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Microbiological Hazard Evaluation

MICROBIOLOGICAL QUALITY OF READY-TO-EAT SAUCES AND LIKE PRODUCTS

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Table of Contents

	Page
Executive Summary	2
Objectives	6
Introduction	6
Scope of Study	7
Methodology	8
Results	14
Discussion	16
Conclusion and Recommendations	20
References	23

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EXECUTIVE SUMMARY

Ready-to-eat (RTE) sauces and like products such as gravies, dressings, and dips, are often served alongside other foods to enhance their flavour or complement dishes. While gravies are typically served hot, dressings or dips are generally served cold or at room temperature. These products are often made in large batches. If these RTE products are contaminated by foodborne pathogens and held for extended periods without proper temperature control, the pathogenic bacteria may proliferate in the contaminated sauces to the levels capable of causing foodborne illnesses. Additionally, the diverse ingredients used in the preparation of RTE sauces, particularly dressing and dips, may involve fresh ingredients without further cooking, which can be potential sources of contamination. Given these risks, the Centre for Food Safety (CFS) conducted a study to assess the microbiological quality of RTE sauces and like products served or prepared by local food premises.

Methodology

Between October and November 2024, 100 samples of RTE sauces and like products were collected from food businesses across various regions of Hong Kong. The samples comprised 50 dressings/dips and 50 gravies that were intended to be served hot. The microbiological quality of the samples was assessed against the criteria stipulated in the Microbiological Guidelines for Food (the Guidelines). The microbiological criteria include (a) aerobic colony count (ACC, a quality indicator), (b) *Escherichia coli* (a hygiene indicator), and (c) specific foodborne pathogens.

Results and Discussion

The microbiological quality of RTE sauces and like products collected in this study was generally satisfactory. All samples complied with the microbiological food safety criteria for pathogenic bacteria, including *Salmonella* spp.*, Staphylococcus aureus*, *Bacillus cereus*, and *Clostridium perfringens*.

ACC is an indicator of quality rather than safety and hence does not indicate food safety concern. ACC level can be influenced by various factors, including the microbiological quality of ingredients, temperature control during the cook-chill process and post-process contamination. The testing result of ACC level of a curry sauce indicated that there may have room for improvement in the food handling processes, but not indicate food safety concern. Further investigation revealed that the hot-holding temperatures may occasionally be insufficient, and the cooling time to reach 20°C could exceed the recommended duration of two hours or less.

Additionally, the testing results of level of *E. coli* of an avocado-based dip (guacamole) sample indicated that there may have room for improvement in the personal and environmental hygiene but there was no food safety concern. A review of the production process highlighted the need for improved personal and food hygiene practices, including the provision of soap for handwashing in the kitchen. Fresh ingredients intended for use without cooking have been identified as a potential source of contamination, emphasising the importance of ensuring the microbiological quality of ready-to-serve raw ingredients and handling them with strict hygiene practices during food preparation.

The CFS provided advice on the Good Hygiene Practices (GHPs) to the concerned operators of the aforesaid samples. Follow-up samples were taken for testing and the results were satisfactory.

Conclusion

The overall microbiological quality of RTE sauces and like products was found to be satisfactory, with all samples complying with the microbiological food safety guideline levels for pathogenic bacteria as stipulated in the Guidelines. Test results of individual samples, including aerobic colony count of a curry sauce sample and *E. coli* count of an avocado-based dip sample (guacamole) indicated that there may be room for improvement in terms of food handling processes, and personal and environmental hygiene, respectively, but there was no food safety concern. The following recommendations for safe handling of RTE sauces and like products are provided for trade and members of the general public.

<u>Advice to Trade</u>

- Precooked sauce should be stored properly in hot or cold-holding devices within two hours if not intended for immediate serving. Hot food must be maintained at temperatures over 60°C and cold food should be kept at 4°C or below.
- For cooling of hot gravy for storage, it should be cooled down stepwise from 60°C to 20°C within two hours, followed by cooling from 20°C to 4°C in a refrigerator within two to four hours.
- Raw food ingredients should be obtained from approved and reliable sources. When using raw eggs or milk products in dressings and dips, pasteurised options, such as pasteurised egg, cheese, and milk products, are safer choices.
- Separate raw food from cooked and RTE food to avoid cross-contamination. Prepared RTE ingredients have to be stored separately from raw food ingredients in the refrigerator. The preparation areas for raw food should be separated from areas for handling of RTE food, as far as possible.
- Implement and maintain strict personal and environmental hygiene practices, including regular handwashing with soap.

