Joint Food Regulation System

Food Safety Guidelines for the Preparation of Raw and Lightly Cooked Egg Foods

Version 1 - May 2025

Disclaimer

The information presented here is distributed by the Food Regulation System and is presented as an information source only.

The information is provided solely on the basis that readers will be responsible for making their own assessment of the matters presented herein and are advised to verify all relevant representations, statements and information. The information does not constitute legal or professional advice and should not be relied upon as such. Formal advice from appropriate advisers should be sought in particular matters.

The Food Regulation System does not accept liability to any person for the information or advice provided in the document or incorporated into it by reference or for loss or damages incurred as a result of reliance upon the material contained herein. In no event shall the Food Regulation System be liable (including liability for negligence) for any damages (including without limitation, direct, indirect, punitive, special or consequential) whatsoever arising out of a person's use of, access to or inability to use or access the document.

Contents

Introduction

In Australia, foodborne illness caused by *Salmonella* has significantly increased over the past 20 years and compared with many similar countries, we have one of the highest rates. There are an estimated 56,200 cases of salmonellosis (2,100 hospitalisations and 15 deaths) with 72% of these considered to be foodborne.

There is clear evidence from recent salmonellosis outbreaks associated with eggs that *Salmonella* requires control steps to be applied across several different parts of the supply chain. Actions to control the prevalence of *Salmonella* will be focussed on egg primary production and processing, in the use of eggs in the retail/food service industries and in the home setting.

Like all potentially hazardous food, eggs need careful handling to keep them safe. Eggs may contain pathogenic bacteria such as *Salmonella*. *Salmonella* on the outside of the eggshell can also enter the egg through cracks that can be too small to see. Once inside the egg, *Salmonella* can then grow rapidly.

There are a number of factors that contribute to the strong association between foodborne illness outbreaks caused by *Salmonella* and food that is sold which contains raw egg. These include:

- contamination of egg contents by *Salmonella* from the shell
- failure to process raw egg foods sufficiently (through acidification or heat) to remove any *Salmonella* risk
- failure to clean and sanitise equipment and food contact surfaces
- temperature abuse of products (i.e. storage above 5°C), and
- keeping raw egg products beyond the recommended storage life (maximum 24 hours) at refrigerated temperature.

The practice of pooling eggs to produce raw egg foods significantly increases the likelihood of *Salmonella* contamination of a product which does not receive any further cooking or treatment to eliminate harmful bacteria.

Salmonellosis symptoms usually include diarrhoea, abdominal pain, fever, nausea, vomiting and headaches. Symptoms usually start 12 to 36 hours after infection. Most people are sick for 4 to 7 days. *Salmonella* is often spread when people eat inadequately cooked foods, such as raw or undercooked eggs.

Foods that contain raw or lightly cooked egg are often used in restaurants, cafes, bakeries, catering and manufacturing food businesses and need extra care, as they can cause food poisoning if not handled correctly. Practices in food services settings were influential in increasing the number of people who became ill in salmonellosis outbreaks. To ensure the food is safe to eat, special attention should be given to the preparation, storage and handling of eggs and raw egg products, to prevent the growth of *Salmonella*.

Food business responsibility

Food businesses should be aware that, although they may attempt to take every precaution to practise safe food handling and storage practices, any food that contains raw eggs may be contaminated with *Salmonella* and can pose a significant food safety risk.

Food businesses are responsible for the food they supply and should know the risk associated with the handling and sale of raw egg products. The easiest solution to reduce the risk of a food business being implicated in a foodborne illness outbreak caused by *Salmonella* is to avoid selling food containing raw or lightly cooked egg. If a food business decides to prepare and sell raw or lightly cooked egg products, the

business chooses to accept the inherent food safety risk and is responsible for effectively managing the risk and producing safe food.

All food businesses should be able to identify and control food safety risks to ensure they can meet the requirements of the Australia New Zealand Food Standards Code (Food Standards Code). In order to protect customers from the risk of foodborne illness, businesses need to comply with Standard 3.2.2 and Standard 3.2.2A (for businesses in food service, catering and retail sectors that handle unpackaged, potentially hazardous food that is ready to eat) to ensure that only safe and suitable food is processed [Clause 7] and that safe handling practices are followed.

To help you meet your responsibilities, this guideline is intended to help businesses consider the food safety risks associated with preparing raw and lightly cooked egg products. Understanding the risk allows businesses to educate their staff to follow safe food processing and handling practices and ensure that their brand or business reputation is not compromised by unsafe food.

As such, food businesses are encouraged to use commercially available versions of these foods. The commercial versions are a safer alternative as they have been heat treated or produced using pasteurised eggs. Food businesses can contact suppliers or manufacturers to ascertain whether a product contains raw eggs. Further recommendations and case studies are also provided to assist businesses' understanding.

Food businesses that are required to have a food safety program or otherwise serve food to vulnerable people should only use commercially available versions of raw or lightly cooked egg products or use pasteurised eggs for making these products. Vulnerable people are more susceptible to foodborne illness because they may have weakened or underdeveloped immune systems. These people can include pregnant women, their unborn and newborn babies, children under the age of five, the elderly and people who may be immunocompromised for medical reasons (for example, cancer patients and people undertaking immunosuppressant drug therapies). However, fresh eggs may be used when preparing foods that are cooked all the way through (for example, cakes).

