

Analysis Report on “Study on Levels of Pathogenic Microorganisms in Light Meals and Rice Balls Available on the Market”

Objective and Samples

1. To learn about the safety and hygiene conditions of light meals and rice balls available on the market, the Municipal Affairs Bureau (IAM) randomly collected **a total of 200 samples of light meals and rice balls** from takeaway shops, coffee shops and fast food restaurants in Macao during the third quarter of 2022, **which were used for a study to find out the levels of pathogenic microorganisms in light meals and rice balls¹.** **The results revealed no abnormality, with a 100% pass rate.** It shows that the light meals and rice balls available on the market in Macao have a relatively low risk of causing foodborne disease outbreaks. The study helps to find out the levels of pathogenic microorganisms in light meals and rice balls sold on the local market and ensure the dietary health of the public.

Background information

2. “Light meals” firstly became very popular in Europe. The portions of food served in light meals are smaller than that of main meals of the day, and the cooking methods of light meals are relatively simple. Light meals can be eaten with ease, without the need of many bowls, plates and other utensils, and are often prepared to be consumed in between main meals. Traditional light meals do not take into account health benefits, while today's light meals emphasise healthy eating and convenience²⁻⁵. Among them, light meals like salads, wraps and sandwiches can make up for a lack of fresh fruit and vegetables when eating out and will not take a toll on the body.
3. Besides light meals, rice balls are gradually gaining popularity in Macao and have become one of the public’s favourite choices of meal items. Rice balls sold on the market in Macao are usually divided into Chinese and Japanese rice balls. Chinese rice balls are generally served hot and made with white or glutinous rice. Other types of rice, like red rice, purple rice

and black rice, are also used to prepare rice balls in different colours. Japanese rice balls are usually served cold, prepared in advance and kept refrigerated. They must be prepared in a separate area in the food preparation room to reduce the risk of cross-contamination. Vegetarian rice balls are also available to accommodate the needs of vegetarians. For example, meat floss is replaced with vegan floss, and ingredients like cucumber, mushrooms, and soy-based products are added.

4. Though light meals and rice balls are generally marketed as nutritious, healthy and convenient, they actually harbour many potential food safety risks. **They are often prepared with uncooked ingredients and condiments, like raw fish, fresh vegetables and fruit, and their preparation involves multiple manual stages, which greatly increases their risk of contamination by pathogenic microorganisms** (for details, refer to point 1 of supplementary notes)⁶⁻¹⁶. Thus, the food sector must be highly cautious in the purchase, processing, preparation and storage of raw food materials, and strictly abide by the relevant hygiene requirements. To find out the levels of pathogenic microorganisms in light meals and rice balls available on the market, IAM conducted a targeted study on light meals and rice balls available on the local market to understand their safety and hygiene conditions.

Definition and types of samples

5. Please refer to the tables below (Table 1 and Table 2) for an introduction to “light meals” and “rice balls” commonly found on the market in Macao.

Table 1 “Light meals” commonly found on the market in Macao

Introduction		
Light meals	Definition	Light meals generally refer to a natural and healthy diet concept, in which food ingredients are prepared or cooked using simple methods (e.g. served cold, boiled, steamed or grilled) with as

		little use of oil, salt and sugar as possible, while retaining the nutritional values and tastes of food ingredients.
	Food ingredients	Including vegetables, fruits, cereals and tubers, food of animal origin, soybeans and nuts, milk and milk products, oil and salt, among others. Chicken breast and lean beef are the common choices of meat, while broccoli, cherry tomatoes and lettuce are the common choices of vegetables. The common types of staple food used are miscellaneous grains, tubers and fusilli pasta, while the common cooking methods include steaming, boiling and making cold dishes.
	Examples	Chicken breast with purple sweet potato, duck breast salad with quinoa noodles, and fusilli pasta mixed with avocado and crab sticks.

