

Risk Assessment Studies
Report No. 69

Microbiological Hazard Evaluation

**MICROBIOLOGICAL QUALITY OF
READY-TO-EAT FOOD SOLD BY
VENDING MACHINE**

January 2023
Centre for Food Safety
Food and Environmental Hygiene Department
The Government of the Hong Kong Special Administrative Region

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EXECUTIVE SUMMARY

Food vending machines provide a convenient way for customers to buy food. In the past, mainly prepackaged drinks and snacks within a limited range are sold by food vending machines. In recent years, there has been a boarder range of foods sold by means of a vending machine which are relatively new to the local market. These new food types sold by means of a vending machine may involve temperature control (e.g. chilling or hot holding), and/or an acceptable and simple processing including a dispensing process on site. Without proper temperature control and cleaning of processing/dispensing systems in vending machines, microbiological growth and build-up of microorganisms may occur. These can contribute to potential microbiological risk in the ready-to-eat foods sold.

As such, this study is conducted to evaluate the microbiological quality of ready-to-eat foods that are of higher risk sold by local vending machines. The mode of operation of these vending machines is also studied from a microbiological perspective.

From November 2020 to June 2021, the Centre for Food Safety (CFS) obtained a total of 120 samples of ready-to-eat food sold by means of a vending machine, including food items requiring hot holding (e.g. hot rice rolls and hot rice boxes), food items under cold keeping (e.g. custard sandwiches), fresh squeezed orange juice, beverages (e.g. coffee, milk tea and chocolate drinks), drinking water with no drinking utensil provided, and frozen desserts manufactured by the vending machine (e.g. soft ice-cream with toppings). Depending on the food types, laboratory analysis for the aerobic colony count (ACC), *Escherichia coli* count/detection of *E.*

E. coli in 100mL sample, *Bacillus cereus* count, *Clostridium perfringens* count, *Listeria monocytogenes* count, presence or absence of *Salmonella* spp. in 25g sample, and *Staphylococcus aureus* and other coagulase-positive staphylococci count, was used to reflect the hygienic quality and microbiological safety of the food samples collected from the vending machines. The rationale for including these microbiological parameters is detailed in paragraph 17-33.

Results showed that for microbiological safety, none of the 102 food samples, which the testing for specific foodborne pathogens is applicable, were detected with the foodborne pathogens tested for each food type.

For hygienic quality, none of the 120 samples were detected with *E. coli*. and all samples were satisfactory in terms of the hygienic indicator organism tested. Out of 74 samples collected where ACC assessment applies, all were satisfactory in terms of the results of ACC except eight samples of beverages with ACC at borderline levels, according to the Microbiological Guidelines for Food. ACC is an indicator of quality rather than safety so there was no food safety concern from microbiological perspectives. One of the reasons for the borderline levels of ACC in these beverage samples may be due to the quality of the ingredients used for preparation of these beverages. The borderline levels of ACC found in the beverage samples also indicated possible contamination during the production process of the beverages, e.g. during the mixing of the ingredients or dispensing of the products inside the concerned vending machines.

Participating food businesses were asked about the mode of operation of their vending machines selling ready-to-eat food from a microbiological

perspective. A questionnaire was prepared to gather information from the participating food businesses regarding the mode of operation of the vending machines. Representative(s) from each food business, e.g. the director, manager(s) or engineer(s) who was familiar with the mode of operation of the vending machines, was invited to participate in the interview. It was noted that in general food products/ingredients were properly stored (e.g. prepackaged or in covered containers) to prevent microbial contamination. Food products/ingredients which require temperature control were also stored at safe temperatures (i.e. at or below 4°C for cold food, and above 60°C for hot food) during transportation and storage in the vending machines. Food products/ingredients were also replenished regularly before the end of shelf life. There were regular checking and maintenance on the functioning of the vending machines to ensure that any control measures of the vending machines for the microbiological quality of the food products sold were functioning normally.

The vending machines and also the food contact surfaces inside were cleaned regularly to prevent microbial growth and build-up of microorganisms. However, for vending machines selling beverages which were cleaned by flowing hot water of around 90-95°C through the dispensing tubes of the ingredients daily, there was no recording system on the hot water temperature to verify if it was at the correct temperature range during the cleaning programme.

Conclusion

There was no microbiological food safety concern on the parameters tested except that eight samples had borderline levels of ACC which is an

indicator of quality rather than safety. The quality of raw materials and hygienic conditions of the vending machines (especially the surfaces in contact with the food ingredients or food products) may lead to the microbiological quality of these beverage samples. Food businesses should handle the ingredients in a hygienic manner during the replenishment of stock to avoid microbial contamination during the handling process. They should consider installing a recording system on the parameters during the cleaning programme (e.g. the temperature of hot water for cleaning dispensing tubes in beverage vending machines) to verify that they are performed according to the pre-set values and rectify any deviation as soon as possible. They should also review their cleaning programmes of the vending machines to ensure that the settings and cleaning agents used are effective to clean the machines to prevent microbial growth especially on the food contact surfaces which may contaminate the food products. As ready-to-eat food sold by means of a vending machine is a relatively new food business in Hong Kong and have become more popular only since a few years ago, it is expected that the vending machines operating in the local market should be generally new and operating in relatively good conditions. Food businesses should pay attention that regular checking, maintenance and replacement of vending machine parts are important, especially when the vending machines continue operating in the market for longer time.

Advice to Public

- Check whether the vending machines have the licence/endorsement for the sale of the ready-to-eat food before purchase.
- Consume the ready-to-eat food bought from vending machines as soon as possible.

Advice to Trade

- Purchase food products/ingredients from approved and reliable suppliers. The food products/ingredients should be in fresh and wholesome state and checked of good quality at the time of receiving, e.g. the packaging is intact with no signs of contamination or damage to the food products/ingredients.
- Store the food products/ingredients which require temperature control at appropriate temperatures, e.g. above 60°C for hot food and at 4°C or below for cold food, during transport in vehicles and storage in vending machines.
- Keep track of the shelf life of food products/ingredients in vending machines. Remove the remaining stock of food products/ingredients and replace with fresh ones before the expiry of the shelf life.
- The ingredients should be refilled to the vending machines in a hygienic manner to prevent any microbial contamination during the handling process.
- Replenish the food products/ingredients as soon as possible to prevent prolonged storage at room temperature, especially for the food products/ingredients which require temperature control.
- Clean vending machines regularly, including the food take out port, outer and inner surfaces and any food contact surfaces.
- Verify that any cleaning-in-place (CIP) system is operated as intended and all target set points were met during the operation: cleaning time, temperature, flow rate, concentrations of cleaning solutions
- Depending on the food types sold and the instructions of the manufacturers of the vending machine, use appropriate detergent in the CIP process and also perform sterilisation-in-place with sanitiser or disinfectant after the CIP process to reduce the load of microorganisms on the food contact surfaces.

- Validate that the CIP system effectively cleaned the vending machines at periodic intervals, e.g. by visual observations at inspection access points and testing of final rinse water.
- Record the findings of the verification and validation process to keep track of the evidence that the cleaning and sanitising activities were completed as intended and are effective.
- Continually monitor the vending machines, e.g. by using computer-controlled monitoring system, during their operation and follow up any system alerts on operational problems as soon as possible. Review the operational records regularly to ensure that the vending machines are functioning normally.
- Keep records of any other control measures for the possible food safety problems during the operation (e.g. the transport and storage of food products/ingredients, and preparation of food products). Conduct systematic check of the records periodically to determine areas requiring attention and improvement.
- Carry out maintenance of the vending machines regularly according to the instructions of the manufacturers of the vending machines.
- Establish Standard Operating Procedures (SOP) on the CIP systems and provide relevant training and regular refresher courses to the operators, so that they well understand the operational requirements and perform the cleaning programme properly.

Microbiological Quality of Ready-to-eat Food Sold by Vending Machine

OBJECTIVES

The purpose of the study is to assess the microbiological quality of ready-to-eat foods that are of higher risk sold by local vending machines, and provide an overview from a microbiological perspective on their mode of operation.

INTRODUCTION

2. Food vending machines provide a convenient way for customers to buy food. In the past, mainly prepackaged drinks and snacks within a limited range are sold by food vending machines. In recent years, there has been a boarder range of foods, including those requiring hot holding or under cold keeping, available. In addition, some vending machines may also involve an acceptable and simple processing, such as freezing of ice cream ingredients, and cutting and juicing of fruit. These food types sold by means of a vending machine are relatively new to the local market.