Advice to Public

- Consume RTE sauces or like products with raw or undercooked ingredients as soon as possible after purchase.
- High-risk groups, including pregnant women, young children, the elderly, immunocompromised persons, and persons taking antibiotics and antacids, are advised not to consume RTE sauces or like products with raw or undercooked ingredients.

OBJECTIVES

The purpose of the study is to assess the microbiological quality of ready-to-eat (RTE) sauces and like products.

INTRODUCTION

2. RTE sauces and like products such as gravies, dressings and dips, are often served alongside other foods to enhance its flavour or complement dishes. Gravies are typically served hot, whereas dressings or dip are generally served cold or at room temperature. Various types of RTE sauce exist, most of which are prepared in advance. However, there are microbiological risks associated with their preparation and handling, rendering them potentially hazardous if the handling is improper.

3. RTE sauces and like products are often made in large batches. If these RTE products are contaminated by foodborne pathogens and held for extended periods without proper temperature control, [1] this practice increases the likelihood of pathogenic bacteria proliferating to levels sufficient to cause food poisoning. Although gravies are usually served hot, they may undergo successive heating, cooling, and re-heating, or be maintained at temperatures insufficient to inhibit bacterial growth. During this process, the heat of cooking can activate the germination of *Clostridium perfringens* spores which survive in anaerobic conditions inside the gravies. The organism can then multiply in environments with low oxygen levels, and cooling gravies at ambient temperature for prolonged periods facilitates the rapid growth of this bacterium. [2] *C. perfringens* has been detected in gravy sample collected through local food surveillance and is also suspected to be the causative agent in local food poisoning

incidents linked to gravies.[3, 4] *Bacillus cereus* is another spore-forming microorganism and able to grow either with or without oxygen, it has the potential to grow in gravies after cooking due to temperature abuse.

4. RTE sauces and like products have been associated with *Salmonella* outbreaks both locally and internationally.[5,6] The diverse ingredients used in preparation of RTE sauces, particularly dressing and dips, may be perishable items such as fresh tomato, berries and scallion and not subjected to further cooking, which can be a potential source of contamination. Moreover, egg-based sauces/dressings/dips such as mayonnaise, aioli, and tartare sauce are potentially high-risk food ingredients as they can be contaminated by using eggs that are either soiled with faecal matters or have cracked shells. Contamination by food handlers can occur when cracking or separating egg white and egg yolk manually.[6] Additionally, eggs can also be contaminated with *Salmonella* through vertical transmission where bacteria are introduced from infected reproductive tissues to eggs prior to shell formation.[7]

5. Considering the potential microbiological risk associated with RTE sauces and like products, the Centre for Food Safety (CFS) conducted a study to assess the microbiological quality of these products served or prepared by local food premises. The results of this study can provide the basis for raising the awareness of the general public regarding the risk associated with these products and formulating advices to the food trade on proper handling practices.

SCOPE OF STUDY

6. This study focused on RTE sauces and like products served or prepared by local food premises, which include dressings, dips, and gravies.

METHODOLOGY

Sampling

7. Target samples were sauces, dips or pastes serving alongside different kinds of dishes and gravies for serving with rice. Only the sauce portion was tested, as far as possible.

8. For dressings and dips, samples in similar studies of other authorities or incriminated food items identified in previous food poisoning outbreaks were selected for this study, with consideration of local availability and prevalence. The target samples included those maintained at either cold or ambient temperature. As for gravies with the main concern being improper food storage temperature in previous outbreaks publicised in the media, commonly available hot gravies (especially those prepared in large batches in advance) were selected.

9. Prepackaged sauces or sauce sachets intended for takeaway use, e.g. tomato sauce for fries, were excluded from the scope of this study due to their low-risk nature.

10. Between October and November 2024, 100 samples (at least 150 gram) of RTE sauces and like products were collected from food businesses by health inspectors of the Food and Environmental Hygiene Department (FEHD) (Table 1). Of these, 50 samples consisted of dressings and dips, and the remaining 50 samples were gravies that were intended to be served hot. The samples were collected evenly from chain and individual stores. To ensure a diverse range of samples from different shops, sampling officers purchased the samples as consumers from different shops located at Hong Kong Island, Kowloon and the New Territories, and from different districts as far as possible, and only one type of product was collected from a shop of the same brand or chain, as far as possible.

