different preferences. Hedonic scales can also use images such as faces or a numbering scale. There is usually a neutral option on a hedonic scale. Line scales or the food action rating scale can also be used.

FIGURE 7.7 Verbally anchored 9-point hedonic scale or ‘the degree of liking scale

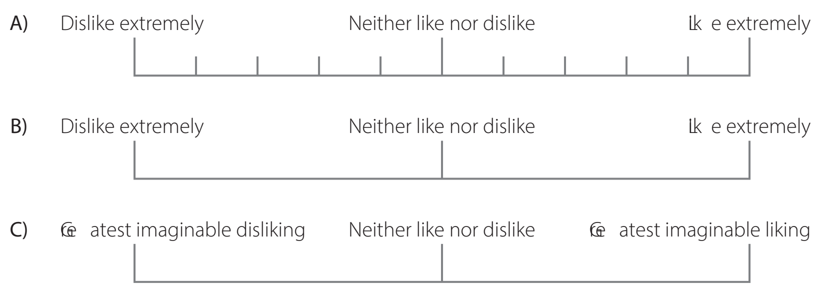


FIGURE 7.8 Sample line scales are used for acceptability testing: (A) marked line scale, (B unmarked line scale, (C) simplified labelled affective magnitude scale.

- ☐ I would eat this food at every opportunity
- ☐ I would eat this very often
- ☐ I would frequently eat this
- ☐ I like this and would eat it now and then
- ☐ I would eat this if available but would not go out of my way

FIGURE 7.9 Food action rating scale can be used as an overall measure of food acceptance, which can be more sensitive than a regular hedonic scale as it is even easier to use for consumers.

Saltiness	**Thickness**
☐ Very much too salty	☐ Very much too thick
☐ Too salty	☐ Too thick
☐ Slightly too salty	☐ Slightly too thick
☐ Just about right	☐ Just about right
☐ Slightly not salty enough	☐ Slightly too thin
☐ Not salty enough	☐ Too thin
☐ Very much not salty enough	☐ Very much too thin

FIGURE 7.10 Just about right scale can measure consumer acceptance or likeability for a specific attribute.

Triangle test

A triangle test is a discriminative method which is used to gauge if an overall difference is present between two products. It involves three samples, two of which are the same. The difference between the samples is very small. The testing is carried out to see if a change in processing or ingredients will significantly change the product, and if consumers can notice the difference.

Lexicons

A lexicon is a descriptive analysis of the sensory attributes of a food product, which usually includes words and descriptions relating to taste, appearance, aroma, flavour, texture and aftertaste of foods. Lexicons provide a tool for communication between consumers and people in the industry and can help to understand the differences between products in a category. Lexicons can help to drive the design of consumer research questionnaires and give a food manufacturer confidence that a product is within its design specification or brief.

Lexicon development usually starts with a desk-based review of the key brands in the immediate or adjacent categories. Web advertising, TV, print and packaging are examined to establish a draft lexicon of sensory terms. Depending on the product, this could be over 100 sensory or describing terms! It will include emotional, abstract and functional conceptualisations of the product. The lexicon can then be further narrowed down through qualitative discussion where target consumers also generate a list of terms. The lexicon is then determined, with approximately 20–30 emotional and abstract terms and 15–25 function terms. Sometimes the terms that are determined are negative, as consumers may want to express what the product is not. For example, a consumer may want to say that the bread is not sweet, or they like it because it is not crusty.

Lexicons can have both 'expert' language and 'consumer' language, which each serve a specific purpose.

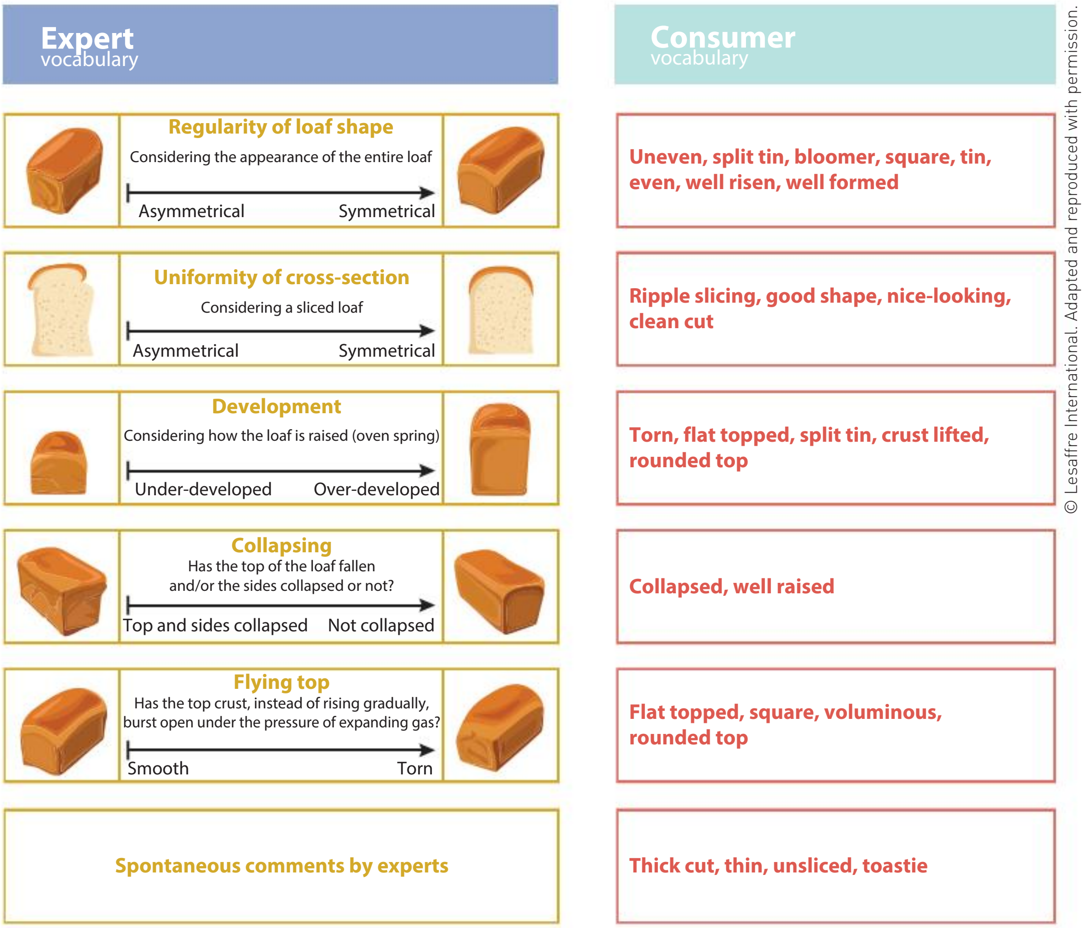


FIGURE 7.11 Sandwich bread in words lexicon developed with both consumer and expert vocabulary to describe a range of different sensory factors

REVIEW QUESTIONS ▶

1 **Describe** the different sensory profiling methods by completing a table like the one below (template also available on NelsonNet).

PROFILING METHOD	DESCRIPTION
Ranking test	
Paired test	
Likeability test	
Triangle test	

2 **Describe** a hedonic scale and how it is used.

3 **Describe** a lexicon and how it is used.

WS
Chapter 7 review template 3

EXPERIMENT 7.1

Experiment to assess consumer perception

AIM

test
take measures to check the quality, performance or reliability of something

To **develop** a lexicon for fruit, vegetable and protein-based foods and **test** the lexicon on a range of fruit, vegetable and protein-based food items

BACKGROUND

Sensory profiling should take place in a specific way to avoid bias and aim for accurate results. A sensory profiling room generally contains booths where tasters can sit, taste and answer questions about the food product independently. It also helps to ensure that tasters are not distracted by others and present an unbiased view. In the tasting room, noise should be kept low and the room should be free from foreign or strong odours. The taster area should be well lit, clean and hygienic. The sample should be prepared somewhere else and presented to the tasters in generic or plain containers. The samples are always randomly numbered, usually with at least three digits, so no bias can be assumed by a logical numbering system (e.g. number 1 is the best sample).

When carrying out sensory profiling, a lexicon is usually developed prior to consumer sensory testing (see pages 176–7).

INSTRUCTIONS

PREPARATION

Prepare a range of fruit, vegetable and protein-based items, so that sensory profiling can take place. Cut up items into smaller pieces for testing when undertaking this activity.

FOODS FOR TESTING

Fruit, vegetable and protein-based items, for example:

- bananas
- strawberries
- kiwifruit
- pineapple
- capsicum
- carrots
- broccoli
- cheese
- yoghurt
- beef
- nuts

EQUIPMENT

- knife
- chopping board
- paper plates or bowls
- pen
- labels

PROCEDURE

1. Select one food item at a time.
2. In groups, or as a class, brainstorm the different characteristics of each item. List these in the characteristics column in a table like the one on the next page.
3. Identify words that could be associated with each characteristic. Once you have agreed on the most appropriate words, list these in the table. A sample row has been provided for red apples.
4. Repeat for other items until all the selected fruit, vegetables and protein-based foods have been explored.

9780170418560

FOOD ITEM: RED APPLES		
SENSORY PROPERTY	CHARACTERISTICS	WORDS
Appearance	• shape • uniformity • colour • shine • skin • bruises/cuts	• round, uneven • uneven, misshaped, uniform • bright red – deep red • shiny, dull, matt, waxy • uncut, shiny, bright colour • bruised, unbruised, smooth, blemished, unblemished
Aroma		
Flavour		
Noise		
Texture		

5 Once the lexicons have been established for each item, use them to **design** a consumer survey and profile a range of fruit, vegetable and protein-based foods as follows:

a **Design** questions about each characteristic. You can either design questions that have rating scales for the describing words, or the testers can have the lexicon handy for reference (e.g. they may use the words from the lexicon to answer the questions).

b **Test** the sensory profiling on the class or with another class, by having them answer the questions.

design produce a plan, simulation, model or similar; plan, form or conceive in the mind

RESULTS ANALYSIS

1 How comprehensive was the lexicon?

2 Were adjustments needed to the lexicon? Did it enable you to get a clear picture of consumer preferences?

CONCLUSIONS

1 What are the advantages or disadvantages of using a lexicon when sensory profiling?

2 **Propose** how a lexicon can help the food industry to assess consumer perception.

propose put forward (e.g. a point of view, idea, argument, suggestion) for consideration or action

The chemical and physical properties of nutrients

Chemical and physical properties of food products will determine their appearance, taste, texture, flavour and aroma. Understanding the chemical and physical properties of foods is essential to produce high-quality products that will appeal to consumers.

Physical properties of foods are those that are visible and detectable, for example, colour, shape, size, viscosity, elasticity and density.

Chemical properties are the components of foods that enable foods to change. This includes enzymes, acids, alkalis, moisture as well as the nutrients carbohydrates, protein, fat, vitamins and minerals. Chemical reactions from the chemical properties of food alter the physical properties of food products. These physical and chemical properties of foods are known together as the ‘functional properties’.

Enzymes

Enzymes act as a biological **catalyst** causing food to change. They can bring about chemical reactions or cause them to speed up. An understanding of enzymes is valuable in food preparation to ensure the physical properties of the final product appeal to consumers. Enzymes work best at around 37°C, are

catalyst causing or accelerating a chemical reaction

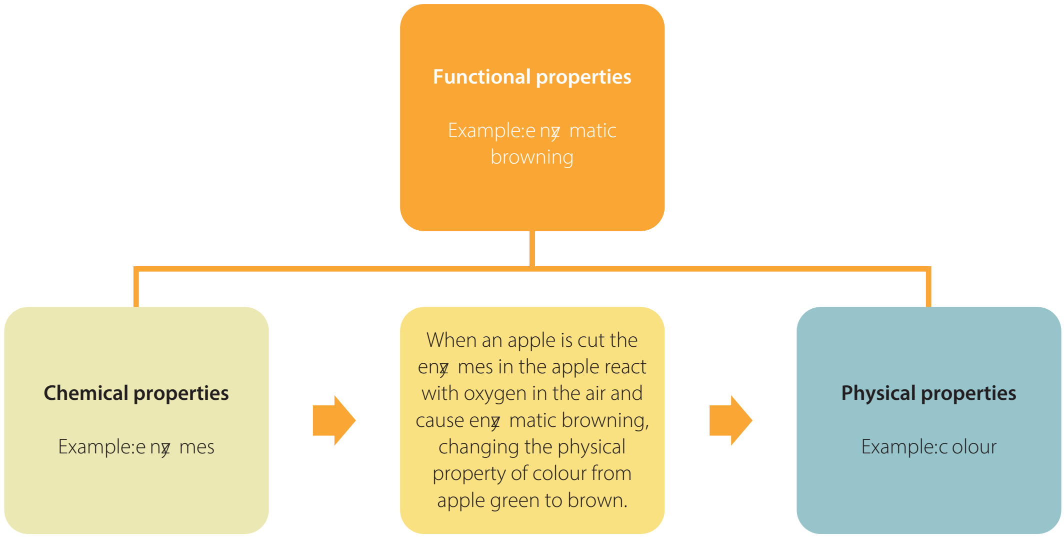


FIGURE 7.12 Functional, chemical, physical properties of food

destroyed at high temperatures and work more slowly at low temperatures. Examples of enzymatic reactions in foods are listed here.

Enzymatic browning in fruit and vegetables

When some fruit such as apples, pears and potatoes are peeled and cut, enzymes in the plant tissue are released. Once they are exposed to oxygen, the enzymes catalyse, a reaction known as 'enzymatic browning'. To overcome this, the fruit or vegetable can be coated with an antioxidant such as juice from citric fruit, such as lemons.

Ripening of fruit and vegetables

Enzymes are responsible for fruit and vegetables ripening and becoming more palatable. Some fruits, such as apricots, avocados, bananas, kiwifruit, tomatoes and mangoes, ripen after they are harvested. The speed of ripening can be manipulated through varying the physical environment that the fruit is in. For example, if unripe avocados are placed in the refrigerator, this will prolong the ripening process by reducing the amount of oxygen available and slowing the cellular respiration of the avocado. To speed up the reaction, keep at room temperature and store in a sealed paper bag. This will increase cellular respiration and increase the intake of ethylene, which is a natural plant hormone that speeds up the ripening process. Do not use a plastic bag, as this may trap moisture and cause the fruit to rot.

Tenderising tough meat

The enzyme protase, found in pineapple, kiwifruit and papaya can be used to tenderise meat. The enzymatic reaction is used to soften tough cuts of meat by denaturing the proteins in the muscle and connective tissue. Marinading tough cuts of meat will soften the meat to make it more palatable for consumers. Meat is best cut into smaller pieces so that the reaction can occur on a larger surface area.

Acids and alkalis

The acidity or alkalinity of a food item is measured on the pH scale. The pH scale stands for the potenz (potential) of hydrogen. pH is measured on a scale of 1–14; a pH of 1–6 indicates an acidic food and 8–14 indicates an alkaline food. A pH measured of 7 is considered neutral, neither acid nor alkaline. Most foods are acidic or neutral. The pH rating of a food item impacts the way that the food item will function and react with other ingredients in the product. For example, if vinegar or lemon juice is added to milk then the milk will curdle. This can be used to make buttermilk, ricotta or paneer cheese.

Alkaline foods are much less common. Bicarbonate of soda is an example of an alkaline ingredient, which when combined with an acid ingredient will produce carbon dioxide gas and helps cakes rise, in the process known as 'aeration', which is discussed in more detail in Unit 1, Topic 4.

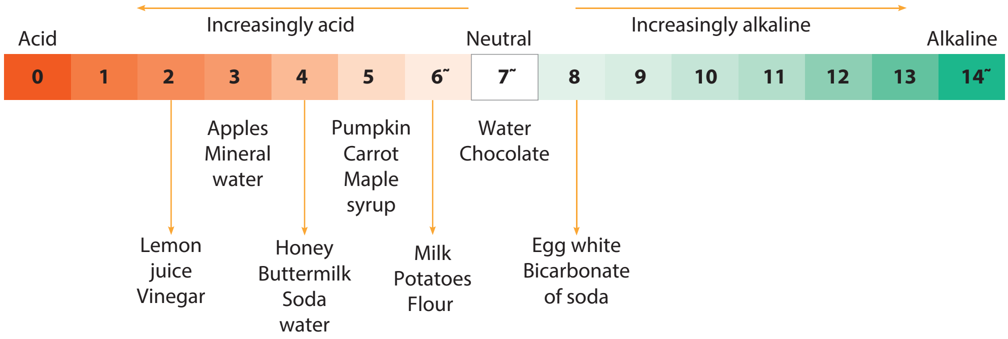


FIGURE 7.13 pH scale

Chemical reactions

The chemical properties of nutrients are responsible for a number of useful chemical reactions for the processing and cooking of food.

Table 7.2 Chemical reactions in food processing and cooking

REACTION	DEFINITION	EXAMPLES
aeration	Incorporation of air into a mixture in order to increase its volume and improve texture and flavour of certain foods and beverages Can occur by: • mechanical actions: whipping, beating, sifting, creaming, folding • chemical addition: baking powder, bicarbonate of soda • biological ingredients: yeast	• bread • sponge cakes • soufflé • pavlova • meringue • macarons
caramelisation	A process used extensively in cooking for the resulting nutty flavour and brown colour; formed by the oxidisation of sugar when food is cooked	• toffee • caramel sauce • dulce de leche • caramelised onions
coagulation	Occurs when denatured proteins separate from other nutrients and solidify or semi-solidify; applying heat for a long period of time will cause the protein structure to create a network and trap liquid, which will form a gel	• grilled meat • eggs • cheese and yoghurt
crystallisation	Process of formation of solid crystals from a homogeneous solution or melt, or more rarely directly from a gas Often used as a technique to separate a solute from a liquid solution, bringing it into a pure crystalline phase	• honeycomb • ice cream • fondant • fudge • chocolate
denaturation	Permanent change in the structure of protein; occurs when the bonds holding the helix shape are broken and the strands of the helix separate and unravel; a functional property of protein, useful in food preparation, e.g. whisking eggs or marinating a piece of meat (acid tenderises the meat before cooking)	• beaten egg white • marinaded meat
dextrinisation	Chemical change in the starch molecule caused by the breakdown of sugar chains in the molecule to form dextrins and causing browning to occur, e.g. toasted bread	• bread • scones • toasted muesli • biscuits • pastries

(*Continued*)

Table 7.2 Chemical reactions in food processing and cooking *(Continued)*

REACTION	DEFINITION	EXAMPLES
emulsification	when two liquids that do not usually combine are mixed together, with the help of mechanical action or an emulsifying agent; emulsions can be temporary or permanent	• mayonnaise • vinaigrette dressing
gelatinisation	process where starch and water are subjected to heat, causing the starch granules to swell and water to be gradually absorbed in an irreversible manner; thickened liquid should be smooth and without lumps	• bechamel (white) sauce • custard
gelification	process of turning a substance into a gelatinous form; common gelling agents include agar-agar, gelatine, carrageenan, gellan gum and methylcellulose	• molecular gastronomy • confectionary • agar-agar, tomato, spaghetti • mango, caviar
leavening	a chemical process used to make baked goods rise by the formation of gas, especially carbon dioxide, in the batter or dough, e.g. by using baking powder or yeast	• choux pastry • puff pastry • bread • muffins
Maillard reaction	chemical reaction between an amino acid and a reducing sugar, usually requiring the addition of heat, e.g. caramelisation of meat; a form of non-enzymatic browning	• cakes • roast meat • toast • dulche de leche

Definitions from *Food & Nutrition 2019 v1.0 General Senior Syllabus*, pp. 62–91.

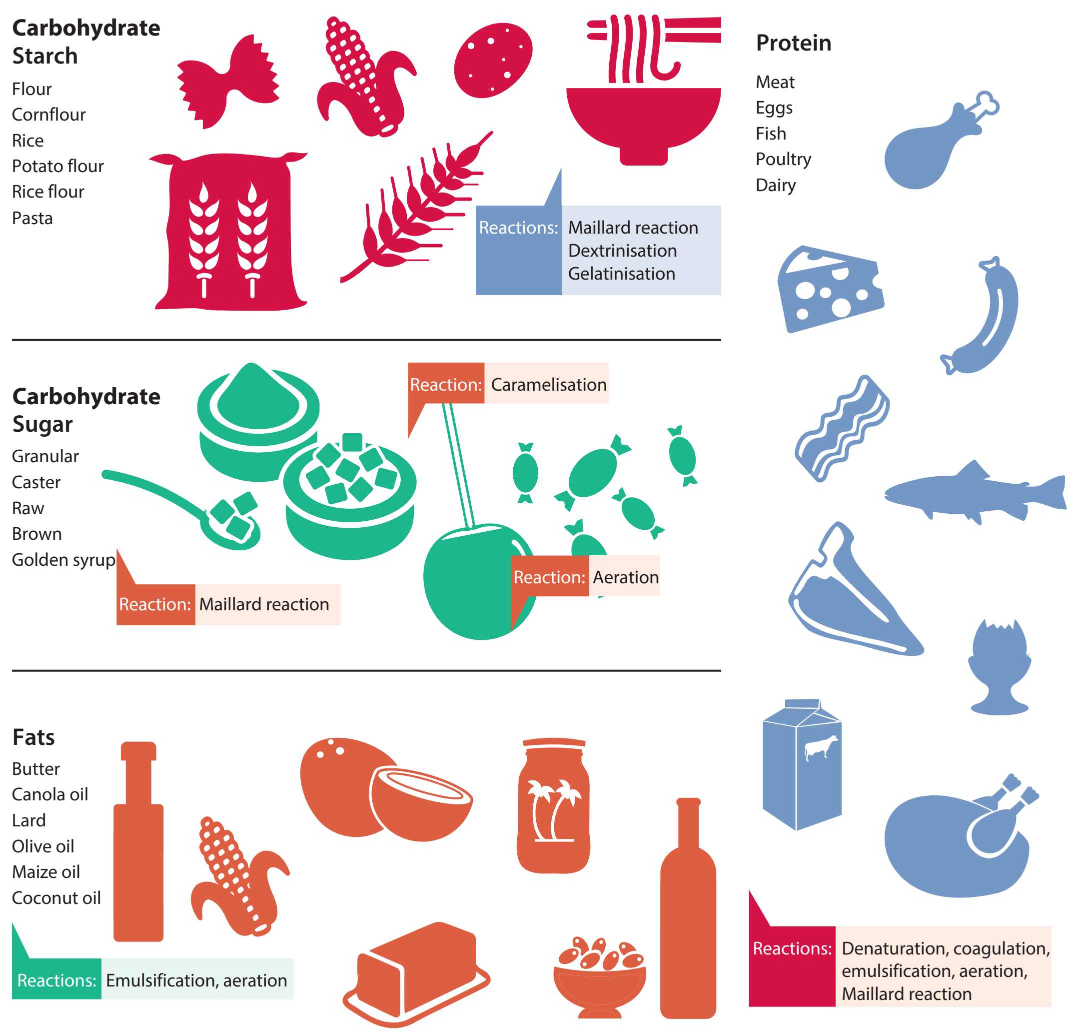


FIGURE 7.14 Major chemical reactions for the nutrient groups

9780170418560

REVIEW QUESTIONS ▶

1 **Summarise** the physical and chemical properties of foods.
2 **Explain** the pH scale. Provide examples of how acids and alkaline food items can affect food products.
3 **Explain** how enzymes can affect the physical properties of food items.
4 Consumer perception is influenced by the properties of food products. **Discuss** how each chemical reaction listed in Table 7.2 can positively or negatively impact on consumer perception of food products.

Retail policy, consumer choice and food wastage

As already discussed, the physical properties of food, such as the shape and appearance, will affect consumer purchasing of these items. Consumer purchasing will drive retail policy, which in effect means that consumers are dictating the acceptability standards for fresh produce in the retail setting.

Food that does not meet the high supermarket standard has traditionally been rejected, meaning the food goes to waste. In more recent years, Coles and Woolworths have aligned themselves with food charities to donate unsold or surplus food. However, if the food never passes the strict specifications that supermarkets require for their retail policy, then it is rejected upfront. This can cause additional wastage.

The 'ugly food' movement has gained momentum in recent years. The French coined the term 'inglorious food' after new legislation cracking down on food waste was introduced. The legislation bans supermarkets from throwing away or destroying unsold food; they must donate it to charity or for animal feed. The 'ugly food' movement has since resulted in different countries around the world adopting the approach.

In Australia, Woolworths has packaged up and marketed odd fruit and vegetables, that are sold at a cheaper price. Some argue this only perpetuates the idea that perfection is better and therefore can be purchased at a higher price. Harris Farm also sells 'ugly' fruit and vegetables with recipes online to accompany them.

OzHarvest is rescuing food and has opened the OzHarvest supermarket, where the public can access food for free.

The 'ugly food' movement is an attempt to persuade consumers that all products do not necessarily need to be perfect, the same size and shape to be fit for consumption. Education of consumers will hopefully allow retail businesses to remove some of their strict retail policy surrounding fresh items and thus reduce food wastage.

Harris Farm

Physical properties of fruit and vegetables

When supplying fruit and vegetables to a supermarket, the product specifications are supplied by the supermarket. Physical properties are specified including the general appearance, level of acceptable or unacceptable defects, and consignment criteria. Food product specifications form part of the retailers' quality assurance standards.

Woolworths product specifications

ACTIVITY 7.3

Aim

To **investigate** the physical properties of fruit and vegetables at your local supermarket

STEPS

1 a Research or **design** a tool to capture the physical properties of fruit and vegetables at the local supermarket. This could be a worksheet, use of an existing app or some other way to record data and photographs.
   b Include benchmark expectations for various physical properties already discussed in this chapter. These will be the quality assurance standards.
2 Visit the local supermarket. Gain permission to photograph the fruit and vegetables on display.
3 Photograph and record the general physical properties of at least 10 different fruit and vegetable items, using the tool you designed in step 1. Ensure you note down whether they meet your quality assurance standards.

Conclusions

1 What general conclusions can you draw from the fresh produce observed?
2 **Describe** any fresh produce that is not uniformly shaped. **Investigate** why these products do not need to be uniformly shaped.
3 **Analyse** consumer acceptance of shape and appearance of fresh produce.
4 **Evaluate** the importance of quality assurance standards for supermarkets. In your answer, consider what else would form part of the quality assurance standards.
5 What is the importance to the retailers and the consumers of utilising food product specifications?

Taking it further

6 Retail policy is informed or determined by consumer choice, therefore it could be argued that consumers cause food wastage at retail stores. **Analyse** this statement, with reference to the investigation carried out.

Using fruit and vegetables that do not meet quality assurance standards

ACTIVITY 7.4

Aim

To **research** strategies currently in place to make use of fruit and vegetables that don't meet quality assurance standards
To **propose** further strategies to utilise these food items to avoid the problem of food wastage

STEPS

1 Research existing ideas for fruit and vegetable items that do not meet quality assurance standards.
2 Present the research in an interesting format that promotes the alternative uses of these fruit and vegetables.

9780170418560

3 Develop additional ideas or strategies for using fruit and vegetables that do not meet supermarket quality assurance standards by brainstorming other uses for food items, e.g. tomatoes that are unevenly shaped or overripe.

4 Develop a presentation to promote your ideas to local or state Queensland policymakers for consideration.

REVIEW QUESTIONS ▶

1 **Identify** how consumers impact retail policy and food wastage.

2 **Explain** what quality assurance standards are. Why do supermarkets develop quality assurance standards?

3 **Identify** different ways to use fruit or vegetables that do not meet supermarket quality assurance standards.

Why are the sensory properties of food valuable in developing successful food products?

Create a mind map of information to help answer the guiding question. Use the supplied template or develop your own mind map. You may find it useful to use online tools such as Bubbl.us, Canva, Coggle, MindMup, iMindQ.

WS Mind mapping template

Mind mapping tools

8 LABELLING AND FOOD SAFETY

How does legislation protect consumers?

Governments put in place legislation, policies and standards, with the aim to protect consumers and provide safe food for consumption. Legislation, policies and standards are updated to reflect current research and development in the industry. Does legislation always protect consumers and provide transparency of industry practices? In this chapter, current labelling legislation will be explored and how the food industry uses labelling to inform consumers. Think about how clear labelling rules are and if average consumers can interpret these.

Food safety programs

A food safety program is a written document that explains how a food business will control food safety hazards. A well-written food safety program that is implemented enables a food business to:

- ensure their food is safe for sale
- manage daily operation of the business, improving record keeping and cost control
- demonstrate that they have shown due diligence in the preparation of food.

In Queensland, the following legislation applies to food production and safety:

- *Food Act 2006* is the primary legislation for food safety; applies to all Queensland food businesses
- *Food Regulation 2006* gives details about licensable food businesses, displaying licences by mobile food businesses, contaminants in food and fees for applications
- *Food Production (Safety) Act 2000* sets out the rules for production of primary produce where a food safety scheme applies. The current primary products covered by this Act are:
  – eggs and egg products
  – dairy products
  – meat and meat products
  – seafood.
- *Food Production (Safety) Regulation 2014* is subsidiary legislation to the *Food Production (Safety) Act 2000*. It provides the guidelines for the producers that are covered under the Act and dictates how the Act is applied. It provides the details on implementation of the Act.

All food businesses must also follow the Australia New Zealand Food Standards Code. Food safety programs are covered under Standard 3.2.1 *Food Safety Programs*. This is adopted into the Queensland legislation. Under this standard, food safety programs are mandatory for businesses that are determined to be in high-risk sectors. These businesses are outlined in the table below.

Table 8.1 Standards covering high-risk businesses

HIGH-RISK BUSINESS TYPE	EXAMPLES	STANDARD
Businesses that process or serve potentially hazardous food to vulnerable people	• hospitals • aged care facilities • childcare facilities • respite centres • delivered meals to vulnerable people	Standard 3.3.1 *Food Safety Programs for Food Service to Vulnerable Persons*
Seafood businesses that produce or process bivalve molluscs	Businesses that produce clams, mussels, scallops, oysters	Standard 4.2.1 *Primary Production and Processing Standard for Seafood*

(*Continued*)

9780170418560

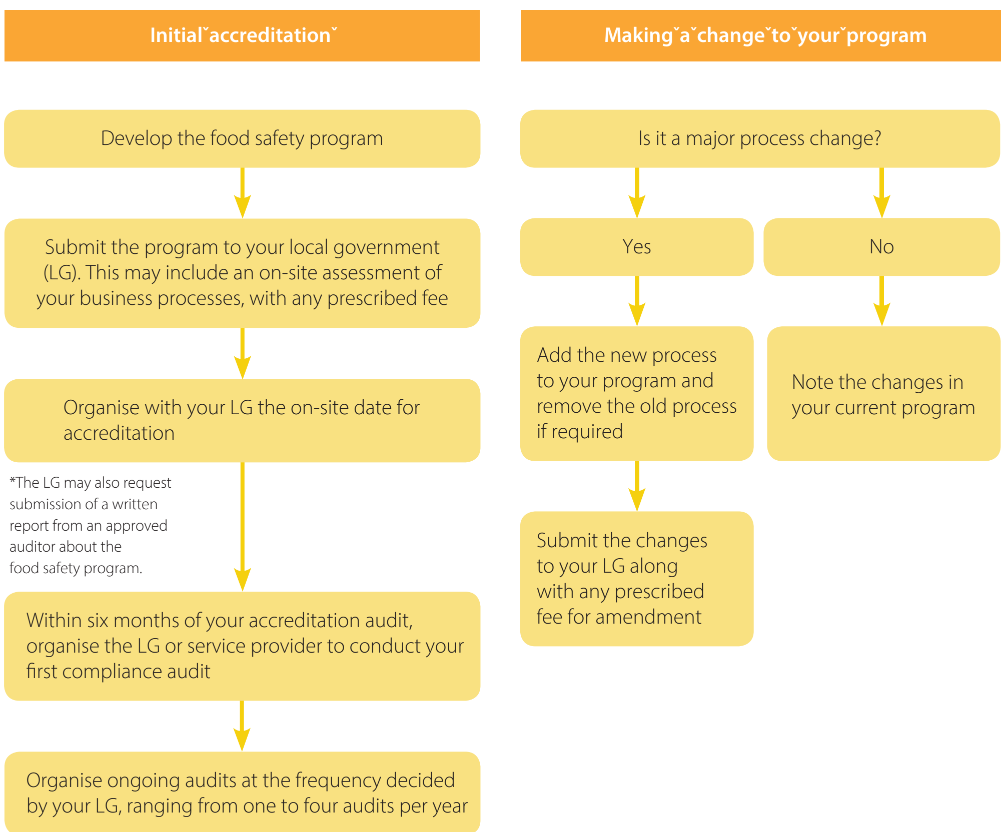
Table 8.1 Standards covering high-risk businesses (*Continued*)

HIGH-RISK BUSINESS TYPE	EXAMPLES	STANDARD
Catering operations serving food to the general public	Queensland catering services, e.g. Culinart Catering Brisbane	Standard 3.3.2 *Food Safety Programs for Catering*
Businesses producing manufactured and fermented meats	Fermented meat companies, e.g. Salumi Australia, Beston Global Food Company	Standard 4.2.2 *Primary Production and Processing Standard for Poultry Meat* Standard 4.2.3 *Primary Production and Processing Standard for Meat*

In addition to those business types identified in the Food Standards Code, Queensland legislation requires licensed businesses to have an accredited food safety program if:

- the food business involves off-site catering
- the primary activity of the food business is on-site catering
- the primary activity is on-site catering, catering for 200 or more people on 12 or more occasions in any 12-month period
- the food business is part of a private hospital or processes and serves potentially hazardous food to six or more vulnerable people.

However, other businesses that are not required to have a food safety program can apply for accreditation of a food safety program.



Source: Based on content © State of Queensland (Queensland Health) 2015. Released under a CC BY 3.0 licence.

FIGURE 8.1 Queensland accreditation process for businesses requiring a food safety program

Hazard analysis

A food safety program must meet the following criteria:

- systematically identify the food safety hazards that are reasonably likely to occur in food handling operations of the food business
- identify where, in a food handling operation of the food business, each hazard identified can be controlled and the means of control
- provide for the systematic monitoring of the means of control
- provide for appropriate corrective action to be taken when a hazard identified is not under control
- provide for the regular review of the program to ensure it is appropriate for the food business
- provide for the keeping of appropriate records for the food business, including records about action taken to ensure the business is carried on in compliance with the program
- contain other information, relating to the control of food safety hazards, prescribed under a regulation.

Source: Queensland Health Food safety programs, www.health.qld.gov.au, accessed 7 April 2018.

Developing a food safety program

HACCP

HACCP stands for Hazard Analysis and Critical Control Point. HACCP is a safety system, to ensure that food is safe for human consumption. It provides a formal method for businesses to manage the safety of food as it progresses through the different stages of production.

Where did HACCP come from?

HACCP was developed in the 1960s in the United States for NASA. The existing system of testing the food products at the end of the production line was not sufficient to ensure that food sent into space for astronauts would be safe for consumption. The existing system would test a sample batch of food at the end of production, which did not necessarily ensure that the entire batch was safe for consumption. NASA needed a system that ensured that food was safe, all the time. The HACCP system ensured this by requiring companies that manufactured food for NASA to systematically control the food hazards at every step of the process, not just testing the food at the end of the process. They were also required to keep records to demonstrate this.

HACCP principles

The HACCP principles enable food producers, manufacturers and retailers to:

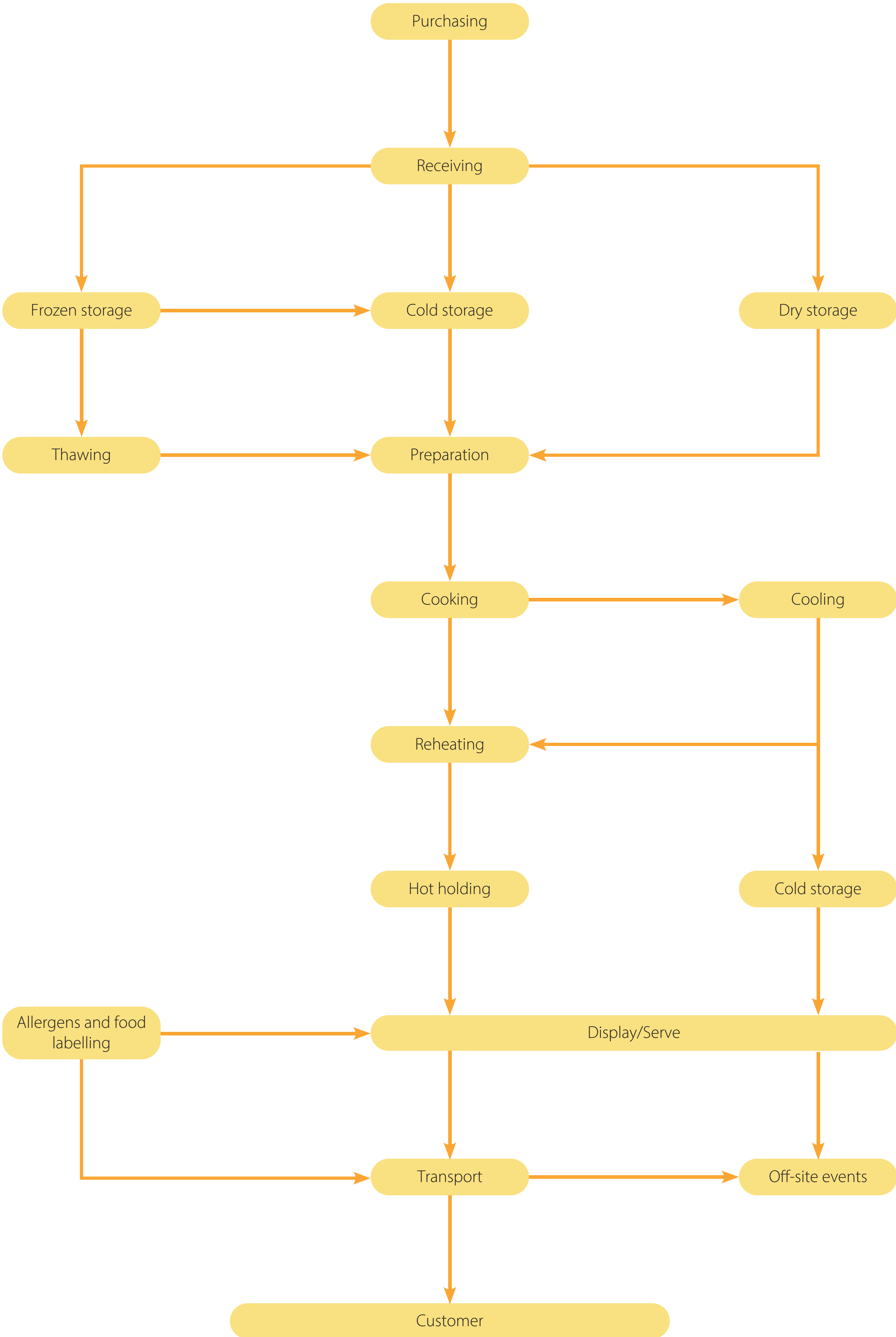
- check every stage of production and identify hazards that could occur
- note where the hazards pose a high risk
- take steps to prevent, remove and reduce hazards
- monitor the control points to ensure adequate measures are taken to ensure food safety
- monitor where serious problems occur and take steps to address the problem
- use documentation to demonstrate all steps in the process.

Steps in creating a HACCP plan

1 **Conduct a hazard analysis**: the food business needs to examine every 'step' in the food production chain. This means conducting an analysis of everywhere the food item travels, from delivery to dispatch, then recording a list of possible hazards at each step. Hazards are identified in terms of physical, biological or chemical hazards.

2 **Determine the Critical Control Points (CCPs)**: from the hazards identified in step 1, determine which of the hazards are critical control points. Critical control points are those where control measures can be applied and, as a result, the food safety hazard can be prevented, eliminated or reduced to an acceptable level. If the control measure was not applied or there was loss of control at this point, it could potentially result in dangerous food.

 9780170418560



Source: Based on content © State of Queensland (Queensland Health) 2015. Released under a CC BY 3.0 licence.

FIGURE 8.2 There are many possible steps in food production for a catering or retail food service establishment.

3 **Establish critical limits for each CCP**: each CCP should have maximum or minimum values to which a physical, biological or chemical hazard must be controlled at to prevent, eliminate or reduce the hazard to an acceptable level. For example, the fridge or freezer temperature would be specified here as a critical limit, or the time that food could remain in the danger zone (5°C–60°C).

4 **Establish a system to monitor control of the CCPs**: once the limits are set for each CCP, determine the method to monitor that the limits are followed. This should be specific and listed on the HACCP plan. There is no point in specifying that the fridge temperature needs to be below 4°C, if it is never monitored to check it is at the correct temperature. The fridge temperature may need to be checked three times a day. This would be recorded on the fridge monitoring checklist and someone would sign it each time they checked the temperature.

5 **Establish the corrective action to be taken when monitoring shows a CCP is not under control**: if the monitoring takes place and the limit is not being met, then this step specifies what corrective action needs to take place. For example, if in the morning it is discovered that the fridge turned off at some point during the night and is now reading 24°C, then the corrective action may be that the contents of the fridge need to be discarded.

6 **Establish procedures to check the system is working effectively**: the HACCP system should be reviewed regularly to ensure that it is working properly. This is often completed as an audit process, sometimes by an independent auditor. After this process, any review or recommendations that are made should be incorporated into the HACCP system.

7 **Establish documentation of all procedures and records**: all HACCP steps and procedures should have accurate and reliable records.

ACTIVITY 8.1

Examples of items:
- chicken noodle soup
- sandwiches containing a range of cold meats
- mushroom and chicken risotto
- beef lasagne

Tool for the development of a food safety program

Activity 8.1 template

Aim

To **design** a simple HACCP plan for one food item

STEPS

1 You are preparing a potentially hazardous item for sale in a retail environment. Using the Tool for the development of a food safety program: Catering and Retail Premises, devise a food safety plan for one item. The raw ingredients will be received then they will go into cold storage, used in preparation, cooked, cooled, returned to cold storage and then displayed/served at the retail outlet.

2 Complete a table like the one below or use the template on NelsonNet for your chosen food item:

	SUMMARY OF WHAT OCCURS AT THIS STEP	POTENTIAL HAZARDS: • BIOLOGICAL • PHYSICAL • CHEMICAL	CCP*	CRITICAL LIMITS	CONTROLS/ MONITORING	CORRECTIVE ACTION	RECORDS
Receiving							
Cold storage							
Preparation							
Cooking							
Cooling							
Display/Serve							

* Refer to Figure 8.3 (page 195) for a CCP decision-making tree

Conclusions

1 **Explain** the purpose of identifying each step of the food production process in a food safety plan.

2 **Explain** the purpose of setting critical limits.

3 Determining the monitoring, corrective action and records will help to ensure that all workers are following the food safety plan. **Explain** why these three steps are important in a food safety plan.

Taking it further

4 **Explain** how your food safety program will protect consumers.

REVIEW QUESTIONS ▶

1 **Identify** the main legislation that is applicable to food production and safety.

2 **Defin** a food safety program, including the main aims of such a program.

3 a **Identify** businesses that must have a mandatory food safety program under the Food Standards Code.

b Which additional businesses must have a food safety program under the Queensland legislation?

4 What does HACCP stand for? **Summarise** the main purpose of HACCP.

5 **Identify** the key steps in creating a HACCP system.

6 a **Consider** the food production and safety legislation did not exist. What would the impact be?

b **Explain** how the legislation protects consumers.

Food deterioration after harvesting

From the time that food is harvested, it is undergoing changes that result in deterioration. Food deterioration can be defined as a series of continuous **degradative** changes that occur in a food item, which may affect the wholesomeness of the product and result in a reduction in quality or safety. Deterioration is a continual process from the time of harvesting, until the item is no longer recognisable as a food item.

degradative
the act of degrading; to break down or decompose

Food spoilage is also a term that is often used with food deterioration. Food spoilage can be defined as an end point of the deterioration process, which signals that a food item is no longer fit for human consumption.

Food deterioration can be categorised into biological, chemical and physical changes that occur in food after harvesting. Refer to pages 155–158 in chapter 3 for more information regarding these changes.

ACTIVITY 8.2

Aim

To **determine**, through investigation, the biological, chemical and physical changes that occur in food after harvesting

STEPS

Investigate the changes that occur in food after harvesting. Examples are provided in the table below, but these can be expanded on. Refer back to Unit 1 Topic 3, as well as researching further the changes that occur in food after harvesting.

	EXAMPLES	CHANGES THAT OCCUR THAT LEAD TO DETERIORATION
Biological changes	Pathogenic bacteria Yeasts Moulds	
Chemical changes	Oxidation Non-enzymatic browning Colour changes Coagulation of proteins	
Physical changes	Colour Odour Texture Insects and rodents	

WS Activity 8.2 template

Food storage requirements

The Australia New Zealand Food Standards Code sets the standard for labelling of food sold in Australia or food imported to be sold in Australia. Generally, all food with a shelf life of less than two years must show a date mark. The different types of date markings are listed in the table below.

Table 8.2 Date markings for different types of food products

DATE MARKING TYPE	EXPLANATION	EXAMPLES
'Use by'	• used when the food manufacturer believes, for a health reason, the food should not be consumed after a certain date • foods labelled with 'use by' cannot be sold after the date has expired	• milk • ready to eat meals that are chilled
'Best before'	• used for foods including shelf stable foods, frozen foods and most raw foods • food can still be sold after the 'best before' date, provided it is still suitable and safe for consumption	• meat, chicken, fish • confectionary, canned foods, biscuits • cheese
'Baked on' and 'Baked for'	• this only applies to bread with a shelf life of less than 7 days • 'baked on' must be a date not more than 12 hours after baking	bread with a shelf life of less than 7 days

9780170418560

The storage conditions must also be displayed on the label. This must include a statement of any specific storage conditions for the food item to ensure that it will keep for the period of time indicated by the 'use by' or 'best before' date; for example, milk – store below 4°C or biscuits–store in a cool, dry place.

Storage conditions relate directly to the nature of the food item, if it is a perishable, semi-perishable or non-perishable item. Accordingly, the labelling will explain the storage requirements for specific food items.

Perishable foods

Perishable foods are likely to deteriorate or go bad quickly, usually within seven days. Perishable items will deteriorate even quicker, sometimes within a matter of hours, given certain conditions. When food has deteriorated it may have begun to decompose so that it is no longer desirable to eat. In these circumstances, the sensory characteristics are no longer appealing. This may mean the taste, smell, texture or appearance is unsavoury. However, perishable food can also be unsafe to eat, yet look, smell, feel and taste fine! This is the danger with food poisoning, as the food may be unsafe to eat, spoiled by microbes, but it often appears acceptable to consume.

Examples: some fresh fruit and vegetables, dairy products, fresh meat, bread, freshly cooked food (leftovers), opened canned or bottled products that have high water content or animal products, opened long-life products such as UHT milk, stock and juice.

Storage:

- Most perishable food is stored in cold storage between 0°C and 4°C.
- Once opened, store long-life products, such as UHT milk, canned or bottled products according to the instructions on the packet.
- Frozen food needs to be stored below −18°C.

Non-perishable foods

Non-perishable foods can be stored at room temperature for months without decay or spoilage. Most non-perishable food items are dried foods, with very low water content, and are packaged or processed items. Once the packaged, non-perishable food item is opened, it may become susceptible to food spoilage. Most non-perishable items will carry a 'best before' date or, if the food can last longer than two years, it may contain no date marking.

Examples: canned products, bottled products, flour, sugar, uncooked pasta, uncooked rice, dried noodles, breakfast cereals, tea, instant coffee, oats, dried products such as powdered milk, soups, fruit, packaged snack foods such as chips, UHT or long-life juice.

Storage:

- Cool, dry, well-ventilated cupboards, pantries or dry store area are needed.
- The food is best stored in the original package.
- Once opened, food should be stored in sealed waterproof and rustproof food containers, to protect from air, dust and pests.
- Leftover canned foods should be stored in another container, generally in the refrigerator (they are then classified as perishable items).
- Refrigerate products from animal sources or high in water content after opening, as they are susceptible to bacterial growth, e.g. cans of tuna, jars of curry paste, cartons of long-life milk.
- Follow the additional storage requirements listed on the label. Examples include:
  - UHT milk: 'Store in a cool, dry place. Keep refrigerated at 0–5°C after opening and use within 5 days'
  - fresh chicken stock: 'Pour unused stock into an ice-cube tray and freeze for up to 3 months; or refrigerate in an airtight container and use within 3 days'
  - canned kidney beans: 'Store in a cool, dry place. After opening, place any unused portion in a non-metallic container, keep refrigerated and consume within 3 days.'

Semi-perishable foods

Semi-perishable foods last for more than a week and may last several months. Semi-perishable foods last longer than perishable foods because they have a lower water content, which slows the multiplication of bacteria and the action of enzymes. This controls microbial growth and enzymatic reactions.

Examples: vegetables such as potatoes, onions and pumpkin, nuts, biscuits, butter, eggs, cheese, chocolate, dressings, smoked or cured meats.

Storage:

- Some, such as cheese, eggs and butter, require refrigeration below 4°C.
- Other semi-perishable items require dry storage.
- Packaged items will generally carry a 'best-before' date. If stored correctly, the item should retain its flavour, texture, taste and colour. After this date the product may deteriorate in quality but may still be safe to eat.

REVIEW QUESTIONS ▶

1 Complete the table below:

   a **defin** each category of food
   b **identify** food examples in each category
   c **summarise** the storage conditions for each category.