3. “Food sold by means of a vending machine” is one of the restricted foods under the Food Business Regulation, Cap. 132X. The regulation stipulates that except with the permission in writing of the Director of Food and Environmental Hygiene, no person shall sell any restricted foods. At present, there are mainly several food types sold by means of a vending machine with such permit locally, including prepackaged ready-to-eat food

requiring hot holding (e.g. hot rice rolls and hot rice boxes) or under cold keeping (e.g. custard sandwiches), fresh squeezed orange juice, beverages (e.g. coffee, milk tea and chocolate drinks), and drinking water with no drinking utensil provided. On the other hand, for certain food types such as the manufacture of frozen desserts (e.g. soft ice cream with toppings) sold by means of a vending machine, a frozen confection factory licence is required. That said, each case has to be assessed on its own merit.

4. The aforementioned new food types sold by means of a vending machine may involve temperature control (e.g. freezing, chilling or hot holding), and/or an acceptable and simple processing including a dispensing process on site. Without proper temperature control and cleaning of processing/dispensing systems in vending machines, microbiological growth or build-up of microorganisms may occur during the storage of food products/food ingredients before delivery, during transport to the vending machines, and re-filling, storage, processing and/or dispensing of food products/food ingredients inside the vending machines. These can contribute to potential microbiological risk in the ready-to-eat foods sold.

5. Recently, certain food samples sold by vending machines were reportedly found unsatisfactory in terms of microbiological quality in a media report, with reference to the Microbiological Guidelines for Food (the Guidelines)¹ issued by the Centre for Food Safety (CFS). The media report also questioned the hygiene and temperature control of the concerned vending machines. This may highlight potential microbiological risk of vending machines selling foods that are of higher risk, e.g. food items requiring temperature control and/or those involving an acceptable and simple processing, including a dispensing process, on

site.

6. As such, this study is conducted to evaluate the microbiological quality of ready-to-eat foods that are of higher risk sold by local vending machines. The mode of operation of these vending machines is also studied from a microbiological perspective.

SCOPE OF STUDY

7. This study aims to provide local data for the recommendations related to the microbiological quality of ready-to-eat foods sold by means of a vending machine.

8. The study involves: (i) microbiological analysis of ready-to-eat foods that are of higher risk sold by local vending machines, and (ii) analysis of the mode of operation of the vending machines from a microbiological perspective. In general, these food items are those requiring temperature control and/or those involving an acceptable and simple processing, including a dispensing process, on site.

9. Based on the types of food sold by means of a vending machine in Hong Kong, six main types of ready-to-eat foods are covered in this study:

- (i) food items requiring hot holding (e.g. hot rice rolls and hot rice boxes);
- (ii) food items under cold keeping (e.g. custard sandwiches);
- (iii) fresh squeezed orange juice;
- (iv) beverages (e.g. coffee, milk tea and chocolate drinks);
- (v) drinking water with no drinking utensil provided; and
- (vi) frozen desserts manufactured by the vending machine (e.g. soft

ice-cream with toppings).

10. In addition, food businesses selling the six types of ready-to-eat food by means of a vending machine covered in this study were visited and asked about the mode of operation of the vending machines in respect of the microbiological quality of the food sold.

METHODOLOGY

Sampling

11. The sampling was conducted from November 2020 to June 2021 and carried out by health inspectors of the Food and Environmental Hygiene Department (FEHD).

12. Samples of ready-to-eat foods sold by means of a vending machine were collected in pairs, i.e. two samples of the same food type were collected from the same vending machine at two different time points (e.g. in the morning and in the afternoon) on different days to compare the microbiological quality. The following types of food were covered:

- (i) food items requiring hot holding (e.g. hot rice rolls and hot rice boxes);
- (ii) food items under cold keeping (e.g. custard sandwiches);
- (iii) fresh squeezed orange juice;
- (iv) beverages (e.g. coffee, milk tea and chocolate drinks);
- (v) drinking water with no drinking utensil provided; and
- (vi) frozen desserts manufactured by the vending machine (e.g. soft ice-cream with toppings).

One pair of food samples was collected from each vending machine, except

for hot rice boxes and frozen desserts from a vending machine in the New Territories (more than one pair of samples were taken from the vending machine, due to the limited numbers of different vending machines available in the region for these food types). A total of 60 pairs of food samples were collected from 57 vending machines.

13. The distribution of collected samples is outlined in Table 1.

Table 1: Sampling distribution in different regions

Food type		Number of pairs of samples taken			
		Hong Kong	Kowloon	New Territories	Total
Food items requiring hot holding	Hot rice boxes	2	2	2	6
	Hot rice rolls	3	3	3	9
Food items under cold keeping	Custard sandwiches	N/A	N/A	1	1
Fresh squeezed orange juice		3	5	6	14
Beverages		5	6	7	18
Drinking water with no drinking utensil provided		3	3	3	9
Frozen desserts manufactured by the vending machine		N/A	N/A	3	3
Total		16	19	25	60

Remarks:

N/A = not applicable, i.e. the vending machine selling the food type is not available in the region indicated.

Laboratory analysis

14. For the microbiological analysis, all samples were stored at 4°C or below during transport and delivered to the laboratory of the contractor commissioned by the CFS to provide the microbiological testing services, within four hours of sampling as far as possible. In case any samples cannot be delivered within four hours of sampling, they were stored in the refrigerator at 4°C and delivered to the laboratory on the next morning as soon as possible. Depending on the food types, aerobic colony count (ACC), *Escherichia coli* count/detection of *E. coli* in 100mL sample, *Bacillus cereus* count, *Clostridium perfringens* count, *Listeria monocytogenes* count, presence or absence of *Salmonella* spp. in 25g sample, and *Staphylococcus aureus* and other coagulase-positive staphylococci count (*S. aureus* count), were used to reflect the microbiological quality and safety of the food samples collected from the vending machines. Details of the microbiological criteria analysed for each food type covered in this study are outlined in Table 2.

Table 2: Microbiological criteria analysed for ready-to-eat food samples collected from the vending machines

Food type	Microbiological criteria
Food items requiring hot holding	<ol style="list-style-type: none"> 1. ACC 2. <i>E. coli</i> count 3. <i>B. cereus</i> count 4. <i>C. perfringens</i> count 5. <i>L. monocytogenes</i> count 6. Presence or absence of <i>Salmonella</i> spp. in 25g sample 7. <i>S. aureus</i> count
Food items under cold keeping	<ol style="list-style-type: none"> 1. ACC 2. <i>E. coli</i> count 3. <i>B. cereus</i> count 4. <i>C. perfringens</i> count 5. <i>L. monocytogenes</i> count

	<ol style="list-style-type: none"> 6. Presence or absence of <i>Salmonella</i> spp. in 25g sample 7. <i>S. aureus</i> count
Fresh squeezed orange juice	<ol style="list-style-type: none"> 1. <i>E. coli</i> count 2. <i>C. perfringens</i> count 3. <i>L. monocytogenes</i> count 4. <i>S. aureus</i> count 5. Presence or absence of <i>Salmonella</i> spp. in 25g sample
Beverages	<ol style="list-style-type: none"> 1. ACC 2. <i>E. coli</i> count 3. <i>C. perfringens</i> count 4. Presence or absence of <i>Salmonella</i> spp. in 25g sample 5. <i>S. aureus</i> count
Drinking water with no drinking utensil provided	<ol style="list-style-type: none"> 1. Detection of <i>E. coli</i> in 100mL sample
Frozen desserts manufactured by the vending machine	<ol style="list-style-type: none"> 1. ACC 2. <i>E. coli</i> count 3. <i>L. monocytogenes</i> count 4. Presence or absence of <i>Salmonella</i> spp. in 25g sample

15. The enumeration of ACC in samples was performed according to the method described in the FDA, Bacteriological Analytical Manual (BAM) Online, Chapter 3, Aerobic Plate Count, January 2001 (incubation at 30°C for 48 hours). The enumeration of *E. coli* in food items requiring hot holding, food items under cold keeping, fresh squeezed orange juice, beverages and frozen desserts manufactured by the vending machine samples was conducted using the AOAC Official Method 991.14 (2005) (Dry Rehydratable Film Method). The detection of *E. coli* in drinking water samples was conducted by the method described in the DoE (1983) The Bacteriological Examination of Drinking Water Supplies, 1982 Sections 7.8 and 7.9 (Membrane Filtration Procedure: Section 7.8, 7.9.4.2;

