

# RICE BASED DESSERTS

SURVEY



Department of  
Primary Industries  
Food Authority

More resources at [foodauthority.nsw.gov.au](http://foodauthority.nsw.gov.au)



nswfoodauthority



nswfoodauth

JUNE 17

## Contents

<b>Introduction</b> .....	<b>4</b>
<b>Aim</b> .....	<b>5</b>
<b>Products in scope</b> .....	<b>5</b>
<b>Materials and method</b> .....	<b>6</b>
Compliance inspection.....	6
Product testing.....	6
Results analysis.....	7
<b>Results</b> .....	<b>8</b>
Business profile .....	8
Shelf life .....	8
Processing steps .....	9
Inspections results .....	14
Products collected from the manufacturers .....	14
Products collected at retail .....	17
<b>Discussion</b> .....	<b>18</b>
<b>Conclusion</b> .....	<b>21</b>
<b>References</b> .....	<b>22</b>
<b>Appendix 1 Previous studies</b> .....	<b>24</b>
At manufacturers .....	24
At retail.....	26
In a laboratory setting .....	28
<b>Appendix 2. Example of products included in this project</b> .....	<b>30</b>
<b>Appendix 3. Questionnaire for manufacturer – processing information</b> .....	<b>31</b>
<b>Appendix 4. Asian sweet soup desserts</b> .....	<b>32</b>



The NSW Food Authority conducts food surveys or projects throughout the year. Surveys provide a snapshot of practices at the participating businesses at that point of time. Survey results serve to highlight potential areas requiring further attention by businesses.

More information about our survey program is available at

[http://www.foodauthority.nsw.gov.au/\\_Documents/science/survey\\_program\\_overview.pdf](http://www.foodauthority.nsw.gov.au/_Documents/science/survey_program_overview.pdf)



Department of  
Primary Industries  
Food Authority

## Introduction

Rice based desserts, commonly known as rice cakes, are popular food items in Asian countries such as Korea, Japan, China, Vietnam, Malaysia and Indonesia. Rice based desserts can be manufactured using different bases (such as regular rice or glutinous rice), sugar, and a variety of other ingredients (such as nuts, red beans, yellow beans, mung beans and sesame seeds). They can be cooked by steaming, frying or boiling, with steam cooking the most popular method (Lee, Gwon, Kim & Moon, 2009).

Freshly steamed rice based desserts are soft and elastic, but with time they become hard due to retrogradation<sup>1</sup> which is at its maximum at 5°C. Therefore, it is not recommended to store them under refrigeration (Morris, 1990). This poses an issue however, because with abundant nutrients, high water activity, and almost neutral pH, rice based desserts can be considered a good medium for microbial growth and therefore categorised as products that require temperature control. They are also ready-to-eat and not subjected to any heat treatment prior to consumption, so the microbiological quality of these products is very important.

Enterotoxin-producing *Staphylococcus aureus* and *Bacillus cereus* are the major microbiological hazards with these foods (IFT/FDA, 2001). *B. cereus* is the main microorganism of interest because of the history of food poisoning outbreaks associated with consumption of rice based foods, mainly fried rice. *B. cereus* is also able to survive the cooking process by forming spores (CDC, 1994; Gilbert, Stringer & Peace, 1974; Mortimer & McCann, 1974; Okahisa, Inatsu, Juneja & Kawamoto, 2008; OzFoodNet, 2003, 2007, 2010; Raevuori, Kiutamo, Niskanen & Salminen, 1976; Tewari & Abdullah, 2015). *S. aureus* is commonly associated with human intoxications and was previously studied as an indicator for post processing contamination. Okahisa et al. (2008) reported several outbreaks of *S. aureus* food poisoning due to consumption of steamed rice cakes in Japan; however, no details can be included in this report as the literature is not available.

There are limited studies on the microbiological quality of these products at the end of processing at the manufacturers, at retail, or in a laboratory setting (Appendix 1). Literature suggested that the products can be considered safe for up to a few days of storage at room temperature and a long history of safety has been observed. In the state of California (USA), Korean rice cakes are permitted to be sold at room temperature for up to 24 hours providing the manufacturers specify the date and time when the cakes were made (California State Legislature, 2016).

The NSW Food Authority regularly receives complaints from consumers and Environmental Health Officers (EHOs) in relation to rice based desserts having non-compliant labelling (e.g. no allergen declaration, no manufacturer's address, issues with legibility and no date marking) and storage conditions at retail. Therefore, a project was undertaken to gather relevant information and the findings will be used to inform the risk management approach.

---

<sup>1</sup> When starch is heated in the presence of water and subsequently cooled, the disrupted sugar chains (especially amylose and amylopectin) can gradually re-associate into a different ordered structure in a process termed retrogradation. It is usually accompanied by a series of physical changes such as increased viscosity and turbidity and gel formation (Wang et al., 2016).

## Aim

The project aimed to:

- review the manufacturing processes,
- gather information on the type of products, their intrinsic properties (pH and water activity) and the microbiological quality at the end of processing and at the end of shelf life,
- gather information on the industry baseline compliance in relation to the requirements in the Australia New Zealand Food Standards Code (the Code) and product labelling, implement remedial action for non-compliance and determine the change in compliance rates post intervention,
- develop and implement a risk management approach to make sure that rice based desserts made and sold in NSW are safe for consumption.

## Products in scope

Products included in this project were:

- made of rice or glutinous rice (or their flour), sugar, and other ingredients such as beans, nuts, and sesame seeds,
- ready-to-eat (do not need further processing prior to consumption),
- fresh, 'wet' looking (not fried or baked products),
- pre-packaged,
- stored at room temperature at retail, and
- manufactured in Sydney (not imported).

See Appendix 2 for examples of products.

Plain rice cakes/pasta/noodles (made of rice/glutinous rice, water and salt) that required cooking or heating prior to consumption were excluded from this project.



Department of  
Primary Industries  
Food Authority

## Materials and method

The project was conducted from July to October 2016 by the Science and Technical Unit and Biosecurity and Food Safety Compliance Unit of the Department of Primary Industries Biosecurity and Food Safety.

A questionnaire was used to collect information on the type of products, volume of production, and manufacturing process (Appendix 3).

### Compliance inspection

The inspection regime was designed to assess the businesses' compliance with the requirements of the Code including hygiene, construction, and labelling.

Phase 1 inspections were carried out to determine the baseline compliance level of businesses. When issues were identified, the businesses were notified and asked to fix the issue. The businesses were then re-visited (Phase 2 inspections) to determine the change in compliance rate post intervention.

### Product testing

#### At manufacturer

When possible, three replicates of each product were collected from each manufacturer and tested for a range of microorganisms as outlined in Table 1. All products were kept at room temperature before they were sent to the laboratory for testing. One sample was tested on the day of manufacturing (day 0), one sample was tested the next day (day 1) and the last one was tested at the end of the shelf life as specified on the label (end UBD).

**Table 1. Tests and method**

Test	Method reference
Standard Plate Count (SPC)	AS 5013.1&5:2004
Bacillus cereus enumeration	AS 5013.2:2007
Coagulase positive staphylococci enumeration	AS 5013.12.1:2004
E. coli enumeration	ISO 16649-2: 2001 (E)
Salmonella detection	VIDAS (NF VALIDATION (BIO 12/10-09/02)); AOAC 996.08
Yeast & moulds enumeration	AS 1766.2.2:1997
pH	AOAC 970.21
water activity	Aqua Lab Manual



## At retail

From October 2016 to March 2017 samples were also purchased at retail to observe the microbiological quality of these products at point of purchase and to verify the findings at the manufacturer level. These products were tested after minimum 24 hours of storage at room temperature, except for the Korean style products because their use-by date was the same as the date of manufacturing.

## Results analysis

Products included in this project were ready-to-eat, so the microbiological results were analysed against the Food Authority's 'Microbiological quality guide for ready-to-eat foods' (NSW Food Authority, 2009) as outlined in Table 2.

**Table 2. Guideline levels for determining the microbiological quality of ready-to-eat foods (NSW Food Authority, 2009)**

Organism	Good (cfu/g)	Acceptable (cfu/g)	Unsatisfactory (cfu/g)	Potentially hazardous (cfu/g)
Standard plate count (Category B) <sup>2</sup>	<10 <sup>6</sup>	<10 <sup>7</sup>	≥10 <sup>7</sup>	N/A
<i>B. cereus</i>	<10 <sup>2</sup>	10 <sup>2</sup> to <10 <sup>3</sup>	10 <sup>3</sup> to <10 <sup>4</sup>	≥10 <sup>4</sup>
Coagulase positive staphylococci <sup>3</sup>	<10 <sup>2</sup>	10 <sup>2</sup> to <10 <sup>3</sup>	10 <sup>3</sup> to <10 <sup>4</sup>	≥10 <sup>4</sup>
<i>E. coli</i>	<3	3 to <10 <sup>2</sup>	≥10 <sup>2</sup>	N/A
<i>Salmonella</i>	not detected in 25 g	-	-	detected in 25g
Yeast and mould <sup>4</sup>	not detected	detected but <10 <sup>4</sup>	≥10 <sup>4</sup>	-

All results were entered into a Microsoft™ Excel 2010 spread sheet. Where enumeration was conducted, microbiological counts were converted to log cfu/g.

