

**Risk Assessment Studies**  
**Report No. 57**  
Microbiological Hazard Evaluation

**MICROBIOLOGICAL QUALITY OF SALADS AVAILABLE AT  
THE LOCAL MARKET**

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Centre for Food Safety  
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**MICROBIOLOGICAL QUALITY OF SALADS AVAILABLE AT  
THE LOCAL MARKET**

## EXECUTIVE SUMMARY

Salads are a mixture of raw vegetables and are popular among consumers in Hong Kong. Although previous risk assessment study by the Centre for Food Safety (CFS) on salads did not indicate major problem from perspectives of microbiological safety and quality in general, more recent overseas studies and reports have demonstrated the potential health risk arising from their contamination with pathogens. To better understand the latest local situation, CFS embarked on another risk assessment study entitled “Microbiological Quality of Salads Available at the Local Market” on salads composed primarily of raw vegetables sold in Hong Kong. Since some ready-to-eat or raw hydroponic and aquaponic salad vegetables were available in the local market in recent years, such vegetables were also included in this study to reflect the latest situation in Hong Kong.

From September 2016 to February 2017, the CFS collected a total of 101 samples from the local market, including 8 hydroponic salad vegetable samples and 4 aquaponic salad vegetable samples. Laboratory analysis for specific foodborne pathogens i.e. *Escherichia coli* O157, *Salmonella* spp. and *Listeria monocytogenes*, and that for a hygienic indicator i.e. *E. coli* were conducted by the Public Health Laboratory Services Branch of the Centre for Health Protection, Department of Health. Result interpretation was made reference to the Microbiological Guidelines for Food issued by the CFS in 2014.

Results showed that apart from a salad sample found to contain *L. monocytogenes* at a level of 2,400 cfu/g, the remaining 100 samples reached the satisfactory level of pathogens tested (i.e. no *Salmonella* spp. and *E. coli* O157 were detected in 25 grams of foods; and no *L. monocytogenes* was detected in 25 grams of foods or with *L. monocytogenes* count <10 cfu/g). Regarding the hygiene indicator (i.e. *E. coli* count), none of the samples taken were found to be unsatisfactory according to CFS' Microbiological Guidelines for Food.

In response to the concerned unsatisfactory sample, the CFS informed the premises concerned of the irregularity and instructed it to stop selling the affected food item immediately. The CFS also provided health education on food safety and hygiene to the premises which made temporary voluntary suspension on its business for thorough cleaning and disinfection. All follow-up samples taken afterward were satisfactory.

## **Conclusion and recommendations**

Vast majority of the samples (99%) collected did not have microbiological food safety concern on the parameters tested and all samples were of acceptable hygienic quality in general. Use of contaminated raw materials, inadequate temperature control and/or post-processing contamination might be the possible cause of the unsatisfactory result. Even though it is uncommon, results of the study still highlight the possibility of microbiological contamination of ready-to-eat raw fresh produces and their products and thus consumers (in

particular susceptible groups) should not overlook the potential risks.

### **Advice to public**

- Susceptible groups (including pregnant women, children, the elderly and people with low immunity) are advised not to eat pre-prepared or pre-packaged salads in general. If salad is wanted, they are advised to prepare their own salad and consume it as soon as possible.
- Consume freshly made salad immediately, or refrigerate it immediately and consume it as soon as possible.
- Handle products in accordance with manufacturers' instructions.
- Keep hands clean. Wash hands with clean running water and soap thoroughly before handling salads and ready-to-eat raw salad vegetables.
- Avoid opportunity where cross-contamination can take place when handling vegetables that will be eaten raw (e.g. use one cutting board for ready-to-eat food and a separate one for raw non-ready-to-eat food).

### **Advice to trade**

- Follow Good Manufacturing Practices to help control associated microbial hazards.

- Provide specific directions on product storage and use, including the ‘use-by’ date or other shelf-life indicators.
- Specify the need to keep washed ready-to-eat prepackaged fresh leafy vegetables refrigerated until used as well as other guidance on how to safely handle fresh-cut, pre-cut or ready-to-eat leafy vegetables.
- Food handlers should maintain good personal hygiene and have good hygienic practices when handling food.