Bacterial Confirmation: Section 7.9.4.4 and Urease Test: Appl. Environ. Microbiol. 29, p826-833). The enumeration of *B. cereus* was performed based on the method described in FDA, BAM, Chapter 14, *Bacillus cereus*, January 2012. The enumeration of *C. perfringens* was based on the method described in the ISO 7937:2004 Horizontal Method for the Enumeration of *Clostridium perfringens* -- Colony-count Technique. The enumeration of *L. monocytogenes* was performed according to the method described in the FDA, BAM Online, March 2017, Chapter 10, Detection of *Listeria monocytogenes* in Foods and Environmental Samples, and Enumeration of *Listeria monocytogenes* in Foods. The detection of *Salmonella* spp. was performed based on the method described in FDA BAM, Chapter 5, *Salmonella*, December 2007. *S. aureus* count was enumerated according to the method described in AFNOR validated method in comparison to ISO 6888-1 (3M-01/9-04/03A) and ISO 6888-2 (3M-01/9-03/04B).

Interview on the mode of operation of vending machines selling ready-to-eat foods

16. The participating food businesses were asked about the mode of operation of their vending machines selling ready-to-eat food from a microbiological perspective. A questionnaire was prepared to gather information from the participating food businesses regarding the mode of operation of the vending machines. This includes the storage of food products/ingredients in the vending machines, monitoring of the operation, replenishment of stock, transport and handling of food products/ingredients, and cleaning and maintenance of the vending machines. Several food businesses with the permit to sell food by means of vending machine or other relevant permit/licence were invited to

participate in the interview, with at least one food business covering each food type sold by means of a vending machine in the local market. Representative(s) from each food business, e.g. the director, manager(s) or engineer(s) who was familiar with the mode of operation of the vending machines, was invited to participate in the interview.

Result analysis

17. Results were analysed by the researcher of the CFS. The hygienic quality and microbiological safety were assessed in accordance with the Guidelines, and the World Health Organization (WHO) Guidelines for drinking-water quality, 4th edition.²

Hygienic quality - ACC and E. coli

18. ACC is the total number of bacteria found in food. It includes those naturally occurring and those as a result of contamination. ACC is an indicator of quality but not safety. The level of ACC in food depends on the type and duration of processing that the food has received during production as well as how the food is handled and stored thereafter.³

19. However, ACC is not applicable to fresh fruit or vegetables, where raw ingredients like fresh fruit or vegetables are expected to contain microorganisms present from the environment; ACC is likely to be high. As such, this criterion is not applied to fresh squeezed orange juice samples containing fresh fruit ingredients.¹

20. *E. coli* is a bacterium commonly found in the gastrointestinal tract of humans and warm-blooded animals. It is commonly used as an

indicator organism to reflect the hygienic quality of food. Its presence in food generally indicates direct or indirect faecal contamination. In general, substantial number of the bacterium in food suggests a general lack of cleanliness in handling and improper storage.¹

21. The ACC and *E. coli* results were assessed against the criteria listed in Table 3. These criteria were extracted from the Guidelines, and WHO Guidelines for drinking-water quality, 4th edition.

Microbiological safety – Foodborne pathogens – B. cereus, C. perfringens, L. monocytogenes, Salmonella spp., and S. aureus and other coagulase-positive staphylococci

➤ *B. cereus*

22. *B. cereus* is spore-forming and ubiquitous in the environment. It is readily isolated from soil, cereal crops, and vegetables, etc. It can cause two types of food poisoning known as emetic (cause vomiting) and diarrhoeal food poisoning, caused by different toxins. Emetic food poisoning is caused by a heat-stable toxin pre-formed in food. It is often associated with starchy food such as rice, especially when rice is kept improperly under room temperature for a prolonged period of time⁴. Therefore, *B. cereus* was included as a parameter for samples of hot rice rolls and hot rice boxes under the category of food items requiring hot holding.

23. *B. cereus* was also tested in custard sandwiches under the category of food items under cold keeping. Even most microorganisms are destroyed when the sandwich fillings are thoroughly cooked, some *B. cereus* spores may survive cooking. Prolonged storage of sandwiches

under room temperature may allow the microorganisms to grow and spores to germinate, multiply and may even produce the heat-stable toxin.

➤ *C. perfringens*

24. *C. perfringens* is widely distributed in the environment and frequently found in intestines of both humans and animals, hence is likely to be present in foods of an animal origin and vegetables exposed to soil, dust or faecal materials. In food poisoning caused by *C. perfringens*, common symptoms include sudden abdominal pain, nausea and diarrhoea. Cooking heat can activate the germination of *C. perfringens* spores, which survive in anaerobic conditions like inside internal cavities, rolls of meat, stuffed poultry, or gravies. The organism can then multiply in the area where the oxygen level is low. Cooling of food at ambient temperature for a long period also allows rapid multiplication of the bacterium. Hence, foods prepared in bulk, especially cooked meat, poultry dishes, juice and sandwich fillings, which are stored at ambient temperature with a long cooling period after cooking are at high risk. Therefore, *C. perfringens* was tested in hot rice rolls and hot rice boxes under the category of food items requiring hot holding, and also custard sandwiches under the category of food items under cold keeping.

25. On the other hand, *C. perfringens* is included in licensing conditions for non-bottled drinks. *C. perfringens* was therefore also tested in fresh squeezed orange juice and beverages.

➤ *L. monocytogenes*

26. *L. monocytogenes* is universally found in the environment

including in soil and vegetation. Therefore, raw fruit juice is considered as one of the foods having a higher risk of *Listeria* contamination.⁵ Cooked ready-to-eat foods such as pasta and rice dishes were also detected with *L. monocytogenes* in other overseas studies.⁶ Therefore *L. monocytogenes* was included in the evaluation of the microbiological safety of fresh squeezed orange juice samples, and also samples of hot rice rolls and hot rice boxes under the category of food items requiring hot holding.

27. *L. monocytogenes* can be killed under normal cooking temperature. For frozen desserts such as soft ice-cream with toppings, ultra heat treatment of the ice-cream fillings can destroy the pathogens that pose risk to public health. However, potential microbiological hazards can still be introduced to the final products after the heat treatment through adding contaminated ingredients and improper handling procedures. This is especially important in the preparation of soft ice-cream with toppings as its final stage of the production is carried out at the point of sale. Moreover, *L. monocytogenes* can survive in food even at low temperature. Therefore, *L. monocytogenes* was analysed for the microbiological safety of soft ice-cream with toppings under the category of frozen desserts manufactured by the vending machine.

28. Unlike other food-poisoning bacteria, *L. monocytogenes* can grow slowly at refrigerated temperature as low as 0°C. Therefore, *L. monocytogenes* was analysed in custard sandwiches under the category of food items under cold holding, as they have been refrigerated with a relatively longer shelf life and therefore are of higher risk.

➤ *Salmonella* spp., and *S. aureus*

29. *Salmonella* spp., and *S. aureus* are pathogenic bacteria that may cause food poisoning.

30. *Salmonella* is widely dispersed in nature. It can colonize the intestinal tracts of vertebrates, including livestock, wildlife, domestic pets, and humans, and may also live in the environment such as pond-water sediment. Human infection by *Salmonella* is spread through the faecal-oral route and contact with contaminated water.

31. *S. aureus* is a bacterium which is commonly present in human nasal passage, throat, hair and skin without causing any discomfort. Staphylococci may be present in large numbers in inflamed lesions, and skin infections such as pimples and acne. *S. aureus* can be passed from food handlers to foods. Foods that require considerable handling during processing but without subsequent cooking and are stored at ambient temperature for a prolonged period of time may allow the toxin-producing Staphylococci multiply and elaborate toxins which cause illness.

32. *Salmonella* spp. and *S. aureus* are among the common food poisoning microorganisms in Hong Kong. They were also included in the licensing conditions for non-bottled drinks such as fresh squeezed orange juice and beverages. Therefore, they were used to evaluate the microbiological safety of samples including food items requiring hot holding or under cold keeping, fresh squeezed orange juice, beverages and frozen desserts manufactured by the vending machine in this study.