Given there is a known risk in the preparation of raw and lightly cooked egg products, food businesses at a minimum should:

1. Use safer alternatives to raw eggs in foods which are not cooked. Alternatives include commercially produced dressings and sauces, pasteurised egg products or in-house pasteurised eggs (where prepared in accordance with Appendix 2).
2. If a business however chooses to make a raw or lightly cooked egg product, then all of the following controls should be in place:
    a) Egg receival – Reputable suppliers, good delivery and storage, no cracked or dirty eggs.
    b) Storage – Correct storage and display of ingredients and product, including proper control of temperature.
    c) Processing – Correct handling such as good personal hygiene (including good hand washing practices and proper use of gloves if used), use of sanitised egg separator, and proper control of temperature.
    d) Premises – Clean premises, fixtures, fittings and equipment, compliant hand wash facility, sanitised equipment and food contact surfaces.
    e) If the product is to be acidified, acidify to a pH of 4.2 or lower – this can be achieved using acidic ingredients such as lemon juice or vinegar.

f) The raw egg product should be stored at or below 5˚C for no longer than 24 hours i.e. should be discarded at the end of the day.[1]

Note:

Under the Food Standards Code Standard 3.2.2, the temperature of potentially hazardous foods (such as raw and lightly cooked egg products) should be at or below 5˚C during transport, storage and display. However, the Food Standards Code allows for alternative compliance provided the businesses can demonstrate the product's safety [Clause 25].

The 2-hour/4-hour rule is used by Food Standards Australia New Zealand (FSANZ) as an example of an alternative method for compliance (see Appendix 3). If a business uses the 2-hour/4-hour rule, then a documented system should be in place to demonstrate evidence that it is being used effectively.

Acknowledgements

This document has been developed with assistance from members of the Implementation Sub Committee for Food Regulation (ISFR) Food Safety Culture Working Group and associated Local Government Environmental Health Officers.

[1] As recommended by the Australian Egg Corporation Ltd (AECL) – The Culinary Uses of Eggs, AECL 2015; from Safe Food Australia, Third Edition, Food Standards Australia New Zealand 2016.

Purpose and scope

The purpose of these guidelines is to give food service businesses that sell food containing raw or lightly cooked eggs specific safety steps for preparation and clear guidance and advice on how to meet food safety standards. It covers areas from receipt of eggs through to preparation of raw and lightly cooked egg products. These areas can all potentially affect the safety of the product. How these areas are applied can vary between individual businesses. An example of a monitoring system for use when acidifying raw egg products is also included.

Examples of raw and lightly cooked egg products include:

- sauces and spreads made with raw egg – e.g. mayonnaise, aioli, hollandaise, egg butter.
- desserts made without an effective cook step – e.g. tiramisu, mousse, deep-fried ice cream.
- drinks containing raw egg – e.g. eggnog, egg flip, raw egg high-protein smoothies.

What is not covered

This document does not cover egg products which are cooked or have little or no history of causing salmonellosis due to their traditional method of preparation, use or storage. This is because they are usually made, served and eaten within a short timeframe, to customer order or have received a heat treatment to kill *Salmonella*. Such products include:

- cooked breakfast style eggs such as scrambled or poached eggs and omelettes
- cakes and soufflés (baked)
- meringues (oven baked)
- icing (high sugar content)
- marshmallows (boiled during preparation)
- frozen desserts such as ice cream or frozen mousse (frozen immediately after preparation)
- traditional dishes that incorporate a raw egg added when serving such as tartare, congee, and soups.

All food businesses must meet the requirements of the Food Standards Code to ensure they follow safe food handling practices. This document does not cover all requirements of the Food Standards Code, in particular requirements relating to premises and equipment. Business operators must read the Food Standards Code and ensure they comply with all aspects of the Food Standards Code as it relates to their business including requirements for cleaning and sanitising. Further guidance can be found in Safe Food Australia – a guide to the Food Safety Standards.

Definitions

Term	Definition
Acidified product	Product with vinegar/lemon juice/other acid added to achieve a pH of 4.2 or less.
Authorised Officer	A definition of an Authorised Officer is included in the Food Standards Code (Standard 1.1.2) and also defined in the Food Act in each state or territory.
Cleaning	The process of removing food and other types of soils from surfaces, equipment and utensils. Detergents are used to assist removal.
Cracked egg	An egg which has a cracked shell which is visible, or visible by candling or other equivalent method, and includes a broken egg. Food Standards Code 4.2.5, Division 1, Clause 2*. Hairline cracks often escape visual detection and can worsen as eggs move through the supply chain.
Dirty egg	An egg that has visible faeces, soil or other matter on it (for example yolk, albumen, feathers). Food Standards Code 4.2.5, Division 1, Clause 2.
Egg	An egg from any avian (bird) species, except ratites. Food Standards Code 4.2.5, Division 1, Clause 2.
Egg pulp	The contents of an egg, which may contain sugar or salt. Food Standards Code 4.2.5, Division 1, Clause 2.
Foods sold containing raw egg	Food that is prepared with raw egg and consumed without further processing (for example without cooking). Examples include: Sauces and spreads made with raw egg – for example mayonnaise, aioli, egg butter. Desserts made without an effective cook step – for example tiramisu, mousse, fried ice cream. Drinks containing raw egg – for example egg flip, raw egg high protein smoothies.
Liquid egg white	The white of egg separated as effectively as practicable from the yolk in liquid form. Food Standards Code 4.2.5, Division 1, Clause 2.
Liquid egg yolk	Yolk of egg separated as effectively as practicable from the white in liquid form. Food Standards Code 4.2.5, Division 1, Clause 2.