<sup>2</sup> Category B applies to ready-to-eat foods which contain some components that have been cooked and then further handled (stored, sliced or mixed) prior to consumption.

<sup>3</sup> Coagulase positive staphylococci refers to a group of enterotoxigenic staphylococci including *Staphylococcus aureus* and other strains.

<sup>4</sup> There is no limit prescribed in the Code or NSW Food Authority guideline or overseas for yeast and mould. The limit of 10<sup>4</sup> cfu/g was chosen as a recommendation from the laboratory based on their experience. HPA (2009) states that yeast may cause spoilage at the level of 10<sup>6</sup> – 10<sup>7</sup> cfu/g.

## Results

### Business profile

Manufacturers were identified using the Food Authority database and retail visits by the NSW Food Authority Science Officer and EHOs from Georges River and Fairfield City Council. A total of 19 active businesses were identified and subsequently inspected. Only 14 manufactured products that fell within the scope of the project. Three manufacturers were identified to produce Korean style rice cakes while the rest of the manufacturers produced South East Asian or Chinese rice based desserts/cakes.

This is a relatively 'fluid' industry, which means that there will be various changes in the business profile over time.

The businesses identified had different set ups as outlined in Table 3 and the type of products manufactured at each business ranged from two to fifteen rice based dessert varieties.

**Table 3. Rice based desserts manufacturer profile**

Business set up	No. of businesses	Volume of production (no of units/week)
Home-based businesses (a separate kitchen set up at the back of the house or using their own kitchen)	6	120 – 1000+
Manufacturing plant	6	1000+
Retailer	1	1000+
Kitchen at a wedding venue facility	1	90

### Shelf life

All products were packaged in plastic takeaway containers or Styrofoam trays with cling wrap. They were transported and sold at room temperature.

The Korean style rice based desserts had only one day shelf life, with the use-by date being the day of manufacture. The rest of the products had two to six days shelf life, according to the use-by date on their labels at the time of sampling. No manufacturer had conducted a shelf-life study.

Most manufacturers claimed that they retrieved unsold products when they delivered the new ones (either every day or every two days) and discarded them, unless the shops kept the products in the refrigerator.





## Processing steps

The products included in this project could be categorised into four major groups based on appearance and manufacturing processes:

- Korean style (Figure 1)
- layered (Figure 2)
- moulded (Figure 3), and
- rice balls (mochi) (Figure 4)

The Korean style products used rice as the main ingredient which required soaking and grinding steps. The rest of the rice based desserts used pre-packaged rice flour or glutinous rice flour purchased from shops.

For products using bean paste, the beans were soaked in water for three to five hours then cooked in a rice cooker or steamed for two hours before they were used in the product.

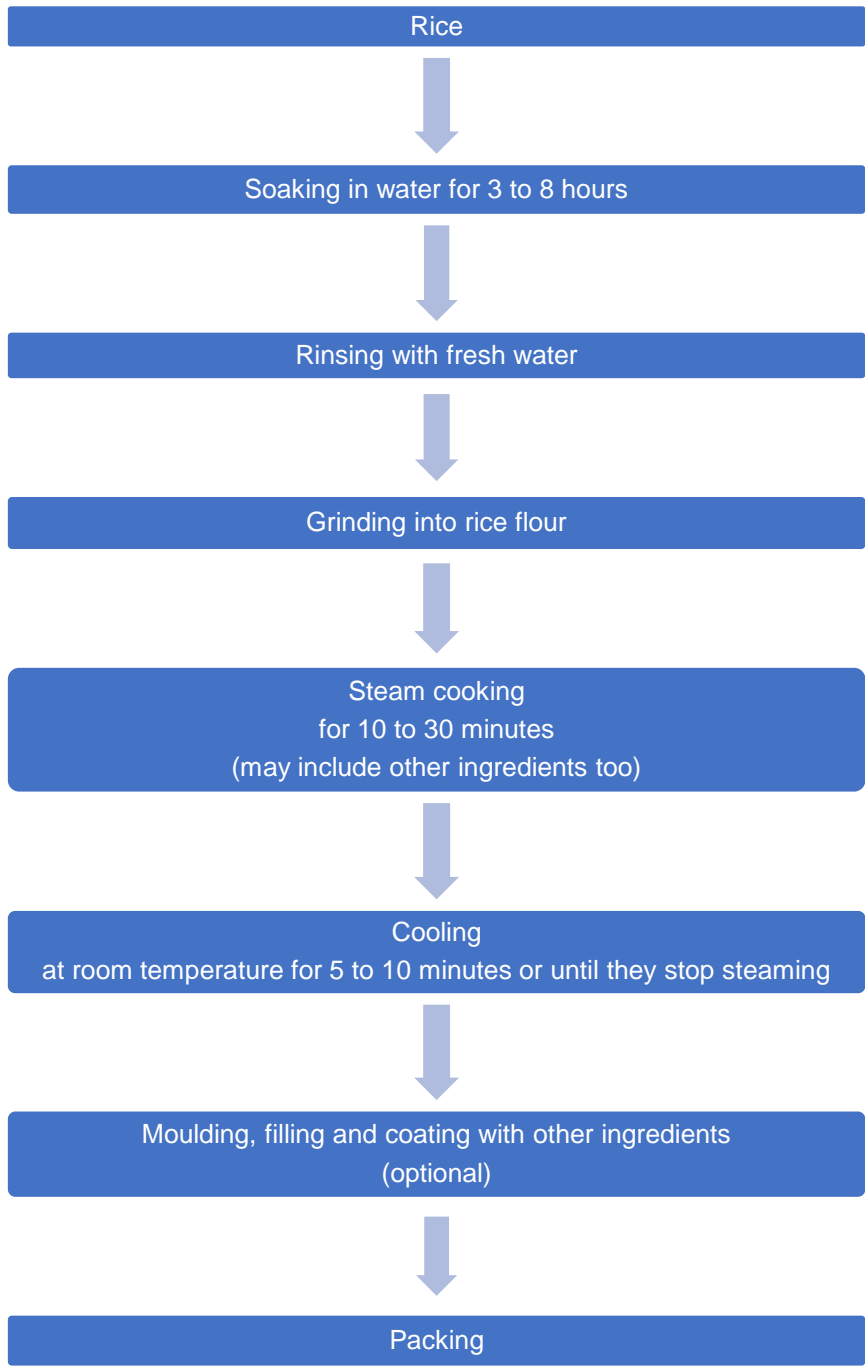
All products were steamed, except for one manufacturer who used a microwave to cook their dough.



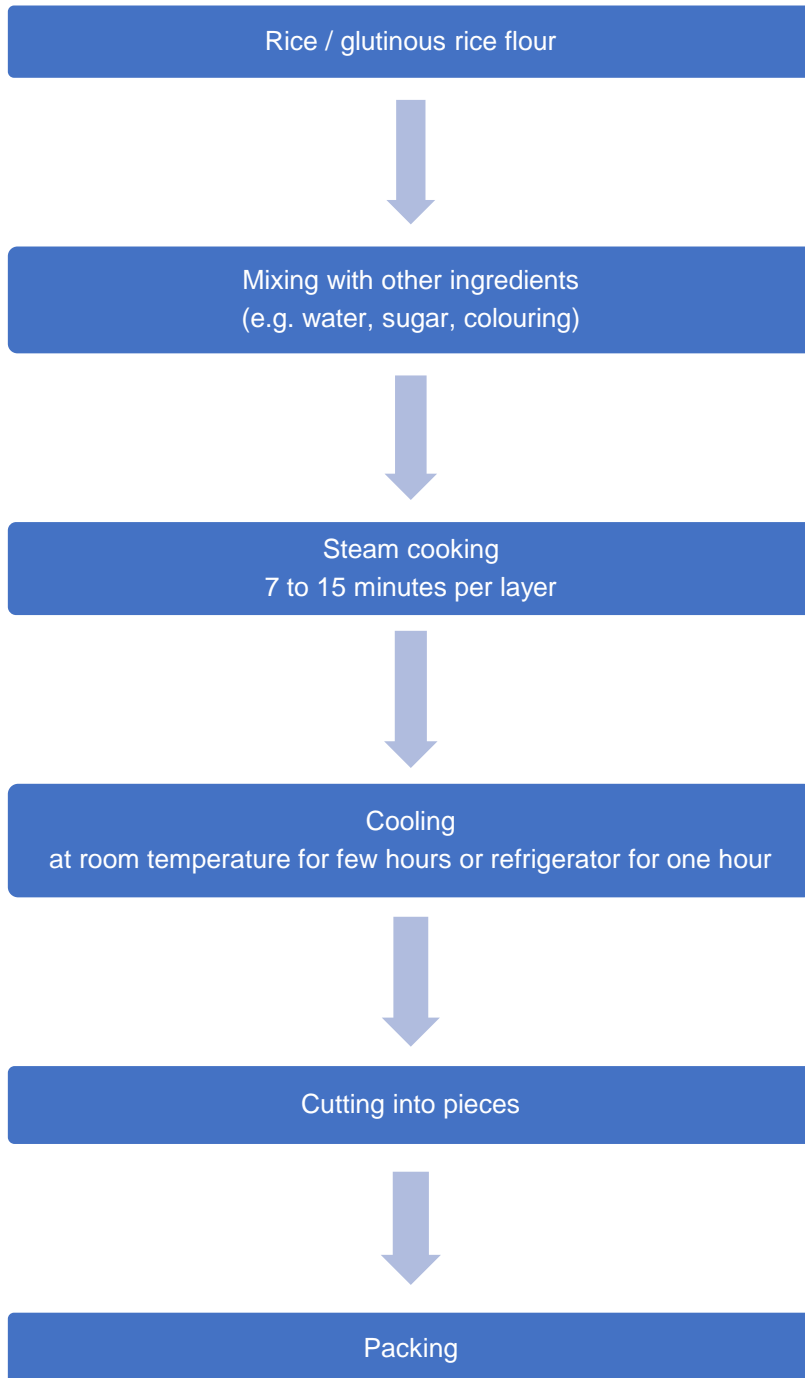
Department of  
Primary Industries  
Food Authority



