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Food Safety Survey Report

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Cook Chill - Ready to heat and eat meals with extended shelf life

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An investigation survey to measure microbiological integrity of extended life cook chill ready to heat and eat meals manufactured and sold in South Australia

Aims & Scope of the Investigation

This survey is the extension of last year's survey which assessed the microbiological integrity of extended shelf life (> 10 days) packaged cook chill meals (commonly known as ready meals or convenience meals) using a modified testing regime.

Cook chill process, refers to the food manufacturing where food items are fully cooked and chilled in advance. They are then stored under refrigeration and typically require reheating before consumption by the consumer. It includes packaged convenience meals e.g. meals with pasta, rice, vegetables, meat etc., curries, soups, cooked pizzas, lasagne and similar products. It does not include shelf stable ready to eat meals or frozen meals or ready to eat foods (e.g. salad items, cheese etc.). Samples were collected from various supermarkets and retail stores within Adelaide and surrounding suburbs. Only South Australian (SA) produced products were sampled as part of this survey.

This survey was a continuation of the cook chill meal survey conducted in the financial year 2016-17. A new sampling criterion was adopted in the 2017-18 survey to broaden the scope of this investigation. The purpose of the new sampling criterion was to confirm, both process controls and accuracy of shelf life validation applied by the manufacturers. As part of this new criterion, the majority of the ready meal products were sampled in pairs with identical batch details. One sample of the pair was tested immediately and the second sample at the end of the shelf life. The shelf life samples were stored by the laboratory under temperature control.

In Jan 2018, FSANZ (Food Standards Australia New Zealand) revised the Compendium for Microbiological Criteria for Food (Compendium) and this resulted in changes in the microbiological limits of standard plate counts (SPC) for the ready meals with extended shelf life. New limits were less stringent compared with previous limits. Prior to this change being introduced 18 had been collected and samples for ;
Pathogens- *Salmonella, Listeria monocytogenes (L.mono), Bacillus cereus (B.cereus),* Coagulase-positive *Staphylococci, Clostridium perfringens*
Hygiene indicators - *Escherichia coli* (*E. coli),* standard plate count (SPC)
Chemical parameters - pH Value, Water Activity (aW)

The survey design was reviewed and the following changes were made.

- Testing of *Salmonella* and *Staphylococcus aureus* was removed as literature review and previous survey data indicated that the likelihood of the presence of these pathogens in ready meals was low.
- Water activity was not tested in this survey because previous survey results indicated that majority of meals had aW>0.98. Water activity at this level cannot be considered an effective hurdle to control the growth of pathogens

- *Escherichia Coli* test was replaced by total coliform to identify the overall hygiene status of the processing environment

Background of the Survey

Increasingly busy lifestyles have contributed to a higher demand for convenience meals in Australia. They are now a common item on the supermarket shelves. The high demand has generated a new market drive and an increase in the number of food businesses such as restaurants and caterers expanding their business model to include a cook chill meals with extended shelf life. These products are generally exposed to anaerobic conditions by vacuum or modified atmosphere packaging (map) which reduces the growth of spoilage microorganisms by reducing the availability of oxygen. However the risk of pathogens like *Clostridium botulinum* and *L.mono* is increased because anaerobic conditions favour the growth of these bacteria.

In general, cook chill products have a good food safety record. Historically, food businesses with larger production facilities and appropriate infrastructure have been involved in cook chill production. More recently though, there has been a shift in small food service businesses entering this arena.

SA Health started this survey in the financial year 2016-17 and sample results indicated high standard plate count in several samples and presence of pathogens in some samples. It was identified that many of the food service businesses that were manufacturing extended shelf life cook chill meals lacked the required infrastructure and adequate technical skills and knowledge to assess the food safety risks in the cook chill process. SA Health worked collaboratively with those businesses to educate them and provide technical assistance on safe production of these ready meals. The intent of the continuation of the survey in current financial year 2017-18 was to monitor the effectiveness of the corrective actions taken by the identified businesses where initial results were poor, and to identify new businesses that are producing these meals and sample their products to assess the microbiological integrity and accuracy of shelf life validation.