*Note at the time of writing, this definition is being reviewed, please refer to the latest version of Standard 4.2.5

Term	Definition
Pasteurisation of egg product	A control measure where eggs are subjected to a process, using heat to reduce the load of pathogenic microorganisms to an acceptable level to ensure safety.
Pathogenic bacteria	Bacteria capable of causing food poisoning for example *Salmonella*.
Potentially hazardous foods	Food that has to be kept at a certain temperature to minimise the growth of any pathogenic bacteria that may be present in the food or to prevent the formation of toxins in the food. Food Standards Code 3.2.2, Division 1, Clause 1.
Ready-to-eat foods	Food that is ordinarily consumed in the same state as that in which it is sold and does not include nuts in the shell and whole, raw fruits and vegetables that are intended for hulling, peeling or washing by the consumer. Food Standards Code 3.2.2, Division 1, Clause 1. For retail businesses this would include cooked foods or other foods that have various dressings (for example raw egg mayonnaise acidified to pH less than or equal to 4.2).
Sanitising	To apply heat or chemicals, or heat and chemicals, or other processes, to a surface (for example food contact surfaces of equipment, eating and drinking utensils) so that the number of microorganisms on the surface is reduced to a level that: • does not compromise the safety of the food with which it may come into contact • does not permit the transmission of infectious disease. Food Standards Code 3.2.2, Division 5, Clause 20(2)(b) There are two methods available: Heat – to sanitise effectively with heat only, temperature of at least 77°C and a contact time of greater than 30 seconds is required. Lower temperatures will require longer contact times. If using a dishwasher, check the manufacturer's instructions to ensure adequate temperature/time is achieved. Chemical sanitiser – generally chlorine or ammonium-based compounds. It is important to choose the right product for the food premises and to follow the manufacturer's instruction especially for dilution rate, contact time and safety instructions.
Shelf-stable foods	Foods which can be stored unrefrigerated without affecting their safety or quality.
Sous-vide pasteurised eggs	Eggs that have been exposed to a mild heat treatment in a water bath to kill *Salmonella* that may be present, without actually cooking the eggs.

Temperature control	Means maintaining food at a temperature of: • 5°C or below if this is necessary to minimise the growth of infectious or toxigenic microorganisms in the food so that the microbiological safety of the food will not be adversely affected for the time the food is at that temperature; or • 60°C or above; or • another temperature – if the food business demonstrates that maintenance of the food at this temperature for the period of time for which it will be so maintained, will not adversely affect the microbiological safety of the food. Food Standards Code 3.2.2, Division 1, Clause 1.
Validate	Validate means: • Confirming a control measure for a critical control point or process is effective to minimise a food safety hazard; and • Providing objective evidence to confirm paragraph (a) Food Standards Code 4.2.5, Division 3, Clause 21.

Receiving and storing eggs

Food safety begins by ensuring only safe and suitable ingredients are purchased from a supplier and that these items are stored correctly.

Standard 2.2.2 of the Food Standards Code prohibits the sale of cracked or dirty eggs. Therefore, food businesses should ensure that any eggs for sale in their business are suitable for sale.

Only clean, crack-free eggs within their date marking from accredited suppliers are to be used in food businesses.

Receiving eggs

- Only accept eggs that are clean. Dirty eggs may have chicken faeces on them, which could contain *Salmonella*.
- Only accept eggs that are free from visible cracks and are not leaking. Any cracks in the shell may allow *Salmonella* to enter the egg. It may not be possible to see micro cracks in eggshells.
- Ensure that eggs are stamped and come in clean packaging.
- Only accept eggs that are correctly labelled with the name of the food, the supplier's name and address, and a date marking (which may also include a batch supply number).
- Food businesses are encouraged to only use commercially supplied eggs as they may have had additional processing controls. Commercially produced eggs may have been cleaned using specialised equipment to remove faeces from the shell; they may also be 'candled' to check for cracks.
- Check the eggs when they arrive and always reject eggs that are broken, cracked or dirty, or that are supplied in dirty, defective, re-used or improperly labelled packaging. Accepting eggs in poor condition places your business at risk.

Supplier and food information

- A list of food suppliers should be maintained in case they need to be contacted.
- For all foods, the label or receipt needs to contain details of suppliers' names and addresses. Phone contact details should also be kept.
- Items that do not meet the above receiving and information requirements should be returned to the supplier.
- Traceability of products and raw ingredients is critical should an incident occur. Standard 2.2.2 of the Food Standards Code requires that eggs for retail sale or for sale to a caterer must be individually marked with the producer's or processor's unique identification.

Storage of whole eggs to be used in raw egg products

The following points are best practice examples for the storage of eggs:

- Store whole eggs (egg in shell) at or below 5°C in a refrigerator or cool room.
- Avoid temperature fluctuations and only take out what is required for service. This helps to prevent the rapid growth of *Salmonella* when out of temperature control.
- Store eggs separately from ready-to-eat food.

- Ensure proper stock rotation so that the oldest stock is used first (as long as they are within date).
- Discard any cartons that contain spilt raw egg to avoid cross contamination.
- Eggs should not be repacked into cartons with labels that do not correctly reflect the origin, weight or egg type.

Tip:	**Fresh is best.** Regularly check date markings and preferably only use eggs that are within their 'best before' dates in raw or lightly cooked egg products.

Note: Pasteurised egg products should be stored and used in accordance with the manufacturer's instructions.

Egg handling practices – Practical steps to control *Salmonella*

Safe food preparation is important when preparing both raw and cooked foods. As raw egg may contain *Salmonella*, it is important to ensure that raw egg does not contaminate any ready-to-eat foods. Poor food handling can result in cross contamination of food and if not stored correctly, the number of *Salmonella* can grow which can result in illness among customers.

Examples of this include when ready-to-eat food comes in contact with contaminated kitchen utensils (such as knives or cutting boards) or when *Salmonella* are transferred on the hands of a food handler. Contaminated cleaning cloths and tea towels can also cause cross contamination (e.g. a cloth is used to wipe up raw egg and is then used on surfaces where ready-to-eat food is prepared).