## **Microbiological Quality of Salads Available at the Local Market**

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### **OBJECTIVES**

The objective of this study is to provide an updated assessment on the microbiological quality of salads composed primarily of raw vegetables, including ready-to-eat raw hydroponic and aquaponic salad vegetables, available at the local market.

### **INTRODUCTION**

2. Salads are a mixture of raw vegetables and are popular among consumers in Hong Kong.

3. Reports of food poisoning outbreaks linked to salads in overseas countries such as Canada, the United Kingdom and the United States have been identified<sup>1,2,3</sup>. The World Health Organization also states that there is an increasing number of *E. coli* O157:H7 outbreaks associated with the consumption of vegetables (including salads) whereby contamination may be due to contact with faeces from domestic or wild animals at some stage during cultivation or handling<sup>4</sup>. The Centre for Food Safety (CFS) has all along paid attention to the safety and hygienic conditions of ready-to-eat raw fresh vegetables.

4. In 2002, the Food and Environmental Hygiene Department (FEHD) conducted a risk assessment study on salads in Hong Kong. The study analysed salad samples tested under the Food Surveillance

Programme from 1999 through 2001. Results showed that 10 (1.7%) out of 573 samples contained unsatisfactory level of specific pathogens (*Listeria monocytogenes* and *Salmonella* spp.) while 3 (1.3%) out of 239 samples were found unsatisfactory in terms of *E. coli* count<sup>5</sup>. Although there was room for improvement for individual salad sample, the report did not indicate major problem from perspectives of microbiological safety and quality in general.

5. To better understand the latest situation, the CFS embarked on another risk assessment study on the microbiological safety and quality of salads composed primarily of raw vegetables sold in Hong Kong.

6. The CFS was aware that there were some ready-to-eat or raw hydroponic and aquaponic salad vegetables available in the local market in recent years; these two types of vegetables were also included in the study.

### Hydroponics

7. The CFS was aware of local media reported that certain local restaurateurs have been growing, harvesting and transforming their own hydroponic plants into dishes during past few years<sup>i,ii,iii,iv</sup>.

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<sup>i</sup> [http://hk.on.cc/hk/bkn/cnt/lifestyle/20150305/bkn-20150305123002248-0305\\_00982\\_001.html](http://hk.on.cc/hk/bkn/cnt/lifestyle/20150305/bkn-20150305123002248-0305_00982_001.html)

<sup>ii</sup> <http://www.scmp.com/magazines/48-hours/article/1802955/five-hong-kong-restaurants-grow-their-own-produce>

<sup>iii</sup> [http://hk.apple.nextmedia.com/etw/%E5%91%A8%E5%88%8A%E4%B8%BB%E9%A1%8C%E9%A3%B2%E9%A3%9F/article/20140404/3\\_17231846/%E5%88%9D%E6%98%A5-%E7%B6%A0%E8%89%B2-%E6%BB%8B%E5%91%B3-%E5%9E%8B%E6%A0%BC%E6%9C%89%E6%A9%9F%E5%B0%8F%E9%A4%A8-](http://hk.apple.nextmedia.com/etw/%E5%91%A8%E5%88%8A%E4%B8%BB%E9%A1%8C%E9%A3%B2%E9%A3%9F/article/20140404/3_17231846/%E5%88%9D%E6%98%A5-%E7%B6%A0%E8%89%B2-%E6%BB%8B%E5%91%B3-%E5%9E%8B%E6%A0%BC%E6%9C%89%E6%A9%9F%E5%B0%8F%E9%A4%A8-)

8. Hydroponics, as stated by CODEX Alimentarius (Codex), is a general term for the production of plants without soil in a water medium<sup>6</sup>. In practice, it is a technology for growing plants in nutrient solutions (i.e. water containing fertilizers)<sup>7</sup>.