Extended Shelf life Cook Chill Meals and Microbiological Safety

Cook chill meals can be categorised into short shelf life or extended shelf life products. Extended shelf life cook chill meals have a shelf life longer than 10 days while short shelf life products have a maximum shelf life of 10 days. A typical extended shelf life cook chill process involves cooking, aseptic packaging, chilling, storage and distribution under refrigeration. Aseptic packaging for these products involves a cooked product packaged in clean hygienic packaging in a clean and hygienic environment followed by immediate sealing to prevent any post process contamination. Generally hot filling or MAP (modified atmosphere packaging)/ vacuum packaging techniques are used for aseptic packaging and to create an anaerobic environment in order to extend shelf life.

Cooking reduces most of the vegetative cells but spores such as *B.cereus* and *Clostridium botulinum* can still survive the cooking process. Therefore temperature is very important to prevent multiplication of these microorganisms. *B.cereus* needs oxygen to grow therefore growth of these bacteria is limited in anaerobic environment. *Clostridium botulinum* is considered the main target organism to control for extended shelf life product because it can grow in an anaerobic environment and produces a potent toxin. The toxin is very heat resistant and not destroyed by pasteurization or cooking temperatures below 100°C.

Clostridium botulinum does not grow at or below 3°C. Where storage and distribution temperature cannot be guaranteed to remain below this temperature, products should have following controls in

place to extend the shelf life. These controls should also be combined with aseptic packaging for shelf life extension.

- Minimum heat treatment of 90°C for 10 minutes or equivalent time temperature combination
- pH of 5 or less throughout the food
- A minimum salt level of 5%(aqueous) throughout the food
- A water activity of 0.97 from salt or 0.94 from glycerol or lower throughout the food

Above controls are effective when cook chill meals are aseptically packed however if the infrastructure and/or equipment of a business is incapable to provide aseptic packaging, then the potential risk of post process contamination increases. In such cases *L.mono* becomes the pathogen of concern because it is a facultative anaerobe which can grow in both aerobic and anaerobic environments and even multiply under refrigeration at a slow pace and is commonly found in manufacturing enviroments. A business producing cook chill meals without aseptic packaging must consider reducing the shelf life below 10 days unless they can introduce other barriers to control L.mono.

What was done?

A total of 96 samples of cook chill meals were purchased from different retail outlets including supermarkets and display sections of manufacturing businesses in Adelaide and surrounding suburbs. Samples were collected from October 2017 to May 2018 and all samples were manufactured by SA based producers.

All samples were analysed by SA Pathology, Food and Environmental Laboratory. The 18 samples were analysed for the following parameters:

Chemical parameter

1. pH Value

Hygiene indicators

1. *Escherichia coli* (*E. coli)*
2. Standard plate count (SPC)

Pathogens

1. *Salmonella*
2. *Listeria monocytogenes (L.mono)*
3. *Bacillus cereus (B.cereus)*
4. Coagulase-positive *Staphylococci*
5. *Clostridium perfringens*

As explained earlier, for the remaining 78 samples *Salmonella* and *Staphylococcus aureus* testing was removed and *E. coli* test was replaced by total coliforms.

All cook chill meals tested in this survey were ready-to-eat (RTE) foods, for which there are no specific microbiological standards in the Australia New Zealand Food Standards Code (the Code) except for *L.mono.* Since July 2014, Standard 1.6.1 Microbiological Limits in foods has included the criteria for *L. mono* when assessing RTE foods and is based on whether the food can support its growth or not.

Criteria	Specification
RTE foods in which growth of *L. monocytogenes* will not occur	less than 100cfu/g

RTE foods in which growth of *L. monocytogenes* will occur	not detected in 25g.

For this survey, all samples were assessed against the limit `Not Detected in 25g' because it was not possible to determine whether sampled products supported the growth of *L.mono* or not without confirming the product parameters with the manufacturer. However it was decided that, if *L.mono* was identified in any sample, the testing for numerical count would be performed and the product would be considered compliant only if it didn't support the growth of *L.mono* and counts were less than 100cfu/g.

The FSANZ Compendium has been used to assess the microbiological results in this survey (Table A.) except for total coliform because the Compendium does not list any limits for total coliform. As per Industry standards total coliform <100 cfu/g is considered acceptable for cooked ready to eat products.