Several factors contribute to the strong association between foods that contain raw egg and *Salmonella* foodborne illness outbreaks. These include:

- contamination of egg-containing food with *Salmonella* from the eggshell
- combining many raw eggs together, or combining raw egg products from different batches
- failure to clean and sanitise equipment and food contact surfaces
- lack of proper temperature control (storage above 5°C)
- keeping raw egg products beyond their recommended storage life (maximum 24 hours) at refrigerated temperature.

Entire batches of food can be contaminated by one egg. If a product like mayonnaise is contaminated, it is likely to affect many customers as the contaminated sauce or condiment can be used on many products throughout the business.

To meet the requirements of the Food Standards Code (Standard 3.2.2) for processing food and to avoid cross contamination, businesses should do the following.

Equipment, utensils and food contact surfaces

- All equipment and utensils should be in good condition and able to be easily cleaned and sanitised.
- Mechanical equipment, such as blenders and food processors, should be able to be easily taken apart for cleaning and sanitising. If they cannot be taken apart, equipment like stick blenders may not be appropriate for processing raw eggs.
- Businesses may need to use separate equipment for processing raw eggs and raw egg products.
- Food contact surfaces such as equipment, benches and utensils are to be clean and sanitised before use.
- Boards and utensils should be cleaned and sanitised between preparing different foods, especially when preparing foods that will not be further cooked (e.g. salads).
- Use a sanitised egg separator to separate egg yolk from egg whites. Eggs must not be separated using their shells as the shells may be contaminated with *Salmonella* on the outside surface.

Handling of eggs

Because eggs can harbour *Salmonella* on the surface, the handling of eggs is critical. When handling eggs, follow these guidelines:

- Do not use dirty or cracked eggs – these should be discarded.
- Do not wash eggs. Eggshells become porous when wet, making it easier for *Salmonella* to enter the egg.
- Visually inspect eggs before use to ensure there are no hairline cracks.
- Use a sanitised egg separator.
- Regularly prepare fresh batches of raw egg mixture.
- Do not store fresh egg pulp (raw egg whites and/or yolks) that has been collected (pooled) in a bowl for later use. Fresh pulp should be disposed of at the end of each service. The use of pasteurised egg pulp is recommended as a lower risk alternative.

A significant handling step in ensuring safe products using eggs is at the breaking or separating process. Minimising contact between the shell and contents of the egg helps prevent the spread of any *Salmonella* from the outside of the shell into the egg. To ensure safe food when separating eggs:

- Always wash and dry hands before and after handling raw eggs.
- Do not wash eggs.
- Do not separate eggs using bare hands as there is no opportunity for appropriate hand washing between handling the shell and separating the egg.
- Do not separate eggs by using the shell as *Salmonella* may be on the surface of the shell.
- Do not break large numbers of eggs into bulk containers then strain the shell from the mixture. This transfers any *Salmonella* on the outside of the shell into the pulp.

Use of disposable gloves

It is not mandatory for food handlers to use disposable gloves, although if used correctly as described below, gloves can assist with minimising contamination. For best practice glove use:

- Only use gloves for one continuous task and then discard them.
- Regularly change gloves to avoid cross contamination – this is especially the case when changing from preparing raw ingredients to handling ready-to-eat foods.
- Always discard gloves once they're taken off – do not keep them for later use.
- Remove and discard gloves before using the toilet, smoking, eating, drinking or touching the hair, scalp or body.

Tip:	**Separate eggs safely.** Use a clean and sanitised egg separator or disposable gloves, with one gloved hand to crack the egg and the other to separate the egg white from the yolk.

Personal hygiene

All food handlers must take all reasonable measures not to handle food or surfaces likely to come into contact with food in a way that is likely to compromise the safety and suitability of food.

Food handlers must ensure they follow good personal hygiene practices:

- People who are, or have recently been, sick with vomiting, diarrhoea or fever should not prepare or serve food.
- Take all practicable measures to avoid touching ready-to-eat food if you are handling raw eggs.
- Wash hands before preparing food and after handling non-food articles, using the toilet, smoking, drinking, eating and touching hair, scalp or body.
- Wash hands between handling of raw ingredients and ready-to-eat foods.

Premises

The cleanliness of the premises, fixtures and fittings assists in minimising cross contamination. In particular, it is important to have an acceptable hand washing facility that includes:

- warm running water;
- soap; and
- single-use hand towels, for example paper towels.

Raw or lightly cooked egg products – Processing controls

If a food business decides to prepare raw egg containing foods that do not undergo a pathogen control step, the foods should be prepared in line with safe food handling practices to slow the growth of *Salmonella* and minimise the risk of foodborne illness.

A pathogen control step is a process step such as cooking, pasteurisation or retorting to reduce any pathogens that may be present in the food to safe levels.

Food businesses should use ingredients such as lemon juice or vinegar to acidify raw egg dressings to a pH value below 4.2 to slow *Salmonella* growth. Food businesses should check the pH with a pH meter or pH strips. Acidification does not make the food safe but may slow the growth of *Salmonella* making it a safer option.

Tip:	**Let your customers know.** Businesses are encouraged to include information on menus providing advice to patrons about raw or lightly cooked egg products. Customers can then make an informed choice, particularly in circumstances where the customer may be very young, elderly or immuno-compromised and such foods should be avoided.

Preparation of acidified raw egg product

Correct preparation of acidified raw egg product (using vinegar or lemon juice) ensures the product is safer to use:

- Product acidified to a pH of less than 4.2 inhibits the growth of (but may not kill) pathogenic bacteria, including *Salmonella*.
- Acidification should occur as part of the preparation step and should be checked to ensure proper acidification has occurred.
- Batches of raw egg mixture should be prepared regularly, rather than making a single large amount and keeping it for a long time.
- Document pH and storage times, as evidence to show that all practicable measures are being taken to process safe and suitable food. Store for maximum of 24 hours at or below 5˚C (see Appendix 1).
- If raw egg product is held out of refrigeration, then storage times and temperatures should be documented to demonstrate evidence of compliance with the 2-hour/4-hour rule (see Appendix 3).