Table 2. Rice balls commonly found on the local market

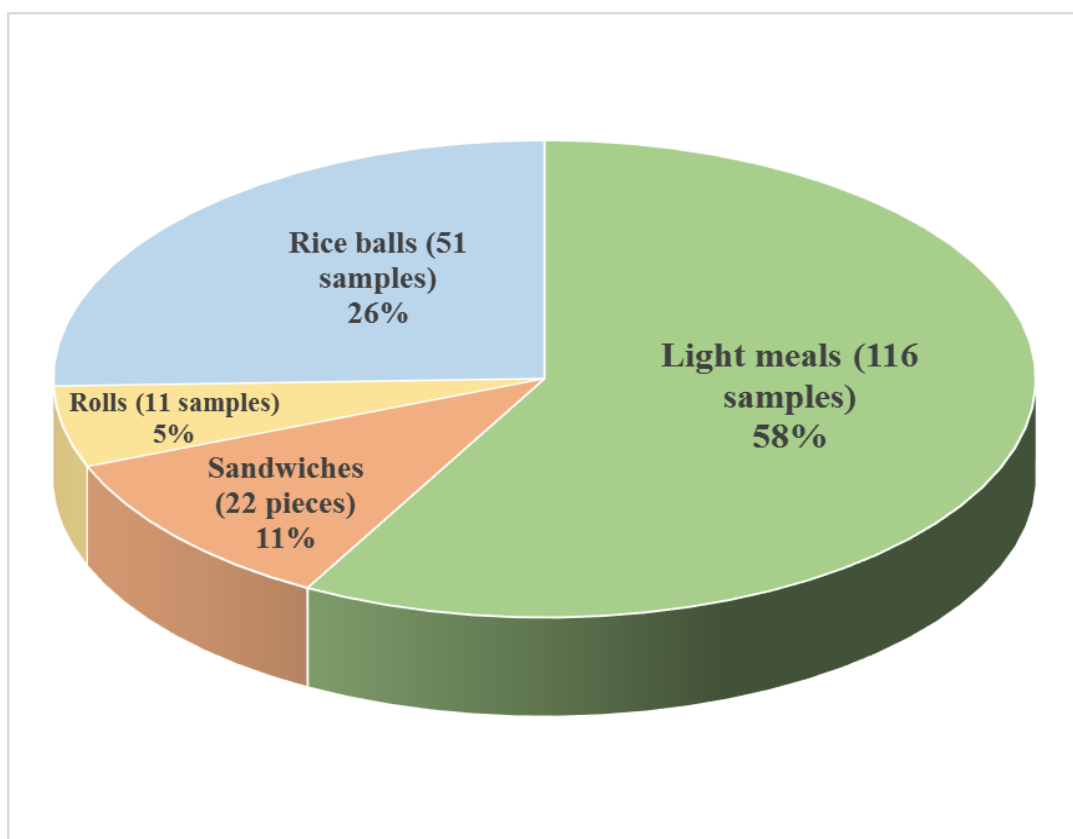
Introduction		
Rice ball	Definition	“Rice ball” refers to a type of food prepared with rice which is stuffed with various kinds of fillings and seasoned with sauces before being kneaded into the shape of a ball.
	Categorization	The rice balls commonly found on the market in Macao are generally divided into: <ul style="list-style-type: none"> ● Chinese sticky rice roll prepared with glutinous rice, stuffed with fillings ranging from fried dough sticks, meat floss, pickled white radish to mashed tuna, corn kernels and shredded chicken steak. ● Japanese rice ball (<i>onigiri</i>), which is usually triangular or cylindrical in shape and stuffed with a variety of seafood like tuna, salmon, whelk and shrimps as fillings. It is wrapped in a dried seaweed sheet to prevent the rice from

		sticking onto hands of consumers.
	Exam ples	Some examples are rice balls made with purple rice and stuffed with pickled radish, vegetarian rice balls, rice balls stuffed with tuna, rice balls stuffed with grilled salmon and whelk and rice balls stuffed with meat floss.