CATEGORY	DEFINITION	EXAMPLES	GENERAL STORAGE CONDITIONS
Perishable foods			
Non-perishable foods			
Semi-perishable foods			

2 For a range of non-perishable food items, **identify** the additional storage requirements after opening.

Critical control points

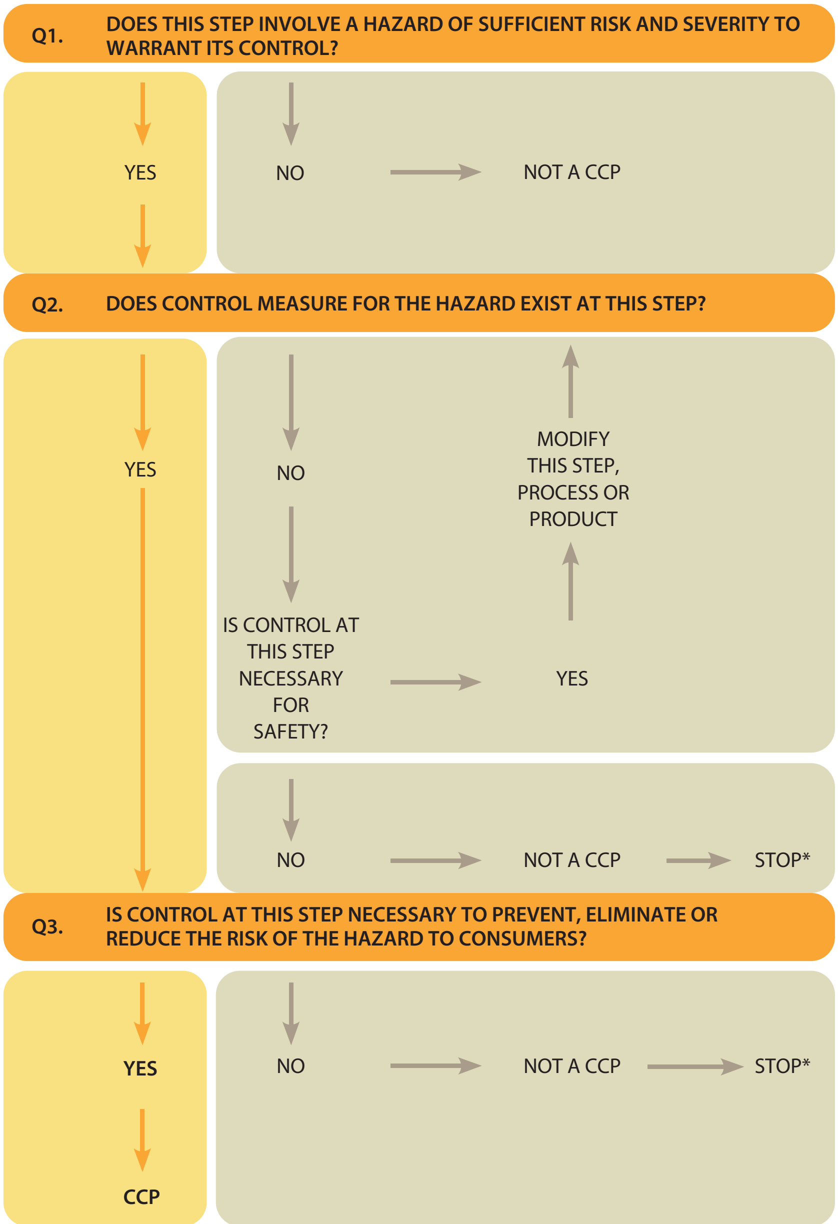
Critical control points (CCPs) in relation to food safety can be determined by asking the questions in Figure 8.3.

Biological hazards

Biological hazards pose a threat to human health. They may be organisms or substances that are produced by organisms, for example, toxins. Biological hazards are a major concern in the food industry, as they can cause food poisoning, which can result in serious illness.

Pathogens

Infection occurs when biological organisms invade a host and then multiply in the body. Infection can be prevented by correctly processing and handling food items. Microorganisms are easily destroyed by heat and can be eliminated during processing.



Source: Based on U.S. Food and Drug Administation, Critical Control Point Decision Tree.

FIGURE 8.3 Determining if a hazard is a critical control point

Spore-forming bacteria can survive cooking. Spores can remain in food items, in a dormant state. When conditions become favourable again, the spores can revert to their original state and continue to multiply. Examples of spore forming bacteria include *Bacillus cereus*, *Clostridium botulinum* and *Clostridium perfringens*.

spore dormant form of some microorganisms that is resistant to environmental factors that could usually cause the death of the microorganism

Intoxication occurs when the microorganisms produce toxins that then affect the human body. Toxins can cause serious harm and illness to humans. Toxins are produced when toxin-producing microorganisms are present in large numbers. The microorganisms must multiply in the food item before they will produce toxins. Toxins are very difficult to remove or detect, as they can survive cooking temperatures. The microorganisms may be killed or eliminated during cooking, but the toxins can remain in the food. The risk of consuming toxins is prevented by controlling the growth of toxin producing microorganisms, including *Clostridium botulinum*, *Bacillus cereus* and *Staphylococcus aureus*.

The main biological hazards are outlined in the table below.

Table 8.3 Main biological hazards

BACTERIA	VIRUSES	PARASITES
• *Salmonella* • *Escherichia coli* • *Campylobacter jejuni* • *Yersinia enterocolitica* • *Listeria monocytogenes* • *Bacillus anthracis* • *Bacillus cereus* • *Staphylococcus aureus* • *Clostridium botulinum* • *Clostridium perfringens* • *Vibrio vulnificus* • *Vibrio parahaemolyticus*	• Hepatitis A virus • Norwalk viruses • Rotavirus	• *Toxoplasma gondii* • *Cryptosporidium* • *Giardia spp.* • *Trichinella spiralis* • *Taenia solium* • *Anisakis spp.*

The main sources of biological contamination in food include:

- faecal contamination (from animal guts)
- contaminated soil and water from non-treated manure
- cross-contamination: poor personal hygiene of food handlers, faecal contamination from food handlers, illness of food handlers, inadequate sanitation of the food processing equipment or environment.

The most effective way to control biological hazards in food is good manufacturing practices and an effective food safety plan. A well-constructed HACCP plan will ensure that hazards are controlled and monitored throughout the entire food production process, from receiving ingredients through to storage, preparation, cooking, cooling, packaging and dispatch. Some strategies used to control biological hazards are listed in the table below.

Table 8.4 Strategies used to control biological hazards

Process controls	• storage temperatures: refrigerator, freezer, dry store • processing controls: temperature and time for cooking, level of water activity when dehydrating, effective cooling system for storage of products
Thermal processing	used as a kill step: cooking, pasteurisation, uht
Effective cleaning and sanitising procedures	use of standard operating procedures for regular cleaning and sanitising of equipment and the food processing environment
Food technologies	• packaging techniques, e.g. vacuum packaging, modified atmosphere packaging, canning, bottling • use of preservatives • processing techniques such as dehydration, high pressure processing (hpp)

ACTIVITY 8.3

Aim

To **explain** how high-pressure processing can be utilised as a control mechanism for biological hazards

STEPS

1 Read the research article below, about high-pressure processing.

2 Respond to the article by answering the questions.

9780170418560

CSIRO HIGH PRESSURE PROCESSING (HPP) INNOVATION

A company that started its life at CSIRO now has their world-first, award-winning juices available in supermarkets nationally and is on a growth curve through its exports to Asia.

The challenge

Consumer trends and fruit juices

New food and drink experiences, exciting flavours, healthier choices and convenient packaging are key ongoing consumer trends.

Food and beverage manufacturing companies are constantly striving towards meeting consumer demands such as these.

However, most fruit juices in the past were reconstituted, had preservatives added and were heat treated, which although makes juice safe to drink, can change the natural taste and colour of juice and destroy some nutrients.

Our response

The benefits of high pressure processing

A small Victorian company, Preshafood, worked with CSIRO to develop premium fruit juices that are pasteurised using high pressure processing (HPP) instead of heat.

HPP is an emerging technology that uses very high pressures to kill yeasts, moulds and bacteria.

The technology has the potential to extend the shelf-life of chilled perishable products and provide improved safety, taste, texture, quality, fresh-like characteristics and nutritional value, without having to use chemical preservatives.

CSIRO are world leaders in the development and implementation of HPP technology in not only juices but also across a range of product categories such as meat, poultry, seafood, fruit and vegetable products, meal solutions, dips and sauces.

In a world first, Preshafood started by manufacturing single variety apple juices such as Pink Lady, Granny Smith, Royal Gala and more in distinctive triangular shaped bottles.

The results

High pressure processing and Preshafruit juices

Owing to HPP, Preshafruit juices retain the taste, colour and fresh-like characteristics of fruit and can be stored up to five times longer than other chilled juices.

The company has expanded into seasonal juice blends, smoothies and vegetable juices, which are sold in supermarkets nationally. They are also increasing their sales in Asia, where the consumer demand for premium Australian food and beverages is high and there are still few similar quality juice products competing with Preshafruit juices.

The company has gone from starting life in our world class pilot plant in Werribee to recently expanding their investment in HPP technology and becoming the largest HPP operation in Australia, creating new jobs and growing sales both in Australia and in export markets.

Source: CSIRO. Reproduced with permission.

Preshafood Pty Ltd. Reproduced with permission.

FIGURE 8.4 Preshafruit is processed using high pressure processing to retain more taste, colour and fresh-like characteristics, while producing a safe product.

Conclusions

1. During production, many juices are condensed, with most of the water being removed and sometimes preservatives added. This concentrate is then transported to another location, and reconstituted (water added back in) before bottling for retail sale. **Identify** the disadvantages of this traditional approach to preparing juices.
2. **Defin** the term 'pasteurisation' and **explain** the purpose of pasteurisation and what it does to the nutritional properties of juice.
3. **Describe** HPP and the benefits of using HPP for chilled juices.

Taking it further

CSIRO

4. **Investigate** other uses of HPP for food products and explain how HPP can be used in a food safety plan such as HACCP.

Insects and animals

Insects, pests or animals are considered a hazard in food preparation. Regular pest control plans should be in place to ensure that the food business is maintaining their premises. The goal of a pest control program is to exclude pests from the food processing plant and is usually carried out by a pest control company. In relation to HACCP, food manufacturing businesses may set critical control limits in relation to pests or insects. For example, an acceptable limit on the number of flies caught in a cheese factory may be five per week.

Physical hazards

Physical hazards in food include materials that are not intended to be present, or naturally occurring objects such as bones. Common physical hazards in food include:

- glass: broken glass from light bulbs, glass containers and glass food containers
- metal: small pieces from equipment such as blades, utensils, staples

- plastics: material used for packaging, pieces of utensils used for cleaning equipment
- stones: from crops such as peas and beans or picked up during harvesting
- wood: splinters from wood structures and wooden pallets used to store or transport ingredients or food products
- natural components of food: hard or sharp parts of a food, e.g. the shell of nut products if consumers do not expect them to be present.

Physical hazards can contaminate a food product at any stage of food production. The food production process should include checks for foreign objects. Hard or sharp objects in food can cause cuts to the mouth or throat, damage to teeth or gums; damage to internal organs, such as intestines or stomach. Foreign objects in food can trigger the need for a food recall, which can affect the brand reputation.

There are different ways food manufacturers can prevent physical hazards in food products. The food operation should assess each step of operation for potential sources of physical contamination. Some control measures that can be implemented include:

- inspecting food products for physical contamination that was not found during receiving, e.g. stones from harvesting
- eliminating potential physical contamination in processing and storage areas by using acrylic light bulbs, lamp or light coverings, eliminating use of glass in processing wherever possible
- installing an effective system to detect physical hazards, e.g. metal detectors or magnets to detect metal fragments in production or use of filters and screens to remove foreign objects when receiving stock
- ensuring good personal hygiene and practices of all food production staff, e.g. no jewellery, no false nails or nail polish, covering all hair including facial hair when working with food
- ensuring regular effective maintenance and service of all equipment to avoid worn out equipment.

There are also methods that can be utilised to detect physical hazards in food. These include:

- metal detectors to detect metal in food. These should be set to reject food items if metal is detected
- an X-ray machine to identify physical contamination such as stones, hard plastic, metal and bones
- magnets to attract and remove metal contamination in food
- food radar systems to detect foreign bodies such as plastics, bones, metals or kernels in food.

Chemical hazards

A chemical hazard is any substance that could potentially cause a health problem if ingested or inhaled. The table below outlines four types of chemical hazards, chemical hazard examples and control methods.

Table 8.5 Four types of chemical hazards, chemical hazard examples and control methods

TYPES	CHEMICAL HAZARD EXAMPLES	CHEMICAL CONTROL METHODS
Naturally occurring chemicals such as: • ciguatera • solanine • lectin • alkaloids • triamines	• ciguatera – fish • solanine – potatoes, tomatoes • lectin – raw legumes and grains • alkaloids – eggplant, capsicum • triamines – cured or smoked meats, soy products, some overripe fruits	Use reputable suppliers for sourcing raw materials that also maintain effective hazard prevention and minimisation techniques

(*Continued*)

Table 8.5 Four types of chemical hazards, chemical hazard examples and control methods (Continued)

TYPES	CHEMICAL HAZARD EXAMPLES	CHEMICAL CONTROL METHODS
Intentionally **added chemicals** such as chemicals added to food (e.g. preservatives, additives) beyond the limits prescribed in the Food Standards	Employee errors in adding excessive food additives or unapproved ingredients	• minimise use of chemicals wherever possible • ensure that the Food Standards are followed for use of food additives
Unintentionally added chemicals such as: • cleaning chemicals • pesticides • chemicals for maintenance or sanitation of equipment	• incoming materials – if contaminated with toxin-producing bacteria or mould, pesticides, veterinary drugs, non-food grade chemicals/ink used in packaging materials • food contact surfaces – use of unapproved materials may lead to migration of chemicals to food • non-food chemicals – sanitation or maintenance chemicals (used or stored near food contact surfaces), dyes or inks from coding machines, water treatment chemicals	• store chemicals in designated areas, away from food and food surfaces, with clear labels • ensure chemical containers and measuring tools are clearly labelled or colour coded to avoid cross contamination with food containers or utensils • label and package adequately • train employees to correctly handle and apply chemicals for cleaning and sanitation • minimise use of grease or lubricants on equipment
Food allergens such as: • peanuts • soy products • dairy • shellfish	• undeclared allergens on ingredient labels • cross-contamination with other allergens	• use designated tools and equipment for allergens to prevent cross-contamination with other food products • correct storage of allergens to prevent cross-contamination with other ingredients

REVIEW QUESTIONS ▶

1 **Identify** examples and control measures for biological, chemical and physical hazards in a table like the one below.

HAZARD TYPE	EXAMPLES	CONTROL MEASURES
Biological hazards		
Chemical hazards		
Physical hazards		

2 **Explain** what a critical control point (CCP) is.

3 **Explain** how to determine which of the HACCP steps are a CCP.

Food Standards Australia New Zealand (FSANZ)

statutory authority an independent body with the power to enact legislation in a specific area on behalf of the government

Food Standards Australia New Zealand (FSANZ) is a **statutory authority**. FSANZ develops and administers the Food Standards Code for Australia and New Zealand. However, FSANZ does not enforce the Food Standards Code. The Food Standards Code is enforced by various agencies across state and territory departments. FSANZ develops the Standards through advice from other government agencies and input from stakeholders.

The Food Standards Code outlines the use of:

- ingredients such as processing aids, colourings, additives, vitamins and minerals
- composition of certain foods such as meat, beverages and dairy
- new technologies such as novel foods
- labelling of packaged and unpackaged food, including mandatory warnings and advisory labels.

In Australia, FSANZ also develops standards for primary production and processing of food, and for food hygiene.

Other roles that FSANZ undertakes include:

- coordinating food surveillance and food recall systems
- supporting the Department of Agriculture to inspect imported foods
- conducting research including supplying science information regarding publications, monitoring the safety of the food supply, monitoring nutrients in the food supply and risk analysis
- monitoring the food supply to ensure it is safe, in conjunction with other government agencies
- conducting targeted surveys and Australian Total Diet Studies to collect data on the levels of microbiological contaminants, chemicals and nutrients in food
- supplying user guides for the Standards that help businesses to ensure food safety and labelling is correct.

FSANZ also provides consumer information on their website, including:

- food additives
- chemicals in food
- food allergies
- food safety and recalls
- food technologies
- novel foods
- food issues
- genetically modified foods
- imported foods
- labelling
- nutrition.

FSANZ Vision and Mission
Vision: A safe food supply protecting and supporting the health of people in Australia and New Zealand.
Mission: To develop effective food standards in collaboration with the Australian and New Zealand governments.

FIGURE 8.5 Food recalls are a joint responsibility between the business, state and territory governments and FSANZ.

REVIEW QUESTIONS ▶

1 What does FSANZ stand for?
2 Make a list of the different standards FSANZ develops.
3 **Explain** who enforces the Food Standards Code.
4 Outline the joint responsibility in relation to food recalls.
5 **Explain** the overarching purpose of FSANZ, including their mission statement and consumer information they provide.

consumer rights
the legal, social or ethical principles that are according to a legal system or accepted as social conventions

transparency
in relation to consumer rights is the visibility or accessibility of information that a business provides and their business practices

Consumer rights, transparency and food labelling

Food standards are set by FSANZ in the Food Standards Code. In Australia, the Standards are enforced by the different states and territories. The Food Standards Code includes the general labelling requirements of all foods. It also sets the requirements for different situations, such as food for catering, food for retail or transferring food within a company. In chapter 2 of the code, there is specific labelling and information requirements that apply to certain food products.

Food labelling legislation is explored for the remainder of this chapter. Various issues that relate to food labelling, **consumer rights** and **transparency** of food businesses are presented for analysis.

ACTIVITY 8.4

Aim

To **explore** food labelling standards and mandatory items that must appear on a food label

STEPS

Using the FSANZ website, **design** your own guidelines for a food business in relation to food labelling laws. Be sure to include all the mandatory components that must appear on a food label.

FSANZ – labelling

Conclusions

1 **Identify** the mandatory items that must appear on a food label.
2 **Explain** how the legislation aims to support consumer rights and transparency on food labels. Provide specific examples.

Genetically modified foods developed in Australia and other countries

Genetically modified foods are foods that have been processed from organisms (plants, animals or microorganisms) in which genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination. Genetic modification allows individual genes to be selected and transferred from one organism to another, even between non-related species. In food production, the purpose of genetic modification is usually to increase yield or to develop specific qualities that enhance the item. Foods produced this way are often referred to as GM foods.

9780170418560

In Australia and New Zealand, all GM foods intended for sale must undergo a safety assessment by FSANZ. FSANZ will only approve GM foods if they are deemed safe to eat.

People have been manipulating plant and animal genetic make-up for many generations. This traditional cross-breeding involves selecting animals and plants that have desirable characteristics, and breeding them. Desirable characteristics may include high yield, good meat quality or disease resistance. New techniques with GM foods involve identifying genes that generate characteristics and transferring them between living organisms. The characteristic can be inserted into the cells of another organism, which then produces the desired characteristic in the second organism.

FSANZ lists GM applications and approvals on its website. All GM foods approved at the moment are from GM plants. Examples include:

- corn plants that are more resistant to insects
- drought-tolerant corn
- potatoes that have reduced acrylamide potential and reduced browning from bruised skin
- soybeans with a modified fatty acid, to make the oil more suited for frying.

GM Foods are regulated under Standard 1.5.2 *Food Produced Using Gene Technology* in the Food Standards Code.

Standard 1.5.2 includes two key points:

- mandatory pre-market approval of GM foods
- mandatory labelling requirements of GM foods.

The Standard ensures that GM foods can only enter the food supply if they are assessed and approved. The approved list of GM foods is listed in Schedule 26 of the Food Standards Code. A list of the GM applications and each application status can be found on the Food Standards site.

In Australia, oversight of development and environmental release of GM organisms is carried out by the Office of the Gene Technology Regulator (OGTR), under the *Gene Technology Act 2000*.

FSANZ - Food Standards Code

FSANZ – applications of GM Food

FSANZ – safety of GM food

Safety assessments

FSANZ conducts a thorough assessment of all GM food applications prior to approving them to be allowed in the food supply.

GM foods and labelling

All foods containing novel DNA or novel protein must be labelled with the words 'genetically modified'. This includes food additives and processing aids that may be used throughout processing of the item. Novel DNA and novel protein are defined in Standard 1.5.2 as:

> DNA or protein which, as a result of the use of gene technology, is different in chemical sequence or structure from DNA or protein present in counterpart food that has not been produced using gene technology, other than protein that:
>
> **a** is *used as a processing aid or *used as a food additive; and
>
> **b** has an amino acid sequence that is found in nature
>
> Source: FSANZ, Food Standards Code 1.5.2
>
> * defined in Standard 1.1.2

Labelling is also required when GM foods have an altered characteristic when compared with a non-GM food of the same variety. These foods must also be labelled with the words 'genetically modified' even if they do not contain novel DNA or novel protein.

GM labelling is about helping consumers make an informed choice about the food they buy. The statement 'genetically modified' will appear on the label, either next to the name of the:

- food, e.g. 'genetically modified soybeans' or
- ingredient that is genetically modified, e.g. in the ingredients list 'soy flour (genetically modified)'.

Exemptions from GM labelling

Some exemptions exist in relation to labelling of GM foods, including:

- if the food does not contain any novel DNA or novel protein and does not have an altered characteristic. These foods have the same composition as non-GM foods and are generally higher refined foods such as oil or sugar, and the processing has removed the DNA and protein from the food
- GM flavourings with a concentration of no more than 0.1% are exempt
- there is no more than 1% (per ingredient) of a GM food that is unintentionally present in a non-GM food
- food that is prepared for immediate consumption, that is prepared and sold from the food premises (e.g. cafes, restaurants, takeaway outlets, caterers) is also exempt from GM labelling. In these cases, the consumer can seek information from the food business. The food business must not be untruthful or misleading
- foods from animals (e.g. milk, eggs, meat) that have eaten GM foods are not considered themselves to be genetically modified and therefore do not need to be labelled.

Other labelling

'GM-free' and 'non-GM' are voluntarily made claims. These claims are subject to the relevant fair-trading laws in Australia. These laws prohibit false, misleading or deceptive claims about food.

REVIEW QUESTIONS ▶

1 **Identify** the main legislation that governs food labelling.

2 **Summarise** the meaning of 'GM foods' and the main labelling requirements for GM foods.

3 **Explain** the strict rules that apply for the sale of GM foods in Australia. How do these rules protect consumers and ensure transparency with GM products?

Country of origin labelling

Under Australian Consumer Law, for food sold in Australia there are country of origin labelling requirements. The requirements are set out in the Country of Origin Food Labelling Information Standard.

Country of Origin Food Labelling Information Standard 2016

Consumers are influenced by many different factors when purchasing food products. One of these factors is claims about where a product was grown, produced or made. The Standard prohibits businesses or individuals from supplying, manufacturing or processing food that does not comply with the Standard, making false or misleading representations about the place of origin of food products or engaging in deceptive or misleading conduct in relation to a claim about the origin of food products.

Most food for retail sale in Australia is required to carry a country of origin label. This includes foods that are in a package and some unpackaged food such as fish, meats, fruit and vegetables, herbs, spices, nuts, legumes, seed and fungi. Foods that are exempt from the country of origin labelling requirement include food sold by restaurants and canteens, food that is delivered and ready for consumption (e.g. home-delivered Thai or pizza) and food that is made and packaged on the premises (e.g. bread or pastries made from scratch in a bakery).

 9780170418560

The Standard applies to all food that is imported into Australia for retail sale, but not for foods that are produced for export and sale outside of Australia. Foods for export are subject to labelling laws in the importing country.

If the food product is for retail sale in Australia, then two key questions need to be asked to determine the labelling that is required:

1 Is the food a priority or non-priority food item?
2 Was the food grown, produced, made or packaged in Australia or in another country?

Non-priority foods are foods from the following categories:

- **a** seasonings
- **b** confectionary
- **c** biscuits and snack foods
- **d** bottled water
- **e** soft drinks and sports drinks
- **f** tea and coffee
- **g** alcoholic beverages

Source: FSANZ

If the food item does not belong to one of those seven categories, it is considered a **priority** food item.

Key claims – grown, produced, made and packed

Grown in

The 'grown in' claim is generally used for fresh food (e.g. fruit and vegetables). It means that the food was in fact grown in that country. Foods with multiple ingredients are also 'grown' in a country if all significant ingredients are from that country and most of the processing occurred there.

Product of

The 'product of' claim means that all significant ingredients are from that country and majority of the processing occurred in that country. This claim is commonly used for both fresh and processed foods. A food may only carry a 'Grown in Australia' or 'Produced in Australia' three component standard mark if it contains exclusively Australian ingredients.

Made in

The 'made in' claim means that the food underwent its last substantial transformation in that country, but it does not necessarily mean that any ingredients are from that country. Certain processing (i.e. slicing, canning, freezing, coating or repacking food) will be insufficient to justify a 'made in' claim.

Packed in

A food that cannot claim 'grown in', 'produced in' or 'made in' a particular country can only make the claim 'packed in' a certain country.

The labels

The Standard has three possible country of origin labels, and there are mandatory requirements for each.

Table 8.6 Country of origin labels

 Department of Industry, Innovation and Science  Department of Industry, Innovation and Science	**Three-component standard mark** • graphic and text based • mandatory for priority food items grown, produced or made in Australia
 Department of Industry, Innovation and Science	**Two-component standard mark** • graphic and text based • mandatory for most priority items packed in Australia • can be used for imported priority foods that contain Australian ingredients
 Department of Industry, Innovation and Science	**Country of origin statement** • text only • used for non-priority food items • imported priority foods must also contain a country of origin statement as a minimum

ACTIVITY 8.5

Aim

To **determine** the country of origin labelling requirements for various priority and non-priority food items, using the Country of Origin Labelling (CoOL) tool

STEPS

1. Access the CoOL tool to produce the sample country of origin labels.
2. Read through the scenarios below and answer the questions on the CoOL tool. Provide a sample Country of Origin label for each scenario where appropriate.

Country of Origin Labelling tool

SCENARIOS

1. You are a local chef, producing a seafood dish that will be sold at the Boathouse, a local seafood restaurant.
2. You are a farmer, producing bananas that are for retail sale at a variety of stores. The bananas are unpacked and have been 100% produced in Australia.

9780170418560

3 You are producing a hamburger that will be sold at the local canteen at a Saturday sporting event. The hamburger contains meat and vegetables that are both from Australia and from various countries overseas.

4 You are baking bread that will be sold on the premises. The ingredients in the bread are from two different countries.

5 You are importing packaged beef jerky that was grown and packaged overseas. No processing took place in Australia. The item has no Australian ingredients.

6 You are importing a soft drink that was made and produced overseas with 100% ingredients from one country.

7 You are producing frozen vegetables that are frozen in Australia. The vegetables include 50% carrots produced in Australia and 50% peas, produced in China. The last substantially transformation was in Australia when the vegetables were prepared and frozen. The proportion of Australian to Chinese vegetables remains consistent.

8 You are an Australian beef producer, providing packaged beef meat that is produced in Australia, with no processing outside of Australia.

Flowchart

Do I need to display a country of origin label on my food product?

Is the food required (or permitted) to carry a label?
See page 4 to find out if the Standard applies.

No → You are not required to comply with the Standard.

Yes ↓

Is it a 'non-priority' food?
See page 5 to determine whether the food belongs to a non-priority food category.

Yes → Go to page 10 to find out the labelling requirements for non-priority food.

Was the priority food grown, produced, made or packed in Australia?
See page 6 for an explanation of these key principles.

Yes →
- If the food was grown or produced in Australia–go to page 20.
- If the food was made in Australia–go to page 20.
- If the food was packed in Australia–go to page 25.

Was the priority food imported into Australia?

Yes →
- If yes, see page 29 for the labelling requirements

Does the food contain Australian ingredients?
Go to page 13 to find out how to work out the percentage of Australian content in the food.

FIGURE 8.6 Flowchart to interpret the country of origin requirement

Conclusions

1 **Identify** the law that governs the country of origin labelling.

2 Country of origin labelling is aimed at providing consumers with an easy reference point. **Analyse** how transparent and consumer friendly the sample standard marks are in achieving this.

Health claims labelling

Health claims and nutrition content claims are voluntary statements on labels made by food businesses about a food item. Standard 1.2.7 sets the rules for food businesses who choose to make a health or nutrition claim. Health claims refer to the relationship between food and health, rather than a statement of content, which is what a nutrition claim does. There are two types of health claim.

Table 8.7 Types of health claims

HIGH-LEVEL HEALTH CLAIMS	SUMMARY	EXAMPLES
Refer to a nutrient or substance in a food item and its relationship to a serious disease or to a biomarker of a serious disease	• Must be based on the food-health relationships that are pre-approved by FSANZ. • Currently, there are 13 pre-approved food-health claims. Refer to Standard 1.2.7, Schedule 2 'Conditions for permitted high-level health claims'	• Diets high in calcium may reduce the risk of osteoporosis in people over 65 years • Phytosterols may reduce blood cholesterol • Diets low in saturated fatty acids may reduce total blood cholesterol
GENERAL-LEVEL HEALTH CLAIMS	**SUMMARY**	**EXAMPLES**
Refer to a nutrient or substance in the food and its effect on health. They do not refer to a serious disease or biomarker of a serious disease	• There are more than 200 pre-approved food-health relationships that food businesses can base their claim on • Refer to Standard 1.2.7, Schedule 3 'Conditions for permitted general-level health claims' • Food businesses can self-substantiate a food-health relationship. They must notify FSANZ before making the claim	• Calcium for healthy teeth and bones • Contributes/helps to maintain/support digestive health • Easier to digest compared to regular milk for those with lactose intolerance • Riboflavin contributes to normal energy release from food

FSANZ Standard 1.2.7

Nutrition, health and related claims

Foods that carry a health claim must meet the compositional requirements that are set out in the Standard. This includes the nutrient profiling scoring criterion (NPSC). There is an online calculator to help food businesses determine a food's score.

In Australia, the states and territories are responsible for enforcing the Food Standards, which includes health claims. The Department of Agriculture and Water Resources is responsible for foods that are imported into Australia.

Health Star Rating system

The Health Star Rating system is a labelling system that rates the overall nutritional profile of packaged food. It provides a quick and easy way to compare similar packaged items, by assigning a rating from ½ a star to 5 stars. The more stars the package receives, the healthier it is considered to be.

All packages contain a nutrition information panel, but with varying levels of education and the busy nature of many shoppers, the Health Star Rating system aims to provide a quick way to make healthier choices. The Health Star Rating system was developed by the Australian, state and territory governments in consultation and collaboration with consumer groups, public health authorities and industry. It was jointly funded by the governments and is implemented on a voluntary basis.

9780170418560

The number of stars is decided using a calculator. The calculator assesses the positive and risk nutrients in the food. The calculations were developed in consultation with FSANZ and other nutrition experts.

Food manufacturers are responsible for the accurate and correct use of the Health Star Rating system. Food manufacturers use the calculator to determine their Health Star Rating. They must still comply with all relevant legislation, regulations and nutrition information on their labels.

FIGURE 8.7 Nestle removed the Health Star Rating label from Milo powder after criticism that it was misleading.

The stars are based on the nutritional profile of the food item. The nutritional profile includes:

- the energy, in kilojoules
- positive nutrients – protein, dietary fibre, proportion of fruit, vegetable, nut and legumes
- risk nutrients – saturated fat, sugars, sodium (salt).

The Health Star Rating is displayed on the front of packages. It can be displayed in two ways. The first just displays the rating of the product; the second way has the rating and additional nutrient specific content. The star ratings are all based on a consistent measure of 100 g or 100 mL of a product so that products can be easily compared. In addition to the star rating, there is a quality rating of energy, saturated fat, sodium and sugars. The label may also include one positive nutrient, such as dietary fibre, protein, vitamins or minerals. The design of the label is to allow consumers to make at-a-glance decisions and comparisons of food products in the same category. The nutrition information icons are based on either 100 g or 100 mL of the product or per pack for single serve/portions.

The Health Star Rating is voluntary and relies on individual businesses to assess their product (using an online or Excel-based calculator) and applying the correct Health Star Rating. There is much controversy over the ratings that are sometimes displayed on various items, often related to the fact that items should only be compared within the same product range. For example, some organic nuts may receive the same Health Star Rating as a packet of lollies. In this case, different nutrients are in each item, so they cannot be compared via the Health Star Rating as they are in different categories.

Other controversy surrounds the perceived misuse of the Health Star Rating for products such as Milo. Nestle, the company that owns the Milo brand, removed a 4.5-star rating from Milo powder because the rating included skim milk in the serving. Without the milk, Milo would only receive 1.5 stars according to the online calculator.

ACTIVITY 8.6

Aim

To **investigate** products that bear the Health Star Rating and **analyse** the transparency of the system

STEPS

1 Find at least eight food items that bear the Health Star Rating.

2 Take a photo of the star rating, ingredients list and nutritional panel of each.

Conclusions

1 **Describe** the food items and **summarise** the nutritional properties of each one. Rank them according to the number of stars.

2 **Analyse** the effectiveness of the Health Star Rating system, based on the products that you have found. Did you find any products that have a relatively good star rating but may not be considered 'healthy'? How have the manufacturers of those products not been transparent in their use of the Health Star Rating system?

Health Star Rating

Fact Check – Health Star Rating system

Taking it further

3 **Discuss** the effectiveness of the star rating system for the average consumer. What are the positive and negative features of the system?

Novel sources of protein

In food and nutrition, novel sources of food include:

- food that is produced using new ingredients or processes that were not previously used
- food that does not have a significant history of consumption.

Novel foods are regulated through FSANZ, which requires foods to be assessed to establish safety before they are added to our food supply. Novel foods and novel ingredients are regulated under Standard 1.5.1 *Novel Foods*. A novel food cannot be sold in Australia unless it is listed in the Standard. Companies can apply to FSANZ to have a new food added to the list. If the food item passes the pre-market safety assessment, then it can be added to the list in the Standard. The purpose of this risk-based assessment is to evaluate the potential impact on public health and safety, including a variety of toxicological and nutritional issues together with the chemistry of the food and consumption totals.

Categories of novel foods may include:

- plants or animals and their components
- plant or animal extracts
- herbs, including extracts
- dietary macro-components
- single chemical entities
- microorganisms, including probiotics
- foods produced from new sources, or by a process not previously applied to food.

Companies can request an exclusivity permission to be added to the novel food item. This means that FSANZ would grant the company exclusive permission to market and use a novel food

9780170418560

item. This exclusivity ends after 15 months, after which, any company can then begin to market and use the novel item. The reason the exclusive permission exists is to grant companies who have spent time and money on research and development of the novel food first-to-market advantage for their novel food item.

FSANZ Standard 1.5.1

Insects

The Food and Agriculture Organization (FAO) of the United Nations has investigated edible insects: future prospects for food and food security. It is estimated that insects form part of the traditional diets of at least 2 billion people. Over 1900 species of insect have reportedly been used as food. Globally, the most consumed insects are beetles (31%), caterpillars (18%) and bees, wasps and ants (14%). Other insects that are commonly eaten include grasshoppers, locusts, crickets, cicadas, termites and dragonflies.

Entomophagy is heavily influenced by culture and accepted norms. In most Western countries, people view entomophagy with disgust and associate eating insects with primitive behaviour. This attitude has hindered the progress of insects in agricultural research and development. In other countries, consumption of insects is not viewed with disgust or as primitive. For example, beondegi (번데기) is a common street food in South Korea. It is made with silkworm pupae, which are boiled or steamed, then seasoned and sold in cups as a snack.

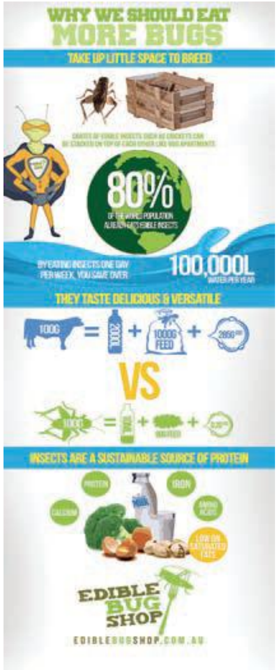
entomophagy the technical term for the human consumption of insects

Regulation and processing of insects in Australia requires further development and governance. Several businesses in Australia are farming insects for both food and feed purposes.

The edible bug shop promotes use of bugs for everyday food and highlights the nutritional value of bugs and the sustainability of producing bugs.

Getty Images/Jodi Cobb

FIGURE 8.8 Common street food found in South Korea, silkworm pupae



Edible Bug Shop. Reproduced with permission.

FIGURE 8.9 Could marketing help to change attitudes and promote edible insects to Australians?

REVIEW QUESTIONS ▶

1 **Identify** the different categories of novel protein.

2 **Identify** the main edible insects that are consumed around the world.

3 **Identify** the behaviours or attitudes that would need to be overcome in Western countries before edible insects could become a mainstream source of protein.

4 **Propose** three ways to overcome attitudes against edible insects.

5 3D printing is another source of novel protein. Read the article in the weblink and answer the following questions:

   a **Identify** the driver behind 3D printed food for the elderly.

   b **Identify** any issues related to 3D printing of food in Australia. Which Standard or laws would need to be considered prior to this novel food being sold for consumption?

3D printing the meals of the future

Food additives

Food additives are substances that are added to food, but they are not normally consumed alone or used as an ingredient in the preparation of food items. Food additives affect the characteristics of the food items they are added to, and they are used in relatively small amounts. They play an important part in food manufacturing, ensuring that our food is nutritious, safe to eat, convenient and displays the qualities that meet the needs of the consumer. There are some food additives that are used in foods as additives but also occur naturally in other foods, for example, vitamin C or lecithin. Food additives can be used for:

- improving or restoring the texture, appearance or taste of food items
- extending shelf life and reducing food waste

- improving or maintaining the nutritional quality of food items
- assisting in the production of food items
- providing for special dietary requirements.

Food additives fall under Food Standard 1.3.1 *Food Additives*. Schedule 15 'Substances that may be used as food additives' covers the food additives that are approved for use in Australia, along with the maximum permitted level (MPL) and any conditions associated with each additive use.

FSANZ Standard 1.3.1 Food additives

Food additives must be listed on the label of most packaged food items, in the statement of ingredients. Most additives are listed by their class name, then the name of the additive or the food additive number. However, enzymes and most flavourings do not need to be named or identified by a food additive number, they can be labelled by their class name only. See below for a list of common class names and explanations.

Table 8.8 Common food additives

Acids/Acidity regulators	• help maintain constant acid level • can be important for taste • influence how other substances in food function, e.g. acid will hinder the growth of some microorganisms
Anti-caking agents	reduce items from sticking together and improve flow, e.g. herbs and spices may contain an anticaking agent to prevent clumping, allowing them to flow freely
Antioxidants	hinder or prevent oxidation that may cause food deterioration, e.g. fats and oils can develop rancid flavours. Antioxidants can help to prevent this from happening
Bulking agents	used to contribute to the volume of food without adding additional energy
Colours	used to restore or add colour to foods
Emulsifiers	prevent oil and water mixtures from separating into layers
Firming agents/stabilisers	disperse two or more substances uniformly in solid and semi-solid foods
Flavour enhancers	will replace or enhance the existing taste and/or odour of a food item
Humectants	prevent food products from drying out
Minerals	replace or add to the nutritive value of the food
Preservatives	• hinder or prevent the deterioration of food by microorganisms • help to extend the shelf life of food items, preventing spoilage
Stabilisers	disperse two or more substances uniformly in solid and semi-solid foods
Sweeteners	• can be artificial or natural • replace the normal sweetness provided by sugar
Thickeners	• improve the viscosity (thickness) of the food
Vitamins	• replace or add to the nutritive value of the food

Exemptions

Some foods, such as unpackaged food or food in a small package, do not require a food label and are not required to declare food additives. Similarly, if a food item uses other foods to produce it, then the ingredients of the first food items do not have to be listed if the ingredients make up less than 5 per cent of the final food. For example, if a tomato paste was used to create dried tomato pasta, and the tomato paste was less than 5 per cent of the new food product, the ingredients of the paste would not need to be declared. If the additives in the compound ingredient perform a purpose in the final food items, then they must be declared in the ingredients list. See Standard 1.2.4 *Information Requirements – Statement of Ingredients*.

FSANZ – additives

FSANZ Standard 1.2.4 – statement of ingredients

Ingredients and percentage labelling

Labelling of ingredients on a food item is mandatory. It is covered under Food Standard 1.2.4 *Information Requirements – Statement of Ingredients*. FSANZ have also published the *Ingredient Labelling of Foods User Guide* to assist businesses in getting the Standard right.

Ingredients must be listed in descending order by weight. When the food was made, the first ingredient on the list must contribute the largest amount and the last ingredient on the list must contribute the least. This helps to inform consumers and give an idea about the main ingredients in the food item. You might be surprised to find sugar is often listed as the second ingredient in items that you may not expect.

Water must be listed in the correct order in the ingredients list, according to the weight of the water used. Some food items are made using other food items that have already been manufactured; the use of canned spaghetti to produce pre-made spaghetti with a tomato sauce is an example. In this case, the ingredients used to make the spaghetti must also be listed on the ingredient list, unless the compound ingredient makes up less than 5 per cent of the final product. If an ingredient in a compound ingredient is a known allergen, then it must be declared, regardless of how much is used.

There are currently 10 allergens that must be declared on food items.

FIGURE 8.10 FSANZ allergen labelling saves lives – the 10 allergens that must be declared on a food label

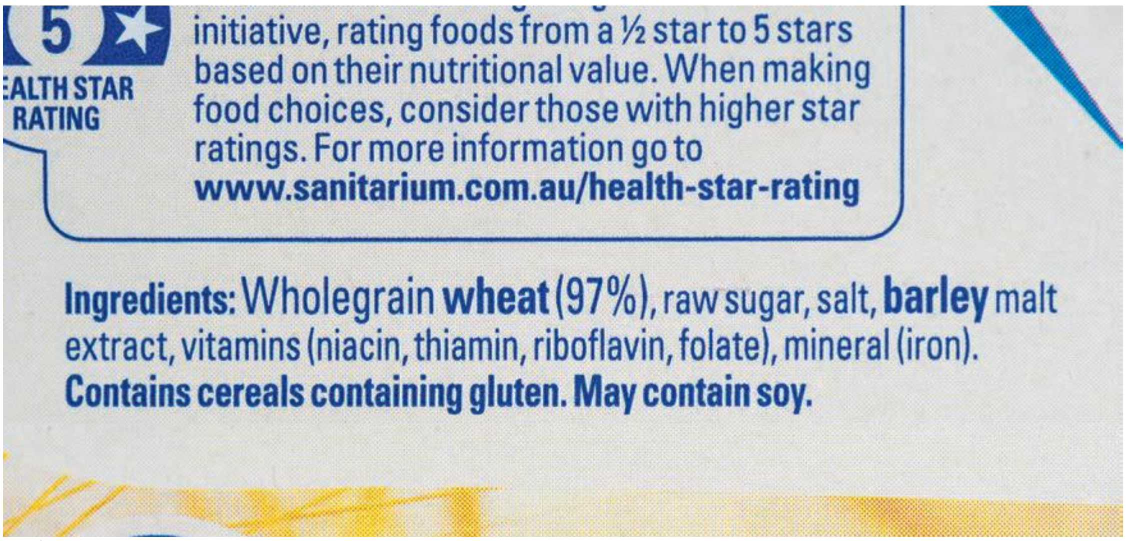
Percentage labelling

Percentage labelling requires a declaration of the proportion of the characterising components and characterising ingredients of the food. Standard 1.2.10 *Information Requirements – Characterising Ingredients and Components of Foods* sets out the rules for calculating the characterising component. Under the Standard, the characterising component means a component of the food that is:

> **a** mentioned in the name of the food; or
> **b** usually associated with the name of the food by a consumer; or
> **c** emphasised on the label of the food in words, pictures or graphics.
>
> The characterising ingredient means an ingredient or a category of ingredients that is:
> **a** mentioned in the name of the food; or
> **b** usually associated with the name of the food by a consumer; or
> **c** emphasised on the label of the food in words, pictures or graphics.
>
> Source: FSANZ

FSANZ Standard 1.2.10

The method to calculate the proportion of the characterising components or ingredients is listed in the Standard. Percentage labelling allows consumers to make more informed choices about food items and to be aware of the actual percentage of what they may perceive as the 'main' ingredient in the food. For example, if a yoghurt is raspberry and coconut flavoured, then the percentage of raspberries and coconut would need to be declared. If a bottle is labelled 'tropical juice' and pictured on the label is pineapple, orange and apple, then the percentage of each of these ingredients would need to be listed.



Mark Fergus Photography

FIGURE 8.11 Percentage labelling must list the percent of the characterising ingredient.

Use and storage instructions (accuracy and effectiveness)

Standard 1.2.6 *Information Requirements – Directions for Use and Storage* sets out the rules regarding the use and storage required for food items. In summary, food labels must contain storage conditions and directions for use if the food:

a requires specific storage conditions to ensure the food will keep until the use by date or the best before date

b must be used or stored with specific directions for health or safety reasons

c contains raw bamboo shoots (a statement that bamboo shoots must be fully cooked before being consumed) or raw sweet cassava (a statement that sweet cassava should be peeled and fully cooked before being consumed).

Source: FSANZ

FSANZ Standard 1.2.6

Mark Fergus Photography

FIGURE 8.12 Storage requirements and country of origin labelling on Mainland Butter

Mark Fergus Photography

FIGURE 8.13 Storage requirements for Perfect Italiano ricotta cheese: keep refrigerated at or below 4°C. Consume within 5 days of opening

Ethics of third-party certifications

In 2015, the Senate referred an inquiry to the Senate Economics References Committee for inquiry regarding third-party certification of food. Several recommendations were made after the inquiry was made, in which 1492 submissions were received and three public hearings were held. The inquiry was to determine the extent of food certification schemes in Australia, including organic, kosher, halal, GM food and general food safety certification schemes. The inquiry also looked at current labelling of products, whether current schemes provide enough information for Australian consumers to make informed decisions, certification fees and the impact on consumers, certification for export markets and the extent and adequacy of information available to the public about certifiers.

The ethics behind third-party certification is debatable. Consumers should seek information about the certification and what it means. There has long been criticism of third-party certification schemes as often members of the public are led to believe that the company 'earned' the third-party certification or was 'awarded' it. With most third-party certification schemes, the company must request an assessment from the certifying body, usually at a cost. An ongoing cost is usually associated with the Trademark Label and there can be other ongoing fees that the company may have to pay to maintain the certification.

There could be some confusion about other products on the market where the company had not chosen to pay for or maintain the certification. For example, products may be as healthy as or

9780170418560

healthier than products that did display the Heart Foundation Tick, but they were not perceived as being as healthy because they did not have the Tick. Generally, products that have received certification do meet that standard set by the certifying body, but this does not mean that other products that have not applied for certification are inferior or not as good. They may even be better products!

Heart Foundation

The Heart Foundation 'Healthy Heart Tick' has appeared on food labels for over 26 years, but has recently been retired by the Heart Foundation. The Heart Foundation tick of approval was criticised over the years for various reasons, including the 2007 disapproval by many members of the public and nutritionists when nine McDonald's meals were given the Tick.

ACTIVITY 8.7

Aim

To **analyse** the use of the Heart Foundation tick of approval in relation to ethics, consumer rights and transparency

STEPS

1. Read the text extract in conjunction with further research surrounding the Heart Foundation tick of approval.
2. **Discuss** as a class the key aspects of using the tick of approval, including:
   - a How could businesses get the Tick on their products?
   - b What were the controversial aspects of the Heart Foundation Tick?
   - c Were there transparency issues with the Heart Foundation Tick?
   - d What is your opinion on the use of third-party certifications such as the Heart Foundation Tick? Should they be used? Justify your answer.

HEART TICK RUNNING OUT OF TICKER, OVERRUN BY HEALTH STAR RATINGS

After 26 years of appearing on many of Australia's food labels, the Heart Foundation's 'Healthy Heart Tick' logo is heading towards oblivion.

Introduced to Australians as an easy way of knowing if a food was a 'healthier' choice and was endorsed by the Heart Foundation, today more than 2000 products carry the tick across 80 categories.

National CEO for the Heart Foundation, Mary Barry, said however that the introduction of the Australian Federal Government's new Health Star Rating system, would mean the tick logo is no longer needed.

'Over the past few years, the Heart Foundation has worked with the Federal Government and other stakeholders to develop the Health Star Rating system (HSR), which was launched in December 2014,' Ms Barry said.

'Since the launch, the HSR system has been well received by food manufacturers (more than 1500 products now carry the HSR) and is becoming sufficiently well established, and understood by shoppers. We feel we can now safely begin to retire the Tick,' she said.

The Heart Foundation said it will now work with food manufacturers who use the Tick to help remove it from labelling, packaging and other communication materials. It is expected that all Ticks will be removed by the end of 2017.

The Tick saw the introduction of nutrition information panels on the back of package foods 13 years before the panels were mandatory in Australia. The Tick did however draw controversy over the years.

Previous criticisms of the Tick

1. In order to display the Tick food manufacturers had to pay a fee to the Heart Foundation, unlike the Federal Government's HSR which is free for all food manufacturers to use. The Tick received criticism over its licencing fee as critics pointed out that consumers could be missing out on a healthy product just because the manufacturer chose not to pay the fee.
2. The Heart Foundation attracted criticism for the 'Healthy Heart Tick' not always being related to heart health. Despite its name, the Heart Foundation advertised the Tick as merely a way of 'making overall healthier choices' and that it encouraged food manufacturers to reformulate their products to become healthier. The Heart Foundation had previously conceded that the Tick was not necessarily connected with heart health. Some critics therefore were of the view that the heart Tick logo was misleading.
3. By the end of the Tick program, there were 80 different food type categories as part of the Tick certification system. Different food categories had different criteria for assessment in an effort to encourage manufacturers of processed foods to reformulate products using healthier recipes. This meant that some processed foods had a Tick whilst some more natural and healthier wholefood producers who did not pay for the Tick, missed out being recognised for their healthier alternative products.
4. When the Tick program was first introduced there were five categories: bread, breakfast cereals, cheese, sweet biscuits, nut and seed bars. Wholegrain breakfast cereals (for example whole oats) were however excluded from the breakfast cereal category and put in a separate 'grains – plain' category which drew some criticism from commentators. The critics included Joe Lederman of the food regulatory consultancy FoodLegal in his *FoodLegal Bulletin* April 2009 edition article 'Heart Foundation criteria re-assessed' and later an article entitled 'Heart Foundation Tick raises further concerns' published in the March 2011 edition of *FoodLegal Bulletin*.
5. One of the biggest criticisms the Tick received was the endorsement it gave in 2007 to McDonald's Australia restaurants. Although salads and fruit sold by McDonald's were in meals that received the Tick endorsement, this also meant that some meal combinations that included deep fried chicken nuggets and burgers also received the Tick. At the time, the Heart Foundation said it gave McDonald's Australia the Tick in order to help Australians make better choices if they were treating themselves to fast food. However, in 2011 the Heart Foundation changed its position and ceased to provide a Tick for meal items of takeaway food outlets.

Source: Australian Food News, Thought for Food, posted 21 December 2015. Reproduced with permission.

9780170418560

FIGURE 8.14 The Heart Foundation Tick of approval was retired after 26 years of use.

Conclusions

1 **Summarise** how the Heart Foundation tick of approval certification worked.

2 **Identify** the transparency issues that were raised during the 26 years the Heart Foundation Tick was used.

3 **Discuss** the positive and negative aspects for the consumer of businesses using this certification.

Taking it further

4 **Investigate** other third-party certifications. Are there any schemes that are transparent and work across all situations? Do you think a level of education is required to understand third-party certifications? Overall, do they benefit or disadvantage the consumer? Use examples to support your argument.