Figure 1. Processing steps for Korean style



**Figure 2. Processing steps for layered**



These products normally have six to eight layers.

Some of them have a bean paste layer in between the rice flour layers.

Figure 3. Processing steps for moulded

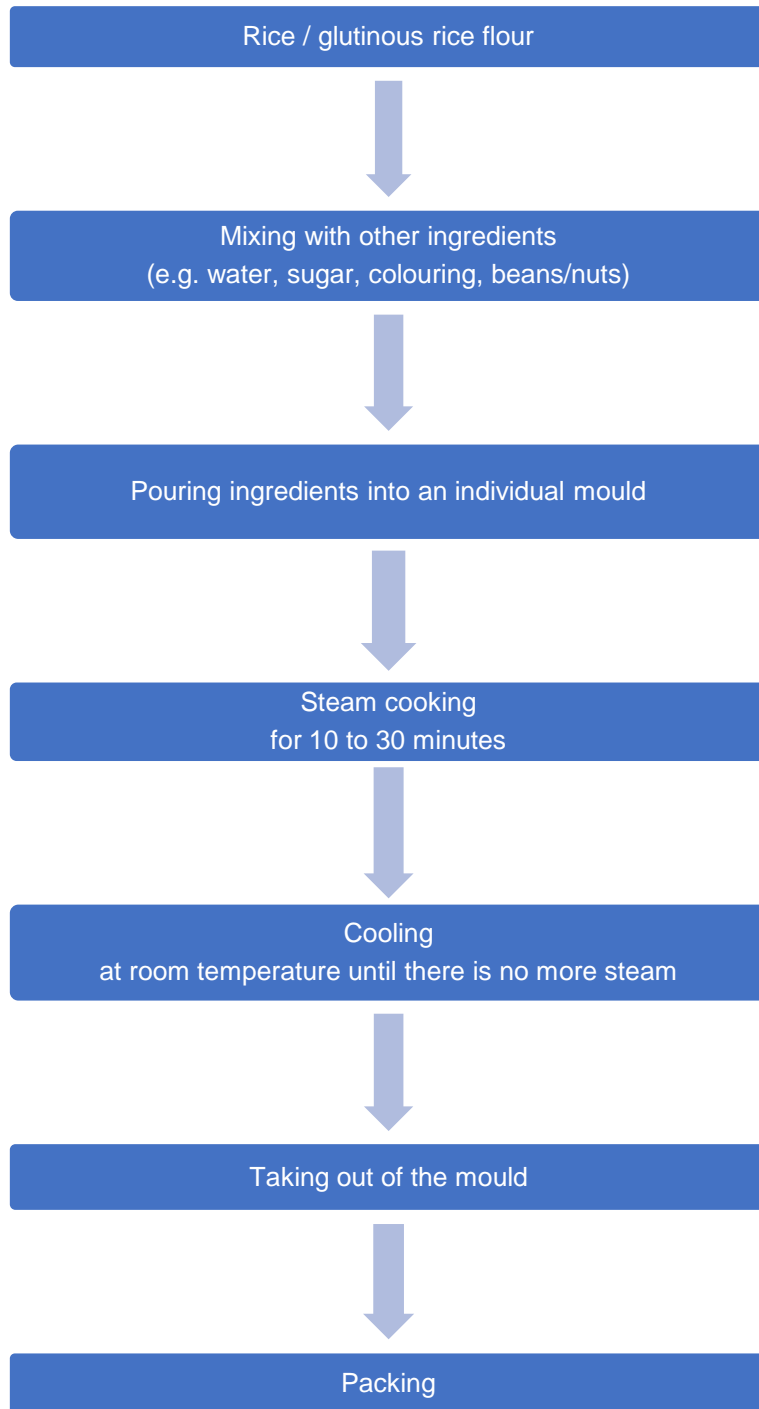
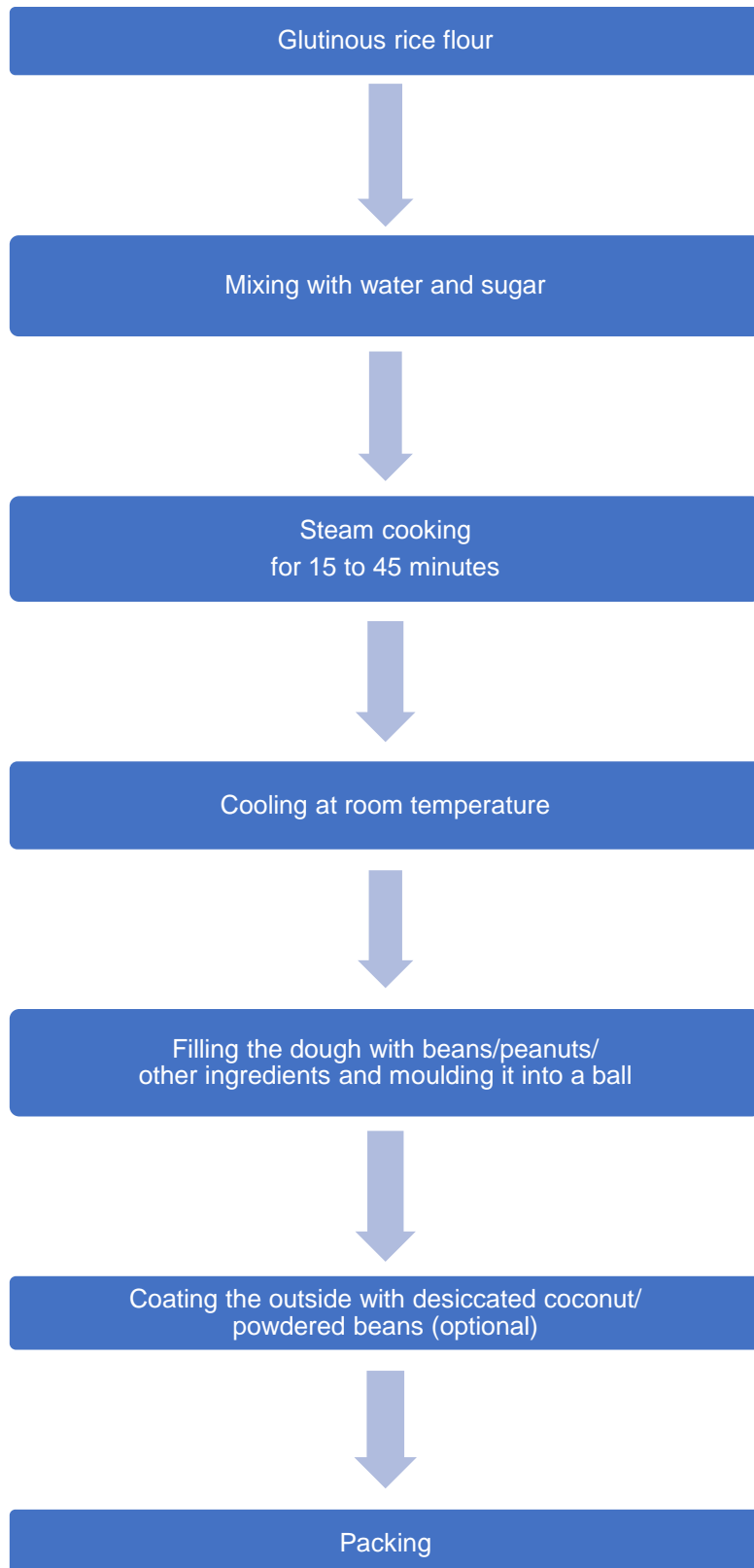


Figure 4. Processing steps for rice balls (mochi)



## What we found

Phase 1 inspections found that: construction of fixtures, fittings and equipment; cleanliness of premises and equipment; use of sanitiser (by way of heat or chemical application) on food contact surfaces; and failure to have a documented food recall system in place were the areas where businesses failed to comply.