33. The results of ACC, *E. coli*, *B. cereus*, *C. perfringens*, *L. monocytogenes*, *Salmonella* spp., and *S. aureus* and other coagulase-

positive staphylococci were assessed against the criteria listed in Table 3. These criteria were extracted from the Guidelines, and WHO Guidelines for drinking-water quality, 4th edition.

Table 3. Criteria for ACC, *E. coli*, *B. cereus*, *C. perfringens*, *L. monocytogenes*, *Salmonella* spp., and *S. aureus* and other coagulase-positive staphylococci used in this study

For (a) Food items requiring hot holding

1. *Microbiological criteria for ready-to-eat food in general, specified in the Guidelines*

Criterion	Microbiological quality		
	Result (colony-forming unit (cfu)/g) unless specified		
	Satisfactory	Borderline	Unsatisfactory
ACC [30°C /48 hours]			
Food category 3. Cooked foods chilled but with minimum handling prior to sale or consumption; canned pasteurised foods requiring refrigeration†	<10 ⁴	10 ⁴ -<10 ⁷	≥10 ⁷
Hygiene indicator organism			
<i>E. coli</i>	<20	20 - ≤10 ²	>10 ²
Specific foodborne pathogens			
<i>B. cereus</i>	< 10 ³	10 ³ - ≤ 10 ⁵	> 10 ⁵
<i>C. perfringens</i>	< 10	10 - ≤ 10 ⁴	> 10 ⁴
<i>L. monocytogenes</i>	< 10	10 - ≤ 100	> 100
<i>Salmonella</i> spp.	Not detected in 25g	N/A	Detected in 25g
<i>S. aureus</i> and other coagulase-positive	< 20	20 - ≤ 10 ⁴	> 10 ⁴

Criterion	Microbiological quality		
	Result (colony-forming unit (cfu)/g) unless specified		
	Satisfactory	Borderline	Unsatisfactory
staphylococci			

Remarks:

- Categorisation when assessing the ACC results for the purpose of this study -
 - † Samples of food items requiring hot holding, i.e. hot rice rolls and hot rice boxes, were grouped under Food category 3.
- N/A = not applicable
- Limit of reporting:
 - ACC: 10 cfu/g
 - Enumeration of *E. coli*: 10 cfu/g
 - Enumeration of *B. cereus*: 100 cfu/g
 - Enumeration of *C. perfringens*: 10 cfu/g
 - Enumeration of *L. monocytogenes*: 10 cfu/g
 - Detection of *Salmonella* spp.: Detected / not detected per 25g
 - Enumeration of *S. aureus* and other coagulase-positive staphylococci: 10 cfu/g

For (b) Food items under cold keeping

1. *Microbiological criteria for ready-to-eat food in general, specified in the Guidelines*

Criterion	Microbiological quality		
	Result (colony-forming unit (cfu)/g) unless specified		
	Satisfactory	Borderline	Unsatisfactory
ACC [30°C /48 hours]			
Food category 6. Non-fermented dairy products and dairy desserts, mayonnaise and mayonnaise based dressings, cooked sauces§	<10 ⁵	10 ⁵ -<10 ⁷	≥10 ⁷
Hygiene indicator organism			
<i>E. coli</i>	<20	20 - ≤10 ²	>10 ²
Specific foodborne pathogens			
<i>B. cereus</i>	< 10 ³	10 ³ - ≤ 10 ⁵	> 10 ⁵
<i>C. perfringens</i>	< 10	10 - ≤ 10 ⁴	> 10 ⁴

Criterion	Microbiological quality		
	Result (colony-forming unit (cfu)/g) unless specified		
	Satisfactory	Borderline	Unsatisfactory
<i>L. monocytogenes</i>	< 10	10 - ≤ 100	> 100
<i>Salmonella spp.</i>	Not detected in 25g	N/A	Detected in 25g
<i>S. aureus</i> and other coagulase-positive staphylococci	< 20	20 - ≤ 10 ⁴	> 10 ⁴

Remarks:

- Categorisation when assessing the ACC results for the purpose of this study -
 - § Samples of food items under cold keeping, i.e. custard sandwiches, were grouped under Food category 6
- N/A = not applicable
- Limit of reporting:
 - ACC: 10 cfu/g
 - Enumeration of *E. coli*: 10 cfu/g
 - Enumeration of *B. cereus*: 100 cfu/g
 - Enumeration of *C. perfringens*: 10 cfu/g
 - Enumeration of *L. monocytogenes*: 10 cfu/g
 - Detection of *Salmonella spp.*: Detected / not detected per 25g
 - Enumeration of *S. aureus* and other coagulase-positive staphylococci: 10 cfu/g

For (c) Fresh squeezed orange juice

1. *Microbiological criteria for ready-to-eat food in general, specified in the Guidelines*

Criterion	Microbiological quality		
	Result (colony-forming unit (cfu)/g)		
	Satisfactory	Borderline	Unsatisfactory
ACC [30°C /48 hours]			
Food category 12. Fresh fruit and vegetables, products containing raw vegetables*	N/A	N/A	N/A
Specific foodborne pathogen			
<i>L. monocytogenes</i>	< 10	10 - ≤ 100	> 100

Remarks:

- Categorisation when assessing the ACC results for the purpose of this study -
 - * Fresh squeezed orange juice samples were grouped under Food category 12 where ACC assessment is not applicable.

- N/A = not applicable
- Limit of reporting:
 - Enumeration of *L. monocytogenes*: 10 cfu/ml

2. *Microbiological criteria for specific food items, i.e. non-bottled drinks, specified in the Guidelines*

Parameters	Limits
<i>E. coli</i>	< 100 cfu/ml
<i>Salmonella</i> spp.	Not detected in 25ml
<i>S. aureus</i>	< 100 cfu/ml
<i>C. perfringens</i>	< 100 cfu/ml

Remarks:

- These are microbiological criteria which are included in the licensing condition for non-bottled drinks.
- Limit of reporting:
 - Enumeration of *E. coli*: 10 cfu/ml
 - Detection of *Salmonella* spp.: Detected / not detected per 25ml
 - Enumeration of *S. aureus* and other coagulase-positive staphylococci: 10 cfu/ml
 - Enumeration of *C. perfringens*: 10 cfu/ml

For (d) Beverages

1. *Microbiological criteria for ready-to-eat food in general, specified in the Guidelines*

Criterion	Microbiological quality Result (colony-forming unit (cfu)/g)		
	Satisfactory	Borderline	Unsatisfactory
ACC [30°C /48 hours]			
Food category 4. Bakery and confectionery products without dairy cream, powdered foods‡	<10 ⁴	10 ⁴ -<10 ⁶	≥10 ⁶

Remarks:

- Categorisation when assessing the ACC results for the purpose of this study -
 - ‡ Beverage samples, i.e. coffee, milk tea and chocolate drinks, were grouped under Food category 4.
- Limit of Reporting:
 - ACC: 10 cfu/ml

2. *Microbiological criteria for specific food items, i.e. non-bottled drinks, specified in the Guidelines*

Parameters	Limits
<i>E. coli</i>	< 100 cfu/ml
<i>Salmonella</i> spp.	Not detected in 25ml
<i>S. aureus</i>	< 100 cfu/ml
<i>C. perfringens</i>	< 100 cfu/ml

Remarks:

- These are microbiological criteria which are included in the licensing condition for non-bottled drinks.
- Limit of Reporting:
 - Enumeration of *E. coli*: 10 cfu/ml
 - Detection of *Salmonella* spp.: Detected / not detected per 25ml
 - Enumeration of *S. aureus* and other coagulase-positive staphylococci: 10 cfu/ml
 - Enumeration of *C. perfringens*: 10 cfu/ml

For (e) Drinking water with no drinking utensil provided

1. *Guideline values for verification of the microbial quality of drinking-water, specified in the WHO Guidelines for drinking-water quality, 4th edition*

Organisms	Guideline value
<i>E. coli</i> or thermotolerant coliform bacteria in all water directly intended for drinking	Must not be detectable in any 100ml sample

Remarks:

- Limit of Reporting:
 - Detection of *E. coli*: 1 cfu / 100ml

For (f) Frozen desserts manufactured by the vending machine

1. *Microbiological criteria for ready-to-eat food in general, specified in the Guidelines*