Celebrity endorsements

Celebrity endorsements are not new – products and brands have used celebrity endorsements for many years to sell products and boost brand power. People idolise celebrities so when famous people are seen in advertisements promoting products, target audiences are prompted to buy the product. In terms of food products, celebrity endorsements tend to come in the form of athletes, celebrity chefs or nutritionists. Sporting culture plays a large role in Australian society so famous sporting stars are a powerful marketing tool in food promotion. Additionally, many key sporting events are sponsored by fast food companies. For example, KFC has sponsored major sporting events like cricket and NRL. However, there is much controversy surrounding marketing food to children through sport and celebrities.

Celebrity chefs such as Jamie Oliver, Heston Blumenthal, Curtis Stone and George Calombaris regularly feature on television shows. However, these personalities are also becoming increasingly well known for their endorsements of food products. Other celebrities also endorse food products: Michelle Bridges, a personal trainer from *The Biggest Loser*, has her own 'Delicious Nutritious' frozen food range from Woolworths. However, she was also criticised for her involvement in a Woolworths advertising campaign for the 'Delicious Nutritious' range that saw her role-playing a 'healthy freak' eating soil.

RSPCA Approved Farming Scheme

The RSPCA Approved Farming Scheme is an independent accreditation scheme that aims to improve the lives of farm animals. Approved brands and producers hold the RSCPA Approved logo. The RSPCA standards focus on providing good housing conditions for farm animals, either indoor, outdoor or a combination of the two. Eligible farms are assessed against the RSPCA standards, and trained RSPCA assessors visit the farms regularly.

There are some fees associated with the RSPCA Approved logo. The Standard states that, as a general rule, fees are not charged for assessment. There is a Trademark Licence Agreement fee, but the RSCPA states that the scheme is run on a not-for-profit model, with fees being used to manage and promote the scheme.

> The RSPCA Approved Farming Scheme focuses on improving the lives of farm animals and making humane eggs and meat readily available. For many, it's not only healthy eating that's important; it's knowing the food we're cooking and eating has been ethically produced. With brands using terms like 'free range' 'organic' 'pastured' and 'fair trade,' it can be hard to know which labels or certifications to believe. If animal welfare is important to you, next time you're dining out, shopping at your local supermarket or butcher for recipe ingredients, choose RSPCA Approved.
>
> Source: rspcaapproved.org.au. Reproduced with permission.

RSPCA Approved

Marine Stewardship Council

The Marine Stewardship Council is an international non-profit organisation that was established to address the problem of unsustainable fishing. The MSC works with seafood producers, fisheries and scientists to promote sustainable fishing and to safeguard supplies for the future. The blue MSC label is for food that is considered to have met the certifiable sustainable standard that is set by MSC. At time of writing, there were 359 certified products available in Australia.

Around the world, different bodies can provide MSC certification. The MSC ecolabel is a registered trademark and companies must sign a licence agreement prior to using it. This will usually involve an annual fee, depending on the ecolabel application and royalties that are payable. The MSC standards include:

- the MSC Fisheries Standard, which measures the sustainability of wild capture fisheries
- the MSC Chain of Custody Standard is to ensure that the blue MSC label is only used for seafood that is traceable to an MSC certified sustainable fishery.

Marine Stewardship Council (MSC)

Third-party bodies carry out the certification that the standard is met. This is carried out by independent, third-party assessment bodies. The MSC standards are reviewed periodically to ensure that they remain current and fit for purpose.

FIGURE 8.15 Blue MSC certified sustainable standard logo

REVIEW QUESTIONS ▶

1 **Summarise** the difference between a health claim and a nutrient claim.
2 **Explain** how the legislation aims to protect consumers in relation to health claims. Do you think the legislation is required?
3 **Describe** the Health Star Rating system.
4 **Explain** how the Health Star Rating system aims to help consumers. Do you think it provides transparency?
5 **Discuss** making the Health Star Rating system mandatory. **Propose** food items for which it could be mandatory.
6 **Identify** the two definitions of a novel food. Who regulates the use and sale of novel foods?
7 Consumption of insects could increase in future years. **Identify** the transparency that the industry would need if insects were to start to be included as ingredients in processed food items.
8 Food additives can only be used if they are listed on Schedule 15 of the Food Standards Code. **Discuss** how this protects consumers.
9 Identify at least six food additives that can be used in food items and the main function of each.
10 a **Defin** 'percentage labelling'. **Identify** the Standard that covers this.
b **Explain** how percentage labelling gives consumers more information and increases transparency.
11 **Consider** why ingredients must be listed according to their weight. How does this add to transparency in the food industry, and who benefits from this rule?
12 **Explain** why it is mandated that allergens are declared on food labels.
13 **Identify** products with labels that require storage instructions. **Explain** why storage requirements must be displayed on labels.
14 **Summarise** certifications and third-party endorsements in the table below.

SCHEME	SUMMARY OF HOW IT WORKS	CRITICISMS/ETHICAL CONCERNS
Health Star Rating system		
Heart Foundation Tick		
Celebrity endorsements		
RSPCA Approved		
Marine Stewardship		

How does legislation protect consumers?

Create a mind map of information to help answer the guiding question. Use the supplied template or develop your own mind map. You may find it useful to use online tools such as Bubbl.us, Canva, Coggle, MindMup, iMindQ.

WS Mind mapping template

Mind mapping tools

9 FOOD FORMULATION FOR CONSUMER MARKETS

» Can changes in food formulations fulfil consumer demands?

In this chapter, consumer food drivers and food formulations are discussed so students can apply the problem-solving process, including creating a brief, in order to answer the guiding question.

Food formulation

Food products are combinations of raw materials in specific proportions following a specific method. Raw materials can be classified as either basic product raw materials or aesthetic raw materials, such as colours or flavours that are added to improve the aesthetic nature of the product. The properties and quality of the raw materials determine the quality and properties of the final product.

Food formulation is very similar to following a recipe, with specific ratios of ingredients and a specific method. However, a recipe is used domestically and amounts are generally recorded in terms of cups, tablespoons or millilitres, while a food formula is used by food manufacturers, and is usually expressed in terms of weight for preciseness and accuracy. With all measurements made in terms of weight, percentages of ingredients can be calculated. Ingredients such as eggs are also measured in terms of weight – as there can be much variation to the weight in one egg. Small variations in commercially produced food products can result in large variations in consistency, nutritional analysis and the cost of the final product; therefore they need to be tightly controlled, unlike cooking in the home.

Large food companies may manufacture in different locations, so preciseness in food formulation is imperative to ensure a consistent product, regardless of where it is produced.

Food formulations will include the following:

- limits on the raw materials
- limits on the processing variables
- specifying method to be used, including variables
- costing.

Shutterstock.com/Roman Samokhin

FIGURE 9.1 Each of these protein bars have been made with a different food formulation

9780170418560

ACTIVITY 9.1

Aim

To **demonstrate** how food formulation works in a commercial setting by converting a traditional recipe to a food formulation

STEP 1

a Find a recipe that is expressed in terms of cups, tablespoons or millilitres **or** use the banana bread recipe provided.

b Measure out each ingredient using a digital scale to find its exact weight. Record it in a table like the one below.

INGREDIENTS	CONVERTED WEIGHT
125 g butter	
1 cup brown sugar	
1 teaspoon vanilla extract	
2 eggs	
2 cups mashed banana	
1¾ cups plain flour	
1 teaspoon baking powder	
1 teaspoon bicarbonate of soda	
1 teaspoon ground cinnamon	
⅓ cup golden syrup	

WS Activity 9.1 template 1

STEP 2

a Copy the ingredients and converted weight from step 1. Calculate the percentage of each ingredient.

b Calculate the total weight of all ingredients combined.

INGREDIENT	WEIGHT	PERCENTAGE
butter		
brown sugar		
vanilla extract		
eggs		
mashed banana		
plain flour		
baking powder		
bicarbonate of soda		
ground cinnamon		
golden syrup		
TOTAL		

WS Activity 9.1 template 2

STEP 3

Prepare the banana bread. A basic method has been provided that can be used or adapted. For example, if the time to bake is too long the banana bread could be divided up into smaller portions (e.g. small loaf tins, muffin tins) and the cooking time decreased.

1 Preheat oven to 160°C.
2 Prepare a loaf tin with baking paper, 26 cm × 11 cm.
3 Place the butter, sugar and vanilla extract in a bowl and beat with an electric mixer for 8–10 minutes or until pale and creamy. Scrape down the sides of the bowl.
4 Gradually add the eggs and beat well to combine.
5 Add the banana, flour, baking powder, bicarbonate of soda, cinnamon and golden syrup. Stir to combine.
6 Spoon the mixture into the prepared tin.
7 Bake for 60–65 minutes or until cooked when tested with a skewer.
8 Allow to cool in the tin before turning out onto a wire rack to cool completely.


Shutterstock.com/A_Lein

FIGURE 9.2 Banana bread from a food formulation

Conclusions

1 A food formulation should be written precisely so that it can be replicated time and time again, by various people if required. Rewrite the instructions in a more precise way so it is clear for someone else producing the same food formulation.

Taking it further

2 Test how precise your food formulation is by having others prepare the product without assistance. How close to the sample product can they get? Are more instructions required to ensure every formulation is undertaken in exactly the same way?

How consumer food drivers influence food production

Food drivers were discussed in detail in chapter 6. These included:

- convenience
- budget
- perceived quality
- ethics and culture.

These consumer food drivers, among others, influence the following consumers:

- ethical food consumers
- time-poor consumers
- gourmet food consumers
- solo food consumers
- cultural food consumers.

ACTIVITY 9.2

Aim

To **investigate** drivers and food products available for the following consumer markets:

- ethical food consumers
- time-poor consumers
- gourmet food consumers
- solo food consumers
- cultural food consumers

STEPS

Using the supplied template, investigate how consumer food drivers have influenced food production for each consumer market.

CONSUMER MARKET	SAMPLE PRODUCTS (LIST AT LEAST FIVE PRODUCTS)	DESCRIBE WHICH DRIVERS HAVE INFLUENCED THIS DEVELOPMENT
Ethical food consumers		
Time-poor consumers		
Gourmet consumers		
Solo food consumers		
Cultural food consumers		

WS Activity 9.2 template

Conclusions

1 **Describe** how food drivers influence the production of food.

2 **Analyse** the range of food products that currently exist for the consumer markets identified. Where are there gaps in the market?

3 If a food company was to ask you which consumer market they should enter, which one would you recommend? **Justify** why this would be a good consumer market to target.

Problem-based learning

In this unit, the teacher will supply the problem stimulus, and the problem-solving process will be followed to:

- explore the problem
- develop ideas
- generate a solution
- evaluate and refine the solution.

Evidence of each of these will need to be provided in the folio. For assistance, refer back to the introduction to problem-based learning in chapter 1, the example in chapter 5 and the sample worksheets. A sample checklist worksheet has been supplied to indicate what should be included in the folio.

The brief

In Unit 1, a brief was supplied by the teacher. In Unit 2, students develop a brief and determine the specifications for the solution.

WS Folio checklist

Food problem examples

There are many food-related problems that are influenced by different consumer food drivers. Sometimes food products that are developed can target multiple consumer drivers and groups. Here are some examples of food problems:

- Time-poor consumers are common due to the demands of work, family and community commitments. As a result, convenience food products are increasing in popularity, with discerning consumers and more educated families demanding variety and better quality. Is reformulation of traditional foods such as canned soups or bottled pasta sauce possible to produce safe, healthier, fresh alternatives that are economically viable?

Getty Images/Liam Norris

FIGURE 9.3 The increase in time-poor consumers has led to a rise in the demand for convenience food products.

9780170418560

- Solo food consumers seek a varied diet, although this can often lead to food waste. Innovative methods of dividing and/or preserving food items are needed for solo food consumers to have a varied diet without food waste due to spoilage. Are there products that can be reformulated to suit solo food consumers or innovatively packaged to produce a variety of meals from the same base?

Alamy Stock photo/MARC ROMANELLI

FIGURE 9.4 More people are now living alone, which can lead to food waste if food items are not sold in appropriate packaging and portion sizes.

- Ethics and animal welfare are a growing concern for many consumers, with greater demand for organic produce and cruelty-free produce. Can existing products be reformulated for a more ethical production?

Shutterstock.com/wavebreakmedia

FIGURE 9.5 The increase in free-range and organic chicken farming is a result of ethical and animal welfare concerns from consumers.

WS Unit 2 review

UNIT 3 FOOD SCIENCE OF CARBOHYDRATE AND FAT

In Unit 3, students study the fundamentals of food science through practical investigation of the nutritional, scientific and sensory properties of carbohydrate- and fat-based food products. Students use the Food & Nutrition problem-solving process to build knowledge and skills that they can use to develop and test ideas, using a range of experimental techniques to create solutions. Students will solve problems for consumer markets by defining and analysing the problem, developing ideas and generating and evaluating a solution.

In Topic 1, students study the food system and food nutrients. In Topic 2, they investigate how the carbohydrate's chemical and functional properties respond to temperature and manipulation to create food products. Students also study food safety, preservation and spoilage-prevention techniques for carbohydrate foods. In Topic 3, students investigate how the chemical and functional properties of fats respond to temperature and manipulation to create food products. Students study food safety, preservation and spoilage-prevention techniques for fat-based food products and experiment with formulation processes. In Topic 4, students develop food solutions using the chemical and physical properties of carbohydrate and fat.

STUDENTS WILL

1 recognise and describe facts and principles about nutritional, chemical, functional and sensory properties of carbohydrate and fat-based food
2 explain food science ideas and problems related to carbohydrate and fat-based food
3 analyse problems, information and data related to carbohydrate and fat-based food
4 determine solution requirements and criteria for carbohydrate and fat-based food problems
5 synthesise information and data to develop ideas for carbohydrate and fat solutions
6 generate carbohydrate and fat-based food solutions to provide data to determine the feasibility of the solution
7 evaluate and refine ideas and solutions to make justified recommendations for enhancement to carbohydrate and fat-based food solutions
8 make decisions about and use mode-appropriate features, language and conventions for particular purposes and contexts.

Food & Nutrition 2019 v1.1 General Senior Syllabus, p. 32.

Shutterstock.com/Y Photo Studio, Jiri Hera, Rutina, Rstudi, ifong

CARBOHYDRATE 10

» How can the chemical and functional properties of carbohydrate, knowledge of food safety and spoilage, and preservation techniques be used to develop food solutions?

In this chapter the chemical and functional properties of carbohydrates will be explored through experimentation. A knowledge and understanding of food spoilage and food safety, as well as preservation techniques, will assist students to develop food solutions.

Facts and principles about carbohydrate

Carbohydrate results from photosynthesis, which occurs when plants convert energy from the sun into simple sugars. Carbohydrate is an essential nutrient in a healthy diet and is found in a large number of plant-based foods. It yields energy which is a fuel source for the body and is broken down in the digestive system to be absorbed by the body. The energy value of carbohydrate is 16.7 kilojoules (kJ) per gram, although not all carbohydrates provide the same amount of energy. The food sources where carbohydrate is in abundance are cereal products such as wheat, rice, oats and barley, starchy vegetables such as potato and sugars, or foods with these food items as ingredients.

All carbohydrate-based foods have a relative ranking according to the effect they have on blood glucose levels in the body. Carbohydrate-based foods have been compared with glucose or white bread as a reference and given a score between 1 and 100. Foods that are digested, absorbed and metabolised more slowly have a value less than 55 and are said to have a low glycaemic index or low GI because they cause a slower and lower increase in blood glucose, resulting in less insulin being required to stabilise blood sugars in the body. Foods that have a low glycaemic index keep the body feeling full for longer. Foods that are digested, absorbed and metabolised quickly cause the blood sugar levels to rise quickly. It is recommended that people eat foods with a low GI to decrease the chance of chronic health conditions such as heart disease, some cancers and diabetes occurring later in life. People diagnosed with diabetes should include foods with a low GI in their diets and avoid food with a high GI.

Table 10.1 The glycaemic index (GI) of foods

FOODS WITH LOW GI < 55	FOODS WITH MODERATE GI 56–69	FOODS WITH HIGH GI > 69
• whole wheat products • oats • pasta • legumes, peas and lima or butter beans, most fruits • non-starchy vegetables • carrots	• white and sweet potatoes • corn • converted rice • couscous • some breakfast cereals	• white bread • glucose • rice crackers and cakes • bagels • cakes • doughnuts • croissants • most breakfast cereals

Functions of carbohydrate

Carbohydrate is responsible for many functions in the body.

Provides heat and energy

Carbohydrate is the main source of energy for the body. A number of carbohydrates are digested and broken down in the body to its simplest form, the monosaccharide glucose, which is easily absorbed by the cells. Glucose is used to fuel every cell in the body, especially for physical activity, and the functioning of the central nervous system, which requires glucose for metabolism and for the body's organs.

Regulates body processes

Carbohydrate assists in regulating blood glucose levels in the body. When we eat, the pancreas secretes the hormone insulin to bind with cells in the body to cause the uptake of glucose in the cells. Carbohydrate assists in digestive health by helping to move food through the intestines and colon, removing waste products, preventing diarrhoea and constipation. Carbohydrate also ferments in the large intestine and promotes the growth of beneficial bacteria which helps the breakdown of food to be used by the body. These bacteria in the gut are known as prebiotics.

Regulates the use of protein and fat

Carbohydrate, fat and protein are all used for energy at different times, depending on the activity the body is undertaking, the level of intensity and diet. In order to maintain health, it is important for the body to use an appropriate balance of these three macronutrients for energy and it is carbohydrate, as the most efficient producer of the body's main source of energy, glucose, that regulates when protein and fat are used. If there is sufficient glucose in the diet from consumption of carbohydrate, glucose can be stored in the liver as glycogen to provide a few hours of additional energy. The liver can only store a finite amount of glycogen so any extra glucose is broken down to be stored as fat, which is the body's long-term energy source. The availability of energy from carbohydrate and fat means protein can be conserved for its other important functions such as muscle repair.

Prevents ketoacidosis

ketones the product of the incomplete breakdown of fat when glucose is not available in the cells

Ketoacidosis is a complication of type 1 diabetes where the body has dangerously high levels of **ketones** and blood sugar. This makes the blood acidic and can change the functioning of internal organs such as the liver and kidneys. It is life-threatening and can also occur in type 2 diabetes where the patient does not produce enough insulin.

Classifications of carbohydrate and food sources

Carbohydrate contains carbon, hydrogen and oxygen. The general formula is $C_m(H_2O)_n$ with the ratio of hydrogen to oxygen 2 : 1. Saccharides are the basic building blocks of carbohydrates. There are four classifications of saccharides: monosaccharide, disaccharide, oligosaccharide and polysaccharide.

Monosaccharides

These are the simplest form of sugar. They are mostly colourless, soluble in water and usually crystalline solids. The body can produce monosaccharides from other carbohydrates, so they do not need to be ingested as food. Monosaccharides are absorbed in the small intestine as they are simple sugars. Because they are simple sugars, glucose and galactose are absorbed by the body easily, giving energy to the cells. Fructose takes a little longer to be absorbed. Glucose and galactose raise the blood sugar quickly as they have a high glycaemic index.

Table 10.2 Monosaccharides and food sources

MONOSACCHARIDE	FOOD SOURCES
Glucose	honey, sweets, syrups, foods with added glucose such as soft drinks, chocolate, desserts
Fructose	fruit, fruit juices, sweet wines and honey
Galactose	milk, seaweed

9780170418560

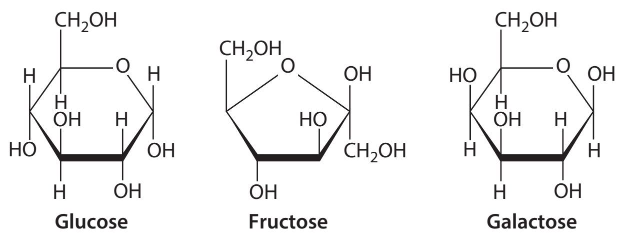


FIGURE 10.1 Examples of monosaccharide

Disaccharides

These are formed when two monosaccharides or simple sugars join together and a molecule of water is lost. For example, milk sugar (lactose) is formed from glucose and galactose. Cane sugar or sucrose is a combination of the monosaccharides glucose and fructose. Maltose is the result of the breakdown of polysaccharides.

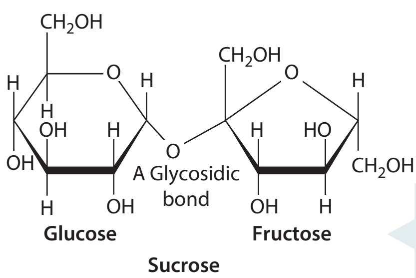


FIGURE 10.2 Example of disaccharide

Table 10.3 Disaccharides and food sources

DISACCHARIDE	FOOD SOURCES
Sucrose	cane sugar, sugar beets
Lactose	milk sugar – consisting of galactose and lactose
Maltose	some cereals and sweets, hydrolysis product of starch breakdown consisting of glucose

Oligosaccharides

Oligosaccharides are molecular chains which typically contain between 3 and 10 simple sugars or monosaccharides. With the exception of maltotriose, these are not digested in the small intestine and are broken down in the large intestine to provide some energy. Most act like soluble fibre and help prevent constipation. Eating large amounts may cause bloating and flatulence. These are often added to food during processing, as a sweetener or to increase soluble fibre.

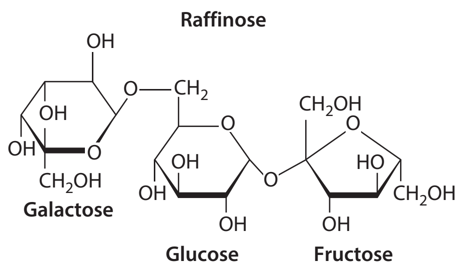


FIGURE 10.3 Example of oligosaccharide

Table 10.4 Oligosaccharides and food sources

OLIGOSACCHARIDE	FOOD SOURCES
Fructooligosaccharides (FOS) or oligofructose	artichokes, red onions, shallots, bananas, acidophilus yoghurt, nutrition bars and diet soft drinks
Maltotriose	from starch during digestion, found in liquid glucose and brown rice syrup – a trisaccharide made of glucose
Raffinose	a trisaccharide found in plants – three monosaccharides, galactose, glucose and fructose
Human milk oligosaccharides (HMO)	human milk

Polysaccharides

These are long chains of 10 or more monosaccharides linked together in repeating units. They are energy stores in plants and animals. There are three main forms of polysaccharide – starch, glycogen and cellulose.

Starch is divided into two distinct groups – digestible and non-digestible. The digestible polysaccharides are broken down in the body to the monosaccharide glucose. Glucose provides energy to the body and is easily absorbed.

Glycogen is the energy store for animals. It is stored in the liver, muscles and adipose (fatty) tissue as an energy reserve and converted to energy when required. The non-digestible polysaccharides provide dietary fibre in the form of cellulose and inulin.

Cellulose forms the cell walls of plants and assists the food to travel through the intestine and maintains regular bowel movements. Inulin, while not digested, is thought to promote the growth of beneficial bacteria in the intestine. Pectin, agar-agar, alginates and carrageenan are also polysaccharides made up of the monosaccharide galactose.

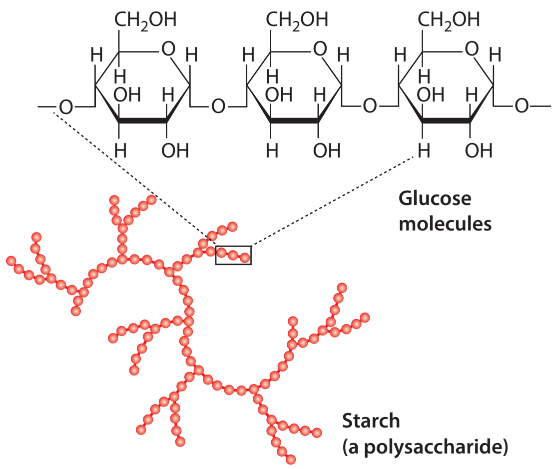


FIGURE 10.4 Example of polysaccharides

Table 10.5 Polysaccharides and food sources

POLYSACCHARIDE	FOOD SOURCES
Starch	potatoes, cereal grains (wheat, rice, rye, barley and corn, and associated products – bread, baked goods), tapioca, legumes
Cellulose	vegetables such as broccoli, cabbage, kale, cauliflower, sprouts, squash, potatoes and carrots
Glycogen	shellfish, potatoes and other starchy vegetables, fresh fruits, whole grain foods and liver

Nutrient Reference Value (NRV) of carbohydrate in the diet

The National Health and Medical Research Council has no set NRV (nutrient reference value) or RDI (recommended dietary intake) for carbohydrate as there is limited data on which to base requirements. This does not reflect a lack of importance in the diet, but it is the type of carbohydrate that is consumed that is important. Complex carbohydrate such as dietary fibre is required as it is linked to lowering the incidence of diabetes, cancer and high cholesterol. Energy or carbohydrate intake is dependent on a number of factors such as the amount of physical activity carried out, age, gender,

9780170418560

height and weight. It is recommended that carbohydrate contributes to 45–65 per cent of our daily energy intake. Carbohydrates yield 16.7 kilojoules of energy per gram.

An AI (adequate intake) of 60–95 g/day is recommended for infants under 12 months, based on the carbohydrate (lactose) content of breast milk.

Health impacts of over- and under-consumption of carbohydrate

Over-consumption of carbohydrate

Over-consumption of carbohydrates leads to a total increase in kilojoules. While weight gain is the initial impact of not balancing the intake of kilojoules to energy expenditure, excess intake of carbohydrate-based food can lead to chronic diseases such as obesity, diabetes, heart disease and high blood pressure.

Under-consumption of carbohydrate

Under-consumption of carbohydrates can lead to a variety of health issues such as fatigue, nausea and constipation. If the carbohydrate in the diet is too low, it leads to ketosis, which is an upset of the acid balance in the body. Some diet plans suggest that the body be forced into ketosis to induce weight loss; however, there is little evidence that this has a long-term weight loss benefit as much of the weight loss will be in the form of water, glycogen from liver tissue and possibly muscle tissue.

explain
make an idea or situation plain or clear by describing it in more detail or revealing relevant facts; give an account; provide additional information

identify
distinguish; locate, recognise and name; establish or indicate who or what someone or something is; provide an answer from a number of possibilities; recognise and state a distinguishing factor or feature

describe
give an account (written or spoken) of a situation, event, pattern or process, or of the characteristics or features of something

REVIEW QUESTIONS ▶

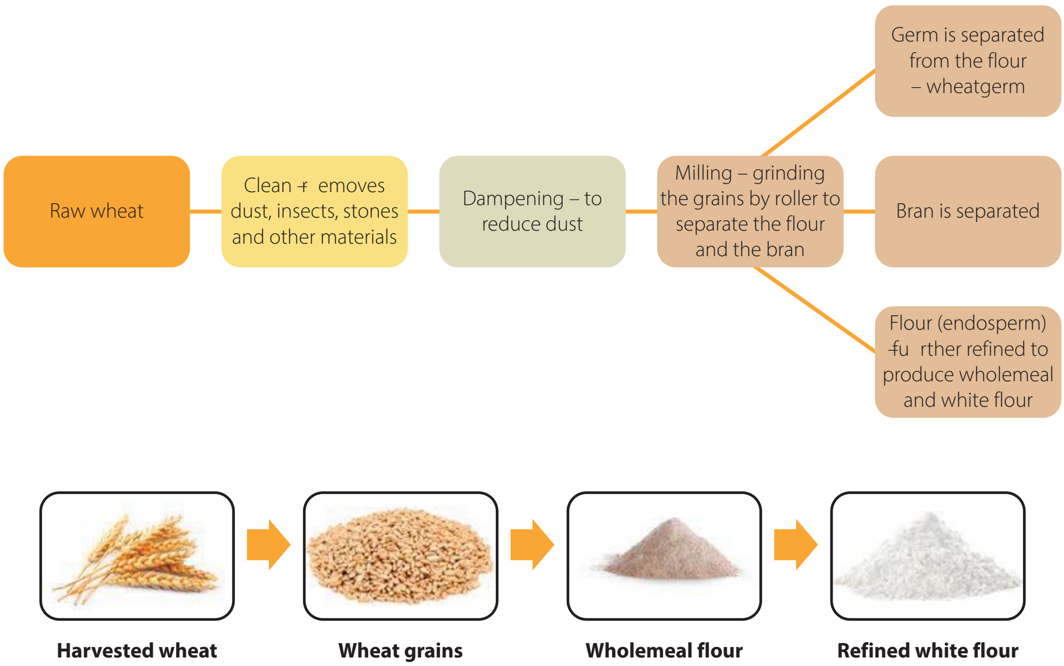
1 Explain the chemical structure of carbohydrate.
2 **Explain** the functions of carbohydrate in the diet.
3 Identify the classifications of carbohydrate and the food sources for each classification.
4 **Explain** the NRV of carbohydrate in the diet.
5 Describe the impact of over- and under-consumption of carbohydrate on health.

Production

Carbohydrate-based foods are mostly of plant origin and follow the process of plant food production: preparing soil for planting, selecting seeds, sowing and planting, fertilising and irrigating, and harvesting. Good sources of carbohydrate include whole grains, vegetables, legumes and fruits, a variety of which are grown in Australia. Australian farms produce over 90 per cent of our own food with over 48 per cent being from plant sources. Our climate favours the growing of crops and Australia not only feeds the local population but, as the population is small and a large amount of grain is produced, the country exports 28 per cent of grain products. Crops grown across Australia include wheat and sugar in large amounts and lesser amounts of other grains such as oats, lupins and barley. Australian farming is a scientific and increasingly technological process. Farmers use science to maximise the crop yield by planting suitable crops for soil and climate. Crops are managed by agronomists who give advice on soil quality and crop management. The majority of farms producing grain are family owned, but companies are increasingly buying up the family farms because they have economic backing, scale, structure and processes to make the farms more competitive in the world market. Crops are harvested when grown, usually by large harvesters. Many farms in Australia store their own grain on the farm in large silos prior to processing and distribution.

Processing

As discussed in chapter 3 (page 39), most fruits and vegetables can be eaten raw or after processing. However, grains must be processed before consumption.



Shutterstock.com/Volosina; Shutterstock.com/andregric; Shutterstock.com/Mona Makela; Shutterstock.com/Africa Studio

FIGURE 10.5 Processing wheat to flour

Processing grains

The grains are milled to remove the husk (primary processing) and processed into products (secondary processing) that are able to be incorporated into other foods. The processed grains are processed into three varieties – wholegrain, wholemeal and highly refined. The highly refined, or white, grain has had most of the bran and germ removed. Some grains are also bleached, and B group vitamins are added to improve their nutritional value. Grains can be processed without being refined. Wheat is processed into wholegrain flour. If wheat is refined, it can be made into white flour, wheat germ and bran. Other methods of processing grains are outlined in the table below.

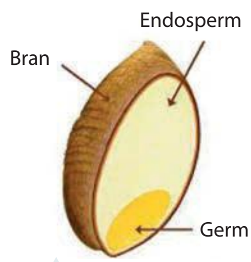


FIGURE 10.6 Whole grain of wheat

Table 10.6 Methods of processing grains

PROCESSING METHOD	PROCESS	BENEFITS AND USES
Cracked	The raw wheat grain is broken into smaller pieces	Reduces cooking time and keeps the nutrient-rich bran and germ. Example: bulgur wheat
Steel cut	The whole grain is cut into thick pieces with steel blades	Can be cut coarse to fine. Enables the grain to cook faster. Has a chewy texture when cooked. Example: steel cut oats

(Continued)

9780170418560

Table 10.6 Methods of processing grains (*Continued*)

PROCESSING METHOD	PROCESS	BENEFITS AND USES
Rolled	The grain is steamed and rolled flat between rollers and dried or toasted	Retains the whole grain. The enzyme that causes the grains to go rancid is inactivated, giving the product a longer shelf life. Cooks faster than steel cut. Example: rolled oats – used in cookies, muffins and other baked products
Puffed	High pressure and steam are used to puff the grain up – like making popcorn	Grain is boiled or steamed then dried to facilitate the puff. Lots of grains can be puffed – wheat, corn, barley, millet, amaranth and pseudo-grain quinoa
Pearled or polished	The grain is polished by removing the outer layer – the bran. Grains are rolled in a drum, which causes the outer coating to rub off. Consumers like perfect product and this gives the product better consumer acceptance. When the bran and germ are removed, the grain is refined	These grains can be stored for longer as the bran can cause the grain to go rancid and reduce the shelf life. The grains cook faster and give better results in food products. Examples: polished rice, barley, amaranth, buckwheat
Ground	The grain is ground between rollers to form a meal about the texture of sand. Many grains are ground into a meal including wheat, corn and oats	Can be used in bread formulations or cooked to create a porridge-like cereal. Examples: wholemeal, oatmeal and cornmeal

Processing sugar

Sugar cane is grown in many areas of Australia, including Wide Bay, and the northern parts of Queensland. The processing of sugar cane requires the stalks to be heated and pressed to extract the juice. The juice is refined to make a variety of sugar products, such as white, castor and icing sugar, syrup and molasses which are used in secondary processing.

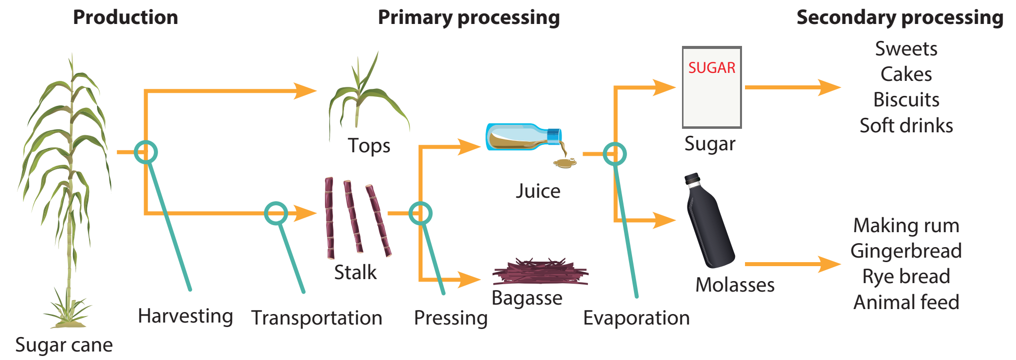


FIGURE 10.7 Sugar processing from production to primary and secondary processing

REVIEW QUESTIONS ▶

1 **Explain** how carbohydrate-based foods are produced.
2 **Identify** the carbohydrate-based foods that can be consumed raw.
3 **Identify** carbohydrate-based foods that must be processed for consumption.

ACTIVITY 10.1

Aim

To **explain** the distribution pathways required to process foods in ways that extend shelf life, and the reasons for and benefits of food processing to consumers

STEPS

1 Turn to chapter 3 page 42 and read the sections on distribution pathways and the reasons and benefits of food processing to consumers.

2 **Summarise** the key points and use your summary and your knowledge from this chapter to answer the questions that follow.

summarise give a brief statement of a general theme or major point/s; present ideas and information in fewer words and in sequence

Conclusions

1 **Explain** the distribution pathways required to process foods in ways that extend shelf life.

2 **Explain** the reasons for processing food.

3 **Explain** how consumers benefit from the convenience of processing food. Give an example using a carbohydrate-based food.

4 **Explain** how the cost of food is reduced by food processing. Give an example using a carbohydrate-based food.

5 **Explain** how food processing ensures access to nutrients in food. Give an example using a carbohydrate-based food.

6 **Explain** why seasonality is minimised by food processing. Give an example using a carbohydrate-based food.

7 **Explain** how pathogen growth cycles are reduced by food processing. Give an example using a carbohydrate-based food.

Food science experiments

These experiments will assist you to determine how food components interact with temperature or other components to produce chemical and functional properties and develop food products. An understanding of how and why carbohydrate-based foods react to heat, cool, acids, alkalis and other food preparation techniques will assist in the development of food solutions.

EXPERIMENT 10.1

Gelatinisation

experiment try out or test new ideas or methods, especially in order to discover or prove something; undertake or perform a scientific procedure to test a hypothesis, make a discovery or demonstrate a known fact

AIM

To **experiment** with different types of starch to identify how they react in the gelatinisation process

BACKGROUND

Gelatinisation occurs when liquids containing starch are heated. The starch granules swell and absorb the liquid as they are heated and then thicken to form a gel. The starch itself is not soluble in water and has to be blended with the water. Unless the mixture is heated, the starch will settle to the bottom of the

9780170418560

mixture. The intermolecular bonds are broken down in the presence of water and heat, and amylopectin is released. This allows the hydrogen bonds to engage more water. Once gelatinised the process cannot be reversed. Different types of starch affect the gel properties.

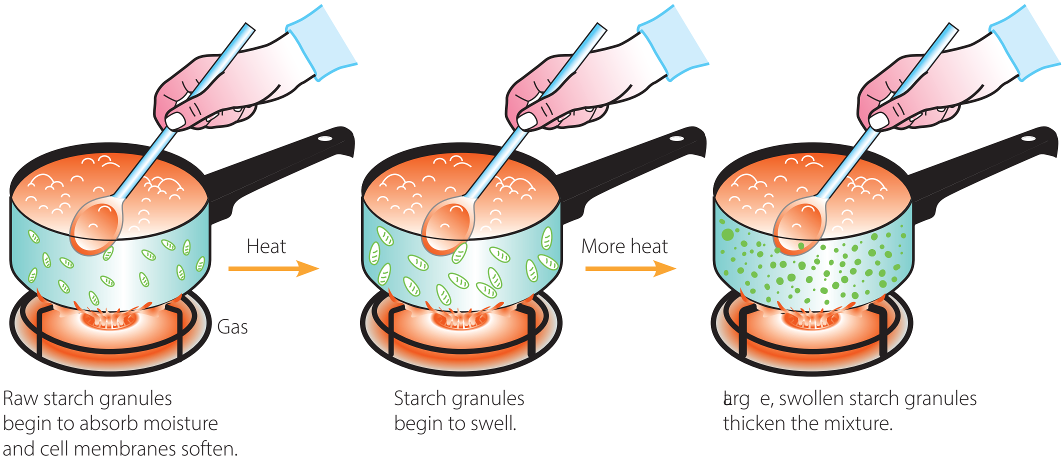


FIGURE 10.8 Process of gelatinisation

Table 10.7 Types of starch and resultant gel

TYPE OF STARCH	RESULTANT GEL	USES IN FOOD FORMULATIONS
Wheat flour	smooth, opaque and slightly elastic	roux sauce
Cornflour	smooth, transparent and strong gel. After gelling any agitation will interfere with the gel – the sauce will thin (syneresis) as the water seeps out of the gel	puddings, pie fillings, sauces, gum candies
Tapioca	clear, high-gloss gel that quickly thickens	fruit pies, soups, puddings, sauces, and soy and meat products
Potato	• clear, viscous paste with an almost bland flavour • thickening power is weakened by boiling	noodles, potato chips, hot dog sausages, cereals, instant soup, cake mixes and gluten-free food formulations
Rice	soft and edible	rice pudding, sticky rice, savoury rice, sushi rice

Each of the following items affect the resultant gel of starch products. They can be used alone in a starch gel or combined to improve the sensory properties of each formulation.

SUGAR

Sugar competes with the starch for the water in the mixture. This slows down the gelatinisation process and increases the temperature required for gelatinisation.

TEMPERATURE

The starch granules will begin to absorb the liquid and swell at 60°C. By 80°C each granule will have absorbed five times their volume of water. They burst open and release the starch to thicken the liquid. The liquid must be boiled at 100°C to complete the cooking of the starch.

TENDERISERS

Tenderisers can be sweeteners and fats. As sugar has been covered the focus here is on fat.

ACIDS

Acids inhibit the ability of starch to gelatinise; therefore, the acid should be added after the gelatinisation process has occurred.

Shutterstock.com/Africa Studio

FIGURE 10.9 Heat applied to a formulation of a starch, such as flour, and water forms a gel

INSTRUCTIONS

PREPARATION

Prepare one (1) formulation of each starch gel following the instructions for the control procedure. Prepare one (1) formulation of each of the other variables using each starch gel for analysis.

CONTROL	VARIABLE 1 – SUGAR	VARIABLE 3 – TEMPERATURE	VARIABLE 5 – TENDERISER	VARIABLE 7 – TYPE OF ACID
Produce one batch of each starch gel following the procedure	Add a teaspoon of sugar to the procedure in step 2	Mix the starch into hot water and follow procedure	Melt 1 teaspoon of butter or margarine in the pan and add the starch. Stir then proceed to step 3	Add a teaspoon of lemon juice before step 4
	VARIABLE 2	**VARIABLE 4**	**VARIABLE 6**	**VARIABLE 8**
	Add 1 tablespoon of sugar to the procedure in step 2	Heat the starch to 40°C	Melt 1 tablespoon of butter or margarine in the pan and add the starch. Stir then proceed to step 3	Add a teaspoon of lemon juice after step 5

FOOD COMPONENTS

- 1 × 20 mL spoon of plain flour, cornflour, potato starch and tapioca
- ¾ cup (185 mL) of cold water
- 1 tablespoon (20 g) sugar
- 1 tsp (5 mL) lemon juice
- 1 tablespoon (20 g) butter

9780170418560

EQUIPMENT

- measuring jug
- small saucepan for each starch
- wooden spoon
- thermometer

PROCEDURE

1. Measure the starch and place into the saucepan.
2. Add a small amount of the cold water to the mixture to blend and remove lumps. Observe the result.
3. Add the remaining water to the saucepan and stir.
4. Place on medium heat and stir continuously until the mixture thickens. Observe the result.
5. Boil for one minute. Observe the result.
6. Remove from heat and place in a small glass dish and allow to cool before testing gel.
7. Record observations in the tables below.

Experiment 10.1 template 1

RESULTS ANALYSIS

Observations should be recorded in a table like the one below (or use the template on NelsonNet) for the control and each of the variables.

TYPE OF STARCH	GELATINISATION PROCESS	APPEARANCE	TASTE	TEXTURE	FLAVOUR	AROMA	POSSIBLE USE IN FOOD FORMULATIONS
Wheat flour							
Cornflour							
Potato starch							
Tapioca							

1. **Analyse** the results of each experiment by comparing the control formulation to each variable. Draw conclusions to determine which products would be suitable for different formulations, comparing each of the characteristics of the gels.

analyse dissect to ascertain and examine constituent parts and/or their relationships; break down or examine in order to identify the essential elements, features, components or structure; determine the logic and reasonableness of information; examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences

Experiment 10.1 template 2

TYPE OF STARCH	SUITABLE FORMULATION	SWEET OR SAVOURY
Wheat flour		
Cornflour		
Potato starch		
Tapioca		

2. **Justify** the choices, referring to the table of observations and the effects of each variable on the gel.

justify give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable

EXPERIMENT 10.2

Crystallisation and nucleation

understand perceive what is meant by something; grasp; be familiar with (e.g. an idea); construct meaning from messages, including oral, written and graphic communication

AIM

To **understand** the process of crystallisation and nucleation

BACKGROUND

Crystallisation is a processing technique used to separate a solid dissolved in a solution from the liquid. Crystallisation occurs when a solution becomes supersaturated or very concentrated and is unable to hold any more of the solute. A supersaturated solution is made by dissolving sugar in water and boiling the solution. As the solution cools, it becomes supersaturated and crystals form in the solution. This is seen mainly when using sucrose in food formulations.

When a sugar solution is supersaturated nucleation occurs. Nucleation is the formation of a crystal from a solution, a liquid or a vapour. Sugar crystals form because the sugar molecules stick together. Allowed to sit, the crystals will continue to form on each other and produce a large crystal structure. When agitated the crystals will be broken up into smaller crystals. When ingredients such as acids or fats are added to a sugar solution it affects the nucleation and crystallisation. This processing technique is used to make confectionery such as fudge, toffee and caramel. Several factors affect the size of the crystals formed during the cooling process.

Table 10.8 Factors affecting the size of crystals

FACTOR	EFFECT	USE IN FOOD FORMULATIONS
Saturation of solution	The more supersaturated the solution, the more crystals will form. This also increases the rate of crystal formation	rock candy – where a few large crystals form
Temperature	Heating the temperature to hard crack (see table that follows) will supersaturate the solution to 99%. Soft ball stage is required for formulations of fudge. Cooling the solution before beating will supersaturate the solution	toffee, fudge, nougat, praline, marshmallow
Agitation	Stirring breaks up the crystals, forming a lot of tiny crystals	fudge, praline where the result is smooth and creamy but firm
Additives	Adding acid, alkalis, gelatin and fats to sugar syrups will alter the crystal formation	• acids such as vinegar and cream of tartar are added to toffee to prevent crystals forming. Invert sugar is formed from sucrose • alkalis such as bicarbonate of soda will react to aerate a sugar solution • gelatin is added to sugar syrup to stabilise marshmallows and enable air to be incorporated • fats – butter or milk fat are added to decrease the formation of crystals, making the sweet smooth and creamy

STAGES OF SUGAR SYRUP SATURATION

A small amount of the syrup is dropped into a glass of cool water to see which stage the syrup has reached. A confectionery thermometer can be used to test the temperature.

9780170418560

Terry McCarten

FIGURE 10.10 A confectionery thermometer in use

▶ To use a confectionery thermometer, place it in a saucepan of water and turn on heat to bring to the boil. When boiling check the temperature – if it sits on 100°C it is accurate and can be used without calibration. When the syrup begins to boil place the thermometer in the saucepan. Once the desired temperature is reached, place the thermometer back into the saucepan of boiling water. This allows it to cool down slowly and cleans the syrup from the thermometer.

Table 10.9 Stages of sugar saturation

STAGE	TEMPERATURE	% SUGAR SATURATION	DESCRIPTION AND USES
Thread	106–112°C	80	Forms a loose, thin thread. Used for sugar syrup
Soft ball	112–115°C	85	Forms a ball that can be flattened and is soft and sticky. Used for caramel fudge and fondants  Shutterstock.com/Anna_Pustynnikova **FIGURE 10.11** Fudge
Firm ball	116–120°C	87	Forms firm but pliable and sticky ball. Used for nougat, marshmallow, toffees

(*Continued*)

Table 10.9 Stages of sugar saturation (*Continued*)

STAGE	TEMPERATURE	% SUGAR SATURATION	DESCRIPTION AND USES
Hard ball	122–130°C	92	Forms a hard, sticky ball and holds shape. Used for caramels, toffees and nougat  **FIGURE 10.12** Nougat
Soft crack	132–143°C	95	Forms strands that are firm but pliable. Used for butterscotch and taffy
Hard crack	146–155°C	99	Forms brittle threads that break. Used for toffees, hard candy, barley sugar, brittles and pulled sugar
Caramel	160–182°C	100	Clear syrup with light golden to dark golden colour. Used for brittles, coated moulds and pralines  **FIGURE 10.13** Brittle

INSTRUCTIONS

Apply heat to a solution of sugar and water.

PREPARATION

Prepare one (1) formulation of the control and one (1) formulation of each variable.

SAFETY

Working with hot sugar solutions is dangerous. As the solutions boil the temperature rises above 100°C. This is hazardous and considered high risk. Follow all the safety procedures to make sure that no one is hurt.

9780170418560

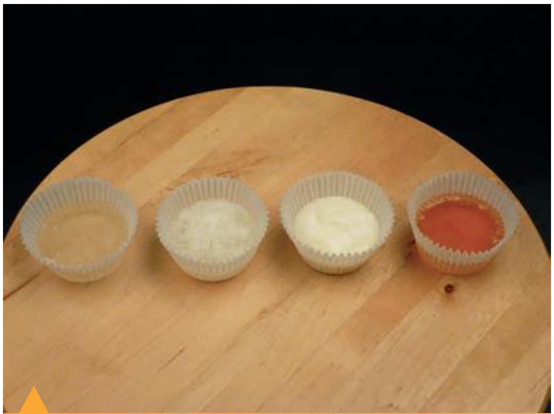
CONTROL	VARIABLE 1 – AGITATION	VARIABLE 2 – ADDITION OF FAT	VARIABLE 3 – ADDITION OF ACID
Produce one formulation using only the sugar and water following the procedure	Use only the sugar and water. Allow the mixture to cool until the bubbles subside, and stir	Allow mixture to cool until the bubbles subside. Add a teaspoon of butter to the formulation and beat until beginning to set Pour into patty papers	Add ¼ tsp of cream of tartar to the control formulation Boil to hard crack (146–155°C) and allow to cool until the bubbles subside. Do not stir mixture Pour into patty papers

FOOD COMPONENTS

- ¾ cup (160 g) sugar
- ¼ cup (60 mL) water
- ¼ tsp (1 g) cream of tartar
- butter (5 g)

EQUIPMENT

- measuring spoon, cup and jug
- medium saucepan
- wooden spoon
- confectionery thermometer
- pastry brush
- patty papers



Terry McCarten

FIGURE 10.14 From left to right: the control and variables 1–3

PROCEDURE

1. Measure the water and sugar and place it into a saucepan over low heat until the sugar dissolves. Do not allow to boil until all the sugar crystals are dissolved.
2. Bring the mixture to the boil. To stop sugar crystals forming in the mixture clean the sides of the saucepan with a wet pastry brush.
3. The mixture will start to become even-sized and glassy (soft ball – 112–115 °C). Do not allow the mixture to change colour (this is variable 3). Remove from heat. Cool slightly.
4. Pour into patty papers and allow to cool.

RESULTS ANALYSIS

Complete a table like the one below or use the template on NelsonNet to record observations.

1. **Explain** the process of crystallisation and nucleation in supersaturated solutions.
2. **Draw conclusions** about where crystallisation and nucleation can be used in food formulations.

draw conclusions make a judgment based on reasoning and evidence

TYPE OF STARCH	SIZE OF CRYSTALS	APPEARANCE	TASTE	TEXTURE	FLAVOUR	AROMA	POSSIBLE USE IN FOOD FORMULATIONS
Control							
Variable 1							
Variable 2							
Variable 3							

WS Experiment 10.2 template

EXPERIMENT 10.3

Caramelisation

AIM

To heat sugar and observe the stages of caramelisation
To **identify** where caramelisation is used in food formulations

BACKGROUND

Caramelisation is a non-enzymatic browning reaction. It is the oxidation of sugar where monosaccharides and disaccharides brown with the application of heat. The sugars that caramelise are sucrose and fructose. These sugars are found in cane sugar, fruits, honey, milk and cereals. Caramelisation occurs when the sugars naturally occur in the food item – such as with the caramelising of onions, or when a sugar is mixed with another ingredient, such as sugar browning in water to make toffee.