See Appendix 1 for further information on acidifying products, how to achieve appropriate acidification and methods of measuring the pH.

Preparation of desserts

Using pH as a means of control normally does not apply to desserts (although some desserts may include the use of tartaric acid or lemon juice).

Other ways to help make non-acidified raw or lightly cooked egg desserts safer are to:

- Use eggs that are commercially pasteurised in-shell, liquid, frozen or dried.
- Use eggs pasteurised in-house using a water bath method (see Appendix 2) or other in-house pasteurisation process.
- Heat the egg(s) in one of the recipe's other liquid ingredients over a low heat, stirring constantly, until the mixture reaches 72°C. Then, combine it with the other ingredients and complete the recipe.
- Consider the use of other validated controls such as water activity (a_w).

Safe temperature and time

- Controlling the temperature throughout the operation is critical in minimising microbial growth, e.g. raw egg product should be at or below 5˚C. This includes all operations during receipt, processing, storage and display.
- If the raw egg product is held between 5˚C and 60ºC, there should be documented evidence that the 2-hour/4-hour rule is being met.
- For lightly cooked egg products that are to be held warm (e.g. hollandaise or béarnaise sauces), it is recommended that the product is prepared just before service and held for that service period only (generally up to 2 hours).[2] These products should be discarded after 2 hours.

The 2-hour/ 4-hour rule

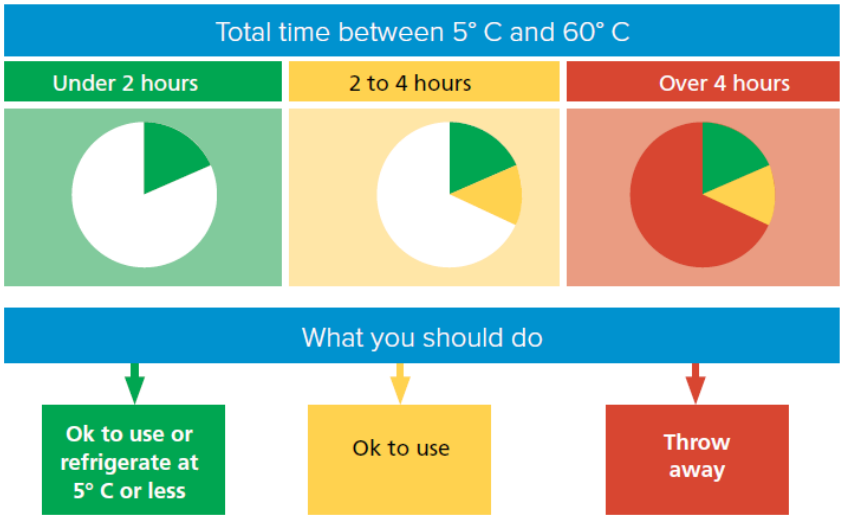

Figure 1. The 2-hour/4-hour rule for potentially hazardous food brought out of refrigeration
(image provided courtesy of SA Health)

Temperature measuring device

- Businesses handling potentially hazardous foods must have a temperature measuring device.
- Thermometers must be easily accessible and able to accurately measure temperatures to +/- 1°C.

[2] As recommended by the Australian Egg Corporation Ltd (AECL) – The Culinary Uses of Eggs, AECL 2015; from Safe Food Australia, Third Edition, Food Standards Australia New Zealand 2016.

- Thermometers should be calibrated to ensure accuracy.
- Appendix 4 provides information on calibrating thermometers

In shell egg pasteurisation using a sous vide method

Eggs can be pasteurised in shell using a sous vide method. An example recipe for sous vide pasteurised shell egg is to hold the eggs in a water bath at temperature of 57°C for at least 75 minutes (Baldwin, 2022). The pasteurised eggs can then be used in sauces or desserts, just like raw eggs (see also Appendix 2).

Correct procedures should be followed to ensure the eggs are safe to use:

- Every batch of sous vide cooking should be documented. An example worksheet is provided in Appendix 2.
- Commercial equipment with adequate heating capacity and precise temperature control should be used.
- Correct water temperature is essential for sous vide, and it should be checked using a tip sensitive digital thermometer that is accurate to 0.1°C.
- Raw shell eggs must be fully immersed in the water bath.
- Avoid overcrowding of eggs in the water bath. Overcrowding can affect cooking times. The time of cooking will need to be increased to compensate.
- Eggs cooked using sous vide methods should be used immediately or cooled and refrigerated.
- If eggs are to be stored, they should be rapidly cooled in a 50:50 ice-water bath. Once cooled, they should be stored at or below 5°C in their shells for a maximum of 10 days. They should be clearly labelled and stored separately from raw eggs.

Pasteurisation of egg products

Standard 4.2.5 Division 3 Clause 21 of the Food Standards Code specifies the time and temperature combination to pasteurise egg products.

Egg Products	Retention[#] temperature to be no less than (°C)	Retention time to be no less than (minutes)	Maximum temperature to be immediately rapidly cooled to (°C)
Egg pulp (without any sugar or salt)	64	2.5	≤ 7
Liquid egg yolk	60	3.5	≤ 7
Liquid egg white	55	9.5	≤ 7

[#] Retention time and temperature means the time required after the centre of the product achieves the specified pasteurisation temperature.

Some egg products, such as those containing salt and sugar, may require higher pasteurisation times and temperatures to eliminate *Salmonella*. FSIS USDA (2020) provides guidance for combinations of times and temperatures to give a 5-log reduction of *Salmonella*.