Table 1: Distribution of the samples of RTE sauces and like products

Type of product	Numbers		Total
	Chain store	Individual store	
Dressings, dips			
Egg-based	5	5	10
Fruit- or vegetables-based	5	5	10
Dairy-based	5	5	10
Others#	10	10	20
Gravies			
Curry sauce	5	5	10
Cream sauce	5	5	10
Tomato sauce	5	5	10
Others*	10	10	20
Total	50	50	100

Remarks:
#: Examples - Sesame sauce, satay sauce for grilled meat, and spicy sauce
*: Examples - Black pepper sauce, pumpkin sauce, and beef brisket sauce

Sample analysis

11. During sampling, sample temperature was recorded with an infrared thermometer. The samples were then stored at 0°C to 4°C and were collected by the laboratory of the contractor commissioned by the CFS to provide the microbiological testing services. Aerobic colony count (ACC), *Escherichia coli* count, *Salmonella* spp., *S. aureus* and other coagulase-positive Staphylococci count, *B. cereus* count and *Clostridium perfringens* count were used to assess the microbiological quality of RTE sauces and like products.

12. The enumeration of ACC in samples was performed using the U.S. Food and Drug Administration (FDA) Bacteriological Analytical Manual (BAM) Online (Jan 2001) Chapter 3 (Conventional Plate Count Method). The incubation condition was 30ºC for 48 hours. *E. coli* count in samples was performed using the AOAC Official Methods 991.14 (18th ed. 2005) (3M Petrifilm™ Plate). The detection of *Salmonella* spp. was performed according to the U.S. FDA BAM Online (Feb 2014), Chapter 5. *S. aureus* count was enumerated according to BAM Online Chapter 12 (Jan 2001) (Direct Plate Count

Method) of the U.S. FDA. *B. cereus* determination was conducted with reference to ISO 7932:2004, colony technique at 30°C. Enumeration of *C. perfringens* was conducted according to BAM Online Chapter 16 (Jan 2001) of the U.S. FDA.

Result analysis

13. The microbiological results of the RTE sauces and like products were analysed by the Risk Assessment Section of the CFS, and assessed against the criteria in CFS' Microbiological Guidelines for Food (the Guidelines).[8] The relevant criteria are extracted from the Guidelines and listed in Tables 2 and 3.

Quality and Hygiene – Aerobic Colony Count and E. coli

14. Aerobic colony count is the total number of bacteria found in food. 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.[8] The number of bacteria increases significantly over time in response to lack of temperature control of the product. Hence, ACC can highlight potential problems of storage and handling since production and provide clues for early detection of problems as well as about how the problems should be solved. It is worth noting that ACC is an indicator of quality but not safety.[8]

15. The Guidelines classify RTE food products[i] into 14 categories because several factors (such as the types of raw ingredients used and the nature of processing) may affect the ACC of a product at the point of sale. For example, heat processes such as cooking will result in low ACC, and products containing raw ingredients such as fresh vegetables will have much higher ACC due to the natural flora present. Handling after heat processing such as slicing, portioning,

[i]"Ready-to-eat food" means food intended by the producer or the manufacturer for direct human consumption without the need for cooking or other processing effective to eliminate or reduce to an acceptable level the microorganisms of concern.

packaging, etc. may increase the ACC, although this should be minimised by the implementation of Good Hygiene Practices (GHPs).

16. Taking the ingredients and the nature of processing into consideration, for the purpose of this study, gravies and dressings or dip in this study were classified according to the Guidelines as shown in Table 2. Gravies are usually cooked in advance and kept hot for mixing or serving alongside with rice. Therefore, they generally belong to category 2, i.e. foods cooked immediately prior to sale or consumption. Dressings or dip, prepared in advance usually mixing with different food ingredients and then kept refrigerated or left under ambient conditions, are considered as category 5 (i.e. cooked foods chilled but with some handling prior to sale or consumption) or category 6 (i.e. non-fermented dairy products and dairy desserts, mayonnaise and mayonnaise-based dressings, cooked sauces) with same ACC limits. Certain types of ingredients, such as sour cream with cultured milk, and fresh onion, are expected to contain higher bacterial load because of naturally occurring microorganisms in raw food items or natural microbiota in the ingredients of fermented foods. For sauce samples mixed with these ingredients which can contain high levels of bacteria as part of their normal micro-flora, ACC is not applicable. ACC is also not applicable to preserved food like pickled cucumber due to the control of bacterial outgrowth by the intrinsic properties including low pH and low water activity (Table 2).[9]