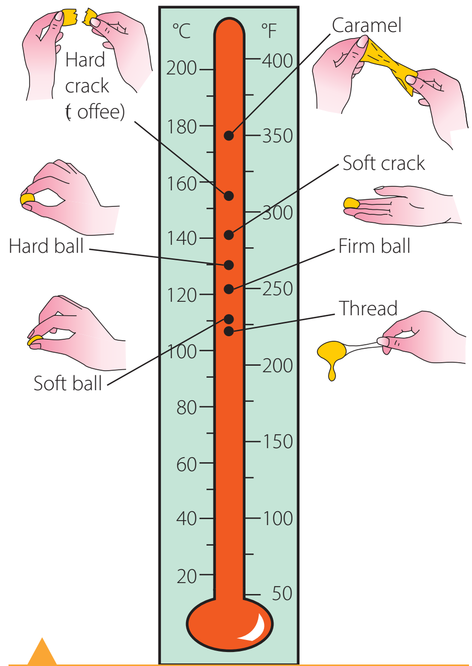


FIGURE 10.15 Stages of caramelisation

SAFETY

Hot sugar reaches very high temperatures and will burn on contact with the skin.

INSTRUCTIONS

Follow the instructions below to prepare the formulation.

PREPARATION

1 Collect all ingredients and equipment before commencing the experiment.
2 Prepare one (1) formulation.

FOOD COMPONENTS

- 1 tablespoon (20 g) white sugar

EQUIPMENT

- tablespoon
- small saucepan
- wooden spoon

To clean the saucepan and spoon fill it with hot water and place back on the heat. The heat will dissolve the caramel making it easy to clean.

PROCEDURE

1 Place 1 tablespoon of sugar into the saucepan.
2 Heat, stirring the sugar. The sugar will begin to melt into a liquid. All the water in the sugar crystals will start to evaporate as the sugar liquefies.
3 Continue to heat the sugar over a medium heat and it will change colour from clear to golden or light caramel. This occurs between 155 and 182°C.
4 Remove from heat to avoid burning the caramel and pour out on to a lined baking tray. Allow to cool.

RESULTS ANALYSIS

WS Experiment 10.3 template

	CHEMICAL CHANGE	APPEARANCE	TASTE	TEXTURE	FLAVOUR	AROMA	POSSIBLE USE IN FOOD FORMULATIONS
Sugar caramel							

1 **Explain** how the process of caramelisation of carbohydrates alters the chemical and functional properties of sugars.
2 **Draw conclusions** about where caramelisation can be used in food formulations.

EXPERIMENT 10.4

Dextrinisation

AIM

To apply dry heat to bread to observe and **understand** the process of dextrinisation

BACKGROUND

Dextrinisation is the process by which starchy foods are browned when they are subjected to dry heat; it involves the breakdown of starch into dextrins or disaccharides. It is non-enzymatic browning and a chemical change. The flavour, colour, taste and aroma change as a result of dextrinisation. If the heat is applied for too long, the result is burning and blackening – the starch has turned to carbon. Dextrinisation is used in many food preparation applications. It is used when making baked products, toasting starches, such as bread and breakfast cereals, browning gravies and sauces and to brown and crisp roasted vegetables.

INSTRUCTIONS 1

Apply dry heat to bread.

PREPARATION

Prepare one (1) formulation, following the instructions.

FOOD COMPONENTS

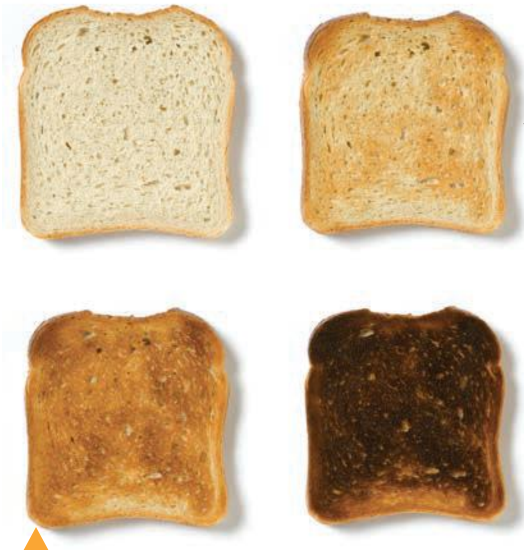
a loaf of sliced white bread

EQUIPMENT

- direct heat grill – on range
- tongs

PROCEDURE

1. Preheat grill to medium.
2. Place two (2) pieces of bread into the grill and observe.
3. Wait until the colour changes and observe the changes. Remove one slice of toast (variable 1).
4. Leave the other slice of bread in the grill until it is dark brown (variable 2).



Alamy Stock Photo/Stuart Burford

FIGURE 10.16 Stages of dextrinisation of toast

RESULTS ANALYSIS

Complete a table like the one below to record observations or use the template on NelsonNet.

SENSORY PROPERTY	VARIABLE 1	VARIABLE 2
Appearance		
Taste		
Flavour and aroma		
Texture		

WS Experiment 10.4 template

INSTRUCTIONS 2

Apply dry heat to flour to make a dark roux.

PREPARATION

Prepare one (1) formulation following the instructions.

FOOD COMPONENTS

- ½ cup (75 g) plain flour
- ½ cup (125 mL) oil

EQUIPMENT

- small, heavy saucepan
- wooden spoon

PROCEDURE

1 Place the flour and the oil in the saucepan over a medium heat.
2 Stir the mixture constantly to brown the flour evenly and prevent burning.
3 Scrape the bottom and the corners of the saucepan. This will ensure the flour is combined.
4 The colour should start to change (20 to 30 minutes) – if you notice dark flecks of colour these will be burnt flour and the roux is cooking too fast. Stir constantly.
5 The aroma will change to a nutty aroma and the colour will darken to a rich chocolate colour. Remove from heat and continue to stir until cooler.

Jess Pyles. Reproduced with permission.

FIGURE 10.17 Stages of dark roux

RESULTS ANALYSIS

1 Complete a table like the one above to record observations.
2 **Analyse** the results of the dextrinisation experiments to explain how dextrinization changes the end product colour and flavour of a thickened liquid or food.
3 **Draw conclusions** about where the process of dextrinisation can be used in food formulations.

EXPERIMENT 10.5

Gelification

AIM

To **experiment** using different gelling agents in food formulations

BACKGROUND

Gelification is the process of converting liquid substances into a solid gelatinous form with the help of a gelling agent. There are a variety of gelling agents that can be used safely in food. Each has its own characteristics and use in food formulations.

Table 10.10 Gelling agents and their uses

GELLING AGENT	WHAT IS IT?	CHARACTERISTIC OF GEL	USE
Agar-agar	An extract from red algae. It is white and semi-translucent. It has no flavour. It comes in powdered and flaked forms and its ability to gel is affected by acid and alkalis. Foods that are acidic require more agar to set. Some fruits because of enzyme activity will not set unless cooked (pineapple, mango, peaches) and chocolate will not set with agar	• Firm clear jelly • Brittle	Can be used in hot or cold liquids but must be blended or whisked. It needs to absorb water and be brought to the boil and allowed to simmer for 3 to 5 minutes Product: agar cubes, creams, noodles, foams, pearls, sheets

(Continued)

9780170418560

Table 10.10 Gelling agents and their uses (*Continued*)

GELLING AGENT	WHAT IS IT?	CHARACTERISTIC OF GEL	USE
Gelatin	Gelatin is a protein extracted through hydrolysis from animals such as cattle and pigs; comes in powdered form or as sheets	Soft to firm	The ratio of gelatin to liquid depends on the firmness of the gel. Used as a setting agent in sweet and savoury foods that are served cold. The gel melts when the temperature rises. It can be used to give foods a pleasing texture, make foams more stable and to emulsify foods
Carrageenan	A polysaccharide that is extracted from red edible seaweeds	Soft and elastic	Used for thickening, gelling and stabilising foods. Used in ice cream, yoghurt, cheese, soy milk
Gellan gum	A food additive produced through bacterial fermentation using a sugar source. It has no flavour or colour	• Fluid gel with weak structure, adds creaminess • brittle and firm gel	Used instead of agar and gelatin when different texture is required. Stabilises food preparations such as purees and spreads Can be used in spherification
Pectin	A polysaccharide found in citrus fruits, pears, apples and plums; a water-soluble fibre	Sticky	Gelling agent, thickening agent and stabiliser in food. Used to set jams as when heated with sugar it forms a thick gel. Used in confectionery to give good structure, clean bite and flavour
Methylcellulose	Cellulose that has been treated with methyl chloride; a hydrocolloid that gels as it heats and melts as it cools	Hot foams and noodles, fluid gel	Foaming agent and thickener; used to make hot ice cream that melts as it cools, meringues

INSTRUCTIONS

Prepare the formulation to make soup noodles or cream cheese noodles using agar-agar.

▶ An online search for 'how to make soup spaghetti (agar-agar)' will give some helpful step-by-step instructions.

Terry McCarten

Terry McCarten

FIGURE 10.18 Soup noodles (left) and cream cheese noodles (right)

PREPARATION

Prepare one (1) formulation for each of the variables.

▶ Work in groups and make each variable.

FOOD COMPONENTS

VARIABLE 1 – SOUP NOODLES	VARIABLE 2 – CREAM CHEESE NOODLES
250 mL vegetable stock 4 g agar-agar	175 g cream cheese 100 mL water 2.5 g agar-agar, 0.9% 0.25 g locust bean gum, 1.0%

EQUIPMENT

- saucepan
- whisk or stick blender
- syringe
- food safe silicone tubing
- measuring jug
- scales

PROCEDURE

VARIABLE 1 – SOUP NOODLES

1. Place ice cubes and water into a plastic container as an ice bath.
2. Place the stock into a saucepan and bring to the boil.
3. Remove from heat and sprinkle in the agar-agar.
4. Whisk to dissolve the agar-agar in the stock.
5. Attach the tubing to the syringe and draw the stock into the tubing. Level up the ends of the tubing and remove it from the syringe.
6. Place it in the ice-and-water bath, keeping the ends level until set.
7. Once set – approximately 2 to 5 minutes – reattach an empty syringe, filled with air, and push the noodle out with the air.
8. Repeat for more noodles.

VARIABLE 2 – CREAM CHEESE NOODLES

1. Place ice cubes into a plastic container as an ice bath.
2. Put the cream cheese and water into a saucepan and sprinkle in the agar-agar and the locust bean gum.
3. Use a stick blender to completely puree the mixture.
4. Bring the mixture to the boil stirring occasionally. Allow to simmer for 3 to 5 minutes.
5. Draw the gel base into the syringe and push the gel into the tubing.
6. Remove the filled tubing and place it in the ice bath.
7. Once set – approximately 2 to 5 minutes, reattach an empty syringe, filled with air, and push the noodle out with the air.
8. Repeat for more noodles.

RESULTS ANALYSIS

1. Complete a table like the one below or the template on NelsonNet using information about sensory properties on pages 169–73 to describe the sensory properties of each of the noodles.

WS Experiment 10.5 template

SENSORY PROPERTY	VARIABLE 1	VARIABLE 2
Appearance		
Taste		
Flavour and aroma		
Texture		

2. **Draw conclusions** about whether the formulations using agar-agar would be acceptable to consumers.

9780170418560

EXPERIMENT 10.6

Optional: using methyl cellulose to make hot vanilla ice cream

INSTRUCTIONS

Prepare one (1) formulation of hot vanilla ice cream.

FOOD COMPONENTS

- 200 mL milk
- 10 g sugar
- 7 g methyl cellulose SGA7C (3.2%)
- 1 vanilla bean, scraped

EQUIPMENT

- stick blender or whisk
- jug or bowl
- measuring jug
- scales
- ice cream scoop or spoon
- paper towel

PROCEDURE

1. Whisk or blend all ingredients together until methyl cellulose is properly dispersed.
2. Refrigerate overnight to allow all aeration to settle out of the mixture.
3. Heat a saucepan of water until it simmers and remove from the heat.
4. Using the ice cream scoop or spoon, scoop the ice cream mixture and wipe off any extra mixture from the bottom and sides of the scoop with a paper towel.
5. Place the scoop of mixture in the hot water and wait a minute until the outer part of the ice cream scoop mixture is solid. Gently remove it from the scoop.
6. Allow the ice cream to poach in the water for 2 more minutes and serve immediately.

RESULTS ANALYSIS

1. Complete a table like the one below using information about sensory properties to describe the sensory properties of hot vanilla ice cream.

SENSORY PROPERTY	HOT VANILLA ICE CREAM
Appearance	
Taste	
Flavour and aroma	
Texture	

WS Experiment 10.6 template

2. **Draw conclusions** about whether using methyl cellulose to make hot ice cream would be acceptable to consumers.
3. Research other formulations using the different gelling agents in the background information table above.

EXPERIMENT 10.7

Leavening

BACKGROUND

Leavening is the expansion of dough, batter or baked products resulting in rising. The purpose of leavening agents is to improve the gas bubbles and rising of dough.

There are three different types of leavening agents used in dough, batter or baked products: biological agents, chemical agents and physical processes. These aeration methods are often used in combination in food preparation.

Too much leavening agent will result in a product that rises quickly, then loses volume and has a coarse texture. Too little leavening agent will result in a heavy product with little aeration.

BIOLOGICAL AGENTS

Biological agents are live single-cell microorganisms that produce carbon dioxide and alcohol in the presence of food (sugar in the formulation), warmth (between 25°C and 35°C) and moisture (liquids incorporated into the formulation – milk, water). The process is called **fermentation**.

fermentation changes in food caused by growth of bacteria, yeast or mould; fermented products include alcohol, vinegar and some dairy products

Yeast is the only biological agent used to raise food products. If the temperature is too low (below 25°C) the yeast will not ferment. If the temperature is too high (above 35°C) the yeast is killed. This happens in the baking process.

Table 10.11 Biological leavening agents

BIOLOGICAL AGENT	HOW IT WORKS TO RISE FOOD FORMULATIONS	FOOD FORMULATION USES
Active dry yeast	During the process of fermentation, the yeast produces carbon dioxide, which is trapped in tiny pockets of air within the dough. In wheat flour the gluten is developed during the kneading process, making the bread dough elastic and stretching it to trap more air. When cooked the gluten sets the dough and the yeast is killed. Gluten-free flour will require other raising agents (e.g. baking powder) and ingredients that form a structure (e.g. eggs) to retain aeration (e.g. of a loaf) after baking	• bread • buns • croissants  Shutterstock.com/Chuah Chiew See

CHEMICAL AGENTS

Chemical raising agents rely on a chemical reaction to produce carbon dioxide. The chemical reaction occurs when heat is applied to the formulation.

Table 10.12 Chemical leavening agents

CHEMICAL AGENTS	HOW IT WORKS TO RISE FOOD FORMULATIONS	FOOD FORMULATION USES
Baking powder	This is a mixture of bicarbonate of soda and cream of tartar. Bicarbonate of soda is a white powder and when it is heated it gives off carbon dioxide. Carbon dioxide is colourless and odourless and is trapped in the batter, causing air bubbles which rise the mixture. An acid is mixed with the bicarbonate of soda for it to work efficiently. The acid helps liberate all the carbon dioxide, forming a salt. The proportion of bicarbonate of soda to cream of tartar is 1 : 2. The liquid containing the baking powder should be added at the last stage of preparation before baking as the carbon dioxide reaction starts when the baking powder is moistened	• cakes • biscuits
Potassium bicarbonate	This raising agent is also known as potassium hydrogen carbonate. It is colourless, odourless and salty, with a slightly base pH. It can be substituted for baking soda in food formulations: 1 teaspoon of baking soda = 1 teaspoon potassium bicarbonate + ⅓ teaspoon calcium salt. The use of this product eliminates sodium from the baked product. Carbon dioxide is produced when the product is mixed with water and heat is applied. The carbon dioxide bubbles are trapped in the formulation, causing the mixture to rise	• cakes • muffins • biscuits • tortillas and other baked food formulations

PHYSICAL PROCESSES

Physical processes rely on the manipulation of the mixture to include air. The mixture can be manipulated in different ways for different food formulations.

Table 10.13 Physical leavening processes

PHYSICAL PROCESSES	HOW IT WORKS TO RISE FOOD FORMULATIONS	FOOD FORMULATION USES
Incorporating air	Sifting dry ingredients – use a sieve or sifter to pass the flour and other dry ingredients through to incorporate air	• cakes • biscuits • slices • bread
	Creaming – beating the fat together with sugar to form a light and fluffy formulation. The air is incorporated during the beating process	• cakes • biscuits • slices • biscuit pastry
	Rubbing fat into flour – using the fingertips to break the fat down into small particles while incorporating it into a flour formulation. Lifting the formulation while rubbing in the fat incorporates air	• scones, slices, biscuits, cakes • shortcrust pastry
	Whisking eggs and sugar together – beating egg whites until they form a foam (see Unit 1, Topic 4). Sugar is added to stabilise the foam. Beaten egg white can be folded into the formulation to incorporate air	• sponge cakes, mousse
	Rolling and folding – the air is trapped by rolling the dough out and folding the dough over itself several times. The process is repeated to incorporate more air	• flaky pastry
Steam	Steam is created by the heating of the liquid in the formulation, which forces its way through the formulation to stretch and raise it Formulations require a high proportion of moisture and a high baking temperature. The texture of the prototype is open and uneven	• Yorkshire pudding • choux pastry

Make sure that you have measuring tools and camera ready to record the results of these experiments as they require photography of the internal texture, measuring the area (height by width), height and volume (weigh each product before and after preparation or cooking) and the diameter of the air bubbles for each sample.

Leavening – yeast

AIM

To use yeast as a raising agent on plain flour, bread flour, gluten-free flour and self-raising flour formulations

INSTRUCTIONS

PREPARATION

Prepare one (1) formulation for each type of flour.

Table 10.14 Types of flour

PLAIN FLOUR	BREAD FLOUR	GLUTEN-FREE FLOUR	SELF-RAISING FLOUR
Usually made from wheat. The wheat is ground to form a powder. Plain flour in Australia contains the endosperm from the wheat grain. There are many grains that are used to make flour. 'Plain' refers to the fact that there is nothing added to the ground grain. Plain flour can be used for most baking formulations. For the purpose of this experiment, we are using wheat flour	Bread flour is made from wheat that has a higher protein content than regular wheat. Protein in the form of gliadin and glutenin forms gluten in the preparation of bread and cakes. This is particularly beneficial when making bread. It makes the bread dough more elastic. It is not so beneficial when making light crumbly baked products	Gluten-free flour is flour made from a plant that does not contain gluten. Tapioca, rice, maize or corn, potato and soy do not produce gluten so are used to make gluten-free flour These are used in different combinations to make gluten-free flour that produces baked products. Gluten-free flour comes in plain flour and self-raising flour formulations. The results using gluten-free flour are crumbly and have different sensory properties to using flour that contains gluten	Self-raising flour is flour that has had a chemical raising agent – usually baking powder (bicarbonate of soda and cream of tartar) added to it in a specific ratio. For 1 cup of flour approximately 1 teaspoon of baking powder is added. Some formulations will require different proportions so will ask for plain flour and raising agent in the food formulation. When liquid is added to baking powder, a chemical reaction occurs where the acid reacts with the alkaline to release carbon dioxide gas

The gluten-free flour formulation will be sticky and more cake-like. This is because the gluten – a protein in wheat flour – is the ingredient that forms the structure of bread. It may be necessary to add a little less water at the mixing stage. It may also be necessary to use a muffin tray and papers to bake the gluten-free rolls.

FOOD COMPONENTS

- 1 cup (150 g) plain flour or gluten-free flour or bread flour or self-raising flour
- 4 g dried yeast
- ½ teaspoon (2.5 g) sugar
- pinch salt
- 125 mL warm water

EQUIPMENT

- mixing bowl
- measuring cup, jug and spoon
- floured baking tray
- bread and butter knife

PROCEDURE

1. Preheat the oven to 180°C.
2. Measure the ingredients. Dissolve the yeast in the warm water. Place the flour and sugar in the mixing bowl. Stir in salt. Make a well in the centre. Add warm water and yeast mixture.
3. Stir the mixture until well combined using the bread and butter knife. Use your hands to make sure that all the flour is combined and place on a lightly floured surface. Knead for 10 minutes or until the dough is smooth and elastic.
4. Place the dough in the bowl and cover with a damp tea towel. Put the bowl in a warm area to prove for 20 minutes or until the dough has almost doubled in size.
5. Punch down the centre of the dough with your fist. Place the dough on to a lightly floured surface and knead for 2 minutes or until the dough is elastic and has returned to its original size.

6 Form the dough into balls about the size of a golf ball. Place on a floured baking tray about 2 cm apart. Cover and place in a warm area to allow the dough to double in size.
7 Once the dough has doubled in size bake in a 180°C oven for 10–15 minutes or until golden brown. The rolls should sound hollow when tapped.
8 Observe the results and complete a table like the one below.

RESULTS ANALYSIS

1 Record observations by completing the table using the measuring tools and camera results.

Experiment 10.7 template

	PLAIN FLOUR	BREAD FLOUR	GLUTEN-FREE FLOUR	SELF-RAISING FLOUR
Internal texture				
Area				
Height				
Volume				
Diameter of air bubbles				

2 **Identify** the sensory properties of each sample.
3 **Analyse** the results of the biological raising agent experiments to explain how different flour formulations change the sensory properties of the prototype.
4 Draw conclusions about the best flour to use with biological raising agents in bread dough food formulations.

EXPERIMENT 10.8

Leavening – baking powder

AIM

To observe the effects of baking powder on leavening a baked product

INSTRUCTIONS

PREPARATION

Prepare one (1) formulation for each of the types of flour – plain flour, bread flour, gluten-free flour and self-raising flour.

FOOD COMPONENTS

- 60 g butter
- ½ cup (125 g) sugar
- 1 egg
- ¼ cup (60 mL) milk
- ¾ cup (120 g) plain flour, bread flour, gluten-free flour and self-raising flour
- 1 tsp baking powder
- drop vanilla

EQUIPMENT

- bowl
- electric mixer or beater mix
- measuring cups, spoons and jug
- wooden spoon
- spatula
- muffin papers and muffin tray

PROCEDURE

1 Preheat oven to 180°C. Place six muffin papers into the muffin tray.
2 Cream the butter and sugar. Beat the egg in a cup with a fork and add to the mixture. Add the vanilla essence.
3 Sift the flour and baking powder together. Add half to the mixture and stir – do not beat. Add the milk and stir. Finally, add the remaining flour and mix.
4 Spoon into the muffin papers, making sure that the mixture amount is even in each paper.
5 Bake in preheated oven 20–25 minutes or until golden. The cake will spring back when touched lightly with a finger if cooked.

RESULTS ANALYSIS

1 Complete the table using the measuring tools and camera results.

WS Experiment 10.8 template

	PLAIN FLOUR	BREAD FLOUR	GLUTEN-FREE FLOUR	SELF-RAISING FLOUR
Internal texture				
Area				
Height				
Volume				
Diameter of air bubbles				

2 **Identify** the sensory properties of each sample.
3 **Analyse** the results of the chemical raising agent experiments to explain how different flour formulations change the sensory properties of the prototype.
4 **Draw conclusions** about the best flour to use with the chemical raising agent in cake batter food formulations.

EXPERIMENT 10.9

investigate carry out an examination or formal inquiry in order to establish or obtain facts and reach new conclusions; search, inquire into, interpret and draw conclusions about data and information

Leavening – physical (incorporating air)

AIM

To **investigate** incorporating air into flour mixtures using plain flour. This experiment could be performed using gluten-free flour. Note: if using gluten-free flour the formulation would need to be adapted.

INSTRUCTIONS

Prepare one (1) formulation of each variable. The variables in this experiment are the ways the formulation is manipulated to incorporate air. There is no raising agent in this formulation.

VARIABLE 1	VARIABLE 2	VARIABLE 3	VARIABLE 4	VARIABLE 5
Melt the butter Use a sieve or sifter to pass the flour and other dry ingredients through to incorporate air Mix all the ingredients together in the bowl	Beat the butter and sugar together until it is light and fluffy Add the egg, beat Fold in flour	Rub the fat into the flour mixture with the fingertips lifting the formulation to incorporate air Add the sugar and mix Add the egg and mix to a firm dough	Mix all ingredients together Whisk the eggs and sugar together and fold into the formulation Add the melted butter stirring gently	Use instructions for formulation 1 Roll the final formulation out and fold it several times, re-rolling to incorporate air between the layers

FOOD COMPONENTS

- 60 g butter, softened
- ¼ cup (60 g) castor sugar
- ¼ teaspoon (1.25 mL) vanilla extract
- 1 egg, at room temperature
- 1 cup (150 g) plain flour

EQUIPMENT

- electric mixer or beater mix or wooden spoon
- mixing bowl
- measuring spoons, cup and jug
- fork
- sieve or sifter
- rolling pin
- baking tray and baking paper

PROCEDURE

1. Preheat oven to 180°C.
2. Place baking paper on the tray.
3. Follow the variable instructions for each set of ingredients.
4. Roll about 1 tablespoon of mixture into balls.
5. Place on baking trays lined with baking paper. Allow 3 cm between each one to allow for spreading.
6. Bake for 10 to 15 minutes or until golden. Cool biscuits on the tray for 5 minutes.
7. Remove from tray to wire racks to cool completely.

RESULTS ANALYSIS

1. Complete a table like the one below, using the measuring tools and camera results.

	VARIABLE 1	VARIABLE 2	VARIABLE 3	VARIABLE 4	VARIABLE 5
Internal texture					
Area					
Height					
Volume					
Diameter of air bubbles					

Experiment 10.9 template

2. **Identify** the sensory properties of each sample.
3. **Analyse** the results of the physical leavening experiments to explain how different ways to incorporate air into formulations change the sensory properties of the prototype.
4. **Draw conclusions** about the type of food formulations that could use each method to incorporate air.
5. **Explain** why it is necessary to use a raising agent of to prepare food formulations and why different formulations require different types of raising agents.

EXPERIMENT 10.10

Leavening – physical (steam)

explore look into both closely and broadly; scrutinise; inquire into or discuss something in detail

AIM

To **explore** the effect of physical leavening with steam by making choux pastry

INSTRUCTIONS

Prepare one (1) formulation for each type of flour.

Cut the butter into small pieces so it melts quickly. Make sure that you let the mixture cool a little before adding the eggs or they will coagulate.

FOOD COMPONENTS

- 80 mL water
- 40 g butter
- 50 g plain flour, bread flour, gluten-free flour or self-raising flour – sifted
- 2 eggs – room temperature
- baking paper

EQUIPMENT

- saucepan
- wooden spoon
- scales
- measuring jug
- whisk
- small jug
- skewer
- lined baking tray

PROCEDURE

1. Preheat oven to 220°C.
2. Measure all ingredients and sift the flour.
3. Melt the butter with the water in a saucepan over medium heat. Cook until butter has melted and mixture just starts to boil.
4. Add all the flour. Cook, stirring, 2–3 minutes or until mixture comes away from side of pan and forms a ball. Allow to cool slightly (2–3 minutes).
5. Add the beaten eggs one at a time using a wooden spoon to beat well between each addition. The mixture should be thick and glossy.
6. Use a metal spoon to place spoonfuls of mixture on a lined baking tray about 3 cm apart.
7. Bake in the oven for 15 minutes and reduce heat to 190°C for a further 35 minutes. The pastry should have risen and be golden brown. Remove from oven and pierce with a skewer to allow the steam to escape.

RESULTS ANALYSIS

1. Complete a table like the one that follows or use the template on NelsonNet. Use the measuring tools and camera results.
2. **Identify** the sensory properties of each sample.
3. **Analyse** the results of the physical raising agent, steam experiments to explain how different flour formulations change the sensory properties of the prototype.
4. **Draw conclusions** about the best flour to use with the physical raising agent, steam in food formulations.
5. Different raising agents are more suitable for some food formulations than others. Use the results of your experiments to **draw conclusions** about the best raising agent to use in specific food formulations, giving reasons to support the conclusions.

9780170418560

	PLAIN FLOUR	BREAD FLOUR	GLUTEN-FREE FLOUR	SELF-RAISING FLOUR
Internal texture				
Area				
Height				
Volume				
Diameter of air bubbles				

RAISING AGENT	FOOD FORMULATIONS	REASONS WHY THE FORMULATIONS ARE SUITABLE
Yeast		
Baking powder		
Sifting		
Creaming		
Rubbing-in		
Whisking		
Rolling and folding		
Steam		

WS
Experiment 10.10 template 1

WS
Experiment 10.10 template 2

Food processing techniques

Different food processing techniques are used to control the access to and consumability of carbohydrate-based food sources. They are the application of cold by chilling or freezing; the application of heat by boiling, baking or microwaving; exposure to air through dehydration; change of pH through the addition of acid or alkali; the addition of additives, such as salt, sugar, antioxidants, yeast, baking powder and cream of tartar; and physical manipulation.

Application of cold by chilling, freezing

Application of cold differs depending on the food source of the carbohydrate. Some carbohydrate-based foods do not require chilling or freezing to control the access to and consumability of the food. Chilling refers to refrigeration of food to below 5°C. Freezing refers to keeping food below –15°C.

Table 10.15 Chilling or freezing used in food processing of carbohydrate-based foods

FOOD SOURCE	NO CHILLING	CHILLING	FREEZING
Honey, syrups	*		
Soft drinks		*	
Chocolate	*		
Desserts		*	*

(*Continued*)

Table 10.15 Chilling or freezing used in food processing of carbohydrate-based foods (*Continued*)

FOOD SOURCE	NO CHILLING	CHILLING	FREEZING
Cane sugar	*		
Cereals – rice, wheat, oats, barley	*		
Bread	*	*	*
Baked goods	*	*	*
Tapioca, legumes	*		
Potatoes and other starchy vegetables	*		
Dried pasta	*		
Fresh pasta		*	

Application of heat by boiling, baking, microwaving

Boiling carbohydrate-based foods is the application of moist heat to food. Some carbohydrate-based foods require boiling for them to be palatable to the consumer. Boiling starchy vegetables gelatinises the starch, causing it to absorb water and making the vegetables light and fluffy. Pasta and rice are boiled to make the starch grains swell and absorb liquid, making them acceptable to the consumer. Products thickened with starch also require boiling to cook the starch and remove the floury flavour as in a white sauce.

Baking is carried out in the oven and some carbohydrate-based foods are baked into products for consumer use. Bread is a staple for consumers and is made from flour of various grains, both wholegrain and refined. Cakes and biscuits are also baked carbohydrate-based products. Baking these formulations makes them extremely desirable to the consumer and gives variety of products for consumer use.

While microwave cookery is a quick and energy-efficient method of cooking, some carbohydrate-based foods will take as long to cook in a microwave oven as to cook conventionally. Rice and pasta are two examples of foods that take the same time to cook in a microwave oven as by boiling. This is because the starch in the pasta and rice takes time to swell and absorb the moisture and it will take the same time no matter where it is cooked. Other carbohydrate-based foods lose moisture in the microwave oven because of higher temperatures on the edges of the food when reheating. For example, pasta that has been reheated in the microwave will appear dry around the edges of the dish if the dish is heated thoroughly.

Exposure to air through dehydration

Dehydration of carbohydrate-based foods is processing to remove the liquid component of the food. Pasta, some fruits and vegetables are dehydrated to give consumers more access to food over a long period of time. Food can also be dried at home in a food dehydrator. Potatoes, sweet potatoes and other carbohydrate-based foods dehydrate well with good results. Foods are dehydrated to reduce bulk and hikers take fully dehydrated meals with them to reconstitute and eat while they are hiking. Dehydrated food is considerably lighter, easy to store and will not be compromised unless moisture is added.

Change of pH through the addition of acid or alkali

The pH of carbohydrate-based foods is changed during food processing in many formulations. Acids, such as acetic acid (vinegar) or citric acid (lemon, lime and orange), are used to improve colour and add a sour flavour. Other acid ingredients are found in fermented foods such as yoghurt and kimchi.

Adding alkaline ingredients to carbohydrate-based foods will alter the texture, colour and flavour. For example, adding alkaline to a flour dough will result in a yellow hue as the colour changes the pigments in the flour, which are usually invisible. The interaction of the gluten with the alkaline ingredient in the flour mixture is also changed to make a firmer dough. There is greater bonding of the gluten molecules in an alkaline mixture. For example, the alkalinity in a noodle dough creates a pleasant flavour when the noodle is cooked.

Addition of food additives

Food additives, such as salt, sugar, antioxidants, yeast, baking powder, cream of tartar, are added to carbohydrate-based foods during processing to produce specific desirable effects, such as making the food more palatable or to preserve it.

A number of processing additives are used in carbohydrate-based foods. See the table below for a list of common processing additives and where they are used.

Table 10.16 Food additives to carbohydrate-based foods

ADDITIVE	FUNCTION	TYPICAL PRODUCT
benzoyl peroxide	bleaching	flour
potassium bromate	conditioning	flour
lecithin	emulsifying	bakery products
yeast, baking powder, baking soda	leavening	bakery products
glycerol	moisture control (humectants)	marshmallows
citric acid, lactic acid	pH control	confections, jams and jellies
pectin, gelatin, carrageenan, gums (arabic, guar, locust bean)	stabilising and thickening	frozen desserts, confections, pudding mixes, jams and jellies

Preserving agents are also used in processing carbohydrate-based foods. Antioxidants are used to decrease the oxidation of food that contributes to its deterioration. Antioxidants such as ascorbic acid, citric acid, sulphites and tocopherols are used to decrease oxidation in food. Antimicrobial agents are often used with other preservation techniques to inhibit the growth of pathogenic microorganisms. Salt is one such agent as it ties up the water, so the microorganisms are unable to grow.

Physical manipulation

Physical manipulation takes four forms in carbohydrate-based foods. The table that follows indicates where aerating, kneading, rolling and shaping is used in processing carbohydrate-based foods. These techniques are mostly used in baked carbohydrate-based products.

Table 10.17 Physical manipulation of foods

FORM OF PHYSICAL MANIPULATION	USES IN FOOD PROCESSING
Aerating	Used in any formulation that requires inclusion of air, such as cakes, pastries and breads, usually by beating or sifting
Kneading	Kneading develops the gluten strands in the carbohydrate-based products using wheat flours or other flours that contain gluten. Kneading creates a smooth, elastic product prior to baking
Rolling	Rolling smooths out the product prior to baking and is used in pastries and bread
Shaping	Where the food has to be a consistent or fancy shape as in bread rolls or biscuits, the food is shaped prior to baking

REVIEW QUESTIONS ▶

1 **Explain** when gelatinisation occurs.
2 **Identify** the three stages of gelatinisation and explain the effect that the type of starch, temperature, quantity of tenderiser and type of acid used has on the starch gel.
3 **Identify** how wheat flour, cornflour, sago or potato starch and tapioca react in the gelatinisation process.
4 **Explain** the process of crystallisation and nucleation.
5 **Explain** what is meant by a supersaturated solution.
6 **Describe** what caramelisation is. Explain how caramelisation occurs.
7 **Explain** the process of dextrinisation.
8 **Identify** and **explain** a use of dry heat application to starch-based end products.
9 a Define gelification.
   b **Identify** four gelling agents used with carbohydrate-based foods.
   c **Explain** how the agents are used, with possible food formulation examples for each one.
10 **Describe** what is meant by the term 'leavening'.
11 **Explain** the purpose of leavening agents.
12 **Identify** and **explain** the effects of three different types of leavening agents including biological, chemical and physical.
13 **Review** the experiments to explain how each leavening agent affected different flours – plain flour, self-raising flour, bread flour and gluten-free flour.
14 **Identify** the food processing techniques used to control the access to and consumability of carbohydrate-based foods.
15 Use the primary data from the experiments to **develop** ideas about the formulation of a carbohydrate food solution.
16 **Explain** the relationship between the structure and functions of carbohydrate and the effects of these in food processing and on food product quality.

define
give the meaning of a word, phrase, concept or physical quantity; state meaning and identify or describe qualities

WS
Summary of experiments

Distribution

The methods of distribution of carbohydrate-based foods are dependent on the processing and preservation techniques used. Preservation techniques for carbohydrate-based foods such as dehydration, canning and freezing extend shelf life of foods to enable the consumer to have access to the foods all year round. Foods processed in different ways may require different transport, storage and distribution options. For more information on distribution see chapter 2, page 15.

Consumption

The following experiments investigate whether different types of bread formulations and cake batters are acceptable to consumers through comparing the sensory properties of appearance, taste, texture, flavour and aroma.

9780170418560

EXPERIMENT 10.11

Bread formulations

AIM

To **compare** the sensory properties of different bread formulations

compare
display recognition of similarities and differences and recognise the significance of these similarities and differences

INSTRUCTIONS

PREPARATION

Purchase one loaf of each bread.

FOOD COMPONENTS

- white bread from the supermarket
- white bread from a bakery
- wholemeal bread
- multigrain bread
- rye bread or pumpernickel
- gluten-free bread

Ensure that there are no allergies to wheat or other products in the bread samples prior to the sampling.

EQUIPMENT

- plate
- bread and butter knife
- bread slicer if loaves are unsliced or serrated knife

PROCEDURE

1 Collect a sample of each bread product and observe the appearance, taking note of the internal texture, area, height, volume and diameter of bubbles in each sample. Record your observations in a table like the one below, using measuring tools.

BREAD APPEARANCE	WHITE (SUPERMARKET)	WHITE (BAKERY)	WHOLEMEAL	MULTIGRAIN	RYE OR PUMPERNICKEL	GLUTEN-FREE
Internal texture						
Area						
Height						
Volume						
Diameter of air bubbles						

WS Experiment 10.11 template 1

lexicon in Food & Nutrition, a source list used to describe the sensory properties of food; similar to a specific technical dictionary

2 Taste each sample and identify the sensory properties of each sample using a **lexicon** (see chapter 7 for more information on lexicons). Record the results of the sensory profiling in the table below.

SENSORY PROPERTY	WHITE (SUPERMARKET)	WHITE (BAKERY)	WHOLEMEAL	MULTIGRAIN	RYE OR PUMPERNICKEL	GLUTEN - FREE
Appearance						
Taste						
Flavour and aroma						
Texture						

WS Experiment 10.11 template 2

RESULTS ANALYSIS

1 **Analyse** the appearance table to conclude which types of bread are most acceptable to the consumer. Give reasons for the response, referring to the table.
2 **Analyse** the results of the sensory profiling to **draw conclusions** about the acceptability of bread types to consumers. Give reasons for the response, referring to the tables above.

EXPERIMENT 10.12

Cake batters

AIM

To **compare** different formulations of cake batters to ascertain the sensory properties of each formulation and **draw conclusions** about the consumer acceptability of each formulation

INSTRUCTIONS

Work in groups to prepare one (1) formulation of each variable across the class. Cook each formulation in a cupcake or muffin paper to ensure that the cake is cooked in time to observe and analyse the results.

PREPARATION

1 Prepare one (1) formulation for each cake batter according to the instructions.
2 Prepare one (1) formulation of each variable. The variables in this experiment are different cake batter formulations and mixing methods.

VARIABLE 1	VARIABLE 2	VARIABLE 3	VARIABLE 4	VARIABLE 5
Butter cake – beaten	Melt and mix cake	Rubbing-in cake	Sponge cake	Packet cake

9780170418560

FOOD COMPONENTS

VARIABLE 1 – CREAMING METHOD CAKE	VARIABLE 2 – ONE BOWL	VARIABLE 3 – SPONGE CAKE	VARIABLE 4 – PURCHASED CAKE	VARIABLE 5 – PACKET CAKE
• 60 g butter • 113 g castor sugar • 1 egg • 125 g self-raising flour • vanilla essence or paste • 125 mL cup milk	• 96 g self-raising flour • 4 g baking powder • 62 g butter – softened • 113 g castor sugar • 1 egg • vanilla essence or paste • 50 mL milk	• 1 large egg • 66 g castor sugar • 5 g cornflour in a cup • 60 g plain flour • 1 g cream of tartar • 0.5 g baking powder • 4 g melted butter • 20 mL warmed milk	Purchase a madeira or butter cake	Purchase a basic vanilla cake or vanilla butter cake packet and the ingredients to make the cake

EQUIPMENT

- electric beater
- mixing bowl
- measuring cups, jug and spoon
- scales
- wooden spoon
- plate scraper
- metal tablespoon
- cupcake or muffin papers
- cupcake or muffin tray

PROCEDURE

VARIABLE 1	VARIABLE 2	VARIABLE 3	VARIABLE 4	VARIABLE 5
1 Beat the butter and sugar to a cream. 2 Add egg and beat well. Sift flour. 3 Add flour and milk alternately and mix gently into a soft dough. 4 Spoon equal amounts into each paper. 5 Bake in 180°C oven for 10 to 12 minutes.	1 Sift the flour and baking powder into the bowl of an electric mixer. 2 Add all other ingredients. 3 Beat at medium speed until combined. 4 Increase the speed, beating all ingredients together for 2 minutes. 5 Spoon equal amounts into each paper. 6 Bake in 180°C oven for 10 to 12 minutes.	1 Separate the egg white from the yolk. 2 Using an electric beater, beat the white until it is light and fluffy. 3 Gradually add the sugar, beating well. 4 Add the egg yolk and beat until the sugar has dissolved. 5 Sift the dry ingredients together three times and fold gently into the mixture. 6 Lastly, add the warmed milk and melted butter. 7 Spoon equal amounts into each paper. 8 Bake in 180°C oven for 10 to 12 minutes.	1 Cut purchased cake into pieces approximately the size of the prepared cakes.	1 Prepare the packet cake according to the instructions on the packet. 2 Spoon equal amounts into each paper. 3 Bake in 180°C oven for 10 to 12 minutes.

RESULTS ANALYSIS

1 Complete a table like the one below or the template on NelsonNet, using the measuring tools and camera results.

Experiment 10.12 template 1

CAKE APPEARANCE	VARIABLE 1 – CREAMING METHOD CAKE	VARIABLE 2 – ONE BOWL	VARIABLE 3 – SPONGE CAKE	VARIABLE 4 – PURCHASED CAKE	VARIABLE 5 – PACKET CAKE
Internal texture					
Area					
Height					
Volume					
Diameter of air bubbles					

2 Taste each sample and identify the sensory properties of each sample using a lexicon. Record the results of the sensory profiling in a table like the one below or use the template on NelsonNet.

Experiment 10.12 template 2

SENSORY PROPERTY	VARIABLE 1 – CREAMING METHOD CAKE	VARIABLE 2 – ONE BOWL	VARIABLE 3 – SPONGE CAKE	VARIABLE 4 – PURCHASED CAKE	VARIABLE 5 – PACKET CAKE
Appearance					
Taste					
Flavour and aroma					
Texture					

3 **Analyse** the appearance table to conclude whether each variable is acceptable to the consumer.

4 **Analyse** the results of the sensory profiling to **draw conclusions** about the acceptability of cake formulations to consumers. Give reasons for the response referring to the tables above.

5 Rate each variable on a scale of 1 to 5 – 1 being 'very acceptable' and 5 being 'not acceptable at all'. Give reasons for the response, referring to the tables.

ACCEPTABILITY TO CONSUMER	REASONS FOR RATING

9780170418560

Research and development

New information and revised thinking occur as science investigates food and health. Recent research into sugars and starches suggests that consumers need to consider the health and usage benefits of each item they consume. Research into sweeteners is discovering that there are benefits to using natural sweeteners other than sugar in food formulations.

ACTIVITY 10.2

Aim

To **compare** the properties of alternative sweeteners to sugar

STEPS

1 **Compare** the properties of each of the listed sweeteners and review each product to work out if it can be substituted for sugar in a food formulation.
2 **Decide** if changes need to be made to quantities of ingredients and the formulation instructions if the sugar substitute is used.

There are many sweeteners on the market that can be used in food. Many of these come from natural sources and can be used as a substitute for sugar in food formulations.

decide reach a resolution as a result of consideration; make a choice from a number of alternatives

NATURAL SWEETENER	FLAVOUR	RULES FOR SUBSTITUTION	POSSIBLE FORMULATIONS
Honey			
Stevia			
Dates			
Coconut sugar			
Maple syrup			

WS Activity 10.2 template

Over the last 10 years scientists have discovered that some starch resists digestion in the small intestine and reaches the large intestine largely undigested. In the large intestine it behaves in a manner similar to soluble, fermentable fibre and therefore helps feed the friendly bacteria in the gut and increases the production of short chain fatty acids, with many health benefits. Resistant starch has been attributed to low incidences of bowel cancer in countries such as Japan and India.

Resistant starch is found in most starchy foods; however, it is only a small amount of up to 5 per cent. In many foods the amount of resistant starch can be increased by processing and cooking. Potato starch is one of the better sources of resistant starch. It cannot be heated as this reduces the concentration of resistant starch; 1 to 2 tablespoons of potato starch can be added to smoothies or yoghurt to increase resistant starch in the diet. Other sources are oats, green bananas, cooked and cooled potatoes, rice and pasta, legumes and natural whole grains.

ACTIVITY 10.3

Aim

To **investigate** resistant starch

STEPS

Read the article below and answer the questions that follow.

RESISTANT STARCH

Our research on the bacteria in the gut (microbiome) has led to important discoveries on the role that fibre from food plays in gut health.

The challenge

We're eating more fibre, but there's still a problem.

Australians eat more fibre than many other westerners but bowel cancer remains the second most common cancer in both Australian men and women.

This is a paradox, because nutritionists agree that fibre may help to prevent bowel cancer.

Our response

DIFFERENT TYPES OF FIBRE

We need to eat a wider variety of fibre from food, according to current research. We are doing a great job of eating roughage like wheat bran which promotes bowel regularity. What we need to eat more of is fermentable fibres such as resistant starch, that help to support good gut bacteria.

Our research shows that eating resistant starch leads to positive changes in the bowel and could protect against the genetic damage that precedes bowel cancer.

Resistant starch promotes gut health by feeding the 'good bacteria' that live in our large bowel. These bacteria are sometimes called our microbiome. They can use resistant starch as food because it resists digestion in our small intestine, and moves on to the large bowel.

When the good bacteria in the large bowel ferment resistant starch, they make short chain fatty acids. One of these, called butyrate, supplies energy to the cells lining the large intestine (colonocytes), promoting their wellbeing.

The results

INCREASING INTAKES OF RESISTANT STARCH

We can feed our gut bacteria or microbiome by eating foods rich in resistant starch, e.g. lentils, peas and beans, cooked and cooled potato, cold pasta salad, firm bananas, and certain wholegrain products. Eating a diet with a variety of fibre is a great way to keep your digestive system healthy.

The recommended intake of resistant starch is around 20 grams a day, which is almost four times greater than a typical western diet provides. To address this challenge we developed BARLEYmax™, a natural, high fibre wholegrain with high levels of resistant starch. We then worked with food manufacturers to create products containing BARLEYmax™, including breakfast cereals, food wraps, rice mixes, and bread.

We hope that eating a wider variety of fibre, including resistant starch, will help us to improve gut health and assist in reducing the incidence of bowel cancer.

Source: CSIRO. Reproduced with permission.

9780170418560

Conclusions

1 **Identify** foods that have high amounts of resistant starch.
2 **Identify** how individuals can increase the amount of resistant starch in their diet.
3 **Identify** why this product has been developed.
4 **Summarise** the health benefits of increasing the amount of resistant starch in the diet.

ACTIVITY 10.4

Aim

To **investigate** the use of carbohydrate to make edible cutlery

STEPS

Read the article below and answer the questions that follow.

EDIBLE CUTLERY COMPANY WANTS US TO EAT OUR WAY OUT OF PLASTIC POLLUTION

The spoon tastes like a cracker and its manufacturer hopes to expand into forks and chopsticks

Plastic waste covers our oceans and landfill. The past 70 years of plastic waste have resulted in pollution so ubiquitous scientists say it's a marker of a new geological epoch, the manmade Anthropocene.

Plastic cutlery is a contributor to this enormous problem – estimates suggest the US alone uses 40bn plastic utensils a year – but the founder of Indian cutlery company Bakeys thinks he might have a solution. Cutlery you can eat.

Bakeys. Reproduced with permission.

FIGURE 10.19 Edible spoons from Bakeys

The vegan friendly spoons are made from rice, wheat and sorghum, an ancient grain originally from Africa. Sorghum was chosen as a primary ingredient for its tough quality (it doesn't go soggy in liquids) and because it is suitable for cultivation in semi-arid areas.

The cutlery comes in three flavours – savoury (salt and cumin), sweet (sugar) and plain. 'It tastes like a cracker, a dry cracker because we don't put any fat in it. It can complement any food. The taste of the food gets into the spoon,' says company founder Narayana Peesapaty.

Bakeys' crowdfunding campaign on Kickstarter had a goal of \$20 000 (£14 000) but has already raised 12 times that. A parallel campaign on Indian platform Ketto has exceeded its

100,000 rupee (£1050) goal 24 times over. Peesapaty says he has had emails pouring in from around the world. 'It is so simple and it is this simplicity that has caught the attention of most people,' he says.

With a background in forest management, Peesapaty previously worked at the International Water Management Institute's crop research centre and says he wanted to use a raw material that won't put much pressure on water resources.

Even if the spoons are dumped after use, they decompose in a few days, according to the company. Bakeys says this makes its product more environmentally friendly than biodegradable plastic utensils made from corn plastic, which need to be subjected to high heat in specialised composting facilities to break down.

The spoons are packaged in paper bags and shipped using styrofoam to prevent breakage. Peesapaty acknowledges this is the least sustainable part of the operation and is looking for alternatives.

Although the edible cutlery has only just found a following – a recent Facebook video with Peesapaty has had more than 5m views – Bakeys has been making spoons at its factory in Hyderabad, India, since 2011, where it employs nine women. It sells 1.5m spoons per year to catering companies serving food at weddings and other events, but Peesapaty hopes take-up among food vendors will grow.

There are challenges. While Peesapaty hopes to expand Bakeys' offering to edible chopsticks and forks, edible knives are out as moisture blunts them. The biggest hurdle is probably cost. Bakeys can sell an edible spoon for 2 rupees (2p), cheaper than the wooden equivalent but twice the price of a plastic spoon.

Peesapaty's goal is to get the cost of a spoon down to 1.5 or 1 rupees. He hopes to do this by sourcing crops directly from farmers and building an economy of scale by adding new production lines with the investment raised online.

Conclusions

1 **Identify** why this product was created.
2 **Identify** the carbohydrate-based foods this product is made from.
3 **Explain** why carbohydrate-based foods were selected for this product.
4 **Explain** the challenges for the future of this product.

Waste management and sustainability

Australians throw away up to 20 per cent of the food they purchase. This equates to approximately $1036 of food per household thrown away each year. Many companies are intent on reducing waste products. One such company, Starbucks, is converting stale bakery goods into succinic acid in China. It is colourless and crystalline, and is used in lacquers, dyes and perfumes. What would otherwise have gone into landfill as waste is now being bio-refined to make a useable and profitable by-product.

ACTIVITY 10.5

Aim

To research alternative methods of waste management for spent grains

BACKGROUND

Spent grains are the by-product of brewing ale. They are the leftover residue from the fermentation process. They constitute up to 85 per cent of a brewery's total by-product. These grains would usually be fed to cattle or used as compost. Some of them end up in landfill. The interesting point about these grains is that they have high protein and fibre content and can be used to make food for human consumption. More brewers are using these grains to make food and thus increase their sustainability and reduce their waste. This food formulation for chocolate brownies uses spent grain flour.