Egg products	Retention# temperature to be no less than (°C)	Retention time to be no less than (minutes)
Salted whole eggs (with 2% or more salt added)	63 62	35 6.2
Sugared whole eggs (2 – 12% sugar added)	61 60	3.5 6.2
Salted yolk (2 – 12% salt added)	63 62	3.5 6.2
Sugared yolk (with 2% or more sugar added)	63 62	3.5 6.2

[#] Retention time and temperature means the time required after the centre of the product achieves the specified pasteurisation temperature.

NOTE:

If a business would like to pasteurise the eggs using any other time & temperature combination or using any other process besides heating, the business must validate the process to confirm that the alternative process is effective in eliminating Salmonella.

Storage and display

Raw egg products should be safely stored and displayed to prevent cross contamination and to slow the growth of *Salmonella*. Some practical steps to achieve this include:

- Raw eggs products should be prepared, stored and displayed in the same container to prevent extra handling and reduce the potential for cross contamination to other food products or equipment and utensils.
- Use date labels to ensure only fresh batches are used (e.g. labels include 'raw egg product' and are dated).
- Do not top up or mix batches of raw egg products.
- For acidified raw egg products:
  - make fresh batches daily
  - store at or less than 5°C, and
  - discard at the end of the day or store no longer than 24 hours.
- For sous vide pasteurised eggs:
  - store at or less than 5°C in their shells
  - label with the date of pasteurisation, and
  - discard within 10 days of pasteurisation.

If any raw egg product is brought out of refrigeration and held between 5°C and 60ºC, then the times and temperatures should be documented to demonstrate compliance with the 2-hour/4-hour rule. This process is not recommended as best practice. Businesses are strongly advised to keep raw egg products in a refrigerator or cool room at 5°C or less when not being used for service.

Documentation

Each business preparing or selling raw or lightly cooked egg products should document the following information. This information should be made available for verification by an authorised officer:

- recipe of each raw egg product – where possible, the recipe should aim to achieve a pH of less than 4.2
- intended use – for example, coleslaw dressing or sandwich dressing, dip etc.
- name of the egg producer, delivery date of the eggs and the relevant use-by date/batch codes
- name(s) of the chef/cook/maker of the raw egg product(s)
- time and date of making each batch – this information should also be recorded on each container of raw or lightly cooked egg product made at that time
- quantity made
- storage conditions – raw egg products should be kept at 5°C or colder at all times other than during manufacture or serving; refrigerator temperatures should be checked and recorded daily with a calibrated thermometer
- time out of refrigeration – use the 2-hour/4-hour rule and record elapsed time for each container, such as by marking on the lid
- time of disposal – no more than 24 hours after manufacture. Disposal of product should be verified by recording the batch number, the time disposed of, and by whom (name and signature).

Tip:	**Document to demonstrate.** Keeping records is one of the simplest ways to demonstrate to an Environmental Health Officer that you understand how you manage food safety risks and that your product is safe. As a minimum, it is recommended that records are kept until the next inspection. Records can be kept electronically, provided the Environmental Health Officer can access them.

When things go wrong – Foodborne illness case studies

Case study 1

A major *Salmonella* outbreak in which over 100 people became ill, was traced back to a popular food business serving banh mi. Whole genome sequencing matched up *Salmonella* isolates from sick people, raw egg mayonnaise, banh mi and environmental samples with *Salmonella* on the farm that supplied fresh eggs to the business.

The food business had previously used pasteurised egg products for its mayonnaise—a safer practice that significantly reduces the risk of *Salmonella* illness. However, before the outbreak, they changed practice and began using fresh eggs instead. Their staff lacked the necessary training and experience to safely prepare raw egg products. Investigation found:

- The mayonnaise was not acidified to the required pH to inhibit bacterial growth—a crucial step in reducing the food safety risk.
- The mayonnaise was also not kept under proper temperature control, enabling *Salmonella* to multiply.
- The bacterial strain that caused the outbreak was also found on kitchen surfaces, indicating poor cross-contamination management.

As a result of the outbreak, the business suffered large financial losses, received overwhelming negative reviews on social media and was prosecuted by the local health authorities.

Case study 2

In a large foodborne illness outbreak, 146 people got sick after eating various foods made by a food business, including raw egg mayonnaise. The cases had confirmed *Salmonella* infection and a quarter of them were hospitalised. Using whole genome sequencing, the *Salmonella* isolated from sick people was matched to swabs taken from a blender used for raw egg mayonnaise and various food ingredients. Further analysis showed the mayonnaise had not been properly acidified—the pH was not low enough to stop *Salmonella* growth.

Where had the *Salmonella* come from? Genomic testing of the *Salmonella* strain did not match strains typically associated with egg farms the food business sourced from. The same blender used to make the mayonnaise was also used to process par-cooked chicken livers. These livers, which may still harbor pathogens, created a cross-contamination risk. Importantly, the blender was not fully dismantled for cleaning and was only washed with detergent between uses. The inadequate cleaning likely allowed *Salmonella* to persist in hard-to-reach areas of the blender, causing cross-contamination of all ingredients it was used with.

Case study 3
78 people fell ill with *Salmonella* linked to consumption of food from one of three linked bakeries. Most cases reporting eating a meat, salad and mayonnaise roll. Environmental Health Officers from local councils inspected the premises and identified shared foods and equipment between the premises that may have caused cross contamination. Multiple food and environmental samples were collected across all three premises, and many were found positive for the same *Salmonella* Typhimurium strain. Issues with cross contamination, inadequate cooking of foods, and cleaning and sanitising practises were identified.