There are four categories of microbiological quality specified in the Compendium

- **Satisfactory** – Results indicate good microbiological quality
- **Marginal** – Results are borderline in that they are within limits of acceptable microbiological quality but may indicate possible hygiene problems in the preparation of the food.
- **Unsatisfactory** – Results are out of acceptable microbiological quality and are indicative of poor hygiene or food handling practices
- **Potentially Hazardous** – The levels in this range may cause food borne illness and immediate remedial action should be initiated.

Table A. Evaluation Criteria as per FSANZ Compendium

Microbiological Quality- Colony Forming Unit (CFU) per gram

Test	**Microbiological results**			
	Satisfactory	Marginal	Unsatisfactory	Potentially Hazardous
Indicators				
Escherichia coli	<3	3-100	Greater than or equal to 100	**
Standard Plate Count	$<10^4$	10^4 - $<10^7$	$\geq 10^7$	NA
Pathogens				
Bacillus cereus	$<10^2$	10^2 –10^3	10^3 –10^4	Greater than or equal to 10^4
Salmonella spp	Not detected in 25g	-	-	detected
Coagulase +ve *Staphylococci*	$<10^2$	10^2 –10^3	10^3 –10^4	Greater than or equal to 10^4
Clostridium perfringens	$<10^2$	10^2 –10^3	10^3 –10^4	Greater than or equal to 10^4

** Pathogenic strains of *E.coli* should be absent

Testing Methods:

Testing methods used by SA Pathology lab were also changed when survey design was changed after initial collection of 18 samples as follows:

Parameter	**Method- for first 18 samples**	**Method- for next 74 Samples**

pH	PRC-MBI-626	PRC-MBI-626
Listeria	TECRA AOAC 995.22	AFNOR SOL 37/02 - 06/13
E. coli	AS 5013.15-2006	-
Coliforms	-	AS 5013.3-2009
Standard Plate Count	AS 5013.5-2004	AS 5013.5-2016
Clostridium perfringens	AS 5013.16-2006	PRC-MBI-615
Bacillus cereus and species	CCFRA Method 3.7.1-2007	CCFRA Method 3.7.1-2007
Salmonella spp.	TECRA AOAC 995.22	-
Coagulase +ve *Staphylococci*	AOAC2003.07, 2003.08, 2003.11	-

Summary of Results and Actions:

During 2017-18, a survey was undertaken to determine the microbiological integrity of cook chill meals with extended shelf life. A total of 96 samples were collected from retail outlets which belong to 12 different SA producers but 95 samples were analysed by microbiological testing. One sample could not be analysed by the laboratory due to excessive growth of mould in the packaged product during storage. In order to keep a consistent approach in analysis of the samples, all results of SPC have been analysed using the current limits outlined in the revised Compendium.

Results Summary: Table B. & Table C.

95 samples tested, 71 samples were deemed satisfactory with the microbiological specifications of all tested bacteria as outlined in the compendium, while 25 samples had marginal or unsatisfactory results including 1 sample that could not be tested because of excessive mould growth during storage for the end of shelf life testing.

Two samples were unsatisfactory and 20 samples were marginal for SPC levels. Two samples had marginal levels of spore forming pathogen *Bacillus cereus*. Samples tested for Salmonella, *Coagulase-positive Staphylococci, E.coli, Clostridium perfringens* and *Coliform* levels were all within satisfactory limits. No pathogen was detected in the potentially hazardous range.

Table B. Assessment using FSANZ Compendium of Microbiological Criteria for Food

Microbiological Test	**No. of Samples**	**Microbiological Quality (%age)**			
		Satisfactory	Marginal	Unsatisfactory	Potentially Hazardous
Standard Plate Count	95	73(76.8%)	20 (21.1%)	2 (2.1%)	-
Escherichia coli	18	18 (100%)	-	-	-
Bacillus cereus	95	93 (98%)	2 (2.1%)	-	-
Salmonella	18	18 (100%)	-	-	-
Coagulase-positive Staphylococci	18	18 (100%)	-	-	-
Clostridium perfringens	95	95(100%)	-	-	-

Total Coliform	77	77(100%)			

All samples were compliant with regulatory limits for *L.mono.* One sample detected presence of *Listeria innocua* which was a non-pathogenic form of Listeria.