CHOCOLATE BROWNIES

Food components

- 71 g unsweetened chocolate
- 28 g dark chocolate
- 75 g butter
- 2 eggs
- 200 g sugar
- 48 g plain flour
- ¼ cup spent grain flour
- 2 g baking powder
- pinch salt
- ½ cup coarsely chopped walnuts

Method

1. Preheat oven to 180°C and measure all ingredients.
2. Melt the chocolate and butter in a double saucepan, stirring until smooth. Allow to cool slightly.
3. Beat eggs one at a time and fold into the mixture. Note: if the mixture is too hot, the egg will coagulate.
4. Combine the sugar, flour, spent grain flour, baking powder and salt in a bowl and add one-third at a time, folding after each addition. Make sure that all the flour is incorporated.
5. Add the walnuts and mix.
6. Pour into a lined baking pan and spread out evenly.
7. Bake 25–30 minutes. Allow to cool in the pan before cutting.

Conclusions

1 Research two other ways spent grains are used in food formulations for human consumption.

2 **Identify** another recipe that could be adapted to use spent grains and formulate a new version of the food formulation.

Spent grains

Food protection

Biological, chemical and physical changes cause food spoilage in carbohydrate-based foods.

Biological changes

The three main biological changes are caused by bacteria, yeast and moulds.

Table 10.18 Biological causes of food spoilage

	EFFECT	CONSEQUENCES OF SPOILAGE
Bacteria	Breaks down food to produce acids and waste products which may have an unpleasant taste or may be harmful to health	• reduced quality of food • harmful to eat • causes foodborne illnesses known as food poisoning • uncooked or undercooked animal foods may be toxic and cause serious illness
Yeast	Decomposes foods with high sugar content, but can be used for production of food and beverages such as bread, yoghurt, cider	
Moulds	Grows on food and produces enzymes which break it down, causing food spoilage	• produces off flavours and discolouration • rots food • some moulds produce **mycotoxins** on food, which if ingested can be fatal

mycotoxin poisonous chemical compound produced by some fungi

Fermentation

Fermentation is the conversion of carbohydrates to alcohol and carbon dioxide or organic acids using yeasts, bacteria or a combination of these under anaerobic conditions. Fermentation is an anaerobic process that takes place in the absence of oxygen though it occurs with oxygen as well. The scientific name for fermentation is zymurgy. The action of microorganisms is used to produce alcoholic beverages such as beer, wine and cider. It is also used in the leavening of bread and for preservation techniques to create lactic acid in sour foods such as sauerkraut, dry sausages, kimchi and yoghurt or vinegar (acetic acid) for use in pickling foods.

Examples of foods that are made by fermentation are grain-based such as beer, bread, rice wine, malt whisky and **dosa**. Vegetable-based fermented products include kimchi and mixed pickle, while fruit-based are wine, vinegar and cider. Honey is also fermented to make mead.

dosa made from a fermented batter of rice and lentil – similar to a pancake or crepe

Spore development

Temperature and other environmental controls inhibit bacteria; however, some bacteria are able to survive environmental changes in spore form. Spores are able to remain in this state for long periods of time if the environment required for them to grow is not correct, as they are resistant to drying and heating. Once the environment becomes conducive to growth, the microorganism changes its form and can cause food to perish and become inedible. *Bacilllus cereus* is a spore that is present in dried rice, legumes and spices, and is able to survive the cooking process. The spores are dormant until water is added and then they germinate and grow. The heat applied in the cooking process is insufficient to kill the heat-resistant spores or the toxins they produce, and the bacteria grow in a warm, moist environment. Cooked rice that is not going to be eaten immediately must be stored in the refrigerator.

Chemical changes

Retrogradation

Retrogradation is a property of starch where the starch reverts or retrogrades to a more crystalline structure when it is cooled. This causes a deterioration of quality in the baked product and needs to be avoided. The polysaccharides amylose and amylopectin in cooked, gelatinised starch realign as the starch cools.

Retrogradation is the recrystallisation of the amylopectin, causing the amylose molecules to clump together and separate from the gel, breaking down the semi-elastic network characteristic of gelatinisation. Very high amylose starches are less likely to undergo retrogradation than those with lower amylose content. These types of starches are available to commercial food manufacturers. Retrogradation is the main reason for baked products becoming 'stale' and no longer 'fresh' tasting or 'fresh' handling. It also leads to an increase in firmness of crumb, flavour and aroma changes. It is the term used to describe changes that occur while cooling from gelatinisation temperatures as well as from long-term storage.

There are benefits of some starches undergoing retrogradation; cooked rice and potatoes form resistant starch when cooled. Resistant starch is not digestible but bacteria in the human gut are able to digest them. The digestion of resistant starch in the colon produces butyrate which can be used as a source of energy for the cells in the colon. The use of butyrate has been shown to have positive health benefits, such as preventing gut inflammation and increasing resistance to metabolic and physical stress.

Syneresis

As a gel ages, the bonds tighten between the amylose molecules as the gel contracts. This liquid from the gel is known as syneresis and the starch gel appears to thin as it stands. It can be a problem for food processors as they have to deliver products to meet consumer demand and expectations. To decrease syneresis in starch products food processors add different thickeners such as agar-agar, xanthan gum and lecithin without sacrificing the sensory properties of the formulation.

Physical changes

Staling is a physical change that occurs in baked products after baking. It is characterised by decreasing consumer acceptance because of changes to the crumb that are not caused by spoilage organisms. Bread starts to become stale shortly after baking as a result of the starch crystallising (retrogradation) and losing moisture. This produces a crumbly texture.

Some changes in bread as a result of staling include:

- more crumb firmness
- more crumbliness of the crumb
- loss of flavour and aroma
- softening of the crust.

Preservation processes

Perishable foods are foods that contain high amounts of water such as watery fruits and vegetables, fresh pasta, bread and baked goods.

Semi-perishable foods

Semi-perishable foods, such as starchy vegetables like potatoes, contain less water and, if stored well, are safe to eat for several months.

Sugar is added to fruit to make it semi-perishable in the form of fruit in syrup, jam and crystallised fruit. It reduces the fruit's moisture content and kills the bacteria and yeast, preventing their regrowth. It is sealed in an airtight container to prevent recontamination.

Non-perishable foods

Non-perishable foods contain very little water and can be kept for many months. Dehydration of foods removes the water content to stop the growth of bacteria and yeasts, to ensure long shelf life. Processed foods such as crackers, dry pasta, flour, rice and dried beans and peas fit into this category.

REVIEW QUESTIONS ▶

1 **Explain** the biological, chemical and physical changes that cause food spoilage in carbohydrate-based foods. Include an explanation of fermentation, spore development, retrogradation, syneresis and evaporation in baked goods.
2 **Explain** the perishable nature of different types of carbohydrate-based foods.
3 **Identify** the benefits that retrogradation can bring to starches when cooled.
4 **Explain** why starch retrogradation is not desirable in bread.

Mind mapping template

Mind mapping tools

How can the chemical and functional properties of carbohydrate, knowledge of food safety and spoilage, and preservation techniques be used to develop food solutions?

Create a mind map of information to help answer the guiding question. Use the supplied template or develop your own mind map. You may find it useful to use online tools such as Bubbl.us, Canva, Coggle, MindMup, iMindQ.

9780170418560

FAT 11

» How can chemical and functional properties of fat, knowledge of food safety and spoilage, and preservation techniques be used to develop food products?

In this chapter the chemical and functional properties of fats will be explored through experimentation. A knowledge and understanding of food spoilage and food safety, as well as preservation techniques, will assist students to develop food solutions.

Facts and principles about fat

Fat is an essential nutrient in the body and aids in the digestion of the fat-soluble vitamins A, D, E and K. Fat is a concentrated source of energy for the body, when compared to carbohydrate and protein.

Fat is made up of carbon, hydrogen and oxygen. The main form of fat is triglyceride. Triglycerides consist of a glycerol unit and three fatty acid units. Fatty acids are made up of long chains of carbon atoms with attached hydrogen atoms. Fat can be ingested in foods and created in the body by the conversion of excess carbohydrate into fat for storage.

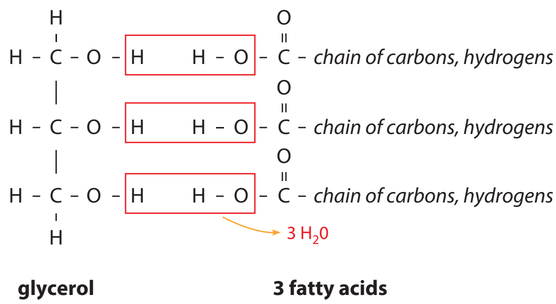


FIGURE 11.1 Triglyceride molecule

Functions of fat in the body

Fat performs multiple functions in the body.

Provides heat and energy

Fat is stored in the adipose tissue in the body and helps insulate the body to maintain a normal core body temperature and keep the body warm. While carbohydrate is the main source of energy for the body, fat is used as a source when carbohydrate is not available. Fat is the body's long-term energy source. However, fat cannot be used to make glucose, the central nervous system's preferred source of energy, in significant amounts, so carbohydrate must be consumed to prevent protein from being diverted from its other important functions for use as an energy source (protein is discussed in detail in chapter 4). Fat provides a concentrated source of energy and is said to have a greater energy density than carbohydrate or protein; one gram of fat provides 37 kilojoules of energy while carbohydrate and protein provide 17 kilojoules. For this reason, no more than 20 to 35 per cent of kilojoules should come from fat intake in the diet.

Protects bones and important organs

Fat in the body provides cushioning and protects bones, in the form of bone marrow, and organs from sudden impacts and movements. Men have on average a minimum of 3 per cent fat and women 13 per cent to support life and reproductive functions; the extra 10 per cent in women is mainly at the breasts, pelvis, hips and thighs to support pregnancy and breastfeeding. Fat is also part of the structure of the

9780170418560

central nervous system as it forms part of brain cell membranes, and forms sheaths that surround nerves and helps them transmit messages around the body.

Provides a vessel for fat-soluble vitamins

Fat-soluble vitamins are absorbed into the fat and, when ingested, the fat carries the vitamins A, D, E and K into the body and assists with their absorption in the intestines.

Classifications of fat

Fat is classified into three categories: saturated fat, unsaturated fat and trans fat.

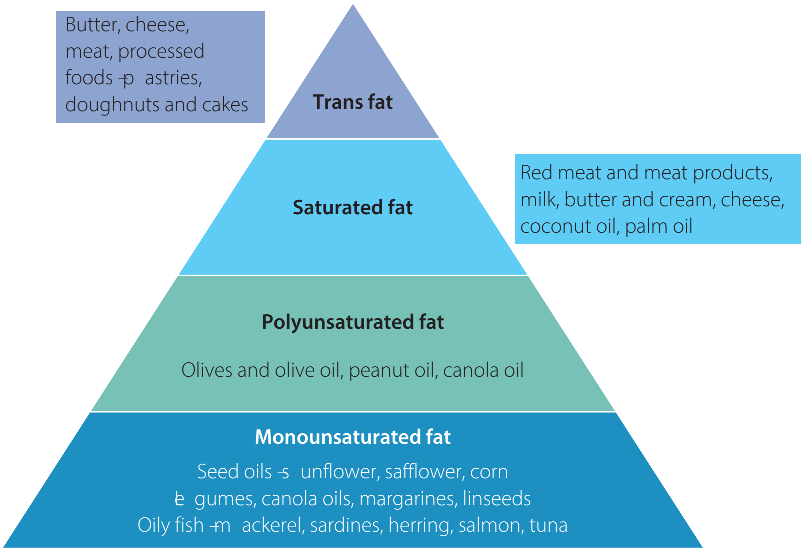


FIGURE 11.2 Classifications of fat

Saturated fat

Animal fats contain saturated fat. Saturated fatty acids have no double bond between the carbons. These fats are usually solid at room temperature, such as butter and meat fat. The Australian Dietary Guidelines suggest that saturated fats can be made in the body and are not therefore required in the diet. Food sources of saturated fat include red meat, meat products, milk and cream, butter and cheese. Coconut oil and palm oil are plant sources of saturated fat. Saturated fat consumption may increase cholesterol in the body.

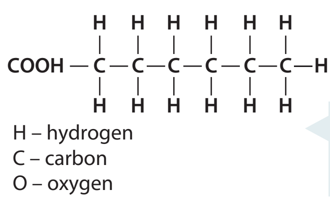


FIGURE 11.3 Chemical structure of saturated fats

Cholesterol

Cholesterol is a fat found in food and also in our blood. It is essential for many metabolic processes in the body; however, the body can make its own cholesterol in sufficient amounts. There are two types of cholesterol: HDL (high density lipoprotein) and LDL (low density lipoprotein). Foods with high levels of saturated fats may increase the overall production of LDL and can increase the production of HDL. Having high levels of LDL cholesterol has been linked to coronary heart disease.

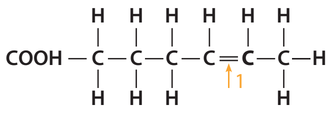
Unsaturated fat

Unsaturated fat is usually liquid at room temperature. Unsaturated fats are found in two main forms: monounsaturated and polyunsaturated. Their chemical structure is different, and this results in them having slightly different health benefits.

9780170418560

Monounsaturated

Unsaturated fat has double bonds between the carbon atoms, which can react with hydrogen. When there is only one carbon–carbon bond, the fat is known as monounsaturated.



H – hydrogen
C – carbon
O – oxygen

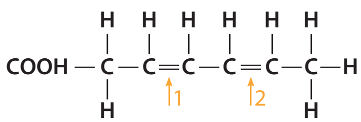
FIGURE 11.4 Chemical structure of monounsaturated fats

Linoleic acid in the form of seed oils, such as sunflower, safflower and corn, are monounsaturated fats. High levels of these have been linked to reducing LDL and increasing HDL, thus reducing the risk of coronary heart disease.

Omega fatty acids are included in this group. These occur in legumes, canola oils, margarines, linseeds, and oily fish such as mackerel, sardines, herrings, salmon, tuna and other seafood. These must be supplied in the diet as we cannot make them in our body.

Polyunsaturated

When there are many carbon–carbon double bonds present, the fat is known as polyunsaturated. These fats are usually liquid at room temperature and in the fridge, and are called oils. Oleic acid is found in olive oil, peanut oil and canola oil.



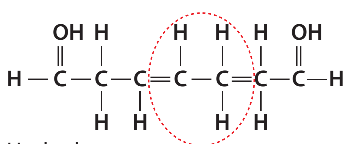
H – hydrogen
C – carbon
O – oxygen

FIGURE 11.5 Chemical structure of polyunsaturated fat

Trans fat

Trans fat occurs when liquid vegetable oils are partially hydrogenated or solidified during processing. Australian food manufacturers remove most trans fat during processing. These fats are harmful to the body. Trans fat occurs naturally in foods such as butter, cheese and meat, and processed foods such as pastries, doughnuts and cakes. Australians can reduce the amount of trans fat they consume by following the Australian Dietary Guidelines.

Australian Dietary Guidelines



H – hydrogen
C – carbon
O – oxygen

FIGURE 11.6 Chemical structure of trans fats

Shutterstock.com/Antonina Vlasova

FIGURE 11.7 Unsaturated fats include olive oil, avocado, nuts, salmon and fish oils.

Shutterstock.com/JPC-PROD

FIGURE 11.8 Saturated fats include palm oil, lard, coconut oil and butter.

Nutrient Reference Value (NRV) of fat in the diet

Protein, vitamins and minerals have an official recommended intake; however, there is no official recommended intake for fat. The Australian Dietary Guidelines recommend that a person consumes about 30 per cent of their total kilojoule intake in the form of fat. This equates to a healthy intake of fat in food and meets the body's requirements for fatty acids, without consuming too many kilojoules.

Depending on an individual's activity level, age and gender, they could consume between 40 and 85 grams of fat a day, with children requiring slightly more fat for their body weight than adults.

Table 11.1 Percentage of kilojoules from fat to grams

AGE AND GENDER	ACTIVITY LEVEL	KILOJOULE INTAKE	30% EQUALS	TYPE AND QUALITY OF FAT CONSUMED
Adult female	Moderately active	8 400 kJ	65 grams	Mono-unsaturated and polyunsaturated fats
Adult male	Moderately active	10 500 kJ	85 grams	
Adult female	Wanting to lose weight	5 000 kJ	40 grams	
Note: the more physically active a person is, the higher the fat intake can be.				

Over-consumption of fat

Over-consumption of saturated fat in the diet can be linked to increased risk of heart disease and high blood cholesterol levels. It is also linked to a higher risk of cancer of the breast, colon and prostate. It is sometimes linked to obesity, but this is not always the case as it is the quantity of food that is consumed in proportion to the energy expenditure that causes obesity.

9780170418560

Under-consumption of fat

While it is unlikely that Australians would consume too little fat in their diet, there are dietary implications for individuals who do not consume enough fat. Fat is a source of fat-soluble vitamins A, D, E and K, and therefore consuming too little fat can cause deficiencies of these vitamins. For more information on the deficiency of specific fat-soluble vitamins see page **xxx**.

REVIEW QUESTIONS ▶

1. **Explain** the multiple functions of fat in the diet.
2. **Identify** and explain the classifications of fat.
3. **Identify** the food sources of each classification of fat.
4. **Identify** the NRV of fat in the diet for adolescents aged 14 to 18 years.
5. **Explain** the reasons for the amount of fat required in the diet.
6. **Describe** the impact of over- and under-consumption of fat on health.

Production

The source of fats can come from all areas of food production. Livestock, through meat and dairy products, fish and plants all provide various forms of fat.

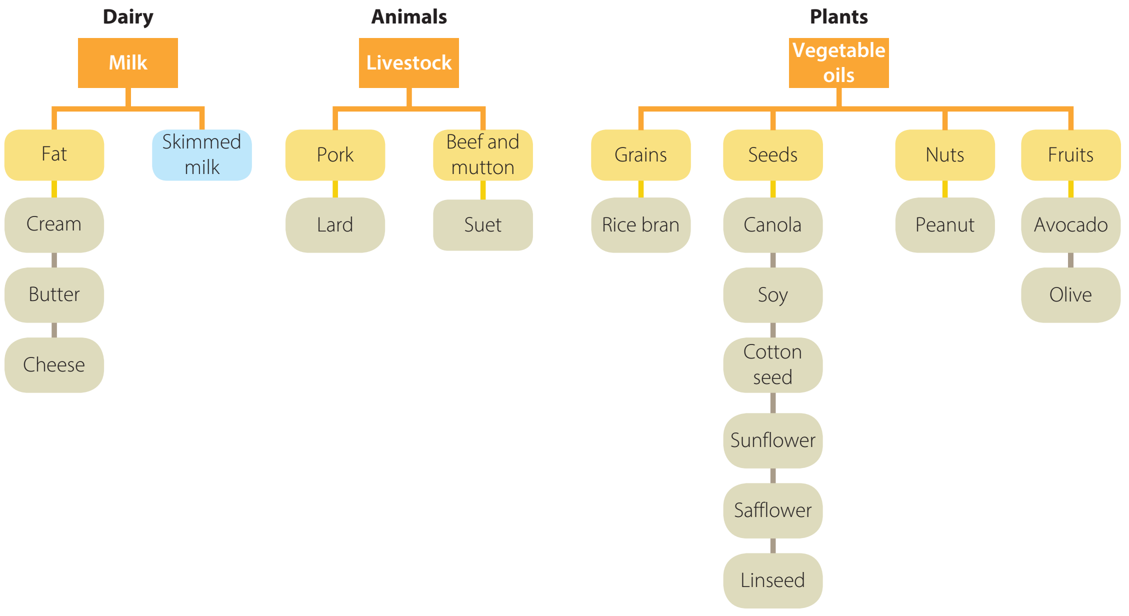


FIGURE 11.9 Fat-based foods produced from livestock, dairy and plants

Processing

ACTIVITY 11.1

Aim

To **explain** the distribution pathways required to process foods in ways that extend shelf life and the reasons for and benefits of food processing to consumers

STEPS

1 Turn to chapter 3, page 43 and read the sections on distribution pathways and the reasons for, and benefits of, food processing to consumers.
2 **Summarise** the key points and use your summary and your knowledge from this chapter to answer the questions that follow.

Conclusions

1 **Explain** the distribution pathways required to process foods in ways that extend shelf life.
2 **Explain** the reasons for processing food.
3 **Explain** how consumers benefit from the convenience of processing food. Give an example using a fat-based food.
4 **Explain** how the cost of food is reduced by food processing. Give an example using a fat-based food.
5 **Explain** how food processing ensures access to nutrients in food. Give an example using a fat-based food.
6 **Explain** why seasonality is minimised by food processing. Give an example using a fat-based food.
7 **Explain** how pathogen growth cycles are reduced by food processing. Give an example using a fat-based food.

ACTIVITY 11.2

Aim

To **analyse** the relationships between the structure and functions of fat, and the effect of these in food processing and on food quality

STEPS

Review the information on the structure of fat on page 274-275 and the functions of fat on page 273 and answer the questions that follow.

compare
display recognition of similarities and differences and recognise the significance of these similarities and differences

WS
Activity 11.2 template

Conclusions

1 **Identify** the differences in structure of each of the classifications of fat.
2 a **Compare** the differences between saturated and unsaturated fat.
  b **Explain** how the differences in structure affect the functions of fat in food processing. You can use a Venn diagram to structure your thoughts.
3 **Explain** the effects on health of saturated fat and trans fat. Consider the origins and characteristics and the effect on health.
4 **Draw conclusions** about whether saturated fat or trans fat has the greatest impact on the health of individuals.
5 **Identify** a type of fat that has less impact on the health of individuals and state why this is the case.

9780170418560

Chemical properties of fat

Hydrolysis

The triglycerides in fat are hydrolysed into fatty acids and glycerol by the heating of fats with water at a very high temperature (up to 200°C) under pressure. Frying food at a high temperature causes the water from the food to react with the fat, causing partial hydrolysis, releasing free fatty acids into the fat.

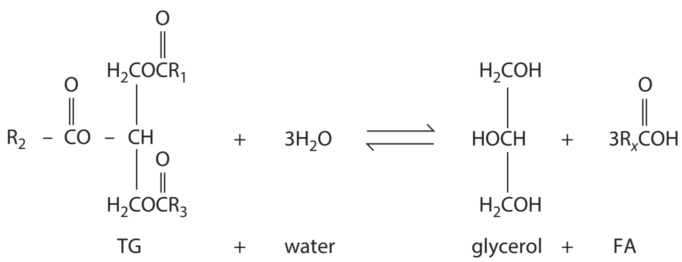


FIGURE 11.10 Complete hydrolysis

Fat can also be hydrolysed by the action of acid, alkali or enzymes in the body. Enzyme and acid hydrolysis produce glycerol and fatty acids from triglycerides.

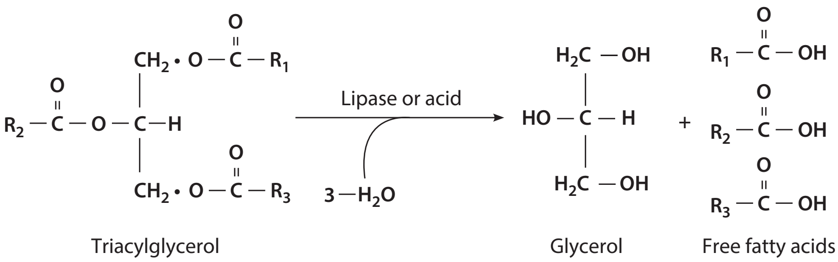


FIGURE 11.11 Hydrolysis – enzyme and acid

Alkaline hydrolysis produces glycerol and salts of fatty acids – soaps, which help with washing oily items.

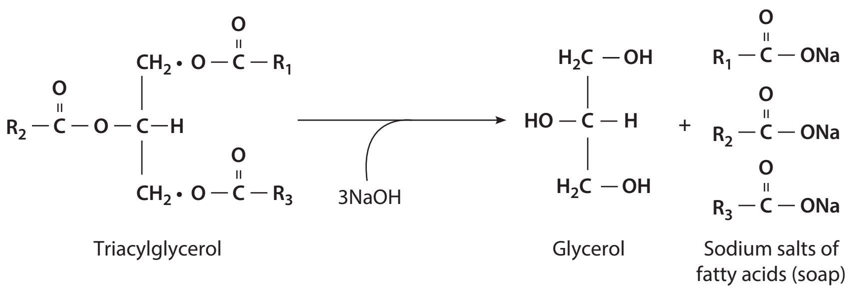


FIGURE 11.12 Hydrolysis – saponification

Hydrogenation

This is an important process in the food industry. It converts liquid fat to semi-solid fat by controlling the number of double bonds that are hydrogenated in the presence of metal (nickel). This process produces fat that has a soft and pliable consistency and can be used in many applications. With many vegetable oils produced, this allows the food industry to use these in other applications as products such as margarine and solidified vegetable shortening. In this way these oils are able to be flavoured and coloured and fortified with nutrients to resemble the qualities of butter.

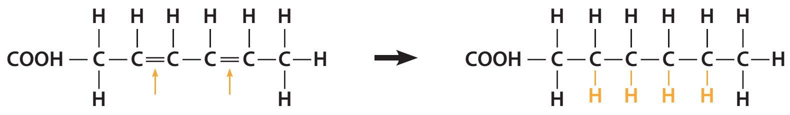


FIGURE 11.13 Hydrogenation - polyunsaturated fat to hydrogenated fat

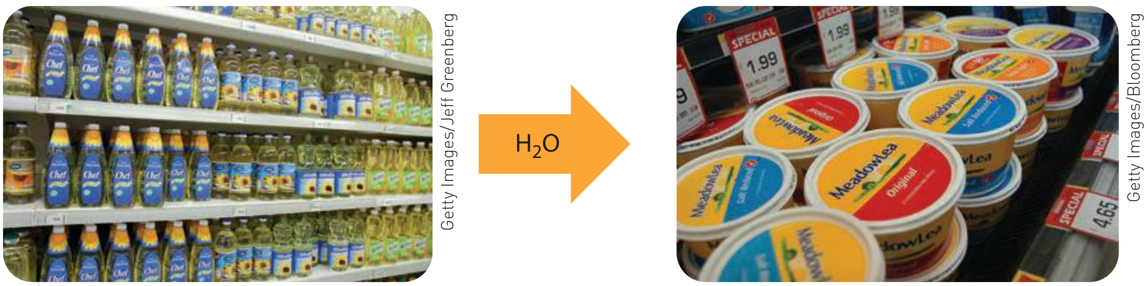


FIGURE 11.14 Hydrogenation - liquid fats to semi - solid fats

Rancidity

Deterioration of fat in food results in unpleasant flavours and odours. The oxidation of the fat component of the food is a chemical reaction between the fat and oxygen, causing the formation of short chain compounds. One such compound formed is butyric acid, which is responsible for the rancid taste. For more information on rancidity, see page 305.

Oxidation

Oxidation – the action of oxygen on fat components in the food – occurs in all food. 'Autoxidation' is the process of fat oxidation by air at room temperature. The presence of light can increase the rate of fat oxidation, as it is usually a slow process. The oxygen reacts with the unsaturated fatty acids at the site of the double bonds, where peroxides are formed. These may form secondary oxidation products such as hydrocarbons or ketones. The result of autoxidation in fats and oils is the development of rancidity. Higher temperatures result in the process occurring more rapidly. An unsaturated fat is less stable and more susceptible to oxidative rancidity than saturated fats.

9780170418560

Table 11.2 Functional and sensory properties of fat

PROPERTY	EXPLANATION	WHERE USED IN PROCESSING
Appearance	Can be liquid or solid at room temperature – fat is hydrogenated to change oil to a solid	Fat in food creates a glossy or moist texture. It aids in the browning process when cooking, making the food appealing to the consumer
Solubility	Fat is insoluble in water, with the exception of castor oil. Other compounds are soluble in fat. These compounds add flavour and even vitamin content to fat	Compounds soluble in fat, such as the fat-soluble vitamins A, D, E and K, are present in foods which contain fat as well as adding flavour to the food
Texture	Fat adds texture to food products. It gives food a lubricating mouthfeel by coating the tongue with oil or fat, which can leave a lasting flavour	Responsible for the creaminess of many food products such as ice cream, thick shakes, some desserts, and sauces
Shortening	Fat alters the texture of a flour-based formulation to create a characteristic crumb. The fat coats the flour grains to prevent them from absorbing water and reduce gluten development. This stops the dough becoming elastic	To make cakes, pastries and shortbread. Vegetable fats or lard can be used for shortening because they have a very low water content. The colour of the fat used is reflected in the colour of the formulation
Thermal properties	Melting point: each fat has a different melting point. The fat used determines the melting point of the formulation Heat transfer: fat has the ability to transfer heat during cooking	Vegetable oils are liquid at room temperature, which makes them suitable for salad dressings, while fat like butter and lard are solid at room temperature so they are perfect for icings and chocolate Fat with a high melting point will usually have a high smoke point. The higher the smoke point, the better the fat is for frying Heat transfer in fats is efficient as the hot oil quickly heats up the food that is being cooked. Deep-frying and sautéing use different amounts of fat or oil to transfer heat to food. Fat is used to form a crust on the outside of food as in fried fish, without overcooking the interior of the product
Density	Fat is less dense that water therefore will float on water	There is a decrease in density of food as the fat content increases
Viscosity	Saturated fats are straight – they line up well, so they are viscous or solid Monounsaturated fats bend so they are not viscous or a liquid	Viscosity is a property required in salad dressings and sauces. Salad dressings can be thin or thick. A thicker salad dressing will be more viscous
Taste	Fat from various sources such as bacon or butter have their own distinctive taste	Fat from various sources is used in different applications in food processing. For example, butter is used where the taste of butter is required, such as in butter cake and croissants. When a savoury product is being made, the choice of fat may be suet or olive oil
Flavour	All fat has a flavour of its own, such as butter, olive oil and coconut oil. It can also absorb flavours from other foods	Fat with strong flavour can impact on the flavour of the food product. Flavour infused oils are available after having herbs and spices added to the oils. Products such as chilli- and herb-infused oil are examples Removing or reducing the fat in food also has an impact on the flavour of the food product. Fat often means flavour in food, which makes food more pleasant to eat
Aroma	Aroma compounds are dissolved in fat and released as the food is cooked	Fat has the ability to concentrate the smells and flavours of food. Foods with a higher fat content have a more pleasing aroma

ACTIVITY 11.3

Aim

To **review** the information on sensory profiling and **develop** a lexicon to evaluate the sensory properties of fat-based food

STEPS

Review the information on fats above and the information on sensory profiling in chapter 7 page 168 (the information on lexicons on page 176 and 177 will be particularly helpful) and answer the following questions.

Conclusions

develop elaborate, expand or enlarge in detail; add detail and fullness to; cause to become more complex or intricate

1 **Develop** a lexicon to use to evaluate the sensory properties of fat-based food products.
2 **Defin** the parameters of the sensory profiling procedure to be used for fat-based food products.
3 **Justify** the choice of procedure to be used for sensory profiling fat-based products during the food science experiments.

Food science experiments

The effects of temperature and manipulation on the chemical and functional properties of fat can be investigated using food science experiments. Conduct a series of experiments to explore the effects that temperature and manipulation of fat can have on food products. Record all observations and the sensory properties analysis from each experiment, and complete the results analysis for future reference to assist in the development of a food product.

EXPERIMENT 11.1

Dispersed systems

BACKGROUND

A dispersed liquid–liquid system is known as an emulsion. An emulsion is formed when one liquid is dispersed within another liquid, using very fast mixing. Two **immiscible** liquids such as water-in-oil and oil-in-water would not normally mix together. Mixing oil with water does not form a stable emulsion and over time it will separate out to a water layer and an oil layer. To prevent this happening in food production, chemicals known as emulsifiers are added to the mixture.

immiscible incapable of being mixed

An emulsifier is made up of a water-loving hydrophilic end and an oil-loving hydrophobic end. Emulsifiers are chemicals that have both lipophilic and hydrophilic bonds that build bridges between the aqueous and oil phases. The ability of the emulsifier to dissolve in fat or oil (lipophilicity) assists the emulsification of the liquids. The emulsifier forms a physical barrier to stop the droplets coming together. They create smooth emulsions by allowing the water and oil to become

Shutterstock.com/Ksenija Toyechkina

FIGURE 11.15 French dressing, a temporary emulsion dispersed in each other, becoming stable and homogenous. Oil-in-water and water-in-oil emulsions are able to be created.

Often emulsions require two steps in the process. Some require a blender or mixer, or high-pressure homogenisation. This is known as **shearing** power. These processes cause a decrease in droplet size and influence the absorption of the emulsifier. An emulsification agent or emulsifier is then added to the formulation.

Two basic types of emulsifiers are used in food preparation – amino acid chains and phospholipids. The amino acid chains have fat- and water-friendly receptors. An example of these are the amino acid chains that make up casein protein and which are found in milk. They are capable of linking fat and water together. Phospholipids, such as lecithin, are found in egg yolk and soy. Lecithin is a strong emulsifier, especially when it is used in an oil-in-water emulsion. It will link the oil and the water together and cause the oil to repel other oil molecules, preventing separation.

Shutterstock.com/margouillat photo

FIGURE 11.16 Mayonnaise

Emulsifiers are used in bread, cakes and pastry to ensure the crumb is soft and tender. Emulsifiers are also used in salad dressings, sauces, mousses, puddings, margarine and ice cream. Examples of emulsifiers include egg yolk (emulsifying agent is the amino acid chain and lecithin), honey, mustard and soy lecithin (322). Other common emulsifiers in Australia include sorbitan monostearate (491), monoglycerides and diglycerides of fatty acids (471) and polysorbate 80 (433).

shear
strain produced by pressure in the structure of a substance or liquid, when its layers are laterally shifted in relation to each other; any real fluids (liquids and gases included) moving along solid boundary will incur a shear stress on that boundary

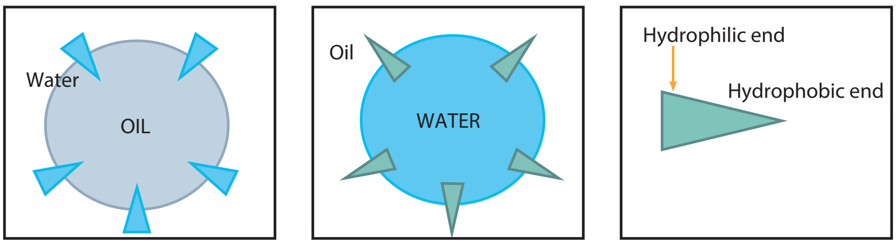


FIGURE 11.17 How an emulsion works

A water-in-oil emulsion is where the water is dispersed in oil. Examples of water-in-oil emulsions include margarine, butter and vinaigrette, which is an emulsion of vegetable oil in vinegar. An oil-in-water emulsion will have high viscosity.

The ingredients used in this emulsion will not be particularly viscous until they are combined. Stirring strongly will, however, reduce the viscosity of this emulsion, as it is a shear thinning fluid. Shear thinning is the non-Newtonian (not normal) behaviour of fluids where their viscosity decreases when stress such as vigorous stirring is applied. Examples of oil-in-water emulsions include milk, cream and mayonnaise.

Emulsions

AIM

To **investigate** the effect of shear on emulsions using different emulsification agents

INSTRUCTIONS

Experiment with the effect of shear and emulsifier types on the stability of oil–water dispersions such as mayonnaise.

> The mayonnaise in this experiment can be used in the viscosity experiment.

PREPARATION

1 Prepare one (1) formulation or mayonnaise and one (1) formulation of salad dressing using each emulsifier.
2 Once the formulations have been completed, beat or blend vigorously and record results.

FOOD COMPONENTS

EMULSIFIER 1: EGG YOLK

- 1 large egg yolk
- 1½ teaspoons fresh lemon juice
- 1 teaspoon white wine vinegar
- ¼ teaspoon Dijon mustard
- ½ teaspoon salt
- ¾ cup canola oil, divided

SAFETY

Note: raw egg is not recommended for some people as it can cause *Salmonella* poisoning.

EMULSIFIER 2: SOY LECITHIN

- ½ teaspoon liquid soy lecithin
- 1½ teaspoons fresh lemon juice
- 1 teaspoon white wine vinegar
- ¼ teaspoon Dijon mustard
- ½ teaspoon salt
- ¾ cup canola oil, divided

EQUIPMENT

- stick blender or blender with opening in the lid, or food processor with opening
- measuring spoons and jug

PROCEDURE

EGG YOLK MAYONNAISE

1. Combine egg yolk, lemon juice, vinegar, mustard, and salt in medium bowl or food processor. Blend until bright yellow, about 30 seconds.
2. Turn on the blender.
3. Slowly drizzle (a few drops at a time) ¼ cup oil into the yolk mixture blending constantly.
4. Gradually add the remaining oil, blending constantly until the mayonnaise is thick.
5. Cover and chill. This food formulation will keep for two days, chilled.

SOY LECITHIN MAYONNAISE

1. Combine egg yolk, lemon juice, vinegar, mustard and salt in medium bowl or food processor. Blend until bright yellow, about 10 seconds until smooth.
2. Turn on the blender.
3. Slowly drizzle (a few drops at a time) oil into the yolk mixture, blending constantly until the mixture is thick (5–10 seconds).
4. Immediately turn the blender off as it will shear and liquefy if left mixing.
5. Cover and chill. This food formulation will keep for two weeks chilled.

WS Experiment 11.1 template

TYPE OF EMULSIFIER	THICKNESS OF MAYONNAISE	APPEARANCE	TASTE	TEXTURE	FLAVOUR	AROMA	EFFECT OF SHEAR ON EMULSION
Egg yolk							
Soy lecithin							

RESULTS ANALYSIS

1. **Explain** how each emulsifying agent formed an emulsion in the mayonnaise formulations.
2. **Draw conclusions** about the effect of shear on each emulsifying agent.
3. **Propose** where each emulsifying agent could be used in food formulations.

9780170418560

EXPERIMENT 11.2

Viscosity

AIM

To **investigate** the effects of temperature and manipulation on viscosity by comparing and contrasting the role of emulsifiers in different applications

BACKGROUND

Viscosity is the term used for the thickness of a liquid or the resistance it gives when flowing or moving. The particles that make up the liquid determine its viscosity. If the attractions between the molecules are strong, the thicker the liquid and the higher the viscosity, such as mayonnaise. If the liquid is thin, like oil, it has a lower viscosity. A salad dressing needs to be viscous enough to coat the lettuce but thin enough to be able to be poured from the bottle. A viscometer is used to measure viscosity in food products. In a classroom it is simple to measure viscosity using a few tools such as a measuring cylinder, stopwatch, ruler, calculator, liquid, scales and glass marble or metal ball.

Viscosity is affected by temperature – an increase in temperature will cause the particles in the liquid to move faster, weakening the attraction between the particles and the liquid will become thinner. The heat causes the particles to move, which creates space between the particles, allowing the liquid to flow freely, resulting in shear.

Manipulation, as in the mixing of the emulsion, can also cause a degree of shear. Salad dressings are designed to be shear thinning. This means that on shaking or mixing the liquid becomes thinner and is able to be poured from the bottle.

Salad dressing made at home may not have added emulsifiers and after vigorous shaking will still separate into the oil and vinegar. In commercial food preparation emulsifiers such as xanthan gum and lecithin are effectively used to stabilise emulsions. Different emulsifiers are used in formulations depending on the desired end product. There are two general classifications of salad dressing – spoonable and pourable. Emulsifiers are chosen depending on the desired result. For example, a ranch-style dressing will use propylene glycol alginate as it has good mouthfeel properties while a xanthan gum or mustard will maintain the texture for a pourable salad dressing. Egg yolk and lecithin are used for spoonable dressings such as mayonnaise. Some emulsifiers produce a viscose end product while others produce a much more liquid result.

This experiment will use different emulsifying agents to produce desired results for salad dressing and mayonnaise. Salad dressing is a water-in-oil emulsion and is usually liquid while mayonnaise is an oil-in-water emulsion and will be thicker.

INSTRUCTIONS

PREPARATION

Prepare one batch of variable 1 and purchase variable 2. Use variable 3 and 4 from Experiment 11.1.

FOOD COMPONENTS

- 20 mL balsamic vinegar
- 5 mL French mustard
- 2 × 20 mL extra virgin olive oil
- pinch salt and pepper

VARIABLE 1	VARIABLE 2	VARIABLE 3	VARIABLE 4
Oil-in-water emulsion	Purchased French dressing – oil based	Mayonnaise made with egg yolk emulsifier	Mayonnaise made with soy lecithin emulsifier

EQUIPMENT

- glass jug
- spoon or stick blender
- measuring spoons
- measuring cylinder
- stopwatch
- ruler
- calculator
- liquid
- scales
- glass marble or metal ball

PROCEDURE

1. Measure all ingredients into the glass jug.
2. Stir well until the mixture is of a creamy consistency.
3. Test the viscosity of each variable at room temperature and at 5°C using the procedure in the link on NelsonNet.
4. Stir each sample vigorously and note the changes in viscosity; retest each sample.
5. Record the results of each test.

VARIABLES	EMULSIFYING AGENT USED	ROOM TEMPERATURE	5°C	ROOM TEMPERATURE AFTER STIRRING	5°C AFTER STIRRING
Variable 1					
Variable 2					
Variable 3					
Variable 4					

WS Experiment 11.2 template

RESULTS ANALYSIS

1. **Compare** the viscosity of the pourable variable 1 and 2 salad dressings at different temperatures.
2. **Draw conclusions** about the effect temperature has on the use of emulsifying agents.
3. **Compare** the viscosity of the spoonable variable 3 and 4 salad dressings at different temperatures.
4. **Draw conclusions** about the effect temperature has on the use of emulsifying agents.
5. **Compare** the viscosity of the pourable variable 1 and 2 salad dressings at different temperatures after stirring.
6. **Draw conclusions** about the effect that stirring or manipulation has on the viscosity of salad dressings.
7. **Compare** the viscosity of the spoonable variable 3 and 4 salad dressings at different temperatures after stirring.
8. **Draw conclusions** about the effect that stirring or manipulation has on the viscosity of salad dressings.

9780170418560

EXPERIMENT 11.3

Spherification

BACKGROUND

Spherification is a modern molecular gastronomy technique invented by Spanish chef Ferran Adrià in 2003 at his restaurant elBulli. He discovered that the key ingredient used to make the spheres was sodium alginate. His team experimented and made different kinds of spheres using different liquids. Since then the technique has been trialled and mastered by many chefs. Cold oil and sodium alginate are natural products used in the food processing industry.

There are two types of spherification: basic and reverse spherification.

BASIC SPHERIFICATION

Cold oil can be used to create salad dressing caviar. The oil is cooled in the freezer for 30 minutes while the salad dressing – such as balsamic vinegar – is heated to dissolve agar-agar, bringing it to the boil. The temperature of the salad dressing must be dropped to 50°C. A syringe is filled with the hot solution and pressed out drop by drop into the cold oil, forming spheres. Another method of spherification is using sodium alginate. Sodium alginate is a salt that has been extracted from brown algae. This type of spherification can only occur in cold temperatures where the calcium reacts with excess alginate and forms a protective membrane around a small sphere of liquid. The liquid is mixed with the sodium alginate and placed in a calcium chloride bath. It is easier than reverse spherification and is used to make small caviar-like balls. Unfortunately, the jellification process does not stop once removed from the alginate solution, therefore they must be served or used immediately. This method cannot be used for acidic liquids.

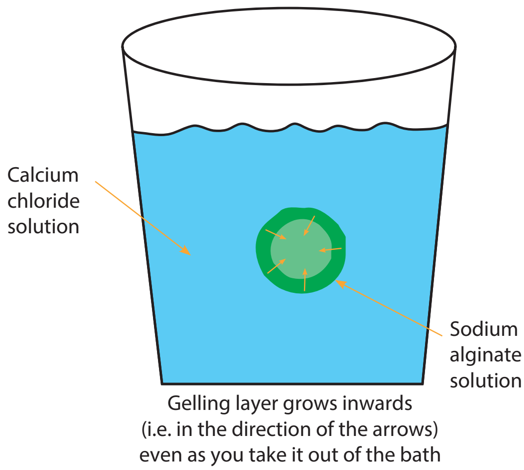


FIGURE 11.18 A thin membrane is formed on the outside of the sphere and continues to form after removal from the calcium chloride solution.

REVERSE SPHERIFICATION

This is more complicated and requires advance preparation. This is reverse as the bath is the sodium alginate when compared to basic spherification where the bath is the solution, which has a high calcium content. Calcium chloride is not generally used for reverse spherification because it has a salty and bitter flavour. Calcium lactate or calcium lactate gluconate are preferred as they have little or no flavour. The liquid with calcium content is added to the sodium alginate bath. This is best for liquids with high calcium content or alcohol. The spheres are long lasting and can be stored in the fridge. The membrane around the sphere is thicker than the membrane with basic spherification. Reverse spherification can be done using liquids that have some acidity. The flavour of the liquid is not altered by the addition of calcium lactate gluconate or calcium lactate.

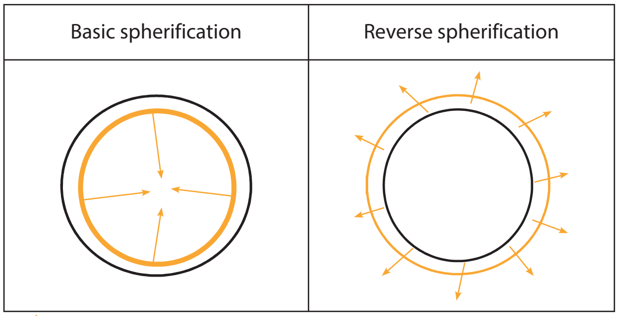


FIGURE 11.19 Basic and reverse spherification

AIM

To **experiment** using basic spherification to produce salad dressing caviar

> Use a tall tumbler for the oil so the caviar balls can set as they sink in the oil solution.

INSTRUCTIONS

PREPARATION

Prepare one (1) formulation following the instructions.

1. Prepare the oil in the freezer 30 minutes prior to the class so it is cold.
2. Cool the agar-agar solution to 50°C prior to using it in the oil.

FOOD COMPONENTS

- 1 cup of cold vegetable oil
- 100 g balsamic vinegar
- 1.5 g (1.5%) agar-agar

EQUIPMENT

- tall glass (e.g. highball)
- scales
- small saucepan
- whisk or beater for stirring
- syringe
- confectionery thermometer
- metal spoon
- slotted spoon

PROCEDURE

1. Measure the oil into a tall glass and place in the freezer for at least 30 minutes.
2. Put the balsamic vinegar into a saucepan with the agar-agar, dissolve and bring it to the boil, whisking or beating constantly. Remove any impurities from the surface with a spoon.
3. Allow to cool until the temperature is 50°C to 55°C.
4. Draw the hot balsamic agar solution into the syringe, hold it 5 cm above the oil and push it out drop by drop into the cold oil.
5. Allow the balls to sit in the oil for a few minutes and use a slotted spoon to carefully remove them. Rinse in water and place in a container for later use.

RESULTS ANALYSIS

1. Record the chemical and functional changes to the salad dressing caused by basic spherification in cold oil.
2. **Describe** the sensory properties of appearance, taste, texture, flavour and aroma.
3. **Propose** where cold oil spherification could be used in food formulations.

9780170418560

EXPERIMENT 11.4

Basic spherification using sodium alginate and calcium chloride

AIM

To form spheres using basic spherification

FOOD COMPONENTS

SODIUM ALGINATE AND JUICE

- 3 g sodium alginate
- 325 mL water
- 200 mL fruit juice such as raspberry juice, watermelon juice or another juice that is not too acidic

CALCIUM CHLORIDE BATH

- 5 g calcium chloride
- 1 L water

EQUIPMENT

- bowl – small
- stick blender or blender
- saucepan
- measuring scales with one decimal point
- measuring jug
- rectangular plastic container with about 1 litre capacity for calcium chloride bath
- syringe or pipette
- slotted spoon

PROCEDURE

1 Place the calcium chloride into a bowl with the litre of water. Mix until dissolved and leave to sit until it is clear. Make sure there are no lumps and that it is transparent.
2 Measure sodium alginate and add to water.
3 Mix using a blender or stick blender to disperse the sodium alginate into the water until it is smooth. This could take 5–10 minutes.
4 Place the solution into a saucepan and bring to the boil. Allow to cool to room temperature.
5 Use a small bowl to mix the sodium alginate solution with the fruit juice.
6 Draw the mixture into a pipette or syringe and gently squeeze out drops of the solution into the calcium chloride bath. If the liquid is dispensed too quickly the spheres will not form. Try to make drops of liquid into the bath.
7 Allow the spheres to form for 1 minute. Use the slotted spoon to remove the spheres and wash well in a bowl of water to remove any traces of calcium chloride.
8 Use immediately.

Try reverse spherification using sodium alginate and a high calcium ingredient, such as yoghurt or fruit juice that is not too acidic with the addition of calcium lactate or calcium lactate gluconate.

Reverse spherification

RESULTS ANALYSIS

1 Record the chemical and functional changes to the fruit juice solution in calcium chloride bath.
2 **Describe** the sensory properties of appearance, taste, texture, flavour and aroma.
3 **Explain** the difference between cold oil spherification and sodium alginate spherification.
4 **Propose** where each spherification agent could be used in food formulations.

propose
put forward (e.g. a point of view, idea, argument, suggestion) for consideration or action

EXPERIMENT 11.5

Powderising

AIM

To convert an oil-based salad dressing into powder

BACKGROUND

Molecular gastronomy is where science meets food preparation. The use of maltodextrin is one such example of a modern slant on traditional foods. Maltodextrin is a polysaccharide that can be used as a food additive. In the food industry, maltodextrin is used as a thickener or filler in processed foods. It is made by partially hydrolysing starch from rice, corn, potato or wheat and its common form is a white powder. The ratio of fat to maltodextrin is 60 : 40, but more maltodextrin can be added if required. The maltodextrin absorbs the fat and the fat is dehydrated. Any type of fat that can be liquefied can be dehydrated using maltodextrin. The powder is soluble in water and has little flavour. The powder dissolves as soon as it is in your mouth, with no powdery sensation, so when combined with oils all that is tasted is the oil.

Maltodextrin

INSTRUCTIONS

PREPARATION

Prepare one (1) formulation following the instructions.

FOOD COMPONENTS

- 4 × 20 mL olive oil
- 10 mL lemon juice or red wine vinegar
- salt, pepper or herbs to taste
- maltodextrin powder

EQUIPMENT

- whisk
- small bowl
- measuring spoons
- metal spoon

PROCEDURE

1 Whisk the lemon juice or red wine vinegar through the olive oil until translucent. Add flavourings and whisk.
2 Mix the salad dressing with the maltodextrin, adding the maltodextrin slowly until a powder forms. The texture can be made fluffier by straining the powder through a fine sieve.