9. In 2013, the Agriculture, Fisheries and Conservation Department (AFCD) and Vegetable Marketing Organization (VMO) jointly established a “Controlled Environment Hydroponic Research and Development Centre” (Hydroponic Centre) in Hong Kong to introduce and demonstrate the related advanced techniques and equipment to the industry and other interested investors<sup>7,8,9</sup>. Information from the Planning Department also showed that there are some 20 hydroponic farms established on farmlands in the New Territories or in industrial buildings supplying hydroponic vegetables to restaurants, retail shops, supermarkets and individual households<sup>7</sup>.

### Aquaponics

10. On the other hand, another farming mode known as "aquaponics" seems to have emerged in the background of increasing popularity of environmentally friendly business.

11. Aquaponics integrates the recirculating aquaculture system and hydroponics in one production system, which claims to have a better use of land and water, simpler pollution control methods (e.g. do not use

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<sup>iv</sup> <http://hk.apple.nextmedia.com/supplement/food/art/20141012/18896851>

fertilizers or chemical pesticides), etc<sup>7,10,v</sup> .

12. Though not common, the CFS notes that some operators of local aquaponic farms engage in production and promote aquaponics (as an element of green living) through provision of seminars, technical support on setting up aquaponic farm for clients on trial basis and similar endeavour in schools, churches and social enterprises. They also sell their farm produce directly to the markets<sup>7</sup>.

### Microbiological hazards in salads, hydroponic vegetables, and aquaponic vegetables

#### *Salads*

13. Literature has revealed the potential microbiological hazards of salads. A study, which examined the microbiological quality of open, ready-to-eat, prepared salad vegetables, showed that 3% of the samples collected from food service areas and customer self-service bars were detected with *E. coli* level ranging from  $10^2$  to  $10^5$  colony-forming units per gram (cfu/g), and one sample was detected with *L. monocytogenes* count at 840 cfu/g<sup>11</sup>.

14. Besides, some studies have also indicated the microbiological hazards in pre-packaged salad leaves. A microbiological survey of Food Safety Authority of Ireland reported the presence of *Salmonella* in a bag of rocket leaves, and the presence of *E. coli* O157 in one bag of mixed

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<sup>v</sup> <http://hk.apple.nextmedia.com/supplement/food/art/20150608/19173711>

salad leaves but the isolate was not of clinical significance as it did not contain the genes necessary to produce verotoxin (shiga toxin)<sup>12</sup>. Separately, the microbiological survey of Ministry of Primary Industries of New Zealand reported the presence of other *Listeria* species (i.e. not *L. monocytogenes*) in 19 out of 307 (6.2%) pre-packaged ready-to-eat leafy salad samples, in which *L. grayi* (n=2), *L. innocua* (n=4), *L. ivanovii* (n=3), *L. seeligeri* (n=8) and *L. welshimeri* (n=2) were identified<sup>13</sup>.

### *Hydroponic vegetables*

15. Similarly, some published studies demonstrated the potential risks of microbial contamination in hydroponically grown vegetables<sup>14</sup>. In particular, a study aimed at determining the incidence of *Salmonella* and *L. monocytogenes* on hydroponically grown bell peppers showed that *Salmonella* was isolated from four bell pepper samples (3%)<sup>15</sup>. Other studies also proved the possibility of internalisation of *E. coli* O157:H7 and *Salmonella* into hydroponically-grown plants<sup>16,17,18</sup>.

16. In addition, present evidence suggested that the principle route of bacterial contamination of growing leaves in a hydroponic system is from the plant roots via internalisation rather than from direct contamination of the leaves<sup>19</sup>. The contamination of the leaves from direct contact with the pathogens would occur because of cross-contamination during the post-harvest process. Pathogenic bacteria from animals and environment may also affect the safety of hydroponic vegetables<sup>20</sup>.

17. Moreover, Codex pointed out that microbial risks of water used in

growing vegetables hydroponically may differ from the microbial risks of water used conventionally to irrigate vegetables in soil because it serves as both irrigation and growth medium, with the latter of which could potentially enhance the survival of pathogens and pose a higher risk of microbiological contamination<sup>6</sup>.