Table C. Assessment based on the specification provided in Standard 1.6.1 of the Code

Microbiological Test	Specification	Total samples tested	No. of samples compliant	No. of samples non-compliant
Listeria monocytogenes	Not Detected in 25g	95	95	0

*cfu = colony forming unit

Out of 12 SA based manufacturers whose samples were tested during the survey, three business processes were investigated. One business was investigated for re occurring high SPC counts and a Listeria supporting processing environment. A second was investigated for marginal levels of *B.cereus* counts in two of their samples. The third business was investigated due to mould growth in their product at the end of shelf life. The risk was managed by appropriate corrective actions being undertaken by the businesses and follow up inspection by their local council and/or SA Health where required.

Detailed Discussion of Individual Test

pH and Water Activity of ready meals:

pH is a measure of acidity or alkalinity of the food. A pH value is the number from 1 to 14, with 7 as the neutral point; values below 7 indicate acidity and value above 7 indicate alkalinity.

Water activity (a_w) refers to unbound or available water i.e. water in food which is not bound to food molecules and can support the growth of bacteria, yeasts and moulds (fungi). The water activity scale extends from 0 (bone dry or no available water) to 1.0 (pure water).
pH values and a_w can be used to predict the growth of pathogens in foods. Food can be made safe, and the shelf life extended by lowering the aW, lowering the pH value, or a suitable combination of the two can be used.

As per Standard 1.6.1 the growth of *L.mono* will not occur in a ready-to-eat food if :

(a) the food has a pH less than 4.4 regardless of water activity; or
(b) the food has a water activity less than 0.92 regardless of pH; or
(c) the food has a pH less than 5.0 in combination with a water activity of less than 0.94

Out of 95 cook chill meal samples analysed, only 1 had pH below 4.4, the remaining 94 samples had pH ranging from 4.4 to 6.7. Water activity was not tested in this survey because in previous survey majority of meals had aW>0.98. Water activity at this level cannot control the growth of *L.mono* irrespective of pH values. pH value results indicate that majority of cook chill meals supports the growth of *L.mono* therefore it is critical to use cooking time temperature combination to kill this pathogen, and use aseptic packing technique to prevent post process contamination.

Table D.

pH range of cook chill ready meals						
pH Range	4-4.4	4.4-5	5-5.5	5.5-6	6-6.7	Total
No. of Samples	1	48	36	6	4	95

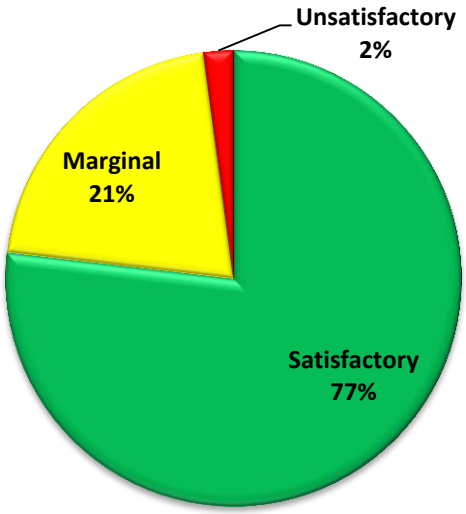
Standard Plate Count (SPC)

SPC is an indicator of quality, and cannot be directly contribute towards a safety assessment of ready-to-eat food. The significance of SPCs, however, varies markedly according to the type of food product and the processing it has received. High counts in ready to eat meals may suggest under processing, poor temperature control and possible post process contamination. These parameters also affect the growth of pathogens in cook chill products. Therefore if high counts are observed in cook chill products within their stated shelf life, it should be investigated.

Out of 95 samples tested, 73 (76.8%) samples results were satisfactory, 20 (21.2%) were marginal and two (2.1%) were unsatisfactory. Generally SPC counts increases during storage and reach the peak at the end of shelf life.