An increase in compliance in these areas was observed during the follow up inspections.

Phase 1 inspections found that no business fully complied with all aspects of food product labelling.

Labelling non-compliances ranged from minor low risk issues such as insufficient nutrition information panels to critical high risk issues such as the omission of allergen declarations. The breaches ranged from single to numerous product types within each business.

An increase in compliance rates was observed following re-inspection for the high risk components of food labelling including allergen declarations, directions for storage, date marking and statement of ingredients. Many businesses design and print their labels overseas, therefore shipping time of new labels affected compliance rates during phase 2 inspections.

## Products collected from the manufacturers

### pH and water activity profile

Information on the ingredients for each product was obtained from ten of the manufacturers. Only one manufacturer used artificial colour and preservatives (sorbic acid), but the level was not quantified. The rest of the manufacturers did not use any preservatives. Based solely on their pH and water activity value, most products (except for banh bo (white steamed cake) and rice pudding) were categorised as products that require temperature control (IFT/FDA, 2001).

**Table 4. pH and water activity for different types of products**

Category	No samples	pH median (range)	Water activity median (range)
Korean style	5	6.69 (5.47 – 7.22)	0.96 (0.95 – 0.99)
Layered	11	6.00 (4.95 – 7.87)	0.96 (0.94 – 0.98)
Moulded	7	6.44 (3.49 – 6.95)	0.96 (0.91 – 0.98)
Rice balls	4	6.41 (5.07 – 6.81)	0.96 (0.91 – 0.97)

### Microbiological results

A total of 54 products – representing 27 different products from eleven manufacturers – were tested for their microbiological quality. The results were assessed against the Food Authority's guideline and summarised in Table 5.



Unfortunately, some samples could not be categorised due to the absence of the SPC value (reported as greater than 300,000 cfu/g<sup>5</sup>), absence of the yeast and mould value (reported as greater than 25,000 cfu/g<sup>5</sup>) or not being tested for yeasts and moulds.

For the 33 samples that could be categorised, all were classified good or acceptable. No sample tested positive for *E. coli*, *S. aureus* or *Salmonella*. *B. cereus* was detected in two moulded rice cakes manufactured by two different businesses at the level of 100 and 300 cfu/g, which was considered as acceptable for this type of product (one product was tested at the day of manufacture and the other one was tested after one day of storage). Products from the same batches tested at different stages of shelf-life had undetectable level of *B. cereus*.

**Table 5. Assessment of products collected at manufacturers using the microbiological criteria for ready-to-eat foods (NSW Food Authority, 2009)**

Category	Day of testing <sup>6</sup>	No of sample	Good	Acceptable	Unsatisfactory	Potentially hazardous	Uncategorised
Korean style	Day 0	5	-	1	-	-	4 <sup>7</sup>
	Day 1	5	-	-	-	-	5 <sup>7</sup>
	End UBD	3	-	-	-	-	3 <sup>7,8</sup>
Layered	Day 0	5	3	-	-	-	2 <sup>9</sup>
	Day 1	11	10	1	-	-	-
	End UBD	4	3	1	-	-	-
Moulded	Day 0	3	1	1	-	-	1 <sup>9</sup>
	Day 1	6	4	2	-	-	-
	End UBD	3	1	-	-	-	2 <sup>7</sup>
Rice balls (mochi)	Day 0	3	3	-	-	-	-
	Day 1	4	2	-	-	-	2 <sup>7</sup>
	End UBD	2	-	-	-	-	2 <sup>7,8</sup>
Total		54	27	6	-	-	23

<sup>5</sup> Due to the lack of dilution employed by the laboratory. The absence of a count for SPC or yeast and mould meant that the product could be in either good, acceptable, or unsatisfactory categories according to the guidelines. A total of six products collected earlier in the project were not tested for yeasts and moulds. It was then decided to expand the testing to include yeasts and moulds.

<sup>6</sup> Day 0 = day of manufacturing. Day 1 = the day after manufacturing (day of manufacturing + 1). End UBD = the end of shelf life on the label (ranged from one to five days).

<sup>7</sup> Uncategorised due to SPC level reported as greater than 300,000 cfu/g. The rest of the testing revealed no issue with other microorganisms.

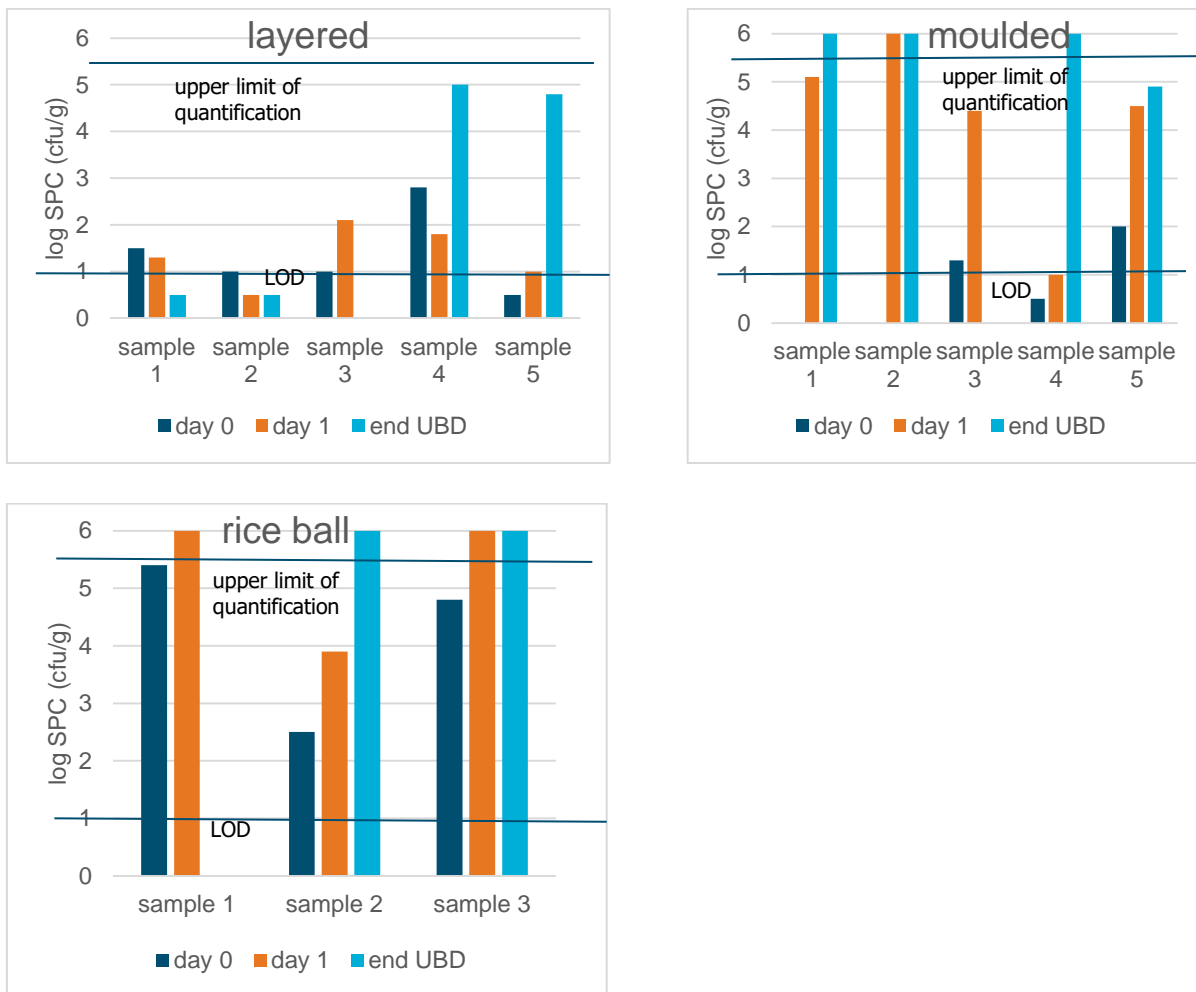
<sup>8</sup> Uncategorised due to yeast and mould level reported as greater than 25,000 cfu/g. The rest of the testing revealed no issue with other microorganisms.

<sup>9</sup> Uncategorised due to the absence of yeasts and moulds testing. The rest of the testing revealed no issue with other microorganisms.

For eighteen products, a minimum of two replicates of the same batch (packaged in separate packs) were obtained and they were tested at different stages of their shelf-life. For most samples, the level of SPC increased as the shelf-life progressed (Figure 5). Note that the presence of the microorganisms may not be evenly distributed in a batch.