Testing of samples and regulatory measures of Macao

6. Distribution of samples: The targeted food study was conducted in the third quarter of 2022 and 200 samples (Figure 1) were collected from takeaway shops, coffee shops and fast food restaurants in Macao. The collected samples, including non-vegetarian, vegetarian and Taiwanese-style rice balls, were tested for pathogenic microorganisms such as *Salmonella* spp., *Staphylococcus aureus*, *Clostridium perfringens*, *Bacillus cereus*, *Listeria monocytogenes* and *Vibrio parahaemolyticus*.

Figure 1. Proportion of samples collected for the study on light meals and rice balls available on the market



7. Regulatory measures implemented in Macao: **“Microbiological Guidelines for Ready-to-eat Food” (GL 009 DSA 2015) applicable in Macao establishes the classification of microbiological quality (Table 3) of ready-to-eat food (including light meals and rice). The presence of pathogenic microorganisms in ready-to-eat food, namely *Salmonella* spp., *Staphylococcus aureus*, *Clostridium perfringens*, *Bacillus cereus*, *Listeria monocytogenes* and *Vibrio parahaemolyticus*, is classified into various levels.** The guidelines are intended to help the food sector and law enforcement monitor the health risks posed by pathogenic microorganisms present in ready-to-eat food and adopt the appropriate measures to manage the risks.

Table 3. Classification of microbiological quality applicable to study of levels of pathogenic microorganisms in light meals and rice balls available on the market (“Microbiological Guidelines for Ready-to-eat Food” of Macao)

Pathogenic microorganisms	Test results (colony-forming unit (cfu)/g or cfu/ml of food sample)		
	Satisfactory ^a	Borderline ^b	Unsatisfactory (potentially harmful to health and/or unfit for human consumption) ^c
<i>Salmonella</i> spp.	Not detected in 25g/ml of food sample	Not applicable	Detected in 25g/ml of sample
<i>Staphylococcus aureus</i> and other coagulase-positive staphylococci	<20	20-≤10 ⁴	>10 ⁴
<i>Clostridium perfringens</i>	<10	10-≤10 ⁴	>10 ⁴

<i>Bacillus cereus</i> and other pathogenic Bacillus	<10 ³	10 ³ -≤10 ⁵	>10 ⁵
<i>Listeria monocytogenes</i> ^d (ready-to-eat food which supports growth of <i>Listeria monocytogenes</i>)	Not detected in 25g/ml of food sample	Not applicable	Detected in 25g/ml of sample
<i>Vibrio parahaemolyticus</i>	<20	20-≤10 ³	>10 ³

Note: Based on the test results, the competent authorities are advised to take actions and measures (not exhaustive) corresponding to each classification: satisfactory, borderline and unsatisfactory.

- a. **Satisfactory:** No action is required.
- b. **Borderline:** The higher the level of pathogenic microorganisms detected, the higher the risk it poses to food safety. Food producers and operators should be advised to identify the causes behind the issue and adopt appropriate measures for improvement. Collecting food samples again for verification and investigative purposes can be considered.
- c. **Unsatisfactory:** Immediate investigation should be conducted to identify the cause of the high microbiological level. Food producers and operators should be instructed to stop selling the affected food items, investigate immediately to find out the causes behind the issue and adopt appropriate measures for improvement. Food samples should be collected again for investigative purposes. In addition, other law enforcement actions, like food source tracing, should be considered.
- d. Determination of whether food supports the growth of *Listeria monocytogenes* under certain conditions is based on scientific evidence, and reference can be made to the Guidelines on the Application of General Principles of Food Hygiene to the Control of *Listeria monocytogenes* in Food (CAC/GL 61-2007) of Codex Alimentarius Commission. In general, refrigerated ready-to-eat food is likely to support growth of *Listeria monocytogenes*, whereas frozen ready-to-eat food is not. If there is no information proving that a ready-to-eat food item does not support growth of *Listeria monocytogenes* during its expected shelf life, a conservative approach should be taken, that is, the ready-to-eat food item should be treated as one in which growth of *Listeria monocytogenes* can occur.