Survey results revealed that four out of 20 samples that were marginal still had over 10 day's shelf life remaining. One of the two samples that had unsatisfactory SPC levels still had nine days shelf life remaining. This sample also had non-pathogenic form of *Listeria innocua* identified at the levels of 300cfu/g. This indicated that either there was inadequate processing, post process contamination or they had poor temperature controls during processing and storage. This producer was investigated further due to reoccurring high SPC counts. The second unsatisfactory sample was a shelf life sample. Resampling of the products did not identify any high SPC concern for this producer.

Figure1. Cook chill meal compliance status



Escherichia coli (E.coli) & Total Coliform Count

E. coli is an indicator organism and its presence in ready meals indicates post process contamination due to unhygienic processing and poor handling and storage or using contaminated water at the site.

As per the compendium, the satisfactory counts of *E.coli* for ready to eat foods are "<3cfu/g" and count levels between 3cfu/g to 100cfu/g are considered marginal. Generally a level exceeding 100cfu/g indicates unacceptable level of contamination. If high levels are detected, further typing should be done to identify if the *E.coli* strains are pathogenic or not.

Levels of *E.coli* in all the18 samples tested were with in satisfactory limits of *E.coli.*
Total coliform levels are also an indicator of the hygiene status of the processing environment. A level below 100cfu/g is considered acceptable for cooked ready to eat products. 77 samples were tested for total coliform and all the test results were within acceptable limits.

Bacillus cereus (B.cereus)

Bacillus cereus is a spore forming bacteria that can cause food poisoning when cooked food dishes are not cooled correctly. It is typically associated with rice dishes, cereal based products like pasta and noodles or vegetable dishes.

Out of 95 samples tested, results of two samples were marginal with maximum levels of 200 cfu/g. Both samples were from the same batch and collected together. One sample that was tested immediately had *B.cereus* counts of 100 cfu/g and second sample tested at the end of shelf life had *B.cereus* counts of 200 cfu/g. Levels in this range indicate possible temperature abuse during cooling and/or storage of the cooked products.

Salmonella

Salmonella is one of the principal causes of foodborne illness worldwide. It is found in eggs, raw milk, meat or poultry. Fruit and vegetables may also be contaminated, from manure based fertilizer, irrigation water, pests in the field, dirty harvest equipment, unclean transport containers, dust and people. Cooked ready-to-eat foods may become cross contaminated by transfer of bacteria from raw

foods, either by direct contact, or via food preparation surfaces and equipment used for both raw and cooked foods.

Salmonella was not detected in any of the initial 18 samples tested.

Coagulase positive *Staphylococci*

Staphylococcus is commonly found on the body of healthy humans, including nasal passages, but also on the hands (especially in infected cuts and sores), scalp and ears. The contamination of cooked food by the *Staphylococcus toxin* is usually a sign that food has been contaminated post processing due to poor hygienic handling and has further been temperature abused to give the organism an opportunity to grow and produce its toxin.

All 18 samples tested were within satisfactory limits of Coagulase positive *Staphylococci.*

Clostridium perfringens

Clostridium perfringens is widely distributed in the environment. Spores of the organism persist in soil, sediments and areas subject to human or animal faecal contamination. It is commonly found in ready to eat foods with plant origin because spores of *Clostridium perfringens* are normally present in the soil where plants are grown. *Clostridium perfringens* toxins are most commonly associated with food poisoning, which can happen when —

- People ingest a large amount of the bacteria, which then multiply and produce toxin in the intestine; or
- People eat contaminated food with the toxin already in it.

All 95 samples tested were within satisfactory limits of *Clostridium perfringens.*

Listeria monocytogenes (L.mono)

Listeria is an environmental microorganism found in soils and the processing environment. Horticultural products can become contaminated at the time of harvest or contaminated during preparation, processing or packaging. Its incubation period can be up to 70 days making it hard to identify the source later during a disease investigation.

L.mono is the only recognised pathogenic form of *Listeria.* Its infection can affect people differently. Healthy people may develop few or no symptoms. However for immune compromised people it can be life threatening. People who are at particular risk of infection include; immune compromised, pregnant women, the elderly and newborns.

Out of 95 samples tested, all were found to be compliant with the regulatory limits.

Follow-up activities

Three out of 12 SA based manufacturers were further investigated due to poor microbiological quality.