Criterion	Microbiological quality		
	Result (colony-forming unit (cfu)/g) unless specified		
	Satisfactory	Borderline	Unsatisfactory
ACC [30°C /48 hours]			
Food category 6. Non-fermented dairy products and dairy desserts, mayonnaise and mayonnaise based dressings, cooked sauces§	<10 ⁵	10 ⁵ -<10 ⁷	≥10 ⁷
Hygiene indicator organism			
<i>E. coli</i>	<20	20 - ≤10 ²	>10 ²
Specific foodborne pathogens			
<i>L. monocytogenes</i>	< 10	10 - ≤ 100	> 100
<i>Salmonella</i> spp.	Not detected in 25g	N/A	Detected in 25g

Remarks:

- Categorisation when assessing the ACC results for the purpose of this study -
§ Samples of frozen desserts manufactured by the vending machine, i.e. soft ice-cream with toppings, were grouped under Food category 6
- N/A = not applicable
- Limit of reporting:
 - ACC: 10 cfu/g
 - Enumeration of *E. coli*: 10 cfu/g
 - Enumeration of *L. monocytogenes*: 10 cfu/g
 - Detection of *Salmonella* spp.: Detected / not detected per 25g

RESULTS

Hygienic quality – ACC and *E.coli* count

34. For hygienic quality, out of 74 samples (i.e. 37 pairs) of food items requiring hot holding (i.e. hot rice rolls and hot rice boxes), food items under cold keeping (i.e. custard sandwiches), beverages (i.e. coffee, milk tea and chocolate drinks), and frozen desserts manufactured by the vending machine (i.e. soft ice-cream with toppings) collected where ACC

assessment applies, all were satisfactory in terms of the results of ACC except eight samples of beverages with ACC at borderline levels, with details outlined in Table 4. For all 120 (i.e. 60 pairs) of samples of ready-to-eat food items collected with *E. coli* count tested, none of the samples were detected with *E. coli*. Therefore, all samples were satisfactory in terms of the hygienic indicator organism tested, according to the Guidelines.

Table 4. Summary on ACC of ready-to-eat food samples with borderline results

Vending machine no.	Company	Food item purchased	Prepared hot or cold	Time collected (a.m./p.m.)§	Cleaning time of vending machines†	ACC (cfu/ml)
1	A	Chocolate drink	Hot	Day #1 a.m.	5:00-6:00 a.m. daily	180,000
1	A	Chocolate drink	Hot	Day #2 p.m.	5:00-6:00 a.m. daily	99,000
2*	B	Chocolate drink	Cold	Day #2 a.m.	11:00 p.m.-12:00 a.m. daily	86,000
3	B	Cappuccino (with milk and sugar)	Cold	Day #1 p.m.	11:00 p.m.-12:00 a.m. daily	52,000
3	B	Cappuccino (with milk and sugar)	Cold	Day #2 a.m.	11:00 p.m.-12:00 a.m. daily	32,000
4	C	Milk tea (with sugar)	Cold	Day #1 a.m.		21,000
4	C	Milk tea (with sugar)	Cold	Day #2 p.m.		42,000
5**	C	Milk tea (with sugar)	Cold	Day #1 p.m.		66,000

§ Day #1 is an earlier date than day #2.

†If the company participated in the interview so that the information on the cleaning time is available.

* Another cold chocolate drink sample was collected from vending machine no. 2 on day #1 p.m. and the level of ACC was 4800, i.e. satisfactory according to the Guidelines.

** Another cold milk tea (with sugar) sample was collected from vending machine no. 5 on day #2 a.m. and ACC was not detected, i.e. satisfactory according to the Guidelines.

Microbiological safety

35. For microbiological safety, all 102 (i.e. 51 pairs) of collected samples including food items requiring hot holding (i.e. hot rice rolls and hot rice boxes), food items under cold holding (i.e. custard sandwiches), fresh squeezed orange juice, beverages (i.e. coffee, milk tea and chocolate drinks), and frozen desserts manufactured by the vending machine (i.e. soft ice-cream with toppings) where testing for foodborne pathogens is applicable, none of the samples were detected with the specific foodborne pathogens tested, i.e. *B. cereus*, *C. perfringens*, *L. monocytogenes*, *Salmonella* spp., and/or *S. aureus* and other coagulase-positive staphylococci depending on the food type, as stated in Table 2 above. Therefore all these samples were satisfactory in terms of the specific foodborne pathogens tested.

Interview on the mode of operation of vending machines selling ready-to-eat food

36. The participating food businesses were asked about the mode of operation of their vending machines selling ready-to-eat food from a microbiological perspective. Some of key findings are summarised in Table 5.

Food items requiring hot holding (e.g. hot rice rolls and hot rice boxes)

37. It was noted that each hot rice roll was prepackaged in vacuum packaging and placed in a paper carton, while each hot meal was packed in a lunch box before transportation. These helped prevent microbial contamination of the food products from the outside environment during transportation and storage inside the vending machines.

38. The participating food businesses also stored the hot rice rolls and hot rice boxes at safe temperatures during transportation and storage in the vending machines to prevent rapid multiplication of microorganisms. After production, the hot rice rolls and hot rice boxes were transferred to thermal boxes and kept above 60°C, and then the thermal boxes with the food products were transported to the vending machines. After arrival at the vending machine, the hot rice rolls and hot rice boxes were loaded into the vending machines and stored inside also above 60°C. There were monitoring systems for the food storage temperatures inside the vending machines. The systems would suspend the food sale and notify the food businesses for checking and repairing of the concerned vending machine as soon as possible when the food storage temperature was below the temperature of 60°C.

39. It was noted that apart from the product turnover rate, the participating food businesses also took into consideration of the shelf life of the hot rice rolls and hot rice boxes and would replenish the stock before the shelf life of the food products ended. For both hot rice rolls and hot rice boxes, the participating food businesses replenished the stock once per day. For hot rice rolls the stock was replenished either early in the

morning or late in the afternoon, while for hot rice boxes the remaining stock was removed after lunch hour and new stock was replenished just before lunch hour the next day.

40. For vending machines selling hot rice boxes, the participating food business required their staff to wear gloves when stocking food products in the vending machines. For vending machines selling hot rice rolls, wearing gloves was not required by the participating food business when stocking food products in the vending machines as each hot rice roll had already been packed in another layer of paper carton in addition to the vacuum packaging beforehand.

41. Wearing gloves was required during the cleaning of the vending machines selling hot rice rolls and hot rice boxes. For vending machines selling hot rice rolls, the food storage area, food take-out port and outer surfaces of the vending machines were cleaned with sanitiser every day. There were doors sealing the inner surfaces from the outside environment in each vending machine and these doors and inner surfaces were cleaned with sanitiser once or twice a week. For vending machines selling hot rice boxes, the food take-out port, inner surfaces of the vending machine, food storage area and conveyor belts in contact with the rice boxes were cleaned with disinfectant every day. The outer surfaces of the vending machine were also cleaned with 1:99 diluted household bleach daily.

42. There were regular checking and maintenance on the functioning of the vending machines selling hot rice rolls and hot rice boxes, which is important to ensure that any control measures of the vending machines for the microbiological quality of the products sold were functioning normally.

Food items under cold keeping (e.g. custard sandwiches)

43. The custard sandwiches were prepackaged in plastic packaging to prevent microbial contamination from the outside environment during transportation and storage inside the vending machines.

44. The custard sandwiches were also kept at safe temperatures during transportation and storage in the vending machines to prevent rapid multiplication of microorganisms. They were frozen at -18°C and transported in cool boxes with dry ice, and then stored at or below 4°C inside the vending machines. There was a monitoring system for the food storage temperatures inside the vending machines. The system would suspend the food sale and notify the food business for checking and repairing of the concerned vending machine as soon as possible when the food storage temperature was above 4°C .

45. It was noted that the participating food business kept stock of the shelf life of the custard sandwiches and replenished the stock once per week before the shelf life of the food products ended, in a first-in first out basis. The participating food business required their staff to wear gloves when stocking the custard sandwiches in the vending machines.

46. Wearing gloves was also required during the cleaning of the vending machines selling custard sandwiches. The food take-out port, inner surfaces of the vending machine, food storage area and conveyor belts in contact with the food products were cleaned with disinfectant weekly. The outer surfaces of the vending machine were also cleaned with 1:99 diluted household bleach weekly.