### *Aquaponic vegetables*

18. Similarly, literature also supported the potential risk of microbiological contamination among aquaponic vegetables. In a published study, it was shown that aquaponic lettuce may harbour spoilage and faecal microorganisms despite that the concentration of microorganisms is lower than that of soil grown lettuce<sup>21</sup>. Other studies suggested that fish can carry human pathogens like *E. coli* and *Salmonella* if they are exposed to contaminated feed, waters or sediment<sup>22</sup>. In fact, fish have natural defenses against bacterial colonization of human pathogens. However, if the hygiene of an aquaponic system goes unchecked which allows the population of pathogens to go up, fish in the system could become stressed and ended up in increased susceptibility to carrying human pathogens and becoming infected with other fish pathogens<sup>22</sup>.

## **SCOPE OF STUDY**

19. Although fresh produce at harvest is usually colonized by non-pathogenic natural epiphytic microflora with no public health

significance, further accidental or intentional microbial contamination with pathogenic microorganisms is possible from the environment, animals or humans throughout the farm-to-consumer continuum (i.e. any steps during growth, harvest, processing, packaging, transportation, handling, distribution and retailing)<sup>23</sup>. Codex reported that pathogenic microorganisms such as *Salmonella* spp., *Shigella* spp., pathogenic strains of *E. coli* and *L. monocytogenes* as well as some viruses and parasites are commonly associated with fresh vegetables<sup>6</sup>. Having regard to local epidemiology, public concern and laboratory resources, sample testing was restricted to specific foodborne pathogens including *E. coli* O157, *Salmonella* spp. and *L. monocytogenes*. Moreover, in order to get an overall hygiene assessment, all samples taken were also tested for a hygiene indicator, *E. coli*.

20. Targets for this study included both prepackaged and non-prepackaged salads made primarily with raw (i.e. uncooked) vegetables, including ready-to-eat<sup>vi</sup> raw hydroponic and aquaponic salad vegetables at the local market.

21. As salads that had an overwhelming portion of non-vegetable ingredients were not the primary target of this study, products which contained non-plant ingredients like fish, seafood, meat (e.g. ham) and egg were excluded. After taking into account factors in particular market availability, it was decided that salad samples which contained

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<sup>vi</sup> “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<sup>24</sup>.

significant amounts of raw vegetables together with a relatively minor portion of other plant ingredients e.g. cereals (including quinoa and crouton) and fruit as well as specific non-plant ingredients, namely cheese (except cheese made from raw milk), dried bacon/ dried fish and oil/ vinegar/ sauces/ dressings would still be considered as valid salad samples in the study.

22. Regarding raw salad vegetables, since washing has the potential to reduce the overall microorganisms load if properly performed<sup>23</sup>, products labelled as “wash before use” were not included in the study. Also, assessment on prepackaged products that were not specifically labelled as “ready-to-eat” and non-prepackaged products that were not intended for “ready-to-eat” fell out of the scope of this study.

23. In view of the anticipated scarcity of hydroponic and aquaponic salad vegetables in the local market, if raw hydroponic or aquaponic vegetables were identified as an ingredient in a salad sample during sampling, only that particular raw hydroponic or aquaponic vegetable component (i.e. all other ingredients such as vinegar, oil and dressing in that particular sample would be excluded upon purchase) would be taken whenever possible and feasible.

## **METHODOLOGY**

### **Sampling**

24. Sampling work was conducted from September 2016 to February 2017.



25. A total of 101 samples (each sample consisted of two sets; each set weighed at least 150 grams) were collected from the local market, including 8 hydroponic salad vegetable samples and 4 aquaponic salad vegetable samples.

### Laboratory analysis

26. All samples were stored at 4°C or below after collection and on their way to the Public Health Laboratory Services Branch of the Centre for Health Protection, Department of Health, within four hours of sampling.

27. Every sample was subjected to test of three specific pathogens (i.e. *E. coli* O157, *Salmonella* spp. and *L. monocytogenes*) and a hygiene indicator (i.e. *E. coli*).