17. *E. coli* is a bacterium found in the gastrointestinal tract of humans and is commonly used as a faecal indicator to reflect the hygienic quality of a food product. *E. coli* are killed by the heat processes used in food production and should be readily removed from the equipment and surfaces by appropriate cleaning procedures. The presence of *E. coli* in food would therefore indicate direct or indirect faecal contamination, and a substantial number of the bacteria in food would further suggest a general lack of cleanliness in handling and improper storage.[8]

Table 2. ACC and *E. coli* criteria used in this study

Food category in the Guidelines	Microbiological quality Result (colony-forming unit (cfu)/g)		
	Satisfactory	Borderline	Unsatisfactory
Aerobic colony count (ACC) [30°C /48 hours]			
2. Foods cooked immediately prior to sale or consumption	$<10^3$	10^3-$<10^5$	$\geq 10^5$
5. Cooked foods chilled but with some handling prior to sale or consumption	$<10^5$	10^5-$<10^7$	$\geq 10^7$
6. Non-fermented dairy products and dairy desserts, mayonnaise and mayonnaise-based dressings, cooked sauces			
10. Preserved food products – pickled, marinated or salted	N/A	N/A	N/A
11. Dried foods			
12. Fresh fruit and vegetables, products containing raw vegetables			
13. Fermented, cured and dried meats, fermented vegetables, ripened cheeses			
Hygiene indicator organisms			
E. coli	<20	20 - $\leq 10^2$	$>10^2$

Remarks:
Category numbers as marked for the food categories under ACC are directly adapted from the CFS' Microbiological Guidelines for Food.

Microbiological safety – Pathogens

18. *Salmonella* spp., *S. aureus*, *B. cereus*, and *C. perfringens* are pathogenic bacteria. They have been implicated in a number of food poisoning outbreaks both within Hong Kong and abroad, and were therefore used to assess the food safety of the samples of RTE sauces and like products collected in this study.

19. *Salmonella* spp. is a well-known hazard of food containing raw egg ingredients. Local food poisoning outbreaks caused by *Salmonella* involving undercooked eggs is not uncommon. For example, an outbreak in 2019 was found to be caused by whisked eggs that were inadequately cooked and left under inappropriate temperature, allowing *Salmonella* multiplied to high number.[10] Salmonellosis is the disease caused by *Salmonella* and is usually characterised by acute onset of fever, abdominal pain, diarrhoea, nausea and sometimes vomiting.[11]

20. *S. aureus* is another microorganism commonly associated with food poisoning in Hong Kong. The most frequent route of contamination is via contact with food handlers' hands, especially when the food is handled after cooking. Once contaminated, prolonged storage without refrigeration allows *S. aureus* to grow to high numbers and form enterotoxins. Although staphylococcal enterotoxins can also be produced by some other coagulase-positive staphylococci such as *Staphylococcus intermedius*, most coagulase-positive staphylococci which cause foodborne illness are *S. aureus*.[8]

21. *B. cereus* is a spore-forming bacterium ubiquitous in the environment and readily isolated from soil cereal crops and vegetables, etc.[8] Emetic intoxication is caused by a heat-stable toxin produced by the bacteria preformed in food. Symptoms include nausea and vomiting occur in the first few hours after ingestion of incriminated food, followed by diarrhoea in some cases. Another type of poisoning is diarrhoeal, which is characterised by watery diarrhoea associated with abdominal pain.[8]

22. *C. perfringens,* similar to *B. cereus*, is a spore-forming microorganism that could survive cooking temperature. It is also capable of growing in the absence of oxygen and multiply relatively rapidly in warm conditions (its generation time is less than 10 minutes in meat between 43°C and 47°C).[12] *C. perfringens* poisoning is usually characterised by sudden onset of abdominal pain followed by diarrhoea and nausea.[8]

23. The microbiological safety of the samples was determined using the criteria for pathogens of the Guidelines (Table 3).[8]

Table 3. Pathogen criteria of the Guidelines

Criterion	Result (cfu/g unless otherwise specified)		
	Satisfactory	**Borderline**	**Unsatisfactory:** potentially injurious to health and/or unfit for human consumption
Salmonella spp.	Not detected in 25g	N/A	Detected in 25g
S. aureus and other coagulase-positive staphylococci	< 20	20 - $\leq 10^4$	> 10^4
Bacillus cereus	< 10^3	10^3 - $\leq 10^5$	> 10^5
Clostridium perfringens	< 10	10 - $\leq 10^4$	> 10^4

RESULTS

Specific foodborne pathogens

24. Laboratory analysis of the 50 dressings/dips and 50 gravies showed none were detected with *Salmonella* spp., *S. aureus*, *B. cereus*, and *C. perfringens* at levels that are considered potentially injurious to health and/or unfit for human consumption.