1. Follow up – A business with high levels of reoccurring SPC and potential for Listeria growth

The inspection of this business revealed several issues including poor infrastructure, difficult to clean and sanitise contact surfaces, lack of skills and knowledge of food handlers and poor cooling practices. This manufacturing facility was made to reduce the shelf life of its products from 14 days to less than 10 days to minimise the food safety risk. SA Health also provided technical support to ensure safe production of meals by the business. Local council followed up with the business for the corrective actions.

2. Follow-up– A business with marginal levels of *B.cereus*

The inspection of this business practices revealed minor concerns around cooling of pasta products. The business actively adopted corrective actions to improve cooling practices. A further six follow-up samples were collected and all were found to be compliant.

3. Follow-up – A business with mould growth in its end of shelf life product

One sample with extended shelf life had mould growth during storage when checked at the end of shelf life. The initial sample of the same batch had been tested immediately and found to be fully compliant. The business was investigated for potential inaccurate shelf life validation or packaging defect. This business was also investigated in previous financial year 2016-17 due to non-aseptic packaging and potential for post process Listeria contamination in their extended shelf life cook chill meals. The business had voluntarily reduced the shelf life of their three product lines to less than 10 days until such time that they could research and validate alternative ways such as recipe reformulation to reduce the pH below 4.4 or add a preservative permitted under the Code to extend the shelf life. The business is currently validating shelf life of all its ready meal products to ensure the accuracy of shelf life.

Other Activities

SA Health also shared the survey findings via presentation with other jurisdictions to highlight the food safety concerns with this rapidly growing trend of small manufacturers entering into production of convenience meals with extended shelf life without adequate skills and knowledge. A presentation on cook chill was delivered by SA Health on behalf of Environmental Health Professionals Australia (EHPA) Vic at the 2018 EHPA Food Forum in Melbourne where a technical overview was provided and outcomes from the cook chill survey discussed.

Conclusion:

The manufacturing of extended shelf life convenience meals is a high risk and technically complex activity and any business who wants to enter in this processing sector should have necessary infrastructure, appropriate knowledge, technical skills and suitable equipment. Since the beginning of the cook chill survey, SA Health has done significant work with SA based producers to achieve better quality results. Test results indicated that overall microbiological quality has improved for the cook chill meals in South Australia. Compared to the previous survey in 2016-17, sample compliance percentage has improved from 57% to 77% in the year 2017-18 which is 20% improvement. All those businesses which were non-compliant in previous survey were resampled and their results were now compliant with the specifications.

Skills and knowledge of the operators were found to be the key issue among most of the producers in SA. The businesses that were non-compliant were investigated with site visits, resampling and education. Where the business failed to take necessary corrective actions, enforcement actions were also taken to ensure the food safety. The samples that were identified as noncompliant in this survey were mainly due to the hygiene indicator SPC. Very low levels of pathogens were identified in the samples of only one SA producer. Follow-up sample results were satisfactory for this business. None of the sample results were unsatisfactory or potentially hazardous for any pathogen tested.

The survey results indicate that awareness of food safety of cook chill process has increased in the existing SA business and they are working collaboratively with SA Health and their local councils to achieve better compliance for ready meal production. However new small food businesses entering in cook chill area are still presenting a food safety challenge. Therefore potential future public health risk may still exist if new businesses that are entering into this business do not have appropriate skills and knowledge to identify and mitigate food safety risks associated with extended shelf life convenience meals. SA Health will continue to monitor new businesses and conduct proactive sampling if required. SA Health endeavours to provide education and technical assistance to the businesses if food safety concerns are identified during monitoring. Councils are now more aware that this market area is growing and it is a high risk process therefore they will ensure that during inspections, cook chill processing is assessed thoroughly especially if the meals have extended shelf life.

References:

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- South Australian *Food Act 2001*
- CSIRO MAKE IT SAFE – A guide to Food Safety 2010
- The Australia New Zealand Food Standards Code (the Code), Standard 1.6.1- Microbiological criteria for *Listeria monocytogenes* in ready-to-eat (RTE) Foods
- Food Standard Australia New Zealand (FSANZ) “Compendium of Microbiological Criteria for Food” October 2016
- FSANZ document -Guidance on the application of microbiological criteria for Listeria monocytogenes in RTE food