28. While the detection of *E. coli* O157 and *Salmonella* spp. was performed using bioMérieux VIDAS ECPT kit and National Standard Method F13 issue 1 published by Health Protection Agency in the United Kingdom respectively, *E. coli* count was carried out using AOAC Official Methods 991.14 (Revised: March 1998) (Petrifilm Method).

29. Qualitative and quantitative analysis of *L. monocytogenes* were performed according to the Health Protection Agency (2004) National Standard Method F19 issue 1. It is worthwhile to mention that qualitative analysis was only meant for refrigerated products<sup>vii</sup> with shelf

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<sup>vii</sup> “Refrigerated product” means perishable food stored in a refrigerator (not freezers) so as to maintain

life more than five days<sup>viii</sup> while the rest was subject to quantitative analysis.

### Result analysis

30. Results of the samples were interpreted and analysed by the Risk Assessment Section of the CFS.

### *Microbiological criteria used in this study*

31. The Microbiological Guidelines for Food issued by the CFS stipulates the microbiological criteria for foodborne pathogens — *E. coli* O157, *Salmonella* spp. and *L. monocytogenes* (Table 1a); and a hygiene indicator — *E. coli* (Table 1b), in ready-to-eat foods in general<sup>24</sup>.

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its safety and quality. These products usually carry a special storage instruction e.g. “keep refrigerated”/ “keep at 4°C on the label.

<sup>viii</sup> “Shelf life more than five days” means durable life date shown as a “use by” or “best before” date on the package greater than five days.

*Foodborne pathogens – E. coli* O157, *Salmonella* spp. and *L. monocytogenes*

**Table 1a. *E. coli* O157, *Salmonella* spp. and *L. monocytogenes* criteria stipulated under the Microbiological Guidelines for Food**

	<b>Microbiological quality</b> Result (colony-forming unit (cfu)/g unless otherwise specified)		
	<b>Satisfactory</b>	<b>Borderline</b>	<b>Unsatisfactory:</b> Potentially injurious to health and/or unfit for human consumption
<i>Escherichia coli</i> O157	Not detected in 25g	N/A	Detected in 25g
<i>Salmonella</i> spp.	Not detected in 25g	N/A	Detected in 25g
<i>Listeria monocytogenes</i>			
For refrigerated food <sup>^</sup> (excluding frozen food) or food intended for infants	Not detected in 25g	N/A	Detected in 25g
For other ready-to-eat food	< 10	10 - ≤100	> 100

N/A= not applicable

<sup>^</sup> This criterion applies to all refrigerated food (excluding frozen food) unless there is scientific evidence supporting that the food concerned does not support the growth of *Listeria monocytogenes* under refrigeration. Reference can be made to the Codex Guidelines on the Application of General Principles of Food Hygiene to the Control of *Listeria monocytogenes* in Food (CAC/GL 61-2007).

### ***E. coli* O157**

32. *E. coli* refers to bacteria commonly found in the gastrointestinal tract of humans and warm-blooded animals and its presence in food generally indicates direct or indirect faecal contamination<sup>4,24</sup>. Most strains of *E. coli* are harmless, though pathogenic strains such as *E. coli*

O157 can cause severe foodborne diseases. The bacteria, including *E. coli* O157, can be transmitted to humans through consumption of contaminated food or water<sup>4</sup>. In accordance to the CFS' microbiological criteria (Table 1a), it will be considered unsatisfactory if *E. coli* O157 is detected in 25 grams of food.

### **Salmonella spp.**

33. *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 environments such as pond-water sediment. Human infection by *Salmonella* is spread through the faecal-oral route and contact with contaminated water. Although *Salmonella* was traditionally thought to be associated with consumption of animal products in the past, fresh produce has recently been implicated as source of major outbreaks<sup>25</sup>. As shown in Table 1a, according to the CFS' microbiological criteria, it will be considered unsatisfactory if *Salmonella* spp. is detected in 25 grams of food.

### **L. monocytogenes**

34. *L. monocytogenes* has been isolated in foods including raw vegetables. Even when *L. monocytogenes* is initially present at a low level in a contaminated food, its ability to grow during refrigerated storage means that its levels are likely to increase during refrigerated storage of those foods that support the growth of the microorganism.