RESULTS ANALYSIS

1 Record the chemical and functional changes to the salad dressing caused by the addition of maltodextrin.
2 **Describe** the sensory properties of appearance, taste, texture, flavour and aroma.

REVIEW QUESTIONS ▶

1 **Identify** and **explain** the chemical properties of fat.
2 **Identify** and **describe** the functional and sensory properties of fat and describe how these are used in food processing.
3 **Describe** a dispersed liquid–liquid system.

4 **Identify** the two types of emulsions and give examples of each.
5 Use diagrams and text to **describe** in detail the properties of the different types of emulsions.
6 **Defin** viscosity.
7 **Analyse** the effects of temperature and manipulation on the viscosity of emulsions.
8 **Explain** ways in which spherification can occur and summarise in detail the different types and uses in food.
9 **Explain** 'powderising' and how it is used in food processing and give examples of its use.
10 **Identify** the food processing techniques used to control the access to and consumability of fat-based food sources.
11 Revise the sensory profiling information and use it to evaluate the quality of fat-based food products in experiments including appearance, taste, texture, flavour and aroma.
12 **Summarise** the results of food science experiments (including sensory properties) to draw conclusions about the functions of fat in food preparation and how fat can contribute to food formulations.
13 **Analyse** the results of the food science experiments on fat-based products to draw conclusions to justify food formulations and why they are altered to increase the functional and sensory properties of food products.
14 Use the primary data from the experiments to **develop** ideas about the formulation of a fat-based food solution.
15 **Explain** the relationship between the structure and functions of fat and the effects of these in food processing and on food product quality.

evaluate
make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria

Distribution

Foods are transported across Australia using the network of road and rail in fleets of refrigerated transports. It is important to note that fat in the form of meat and dairy needs to be stored in refrigerated conditions (0°C to 5°C) to remain fresh until it is delivered to all consumers, including isolated and remote consumers.

The method of distribution of fat-based foods is dependent on the processing and preservation techniques used. Processing of foods with fat as a key nutrient includes some cheeses, butter, cream, pastries, many savoury snacks, cakes and biscuits as well as some desserts such as ice cream and mousse. Processing in some cases increases shelf life and safety of the food product by decreasing the pathogen growth cycles.

Preservation techniques for fat-based foods such as the addition of antioxidants and the exclusion of air to prevent oxidation, the addition of antimicrobial preservatives such as calcium propionate or sodium nitrate and sulphites, refrigeration and freezing extend shelf life of food items so they are available to the consumer all year round. Foods processed in different ways may require different transport, storage and distribution options. For more information on distribution, see chapter 2, page 15.

Consumption

Food containing fat is consumed every day. While the Australian Dietary Guidelines suggest that consumers should eat less fat, it is present in many of the foods that are consumed on a regular basis. Fat in food contributes to the sensory properties of foods: appearance, taste, texture, flavour and aroma. The following experiments will investigate different methods of food preparation for fat-based foods, including frying, stir-frying, roasting and baking.

EXPERIMENT 11.6

Sensory properties of fat-based foods

AIM

To use frying as a food preparation technique to investigate the different fats used for deep-frying and the sensory properties of chips fried in different types of oils and fat

BACKGROUND

Frying is using direct heat for heat transfer. A frying medium such as oil is used in the process.

The purpose of fat in frying is:

- as a heat transfer medium
- as a lubricant to prevent the food from sticking to the pan
- to add flavour to the food
- to assist the food to brown and create a crisp outer texture in some cases.

To determine the type of oil used in frying an understanding of smoke point and flash point is required.

Smoke point is the temperature that oil reaches before it smokes. This temperature point means the temperature that the oil will ignite (flash point) is close. Once an oil reaches smoke point it is breaking down as the bluish coloured smoke is generated. The smoke is composed of aldehyde acrolein and results from the breakdown of the glycerol from the triglycerides.

SAFETY

It is important to use an oil with a high smoke point when frying. Frying food formulations require close attention as they can ignite very quickly and can cause damage to the kitchen and injury to the cook.

In the event of a fire, cover the container with a fire blanket to extinguish the flames.

Table 11.3 Uses and smoke point of various fat-based products

TYPE OF FAT	USE	SMOKE POINT (APPROXIMATE)
Canola oil	Bland flavour so can be used in many frying formulations. Monounsaturated	242°C
Butter	Buttery flavour used with other oils to fry at low temperatures. Used as a shortening in baked products	177°C
Olive oil	The more refined oil has a higher smoke point. Use the oil which has the desired flavour for the usage. It is a good compromise oil to use for frying because of its smoke point and health benefits	Extra virgin – 190°C Virgin – 230°C Extra light – 242°C
Sesame oil	Has a sweet, nutty flavour – not suitable for frying, but added to Asian dishes sparingly just before serving	210°C
Sunflower oil	Used as a frying medium with mild taste. Degrades on use	232°C
Rice bran oil	Suitable for use as a frying medium for stir-frying and deep-frying. Virtually flavourless	232°C
Avocado oil	Used for high heat cooking techniques, such as grilling and pan roasting. Can be used for salad dressings. Has a mild flavour	271°C
Coconut oil – refined	Neutral flavour (unrefined, has a nutty flavor) and is best used for heat applications such as sautéing, baking, roasting and frying	232°C

(*Continued*)

Table 11.3 Uses and smoke point of various fat-based products (*Continued*)

TYPE OF FAT	USE	SMOKE POINT (APPROXIMATE)
Lard	Used as a shortening or spread similar to butter. Distinctive flavour used for savoury dishes. Used for a flaky and savoury pastry	121–218°C
Vegetable oil	A blend of several plant oils. Good for many frying formulations	Smoke point varies depending on the dominant oil in the formulation

There are several methods of frying used in food preparation. They are distinguished by the amount and type of oil used in the process.

Table 11.4 Methods of frying

METHOD OF FRYING	TEMPERATURE OF OIL	SUITABLE OILS	FOOD FORMULATIONS
Deep-frying – the food is completely covered by the oil. The food is sometimes covered with a batter or breadcrumbs. This adds flavour, texture, retains moisture in the food and gives a pleasing brown appearance	very hot – 177 to 232°C	oil with a high smoke point is only suitable for deep frying	• battered or crumbed meat and fish products • churros or doughnuts • chips and French fries • vegetable crisps
Sautéing – a small amount of oil is used in a frying pan	medium to hot	• vegetable oils • olive oils	onion, vegetables
Shallow- or pan-frying – a moderate amount of oil is used. The oil is heated to hot and the food is added	hot oil	• vegetable oils • oils from meat contribute to the fat in the pan	meat, chicken, fish
Stir-frying – a small amount of fat is used. The food is turned over very quickly	medium to hot	vegetable oils	meat and vegetables usually in Asian foods

As oil is used for deep-frying, the flavours of the food are absorbed into the frying medium. Oil will be subject to the chemical reactions of hydrolysis and oxidation during deep-frying. Absorption of the flavours and compounds from the fried food will mean that the oil will need to be replaced regularly.

INSTRUCTIONS

Use different oils to prepare frozen chips to test the sensory properties.

PREPARATION

Use 1 kg of frozen chips. Fry each 250 g in a different fat and record the results.

FOOD COMPONENTS

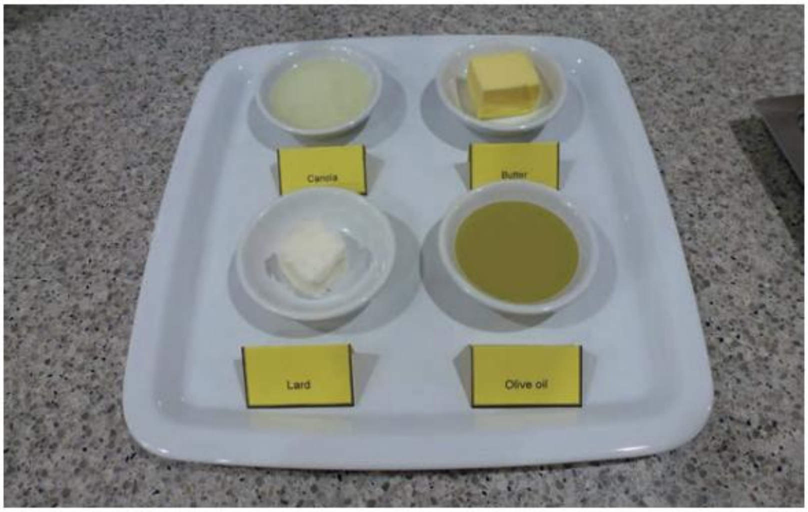
CANOLA OIL	BUTTER	LARD	OLIVE OIL
250 grams chips	250 grams chips	250 grams chips	250 grams chips

- 1 kg frozen chips
- 500 mL of canola oil
- 500 g of butter
- 500 g of lard
- 500 g of olive oil

The hot oil should not be returned to the original container as it will cause the container to melt. Neither should the used oil be returned once it is cooled as it contains compounds from the food that has been fried, which will contaminate the original oil.

SAFETY

Oil used for frying will reach high temperatures. (*Teachers*, please assess the risks in using hot oil with students and take the necessary precautions to ensure safety.)



Terry McCarten

FIGURE 11.20 Labelled variables before frying

EQUIPMENT

- 4 large saucepans
- tongs
- paper towel – for draining the chips after frying

PROCEDURE

1. Heat the fat in a saucepan and wait until hot. It is a good idea to test the fat with one chip to ensure that it is hot enough. The chip should sizzle when dropped gently into the fat. If the fat is hot enough, add the chips.
2. Allow to cook until golden brown. Be careful, the chips in butter may burn as it has a low smoke point.
3. Turn off the heat and remove the chips from the hot fat onto paper towel.
4. Make observations of the oil and residue and record.
5. Record the results.

RESULTS ANALYSIS

Observations should be recorded in a table like the one that follows or use the template on NelsonNet.

1. **Draw conclusions** about the best oil for use for deep frying. Comment on the flavour, taste, texture, colour, aroma and the residue left in the oil after frying.

WS Experiment 11.6 template

TYPE OF FAT	COLOUR	APPEARANCE	TASTE	TEXTURE	FLAVOUR	AROMA	SUITABILITY FOR FRYING
Canola oil							
Butter							
Lard							
Olive oil							

2. **Explain** why deep-frying is considered to be an unhealthy method of cooking.
3. **Propose** where each fat or oil could be used in food formulations.

9780170418560

EXPERIMENT 11.7

Stir-frying

AIM

To compare the sensory properties of stir-fried food using the Chao and Bao method of stir-frying

BACKGROUND

Stir-frying originated in China and is now used extensively in all parts of the world. The technique uses a small amount of very hot oil in which ingredients are fried while being constantly stirred. The original cooking pan was a wok with two techniques being employed.

Chao technique is similar to sautéing where the pan is heated and a small amount of oil is added. This is followed by dry seasonings such as garlic, ginger and shallots, which are tossed until they are fragrant. The other ingredients are then added, with those taking longer to cook being added first. Once these ingredients are almost cooked, the seasonings, such as sauces, wines, salt and sugar as well as cornstarch to thicken, are added to complete the dish.

Bao technique is where the wok is heated to glow red over a high heat. Oil and meat cut into small pieces and covered with egg wash or starch, and seasonings are added, and the food is continually tossed. Other ingredients are added, such as broth and vegetables. The wok is rinsed quickly after the food is prepared to prevent food burning in the wok. More fat with a higher smoke point is used in this method.

INSTRUCTIONS

PREPARATION

Produce one of each variable using different wok cooking techniques.

VARIABLE 1	VARIABLE 2
Using Chao technique	Using Bao technique

SAFETY

The wok in this experiment will be very hot. (*Teachers*, Warn students and carry out safety recommendations.)

FOOD COMPONENTS

VARIABLE 1 – STIR-FRY VEGETABLES

- 30 g cornflour
- 40 mL water
- 1 cup mixed vegetables, e.g. baby corn, sweet corn, mushrooms, broccoli, cauliflower, ginger, garlic, onion, carrot, capsicum, cabbage
- 2 × 20 mL dark soy sauce
- 1 × 20 mL tomato sauce
- 30 mL chilli sauce – adjust to taste
- salt and pepper
- 20 mL oil

VARIABLE 2 – HONEY AND CHILLI CHICKEN

- 200 g chicken breast or thigh meat
- flour to coat chicken
- oil for deep frying
- 0.5 cm piece green ginger
- 10 g honey
- 5 g cornflour
- 20 mL water

- 2.5 mL Chinese chilli sauce
- 10 mL lemon juice
- 2.5 mL soy sauce
- ½ shallot

EQUIPMENT

- wok
- scales
- measuring spoons, jug and cup
- chopping board
- cook's knife
- draining ladle
- wok stirrer or wooden spoon
- paper towel

PROCEDURE

VARIABLE 1 – STIR-FRY VEGETABLES

1. Heat the wok and oil on high and add a pinch of salt.
2. Add grated ginger, garlic, onion, carrot, capsicum and cabbage and other vegetables, stirring all the time.
3. Mix together the dark soy, tomato sauce and chilli sauce and add to wok, stirring all the time.
4. Lower the heat to medium.
5. Add the cornflour and water mixture and stir until the mixture thickens; cook for a minute to cook the starch.

VARIABLE 2 – HONEY AND CHILLI CHICKEN

1. Cut chicken into 2 cm cubes and coat lightly with flour seasoned with salt.
2. Heat the oil in the wok until it is hot but not at smoke point. Add the chicken and deep fry until golden brown.
3. Reduce heat and cook until the chicken is cooked through.
4. Drain on paper towel.
5. Drain oil from wok, leaving about 1 teaspoon. Add grated ginger and sauté. Add honey and stir for 30 seconds.
6. Combine chilli, cornflour, lemon juice and soy sauce and add to pan. Stir until thick.
7. Add chicken and stir in sauce. Heat chicken and add sliced shallot. Cook for 30 seconds.

RESULTS ANALYSIS

1. Using the lexicon developed for the food science experiments, consider the sensory properties of each of the variables. Determine a rating for each variable on a scale of 1 to 5 – 1 being 'not acceptable' and 5 being 'very acceptable'.

WS Experiment 11.7 template

STIR-FRY	APPEARANCE	TASTE	TEXTURE	FLAVOUR	AROMA	RATE FOOD FORMULATION FROM 1 TO 5
Variable 1						
Variable 2						

2. **Draw conclusions** as to the sensory properties of each formulation and how each technique could be incorporated into a food formulation in response to a food and nutrition problem.

9780170418560

EXPERIMENT 11.8

Baking

AIM

To **compare** the sensory properties of two baked goods

BACKGROUND

Baking is the term used for cooking food (not meat) in the oven using convection. Roasting is the term used when meat products are cooked in the oven. Convection is a type of heat transfer using hot air. Convection occurs when air is heated and expands. It becomes less dense and rises with the cooler, heavier air moving to the bottom of the oven where it is heated, creating convection currents.

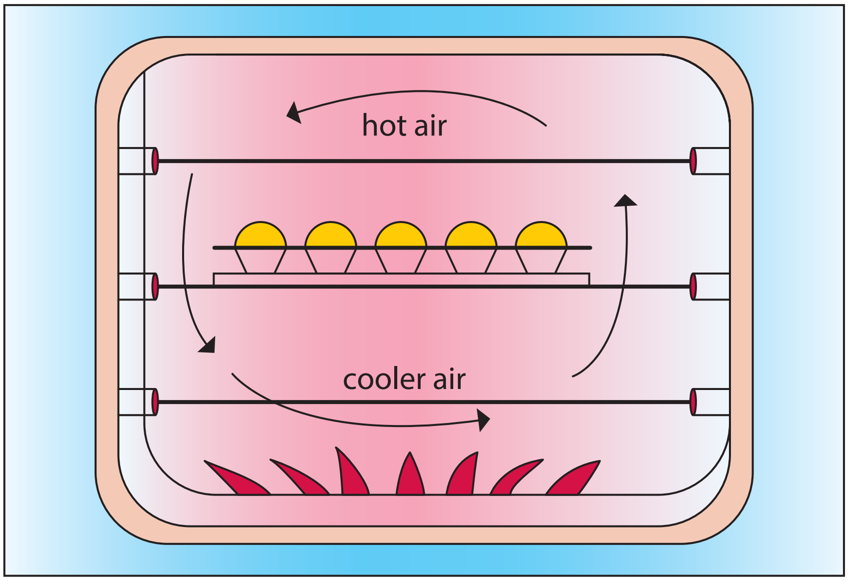


FIGURE 11.21 Convection currents in an oven

Most convection ovens are now fan-forced. They have an air circulation system in the form of a fan that moves the air around the oven, keeping an even heat. They do have the disadvantage that they cause drying of baked products. Some convection ovens have steam injected to reduce this loss of moisture.

INSTRUCTIONS

PREPARATION

Produce one batch of each variable using baking.

VARIABLE 1	VARIABLE 2
Biscuit	Raspberry coconut slice

Terry McCarten

Terry McCarten

FIGURE 11.22 Variable 1 (biscuit) and variable 2 (raspberry coconut slice)

FOOD COMPONENTS

VARIABLE 1 – BISCUIT

- ¼ cup castor sugar
- 1¼ cups self-raising flour
- 1 egg
- 2.5 mL vanilla extract

VARIABLE 2 – RASPBERRY COCONUT SLICE

Use the biscuit ingredients and procedure for the base until step 3.

- 100 mL raspberry jam
- 1 cup coconut
- ¾ cup sugar
- 1 egg

EQUIPMENT

- scales
- measuring cup, jug and spoons
- mixing bowl
- electric beater
- wooden spoon
- baking tray or slice tray and baking paper

PROCEDURE

VARIABLE 1 – BISCUIT

1. Beat the butter and sugar to a cream.
2. Add the egg and vanilla and beat well.
3. Gradually add the sifted flour mixing into a stiff dough.
4. Take 30 g pieces of mixture and roll into balls. Place on a lined baking tray with space in between and flatten slightly.
5. Bake in a 180°C oven until golden brown. Allow to cool.

VARIABLE 2 – RASPBERRY COCONUT SLICE

Follow steps 1 to 3.

4. Line a tray with baking paper and press the mixture into the tray in an even layer.
5. Spread the jam thinly over the base.
6. Mix together the coconut, egg and sugar.
7. Sprinkle the coconut mixture evenly over the jam.

9780170418560

8 Bake in a 180°C oven until golden brown.
9 Cool slightly and cut into squares.

RESULTS ANALYSIS

1 Using the lexicon developed for the food science experiments, assess the sensory properties of each of the variables. Rate each variable on a scale of 1 to 5 – 1 being 'not acceptable' and 5 being 'very acceptable'.

BISCUIT AND SLICE	APPEARANCE	TASTE	TEXTURE	FLAVOUR	AROMA	RATE THE SENSORY PROPERTIES 1 TO 5
Variable 1						
Variable 2						

WS Experiment 11.8 template

2 **Draw conclusions** as to the sensory properties of each formulation and how each technique could be incorporated into a food formulation in response to a food and nutrition problem.

EXPERIMENT 11.9

Roasting

AIM

To **prepare** roast potatoes to observe and record the sensory properties of different methods of preparation

BACKGROUND

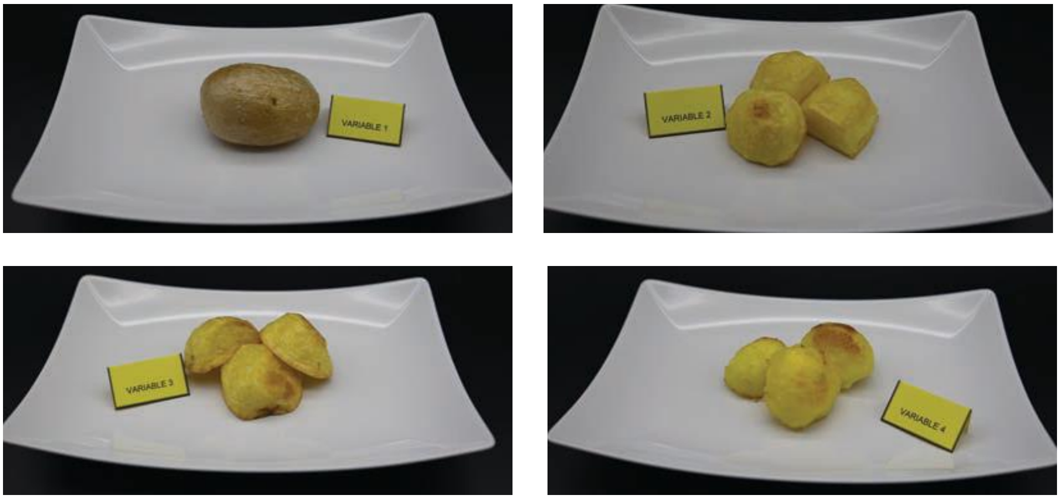
Roasting is very similar to baking; however, the foods prepared are meat and poultry based and any vegetables that can be served with the meat. For more information on roasting meat, see chapter 4, page 103. For this experiment, potatoes will be roasted.

INSTRUCTIONS

PREPARATION

Prepare roast potatoes to compare the sensory properties.

VARIABLE 1	VARIABLE 2	VARIABLE 3	VARIABLE 4
Roasted potatoes in their jacket	Roast potato – cut and placed in oil in roasting pan	Roast potato – cut and placed in hot oil in roasting pan	Potato peeled, cut and parboiled, drained in pan and shaken with salt. Cooled and added to roasting pan



Terry McCarten

FIGURE 11.23 Variables 1–4 labelled prior to roasting

FOOD COMPONENTS

- 4 potatoes
- oil for baking – olive or canola oil
- salt

EQUIPMENT

- roasting pan
- paper towel
- saucepan

PROCEDURE

VARIABLE 1

1 Wash potato and brush with oil and season with salt.
2 Place in 200°C oven for 45 minutes or until potato is soft.

VARIABLE 2

1 Peel and cut potato into roasting size pieces – approximately two-thirds of a large potato.
2 Place oil in the roasting pan, add potatoes and place in 200°C oven for 45 minutes or until cooked.

VARIABLE 3

1 Cut as for variable 2 and place in hot oil. Cook as for variable 2.

VARIABLE 4

1 Peel, cut and parboil for 10 minutes.
2 Drain liquid from pan and shake with salt. Allow to cool.
3 Add to roasting pan of hot oil in 220°C oven and reduce oven temp to 200°C for approximately 45 minutes until crispy and golden.

9780170418560

RESULTS ANALYSIS

1 Record the sensory properties of each variable on a table like the one below or use the template on NelsonNet and rate each from 1 (being poor) to 5 (being the best) for consumer acceptability.

SENSORY PROPERTY	CONTROL	VARIABLE 1	VARIABLE 2	VARIABLE 3	VARIABLE 4
Appearance					
Taste					
Flavour and aroma					
Texture					

1 **Describe** the method of preparation that gives the most acceptable results and discuss why this is the case referring to the sensory properties of the cooked product.

2 **Determine** where roasting could be used in food formulations in response to food and nutrition problems.

WS Experiment 11.9 template

determine establish, conclude or ascertain after consideration, observation, investigation or calculation; decide or come to a resolution

Research and development

ACTIVITY 11.4

Aim

To **research** new and emerging fat-based products

STEPS

Read the information below and answer the questions that follow.

EMERGING OILS – ARE THEY GOOD FOR YOU?

Coconut oil

Coconut oil comes from the fruit of the coconut palm. It is extracted from the white flesh of the coconut. There has been a surge in the use of coconut oil over the last 10 years. It is used in Asian cookery and is now being used in smoothies, desserts and as a replacement oil in other cooking applications. Coconut oil, however, is very high in saturated fat.

Avocado oil

Avocado is the fruit of the avocado tree. It is a good source of potassium and the fat-soluble vitamin D. Avocado oil is extracted from the fruit and contains oleic acid and essential fatty acids. It is a beneficial choice to lower low-density lipoprotein, or bad cholesterol levels, as it is high in monounsaturated fat. It can be used for cooking as it has a high smoke point and does not have a strong flavour.

Nut oils

Nut oils come from a variety of different nut trees including macadamia, almond, pecan and pistachio. They are used to flavour dishes and to produce spreads such as macadamia butter. Each nut oil will have specific characteristics and needs to be carefully considered when cooking as they may have different smoke points. They are thought to have health benefits but do not contain the fibre that is in the whole nut. The oils in these nuts are low in saturated fats; they contain monounsaturated fat. Walnut oil has extra omega 3, while almond and hazelnut have an abundance of vitamin E.

Conclusions

1 **Identify** the new and emerging fat-based products listed above.
2 Research the health benefits of each of the above emerging plant-fat-based products.

Waste management and sustainability

ACTIVITY 11.5

Aim

To **explain** that extending food shelf life and using correct storage methods can assist with sustainability and reduce waste

STEPS

1 List all the experiments completed in this chapter and the food products created.
2 Use your knowledge and conduct further research to **identify**:
   a the correct storage methods for these products
   b how the shelf life could be extended (use Activity 11.1 to complete this step).
3 Review and **summarise** chapter 2, pages 18 and 21 on sustainability and waste management.

Conclusions

Determine how extending the shelf life and using correct storage can assist with sustainability and reduce waste.

9780170418560

ACTIVITY
11.6

Aim

To **investigate** secondary products made using fat – animal feed

STEPS

Read the article below and answer the questions that follow.

SAFEMEAT: SAFE USE OF FATS AND OILS IN STOCK FEEDS PREPARED FOR RUMINANTS

SAFEMEAT, the Australian Renderers Association (ARA) and the Stock Feed Manufacturers' Council of Australia (SFMCA) remind producers about the safe use of recycled fats and oils in ruminant feed. The Australian livestock industries are strongly committed to the highest levels of food safety and product integrity in the meat products we produce. For this reason it is critical that producers fully understand the contents of purchased feed and the ingredients they use when mixing stock feeds. The use of recycled fats and oils has potential impacts both in regard to the feeding of Restricted Animal Material (RAM) and the feeding of Animal Fats. Both of these have implications for the safety of Australian product and access to our markets. A number of instances have occurred overseas, where contaminated used cooking oil and glycerine have been incorporated into animal feeds with severe food safety and market consequences. In Belgium in 1999, vegetable oil that was contaminated with Dioxin was used in mixing stockfeed. At the height of the incident Belgium and German authorities were forced to block meat and egg sales from 4670 farms.

Remember that anything fed to ruminants must comply with State regulations which prohibit feeding of RAM. *The use of fats and oils in feed for ruminants must take into account market access requirements*.

Safe use of fats and oils in ruminant feed

- Used cooking oils should only be sourced from establishments that are accredited to the National Standard for Recycling of Used Cooking Fats and Oils Intended for Animal Feeds, this ensures that recognised standards have been adhered to and the product is deemed to be free of RAM. Ask your supplier if they are accredited next time you purchase feed or feed ingredients.
- Unprocessed used cooking oils should not be used and are designated as RAM and do not meet the requirements of the ruminant feed ban as ingredients for use in ruminant feeds.
- Avoid using recycled oils and fats that are not specifically intended for use in stock feed. Also avoid using any feed/feed ingredient if you cannot be sure it is free from contamination.
- Request a commodity vendor declaration from your feed supplier and/or your feed ingredient supplier when you purchase feed so you have documentation to show that your livestock have not been fed anything contaminated with substances that may be of concern to markets.
- When purchasing feed look for feeds that have been prepared under a quality assurance program such as FeedSafe®. For a list of FeedSafe® accredited feed suppliers see the SFMCA website: www.sfmca.com.au or ask your feed supplier if they are accredited.

Source: safemeat.com.au, accessed 8 March 2018. Reproduced with permission.

Conclusions

1 **Explain** the use of recycled fat as stock feed.

2 **Summarise** the issues of using recycled fat as stock feed.

ACTIVITY 11.7

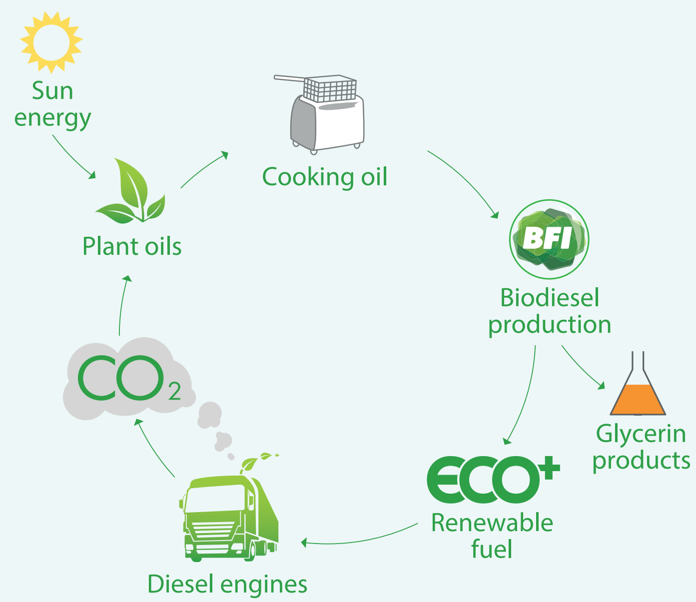
Aim

To **investigate** secondary products made using fat – biodiesel

STEPS

Read the article below and answer the questions that follow.

ECO+ BIODIESEL



Source: Adapted with permission from Biofuel innovations, accessed 8 March 2018

Eco+ Biodiesel is a sustainable and cost effective alternative to petroleum diesel. Our biodiesel is produced from waste cooking oil using green chemistry methods. We are pushing innovative research into enzyme catalysts and automated biotechnologies. Our biodiesel system is safer to operate, and is much more cost effective than traditional biodiesel production methods. We produce zero wastewater and use 50% less energy in our operations. Made from used cooking oils and waste fats, Eco+ Biodiesel does not compete with food crops and is close to carbon neutral. In addition to reducing carbon emissions, Eco+ Biodiesel produces less toxic exhaust gases like sulfur and carbon monoxide.

Source: Adapted with permission from Biofuel innovations, accessed 8 March 2018.

Conclusions

1 **Identify** the benefits of using recycled fat as biodiesel.
2 Conduct further research and **explain** the issues of using recycled fat as biodiesel.
3 **Explain** the use of recycled fat as biodiesel.
4 **Explain** the value of secondary products made using waste oil or fat in assisting with waste management and sustainability.

9780170418560

Food protection

Rancidity

Fats or oils can deteriorate in food products. The term used to describe the deterioration of fat or oil in a fat-based food is rancidity. Rancidity is characterised by an unpleasant odour and flavour in the food. Rancidity may occur through different mechanisms – oxidative and hydrolytic.

Oxidative rancidity of fat is caused by oxidation. This occurs when the fat is exposed to the oxygen in the air and the peroxides decompose. These are the result of the oxidation of unsaturated fats and result in aldehydes, ketones and hydrocarbons being produced. These chemicals are responsible for the odours and flavours in rancid food.

Oxidative rancidity

Hydrolytic rancidity is caused by hydrolysis. This occurs with moisture, but in the absence of air. The enzymes found in the natural plant oils cause reactions between the oil and the moisture. Hydrolysis splits fatty acid chains from the glycerol in glycerides, allowing the free fatty acids to undergo further auto-oxidation.

Enzymes from microorganisms such as bacteria, moulds and yeast have the ability to break down the chemical structure in oil and cause the unpleasant odours and flavours in fat-based foods. There has to be moisture present in the food for this to occur.

Temperature, time, light, water and catalysts (chemicals that speed up a reaction but do not alter their state) contribute to increased and faster rancidity in fat-based food products.

Preservation processes

Fat-based food sources can be perishable and require refrigeration, e.g. dairy and meat sources and can be semi-perishable, e.g. coconut products, avocados, oil and other plant-fat-based products, which, depending on climate, may require refrigeration.

Perishable fat-based foods

Perishable foods need to be refrigerated at 4.4°C or below, or frozen at –17.8°C. If this does not occur, they will spoil and become unsafe for human consumption. Fat-based perishable foods include meat, poultry, fish and dairy products. Ready-to-eat foods are perishable and need to be stored correctly. These include casseroles, quiche, pizza and cakes.

Placing these foods into the refrigerator or freezer reduces the deterioration rate. The two major causes of food deterioration are microorganisms, including enzymes and chemical changes. The low temperature will slow down the growth of microorganisms and rates of chemical and enzymatic change in the food. The oxidation of the lipids or fat in meat and fish that has been frozen is the key cause of loss of quality in frozen food. The air that is in contact with the food causes the food high in polyunsaturated fat to oxidise, causing a breakdown in the fatty acids as described in the section on rancidity. Hydrolysis causes softening of the texture and colour loss due to the enzyme activity.

Semi-perishable fat-based foods

Semi-perishable food sources do not need to be refrigerated, but they will deteriorate over time. Some semi-perishable foods, when stored correctly, will be unspoiled for periods of six months to a year. They include wholegrain products such as wholegrain flour as the flour contains the germ which is where the fat in the grain is stored. Foods such as bread, cakes, pies and pastries will go stale. The product will go stale before the oxidative processes working on the fat in the food cause rancidity. Good storage of these products will increase shelf life – dry storage areas must be well ventilated, have controlled humidity levels and the temperature should not exceed 24°C.

Preparation and cooking of food will destroy microorganisms that may cause food spoilage. Foods that are nearing their use-by date can be cooked and frozen to extend their shelf life. After cooking these foods must be either eaten or refrigerated after a short period to cool as soon as possible.

Table 11.5 Fat-based foods and storage time under optimal conditions

PRODUCT	ROOM TEMPERATURE	REFRIGERATOR	FREEZER
Milk		1 week	1 month
Butter		2 weeks	1 year
Cream		1–2 weeks	
Margarine		1 month	1 year
Cheese		1 month	4–6 months
Meat pies		2–3 days	3 months
Baked goods – biscuits (homemade)		2–3 weeks	6–12 months
Baked goods – biscuits (packaged)	2 months	2 months	12–18 months
Shortening, solid	8 months		
Vegetable oils	1–3 months		
Mayonnaise		10–12weeks	

ACTIVITY 11.8

Aim

To **explain** the effects of preservation techniques on sensory properties of foods using rancidity in potato chips as an example

STEPS

Read the information below and answer the questions that follow.

RANCIDITY IN POTATO CHIP FAT

Rancidity cannot occur in potato chips until the nitrogen that they are packaged with is removed. The nitrogen does not react with the fat and oil in the chips so stops oxidative rancidity from occurring. Once the bag is opened and the oxygen is allowed to enter the bag, oxidation begins to occur. Potato chips are cooked in unsaturated oils and these oils are more susceptible to oxidation. The oxidation causes rancidity and unpleasant flavours and odours causing the chips unsuitable for consumption. The temperature moisture and exposure to light affect the rate of oxidation. Antioxidants are added to these foods to slow down the oxidation process.

Conclusions

1 **Identify** the preservation techniques that prevent rancidity.
2 **Identify** the sensory properties affected by rancidity in potato chips.
3 **Explain** the cause of rancidity in potato chips.

Taking it further

1 Open a packet of chips and place chips in two glass bottles with lids.
2 Cover one bottle with foil and leave one jar uncovered.
3 Taste the chips and record the sensory properties of appearance, taste, texture, flavour and aroma.
4 Close the jars tightly.
5 Place on a windowsill or where they will be exposed to the sun. Rotate the bottles a quarter turn and check each 1 to 2 days for 2 weeks. Record observations.

Rancidity

ACTIVITY 11.9

Aim

To **explain** the effects of preservation techniques on sensory properties of foods using chocolate bloom as an example

STEPS

Read the information below and answer the questions that follow.

CHOCOLATE BLOOM

The bloom that appears on the outside of chocolate is made up of fat. It is able to be eaten but it does change the appearance and texture of the chocolate. The bloom can be caused by fat and sugar. The one that is most common is the fat bloom. There are many factors that contribute to fat bloom. It is thought to be contributed to by temperature changes, storage conditions, and the mixture of fats in the product, and possibly finger marking or handling. Fat bloom will occur on all chocolate; however, it can be controlled using the right conditions to extend the shelf life of chocolate. When chocolate is exposed to high temperatures the cocoa butter will melt and separate from the other ingredients in the chocolate. The cocoa butter rises to the surface of the bar causing the white bloom. It can be caused by incorrectly tempering chocolate. The best way to avoid the possibility of bloom is to store chocolate in a cool place with a consistent temperature. Chocolate is still safe to eat and use in cookery with fat bloom.

Shutterstock.com/Svetlana Lukienko

FIGURE 11.23 Chocolate bloom

Conclusions

1 **Identify** the sensory properties affected by chocolate bloom.
2 **Explain** the cause of chocolate bloom and **research** what can be done to reduce its occurrence.

How can chemical and functional properties of fat, knowledge of food safety and spoilage, and preservation techniques be used to develop food products?

Create a mind map of information to help answer the guiding questions. Use the supplied template or develop your own mind map. You may find it useful to use online tools such as Bubbl.us, Canva, Coggle, MindMup, iMindQ.

Mind mapping template

Mind mapping tools

12 DEVELOPING FOOD SOLUTIONS

How can chemical and functional properties of carbohydrate and/or fat, together with preservation techniques, be used to develop food products?

The chemical and functional properties of carbohydrate and fat dictate the characteristics and sensory properties of the end food product. The processing of each nutrient in a food product is unique and creates different sensory properties for the consumer. The cooking process applied to the ingredient dictates the performance of the nutrient and its final form. By carefully and scientifically applying different processes to the foods containing carbohydrate and/or fat, different end products can be developed. Each process applied to the food product alters the structure and function of the ingredients as well as its storage time and preservation requirements.

When developing food formulations and prototypes to a specific brief it is important to consider all the chemical and functional properties of the ingredients to be used. The final solution depends on each step of the problem-solving process being followed and on the appropriate application of each cooking process and evaluation and refinement at each phase of the process.

The brief

In Unit 1, a brief was supplied by the teacher. In Unit 2, students developed a brief and determined the specifications for the solution. In Unit 3 the same process is followed as in Unit 2, but in this unit the folio forms part of your summative assessment and will contribute 25 per cent to your final subject result.

Problem-based learning

In this unit, the teacher will supply the contextual stimulus, and students follow the problem-solving process to:

- explore the problem
- develop ideas
- generate a solution
- evaluate and refine the solution.

Evidence each step of the problem-solving process will need to be provided in the folio. Refer back to the introduction to problem-based learning in chapter 1, page 1, the example in chapter 5, pages 124–7 and the sample worksheets for assistance. A sample checklist worksheet is supplied to indicate what should be included in the folio.

WS Folio checklist

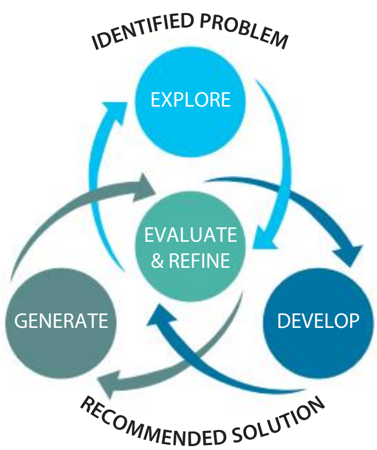


FIGURE 12.1 Problem-based learning process in Food & Nutrition

9780170418560

Summative assessment

The project folio in this unit is summative internal assessment 2 (IA2): Project – folio (25%).

The conditions for this assessment include an allowance of 15 hours of work with a length of 10–12 A3 pages.

The table of contents and the reference list are not to be included in the page count.

The Project – folio is an individual student's documentation of applying the problem-solving process to a real-world problem in need of a solution. The response will include the following:

- headings that organise and communicate the student's thinking through the iterative phases of the problem-solving process
- a table of contents page
- a reference list and a recognised system of in-text referencing.

The Project – folio in this unit will determine the student's achievement of the unit objectives listed on page 228.

Food & Nutrition problem examples

Carbohydrate

In this section the problem is based on the functional and chemical properties of carbohydrate, the preservation of carbohydrate-based foods and the traditional food drivers. The chemical and functional properties of carbohydrate, together with the preservation techniques that impact the choice of problem, are outlined in chapter 10 (pages 229–33). The traditional food drivers outlined in chapter 6 (pages 141–6) also impact on the choice of problem.

Examples of Food & Nutrition problems – carbohydrate

1 A local craft brewer has a surplus of spent grains from their brewery. Traditionally, the brewer uses these as stockfeed, but production has increased to such an extent that the demand for the spent grains in stockfeed is being fulfilled, with the surplus going to waste. The brewer has heard that spent grains have a high nutrient content and can be used for human food. Explore the options for the brewer to use the spent grains so the spent grains do not go into landfill, the food products they are used in are able to be produced locally, the food products are acceptable to the consumer and can be distributed without excess cost.

Getty Images/Jesper Mattias

FIGURE 12.2 Using surplus spent grains from a craft brewery

2 Corn production in Australia has produced a glut of corn. The farmers have too much for local consumption by both humans and animals. The farmers do not want to plough the corn back into their fields and have come to you as a food scientist to create a new range of corn-based products that are acceptable to Australian consumers. Explore the current range of corn-based products sold in Australia and develop a food formulation that is healthy, easy to transport without refrigeration and acceptable to the consumer.

3 Sugar is a key ingredient in many cakes and biscuits in Australia. With campaigns such as 'Rethink Sugary Drink' and the 'No sugar diet', Australians are looking for foods with no added refined sugar. A food manufacturer of cakes is keen to capitalise on the issue and remake their line of products with natural sugars. Develop a cake formulation that uses natural sugars, has all the acceptable sensory properties of cakes and meets consumer demand for foods with no added refined sugar.

Shutterstock.com/Isa Fernandez Fernandez

FIGURE 12.3 What new corn-based products could appeal to consumers?

Shutterstock.com/Suto Norbert Zsolt

FIGURE 12.4 Is maple syrup a natural sugar that could be used for baking?

Other possible stimuli

- Use dextrinisation to make a gluten-free gravy formulation with sensory properties acceptable to consumers.
- Gelatin has traditionally been used to set a particular product, but it is of animal origin. Investigate the use of other gelling agents to give the product a wider market and make it acceptable to vegetarians and vegans without losing sensory properties.
- Investigate the use of gluten-free flour in baked formulations to formulate a new cake or biscuit. Identify the varieties of gluten-free flour and raising agents that make it possible to produce a cake that has sensory properties that appeal to the consumer.

Fat

In this section the problem is based on the functional and chemical properties of fat, the preservation of fat-based foods and the traditional food drivers. The chemical and functional properties of fat, together with the preservation techniques that will impact the choice of problem, are outlined in chapter 11 (pages 273–7). The traditional food drivers outlined in chapter 6 (pages 141–6) also impact on the choice of problem.

9780170418560

Examples of Food & Nutrition problems – fat

1 The world is experiencing a shortage of butter and food manufacturers are concerned about what to use as a butter substitute in food products that traditionally require butter for texture and flavour. Devise a food formulation for a butter substitute for a traditional butter-rich product that will satisfy consumer demand, be cost-effective and have a long enough shelf life to be viable in production.

2 Consumers are exploring new or trendy fat-based products that have become popular on the market, such as coconut oil and avocado oil or nut oils. These products have limited uses in food manufacturing; however, food manufacturers want to cash in on the trend. This food manufacturer traditionally makes a range of fried products using canola oil and wants to investigate the use of trendy fat-based products to produce an extended range. As a food scientist for the manufacturer, investigate the feasibility of using one of these trendy products to produce a new food formulation with appropriate sensory properties for consumer acceptability.

3 A company that produces a salad dressing wants to break into the vegan market with its range of salad dressings. The salad dressings are of two varieties – pourable and spoonable. The company has traditionally used emulsifiers that are of animal origin such as egg yolk. Knowing that vegan consumers avoid foods from animal sources, the company wants to investigate all possible food formulations before producing a pourable and a spoonable salad dressing for vegan customers that is cost-effective, has a good shelf life and has sensory properties acceptable to the consumer.

Other possible stimuli

- A fat-based product does not have sufficient shelf life and needs to be reformulated to extend its shelf life.
- A product traditionally made of lard or another saturated fat needs to be made from a polyunsaturated fat, but keeping all the sensory properties of the traditional product.
- A frying medium needs to be changed to a polyunsaturated frying medium while retaining the sensory properties that the product currently exhibits.

WS Unit 3 review

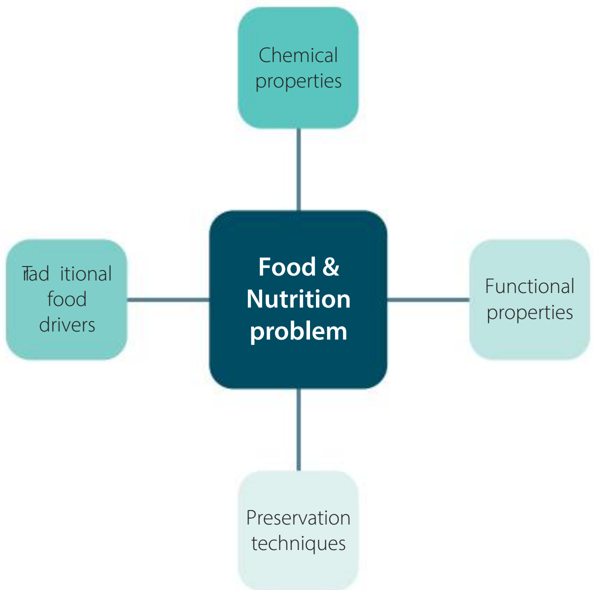


FIGURE 12.5 All aspects need to be considered when solving a carbohydrate and fat Food & Nutrition problem.

UNIT 4 FOOD SOLUTION DEVELOPMENT FOR NUTRITION CONSUMER MARKETS

In Unit 4, students solve food and nutrition problems to improve safety, nutrition, convenience, transparency and accessibility for nutrition consumer markets.

Currently, the food industry and its stakeholders recognise that the climate of consumer needs and wants is dynamic and constantly provides new opportunities in food solution development. Ipsos investigated shifting consumer purchase decisions and behaviours and found that consumers have changed in fundamental ways; their *Food CHATS* report (Ipsos 2016) showed that consumer purchase decisions are increasingly based on a mix of traditional drivers (price, taste and convenience) and evolving consumer drivers (health, safety, social impact, experience and transparency). This creates new challenges and opportunities for food solution development, and industry success will be determined by how effectively these are managed.

Topic 1 focuses on the investigation of problems in nutrition consumer markets. Many current formulations of food have high-risk components, such as salt, sugar, and saturated and trans fats, and are low in dietary fibre. Reformulating to improve the nutritional quality of food solutions presents significant challenges to the food industry, such as maintaining desirable sensory properties and shelf life of a food product. In Topic 2, students research and solve nutrition problems using information and data from relevant stakeholders. Students integrate this information with existing knowledge from Units 1, 2 and 3 to explore how food formulation and reformulation can contribute to solutions for different nutrition consumer markets, and support health and decrease chronic disease.
Using the Food & Nutrition problem-solving process, students formulate or reformulate a marketable food solution that addresses a need of a nutrition consumer market.

STUDENTS WILL

1. recognise and describe facts and principles about the food system, food formulation, labelling and a nutrition consumer market
2. explain ideas and problems related to current and emerging nutrition consumer markets
3. analyse problems, information and data related to current and emerging nutrition consumer markets
4. determine solution requirements and self-determined criteria for nutrition consumer market problems
5. synthesise information and data to develop ideas for solutions related to nutrition consumer market problems
6. generate nutrition consumer market solutions to provide data to determine the feasibility of the solution
7. evaluate and refine ideas and solutions to make justified recommendations for enhancement
8. make decisions about and use mode-appropriate features, language and conventions for particular purposes and contexts.

Food & Nutrition 2019 v1.1 General Senior Syllabus, p. 50.

FORMULATION AND REFORMULATION FOR NUTRITION CONSUMER MARKETS 13

» What formulation and reformulation opportunities exist for specific nutrition consumer markets?

Food solution development through formulation and reformulation of food products is constantly changing and evolving. New opportunities in the market and current trends will determine where food product development opportunities exist. Consumers purchase food products for a variety of reasons, one of which is to meet their nutritional requirements. Nutrition consumer markets have resulted in many opportunities for food product reformulation of existing products, as well as formulation of new innovative solutions to solve consumer problems. This topic explores nutrition consumer markets and current trends in opportunities for food product development.

Nutrition consumer markets

Consumer needs and wants are dynamic. They evolve and change as the world and society change and develop. As a result, food producers are constantly presented with new opportunities in food development. Food development for **nutrition consumer markets** is focused on the nutrient content of foods to assist the nutritional status of the target group. For example, foods that are developed for people who have diabetes or an intolerance, such as lactose intolerance, will solve the need to lower sugar consumption or for lactose-free products.

nutrition consumer market
market specifically focusing on nutrient content of foods that aim to assist the nutritional status of the consumer, e.g. low salt, low fat and high fibre

Food developed for nutrition consumer markets tends to target consumers with specific nutrition requirements initially, such as those with diabetes or high blood pressure. These food products are interesting because they may start out as a product suitable for diabetics, but they can also be marketed to the general public for their general health benefits. For example, low-joule products, such as diet soft drink or diet yoghurt, may originally have targeted obese or diabetic consumers, but have since been marketed as alternative sweet products without the kilojoules for the health-conscious consumer. Another interesting development in consumer nutrition markets are products that are designed specifically for a diet-related disorder, such as gluten intolerance or people who have coeliac disease, which then become a health food 'trend'. Gluten-free products have grown in popularity, among people with an intolerance and the general public. Gluten-free diets are being used by many individuals for a variety of reasons. The other interesting thing to note about nutrition consumer markets is that some individuals may be prescribed diets by doctors, and then choose not to follow them or have difficulty following them. For example, some diabetics should follow strict diets but may choose not to for a variety of reasons.