Layered cakes had the lowest SPC compared to other products, possibly due to the processing steps for these products. A thin layer of the batter was poured into the tin and steamed for about ten minutes, before another layer was poured. The total steaming time for some layers could be between 60 to 80 minutes. Conversely, for all five of the Korean style (not shown in the graph), the SPC at day 0 was already at the level greater than 300,000 cfu/g and remained high during the one day shelf life.

**Figure 5. SPC in products during different days of the shelf life<sup>10</sup>**



<sup>10</sup> The use-by date ranged from two to four days. The upper limit of quantification for the dilution used by the laboratory for these products was 300,000 cfu/g.



## Products collected at retail

### Microbiological results

A total of 105 products were purchased from retailers around Sydney and tested. In the absence of the manufacturing date on the label, assumption (based on information collected at manufacturers) was made to ensure that products were tested after being stored for at least 24 hours at room temperature, except for the Korean style products because their use-by date was the same as the day of manufacturing. The summary is presented in Table 6.

Most samples (79%) were categorised as good or acceptable. A further 21% of samples, mostly rice balls, were categorised as unsatisfactory due to high SPC and/or yeasts. Additional handling after the cooking steps of rice balls may contribute to this result.

No *E. coli*, *S. aureus* or *Salmonella* were detected in any of the samples. *B. cereus* was detected in one rice ball sample at the level of 1,000 cfu/g, which was considered unsatisfactory. This product was tested at the end of its shelf life and based on the information provided by the manufacturer, would have been on the shelf for five days at the time of testing.

**Table 6. Assessment of products collected at retail using the microbiological criteria for ready-to-eat foods (NSW Food Authority, 2009)**

Category	No of sample	Good	Acceptable	Unsatisfactory	Potentially hazardous
Korean style	22	15	4	3	-
Layered	35	34	-	1	-
Moulded	24	21	1	2	-
Rice balls	24	4	4	16	-
Total	105	74 (70%)	9 (9%)	22 (21%)	-



## Discussion

A significant increase in overall compliance rates was observed for rice based desserts manufacturers between phase 1 and phase 2 inspections (from 11% to 84% compliance rate). Overall compliance was measured by a combination of hygiene, sanitation, construction, maintenance, storage, labelling and traceability. The catalyst for increased compliance rates was a combination of education and enforcement actions.

Testing results for products collected from the manufacturers showed that the cooking process (steaming or microwaving) used by the manufacturers included in this project was effective in destroying the vegetative cells of common pathogens. There was no *E. coli*, *S. aureus* or *Salmonella* detected in any of the samples, even after up to five days of storage at room temperature. *B. cereus* was detected in two products just above the limit of detection of 100 cfu/g (at the level of 100 and 300 cfu/g), which was considered acceptable.

Twenty products had high SPC and/or high levels of yeasts and moulds. These results were outside the expected microbiological levels for this type of product; however, a high SPC did not mean that the food was considered unsafe (FSAI, 2016). SPC represents all microorganisms present in a food including yeasts, moulds and other spoilage organisms which are not harmful to humans (McLean, Dunn & Palombo, 2010). Almost all Korean style cakes had a SPC level greater than 300,000 cfu/g. Several studies conducted in South Korea found similar results and concluded that even though steam cooking kills all vegetative cells, post processing steps such as moulding, cutting and coating with powder, re-introduce microorganisms to the products. The organisms could come from the ingredients added post steaming, equipment or food handlers (Jeong et al., 2012; Lee & Jang, 2006; Lee & Kwon, 2013; 2014; Wang, Park, Choi, Ha & Oh, 2016).

The project also included testing of products purchased at retail which represent the 'real' risk for consumer since these products were not cooked or heated prior to consumption. No *E. coli*, *S. aureus* or *Salmonella* were detected in any of the products. High SPC and/or yeasts were detected in 20% of samples, mostly rice balls, which did not necessarily mean that the food was unsafe. *B. cereus* was detected in one sample at an unsatisfactory level, after five days of display. The high SPC results were similar to studies conducted in Korea and Australia. However, three of these other studies also found *S. aureus* with prevalence ranged from 7 to 16%, while none of the samples included in this project had detectable level of *S. aureus* (Choi et al., 2012; Cho, Wang, Lee, Lee & Shin, 2013; Huong et al., 2010; McLean, et al., 2010; Oh et al., 2007).

Literature suggests that *B. cereus* is the main concern for these products because of its ability to survive the cooking process by forming spores and the possibility of the surviving spores to germinate during storage. When the level of *B. cereus* reaches  $10^5$  to  $10^6$  cfu/g, toxins may be produced. Toxin production is dependent on pH, water activity and storage conditions such as temperature (FSANZ, 2013; Lee, Chung, Shin, Dougherty & Kang, 2006). *S. aureus* is another microorganism of interest which is commonly associated with human intoxications and was previously studied as an indicator for post processing contamination.

Modelling (ComBase, 2016) was undertaken to predict the growth of *B. cereus* and *S. aureus* in these products during storage at 25° and 30°C for a maximum of 48 hours (Figure 6 and Figure 7). The modelling was done solely based on the median pH and water activity for each product type included in this project. Assumption: all the vegetative cells were killed during the steaming process.

The graphs show that in all products, *B. cereus* will not reach high enough levels to produce toxins, even after 48 hours of storage at 30°C.



Figure 6. Predicted growth for *B. cereus* in rice cakes stored at 25°C and 30°C for up to 48 hours<sup>11</sup>

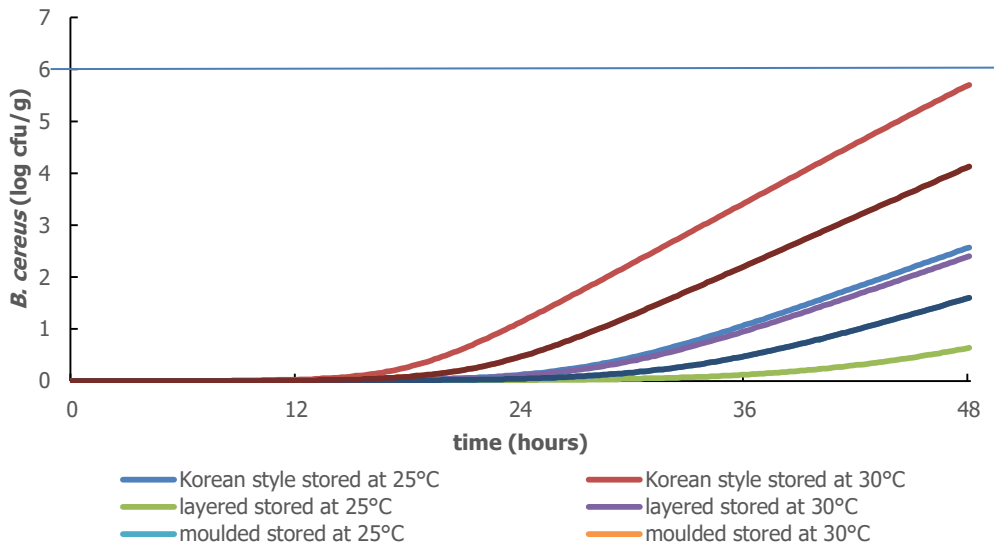
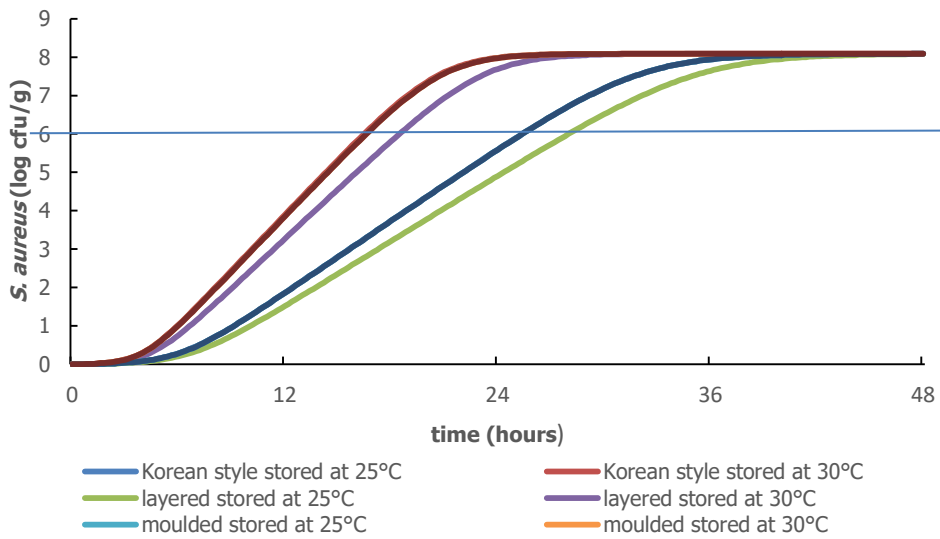


Figure 6. Predicted growth for *S. aureus* in rice cakes stored at 25°C and 30°C for up to 48 hours<sup>12</sup>



<sup>11</sup> Due to the similarity in the median pH and water activity value for moulded and rice balls, the predicted growth curve for both products is overlapped.