Conclusion and recommendations

8. The test results revealed that the **level of pathogenic microorganisms in all samples of light meals and rice balls complied with the limits (refer to Table 4)** stated in “Microbiological Guidelines for Ready-to-eat Food” (GL 009 DSA 2015), **with a 100% pass rate** (“unsatisfactory” level of

pathogenic microorganisms was not detected in the samples).

Table 4. Results of investigation of light meals and rice balls available on the market

Pathogenic microorganisms (colony-forming unit (cfu)/g or cfu/ml of food sample)	Test results			
	Light meals	Sandwiches	Rolls	Rice balls
<i>Salmonella</i> spp.	Satisfactory	Satisfactory	Satisfactory	Satisfactory
<i>Staphylococcus aureus</i>	Satisfactory	Satisfactory	Satisfactory	One sample is rated as borderline* while the rest of the samples are rated as satisfactory
<i>Clostridium perfringens</i>	Satisfactory	Satisfactory	Satisfactory	Satisfactory
<i>Bacillus cereus</i>	Satisfactory	Satisfactory	Satisfactory	Satisfactory
<i>Listeria monocytogenes</i>	Satisfactory	Satisfactory	Satisfactory	Satisfactory
<i>Vibrio parahaemolyticus</i>	Satisfactory	Satisfactory	Satisfactory	Satisfactory
Number of samples	116	22	11	51

9. The test results revealed no abnormalities in the levels of pathogenic microorganisms in the food samples, but in terms of hygiene indicator organisms (aerobic colony count and *Escherichia coli*), the results showed that the aerobic colony count in about 14% of the food samples was $10^8 < 10^9$ cfu/g (Figure 2), while *Escherichia coli* was detected in 10% of the food samples (Figure 3). The possible reasons behind this are improper time and temperature management and inappropriate manual handling of food ingredients. In addition, uncooked fresh ingredients and condiments are often used for preparation of light meals and rice balls, greatly increasing the risk of microbiological contamination. IAM will step up inspection and

supervision of food establishments and remind the food sector to pay close attention to all stages of food processing and production, as well as the hygiene practices of their employees and hygiene condition of the working environment, so as to ensure the safety and hygiene of food products. For establishments where inspections revealed poor hygiene and storage conditions and where the staff lack personal hygiene awareness, education and training on food safety will be provided to the staff of the establishments concerned to improve their food safety awareness and standards of food safety practices.

10. The study helps to determine the levels of pathogenic microorganisms in light meals and rice balls sold in Macao and provides a scientific basis for related studies in the future. Moreover, IAM has issued a press release to inform the food sector and the general public about the results of the study, which **have already been uploaded to the Food Safety Information website¹**.

Figure 2. Distribution of aerobic colony counts in light meals and rice balls available on the market