Case study 4
An outbreak of foodborne illness occurred in an aged care facility. Investigations found everyone who fell ill had eaten breakfast smoothies that had been prepared using a stick mixer (hand-held blender). The mixer was tested for *Salmonella* and found to be contaminated. Further investigation found the mixer stick had not been properly cleaned and sanitised between uses, so bacteria had multiplied in food debris and then been transferred to the next smoothie batch.

Case study 5
Five people diagnosed with *Salmonella* illness had all consumed food from the same café. A variety of foods were eaten, including aioli and eggs. All cases ate at the café over a three-day period. Environmental Health officers from the local council inspected the premises and identified issues around incorrect egg handling and the preparation of raw egg products.

References

Baldwin, D.E. (2022). A practical guide to sous vide cooking. Version 0.4k. Retrieved 15 February 2023 from www.douglasbaldwin.com

Davis, B.P.F., Amin, J., Franklin, N. & Beggs, P.J. (2022). Communicable Diseases Intelligence. Salmonellosis in Australia in 2020: possible impacts of COVID-19 related public health measures. Retrieved 15 February 2023 from https://www1.health.gov.au/internet/main/publishing.nsf/content/8FA6078276359430CA257BF0001A4C42/$File/salmonellosis_in_australia_in_2020_possible_impacts_of_covid_19_related_public_health_measures.pdf

Food Safety and Inspection Service. US Department of Agriculture. (FSIS USDA). (2020). FSIS Food Safety Guideline for Egg Products. Retrieved 15 February 2023 from https://www.fsis.usda.gov/guidelines/2020-0005

Ford, L., Glass, K., Veitch, M., Wardell, R., Polkinghorne, B.,…, Kirk, M.D. (2016). Increasing incidence of Salmonella in Australia, 2000-2013. PLoS One, 11(10):e0163989.

Food Standards Australia New Zealand. (2016). Safe Food Australia – A guide to the Food Safety Standards. Retrieved 15 February 2023 from https://www.foodstandards.gov.au/publications/pages/safefoodaustralia3rd16.aspx

Food Standards Australia New Zealand. (2023). Food Standards Code. Retrieved 15 February 2023 from https://www.foodstandards.gov.au/code/Pages/default.aspx

Appendix 1: Acidification of raw egg products

Using pH as a means of control does not generally apply to desserts.

pH is the measure of acidity or alkalinity. A pH of less than 7 is known as acid whereas a pH of more than 7 is known as alkaline. A pH of 7 is neutral.

The pH of a food is important because it has an effect on the stability and shelf life of the food. Most bacteria for example do not like low pH (acid) foods.

At pH values of 4.2 or less, pathogenic bacteria do not grow, form spores, or produce toxins. Lowering the pH of a product to 4.2 or less could be used as a control measure for preventing the growth of *Salmonella*.

Adding vinegar (which contains acetic acid) lowers the pH making the food more acidic. Vinegar has been made and used by people for thousands of years and it is commonly added to provide extra flavour and taste, and more importantly to extend the shelf life of the food. Pickling is a good example of using vinegar to preserve food.

Most foods such as raw or lightly cooked egg sauces do not contain enough vinegar to actually kill the *Salmonella* present in the food, but a pH of less than 4.2 can stop *Salmonella* growing and reaching dangerous levels but other bacteria, yeasts or moulds can still spoil the product.

The pH of the raw egg product should be checked to make sure it has reached the 4.2 pH limit.

Refrigeration below 5°C also protects against *Salmonella* growth.

Note: it may be possible to use lemon juice instead of vinegar, depending on the recipe. However, the pH should still be recorded.

Tip:	**How to achieve a pH of less than 4.2** As a general guide, add at least 5ml (a metric teaspoon) of commercially available vinegar per egg in the mix. Blend all ingredients well before measuring the pH to check it is less than 4.2. If needed, add more vinegar and recheck the pH. Once you are sure the pH is right, record the final amount of vinegar in your recipe. You will then only need to test the food's pH again if the recipe is changed (i.e. additional eggs are added) or a different batch of vinegar is used.

Steps for measuring pH

The pH of a raw egg product can be measured using a pH meter, pH strips or pH paper, as follows:

1. Once the raw egg product has been prepared, place a small sample (¼ cup) in a clean container.
2. Dip the pH paper/strip directly into the sample and compare with the colour chart (for pH meters follow the manufacturer's instructions).
3. Record the pH on the *Raw egg product acidification check sheet* (below).
4. If the pH is greater than 4.2, add more lemon juice or vinegar to the raw egg product and mix. Then start the process again from step 1.
5. Continue adding lemon juice or vinegar until pH is less than 4.2. If extra lemon juice, vinegar or other acid is needed, raw egg product recipes should be revised to account for the extra acidification required.

Figure 2. Equipment needed for measuring pH values

Different pH measuring methods

pH paper

- The pH paper should be able to read pH in 0.3 units, although it is difficult to distinguish less than 0.6 of a unit.
- Incorrect readings can occur from improper handling (contamination from hands).
- pH paper requires careful handling.

pH strips

- The strips should read pH in units of 0.5, although it is difficult to distinguish less than whole units.
- pH strips are easy to use and do not require as careful handling as the pH paper.

Hand-held digital pH meter

- Meters read pH in 0.1 units with certainty.
- Some hand-held pH meters also measure the sample's temperature and compensate the measurement for sample temperature.
- The meter requires calibration before use with at least a single buffer (buffer pH 4.0 is suitable for acidified raw egg product).
- The pH meter comes with instructions but may require some training of operators.