Generally, fresh cut vegetables have a relatively short shelf-life and do not support as rapid growth of *L. monocytogenes* as some other high risk foods like milk or deli-meats. It is therefore expected that the growth of *L. monocytogenes* in fresh cut vegetables would not be as drastic as that in other foods and this explains its lower risk for given initial contamination rates and levels<sup>26</sup>.

35. As shown in Table 1a above, different *L. monocytogenes* criteria, which made reference to the international practices, have been established for (i) refrigerated food (excluding frozen food) or food intended for infants and (ii) other ready-to-eat food, at which levels were based on the current knowledge that the risk of *L. monocytogenes* increases in ready-to-eat food i.e. refrigerated food (excluding frozen food) that supports the growth of the pathogen. Establishing the limit of “not detected in 25g” for this class of high risk foods is to provide a degree of confidence that *L. monocytogenes* will not be present in food at levels that represent a risk to consumers. A less stringent limit (100 cfu/g) could be applied for other ready-to-eat food as well as any refrigerated food with scientific evidence demonstrating that it does not support the growth of *L. monocytogenes* under refrigeration.

36. Referenced from overseas practices, it is considered that growth of *L. monocytogenes* to levels above 100 cfu/g throughout the stated shelf-life, under reasonably foreseeable conditions of distribution, storage and use, will not generally occur in food samples with refrigerated shelf life of no greater than five days due to insufficient multiplication time<sup>27,28</sup>.

*Hygiene Indicator organism - E. coli*

**Table 1b. *E. coli* criteria stipulated under the Microbiological Guidelines for Food**

	<b>Microbiological quality</b> Result (colony-forming unit (cfu)/g)		
	<b>Satisfactory</b>	<b>Borderline</b>	<b>Unsatisfactory</b>
<b>Hygiene indicator organisms</b>			
<i>Escherichia coli</i>	< 20	20 - $\leq 10^2$	$> 10^2$

37. As mentioned above, *E. coli* 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 bacteria in food suggests a general lack of cleanliness in handling and improper storage<sup>24</sup>. In our criteria as shown in Table 1b, it will be considered unsatisfactory if *E. coli* count is larger than 100 cfu/g of food.

## **RESULTS**

38. For foodborne pathogens, no *Salmonella* spp. and *E. coli* O157 were detected in 25 grams of foods of all samples. In addition, using the criteria stated before, all samples were considered satisfactory except one salad sample was detected with the pathogen *L. monocytogenes* at an unsatisfactory level of 2,400 cfu/g.

39. Regarding the hygiene indicators (i.e. *E. coli* count), none of

the samples taken were found to be unsatisfactory according to CFS' Microbiological Guidelines for Food.

## DISCUSSION

### Microbiological safety of samples collected

40. This study showed that vast majority (100/101 or 99%) of the samples was satisfactory in terms of microbiological safety; yet one salad sample was detected with an unsatisfactory level of *L. monocytogenes*. Use of contaminated raw materials, inadequate temperature control and/or post-processing contamination might be the possible cause of the unsatisfactory result.

### *L. monocytogenes*

41. *L. monocytogenes* is a bacterium commonly found in soil and has been isolated from foods such as raw vegetables. It can grow at refrigeration temperatures, and survive for long periods in the environment, on foods, in the processing plant, and in the refrigerator<sup>29</sup>.

42. Control of *L. monocytogenes* growth in ready-to-eat food can be achieved by various approaches. For instance, strict control of temperature so that ready-to-eat foods never exceed 6°C (preferably 2°C - 4°C) is essential to assure that the growth of *L. monocytogenes* to any significant degree does not occur before the product is consumed. Temperature abuse that may occur supporting the growth of *L. monocytogenes* could result in a reduction of product shelf life<sup>29</sup>.

43. In addition, basic cleaning and disinfection programmes are critical to assuring control of *L. monocytogenes*. As *L. monocytogenes* has the ability to form biofilms on a variety of surfaces, food contact surfaces should be properly cleaned and disinfected. Moreover, preventing recontamination of the products, e.g. prior to final packaging, can also control the risk of foodborne listeriosis<sup>29</sup>.