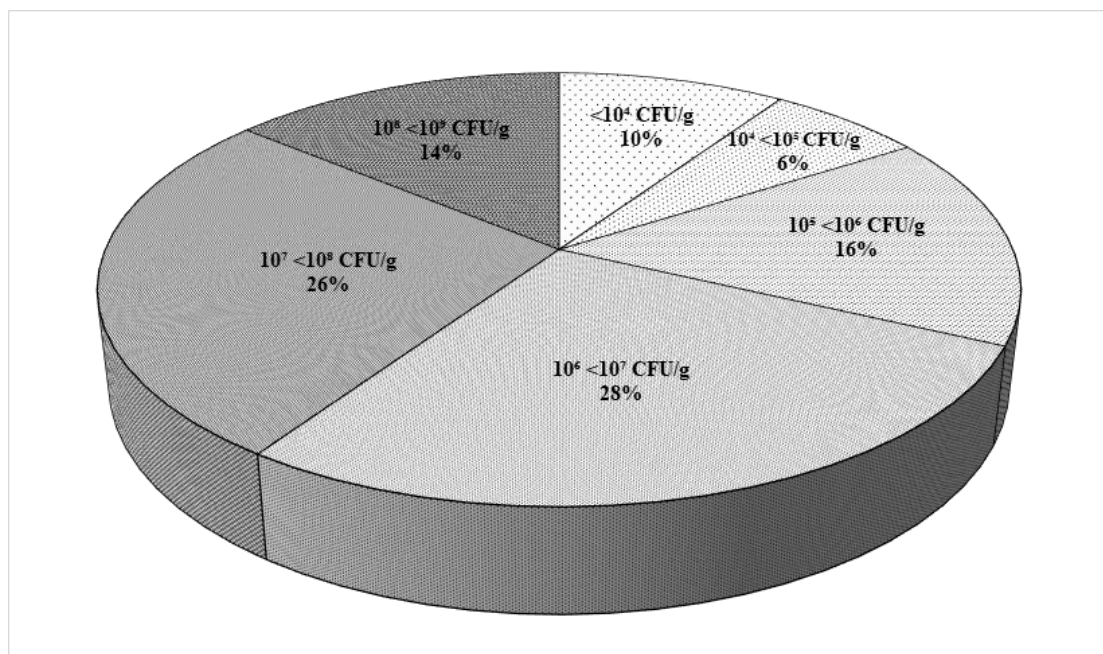
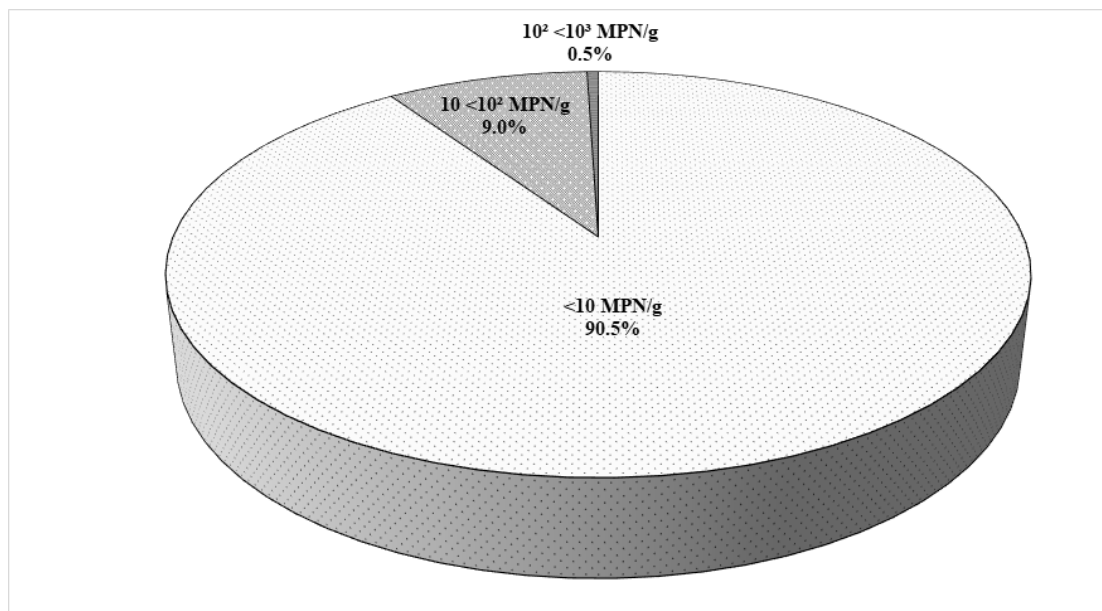


Figure 3. Distribution of *Escherichia coli* in light meals and rice balls available on the market



11. Moreover, considering there are multiple channels to sell food products in Macao, the public also shop for food products online through social networking sites and instant messaging applications, besides buying rice balls directly from takeaway shops, coffee shops and fast food restaurants. However, when buying food products from abroad through online stores and shopping agents, it is difficult to know whether the production, storage and transport of the foreign food products complied with food safety and hygiene requirements. In this respect, consumers should avoid buying food products through the aforesaid channels.