47. There were regular checking and maintenance on the functioning of the vending machine selling custard sandwiches, which is important to ensure that any control measures of the vending machine for the microbiological quality of the products sold were functioning normally.

Fresh squeezed orange juice

48. It was noted that whole oranges stored in the vending machines selling fresh squeezed orange juice had been previously washed and properly dried before being transported and then loaded into the vending machines to prevent microbial contamination from the orange surfaces to the fruit juice during juicing.

49. The whole oranges loaded into the vending machines were stored at 0-3°C. There was a monitoring system for the temperatures inside the vending machines. The system would suspend the food sale and notify the food business for checking and repairing of the concerned vending machine as soon as possible when the temperature was above 7°C inside vending machines placed indoor or 9°C inside vending machines placed outdoor, or when the temperature of the processing area for cutting oranges was above 3°C.

50. There was a detecting system inside the vending machines to avoid filling to much orange juice into a paper cup for serving. The food sale from the vending machines would also be suspended when the waste water tank inside was full. This would avoid the overflowing of the orange juice or waste water which may allow microbiological growth or build-up of microorganisms inside the vending machines.

51. It was noted that apart from the product turnover rate, the participating food business also took into consideration of the shelf life of the oranges and would replenish the stock before the shelf life ended. Oranges inside a vending machines were generally replaced at least once every two days, depending on the remaining stock. The participating food business required their staff to wear gloves when stocking oranges in the vending machines.

52. Wearing gloves was also required during the cleaning of the vending machines selling fresh squeezed orange juice. The cleaning procedures were carried out every day. The food take-out port, outer surfaces of the vending machine, storage area for whole oranges and conveyor belts for transporting the oranges to the processing area were cleaned with towels. The inner surfaces of the vending machine were also cleaned by spraying with water. The knife for cutting oranges and parts for dispensing orange juice were cleaned thoroughly with detergent. The parts for squeezing orange juice were replaced with clean ones and the used ones were removed, washed and dried thoroughly for use again next time after cleaning. The plastic bag for storing waste orange skins was replaced with a new one and the waste water tank was also washed thoroughly.

53. There were regular checking and maintenance on the functioning of the vending machines selling fresh squeezed orange juice, which is important to ensure that any control measures of the vending machines for the microbiological quality of the products sold were functioning normally.

Beverages (e.g. coffee and chocolate drinks, etc.)

54. It was noted that ingredients used for preparation of beverages in the vending machines had been prepackaged before transportation which helped prevent microbial contamination from the outside environment. For example, distilled water was transported and stored inside the vending machines in the original carboys. Prepackaged coffee beans, chocolate powder, milk powder and sugar, etc. for preparation of beverages were also refilled directly from their original packaging into clean covered containers inside the vending machines for storage.

55. The ingredients used for preparation of beverages including coffee beans, chocolate powder, milk powder and sugar, etc. were in a dried powder form and had relatively longer shelf life. They were stored at room temperature inside the vending machines. The participating food businesses replenished these ingredients and distilled water before they were out of stock, or before the shelf life of these ingredients ended, with the frequencies varying from generally twice a week to once every six weeks. The participating food businesses required their staff to wear gloves when stocking ingredients in the vending machines.

56. Wearing gloves was also required by the participating food businesses during the cleaning of the vending machines selling beverages. Cleaning procedures were performed generally once or twice a week. The food take-out port, and inner and outer surfaces of the vending machine were cleaned with hot water or detergent. The waste water storage was also emptied and cleaned with 1:99 diluted household bleach or detergent. The plastic bag for holding coffee bean waste was removed and replaced with a new one. The dispenser for directing each ingredient from the storage container into the dispensing tube was replaced directly with a new one. On the other hand, the computer systems of the vending

machines of the participating food businesses were set to automatically rinse all dispensing tubes with hot water of around 90°C-95°C daily. In each vending machine, the water boiler was controlled by the computer system to heat distilled water to the temperature range required for rinsing the dispensing tubes. However, there was no recording system on the temperature of the hot water inside the boiler for verification of the hot water temperature.

57. All the participating food businesses had regular checking and maintenance on the functioning of their vending machines, which is important to ensure that any control measures of the vending machines for the microbiological quality of the products sold were functioning normally.

Drinking water with no drinking utensil provided

58. It was noted that the distilled water was transported and stored in the original carboys to prevent microbial contamination from the outside environment during transportation and storage inside the vending machines.

59. The distilled water carboys were stored at room temperature inside the vending machine. On the other hand, there were a water storage tank and a water chiller inside the vending machine for preparing/storing drinking water at room temperature and cold drinking water for sale, respectively. The water storage tank and water chiller had round corners so that they were easy to clean and did not provide harbourage for pests. The distilled water was further treated by ultraviolet sterilisation before being served when it flowed through the water dispensing tubes with a UV lamp enclosed in the middle.

60. The participating food business replenished the distilled water depending on the remaining stock, varying from once per day to once per week. Wearing gloves was required during the replenishment of stock. The sale of drinking water would be suspended once the waste water tank was full and the waste water tank would be emptied before resuming service.

61. Wearing gloves was required during the cleaning of the vending machines selling distilled water. The cleaning procedures were performed every six to nine months. The take-out port, and inner and outer surfaces of the vending machine were cleaned with towels and then disinfected with alcohol wipes and dried. The waste water tank was replaced with a clean one while the used one would be cleaned with sanitiser for use again next time. The remaining distilled water was dispensed from the dispensing tubes, water storage tank and water chiller, which were then rinsed with sanitiser for 3-5 mins and the remaining sanitiser was completely washed out with distilled water.

62. The participating food business had regular checking and maintenance on the functioning of their vending machines, which is important to ensure that any control measures of the vending machines for the microbiological quality of the products sold were functioning normally.

Frozen desserts manufactured by the vending machine (e.g. soft ice-cream with toppings)

63. Ice-cream fillings used in the vending machine manufacturing frozen desserts had been sterilised by ultra-high-temperature method and prepackaged before transportation, and refilled directly into the ice-cream

machine from the original packaging. Toppings (e.g. chocolate sprinkles and syrup) for the preparation of frozen desserts were also refilled directly from their original packaging into clean covered containers inside the vending machines for storage. These helped prevent microbial contamination of the ingredients from the outside environment during transportation and storage inside the vending machine.

64. Toppings were stored at room temperature in covered containers inside the vending machine. On the other hand, the ingredients requiring temperature control were stored at safe temperatures in the vending machine to prevent rapid multiplication of microorganisms. The ice-cream fillings refilled in the ice-cream machine were kept at 4-5°C. There was a monitoring system for the storage temperatures of the ice-cream fillings. The system would suspend the food sale and notify the food business for checking and repairing of the concerned vending machine as soon as possible when the storage temperature of the ice-cream fillings was higher than 7°C.

65. Wearing gloves was required for replenishing the stock. It was noted that apart from the product turnover rate, the participating food business kept track of the shelf life of the ice-cream fillings and toppings and would replenish the stock before the shelf life ended. Depending on remaining stock, the stock was usually replaced every one to two days.

66. Wearing gloves was also required during the cleaning of the vending machine manufacturing frozen desserts. The food take-out port and outer surfaces of the vending machine were cleaned with disinfectant every few hours. The inside area of the vending machine was cleaned with disinfectant during replenishment of stock. The storage tank for

storing ice-cream fillings was rinsed with hot water, and the parts of the ice-cream machine which could be disassembled were cleaned with detergent and then disinfectant every day. The covered containers for toppings were cleaned with detergent once every two weeks.

67. The participating food business had regular checking and maintenance on the functioning of the vending machine, which is important to ensure that any control measures of the vending machine for the microbiological quality of the products sold were functioning normally.

Table 5. Summary on the mode of operation of the vending machines of participating food businesses selling ready-to-eat food from a microbiological perspective.