Quality and hygiene indicators – ACC and E. coli count

25. The quality indicator (ACC) was applicable to 76 out of 100 samples collected. These included 29 samples of dressings and dips (classified under category 6) and 47 gravy samples (classified under category 2). As shown in Table 4, none of the dressings and dips were found to be unsatisfactory ACC level. However, among the gravy samples, one curry sauce was found to have testing result of ACC level of 5.9×10^5 cfu/g which was categorised as unsatisfactory for quality according to the Guidelines, (Table 4).

Table 4. ACC results (Number of applicable samples=76)

Microbiological quality	Microbiological results (cfu/g)					
	$<10^3$	10^3-$<10^4$	10^4-$<10^5$	10^5-$<10^6$	10^6-$<10^7$	$\geq 10^7$
Food category 6 n=29	**Satisfactory**			**Borderline**		**Unsatisfactory**
Non-fermented dairy products and dairy desserts, mayonnaise and mayonnaise based dressings, cooked sauces	26	2	1	0	0	0
Food category 2 n=47	**Satisfactory**	**Borderline**		**Unsatisfactory**		
Foods cooked immediately prior to sale or consumption	46	0	0	1	0	0

26. ACC was not applicable to 24 samples of dressings and dips. These samples contained raw or fermented ingredients (such as avocado, fresh herbs and cultured cream etc.) which inherently contained high ACC as natural flora.

27. Additionally, the testing result of *E. coli* level of one avocado dip sample was rated as unsatisfactory for the hygiene indicator (according to the criterion in Table 2) with 1.3×10^5 cfu/g *E. coli* detected. All other samples were rated as satisfactory with *E. coli* counts less than 20 cfu/g.

Storage condition of samples

28. Based on the collected information, over half of dressings/dips samples (32, 64%) were stored under refrigeration (Table 5). Among those dressings/ dips that were under refrigeration prior to use, 22 (68.8%) of them were reported to have a time limit of 24 hours or less, while 10 (31.3%) had no specific usage time limit. Two dressings/dips samples were reported to be kept under ambient conditions, with one had a time limit of six hours and the other did not specify a usage time limit. The measured temperature of 22 (44%) dressings/dips samples

were at or below 8ºC, while the remainders exceeded 8ºC (Table 6).

29. As for the storage condition of gravies, 32 out of 50 samples (64%) had no specific time limit for usage. All gravies were maintained through hot-holding with measured temperature at or above 60ºC (Tables 5 and 6).

Table 5. Storage condition of samples

	Storage condition	Time limit of storage (Hours)	No. of Samples
Dressings and dips	Refrigerated (n=32)	≤ 4	0
		> 4 to ≤8	4
		> 8 to 24	18
		No	10
	Ambient (n=2)	≤ 4	0
		> 4 to ≤8	1
		> 8 to 24	0
		No	1
	No storage (n=16)		16
Gravies	Hot-holding (n=50)	≤ 4	3
		> 4 to ≤8	2
		> 8 to 24	13
		No	32

Table 6. Sample temperature of samples

	Sample Temperature	No. of Samples
Dressings and dips (n=50)	4ºC to ≤ 8 ºC	22
	9 ºC to ≤ 20 ºC	13
	≥21 ºC	15
Gravies (n=50)	≥60ºC to 70 ºC	37
	>70 ºC	13

DISCUSSION

30. The microbiological quality of RTE sauces and like products collected in this study was generally satisfactory, all samples complied with the microbiological food safety guidance levels for pathogenic bacteria as stipulated in the Guidelines.