12. IAM has compiled the “Hygiene Guidelines for the Preparation and Sale of Salads” (GL 004 DSA 2016) and “Hygiene Guidelines for the Preparation and Sale of Sandwiches” (GL 005 DSA 2016)¹⁷ to remind the food sector to pay close attention to food safety and hygiene practices in the preparation and handling of fresh food ingredients. In response to the increasing popularity of food delivery services, IAM has also compiled the “Hygiene Guidelines for Online Food Ordering and Delivery Service” (GL 003 DSA 2018) for reference of the food sector¹⁷, so as to strengthen the control of

food safety in food transportation and delivery.

13. Advice to the food sector and the public (Table 5):

Table 5. Advice to the food industry and sector and to the public

Advice to the food sector	Advice to the public:
<ul style="list-style-type: none"> ● The sector should purchase food ingredients of good quality and in good hygiene condition from reputable suppliers. <u>Do not purchase fruit, vegetables, meat, seafood, among others, of unknown origin or food products which have not been subject to mandatory inspection;</u> ● Plan in advance the amount of food ingredients required for the day or for the food serving periods. <u>Avoid preparing too much food and too early in advance,</u> and pay attention to whether the food ingredients are in good condition; ● Properly store perishable food ingredients in the refrigerator. Fresh food ingredients, like cut vegetables and fruits, should be properly wrapped or placed in covered containers before storing them in the refrigerator; ● Moreover, the sector has the obligation to <u>retain records of the purchase and sale of food or any relevant invoices,</u> so as to help the competent authorities trace the origin of food and its 	<ul style="list-style-type: none"> ● Always buy from reputable shops in good hygiene condition; ● After purchase, <u>consume the light meals and rice balls as soon as possible. Avoid leaving them at room temperature for an extended period of time;</u> ● If the light meal or rice ball is not for immediate consumption, keep it refrigerated as soon as possible or store it properly by following the storage instructions indicated on its packaging; ● When choosing a food-delivery service, pay attention to whether the food storage and transportation processes comply with food safety requirements and be aware of the potential food safety risks involved; ● If the light meal or rice ball appears to be spoiled or has an unpleasant smell, do not buy or eat it; ● In addition, considering that the sauces/dressings added to some rice balls and light meals are high in fat and sodium, it is advisable to maintain a balanced diet and consume them in moderation.

distribution as necessary. It also serves to protect the interests of the sector.	
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Note: In general, the more samples of light meals and rice balls are tested, the more information is obtained to understand the safety of commercially available light meals and rice balls. As this investigation only sampled and tested some of the most popular light meals and rice balls, the results can only reveal the levels of pathogenic microorganisms in light meals and rice balls sold in Macao in a given period.

Supplementary notes:

1. The table below (Table 6) provides an introduction to the pathogenic microorganisms tested in the investigation and their adverse impacts on human health.

Table 6. Introduction to pathogenic microorganisms and their adverse impacts on human health

Pathogenic microorganisms	Introduction and adverse impacts on human health
<i>Salmonella</i> spp.	<ul style="list-style-type: none"> ● <i>Salmonella</i> is a group of pathogenic microorganisms that can live in the intestinal tract of humans and animals. It is commonly found in food animals (such as chickens, pigs and cattle), animal offal and their products. They can be killed by thorough cooking of food. ● In general, the common symptoms that appear after consumption of <i>Salmonella</i>-contaminated food include acute fever, nausea, abdominal pain and diarrhoea. Moreover, <i>Salmonella</i> can cause severe dehydration in young children and the elderly, which can be life-threatening.
<i>Staphylococcus aureus</i>	<ul style="list-style-type: none"> ● <i>Staphylococcus aureus</i> is commonly found in the nasal cavity, throat, hair and skin of human body, and can also be found in large amounts in inflamed