Nutritional requirements for specific consumers

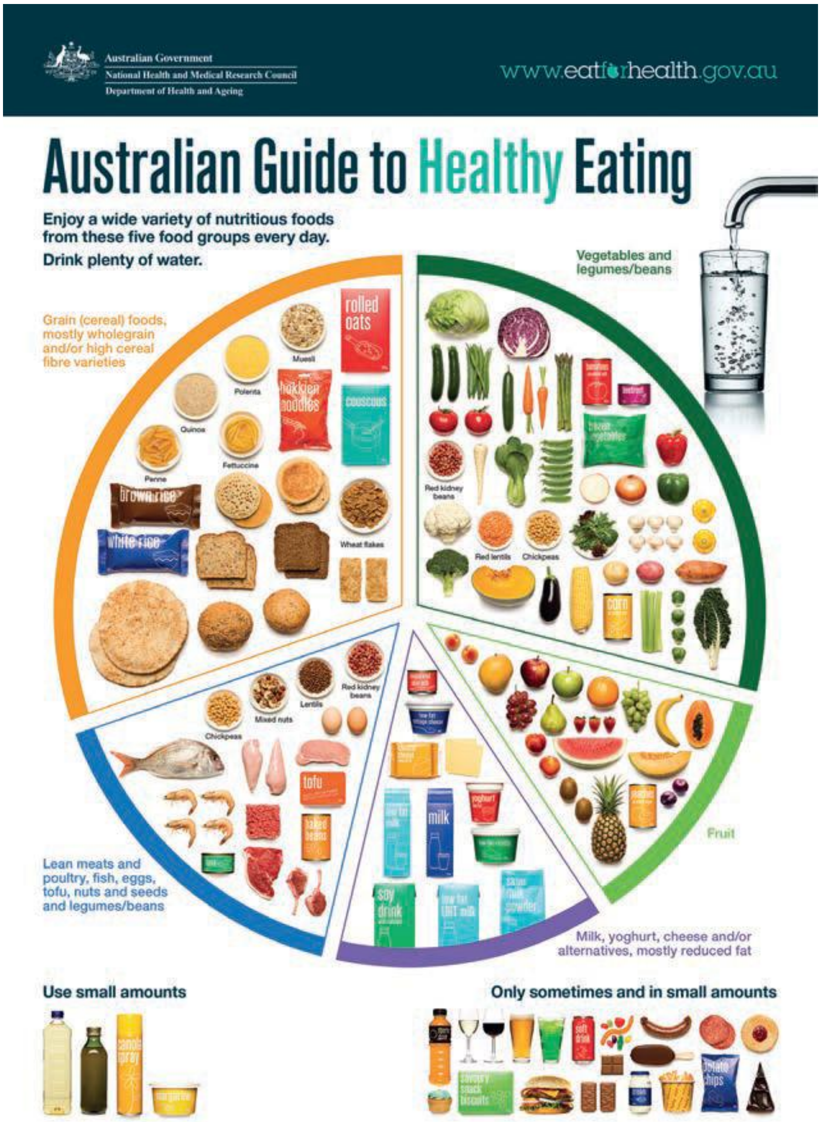
Nutrition requirements for nutrition consumer markets are varied, but there is some overlap between different markets. For example, products that are low joule could be marketed to several markets with a chronic disease such as diabetes, obesity and heart disease. The following nutrition consumer markets will be analysed:

- elderly
- health-conscious
- fitness-focused
- pregnant women
- vegetarian and vegan
- infants
- allergy or food intolerance
- diet-related conditions such as obesity, type 2 diabetes, coronary heart disease and diet-related cancer.

This section analyses the nutritional requirements of different nutrition consumer markets to find and solve problems for different consumer groups. The Australian Dietary Guidelines can be used as a reference for base data when comparing nutrients required by specific nutrition consumer markets to those that do not have specific requirements. The dietary guidelines provide tables with gender, age, food types and servings required for good health. Reference values for dietary adjustment for individuals and groups are also used for base data.

Australian Dietary Guidelines

Table 13.1 Recommended nutritional requirements for Australians from the Australian Dietary Guidelines



Source: Australian Dietary Guidelines, www.eatforhealth.gov.au, 2013, accessed 8 March 2018. National Health and Medical Research Council. Released under a CC BY 4.0 AU licence.

9780170418560

Elderly

Specific nutrient needs for an older person are difficult to define as their lean body mass, metabolic rate and need for energy declines with age. The World Health Organization (WHO) suggests that nutrient requirements for the elderly are very complex due to the large age range, health history, degree of independence and level of physical activity of each individual. Malnutrition is also a concern because of decreased appetite or reduced ability to purchase and prepare foods, which can lead to a lack of essential vitamins (water soluble), minerals (calcium and iron) and fibre.

Physical activity is important to maintain muscle strength and healthy weight. Exercise improves flexibility, bone and muscle strength. There is an increased risk of falls over 80 years of age. While most of the older population live independently, it has been estimated that 25–40 per cent of those over 80 years of age could be considered 'frail'. Energy needs decline with age, as does energy expenditure, with a reduction of 15 per cent between 30 and 80 years of age. This contributes to a decrease in metabolic rate. The Australian Government divides older people into three groups whose nutrient needs differ considerably. These are:

- free living healthy individuals capable of everyday activity
- frail 80+ year-olds who are still somewhat physically active
- individuals with limited mobility requiring high care.

For many older people, dietary issues that have existed since infancy are compounded by natural changes which occur through ageing. Consequently, there are other considerations related to food for the elderly, which include:

- isolation due to a lack of mobility, which can impact on the elderly as it leads to reduced access to a nutritious variety of foods to stimulate the appetite
- poverty as a lack of income after retirement can affect the quantity and quality of food available to eat
- illness – the elderly who are frail are at a higher risk of foodborne illness, so high-risk foods should be thoroughly cooked, dairy foods pasteurised, and foods associated with *Listeria* bacteria should not be consumed. All foods need to be handled and stored safely as food poisoning will have more severe consequences for this group.

Some important nutritional recommendations for elderly people are that they:

- consume lean meat, fish, poultry, eggs, legumes and beans, as these foods are reliable protein sources and will help maintain existing muscle mass. Whole nuts can be ground into pastes or meal and used in soups and casseroles as a softer alternative for protein inclusion in the diet
- consume dairy foods, including whole milk, which is important for protein, calcium and energy and helps with bone health
- ensure adequate intake of liquids as dehydration is serious if water intake is low. A decline in kidney function and decreased thirst perception happens with age. Dehydration can produce cognitive impairment and body function decline, with an increased risk of falls and strokes
- consume a high intake of fruit and vegetables. If a person has issues with teeth and chewing, tinned or frozen vegetables may prove a better alternative as the fibrous cell walls have been softened by processing and will be easier to chew
- consume a high intake of whole grains to help the bowel. Again, softer varieties such as wholemeal bread may be better to chew than multigrain.

Health-conscious

Health-conscious Australians are placing increasing demands on consumer markets for natural, unprocessed, fresh fruit and vegetable produce, eggs, poultry and meats. The Ipsos *Food CHATs* (Consumption, Habits, Attitudes and Trends) report gives the top five trends in Australia as:

health conscious individuals who are concerned about their diet and lifestyle

- eating more fresh fruit and vegetables (40%)
- smaller portion sizes (31%)
- reducing sugar intake from food (24%)
- eating healthier snacks (23%)
- cutting down on fat (23%).

Ipsos *Food CHATs* report

All the trends in the report relate to health-conscious preferences as a priority for consumption. This demand has placed pressure on the food industry to develop new food products and processes, which presents both opportunities and risks for food safety across food production pathways. Some of the new opportunities and risks include:

- There is a rise in the number of dual-income families, which means fewer meals are being prepared at home. This has led to the rise in convenient meals and meal solutions foods, such as HelloFresh, for busy people.
- A growing demand for raw/unpasteurised milk increases the likelihood of foodborne disease by 150 times. However, this can also be seen as an opportunity, as discussed in chapter 6 with high-pressure processing milk.
- Social media articles and stories about food safety are creating 'sceptical' consumers, who question the safety of foods that they are purchasing as well as safe processing and production pathways.
- Food products that make nutrition claims may be poor in other nutrition areas. For example, 'low fat' can be beneficial, but many of the foods labelled as 'low fat' are high in added sugars. Similarly, food products may claim they 'contain whole grains' but can still be highly processed, reducing health benefits. It is essential to use common sense by checking the product label and recognising the degree of processing that has occurred during production.
- Eating some fat is essential for sourcing the fat-soluble vitamins. By choosing foods that increase High Density Lipoproteins (HDL) cholesterol, or good fats, and lowering LDL, people can reduce their risk of heart disease. There is potential for marketing of products, such as Flora ProActiv, to help reduce cholesterol.
- The demand for natural colours and flavours, organic produce and less processing can create opportunities for reformulation of existing products for the health-conscious nutrition consumer market.

ACTIVITY 13.1

analyse
dissect to ascertain and examine constituent parts and/or their relationships; break down or examine in order to identify the essential elements, features, components or structure; determine the logic and reasonableness of information; examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences

Aim

To **analyse** the nutrition requirements of elderly people

STEPS

1 **Examine** the table on page 315 of the recommended nutritional requirements for Australians. Make a list of differences you can see for males and females across the five food groups as age increases.

FOOD GROUP	CHANGES FOR MALES	CHANGES FOR FEMALES
Vegetables and legumes/beans		
Fruit		
Grain (cereal) foods, mostly wholegrain		
Lean meat and poultry, fish, eggs, nuts and seeds, and legumes/beans		
Milk, yoghurt, cheese and/or alternatives (mostly reduced fat)		

9780170418560

Conclusions

1. Identify the food groups that decrease in the recommended number of serves with age. Which ones remain the same?
2. From the list of food groups, investigate the consumption of nutrients with age. Determine which particular nutrients decrease in the recommended amounts required.
3. Outline why it is difficult to provide recommended servings for the elderly. Propose other factors that are taken into account for diet recommendations for the elderly.

examine
investigate, inspect or scrutinise; inquire or search into; consider or discuss an argument or concept in a way that uncovers the assumptions and interrelationships of the issue

WS Activity 13.1 template

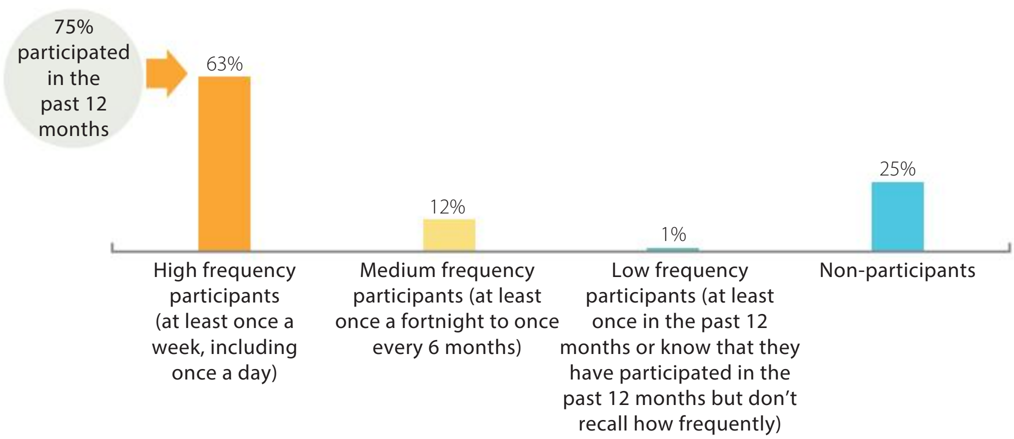
Taking it further

4. Overweight and obesity is more common in men than women (68 per cent versus 55 per cent) and is equal for all people aged 65–74 years at 75 per cent. Using the information from the text and data analysis, **propose** recommendations that could improve the health of elderly Australians, particularly those who are overweight.

propose
put forward (e.g. a point of view, idea, argument, suggestion) for consideration or action

Fitness-focused

Increasing obesity levels in Australia have led the government to introduce programs to increase the awareness of health and nutrition for people who exercise regularly. A combination of exercise and suitable nutrition leads to better health and greater life expectancy for Australians. In Queensland, a 2015 survey showed that 63 per cent of the participants self-reported that they participated in physical activity one or more times per week, with 21 per cent of participants engaged in physical activity once or more a day.



Source: Adam Hinds, Jodie Gordon & Lexi Crouch, *Queensland Sport, Recreation and Exercise Survey (QSERSA) Research Report*, 25 May 2016.

FIGURE 13.1 Almost two-thirds of Queenslanders surveyed self-reported and are described as high frequency participants, exercising at least once a week.

Most popular physical activities

Most popular physical activities

1. any walking activity (63%)
2. any gym activity (31%)
3. Running/jogging (18%)
4. Swimming (17%)
5. Bushwalking (14%)
6. Yoga/pilates (10%)
7. Leisure cycling (e.g. hybrid bike on bike paths) (9 %)
8. Fitness classes/aerobics/zumba (8 %)
9. Golf (6 %)
10. Tennis (6 %)

FIGURE 13.2 Most popular physical activity reported by Queenslanders

Source: Adam Hinds, Jodie Gordon & Lexi Crouch, Queensland Sport, Recreation and Exercise Survey (QSERSA) Research Report, 25 May 2016.

From the same survey, the four most important reasons for high-frequency participation in fitness activities are:

- personal interest and motivation in health and fitness (41%)
- making time or having more time to be available for fitness activities (38%)
- making a social occasion of exercising (37%)
- having transportation to get to places that do the activities of interest (36%).

Fitness-focused consumers have led to a new and rapidly expanding industry sector for research and development, production and distribution of consumers' fitness and sports products. Having knowledge of nutrition is important for an individual who is fitness- or sport-performance focused, enabling consumers to make wise food selections and maintain adequate nutrition. The amount of each food group and specifically extra nutrient requirements for good health are dependent on the type of sport, amount of training and the time spent on activities to achieve that level of fitness.

Eating a wide variety of nutritious foods is part of the Australian Dietary Guidelines. Fitness-focused consumers and athletes need a well-planned diet that contains vitamins and minerals that support their activity, while providing enough protein for growth and repair of body tissues. For athletes and fitness-focused consumers, a consumption of 55 per cent of total intake dietary foods containing unrefined carbohydrates is recommended. Many of these foods have a low glycaemic index (GI), which provides more gradual energy release during digestion. This slow-release effect on blood glucose levels can be useful during moderate exercise. Protein-based food consumption is recommended as 12–15 per cent of daily intake, as it plays a key role in post-exercise recovery. Consumer markets have developed food alternatives such as protein powders to address protein requirements. Hydration, through the consumption of water, is essential for good health with increased demand during physical activity. Sports drinks have largely been developed to replace electrolytes lost during bursts of intensive activity (although they are not always consumed for this reason). Consumption of foods containing fat should be no more than 30 per cent of dietary intake.

The following are recommendations to implement when planning a fitness- or sport-focused diet.

Table 13.2 Recommendations for a fitness- or sport-focused diet

Carbohydrates	Use wholegrain and wholemeal cereal (pasta, rice and breads) carbohydrate sources, avoiding refined foods such as white bread, lollies, jams Adjust carbohydrate consumption, depending on the level of activity. For endurance and extreme physical activities, it is recommended that carbohydrates are used in the following manner: • pre-event meal that is high in carbohydrates, for example pasta with a tomato-based sauce • smaller snack, such as muesli bar, 1–2 hours before the event • during activities that last longer than 60 minutes, it is recommended that 30–60 g of high GI foods are consumed per hour to delay fatigue of muscles. Examples of foods include sports gels, lollies, low fat muesli/sports bars or white bread sandwiches. • for 4 hours or more of endurance activity, 90 g of low GI carbohydrates are recommended • a post-activity meal is important for the rapid replacement of glycogen within the first 2 hours so moderate to high GI foods are recommended until normal eating regimes resume. Suitable foods include sports drinks, juices, low-fat milk, pasta, fruit and yoghurt
Protein	Include high-protein foods carefully, as a diet too high in protein can be expensive and may affect kidney function. It may also create excess weight gain if the protein consumed is not lean; the follow-on effect could result in a lack of other nutrient-dense foods being eaten regularly Caution is advised with the consumption of protein supplements. It is recommended that a person discusses the need for protein supplements with a qualified general practitioner or dietician
Vitamins and minerals	Caution is advised with the consumption of nutritional supplements for vitamins and minerals, as consumption of a healthy diet should meet basic nutrient needs Vitamins, minerals, herbs, meal supplements, sports nutrition and natural food products need to be examined to assess the value added to the diet of a fitness-conscious person, and the likelihood of overconsumption It is recommended that a person discusses the need for any supplementation with a qualified general practitioner or dietician

(*Continued*)

Table 13.2 Recommendations for a fitness- or sport-focused diet (*Continued*)

Water	Dehydration in extreme cases can cause kidney failure and death. While water is the best source for hydration, salts lost during sweating in a hot climate can make dehydration worse It is recommended that sodium is replaced so that water can be absorbed into the blood stream more effectively. Sports drinks containing sodium of 30 mmol/L (millimoles per litre) are suitable for endurance and extreme sports/fitness activities. The longer the activity, the more water and frequency of consumption is needed Consume water at regular intervals and do not wait until thirsty, as the body will be already dehydrated; continue to consume liquids after activity for up to 6 hours depending on the endurance level

Pregnant women

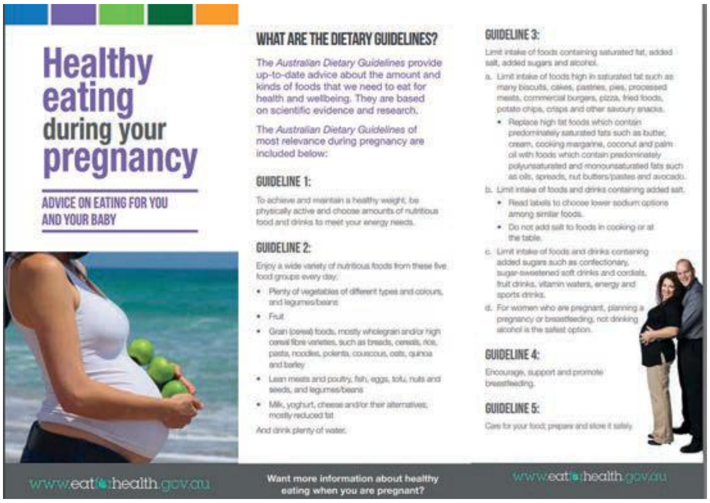


FIGURE 13.3 Australian Government information for pregnancy health

Access to media and information has led to a barrage of advice online and through social media about the ‘best’ things to do and eat when trying to get pregnant and during pregnancy. This is often confusing, because Australians in general are very conscious of doing the best thing for the unborn child. When reading advice about nutrition before and during pregnancy, talking to a qualified general practitioner and reading information from reputable sources is recommended.

Regulating weight gain during pregnancy is essential as a health priority. Gaining too little weight may lead to low birth weight of the infant. Gaining too much weight during pregnancy or obesity when pregnant is a significant issue for both the mother and foetus. Considering one-third of Australian women are already overweight, this is a priority area.

The Australian Dietary Guidelines recommend steady weight gain throughout pregnancy to avoid adverse effects to foetal organ systems during critical periods such as neural tube development at 6–8 weeks and kidney development at 28–30 weeks. Excess weight gain also increases the risk of macrosomia (a newborn with excessive birth weight) and gestational diabetes for the mother. This in turn will increase the likelihood of obesity and metabolic syndrome later in the infant’s life.

According to the Australian Dietary Guidelines, it is necessary during pregnancy to eat foods that contain the following nutrients:

- Pre-conception: it is essential that, where possible, women increase their folate intake to at least 400 µg per day for at least 3 months prior to falling pregnant. This helps to prevent neural tube defects. It is also recommended that women increase their folate levels in their 3rd trimester.

Healthy eating guidelines for pregnancy

- The average requirement for iron in pregnancy is 22 mg per day but some women may need 27 mg per day or more. Low iron levels in early pregnancy have been linked to premature birth and low birth weight. A mixed diet of animal and plant foods can help a woman achieve the correct iron intake. Red meat is the best source of iron as well as also being a good source of protein and zinc. Sometimes iron supplements are recommended by the doctor if a woman's iron level is low.
- Zinc is a component of various enzymes that help maintain structural integrity of proteins and help regulate gene expression. Getting enough zinc is particularly important for the rapid cell growth of the mother's blood and the growth of the unborn baby.
- The average requirement for vitamin C during pregnancy is 40 mg per day. Vitamin C is necessary for the formation of collagen and is especially important for blood vessels. Vitamin C also improves digestive absorption of iron.
- The recommended dietary intake of calcium per day for pregnant women over 18 is 1000 mg. Eggs, fish with bones, milk and dairy foods are excellent sources of calcium.
- Increasing extra iodine (150 μg/day) may not be necessary as most leavened bread in Australia is made with iodised salt, which will contribute to these levels.
- FSANZ have cautioned eating fish species that could be high in mercury, as it affects foetal development. If consuming shark/flake, marlin or broadbill/swordfish, have no more than one serve (100 g cooked) per fortnight and no other fish that fortnight. Similarly, orange roughy (deep sea perch) or catfish should be eaten as one serve (100 g cooked) per week and no other fish that week.
- Avoid eating foods containing raw eggs because of the risk of salmonella.
- Increase water intake, due to increasing extra cellular fluid space needed, the requirements of the foetus, the amount of amniotic fluid, and after birth for milk production. Fluid intake should be 750–1000 mL a day above 1.5 L of liquids. It is recommended that the intake of caffeine is restricted to less than 300 mg per day. This is equivalent to three cups of coffee or six cups of tea.
- Finally, women do not need to avoid consuming nuts for fear of causing an allergic reaction in their babies; they only need avoid them if they themselves have allergies.

Weight loss diets are not recommended during pregnancy. Regular meals that include plenty of fruit and vegetables, high-fibre bread, and restricting sugar snacks are recommended to help women achieve an average weight gain and help to provide optimum nutrition for the infant. There is also increasing evidence to support optimum nutrition in relation to cognitive development and future bone mass of the infant. Smoking and the consumption of alcohol during pregnancy affects optimal nutrition, among other negative impacts, and are not recommended.

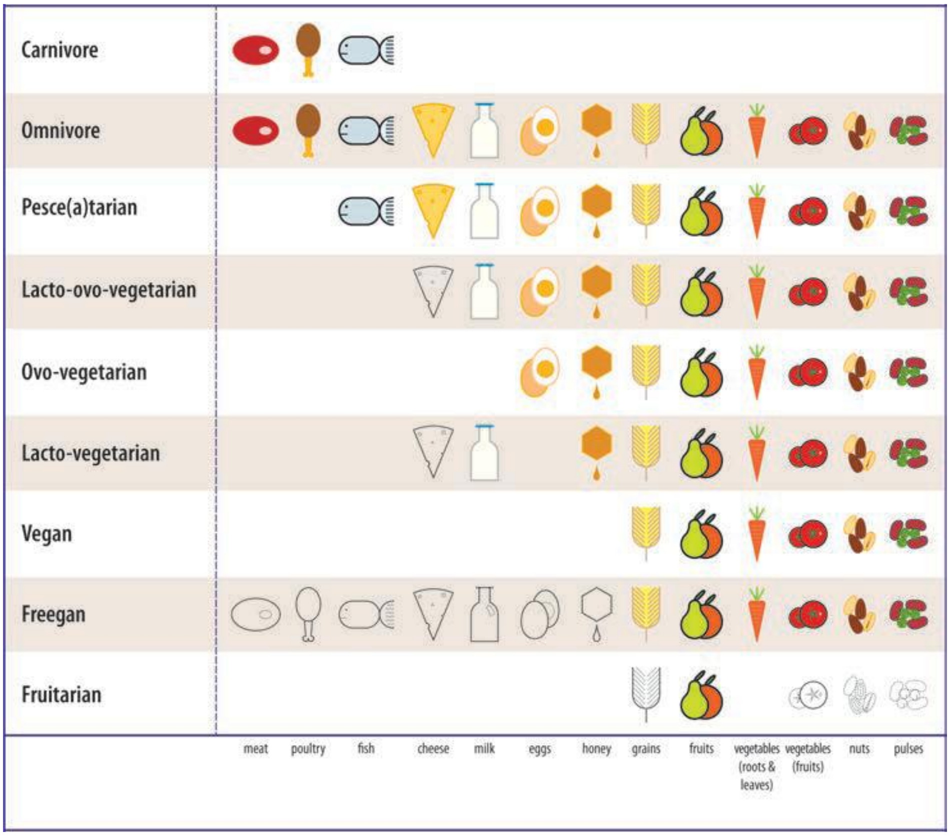
Women and foetuses are very susceptible to foodborne contamination and should avoid foods associated with an increased risk of the Listeria bacteria such as unpasteurised milk, soft cheeses (brie, camembert, ricotta, feta and blue cheeses), cold seafood, sandwich meats, pâté, bean sprouts and packaged or pre-prepared salads. A high-fibre diet is also recommended for pregnant women to prevent constipation.

Vegetarianism

People who are vegetarian don't eat meat for a range of health, environment, ethical, religious or economic reasons. There are many different types of consumers who limit some or all foods sourced from animals.

Some consumer practices are restrictive and more extreme, making it difficult to maintain optimum health. A 2106 Morgan Poll indicated that 11.2 per cent or 2.1 million Australians followed a vegetarian diet, compared with 9.7 per cent or 1.7 million people in 2012. This rise of 1.5 per cent has had considerable impact on consumer market demand.

A vegan is a person who excludes meat (plus by-products derived from slaughtered animals such as gelatine and rennet), fish, dairy products and eggs from their diet. A well-balanced vegetarian or vegan



Source: Version 2.0 © 2011-2018. George Perimentas/ANTIFORMA Design. Http://themissinggraph.com.

FIGURE 13.4 Common Australian diets

diet can reduce the risk of chronic diseases such as obesity, coronary artery disease, high blood pressure, diabetes and some types of cancer, provided that a wide variety of plant-based foods are consumed.

Special consideration needs to be given in planning diets for both vegetarians and vegans.

- Protein is an essential macronutrient and must be included in the diet. As soy protein is the only complete vegetable protein, a carefully considered combination of foods should be consumed to ensure all essential amino acids are obtained. Lacto-vegetarians consume these proteins in dairy foods and lacto-ovo from dairy food and eggs. Consumers who follow a vegan diet should consume soy products regularly.
- Non-haem iron is abundant in plant foods such as wheat-based cereals, leafy green vegetables, legumes (peas, beans, chickpeas, lentils, soy foods) and nuts, but is not well absorbed from the intestine. Non-haem iron means iron that is obtained from plant sources. The addition of vitamin C in foods such as citrus fruits or juice will increase uptake of iron during digestion. Those who eat eggs should do so regularly as they are a very good source of haem iron.
- Calcium sources include dairy products, fortified cereals, fruit juices, soy milk and some brands of tofu. Dark green leafy vegetables, peas, beans and lentils along with almonds and brazil nuts also contain calcium that can be used by the body.
- Zinc is accessible by consuming nuts, tofu, miso, legumes, wholegrain foods and wheatgerm.
- Vitamin B12 is of greatest concern when planning a vegetarian diet, as it is only found in dairy foods and eggs. Vegans are at high risk of anaemia as the body's stores become depleted over time.

This can lead to interference with normal brain development in a foetus, in infants and children. To solve this, vitamin supplements or fortified products like So Good soy milk, Marmite and some Sanitarium Vegie Delights products are recommended.

- Vitamin D can be synthesised by the body through exposure to sunlight. However, for those who do not regularly get into the sun, supplementation may be necessary. Seek advice from a medical practitioner.
- Vegetarian diets include higher intakes of whole cereal grains, fruit, vegetables, legumes which are higher in fibre, lower in saturated fats and salt. This could mean increased optimal health including less risk of cancer and heart disease. Fewer strokes and general longevity is a consumer driver for this type of diet/lifestyle.

Infants

Important nutrients for the growth and development of a baby include vitamin A, vitamin B12, riboflavin, calcium, carbohydrate, magnesium, phosphorus, protein, potassium and zinc. Given that infants do not shop for their own food, it is essential that parents and caregivers provide food with nutrition for optimal growth and development.

Australian Dietary Guideline 4 is: 'encourage, support and promote breastfeeding for around the first six months of the infant's life'. Research suggests that 96 per cent of mothers in Australia start breastfeeding. This rate dramatically declines to only 39 per cent of babies being exclusively breastfed after 3 months. However, not all mothers and infants can breastfeed and many have significant issues with breastfeeding. In cases where breastfeeding is not possible, technology has developed formula milk, which is close to optimum nutrition for babies.

Breastfeeding requires little preparation, is fresh, at the correct temperature and storage is ideal for the infant. Breast milk contains live antigens that are transferred to the infant. These provide immunity against illnesses which can harm the baby. From 6 months onwards, rice cereal mixed with boiled water or breast milk can be introduced, particularly where the infant is no longer satisfied with breastmilk alone.

Table 13.3 Sample daily food pattern for infants aged 7–12 months

FOOD	SERVE SIZE	SERVES A DAY	SERVES A WEEK
Vegetables and legumes/beans	20 g	1½ –2	10–14
Fruit	20 g	½	3–4
Grain (cereal) foods	40 g bread equivalent	1½	10
Infant cereal (dried)	20 g	1	7
Lean meats, poultry, fish, tofu, eggs	30 g	1	7
Breast milk or formula	600 mL	1	7
Yoghurt/cheese or alternatives	20 mL yoghurt or 10 g cheese	½	3–4

Source: National Health and Medical Research Council. Released under a CC BY 4.0 AU licence.

*An allowance for unsaturated spreads or oils or nut/seed paste of ½ serve (4–15g) per day is included, however whole nuts and seeds are not recommended at this age because they may cause choking.

The following are recommendations from the National Health and Medical Research Council via the Australian Dietary Guidelines and are designed to enhance optimum growth and development of infants. The recommendations are based on normal birth weight of >2500 g.

- To prevent iron deficiency, iron-containing nutritious foods are recommended for inclusion in the first foods (iron-fortified cereals) and later pureed meat and poultry dishes; also cooked plain tofu and legumes/beans.

- Provide whole foods and avoid fruit juices and sugar sweetened drinks, limiting the intake of all foods with added sugars.
- Do not add salt to foods for infants. This is an important safety issue as an infant's kidneys are immature and unable to excrete excess salt.
- Infants should be offered nutrient-dense foods and should not be consuming poor quality discretionary foods which contain high levels of saturated fat, added sugar and salt, for example, cakes, biscuits, lollies and potato chips.
- At 12 months, infants can drink pasteurised full-cream milk as it is a rich source of protein, calcium and fat-soluble vitamins A, D, E and K. Reduced- and low-fat milk is not recommended for children under two as their energy needs are high and fat-soluble vitamins are essential for growth.
- From 12 months onward, infants can consume family foods as per the dietary guidelines.
- Prepare and store food safely, avoiding honey under 12 months to prevent risk of botulism. To prevent salmonella, cook eggs thoroughly and do not use foods containing uncooked eggs like mayonnaise.
- Hard, small, round foods, such as whole nuts and raw hard vegetables, can become a choking hazard.
- If parents are concerned about nutrition or health, it is essential that they consult an appropriate health professional in a timely manner.

Food allergies

A food allergy is an abnormal reaction by the body to a food protein, where the reaction causes the immune system to produce antibodies that react with the allergen. Symptoms include hives, swelling of mouth and throat preventing regular breathing, vomiting or diarrhoea, collapse and in most severe cases anaphylaxis. Common foods that cause allergic reactions include peanuts, tree nuts, milk, eggs, sesame seeds, fish, shellfish, soy and wheat. Modern food-processing techniques can create food safety issues if machines are used to produce multiple products with varying ingredients. This can potentially cause contamination of foods without allergen ingredients.

FSANZ have allergen standards for food labelling, including mandatory statements that must be placed on products. Food allergies are usually diagnosed during childhood and affect 5 per cent of all Australian children. This number reduces over time with age and improved tolerance of the allergen, with 1 per cent of Australian adults having a food allergy. Teenagers and young adults with peanut and tree nut allergy are at greatest risk of fatal allergic reactions. Those at high risk of anaphylaxis are generally prescribed an adrenaline autoinjector 'EPI pen' and should always keep their adrenaline close by (and easily accessible). Family, friends and teachers should know how to use the pen if needed.

This nutrition consumer market requires food products that do not contain specific ingredients.

Food intolerance

Food intolerance is caused by reactions to certain foods or components of foods but does not involve the immune system. This could include an enzyme deficiency in the body that prevents the digestion of lactose, gluten and salicylates (chemicals that occur naturally in many fruits and vegetables). Added ingredients including food additives and processing aids may also be the cause of food intolerance. These reactions are not the same as allergies, but may include the following:

- rashes and swelling of the skin, asthma, and stuffy or runny nose
- irritable bowel symptoms, colic, bloating, and diarrhoea
- migraines, headaches, lethargy and irritability.

Food intolerance can be difficult to diagnose. Keeping a food diary can assist with recognising foods which trigger a reaction. Total avoidance of these foods is not generally necessary but dietary adjustment is needed to manage good health such as limiting consumption. The two most widely recognised food intolerances in Australian society are lactose intolerance and gluten intolerance. The consumer market of gluten- and lactose-free food products has grown rapidly since 2012.

Diet-related or chronic health conditions

A chronic condition is a persistent disease or health-related condition that has a lasting impact on a person's health. In 2015, the World Health Organization produced a report on non-communicable diseases, citing the four major types as cancers, cardiovascular diseases, respiratory diseases (including asthma) and diabetes mellitus (type 2 diabetes). It also listed 34 other chronic diseases and health conditions. As an individual's health is very complex, so is the diagnosis and treatment of chronic health conditions. The chronic health conditions of obesity, diabetes (specifically type 2 diabetes), coronary heart disease and diet-related cancers are possibly preventable causes of death.

Obesity

Overweight and obesity is caused by a sustained energy imbalance. This is not as simple as an equation where food input must equal energy output. The sustained energy imbalance is influenced by environmental factors. The term 'obesogenic environment' has been used to describe environments that promote obesity in individuals. This includes physical, socio-cultural, political and economic factors. Schools, workplaces, home, local neighbourhoods, media, the government and the food industry are all part of these environments.

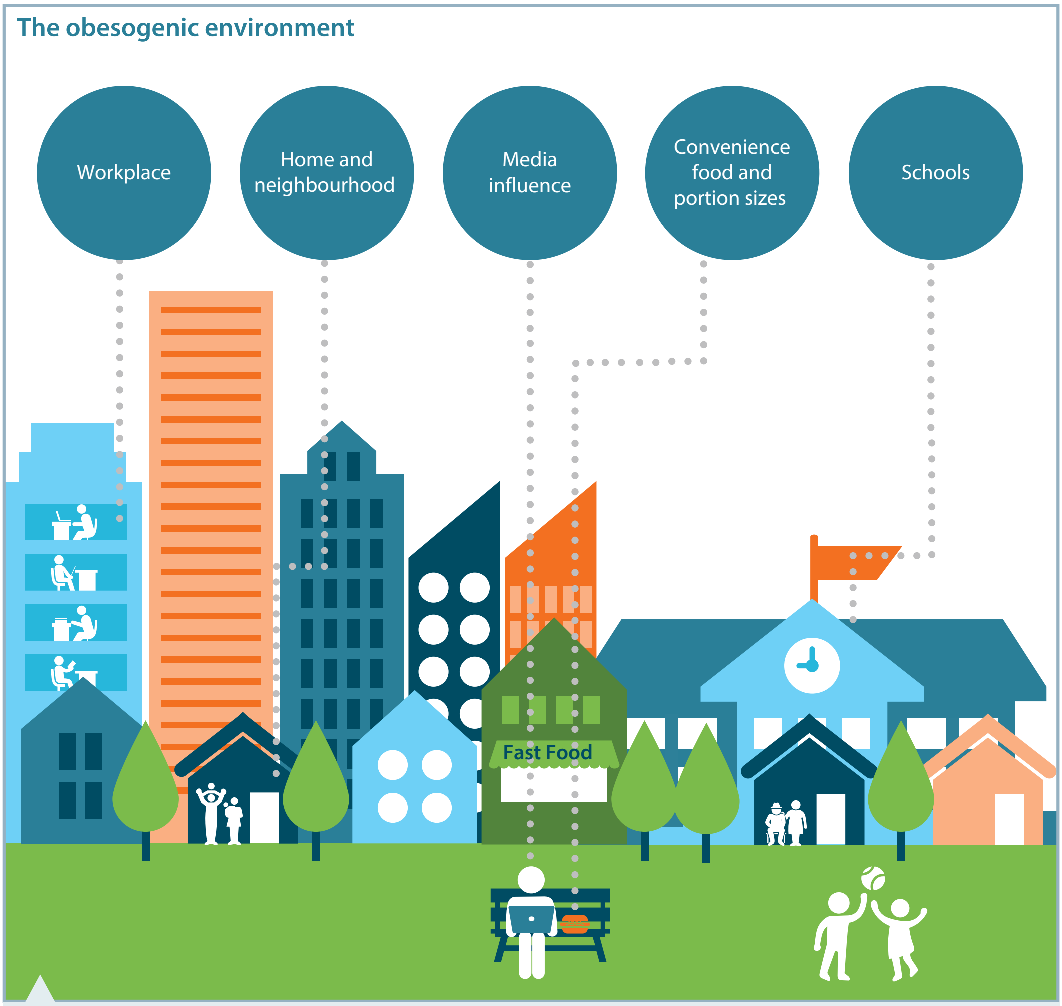
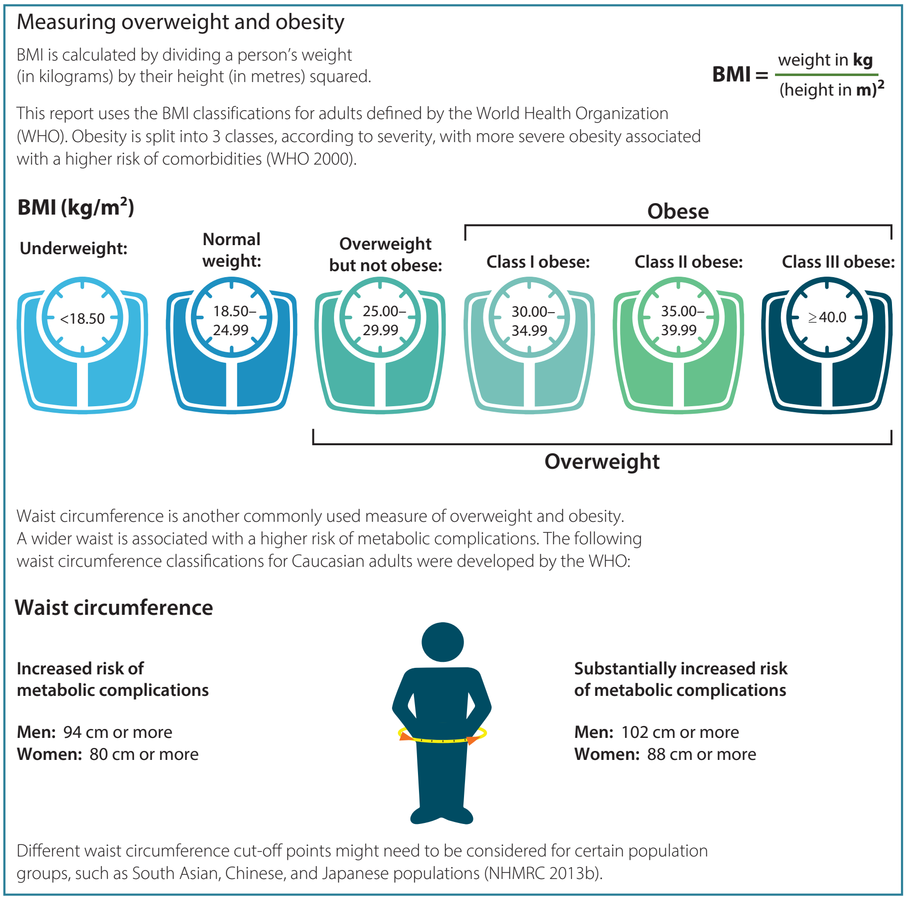


FIGURE 13.5 Obesity is a complex issue that is caused by environmental and physical factors.

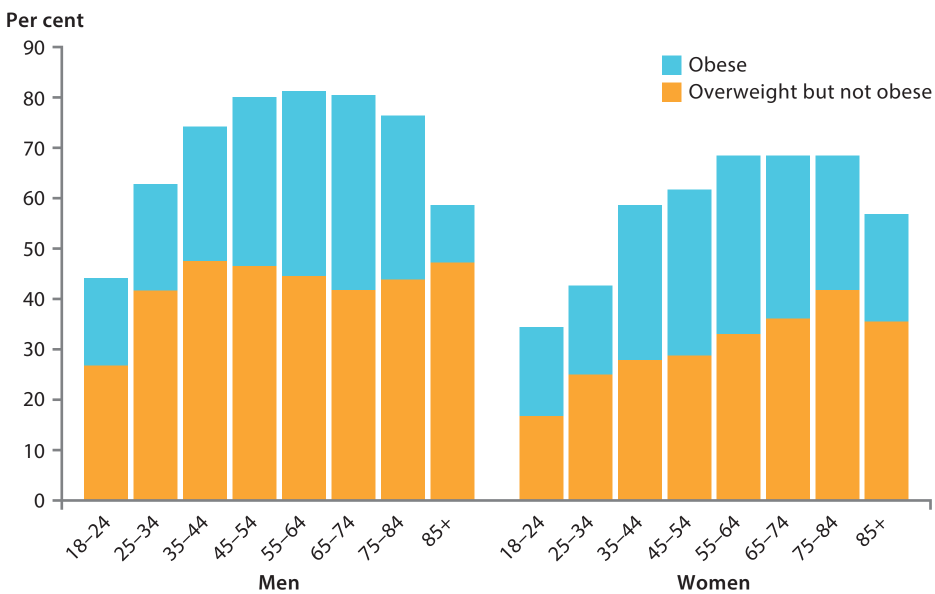
Source: *A picture of overweight and obesity in Australia*, Australian Institute of Health and Welfare, 2017, p. 9. © Australian Institute of Health and Welfare 2017. Released under a CC BY 3.0 licence.

9780170418560



Source: A picture of overweight and obesity in Australia, Australian Institute of Health and Welfare, 2017, p. 9. © Australian Institute of Health and Welfare 2017. Released under a CC BY 3.0 licence.

FIGURE 13.6 Measuring overweight and obesity



Source: *A picture of overweight and obesity in Australia*, Australian Institute of Health and Welfare, 2017, p. 15. © Australian Institute of Health and Welfare 2017. Released under a CC BY 3.0 licence.

FIGURE 13.7 Prevalence of overweight and obese men and women in Australia

ACTIVITY 13.2

Obesity and diet

AIM

To **analyse** the nutrition requirements of overweight and obese people

Obesity and diet

The amount of kilojoules people eat and drink has a direct impact on their weight. When trying to achieve weight loss, a reduction in daily kilojoule intake is needed. This may mean eating and drinking less, with smaller portion sizes. It also will usually mean a lifestyle change is required, to select healthier, more nutritious options. Swapping high energy food choices for healthier choices is a start, along with limiting the intake of soft drinks and alcohol. Australians are recommended to:

- Drink plenty of water
- Enjoy a wide variety of nutritious foods from the following five food groups:
  - Vegetables and legumes
  - Fruit
  - Grain / cereal foods high in fibre or wholegrain varieties
  - Lean meats and poultry, fish, eggs, tofu, nuts, seeds
  - Milk, yoghurt, cheese
- Limit the intake of saturated fat, added salt and sugar
- Limit the intake of alcohol

Packaged food items must contain mandatory nutrition labelling. However, restaurants, cafes and fast food outlets will not necessarily display the nutrition information on the product itself, so it easy to consume high amounts of energy without realising it, particularly fried food items, burgers and soft drinks.

FAD DIETS

Fad diets generally promise quick weight loss through unhealthy or unbalanced eating practices such as fasting for periods of time, cutting out whole food groups or substituting food for shakes or vitamin supplements. These fad diets are generally unsustainable and can cause unpleasant side effects.

There are some commercial diet programmes that are safe. Many are based on sound nutritional principals and can work well for some people. When looking for a diet programme, it is recommended that you select on that:

- is not overly restrictive in terms of the type of food you can eat
- is aimed at achieving gradual weight loss, not short term rapid weight loss that will likely be unsustainable
- is educative and informative about portion sizes, making long-term changes to habits and promotes healthy eating

LOW CALORIE DIETS

A very low calories diet (VLCD) means consuming less than 3350 kilojoules per day (800 calories). While this can be an effective method to lose weight for some obese people, it is generally only recommended if rapid weight loss was required to reduce the risk of an obesity-related complication. A VLCD should only be undertaken under the supervision of a qualified health professional and generally not for long periods of time.

CONCLUSIONS

1. **Summarise** the key recommendations in the article.
2. **Describe** what makes a responsible diet program.
3. **Explain** why fad diets are to be avoided.
4. **Propose** a list of foods for an obese person to include and exclude from a diet they are planning to start.

TAKING IT FURTHER

5. **Discuss** how the environmental factors in your community could influence an individual to become overweight or obese. Make reference to physical, socio-cultural, political and economic factors in your discussion – research these terms if necessary.

summarise give a brief statement of a general theme or major point/s; present ideas and information in fewer words and in sequence

describe give an account (written or spoken) of a situation, event, pattern or process, or of the characteristics or features of something

explain make an idea or situation plain or clear by describing it in more detail or revealing relevant facts; give an account; provide additional information

discuss examine by argument; sift the considerations for and against; debate; talk or write about a topic, including a range of arguments, factors or hypotheses; consider, taking into account different issues and ideas, points for and/or against, and supporting opinions or conclusions with evidence

Diabetes

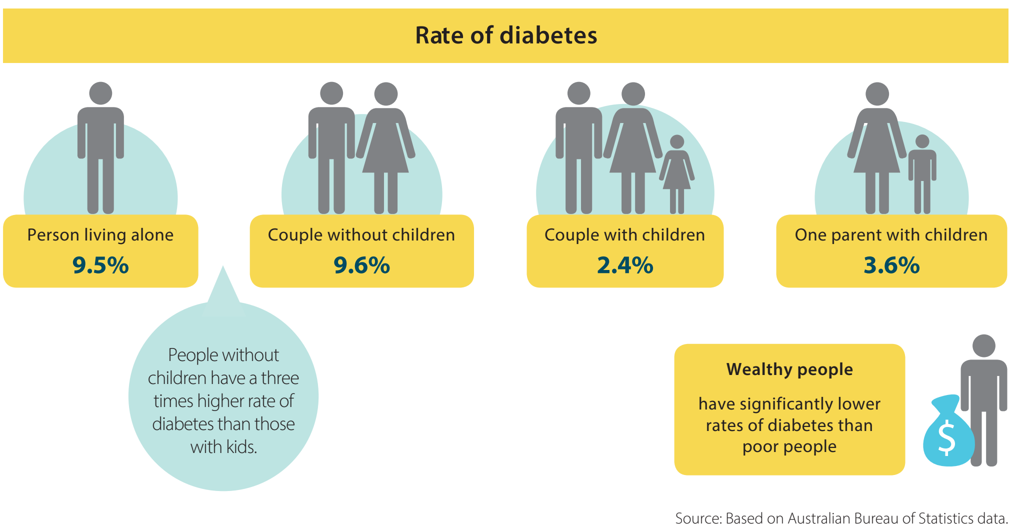


FIGURE 13.8 Rates of diabetes in Australia

Diabetes Australia

Diabetes is a disease that is a result of the body's inability to produce or respond to the hormone insulin. This causes abnormal metabolism of carbohydrates or food containing cereal grain. In simple terms, the body cannot maintain healthy levels of blood glucose needed for energy metabolism.

Diabetes Australia is a group with a leading edge in the research, management and reduction/prevention of this chronic disease.

How does diabetes affect the body?

When someone has diabetes, their body can't maintain healthy levels of glucose in the blood. Increased levels of glucose in the blood over time can lead to health complications which may hinder the body's ability to convert glucose to energy during cell metabolism.

The hormone insulin, which is made by the pancreas, regulates blood glucose levels. Insulin is essential for the conversion of glucose to energy. A person with diabetes can no longer regulate the production or quantity of insulin, resulting in glucose building up in the blood, which cannot get into the cells for energy. When a person with diabetes consumes glucose in foods such as breads, cereals, fruit and starchy vegetables, legumes, milk, yoghurt and sweets, the carbohydrates cannot be converted into cellular energy. Instead of being turned into energy, the glucose stays in the blood resulting in high blood glucose levels. Hyperglycaemia is excess glucose in the blood stream (above 130 mg/dL) and hypoglycaemia (less than 70 mg/dL) is a deficiency of blood glucose levels.

The common symptoms do not occur all at once but may include:

Table 13.4 Common symptoms of glycaemia

SIGNS OF HYPERGLYCAEMIA	SIGNS OF HYPOGLYCAEMIA
Extreme thirst	Racing pulse
Frequent urination	Cold sweat
Fatigue	Pale face
Listlessness	Headache
Nausea	Feeling incredibly hungry
Dizziness	Shivering and weak in the knees
	Difficulty concentrating
	Confusion

It is essential that people experiencing these symptoms have access to medical help immediately by calling 000.

There are three main types of diabetes: type 1, type 2 and gestational diabetes. All types of diabetes are complex and need daily care and vigilant management to avoid other complications. Diabetes does not discriminate; anyone can develop diabetes.

Type 1 diabetes is caused by the autoimmune system destroying insulin-making cells in the pancreas so that insulin can no longer be produced by the body. This is largely a genetic disease and can be managed by insulin injections, nutrition and regular exercise. About 10 per cent of individuals with diabetes have this type.

Type 2 or diabetes mellitus is sometimes referred to as 'lifestyle diabetes' as it is strongly related to individuals who have a sedentary life with little physical activity, who are also overweight or obese. This chronic disease is characterised by insulin resistance and/or abnormal insulin secretion. People over 40 years of age are more susceptible; however, this type of diabetes can be managed through diet, weight loss and increasing physical activity.

Gestational diabetes affects between 3 and 8 per cent of all pregnant women. It occurs during pregnancy and usually disappears after the birth of the baby, allowing glucose levels to return to normal

9780170418560

levels. This can cause excessive growth and fat deposits in the baby (making birth weight higher), but it can be monitored and treated using either diet or insulin injections during the term of the pregnancy.

Type 2 diabetes

Of diabetes sufferers in Australia, 85 per cent suffer from type 2 diabetes. To help understand and treat type 2 diabetes, the glycaemic index (GI) was developed as a tool which rates carbohydrate-based foods on a scale of 1–100.

Foods that release energy into the blood stream quickly are high on the GI scale. Correspondingly, foods that release energy more slowly are lower on the GI scale. The impact of consuming foods with a lower GI means that the level of glucose in the blood stream remains more constant for a longer period. A food product with the circular symbol below can be easily recognised by consumers as a food that helps maintain a sustained blood glucose level. As this is not a mandatory symbol, checking the Nutrition Information Panel on each food label is crucial for diabetics.

Source: Glycemic Index Foundation. Reproduced with permission.