*Follow-up actions on sample with unsatisfactory level of L. monocytogenes*

44. Upon receipt of the unsatisfactory result on 15 November 2016 as mentioned in paragraph 38 above, CFS/FEHD conducted a joint investigation at the food premises. The CFS informed the premises concerned of the irregularity and instructed it to stop selling the food item in question immediately. The CFS also provided health education on food safety and hygiene to the person-in-charge and staff of the premises. The premises voluntarily suspended its business temporarily to carry out thorough cleaning and disinfection. The CFS also traced the sources of the ingredients of the affected food item and subsequent 13 food samples and 20 environmental swabs (ES) taken on 15 November 2016 were all tested negative for *L. monocytogenes*

45. Among the submitted food safety plan, the affected premises has since then stopped the selling of high risk raw food (smoked salmon) and salad, started the use of more effective sanitizer targeted for reduction and elimination of *L. monocytogenes* and increased the frequency of



cleaning. The premises also enhanced its staff training to strengthen their prevention of *L. monocytogenes* cross-contamination.

46. CFS/FEHD had conducted another joint inspection on 5 December 2016 and was satisfied with the improvement measures implemented by the food factory. A total of 19 ES taken were all negative for *L. monocytogenes*.

47. In view of the improvement measures implemented by the food premises, confirmation of improvement measures in follow-up visit and negative environmental swab and food samples, CFS/FEHD acceded to request made by the premises concerned to resume its business. Having said that, the inspection and surveillance had been enhanced to ensure greater protection to the public.

## **LIMITATIONS**

48. Sampling work was conducted from September 2016 to February 2017 where samples were mainly collected during the winter time. This may limit the generalisability of the study as the microbial load of foods including salads and vegetables is likely affected by ambient temperature and humidity which are season dependent<sup>30</sup>.

49. Limited availability of ready-to-eat raw hydroponic and aquaponic salad vegetables in the local market resulted in small sample size of these samples in this study and limited the representativeness of the conclusion drawn.

## **CONCLUSION AND RECOMMENDATIONS**

50. Vast majority of the samples (99%) collected did not have microbiological food safety concern on the parameters tested and all samples were of acceptable hygienic quality in general. Use of contaminated raw materials, inadequate temperature control and/or post-processing contamination might be the possible cause of the unsatisfactory result. Even though it is uncommon, results of the study still highlight the possibility of microbiological contamination of ready-to-eat raw fresh produces and their products and thus consumers (in particular susceptible groups) should not overlook the potential risks.

51. Below are some advices for public and trade in relation to the safety of salads, including ready-to-eat raw salad vegetables.

### **Advice to public**

- Susceptible groups (including pregnant women, children, the elderly and people with low immunity) are advised not to eat pre-prepared or pre-packaged salads in general. If salad is wanted, they are advised to prepare their own salad and consume it as soon as possible<sup>31,32,33,34</sup>.
- Consume freshly made salad immediately, or refrigerate it immediately and consume it as soon as possible<sup>34,35,36</sup>.
- Handle products in accordance with manufacturers' instructions<sup>35,36</sup>.
- Keep hands clean. Wash hands with clean running water and soap

thoroughly before handling salads and ready-to-eat raw salad vegetables<sup>35,36</sup>.

- Avoid opportunity where cross-contamination can take place when handling vegetables that will be eaten raw (e.g. use one cutting board for ready-to-eat food and a separate one for raw non-ready-to-eat food)<sup>35,36</sup>.

### **Advice to trade**

- Follow Good Manufacturing Practices to help control associated microbial hazards<sup>37</sup>.
- Provide specific directions on product storage and use, including the ‘use-by’ date or other shelf-life indicators<sup>6</sup>.
- Specify the need to keep washed ready-to-eat prepackaged fresh leafy vegetables refrigerated until used as well as other guidance on how to safely handle fresh-cut, pre-cut or ready-to-eat leafy vegetables<sup>6</sup>.
- Food handlers should maintain good personal hygiene and have good hygienic practices when handling food<sup>38</sup>.

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