Raw egg product acidification check sheet

Preparation of acidified raw egg product							Date and time discarded and finished (should be within 24 hours of preparation)	Comments
Date acidified	Time acidified	Egg supplier	Product made	Amount made (volume)	pH (should be ≤ 4.2)	Person responsible		

Appendix 2: Whole egg pasteurisation method

Eggs can be pasteurised in shell using a water bath (sous vide) method. The pasteurised eggs can then be used in sauces or desserts, just like raw eggs. An example recipe for pasteurised shell egg is to cook the eggs to an internal temperature of 57°C for at least 75 minutes (Baldwin, 2010)[3]. Correct procedures should be followed to ensure the eggs are safe to use:

- The water bath times and temperatures should be established through in-house testing.
- Every batch of pasteurisation should be documented. An example worksheet is provided in this Appendix.
- Commercial equipment with adequate heating capacity and excellent temperature control should be used.
- Water temperature should be checked using a tip sensitive digital thermometer that is accurate, ideally to 0.1°C.
- Raw shell eggs should be fully immersed in the water bath. Eggs may be placed in a sealed bag before immersion.
- Eggs pasteurised using water bath methods should be used immediately, hot held at or above temperatures of 60°C or cooled and refrigerated.
- If eggs are to be stored, they should be rapidly cooled in a 50:50 ice-water bath. Once cooled, they should be stored at or below 5°C in their shells for a maximum of ten days. They should be clearly labelled and stored separately from raw eggs.

Thermometer calibration

Hand-held thermometers should be calibrated at least once every 12 months using both the ice point and boiling point techniques and results recorded on a checklist. Where accuracy may be affected (e.g. if dropped or damaged), thermometers should be calibrated soon after to ensure the thermometer is working effectively. Refer to Appendix 4 for calibration method.

[3] Baldwin, D.E. (2010). Sous vide for the home cook. Incline Village NV USA: Paradox Press.

Whole egg pasteurisation check sheet

Whole egg pasteurisation						Date discarded (should be within 10 days of pasteurisation date)	Comments
Date of pasteurisation	Temperature of water bath	Length of pasteurisation	Egg supplier	Number of eggs	Person responsible		

Appendix 3: The 2-hour/4-hour rule

Food businesses are required to maintain the temperature of potentially hazardous food either at or below 5ºC or at or above 60ºC during transport, storage and display *unless* the food business can demonstrate that maintaining food at another temperature for a specific length of time will not adversely affect the microbiological safety of the food.

Holding potentially hazardous food between 5ºC and 60ºC for a short time will not reduce the safety of the food because it takes time for the bacteria to grow. As a general rule, the **total time** that ready-to-eat potentially hazardous food can be at temperatures between 5ºC and 60ºC is 4 hours.

What is the 2-hour/4-hour rule?

The 2-hour/4-hour rule is a system that can be used when potentially hazardous food needs to be brought out of refrigeration for some time, for example, during preparation, serving or display for sale.

The rule states:

Ready-to-eat potentially hazardous food brought out of refrigeration, if it has been at temperatures between 5ºC and 60ºC:

- for a total of 2 hours or less, should be refrigerated or used immediately;
- for a total of longer than 2 hours but less than 4 hours, should be used immediately and cannot be returned to the refrigerator; or
- for a total of 4 hours or longer, should be thrown out.

Documentation

To help you keep track of the 2-hour/4-hour rule, it is good practice to record the time history of when potentially hazardous food is out of refrigeration. That way it can be monitored, and corrective action taken if required. This should also include time the food was held between 5ºC and 60ºC before you received the food (e.g. during transport to your business).

Documentation should include:

- the temperature history of the potentially hazardous food; and
- the time history that the potentially hazardous food has been at temperatures between 5ºC and 60ºC.

Tip:	**Remember, the time is cumulative.** For example, if an item of potentially hazardous food has been between 5ºC and 60ºC for half an hour before being placed back into the refrigerator, then the product can be out of refrigeration at a later time for 3 ½ hours before it should be discarded.

The 2-hour/4-hour rule check sheet

Date	Food description	Time taken out of refrigeration	Activity	Time placed back in refrigeration	Total time	Corrective action	Comments

Temperature control

- Maintain potentially hazardous food at a temperature of 5°C or below or 60°C and above. If food is kept between 5°C and 60°C, the time period should be monitored and recorded.
- Remember when using the 2-hour/4-hour rule, that time periods are cumulative – each time period that food is kept between 5°C and 60°C has to be added up to reach a total time.

Corrective actions

- Potentially hazardous food that has been kept between 5°C and 60°C for less than two hours should be refrigerated or used immediately.
- Potentially hazardous food that has been kept between 5°C and 60°C for longer than two hours but less than four hours should be used immediately.
- Potentially hazardous food that has been kept between 5°C and 60°C for longer than four hours should be thrown out.

Appendix 4. Temperature calibration and measurement

Calibration procedures

Hand-held thermometers should be calibrated monthly, and results recorded on a checklist (as below).

Ice point (0°C)

1. Fill a small container with crushed ice.
2. Add a little water to the container to make an ice slurry.
3. Place the thermometer in the centre of the container so that the point of the probe is in contact with the ice.
4. Allow the temperature reading of the thermometer to reach a steady reading.
5. Record the reading and calculate the difference from 0°C.
6. Thermometers with a deviation of more than 1°C should be discarded.

Boiling water point (100°C)

1. Fill a small container with boiling water.
2. Immediately place the thermometer in the centre of the container so that the point of the probe is in the centre.
3. Allow the temperature reading of the thermometer to reach a steady reading.
4. Record the reading and calculate the difference from 100°C.
5. Thermometers with a deviation of more than 1°C should be discarded.

Thermometer calibration record

Date	Equipment	Ice point calibration		Boiling point calibration		Variance	Corrective action (e.g. service, batteries changed, discarded)	Calibrated by
		Ice point 0°C		Boiling point 100 °C		≤ 1.0°C		