FIGURE 13.9 The symbol for GI certification

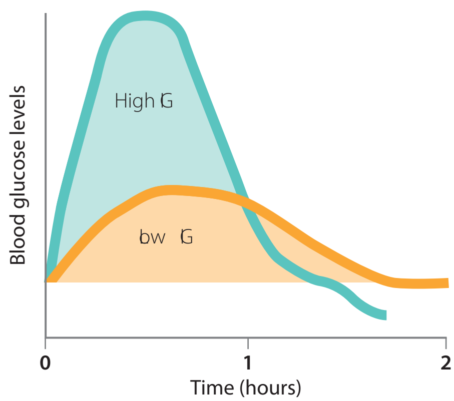


FIGURE 13.10 Graph mapping glycaemic index

Table 13.5 Examples of lower GI foods and food products for each food group

FOOD GROUP	LOWER GI CHOICES
Bread	Bürgen – soy-linseed, wholemeal and seeds, grain with barley, rye, pumpkin seed, wholegrain and oats, fruit and muesli Tip Top – 9 Grain Original, 9 Grain Wholemeal, 9 Grain Original Mini Loaf Country Life – gluten-free, low GI UpEnerGI – Authentic Pumpernickel, Authentic Sourdough Rye, Authentic Sourdough Wheat
Breakfast cereals	Goodness Superfoods – Digestive 1st, Protein 1st Kellogg's – All Bran, Guardian, Sustain Morning Sun – Apricot & Almond Muesli, Peach and Pecan Muesli Sanitarium – Hi-Bran Weet-Bix, Up & Go Woolworths Select – Bircher Muesli Vogel's – Ultra Bran Unprocessed oats, rice bran and oat bran
Grains	Pasta (all types) Rice – Basmati, Sunrice Doongara Clever Rice (white), wild rice, Moolgiri white rice Noodles – mung bean noodles, rice noodles (fresh), soba noodles Blue Gourmet Pearl Couscous Barley, buckwheat, bulgur, quinoa, semolina, whole rye kernels
Legumes	Kidney beans, soy beans, chickpeas, split peas, lentils, baked beans (dried and canned)
Vegetables	Sweet corn, taro, yam, Carisma potatoes, Nicola potatoes, parsnips
Fruit	Apple (fresh and dried), apricots (fresh, dried, canned), banana, grapes, kiwifruit, mango, nectarine, orange, peach, pear (fresh, dried, canned), plums, grapefruit
Dairy and alternatives	Milk, soy drink, yoghurt (low fat and diet), Frûche, custard, Le Rice, light flavoured milk
Biscuits and snacks	Freedom foods (97% fat-free fruit cookies), Ryvita (pumpkin seeds and oats, sunflower seeds and oats), Arnott's Snack Right (Fruit Pillow – apple and blackberry, apple and sultana, wild berry; Fruit Slice – sultana)

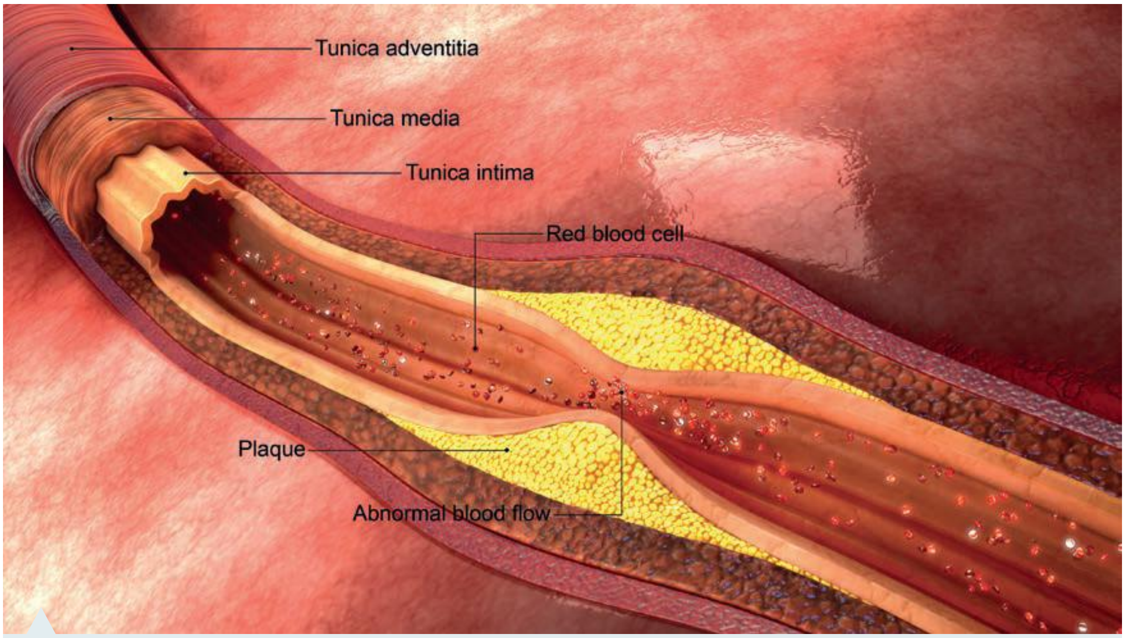
Source: Reproduced and adapted from Diabetes Queensland with permission, www.diabetesqld.org.au, accessed 8 March 2108.

To reduce the risk of developing type 2 diabetes or to reduce the impact that this disease has on the body, the following recommendations are advised:

- reduce the amount of energy that comes from refined cereal and fat-based products
- eat a wide range of healthy whole foods including fruits and vegetables
- if overweight or obese, reduction of weight is important
- be physically active and include 30 minutes of exercise a day relative to your health status.

Coronary heart disease

Coronary heart disease (CHD) is caused by a build-up of fatty plaque substances in the coronary arteries. This leads to narrowing of the vessels, reducing the blood flow to the heart and potentially causing angina or a heart attack. This chronic health condition is known as atherosclerosis and is associated with lifestyle habits such as smoking, high cholesterol levels, high blood pressure (hypertension) or diabetes.



Shutterstock.com/sciencepics

FIGURE 13.11 Coronary heart disease – thickening of the arteries

Around 3.6 million Australians are affected by CHD, stroke and vascular disease each year. This continues to rise due to the increasing rate of overweight and obese people. Aboriginal and Torres Strait Islanders are 2.6 times more likely to die from CHD. Risk factors for CHD include:

- smoking
- hypertension
- diabetes type 2
- high cholesterol
- heavy alcohol consumption
- oral contraceptive pill.

It is recommended that those who are suffering from or at risk of CHD follow the following guidelines:

- Eating an additional daily serve of vegetables is associated with a reduced risk of coronary heart disease.
- Eating an additional daily serve of fruit is associated with a reduced risk of coronary heart disease.
- Increasing the consumption of legumes has proven to be a good alternative to animal proteins which are high in saturated fat. Replacing saturated fat with monounsaturated and polyunsaturated fat (in correct proportions) leads to an improved blood lipid profile and reduced risk of coronary heart disease (CHD).
- Eating grain (cereal) foods (especially wholegrains and those with fibre from oats or barley) reduces the risk of CHD disease in adults.
- Consumption of at least two serves per day of dairy foods (milk, cheese and yoghurt) is associated with reduced risk of ischaemic heart disease and hypertension.
- Seek medical advice and gradually increase physical activity to 30 minutes a day.

Diet-related cancers

Only in the past 20 years has there been considerable evidence to support a link between diet and cancer. According to the Australian Institute of Health and Welfare, the cancers directly associated with dietary intake include mouth, upper throat, larynx, lung, stomach and bowel. The research and development in this area is still in fledgling stage – the number of studies that have been completed and verified is small.

Diet evidence suggests that high intake of particular foods such as processed meat and foods that are high in fat may be associated with an increased risk of cancers of the colon, oesophagus and stomach.

Research conducted for the 2013 Australian Dietary Guidelines categorises evidence from studies conducted on Australian people. The evidence is assigned a grade, from A to E, depending on the type of study, size and reason. Evidence graded A would be considered more credible as there is convincing evidence that this is true. Evidence that is graded D means that the study or link is weak.

The Evidence Report used a systematic approach to a literature review including:
A minimum of five high quality studies were required before a graded evidence statement was made. The Evidence Statements were graded A to D according to standard NHMRC protocols.

- Grade A (convincing association) indicates that the body of evidence can be trusted to guide practice.
- Grade B (probable association) indicates that the body of evidence can be trusted to guide practice in most situations.
- Grade C (suggestive association) indicates that the body of evidence provides some support for the recommendations, but care should be taken in its application.
- Grade D indicates that the body of evidence is weak, and any recommendation must be applied with caution.

In relation to dietary links to cancer, the following grade B and C evidence links were made:

Table 13.6 Grade B and C evidence links in relation to cancer

GRADE B EVIDENCE
Consumption of more than one serve of dairy foods per day (especially milk) is associated with reduced risk of colorectal cancer.
Consumption of three or more serves of milk per day is not associated with risk of renal cell and colorectal cancer.
Consumption of alcohol, even at low levels (10 g/day), is linked to increased risk of breast cancer.
Consumption of alcohol is linked to increased risk of cancer of the oesophagus.
Fruit consumption is associated with reduced risk of several types of cancer along the alimentary tract. Consumption of fruit is associated with a reduced risk of oral and nasopharyngeal cancer.
Consumption of red meat is associated with an increased risk of colorectal cancer.
GRADE C EVIDENCE
Consumption of more than one serve of milk per day is associated with reduced risk of rectal cancer.
Consumption of one serve of dairy food (milk, cheese, yoghurt) per day is not associated with the risk of breast cancer.
Consumption of coffee is not associated with risk of breast cancer, colorectal cancer or ovarian cancer.
Consumption of alcohol is associated with an increased risk of cancer of the oral cavity, pharynx and larynx.
Consumption of alcohol, even at low levels (10 g/day), is associated with increased risk of liver cancer in some populations.
Consumption of sucrose is not associated with risk of cancer, but caution is advised as there is a direct link between sugar intake, obesity and diabetes.
Consumption of fruit is not associated with the risk of breast, ovarian, endometrial or colorectal cancer.

Source: National Health and Medical Research Council

9780170418560

In this same report, it was observed that there is no dominant mechanism to explain the protective effect of vegetables, legumes/beans and fruit for some cancers. Some risk factors for cancer, such as oxidising radiation, can operate primarily from childhood or early adult life and antioxidants or other protective constituents of vegetables, including legumes/beans, and fruit may need to be consumed regularly from early life to be effective. Phytochemicals and several vitamins and minerals found in vegetables and fruit are thought to protect against some cancers by a range of mechanisms. Vegetables in the green leafy and brassica subgroup are particularly high in folate and inadequate amounts of folate are thought to increase the risk of cancer.

When examining the grades of evidence, it may suggest that many individual foods can give people cancer. The focus of a healthy person should be to follow the dietary guidelines and their suggested portion sizes to help lower the risk of diet-related cancer. This area of research is continuous, so keeping up to date on recent reliable studies is essential.

ACTIVITY 13.3

AIM

To **research** nutrition consumer markets to **determine** nutrition requirements for formulating foods that support health

determine establish, conclude or ascertain after consideration, observation, investigation or calculation; decide or come to a resolution

STEPS

Primary data about the food choices of individuals will be collected through interviews. This data will be used to determine appropriate dietary choices to maintain or improve health. A range of individuals should be interviewed, and the primary data collected should remain anonymous.

1 **Devise** an interview to collect data on individual food choices. Refer to the interview techniques in the introductory chapters for hints. The interview does not have to be long to be effective. The interview should include questions on the following:
   - general health status, e.g. age, gender, level of fitness, level of activity on a day-to-day basis, level of activity in occupation
   - dietary health status, e.g. diet-related concerns such as food allergies, intolerances, diabetes
   - general food choices, e.g. number of meals per day, number of serves of fruit and vegetables consumed, number of times fast food is consumed per week, number of sugary drinks consumed each week, amount of alcohol consumed each week
   - reasons for food choices, e.g. when fast food is consumed, what is the main reason?
2 Produce a record sheet to use when conducting the interviews. This could be a simple table with each question and a place to record the answer.
3 **Conduct** the interviews using the predetermined questions, recording the data.

devise think out; plan; contrive; invent

conduct direct in action or course; manage; organise; carry out

Conclusions

1 For each person interviewed, **summarise** their food choices into a table. This summary is for data analysis and should not identify individual names.
2 **Propose** foods that could be substituted or added to the diet to maintain or improve health. Provide a reason for each suggestion.
3 **Propose** reasons why poorer food choices are sometimes made by consumers. How can food product developers use these reasons to develop and target products to help the health of consumers?

Remember: this exercise is to collect primary data. Questions should be phrased and asked in a non-judgemental way.

Taking it further

4 A food company has conducted research and found a gap in the breakfast food market, for a breakfast item that can be consumed at work with little to no preparation. **Propose** a breakfast item for the following nutrition consumer markets, that can be consumed when at work, without heating, to improve health and supply adequate energy.

a Fitness-focused consumer who rides 45 mins to work each day

b Vegan consumer who is a tradesperson and has a physically strenuous job

c Obese consumer who is trying to lose weight and works in an office job

d Pregnant consumer who has two infant children to feed and get to school each morning

e Diabetic consumer who travels for work and is often not at home

Emerging nutritional food trends

formulation putting together the food components in appropriate relationships or structures, according to a formula or recipe

reformulation formulate a mixture of ingredients in a different way; to alter or revise

Australian consumer trends result in the need for new products or the redevelopment of existing market products to cater for current life changes. **Formulation** is the development of new food products and **reformulation** is the change made to existing products to meet consumer demand and needs.

A trend is a general direction in which something is changing or heading in. Emerging food trends are difficult to predict and are not always founded in scientific principles. Also, some foods, particularly nutritional trends, become 'trendy' in Western culture, even though they may have been consumed in other cultures for many years. Foods such as quinoa and chia have been consumed for centuries in other cultures, but have recently been hailed as 'superfoods'. Whatever the reason behind the trend, food trends provide food product development opportunities.

Emerging nutritional food trends include:

- snack food products
- gluten-free alternatives (refer to chapter 6 for more information)
- probiotic products (refer to chapter 4 for more information)
- lactose- and dairy-free alternatives
- sustainable products such as use of by-products from existing processing (refer to chapter 4 for more information).

ACTIVITY 13.4

investigate carry out an examination or formal inquiry in order to establish or obtain facts and reach new conclusions; search, inquire into, interpret and draw conclusions about data and information

AIM

To **investigate** emerging nutritional food trends and understand their purpose

STEPS

1 **Investigate one** of the following emerging nutritional food trends, individually or as part of a group.

2 Prepare a summary of the research to share with the class, using a presentation or sharing technology.

Some background and research points have been provided as a starting point but research does not need to be limited to these points only.

EMERGING FOOD TREND	BACKGROUND/RESEARCH QUESTIONS
Snack food products	**1** Investigate the worth of the snack food industry in Australia. **2** List popular snack foods, in particular, snack foods that are marketed as 'nutritional' **3** Compare the nutritional characteristics of popular 'nutritional' snacks such as pretzels, muesli bars, dried fruit to fresh alternatives such as bananas or apples. Analyse the perceived nutritional benefit versus the actual nutritional benefit of these snack foods. **4** Propose reasons why nutritional snack food products have become increasingly popular. Are there alternative snack foods that could be considered healthier?
Gluten-free alternatives	**1** Investigate the incidence of coeliac disease in Australia (to find out how many people need to consume gluten-free products for this reason). **2** Investigate other reasons why people choose to purchase gluten-free alternatives. **3** Research current gluten-free options on the market and how this has increased over time. **4** Research emerging areas of gluten-free products such as sorghum. Outline the potential health benefits and which consumer markets these products would target.
Probtiotic products	**1** List probiotic products that are currently on the market – both food and drink items. **2** Research innovative new probiotic products such as PERKii – identify the point of difference in new products such as PERKii. **3** What are the perceived benefits of consuming probiotic products? **4** Which nutrition consumer market do probiotic products target? Do you think this will continue to be a food trend?
Lactose- and dairy-free alternatives	**1** Investigate the incidence of lactose intolerance in Australia. **2** Research other reasons consumers choose to purchase lactose- or dairy-free products. **3** Investigate latest dairy-free and lactose-free products. **4** Outline the nutrition consumer markets that these products may be targeted to and propose reasons that this will continue as a food trend in Western culture.
By-products from existing processing	**1** Investigate current consumer attitudes toward sustainable food products. How have attitudes shifted over the years? What age groups are more likely to have this concern? **2** List food products that can be created from by-products. **3** What nutrition consumer market are these products targeted toward? **4** Propose other food products that can be developed from by-products.

PERKii

Dairy-free products

Conclusions

1 **Determine** the purpose of nutritional food trends.

2 From the emerging food trends investigated, **identify** where there are opportunities for food product development or current gaps in the market.

3 **Propose** a new food product for each emerging food trend.

Formulation

Food products are combinations of measured ingredients and additives that are prepared in a specific way. This is known as the formula or recipe.

Improvements or changes in food formulation can be caused by a number of reasons, including updates to technology, changes in legislation or changes in consumer demand.

Product formulation has become very scientific over the past 10 years as the development of computer software databases has enabled the storage of information about raw products and their reaction under scientific analysis. The quality and quantity required is also recorded for companies to visualise ingredients and determine which combinations may fit with criteria for the product being developed. This knowledge-based technology assists companies by reducing time spent on research and development while increasing the opportunity for the success of new products.

Reformulation

Reformulating food products occurs when existing products are altered or revised, and a new combination of ingredients, ratios and methods are devised. Reformulation of products can occur for a number of reasons. These include changes in:

- consumer demand, such as more health-conscious consumers
- technology, such as improved machinery and introduction of robotics
- legislation, such as allowable food additives
- processing methods and techniques, such as high-pressure processing
- revenue from current products (e.g. declining revenue)
- competing products on the market
- research, such as reports and statistics on obesity or current consumption of sugar.

These changes may prompt food producers to reformulate existing products to fulfil a specific need. Reformulation is an important part of the food industry and is considered less risky than completely new products or formulations, as they are building on and tweaking existing food formulations. This method can also be used for creating line extensions to products, such as variations of flavour or lower fat versions of existing products.

Food Standards Australia New Zealand labelling

Food Standards Australia New Zealand (FSANZ) develops and administers the Food Standards Code for Australia and New Zealand. Refer to chapter 8 for more information on the general purpose of FSANZ and the Food Standards Code.

Labelling of nutritional content

Labelling of nutritional content is covered under Standard 1.2.7 *Nutrition, Health and Related Claims* and Standard 1.2.8 *Nutrition Information Requirements*. Standard 1.2.7 was outlined in chapter 8.

Nutritional content on food labels enables the consumer to make informed decisions about the foods they choose to eat. Standard 1.2.8 sets out:

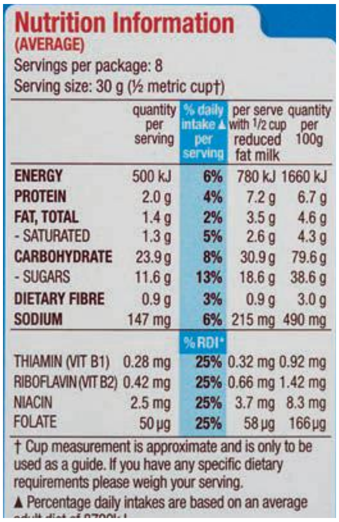
- the information required on the nutrition information panel
- foods that must contain a nutrition information panel
- foods that are exempt from displaying a nutrition information panel
- additional nutrition information that must be displayed if a nutrient claim is made or a biologically active substance is present (such as a probiotic).

In Australia, nutrition information panels must provide information on the average amount of energy, protein, total fat, saturated fat, carbohydrate, sugars and sodium present in the food. They must also contain information about any nutrient where a nutrient claim is made, such as 'high in calcium' or 'good source of fibre'. The additional nutrients must be shown on the nutrition information panel.

The panel itself is displayed in a standard format in a table. It must display the nutrition content per serve and the nutrition content per 100 g or 100 mL of liquid. Food serving sizes may vary, depending on the manufacturer. Serving sizes can vary even for foods by the same manufacturer! This means that the nutrient values cannot be compared across different serving sizes. The inclusion of nutrients per 100 g means that nutrients in products can be compared.

9780170418560

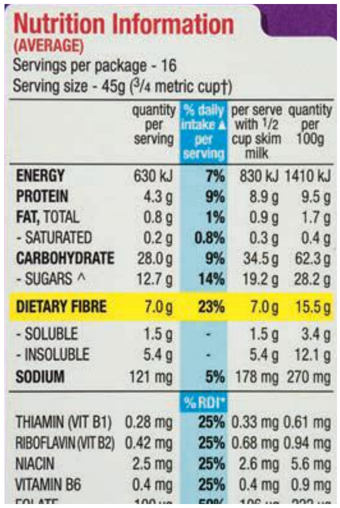
Foods that are exempt from a nutrition panel include herbs and spices, foods sold unpackaged such as fruit or vegetables and foods that are made and sold on the premises such as cake from a bakery. Foods in small packages also do not require a nutrition panel.



Nutrition Information
(AVERAGE)
Servings per package: 8
Serving size: 30 g (½ metric cup†)

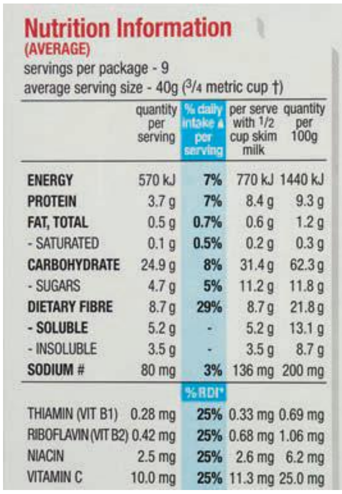
	quantity per serving	% daily intake ▲ per serving	per serve with 1/2 cup reduced fat milk	quantity per 100g
ENERGY	500 kJ	6%	780 kJ	1660 kJ
PROTEIN	2.0 g	4%	7.2 g	6.7 g
FAT, TOTAL	1.4 g	2%	3.5 g	4.6 g
- SATURATED	1.3 g	5%	2.6 g	4.3 g
CARBOHYDRATE	23.9 g	8%	30.9 g	79.6 g
- SUGARS	11.6 g	13%	18.6 g	38.6 g
DIETARY FIBRE	0.9 g	3%	0.9 g	3.0 g
SODIUM	147 mg	6%	215 mg	490 mg
		%RDI*		
THIAMIN (VIT B1)	0.28 mg	25%	0.32 mg	0.92 mg
RIBOFLAVIN (VIT B2)	0.42 mg	25%	0.66 mg	1.42 mg
NIACIN	2.5 mg	25%	3.7 mg	8.3 mg
FOLATE	50 µg	25%	58 µg	166 µg

† Cup measurement is approximate and is only to be used as a guide. If you have any specific dietary requirements please weigh your serving.
▲ Percentage daily intakes are based on an average



Nutrition Information
(AVERAGE)
Servings per package - 16
Serving size - 45g (3/4 metric cup†)

	quantity per serving	% daily intake ▲ per serving	per serve with 1/2 cup skim milk	quantity per 100g
ENERGY	630 kJ	7%	830 kJ	1410 kJ
PROTEIN	4.3 g	9%	8.9 g	9.5 g
FAT, TOTAL	0.8 g	1%	0.9 g	1.7 g
- SATURATED	0.2 g	0.8%	0.3 g	0.4 g
CARBOHYDRATE	28.0 g	9%	34.5 g	62.3 g
- SUGARS ^	12.7 g	14%	19.2 g	28.2 g
DIETARY FIBRE	7.0 g	23%	7.0 g	15.5 g
- SOLUBLE	1.5 g	-	1.5 g	3.4 g
- INSOLUBLE	5.4 g	-	5.4 g	12.1 g
SODIUM	121 mg	5%	178 mg	270 mg
		%RDI*		
THIAMIN (VIT B1)	0.28 mg	25%	0.33 mg	0.61 mg
RIBOFLAVIN (VIT B2)	0.42 mg	25%	0.68 mg	0.94 mg
NIACIN	2.5 mg	25%	2.6 mg	5.6 mg
VITAMIN B6	0.4 mg	25%	0.4 mg	0.9 mg



Nutrition Information
(AVERAGE)
servings per package - 9
average serving size - 40g (3/4 metric cup †)

	quantity per serving	% daily intake ▲ per serving	per serve with 1/2 cup skim milk	quantity per 100g
ENERGY	570 kJ	7%	770 kJ	1440 kJ
PROTEIN	3.7 g	7%	8.4 g	9.3 g
FAT, TOTAL	0.5 g	0.7%	0.6 g	1.2 g
- SATURATED	0.1 g	0.5%	0.2 g	0.3 g
CARBOHYDRATE	24.9 g	8%	31.4 g	62.3 g
- SUGARS	4.7 g	5%	11.2 g	11.8 g
DIETARY FIBRE	8.7 g	29%	8.7 g	21.8 g
- SOLUBLE	5.2 g	-	5.2 g	13.1 g
- INSOLUBLE	3.5 g	-	3.5 g	8.7 g
SODIUM #	80 mg	3%	136 mg	200 mg
		%RDI*		
THIAMIN (VIT B1)	0.28 mg	25%	0.33 mg	0.69 mg
RIBOFLAVIN (VIT B2)	0.42 mg	25%	0.68 mg	1.06 mg
NIACIN	2.5 mg	25%	2.6 mg	6.2 mg
VITAMIN C	10.0 mg	25%	11.3 mg	25.0 mg

Mark Fergus Photography

FIGURE 13.12 Three different serving sizes of breakfast cereals (Coco Pops 30 g, Sultana Bran 45 g, Rice Bubbles 35 g) made by the same company mean that the nutrients per serving cannot be compared across each label. The 100 g column can be compared across all three labels, however.

ACTIVITY 13.5

AIM

To use the Nutrient Profiling Scoring Criterion (NPSC) to **analyse** information and data on food packaging and **determine** suitability for nutrition consumer markets

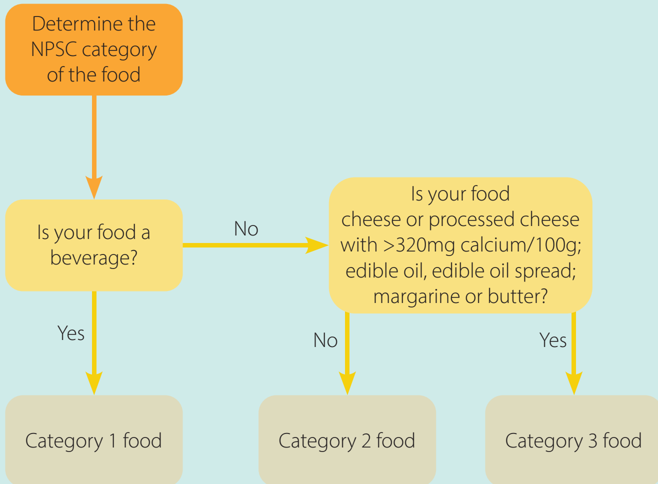
BACKGROUND

The Nutrient Profile Scoring Criterion was developed by FSANZ for use when determining if a food is suitable to make a health claim. It is based on the nutrient profile of the food. The following scores are required for a food producer to be able to make a health claim about a product:

NPSC CATEGORY	FINAL SCORE
Category 1	less than 1
Category 2	less than 4
Category 3	less than 28

STEPS

1. Refer to the nutritional information panels on page 338.
2. Follow the steps in the flow chart to determine the category of the food item.
3. Access the online NPSC calculator linked below and input the figures from one of the nutritional information panels.
4. Identify the percentage of fvnl ingredients – fruit, vegetables, nuts and legumes, including coconut, spices, herbs, fungi, seeds and algae, from the ingredients list.



5. Print or make a screen shot of your record.
6. Repeat the process with the other two nutritional information panels on page 338.

Conclusions

1. **Determine** whether the food meets the Nutrient Profile Score Criterion, using the table above.
2. One of the products contains a health claim of 'high fibre' on the packaging. **Determine** which product can make this health claim.
3. Review the information in this chapter on each of the nutrition consumer markets and **determine** which nutrition consumer market or markets a 'high fibre' health claim would be suitable for.

Nutrient Profile Standard Score calculator

NPSC guide

Taking it further

4. **Research** other nutritional information panels and analyse them using the NPSC calculator.
   a. For products that **do not** meet the NPSC score required for a health claim, propose which ingredients could be removed or added to meet the NPSC score.
   b. For products that **do** meet the NPSC score required for a health claim, propose which nutrition consumer market(s) the product is suitable for.

ACTIVITY 13.6

AIM

To **investigate** how food formulations solve problems associated with food choices for different consumers

STEPS

Investigate the nutrition consumer markets in the table and determine:

a. the problem that each nutrition consumer market faces
b. unsuitable foods for this nutrition consumer market
c. food solutions that have been developed to solve the problem or alter unsuitable foods.

9780170418560

NUTRITION CONSUMER	PROBLEM	UNSUITABLE FOODS	INVESTIGATE FOOD PRODUCTS DEVELOPED
Diabetic consumers			
Pregnant consumers			
Coeliac consumers			
Lactose-intolerant consumers			
High blood pressure/Hypertension			
Peanut allergy			

WS
Activity 13.6 template

Conclusions

1 From the investigation into food products on the market, **judge** if food formulations can solve problems for specific nutrition consumer groups.

2 If formulations for gluten-free products were not developed, what would be the alternatives for people who are coeliac or gluten-intolerant?

3 **Propose** how food formulations for specific nutrition consumer markets can improve quality of life for consumers within this market.

4 **Decide** if unsuitable foods can be reformulated to achieve suitable nutritional value for nutrition consumer markets. Provide examples of this from the investigation.

Taking it further

5 **Deduce** if there are benefits for the broader community from products that are developed for specific nutrition consumer markets. Provide specific examples of products that can benefit the wider community but may have been developed for a specific market.

Formulating and reformulating products to enhance nutritional outcomes

Considering current Australian heath issues, foods high in fat, high in salt, added sugars, and low in fibre could best benefit from reasonable changes or substitution of ingredients to produce new products. Gluten-free and lactose-free alternatives can be added to the list of reformulations which could create new products that reasonably compare with the sensory properties to those existing on the market. Foods can be reformulated or line extensions created to help solve some of the current health issues in Australia. An example of this is the reduction in salt or sodium in processed food products.

ACTIVITY 13.7

AIM

To develop lists of food products through investigating needs or opportunities for formulating or reformulating products to enhance nutritional outcomes.

INSTRUCTIONS

1 As a class, make a list of all the snack food products that are consumed regularly or collect packets over a two-week period.

2 Determine which food items are high or low in the nutrients identified in the table. Some samples have been provided.

Research

FOOD	HIGH IN SALT	HIGH IN FAT	HIGH IN SUGAR	HIGH IN GLUTEN	CONTAINS LACTOSE	LOW IN DIETARY FIBRE
Smith's Salt and Vinegar Potato Chips	✔	✔				✔
LCMs Coco Pops with milk			✔		✔	✔
Le Snak cheddar cheese	✔	✔			✔	

3 Highlight the foods in the table that you consume the most.

Stakeholders can mean individuals, groups or businesses who have an interest or concern with the situation. In this situation, think about all stakeholders who would have an interest in the re-development of snack food products, in particular, reducing salt, sugar and fat. Some examples of stakeholders in this field might be parents who are buying snacks for children, nutritionists who are designing diets for particular nutritional needs, individuals who require a specific diet, not-for-profit organisations such as the Heart Foundation, members of the general public who are interested in lowering the medical burden of those who have diet-related illness.

Conclusions

1 **Identify** where is the greatest need existing for reformulation of snack food products.

2 **Discuss** with the class which products are consumed most by others. Out of the class list of top consumed snack foods, which one nutrient appears the most? Salt? Sugar? Lack of dietary fibre?

3 Select 5 snack food items in the table and suggest reformulations that would retain their appeal but have better nutrient value. Ideas can be totally different in the brainstorming phase, and then testing for feasibility during prototyping. For example, reducing the salt and fat in Le Snak cheddar cheese by substituting the crackers for fresh vegetables or vegetable chips that are not salted.

4 Using a food product from the gluten or lactose lists, find a simple recipe that you could reformulate to include gluten- and lactose-free ingredients. Write up the new formulation.

Taking it further

5 **Research** stakeholders who would have an interest in reducing the amount of salt, fat and sugar in snack food products. Make a list of stakeholders and in point form, outline their interest in this type of food product development.

STAKEHOLDER	INTEREST IN SNACK FOODS LOWER IN SALT, SUGAR OR FAT

6 Collect primary and secondary research data from some of the stakeholders listed above, to assist in developing ideas to reformulate existing food products. Note in the table the stakeholder, if you collected primary or secondary data, and what data you collected.

STAKEHOLDER	PRIMARY OR SECONDARY DATA	DATA ON REFORMULATION OF SNACK FOOD PRODUCTS

7 Make suggestions and develop ideas to reduce the salt, sugar and fat in snack food products based on the research data into what stakeholders are interested in.

EXPERIMENT 13.1

Reformulating savoury crackers to reduce salt consumption in foods

AIM

To **test** ideas and solutions for food formulations for specific consumers who require less salt in their diet

test
take measures to check the quality, performance or reliability of something

BACKGROUND

As salt is an electrolyte (sodium chloride) needed by the body to regulate blood and tissue fluid levels there is a need for some salt in the diet. However, most Australians consume too much salt. The consumption recommended by the National Health and Medical Research Council (NHMRC) is no more than 1 teaspoon or 4 g (1600 mg of sodium) of salt a day, to avoid chronic diseases related to high salt intake. Salt has traditionally been added to foods and used as a preservative. It also increases the sensory property of flavour. A gradual reduction of salt from the diet could significantly decrease the likelihood of high blood pressure or hypertension, which in turn increases chances of developing kidney and cardiovascular diseases. The upper limit of salt consumption per day is 6 g or 2300 mg.

While some natural foods such as meat, dairy products and wholegrains contain small amounts of salt, most of the sodium ingested by people comes from processed foods where it is hidden as part of a combination of foods. Therefore, the reformulation of current processed foods would decrease Australia's health burden for chronic illness related to sodium consumption.

Opportunities that exist with reduction of salt/sodium in the food industry include products that replace salt by swapping salt for:

- sea, onion or garlic salt as they have a low sodium content
- fresh or dried herbs to enhance the flavour naturally, e.g. parsley, basil, thyme, rosemary
- spices to enhance the flavour naturally, e.g. garlic, curry, chilli
- citrus fruits or vinegar that not only add flavour but may also act as a chemical agent to change the texture of food
- lower salt cheese options e.g. cottage, ricotta, mozzarella or Swiss cheese.

INSTRUCTIONS

1 You will be required to prepare one (1) portion of each formulation and store it appropriately.
2 Each technique will be examined for changes in the salt content and sensory properties.

PREPARATION

CONTROL	VARIABLE 1: LOWER SALT SAMPLE	VARIABLE 2: LOWEST SALT SAMPLE
1 batch of the basic formulation + 40 g grated parmesan cheese	1 batch of basic formulation with the following changes: Remove the salt and use unsalted butter + 40 g parmesan cheese After glazing, sprinkle with sesame seeds	1 batch of basic formulation with the following changes: Remove the salt and use unsalted butter + 40 g Swiss cheese and 1 tbsp sundried tomato paste or Italian dried herbs After glazing, sprinkle with sesame seeds

FOOD COMPONENTS

Basic batch (you will need 3 batches)

- 125 g plain white flour, plus extra for dusting
- 75 g self-raising white flour
- ½ tsp salt
- 70 g salted butter, softened

- 20–25 mL water
- ½ medium egg + ½ for glazing

ADDITIONS

- 2 × 40 g grated parmesan cheese
- 40 g Swiss cheese
- 1 tbsp sundried tomato paste or dried Italian herbs
- 2 tbsp sesame seeds

EQUIPMENT

- measuring spoons and jug
- scales
- food processor
- spatula
- baking paper
- rolling pin
- cup for glaze
- fork to beat egg
- pastry brush
- knife or biscuit cutter
- baking trays
- cooling rack

PROCEDURE

1. Preheat oven to 180ºC (shelf positions just above and below centre of oven).
2. Measure all ingredients for each batch and set aside.
3. Make each batch required by placing all ingredients into the food processor and mixing for 1 minute at medium speed.
4. Using two sheets of baking paper, sandwich the pastry between sheets, rolling out pastry until it is 3 mm thick.
5. Remove the top sheet of baking paper and cut pastry into shapes.
6. Glaze with egg.
7. Place on baking tray (lined with the top sheet of paper).
8. Bake for 13 minutes.
9. Remove from oven and transfer to a cooling rack and cool for tasting.
10. Repeat with remaining variables.

RESULTS ANALYSIS

1. Complete a sensory analysis of each product and record in a table.

SENSORY PROPERTY	CONTROL	VARIABLE 1	VARIABLE 2	VARIABLE 3
Appearance				
Taste				
Flavour and aroma				
Texture				

WS Experiment 13.1 template

2. Make a list of the foods that contain sodium in the control formulation.
3. **Explain** how the amounts of sodium were adapted for each variable.

9780170418560

WRITE A REPORT

1. Using this information, make a statement about each product for consumers on the:
   a. quality of the solution
   b. functionality of the solution
   c. reliability of the solution.
2. Which of these formulations has the greatest potential to be a success in the consumer snack food market? Justify your answer.
3. Are there other changes that could be made to better meet the salt-reduced snack food consumer market? **Explain** your answer.

justify give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable

EXPERIMENT 13.2

Formulating savoury crackers to reduce saturated fat consumption in foods

AIM

To **test** ideas and solutions for food formulations for specific consumers who require less salt in their diet

BACKGROUND

ENHANCING NUTRITIONAL OUTCOMES BY REDUCING SATURATED FAT

As fat is responsible for protection of body organs and is a carrier of fat-soluble vitamins A, D, E and K, the body requires some fat to maintain good health. The type of fat consumed by individuals, particularly saturated fat (largely from animal sources), can increase the risk of coronary heart disease with the deposition of fatty plaque in arteries around the heart. The energy density of fat is twice that of protein and carbohydrates, which means diets high in fat without energy expenditure will lead to an increased risk of obesity, high blood pressure and diabetes type 2. As saturated fats also increase LDL levels, cholesterol becomes a factor that contributes to ill health.

Opportunities exist with reduction of saturated fat in the food industry, include products which contain:

- polyunsaturated fat sources found in oils, nuts and seeds, which can reduce the risk of diabetes
- oils such as olive and grape seed
- less meat, but good quality protein including oily fish
- high fibre ingredients which assist with binding of fat molecules
- unrefined carbohydrates like whole grain cereals that lower GI
- garlic and plant sterols which lower cholesterol
- plant protein sources, e.g. legumes and soy.

INSTRUCTIONS

1. You will be required to prepare one (1) portion of each formulation and store it appropriately.
2. Each technique will be examined for changes in the fat content and sensory properties.

CONTROL COULD USE PRODUCT FROM THE PREVIOUS EXPERIMENT	VARIABLE 1: LOWER FAT SAMPLE	VARIABLE 2: LOWEST FAT SAMPLE	VARIABLE 3: ALTERNATIVE TO SATURATED FAT
1 batch of the basic formulation + 40 g grated parmesan cheese	1 batch of basic formulation with the following changes: Remove the butter and add Greek yoghurt + 40 g parmesan cheese. After glazing, sprinkle with paprika Note: you may need to reduce the water quantity	1 batch of basic formulation with the following changes: Remove the butter and add Greek yoghurt, remove the whole egg and just use egg white + 2 tsp oven-roasted garlic powder After glazing, sprinkle with Italian dried herbs	1 batch of basic formulation with the following changes: Remove the whole egg and just use egg white + 2 tsp oven-roasted garlic powder Replace the butter with olive oil After glazing, sprinkle with Italian dried herbs

PREPARATION

FOOD COMPONENTS

Basic formulation (you will need three)

- 3 × 125g plain white flour, plus extra for dusting
- 3 × 75g self-raising white flour
- 3 × ½ tsp salt
- 7 g salted butter, softened
- 20–25 mL water
- 2 × ½ medium egg + ½ for glazing

ADDITIONS

- 1 egg white
- 70 g Greek yoghurt
- 70 mL olive oil
- 2 × 40 g grated parmesan cheese
- 1 small jar of dried Italian herbs

EQUIPMENT

- food processor
- measuring spoons and jug
- scales
- spatula
- baking paper
- cup for egg glaze
- fork to beat egg
- pastry brush
- rolling pin
- knife or biscuit cutter
- baking trays
- cooling rack

PROCEDURE

1. Preheat oven to 180°C (shelf positions just above and below centre of oven).
2. Measure all ingredients for each batch and set aside.
3. Make each batch required by placing all ingredients into the food processor and mixing for 1 minute at medium speed.

9780170418560

4 Using two sheets of baking paper, sandwich the pastry between sheets, rolling out partly until it is 3 mm thick.
5 Remove the top sheet of baking paper and cut pastry into shapes.
6 Glaze with egg.
7 Place on baking tray (lined with the top sheet of paper).
8 Bake for 11–13 minutes.
9 Remove from oven and transfer to a cooling rack and cool for tasting.

RESULTS ANALYSIS

1 Complete a sensory analysis of each product and record it in a table.
2 List the foods that contain fat in the control formulation.
3 **Explain** how changing the type of fat in a product can improve a person's health.
4 **Explain** how the amounts of fat were adapted for each variable.

SENSORY PROPERTY	CONTROL	VARIABLE 1	VARIABLE 2	VARIABLE 3
Appearance				
Taste				
Flavour and aroma				
Texture				

WS Experiment 13.2 template

WRITE A REPORT

1 Using this information make a statement about each product for consumers.
  a Quality of the solution
  b Functionality of the solution
  c Reliability of the solution
2 Which of these formulations has the greatest potential to be a success in the consumer snack food market? **Justify** your answer.
3 Are there other changes that could be made to better meet the fat-reduced snack food consumer market? **Explain** your answer.

EXPERIMENT 13.3

Reducing sugar consumption in foods by reformulation

AIM

To **test** ideas and solutions for food formulations for specific consumers who require less sugar in their diet

BACKGROUND

Sugar exists naturally in foods such as fruit, milk and some grains. It is an energy source necessary for our wellbeing. While sugar ingestion leads directly to dental issues such as increased plaque, gingivitis and subsequent tooth decay, it is the energy value in kilojoules that poses a direct link through overconsumption and energy expenditure to obesity, diabetes, heart and fatty liver disease. In the case of diabetes, it is the consumption of high GI foods that puts the body at risk of type 2 diabetes (diabetes mellitus), where excessive blood sugar molecules impede proper cell metabolism, placing stress on other parts of the body.

Opportunities that exist to reduce sugar in food products include:

- alternative sources of sweetener – recent and increasing interest in natural sources or sweetness, e.g. stevia
- fresh or frozen fruit as a natural alternative to sucrose or syrup
- fruit juice as a base for drinks to replace cordial
- added natural flavouring that enhances the sensory property of flavour
- more complex carbohydrates than single or double sugars, lowering the GI
- wholegrain cereal products where the GI is lowered, e.g. breads, cakes and biscuits

It is also important for consumers to compare the sugar, carbohydrate and fibre amounts on a food product label, so a wise choice can be made by people prior to purchase.

INSTRUCTIONS

1. You will be required to prepare one (1) portion of each formulation and store it appropriately.
2. Each technique will be examined for changes in the fat content and sensory properties.

PREPARATION

CONTROL	VARIABLE 1: LOWER SUGAR SAMPLE	VARIABLE 2: LOWEST SUGAR SAMPLE	VARIABLE 3: ALTERNATIVE TO SUGAR
1 batch of the basic formulation + 2.5 mL vanilla essence	1 batch of basic formulation with the following changes: Remove sugar and replace with ¾ cup mixed frozen berries + ¼ tsp vanilla bean paste	1 batch of basic formulation with the following changes: Remove the sugar and replace with ½ cup orange juice and rind Replace milk with coconut milk	1 batch of basic formulation with the following changes: Remove the sugar and replace with equivalent amount of stevia + 2.5 mL vanilla essence

FOOD COMPONENTS

Basic batch (you will need 4 batches)

- 4 × 1½ cups self-raising flour
- ½ cup caster sugar
- 4 × ½ egg
- 4 × ¼ cup vegetable oil
- 3 × 120 mL milk

Additions

- ¾ cup mixed frozen berries
- ½ cup orange juice + rind
- vanilla essence
- 12 mL coconut milk
- vanilla bean paste
- stevia

EQUIPMENT

- food processor
- muffin papers
- muffin tray
- measuring spoons and jug
- scales

9780170418560

- spatula
- cup for egg glaze
- fork to beat egg
- oven

PROCEDURE

- Preheat oven to 180ºC (shelf positions just above and below centre of oven).
- Prepare muffin trays.
- Measure all ingredients for each batch and set aside.
- Make each batch required by placing all ingredients into the food processor and mixing until well combined, at a medium speed.
- Using ¼ cup measure, place mixture into papers.
- Bake for 20–25 minutes.
- Remove from oven and transfer to a cooling rack and cool for tasting.

RESULTS ANALYSIS

1 Complete a sensory analysis of each product and record it in a table.

SENSORY PROPERTY	CONTROL	VARIABLE 1	VARIABLE 2	VARIABLE 3
Appearance				
Taste				
Flavour and aroma				
Texture				

Experiment 13.3 template

2 List the foods that contain sugar in the control formulation.
3 Explain how changing the type of sugar substance in a product improves a person's health.
4 Explain how the amounts of fat were adapted for each variable.

WRITE A REPORT

1 Using this information make a statement about each product for consumers.
 a Quality of the solution
 b Functionality of the solution
 c Reliability of the solution
2 Which of these formulations has the greatest potential to be a success in the consumer snack food market? **Justify** your answer.
3 Are there other changes that could be made to better meet the sugar-reduced snack food consumer market? **Explain** your answer.

ACTIVITY 13.8

Aim

To **investigate** needs and opportunities to reduce the use of additives in food

BACKGROUND

Food additives and preservatives are used in processing and storage of food to extend the shelf life or maintain sensory properties of food. Although Australia has rigid food standards, which require chemicals added to food to be listed on the label, there is a small percentage of people who have

Food additives

Experiment 13.3 template

an atypical reaction to certain chemicals. 50 of the 400 food additive compounds regularly used in Australian food production have been known to create an adverse reaction for people who are sensitive to specific chemicals. Some of these additives which cause health issues are listed below.

- Flavour enhancers – monosodium glutamate (MSG) 621
- Food colourings – tartrazine 102; yellow 2G107; sunset yellow FCF110; cochineal 120
- Preservatives – benzoates 210, 211, 212, 213; nitrates 249, 250, 251, 252; sulphites 220, 221, 222, 223, 224, 225 and 228
- Artificial sweetener – aspartame 951

STEPS

Using the information provided above and the weblink, analyse the label below for the safety of food additives in this product.

Alamy Stock Photo/Alisha Arif

Mark Fergus Photography

FIGURE 13.12 The additives in Arnott's Shapes, a popular Australian snack food

- E500 – sodium carbonates
- E306 – tocopherol-rich extract
- E222 – sodium bisulphate
- E304 – fatty acid esters of ascorbic acid

Conclusions

1. Are there any recognised additives in this product that could potentially cause adverse reactions for people? **Explain** your answer.
2. List the additives used in the product and explain why Arnott's has included these in Shapes. You will need to research each of these for your answer.
3. If a person was sensitive to a food additive, **discuss** possible solutions to the issue, considering each food additive and its function.

Mind mapping template

Mind mapping tools

What formulation and reformulation opportunities exist for specific nutrition consumer markets?

Create a mind map of information to help answer the guiding question. Use the supplied template or develop your own mind map. You may find it useful to use online tools such as Bubbl.us, Canva, Coggle, MindMup, iMindQ.

9780170418560

FOOD DEVELOPMENT PROCESS 14

» How can the food development process solve current and future nutrition consumer market problems?

Consumer market trends continue to drive the need for food formulation and reformulation as a key factor in developing food products. Demand for foods that provide nutrient-specific requirements for optimal health has led to the research and development of new products. The needs of individuals with particular health issues or lifestyle choices, along with new food product development has demonstrated the requirement to adapt current formulations to find suitable sensory substitutes that will be accepted by the Australian consumer.

When developing food formulations and prototypes to a specific brief it is important to consider all the chemical and functional properties of the ingredients to be used. The final solution will depend on each step of the problem-based learning process being followed and on the application of each process and the outcome.

Problem-based learning

In this unit, the teacher will supply the contextual stimulus, and students follow the problem-solving process to:

- explore the problem
- develop ideas
- generate a solution
- evaluate and refine the solution.

Evidence of each step of the problem-solving process will need to be provided in the folio. Refer back to the introduction to problem-based learning in chapter 1 and the example in chapter 5 for assistance. A folio checklist worksheet is supplied to indicate what should be included in the folio.

WS Folio checklist

Summative assessment

The project folio in this unit is summative internal assessment 3 (IA3): Project-folio (30%).

The conditions for this assessment include an allowance of 15 hours of work with a length of 10–15 A3 pages.

The table of contents and the reference list are not to be included in the page count.

The Project-folio is an individual student's documentation of applying the problem-solving process to a real-world problem in need of a solution. The response will include the following:

- headings that organise and communicate the student's thinking through the iterative phases of the problem-solving process
- a table of contents page
- a reference list and a recognised system of in-text referencing.

The Project-folio in this unit will determine the student's achievement in the unit objectives.

Food problem examples

The following dot points are examples of problems that students could solve by developing foods for specific consumer groups or individuals.

- A traditional breakfast food company is responding to consumer demand for healthy gluten-free breakfast products by reformulating their popular breakfast cereal biscuits into single serve, gluten-free convenience food products. The company wants something that is high in fibre and low in fat as outlined in a government health agreement. To be successful, the new product must contain acceptable sensory properties for a children's snack food. Cost is important for the target family-friendly market. The product is to be non-perishable to avoid food safety and storage issues.
- A chef in a day care centre on the Sunshine Coast has 10 children enrolled at the centre that have allergies to the additives and preservatives commonly used in processed foods. The centre's administration has asked her to reformulate a lunch menu for a week using foods that contain few additives and preservatives. The chef has a well-equipped kitchen, an assistant for 5 hours a day and 60 children to cook for, aged from 3 months to 6 years old.
- A supermarket chain has a competition to develop a new line of foods that are classed as 'ready-to-eat better-for-you' for vegetarians and vegans. You have been asked to create a two-course meal that meets the nutrition requirement for this group of consumers. The meal should not require more than 20 minutes finishing time and should be easy to present attractively. Safe food storage is an essential consideration and cost should be no more than $10 for 2 portions.


Shutterstock.com/Rawpixel.com

Figure 14.1 Children's snack foods need to be nutritious.


Shutterstock.com/spass

Figure 14.2 Children in day care centres need nutritious meals.


Shutterstock.com/By Magdanatka

Figure 14.3 Vegans and vegetarians need nutritious food.

WS
Unit 4 review

9780170418560

INDEX

C

D

G

H

I

K

L

M

N

O

P

Q

R

S

T

9780170418560

U

V

W

Y

Z

nelsonnet

Register online at:

www.nelsonnet.com.au

to access digital resources to support improved learning & teaching*

OVERVIEW

- Comprehensively addresses the new QCE Food and Nutrition syllabus
- Written by highly experienced home economics teachers
- Provides the necessary support for teachers and students to approach the course with confidence
- Incorporates a structured, problem-based learning approach and focus on building the 21st century skills of communication, collaboration and teamwork, critical thinking, personal and social and ICT skills.

NELSON
A Cengage Company

ISBN 978-0170418560