Food type sold	Hot rice rolls	Hot rice boxes	Custard sandwiches	Fresh squeezed orange juice	Beverages	Beverages	Drinking water with no drinking utensil provided	Frozen desserts manufactured by the vending machine
Storage of food products/ingredients in the vending machines								
Food storage temperature inside the vending machines	>60°C	>60°C	≤4°C	0-3°C	Room temperature	Room temperature	Room temperature	4-5°C for ice-cream fillings; Room temperature for toppings
Monitoring of the operation								
Temperature	Yes	Yes	Yes	Yes	No	No	No	Yes
Suspending food sale when food storage temperature is out of range	Yes	Yes	Yes	Yes	N/A	N/A	N/A	Yes
Replenishment of stock								
Frequency	Once per day	Once per day	Once per week	Once every two days	Once every six weeks	Twice a week	Varies depending on the stock remaining	Every one to two days

Replenish before shelf life of food products/ ingredients end	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cleaning of the vending machines								
Practice	Food storage areas cleaned daily	Food storage areas cleaned daily	Food storage areas cleaned weekly	Food storage areas and processing parts cleaned daily	Food dispensing parts cleaned daily	Food dispensing parts cleaned daily	Dispensing parts cleaned every 6-9 months	Food processing parts in the ice-cream machine cleaned daily
Hot water					Yes	Yes		Yes
Disinfectant		Yes	Yes					Yes
Sanitiser	Yes						Yes	
Detergent				Yes	Yes	Yes		Yes
Wearing of gloves	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Maintenance of the vending machines								
Regular checking and maintenance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Remark:

- This table is prepared on the basis of reported information from interviewees.
- N/A = not applicable

DISCUSSION

Microbiological safety of the food samples collected

68. The results revealed that none of the 102 food samples, which the testing for specific foodborne pathogens is applicable, were detected with the foodborne pathogens tested (i.e. *B. cereus*, *C. perfringens*, *L. monocytogenes*, *Salmonella* spp., and/or *S. aureus* and other coagulase-positive staphylococci) for each food type. Therefore all these samples were satisfactory in terms of the corresponding specific foodborne pathogens tested.

Hygienic quality of the food samples collected

69. For all 120 food samples collected with *E. coli* count tested, none of the samples were detected with *E. coli*. Therefore, all samples were satisfactory in terms of the hygienic indicator organism tested, according to the Guidelines.

70. Eight samples of beverages were found with ACC at borderline levels, though none were found to be of unsatisfactory quality. These include a pair of hot chocolate drink samples, a pair of cold cappuccino samples and a pair of cold milk tea samples, with each pair collected from the same vending machine in the morning and afternoon on different days, respectively. These three pair of samples were collected from vending machines of different companies. Apart from these samples, there were also separate samples of one chocolate drink collected in the morning from one vending machine and another cold milk tea sample collected in the afternoon from another vending machine found with ACC at borderline

levels.

71. ACC is the total number of bacteria able to grow in an aerobic environment in moderate temperature. It is an indicator of quality, not safety, and cannot directly contribute towards a safety assessment of ready-to-eat food. High level of ACC alone does not indicate an immediate risk to public health. ACC can provide useful information about the general quality and remaining shelf life of the food in question, and thus highlight potential problems of storage and handling since production. It is expected that samples analysed at the end of shelf life, their ACC may approach the upper "borderline" limit³.

72. The ingredients stored in the vending machines selling beverages, e.g. dried coffee beans, chocolate powder, milk powder and sugar are generally not favourable for microbial growth. One of the reasons for the borderline levels of ACC in these beverage samples may be due to the quality of the ingredients for preparation of these beverages. The ingredients should be refilled to the vending machines in a hygienic manner to prevent any microbial contamination during the handling process. The borderline levels of ACC found in the beverage samples also indicated possible contamination during the production process of the beverages, e.g. during the mixing of the ingredients or dispensing of the products inside the concerned vending machines. There were a few research studies reporting high total viable counts and coliform organisms in dispensed drinks from vending machines possibly due to inadequate cleaning procedures or machine design⁷.

73. In vending machines selling beverages, there are generally a clean-in-place (CIP) system, which is an automatically performed method

of cleaning, applied to remove residues from complete items of the vending machines without dismantling or opening the equipment⁸. It is noted that the CIP systems of the participating food businesses were set to clean the tubes for dispensing ingredients automatically by flowing hot water of around 90-95°C through the tubes daily. However, as detailed in Table 4, for vending machine no. 1 and no. 3, it was found that the levels of ACC decreased in the samples collected on different days after the daily cleaning procedures, but the levels remained at borderline levels. For vending machine no. 2, the levels of ACC increased for samples collected on different days even after the daily cleaning procedures and changed from satisfactory to borderline. The cleaning of the vending machine parts in contact with the ingredients or food products may be inadequate to prevent bacterial growth, e.g. the inner surfaces of the tubes dispensing the beverages which provide a moist environment which may allow the build-up of microorganisms. There is room for improvement in the cleaning process.

74. The CIP system relies on the application of suitable cleaning agent(s) at the optimum temperature, concentration and flow velocity for the correct length of time⁹. Four key parameters, i.e. cleaning time, temperature, flow rate and concentration of any cleaning solutions and sanitiser used, should be controlled in a CIP system during the cleaning cycles¹⁰ to ensure effective, repeatable and reliable cleaning is achieved. Since vending machines of different design and/or selling different types of food have different cleaning requirements, the CIP procedures should be performed with these four parameters set according to the recommended performance specification of manufacturers of the vending machines, or other settings validated to be effective to clean the vending machines.

75. These parameters should be monitored and documented to verify that the CIP operation has been carried out correctly. From the interview in this study, it is noted that there was generally a water boiler inside the vending machine selling beverages. The water boiler was controlled by a computer system to heat the water at the temperature range required for rinsing the dispensing tubes for the ingredients during the CIP operation. However, there was generally no recording system on the temperature of the hot water inside the boilers, and therefore the hot water temperature could not be verified. Food businesses should consider setting up a recording system to ensure that the temperature is at the correct range. They should also consider logging the duration of the cleaning and pump rate for the CIP operation and document the records for regular checking. This helps verify that the CIP operation has been carried out according to the pre-set values, and rectify any deviation as soon as possible. It is noted that the participating food businesses were using hot water only as the cleaning agent in the CIP system, appropriate detergent may also be considered. This would increase the effectiveness to remove any debris from the food contact surfaces. Sterilisation-in-place with sanitiser or disinfectant in concentrations according to the instructions of the manufacturers of the vending machines should also be considered after completion of the CIP process to further reduce the load of microorganisms.

76. Food businesses should also validate the operating parameters of the CIP system to ensure that cleaning process is effective. The CIP equipment should be designed with inspection access points to ensure that all interior food contact surfaces throughout the fixed system are being effectively cleaned. Validation can also be performed, for example, by checking whether the CIP operating criteria have been met from the system records, visual inspection of the colour of the rinse water, measurement of

the turbidity and sugar level of the rinse water with turbidity meter and brix meter respectively, or product testing for microbial contamination.

77. Apart from the cleaning procedures, food businesses should also keep records of any other control measures for the possible food safety problems during the operation, such as the transport of food products /ingredients (e.g, food storage temperatures in the transport vehicles), storage of food products/ingredients (e.g. food storage temperatures in the vending machines, remaining shelf life of the food products/ingredients) and processing of food products in the vending machines (e.g. temperature in the food processing areas in the vending machines), etc. A systematic check of the records should be performed periodically (e.g. once a week), in order to determine areas requiring attention and improvement.

78. In addition, it is noted that the participating food businesses replace the dispenser for each ingredient in the vending machine selling beverages regularly. It is also noted that water filters were used in this type of vending machine too. For parts in the vending machines in contact with food and should be replaced regularly, they should be replaced according to the instructions of the manufacturers of the vending machines and handled in a sanitary manner during the replacement process.

79. It is also important that the operators of the CIP systems receive adequate training so that they are aware of the functions of the CIP systems, the operational procedures, cleaning time, temperature, flow requirements and concentration of the cleaning agent, etc. Standard Operating Procedures (SOP) on clear step-by-step instructions of the CIP systems should be established and provided to all operators. Relevant training and regular refresher courses should be provided to new employees and

existing staff operating the CIP systems, respectively.

80. Food businesses should also monitor the operation of the vending machines. It is noted that the vending machines are generally equipped with computer-controlled monitoring system for the operation of the vending machines. Food businesses should ensure that such operational records are being monitored, and system alerts on problems encountered during the operation are being checked and any corrective actions required are carried out as soon as possible. The system operational records should also be reviewed regularly to determine areas requiring attention and improvement.