<sup>12</sup> There are only four lines in the graph because the growth curve for the Korean style, moulded, and rice balls at 25°C is overlapping. The same case with the Korean style, moulded, and rice balls at 30°C.

Despite the theoretical ability of these food to support the growth of *B. cereus* and *S. aureus*, Lee et al. (2006) argued that the risk of food poisoning can be reduced even at room temperature provided other conditions are properly controlled to keep the concentration of these organisms low. The critical control points include high quality of raw ingredients, an effective cooking step and prevention of post-processing contamination from food handlers, equipment and packaging material (Cho et al., 2013; Ji, Zhu, Qian & Zhou, 2007; Wang et al., 2016).

Lee et al. (2006) found that steam cooking significantly reduced (more than  $10^6$  cfu/g) non-spore forming foodborne pathogens and inactivated spores of *B. cereus* by  $10^1$  to  $10^2$  cfu/g. The *B. cereus* spores that survive the steam cooking, germinated during the three days of storage at room temperature, but the populations remained below  $10^6$  cfu/g. They also found that the rapid growth of mesophilic organisms by more than  $10^7$  to  $10^8$  cfu/g during the first day of storage produced off flavours and spoilage before *B. cereus* could grow enough to produce toxins. The finding was supported by work carried out by Okahisa et al. (2008) that found that the steaming process was sufficient to kill *S. aureus* cells and most of the *B. cereus* spores. If products were contaminated after the steaming process (at the level of  $10^3$  cfu/g), then the organisms can grow rapidly at 30°C and produce toxins. In their study, Okahisa et al. (2008) found that it took two days for *S. aureus* and seven days for *B. cereus* to reach the level required to produce toxins. Lastly, Ji et al. (2007) also found that populations of microorganisms increased over time in rice cakes and the product was completely spoiled (in term of the colour, texture, and flavour) after three days of storage at room temperature. During the first three days, Staphylococci species were the dominant group and Bacillus species was not widely represented during the first two days of storage.



Department of  
Primary Industries  
Food Authority

## Conclusion

The project revealed that manufacturers lacked understanding of cleaning and sanitation practices and had not verified the appropriate product shelf life at room temperature. None of the businesses knew about sanitising and the shelf life of the products was chosen without any knowledge of the products' intrinsic characteristics. A lack of focus on these areas could lead to hazardous levels of pathogenic organisms in the finished products. The issue with cleaning and sanitation was addressed during the project and rectified.

Product testing at both manufacturer and retail level revealed that there is no major safety issue with these products, even when they are displayed at room temperature. Three of the most important control measures for ensuring the safe production of rice based desserts involve:

- using high quality ingredients,
- effective heat treatment, and
- strict hygiene and sanitation regime to prevent post-processing contamination.

Products manufactured correctly should be safe to be stored at room temperature until the end of the next day (day of manufacturing +1). Based on literature and the microbiological testing, these products are more likely to spoil before they become unsafe during that time.



Department of  
Primary Industries  
Food Authority

## References

- California State Legislature. (2016). Health and Safety Code – HSC. Division 104. Environmental Health. Part 5. Sherman Food, Drug, and Cosmetic Laws. Chapter 5. Food. Article 14. Asian rice noodles, Korean rice cakes and Vietnamese rice cakes. Retrieved 11 January 2017 from [http://leginfo.legislature.ca.gov/faces/codes\\_displayText.xhtml?lawCode=HSC&division=104.&title=&part=5.&chapter=5.&article=14](http://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=HSC&division=104.&title=&part=5.&chapter=5.&article=14).
- Centers for Disease Control and Prevention (CDC). (1994). Bacillus cereus food poisoning associated with fried rice at two child day care centers – Virginia, 1993. *Morbidity and Mortality Weekly Report*, 43(10), 177 - 178. Retrieved 2 November 2016 from <http://www.cdc.gov/mmwr/pdf/wk/mm4310.pdf>
- Cho, Y.S., Wang, H.J., Lee, J.Y., Lee, D.Y. & Shin, D.B. (2013). Prevalence and characterization of Staphylococcus aureus pathogenic factors isolated from Korean rice cakes. *Food Science and Biotechnology*, 22(4), 1153 – 1159.
- Choi, S.Y., Jeong, S.H., Jeong, M.S., Park, K.H., Jeong, Y.G., Cho, J.I. et al. (2012). A monitoring for the management of microbiological hazard in rice-cake by climate change. *Journal of Food Hygiene and Safety*, 27(3), 301 – 305.
- Food Safety Authority of Ireland (FSAI). (2016). Guidelines for the interpretation of results of microbiological testing of ready-to-eat foods placed on the market (revision 2). Retrieved 8 December 2016 from [www.fsai.ie/publications\\_GN3\\_microbiological\\_limits/](http://www.fsai.ie/publications_GN3_microbiological_limits/)
- Food Standards Australia New Zealand (FSANZ). (2013). Bacillus cereus. Retrieved 5 December 2016 from <https://www.foodstandards.gov.au/publications/Documents/Bacillus%20cereus.pdf>
- Gilbert, R.J., Stringer, M.F. & Peace, T.C. (1974). The survival and growth of Bacillus cereus in boiled and fried rice in relation to outbreaks of food poisoning. *Journal of Hygiene*, 73, 433 – 444.
- Huong, B.T.M., Mahmud, Z.H., Neogi, S.B., Kassu, A., Nhien, N.V. et al. (2010). Toxigenicity and genetic diversity of Staphylococcus aureus isolated from Vietnamese ready-to-eat foods. *Food Control*, 21, 166 – 171.
- Institute of Food Technologies/Food and Drug Administration of the U.S. Department of Health and Human Services (IFT/FDA). (2001). Evaluation and definition of potentially hazardous foods. Retrieved 21 November 2016 from <http://www.fda.gov/Food/FoodScienceResearch/SafePracticesforFoodProcesses/ucm094141.htm>
- Jeong, S.H., Choi, S.Y., Cho, J.I., Lee, S.H., Hwang, I.G. et al. (2012). Microbiological contamination levels in the processing of Korea rice cakes. *Journal of Food Hygiene and Safety*, 27(2), 161 – 168.
- Ji, Y., Zhu, K., Qian, H. & Zhou, H. (2007). Microbiological characteristics of cake prepared from rice flour and sticky rice flour. *Food Control*, 18, 1507 – 1511.
- Lake, R., Hudson, A., & Cressey, P. (2004). Risk profile: Bacillus spp. in rice. Retrieved 3 November 2016 from [http://www.foodsafety.govt.nz/elibrary/industry/Risk\\_Profile-Science\\_Research.pdf](http://www.foodsafety.govt.nz/elibrary/industry/Risk_Profile-Science_Research.pdf)
- Lee, H.S & Jang, M.S. (2006). Microbiological hazard evaluation of the product flow of Korean rice cakes. *Korean Journal of Food and Cookery Science*, 22(6), 747 – 755.
- Lee, S.Y., Chung, H.J., Shin, J.H., Dougherty, R.H. & Kang, D.H. (2006). Survival and growth of foodborne pathogens during cooking and storage of oriental-style rice cakes. *Journal of Food Protection*, 69(12), 3037 – 3042.
- Lee, S. Y., Gwon, S.Y., Kim, S.J. & Moon, B.K. (2009). Inhibitory effect of commercial green tea and rosemary leaf powders on the growth of foodborne pathogens in laboratory media and oriental-style rice cakes. *Journal of Food Protection*, 72(5), 1107 – 1111.