31. ACC is an indicator of quality rather than safety and hence does not indicate food safety concern. ACC level can be influenced by various factors, including the microbiological quality of ingredients, temperature control during the cook-chill process and post-process contamination.[12] Elevated ACC level highlights possible deficiencies in these food preparation practices, storage conditions or the shelf-life of the food.[9]

32. The testing result of ACC level of a gravy sample (curry sauce) was categorised as unsatisfactory for quality under the Guidelines, indicating there may have room for improvement in food handling processes, but not indicate food safety concern. The unsatisfactory ACC result of the gravy sample suggested the potential for proliferation of microorganisms. Although spore-forming organisms, *C. perfringens* and *B. cereus*, were not detected, it is important to note that the spores of these organisms are resistant to cooking temperature and can proliferate in gravies if they are improperly left under temperature danger zone (i.e. between 4°C and 60°C) for extended periods.

33. For the aforesaid gravy sample (curry sauce), a follow up investigation to the restaurant concerned was conducted to understand the preparation process. In brief, hot gravy was prepared in the morning and stored in various containers for immediate use and frozen storage. Gravy intended for immediate use was maintained in hot-holding conditions in a bain-marie (water bath) or a steam oven with the power turned off. For frozen storage, gravy would be cooled by fan for four to six hours before it was placed in a freezer, and the gravy would be reheated in a steam oven for hot-holding in a bain-marie as needed. The investigation revealed that the hot-holding temperatures might be insufficient, particularly when there was no temperature monitoring mechanism in place for the gravy was maintained in hot-holding conditions. In contrast with the recommended cooling time for cooked food to reach 20°C within two to four hours,[13] the extended cooling time up to six hours could potentially allow spore-forming organisms, if

present, to proliferate in the gravy after cooking. In this regard, advice on the food preparatory process were provided to the food handler concerned. A follow-up gravy sample was taken three weeks after the first sampling for testing and the ACC result was satisfactory.

34. While the hot-holding temperature of gravy samples in this study were found to be at or above 60°C, food handlers should ensure that the gravy remains steaming hot throughout - from the moment it is cooked until it is served.[14] Monitoring the holding temperature with thermometer as a control measure is recommended.[13] Food handlers may rely on the indicator on the switch of the heating equipment for temperature of the food. However, the best way to check whether gravy in hot holding is at or above 60°C, is to use a clean, disinfected probe. The probe should be inserted so the tip is in the centre of the food (or the thickest part).[15] This is particularly crucial for thick gravy in which the heat transfer takes times.

35. The testing result of level of *E. coli* of an avocado-based dip sample (guacamole) was categorised as unsatisfactory for this hygiene indicator under the Guidelines, indicating there may have room for improvement in personal and environmental hygiene, but there was no food safety concern. The sample was found to have high level of *E. coli* and substantial number of *E. coli* in the food suggests a general lack of cleanliness in handling and improper storage.[8]

36. In response to the aforesaid testing result of *E. coli*, a follow up investigation to the restaurant concerned was conducted and revealed that there were room for improvements in personal and food hygiene. First, there was a lack of soap for handwashing in the kitchen and food handlers did not always wear gloves when handling RTE ingredients (especially raw ingredients) when preparing the sauce. Secondly, fresh ingredients intended for use without cooking might be of inadequate microbiological quality and were stored alongside

raw food in the refrigerator. These factors, either alone or in combination, could lead to cross-contamination, resulting in the unsatisfactory microbiological quality of the prepared guacamole. Relevant food handlers of the restaurant concerned were reminded to follow GHPs when handling RTE ingredients to prevent cross-contamination and bacterial growth. A follow-up sample taken from the concerned shop two weeks after the first sampling showed satisfactory level of *E. coli*.

37. It is not uncommon to use raw ingredients such as fresh herbs or spices, onions, and tomatoes, to prepare dressings/dips, and as they may be not subjected to further cooking, these ingredients could be potential sources of contamination which in turn contribute to food poisoning outbreaks. Notably, outbreak of *C. perfringens* food poisoning in cheese sauce associated with leeks potentially contaminated with spores from soil has been reported.[16] Additionally, imported basil used in the preparation of pasta salad was believed to be the source of an outbreak caused by enterotoxigenic *E. coli* (ETEC).[17] Another study conducted by the authority of the United Kingdom on fresh herbs from retail premises found that 3.9% of herb samples were of unsatisfactory quality due to the presence of *Salmonella* and/or excessive levels of *E. coli*.[18] Therefore, it is crucial to ensure the microbiological quality of raw ingredients is suitable for direct consumption, and that these ingredients should be handled with strict GHPs.