81. Food businesses should also carry out maintenance regularly to ensure it is functioning normally, so that any temperature control system and CIP operation can be carried out according to the operational criteria set to ensure the microbiological quality of the food products. As ready-to-eat food sold by means of a vending machine is a relatively new food business in Hong Kong and have become more popular since a few years ago, it is expected that the vending machines operating in the local market should be generally new and operating in relatively good conditions. Food businesses should pay attention that regular checking, maintenance and replacement of vending machine parts are important, especially when the vending machines continue operating for longer time in the market.

Limitations

82. In this study, only 120 samples were taken from limited number of vending machines. Comparison of the microbiological quality of the food samples from the same vending machine was only made at two different time points in the morning and afternoon respectively on different

days.

83. Samples are only collected from the types of food products sold by means of vending machines during the sampling period. As the industry continues to develop, the types of food products sold by means of vending machines will expand to a wider range of varieties which have not been covered in this study.

CONCLUSION and RECOMMENDATIONS

84. This study showed that none of the ready-to-eat food samples collected from the vending machines were found to have microbiological food safety concern. Of the beverage samples examined, eight samples (22%) were found with ACC at borderline levels, which is an indicator of quality rather than safety so there was no food safety concern from microbiological perspectives. Factors like the quality of raw materials and hygienic conditions of the vending machines (especially the surfaces in contact with the food ingredients or food products), either alone or in combination, may result in the microbiological quality of these beverage samples.

85. Below is some advice for public and trade in relation to ready-to-eat food sold by vending machines.

Advice to Public

- Check whether the vending machines have the licence/endorsement for the sale of the ready-to-eat food before purchase.
- Consume the ready-to-eat food bought from vending machines as soon as possible.

Advice to Trade

Design and Location and of Vending Machines —

- All food delivery orifices of vending machines should be protected from manual contact by customers and entry of insects, rodents, dust etc. by means of a tight-fitting, self-closing door or cover which should be kept shut at all times, except when food is being removed.
- All elements which generate heat in vending machines should either be sealed off from the food compartment or so fitted that the heat generated does not affect the storage properties of the food.
- All portable food containers, including containers for water to be placed inside vending machines should be provided with a cover which can prevent contaminants from reaching the interior of the containers.
- Avoid angles, recesses and voids in the design of vending machines so that the machines are easy to clean and do not provide harbourage for pests.
- Vending machines should be sited in clean areas, and protected from the weather and possible contamination of food from the ambient environment. Their space and the immediate surroundings shall be maintained in a clean condition.

Purchase and Receiving —

- Purchase food products/ingredients from approved and reliable suppliers.
- The food products/ingredients should be in fresh and wholesome state and checked of good quality at the time of receiving, e.g. the packaging is intact with no signs of contamination or damage to the food products/ingredients.

Transportation —

- Transport the food products/ingredients in clean vehicles to avoid contamination.
- Avoid transporting the food products/ingredients with other raw food at the same time.
- Store the food products/ingredients which require temperature control at appropriate temperatures, e.g. above 60°C for hot food and at 4°C or below for cold food, in vehicles and monitor the storage temperatures.

Replenishment of Stock —

- Keep track of the shelf life of food products/ingredients in vending machines. Remove the remaining stock of food products/ingredients and replace with fresh ones before the expiry of the shelf life.
- The ingredients should be refilled to the vending machines in a hygienic manner to prevent any microbial contamination during the handling process.
- Replenish the food products/ingredients as soon as possible to prevent prolonged storage at room temperature, especially for the food products/ingredients which require temperature control.
- Expired food, damaged food, and food waste (e.g. fruit peel left after juicing) shall be placed in an enclosed container for disposal.

Storage and Temperature Control —

- Except whole fruits and food prepared on-site inside vending machines, ready-to-eat food sold should be prepackaged to prevent microbial contamination.
- Food products should be stored on a first-in-first-out basis in vending machines to avoid prolonged storage which affects the freshness and

safety.

- Store the food products/ingredients which require temperature control at appropriate temperatures, e.g. above 60°C for hot food and at 4°C or below for cold food, in vending machines.
- Vending machines selling food which requires temperature control should be fitted with a thermostatically controlled device to maintain the correct temperature. The thermostatically controlled device should be properly calibrated.
- Suspend the sale of food products when the storage temperature is out of the appropriate range (e.g. during power failure, mechanical failure or other condition), and follow up as soon as possible. All food affected should be disposed appropriately.
- All disposable containers which receive food or beverages from vending machines and disposable utensils shall be purchased in sanitary cartons or packages which protect the contents from contamination. They shall be stored in a clean and dry place until introduced into the vending machine, and shall be handled in a sanitary manner.

Cleanliness of Vending Machines —

- Clean vending machines regularly, including the food take out port, outer and inner surfaces and any food contact surfaces.
- The chemicals used for sanitation, appropriately of food grade, should be suitable for use with food contact surfaces. Follow the instruction of the manufacturer of the sanitiser or disinfectant for effective sanitation, e.g. contact time, correct concentration, and shelf life after dilution, etc.
- Empty and clean any waste containers inside the vending machines regularly. Suspend the sale of food products when the waste container

is full and follow up as soon as possible.

- For vending machines with CIP systems:
 - Use clean water source for cleaning during the CIP process.
 - During the CIP process, cleaning solutions should be circulated to contact all interior food contact surfaces and being completely drained after cleaning.
 - There should be inspection access points in the CIP system to ensure all interior food contact surfaces are being effectively cleaned.
 - Ensure the CIP system operates appropriately as designed, e.g. by monitoring the cleaning time, temperature, flow rate and concentration of cleaning solutions.
 - The cleaning cycle should be performed according to the recommended performance specification of the manufacturers of the vending machines or other settings validated to be effective to clean the vending machines.
 - Depending on the food types sold and the instructions of the manufacturers of the vending machine, use appropriate detergent in the CIP process and also perform sterilisation-in-place with sanitiser or disinfectant after the CIP process to reduce the load of microorganisms on the food contact surfaces.
 - Verify that the CIP system is operated as intended and all target set points were met during the operation: cleaning time, temperature, flow rate, concentrations of cleaning solutions, e.g. by in-build computer system or manual checking, depending on the CIP system used.
 - Validate that the CIP system effectively cleaned the vending machines at periodic intervals, e.g. by visual observations at inspection access points and testing of final rinse water.

- Record the findings of the verification and validation process to keep track of the evidence that the cleaning and sanitising activities were completed as intended and are effective.

Monitoring of the Operation and the Maintenance of Vending Machines

- Continually monitor the vending machines, e.g. by using computer-controlled monitoring system, during their operation and follow up any system alerts on operational problems as soon as possible. Review the operational records regularly to ensure that the vending machines are functioning normally.
- Keep records of any other control measures for the possible food safety problems during the operation (e.g. the transport and storage of food products/ingredients, and processing of food products). Conduct systematic check of the records periodically to determine areas requiring attention and improvement.
- Carry out maintenance of the vending machines regularly according to the instructions of the manufacturers of the vending machines.
- Food contact parts, water filters and other parts in the vending machines which require regular replacement should be properly replaced according to the instructions of the manufacturers, and handled in a sanitary manner during the replacement process.

Training

- Establish clear cleaning procedures and ensure that employees have undergone training so that they well understand the operational requirements and perform the cleaning programme properly.

- For vending machines with CIP systems, employees should well understand the operation procedures, cleaning time, concentration of any cleaning solutions or sanitiser used, flow and temperature requirements, etc. Establish Standard Operating Procedures (SOP) on the CIP systems and provide relevant training and regular refresher courses to the operators, so that they well understand the operational requirements and perform the cleaning programme properly.

Personal Hygiene —

- Keep hands clean at all times. Wash hands with liquid soap and water, and rub for at least 20 seconds. If hand washing facilities are not available, or when hands are not visibly soiled, hands could be cleaned with 70% to 80% alcohol-based handrub.
- Wear clean and light-coloured outer clothing or protective overalls.
- If staff wear disposable gloves when handling ready-to-eat food or in contact with the vending machine, they should be aware that gloves cannot be used as a substitute for cleaning hands and should be used properly. If the gloves are damaged, soiled or removed when interruptions occur in the operation, they should be discarded. Gloves must be changed frequently and hands must be cleaned between glove changes.
- Open wound should be covered by gloves or bright-coloured waterproof bandages.
- Suspend from engaging in any food handling work when suffering or suspected to be suffering from an infectious disease or symptoms of illness such as flu, diarrhoea, vomiting, fever, sore throat and abdominal pain.

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