- Lee, U.S. & Kwon, S.C. (2013). The application of the HACCP system to Korea rice-cake. *Journal of the Korea Academia – Industrial Cooperation Society*, 14(11), 5792 – 5799.
- Lee, U.S. & Kwon, S.C. (2014). The study on the microbiological limitation standards setting of handmade rice-cake by steam processing. *Journal of the Korea Academia – Industrial Cooperation Society*, 15(7), 4310 – 4317.
- McLean, S.K., Dunn, L.A. & Palombo, E.A. (2010). A pilot study of the microbiological quality of culturally diverse, ready-to-eat foods from selected retail establishments in Melbourne, Australia. *Foodborne Pathogens and Disease*, 7(5), 585 – 588.
- Morris, V.J. (1990). Starch gelation and retrogradation. *Trends in Food Science & Technology*, 1, 2 – 6.
- Mortimer, P.R. & McCann, G. (1974). Food-poisoning episodes associated with *Bacillus cereus* in fried rice. *The Lancet*, 303(7865), 1043 – 1045. Retrieved 2 November 2016 from [http://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(74\)90434-6/abstract](http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(74)90434-6/abstract)
- NSW Food Authority. (2009). Microbiological quality guide for ready-to-eat foods. Retrieved 21 November 2016 from [www.foodauthority.nsw.gov.au/\\_Documents/scienceandtechnical/microbiological\\_quality\\_guide\\_for\\_RTE\\_food.pdf](http://www.foodauthority.nsw.gov.au/_Documents/scienceandtechnical/microbiological_quality_guide_for_RTE_food.pdf)
- Oh, S.K., Lee, N., Cho, Y.S., Shin, D.B., Choi, S.Y. & Koo, M. (2007). Occurrence of toxigenic *Staphylococcus aureus* in ready-to-eat food in Korea. *Journal of Food Protection*, 70(5), 1153 – 1158.
- Okahisa, N., Inatsu, Y., Juneja, V.K. & Kawamoto, S. (2008). Evaluation and control of the risk of foodborne pathogens and spoilage bacteria present in Awa-Uirou, a sticky rice cake containing sweet red bean paste. *Foodborne Pathogens and Disease*, 5(3), 351 – 359.
- OzFoodNet. (2003, 2007, 2010). Foodborne disease in Australia Annual reports of the OzFoodNet network. Retrieved 2 November 2016 from <https://www.health.gov.au/internet/main/publishing.nsf/Content/cda-pubs-annlrpt-ozfnetar.htm>
- Park, Y.B., Kim, J.B., Shin, S.W., Kim, J.C., Cho, S.H. et al. (2009). Prevalence, genetic diversity, and antibiotic susceptibility of *Bacillus cereus* strains isolated from rice and cereals collected in Korea. *Journal of Food protection*, 72(3), 612 – 617.
- Raevuori, M., Kiutamo, T., Niskanen, A. & Salminen, K. (1976). An outbreak of *Bacillus cereus* food-poisoning in Finland associated with boiled rice. *Journal of Hygiene*, 76, 319 – 327.
- Texas Department of State Health Services. (2016). How to determine whether foods require time/temperature control for safety (TCS). Retrieved 29 November 2016 from <https://www.dshs.texas.gov/foodestablishments/pdf/GuidanceDocs/How-to-determine-if-foods-require-time-and-temperature/>
- Tewari, A. & Abdullah, S. (2015). *Bacillus cereus* food poisoning: international and Indian perspective. *Journal of Food Science and Technology*, 52(5), 2500 – 2511.
- Wang, J., Park, J.H., Choi, N.J., Ha, S.D. & Oh, D.H. (2016). Microbiological analysis of rice cake processing in Korea. *Journal of Food protection*, 79(1), 157 – 162.



## Appendix 1. Previous studies

### At manufacturers

Year	Country	Products tested	Findings	References
2012 – 2013	South Korea	<ul style="list-style-type: none"> <li>Korean rice cake</li> </ul>	<p>The raw ingredients, utensils and workers were tested for SPC, coliforms, <i>Salmonella</i>, <i>E. coli</i> O157:H7, <i>S. aureus</i>, <i>B. cereus</i>, <i>L. monocytogenes</i> and <i>C. perfringens</i>.</p> <p>A high SPC (approximately <math>10^4</math> cfu/g) was detected in the powdered raw ingredients.</p> <p>SPC was also detected at the level of <math>10^2</math> cfu/cm<sup>2</sup> on utensils and worker's hand.</p> <p>No pathogens were detected in any of the samples.</p>	Lee & Kwon, 2013
2012 – 2013	South Korea	<p>Korean rice cakes:</p> <ul style="list-style-type: none"> <li>kongseolgi</li> <li>potato songpyeon</li> <li>kongchalteok</li> <li>duteoptteok</li> </ul>	<p>Raw ingredients, rice cakes (before and after steaming), utensils and workers were tested for SPC, coliforms, <i>Salmonella</i>, <i>E. coli</i> O157:H7, <i>S. aureus</i>, <i>B. cereus</i>, <i>L. monocytogenes</i> and <i>C. perfringens</i>.</p> <p>Steaming reduced the SPC in rice cakes by <math>10^3</math> – <math>10^4</math> cfu/g.</p> <p>No pathogens were detected in any of the samples.</p> <p>The SPC for utensils and worker's hand ranged from 12 to <math>6.4 \times 10^4</math> cfu/cm<sup>2</sup>.</p>	Lee & Kwon, 2014
2011	South Korea	<p>Korean rice cakes:</p> <ul style="list-style-type: none"> <li>sirutteok – red bean rice cakes,</li> <li>garatteok – plain rice cakes,</li> <li>gyeongdan – rice balls</li> </ul>	<p>Raw ingredients, rice cakes at different steps of processing, equipment and workers from two factories (one with HACCP and one without) were tested for SPC, coliforms, <i>E. coli</i>, <i>S. aureus</i>, <i>B. cereus</i>, <i>C. perfringens</i> and yeasts and moulds.</p> <p>All raw materials had detectable SPCs, coliforms, <i>B. cereus</i> and yeasts and moulds.</p> <p>After soaking and smashing, the microbial levels increased significantly compared to those of rice.</p> <p>After steaming, the microbial level decreased significantly to the point where coliforms were not detected and <i>B. cereus</i> was detected at the level of <math>10^2</math> cfu/g.</p> <p>The microbial levels were slightly increased after the</p>	Wang et al., 2016



Year	Country	Products tested	Findings	References
			<p>moulding, which may be due to cross contamination.</p> <p>Most of the equipment was contaminated with high levels of coliforms, yeasts and moulds, <i>B. cereus</i> and a high SPC. The moulding inlet had the highest level of organisms.</p>	
n.d.	South Korea	<p>Korean rice cakes:</p> <ul style="list-style-type: none"> <li>• sirutteok – red bean rice cakes,</li> <li>• garatteok – plain rice cakes,</li> <li>• gyeongdan – rice balls</li> </ul>	<p>The SPC and levels of coliforms, fungi and <i>B. cereus</i> increased during soaking and grinding steps but then decreased after steaming.</p> <p>For the end product, on average, <i>B. cereus</i> was detected at the level of 25 cfu/g, fungi at the level of 30 cfu/g, and coliforms at the level of 60 cfu/g.</p> <p><i>E. coli</i>, <i>S. aureus</i> and <i>C. perfringens</i> were not detected in any product or environment.</p> <p>High SPC was detected on workers' hands and rice grinder (at different levels, ranging from 15 to <math>4 \times 10^4</math> cfu/100 cm<sup>2</sup> or hand).</p> <p><i>B. cereus</i> was also detected on equipment and some workers' hands (ranged from 10 to <math>5 \times 10^3</math> cfu/100 cm<sup>2</sup> or hand).</p>	Jeong et al., 2012
n.d.	South Korea	<p>Korean rice cakes:</p> <ul style="list-style-type: none"> <li>• gaepidduk – rice cakes with red bean pastes</li> <li>• injulmi – rice cakes covered with soybean powder,</li> <li>• julpyon – plain rice cakes</li> </ul>	<p>High SPC was detected in red bean paste, soybean powder and oil at levels as high as <math>10^5</math> CFU/g.</p> <p>Steam cooking killed all vegetative cells, but post processing steps re-introduced SPC and coliforms. Post processing contamination may come from the additional ingredients, equipment and food handlers.</p> <p>After 24 hours of storage: no change in pH and water activity, but the SPC, coliforms and fungi increased by at least ten-fold.</p>	Lee & Jang, 2006

## At retail

Year	Country	Products tested	Findings	References
2006 - 2011	South Korea	Korean rice cakes: <ul style="list-style-type: none"> <li>Jeolpyeon – plain rice cakes</li> <li>injulmi – rice cakes covered with soybean powder,</li> <li>baramtteok – rice balls with red bean paste filling, and</li> <li>steamed rice honey rice cake</li> </ul>	<i>S. aureus</i> was detected in 79 out of 1,151 samples (6.9%).	Cho et al., 2013
n.d.	South Korea	Korean rice cakes: <ul style="list-style-type: none"> <li>garaetteok – plain rice cake,</li> <li>siru dduk – red bean rice cake, and</li> <li>gyeongdan – rice balls</li> </ul>	A total of 540 samples were tested. SPC were highest in gyeongdan, with an average of $1.5 \times 10^5$ cfu/g. No <i>E. coli</i> was detected. <i>B. cereus</i> was detected in one garaetteok sample at the level of 15 cfu/g.	Choi et al., 2012
n.d.	Australia	che dau trang – Vietnamese dessert made from sticky rice, white beans and coconut milk  Kueh talam – Malaysian dessert consisting of two layers, the top layer is made from rice flour and coconut milk and the bottom layer is made from green pea flour, pandan leaf and palm sugar	High SPC ( $>3 \times 10^6$ cfu/g) was detected on these products. They also contained yeasts and moulds at the level of $>3 \times 10^3$ cfu/g. <i>Salmonella</i> , <i>Shigella</i> , coliforms and <i>E. coli</i> were not detected. A challenge testing was also done on these samples. The products were diluted 1:10 in sterile saline, stomached and then sterilised. A volume (0.01 ml) of <i>B. cereus</i> , <i>E. coli</i> , <i>S. aureus</i> and <i>Salmonella</i> culture was added to 3 ml of the sterile sample and incubated at 25°C. At 1-hour intervals, for a total of 6 hours, a 0.1ml aliquot was taken and plated. The results showed that these products could support the growth of pathogens with $10 - 10^2$ increases in viable bacteria over the 6-hour test period.	McLean, Dunn, & Palombo, 2010