38. Sauces and sauce-like products are often prepared in large batches for use over an extended period, and may be kept in use for excessively long durations or stored without proper temperature control.[6] In this study, information on the storage practice and shelf life of these RTE sauce products were also collected. It was noted that a considerable number of sauces lacked a specified shelf life, which could potentially increase the microbiological risk. For RTE sauces prepared in-house, it is recommended to label the preparation time and specify the shelf life to ensure the "first-in-first-out" principle can be effectively implemented,

especially when multiple food handlers are involved.

Limitations

39. In this study, only 100 samples of RTE sauces and like products were collected and only selected types were included due to limited sample size.

40. While collected samples were categorised based on ingredients and information given to sampling officers, it should be noted that the food production process and the ingredients could vary among different food producers.

CONCLUSION AND RECOMMENDATIONS

41. The study revealed that the overall microbiological quality of RTE sauces and like products was satisfactory, with all samples complying with the microbiological food safety guideline levels for pathogenic bacteria as stipulated in the Guidelines.

42. The test results of individual samples, including aerobic colony count of a gravy sample (curry sauce) and E. coli count of an avocado-based dip sample (guacamole) indicated that there may be room for improvement in terms of food handling processes, and personal and environmental hygiene, respectively, but there was no food safety concern.

43. The production and handling of RTE sauces and like products carry certain microbiological risks. In hot gravies, spore-forming organisms that can survive cooking temperature are of particular concern. Any lapses in the post-cooking process may allow these bacteria to proliferate, potentially leading to foodborne illness. For dressings and dips, which often involve the mixing of various ingredients (including raw ingredients) that could be sources of

contamination, food handlers should exercise strict hygienic practice to minimise the risk.

44. The following recommendations for safe handling of RTE sauces and like products are provided for trade and members of the public.

Advice to Trade

Good Hygiene Practices for preventing contamination in food and proper storage of food, particularly RTE food, should be adhered at all times. Food businesses also have the responsibility to provide sufficient ongoing food safety/hygiene training to their staff (i.e. food handlers in their businesses). Further, a preventive food safety management system (such as the Hazard Analysis and Critical Control Point (HACCP) system) should be established to ensure that effective control measures are in place to minimise potential contamination of the products during the manufacturing process. Some GHPs are highlighted below:

- Precooked sauce should be stored properly in hot or cold-holding devices within two hours if not intended for immediate serving. Hot food must be maintained at temperatures over 60°C and cold food should be kept at 4°C or below. Equipment should be pre-heated or pre-chilled before storing food. Regular temperature checks with a thermometer is essential; if the temperature of the hot or cold holding equipment deviates by more than 1°C, a check-up is warranted.
- For cooling of hot gravy for storage, it should be cooled down stepwise from 60°C to 20°C within two hours, followed by cooling from 20°C to 4°C in a refrigerator within two to four hours. To speed up cooling, the gravy can be divided into small portions and placed in shallow covered containers in well-ventilated area. An ice water bath, combined with stirring, can also facilitate faster cooling; however, a thermometer should be used to ensure that the ice water temperature remains consistently at 4°C or below.

- Label the preparation time of the sauce and specify the shelf life to ensure the "first-in-first-out" principle and prevent extended usage.
- Raw food ingredients should be obtained from approved and reliable sources. When using raw eggs or milk products in dressings and dips, pasteurised options, such as pasteurised egg, cheese, and milk products are safer choices. Except for fresh produces or salad vegetable labelled “ready-to-eat”, “triple washed” or “no washing necessary”, etc., all fresh produce or salad vegetables should be washed thoroughly under running water.
- Prepared ready-to-eat ingredients have to be stored separately from raw food ingredients in the refrigerator (e.g. ready-to-eat food on upper shelves above raw food to prevent cross-contamination).
- The preparation areas for raw food should be separated from areas for handling ready-to-eat food, as far as possible. If raw, cooked and ready-to-eat ingredients need to be handled in the same preparation area, disinfect the area thoroughly between uses.
- Implement and maintain strict personal and environmental hygiene practices, including regular handwashing with soap.

<u>Advice to Public</u>

- Consume RTE sauces or like products with raw or undercooked ingredients as soon as possible after purchase.
- High-risk groups, including pregnant women, young children, the elderly, immunocompromised persons, and persons taking antibiotics and antacids, are advised not to consume RTE sauces or like products with raw or undercooked ingredients.

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