	<p>or purulent wounds.</p> <ul style="list-style-type: none"> ● <i>Staphylococcus aureus</i> readily grows on uncooked manually processed food, and improper food storage can cause it to multiply rapidly on food and release toxins. ● Although <i>Staphylococcus aureus</i> can be killed in the cooking process, the toxins it produced are not readily destroyed despite high-temperature cooking. ● The common cause of staphylococcal food poisoning is consumption of contaminated poultry, meat products and dairy products. In general, the symptoms that may appear after consumption of food contaminated with <i>Staphylococcus aureus</i> include nausea, vomiting, stomach cramps and diarrhoea.
<p><i>Clostridium perfringens</i></p>	<ul style="list-style-type: none"> ● <i>Clostridium perfringens</i> exists naturally in the environment and is commonly found in the intestinal tract of humans and animals. It is likely present in vegetables exposed to soil, dust and faecal matter. <i>Clostridium perfringens</i> infection is often associated with inadequately cooked food and food that is cooked but stored at inappropriate temperatures. ● Moreover, the heat of cooking can activate the germination of spores of <i>Clostridium perfringens</i>, which survive in anaerobic condition and multiply in the low-oxygen environment. ● In general, the symptoms that may appear after consumption of food contaminated with <i>Clostridium perfringens</i> include vomiting, diarrhoea, abdominal pain and fever.

<p><i>Bacillus cereus</i></p>	<ul style="list-style-type: none"> ● <i>Bacillus cereus</i> is ubiquitous in nature, found in soil, dust, air and wastewater, and can survive in both aerobic and anaerobic conditions. It is commonly found in meat and vegetables, and in rice and rice products stored at room temperature. Improper handling and storage of food increases the risk of proliferation of the bacterium. ● <i>Bacillus cereus</i> is capable of producing spores which are very heat-resistant and are not readily destroyed by cooking the food. In view of this, stringent control of food storage temperature is crucial to preventing <i>Bacillus cereus</i> contamination of food. ● Depending on the types of toxins produced by <i>Bacillus cereus</i>, different clinical symptoms will occur after ingestion of food contaminated with <i>Bacillus cereus</i>. It is generally divided into emetic food poisoning and diarrhoeal food poisoning, based on clinical symptoms. In the case of emetic food poisoning, the usual symptoms are nausea and vomiting; whereas abdominal pain, diarrhoea, and abdominal cramps, and possibly nausea, are usual in the case of diarrhoeal food poisoning, but vomiting is rare.
<p><i>Listeria monocytogenes</i></p>	<ul style="list-style-type: none"> ● <i>Listeria monocytogenes</i> is a pathogenic microorganism that causes bacterial foodborne diseases. It can survive in a range of temperatures from 0°C to 45°C, and can grow and proliferate at refrigeration temperatures in the refrigerator. It is commonly found in various types of food that require refrigeration. ● <i>Listeria monocytogenes</i> is widely distributed in nature and the kind of food products which are

	<p>susceptible to its contamination include dairy products, meat products and aquatic products.</p> <ul style="list-style-type: none"> ● In general, individuals infected with <i>Listeria monocytogenes</i> will develop fever, muscle pain, headache, nausea, vomiting and diarrhoea, among other symptoms. Infected newborns, elderly persons and individuals with weakened immune systems may develop serious complications and even death. In the case of infected pregnant women, it can lead to stillbirth, premature birth or severe infections in the newborns.
<p><i>Vibrio parahaemolyticus</i></p>	<ul style="list-style-type: none"> ● <i>Vibrio parahaemolyticus</i> is a halophilic pathogenic microorganism widely distributed in marine environments where the salt in seawater is favourable to its survival. Seafood, including fish and crustaceans, are more susceptible to its contamination. <i>Vibrio parahaemolyticus</i> infection in humans is usually associated with consumption of raw or undercooked seafood, while improper food handling may result in cross-contamination, causing other food to become contaminated. However, <i>Vibrio parahaemolyticus</i> is not heat-resistant and can be destroyed by cooking food thoroughly. ● In general, the main symptoms of <i>Vibrio parahaemolyticus</i> infection include fever, nausea, vomiting, abdominal pain and watery diarrhoea.

November, 2023

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