Year	Country	Products tested	Findings	References
			The limitation with this study was that samples were sterilised and diluted before testing which may affect the chemistry of the food and eliminated any competitive organisms.	
n.d.	Vietnam	Vietnamese rice cake – steamed sticky rice filled with sweet mixture of bean and coconut, then wrapped in banana leaves	<i>S. aureus</i> was detected in 9 out of 55 samples (16.3%), ranged from $10^1$ to $10^3$ cfu/g.	Huong et al., 2010
2003 - 2004	South Korea	Korean rice cakes (with and without filling)	<i>S. aureus</i> was detected in 54 out of 342 samples (15.8%).  Rice cakes with filling had higher prevalence than those without filling, 19.3% and 14.6% respectively. This suggests that the filling itself or the filling process can contribute to the contamination of rice cakes.	Oh et al., 2007



## In a laboratory setting

Year	Country	Products tested	Findings	References
n.d.	South Korea	Sulgidduk – plain rice cakes	<p>Rice cakes were made (with and without green tea powder and rosemary leaves), steam cooked for 30 minutes, cooled and then inoculated with <i>S. aureus</i> or <i>B. cereus</i> at the level of <math>10^1</math> to <math>10^2</math> cfu/g. After inoculation, the rice cakes were placed in zip bags and stored at 22°C for 3 days.</p> <p>For the control sample, the level of <i>S. aureus</i> increased from <math>10^2</math> to <math>10^4</math> cfu/g after 24 hours of storage and <i>B. cereus</i> increased from <math>10^1</math> to <math>10^3</math> cfu/g.</p> <p>The addition of 1 or 3% green tea or rosemary to rice cakes did not significantly affect the number of SPC. However, the growth of <i>B. cereus</i> and <i>S. aureus</i> were inhibited during the 3 days storage at room temperature.</p>	Lee, Gwon, Kim & Moon, 2009
n.d.	Japan	Awa-Uirou – rice flour, sugar and red beans	<p>Awa-Uirou was made by mixing all the ingredients followed by steaming for 70 minutes. Some samples were uninoculated, while some were inoculated with spores of <i>B. cereus</i>, <i>B. subtilis</i> or vegetative cells of <i>S. aureus</i> before steaming (at the level of <math>10^3</math> – <math>10^5</math> cfu/g) and after steaming (at the level of <math>10^3</math> cfu/g). All samples were stored at 30°C for 7 days.</p> <p>For uninoculated samples: the heat-resistant bacteria grew rapidly and reached <math>10^5</math> cfu/g within 3 days.</p> <p>For samples inoculated before steaming: steaming reduced the population by <math>10^1</math>-<math>10^3</math> cfu/g and remained stable during the 7 days storage period. However, residual <i>B. subtilis</i> spores started to germinate rapidly and reached <math>4 \times 10^6</math> cfu/g within 3 days of storage at 30°C.</p> <p>For samples inoculated after steaming: <i>S. aureus</i> grew rapidly to reach <math>10^7</math> cfu/g in 2 days, while <i>B. cereus</i> grew slower and reached <math>10^4</math> cfu/g within 3 days and remained constant and/or increased slightly during the 7 days of storage.</p>	Okahisa et al., 2008
n.d.	China	MiGao – steamed moulded cake made of sticky rice flour, rice flour & sugar	<p>MiGao was made, steamed for 15 – 20 minutes followed by cooling for 10 minutes. Products were packed in polyethylene bags and stored at 25°C for up to five days.</p> <p>The microbiological quality of raw materials was determined on the day of receipt. The microbiological</p>	Ji et al., 2007

Year	Country	Products tested	Findings	References
			<p>analysis and sensory evaluation was carried out daily during the storage period.</p> <p>Products were tested for TVC, <i>Bacillus</i> spp, <i>Staphylococci</i>, yeast and mould, <i>Enterobacteriaceae</i> and lactic acid bacteria. At day 0, no microorganisms were detected.</p> <p>Populations of microorganisms increased over time and the product became unacceptable (in term of colour, texture and flavour) after three days of storage at room temperature. During the first three days, <i>Staphylococci</i> were the dominant group. <i>Bacillus</i> was not widely represented during the first two days of storage.</p>	
n.d.	N/A	Five types of rice cakes made of different flour: rice flour, sweet rice flour, white rice flour, tapioca flour and mung bean flour	<p>The rice cake flours were inoculated with <i>E. coli</i> O157:H7, <i>Salmonella</i> Typhimurium, <i>L. monocytogenes</i>, <i>S. aureus</i> and <i>B. cereus</i> cocktails at the level of <math>10^6</math> to <math>10^7</math> cfu/g (a worst-case scenario), then steam cooked for 30 minutes. All experiments were repeated three times and dilutions were plated in duplicate.</p> <p>All the rice cakes had pH and aw values favourable for growth of microorganisms (pH ranged from 5.4 to 6.9 and aw ranged from 0.92 to 0.99).</p> <p>Steam cooking significantly reduced (<math>&gt;10^6</math> cfu/g) non-spore forming foodborne pathogens and inactivated spores of <i>B. cereus</i> by 10 to <math>10^2</math> cfu/g. <i>B. cereus</i> spores that survived the steam cooking, germinated during 3 days of storage at room temperature, but the populations remained below <math>10^6</math> cfu/g, which was the threshold for producing toxin.</p> <p>Also, the rapid growth of mesophilic organisms by more than <math>10^7</math> to <math>10^8</math> cfu/ml during the first day of storage produced off flavours and spoilage before <i>B. cereus</i> could grow to toxin producing levels.</p> <p>Growth of organisms was inhibited when samples were stored under refrigeration, but they had unacceptable quality due to retrogradation. The authors concluded that steamed-cooked rice cakes made from a variety of flours are safe for sale up to one day after storage at room temperature and should be free of <i>B. cereus</i> toxins.</p>	Lee et al., 2006

## Appendix 2. Examples of products included in this project

Korean style



Layered



Moulded



Rice balls (mochi)



### Appendix 3. Questionnaire for manufacturer – processing information

Number of products:	
Number days of processing	
Number of units manufactured per day/week	
What happens to products after delivery? If the manufacturer collects the products back, after how many days?	

Flowchart of manufacturing processes. Focus on the following areas:

Soaking time	
Soaking temperature	
Steaming time	
Cooling time	
Post-process handling e.g. cutting/packaging	
Shelf life	



## Appendix 4. Asian sweet soup desserts

A few manufacturers also made Asian sweet soup desserts (an example of these products can be found at the bottom of this page). These products were made by cooking the ingredients in a big pot until they softened. Ingredients used may include rice, taro, corn, or beans. Some products also had a layer of coconut milk/cream on top. Even though they were not in the scope of the project, some were tested.

Six products were collected from the manufacturers and a further 23 samples were collected at retail. These products had pH that ranged from 4.7 to 8.02 (with a median of 6.53) and water activity that ranged from 0.92 to 0.98 (median of 0.96). No pathogens were detected in any of the samples, however ten of them had high SPC and one had *B. cereus* at the level of greater than 15,000 cfu/g which was considered as potentially hazardous (this product has been displayed at room temperature for 2 days at the time of the testing).

No literature was found on the processing and microbiological quality of these products. An internet search on how to make these products revealed that more than 45 minutes of cooking is required to get the desired softness and consistency, especially for the rice component. The extended cooking period should eliminate all vegetative cells and reduce the spores (if present). Using the median value for pH and water activity, it is predicted that *B. cereus* will not grow to  $10^6$  cfu/g even when the products are stored for 48 hours at 30°C (ComBase, 2016). Assumption: all the vegetative cells are killed by the cooking process.

Therefore, these products may also be stored at room temperature for one day after they are being made (day of manufacturing +1) provided:

- they are made under strict hygienic conditions to prevent post-processing contamination, and
- they are packaged into small containers as soon as possible after cooking to ensure rapid cooling. Cooling of products in large containers will result in long cooling periods during which time microorganisms can grow.







Department of  
Primary Industries  
Food Authority

6 Avenue of the Americas, Newington NSW 2127  
PO Box 6682, Silverwater NSW 1811  
T 1300 552 406  
contact@foodauthority.nsw.gov.au  
ABN 47 080 404 416

More resources at [foodauthority.nsw.gov.au](http://foodauthority.nsw.gov.au)



nswfoodauthority



nswfoodauth