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BACTERIAL CONTAMINATION IN FOODS SOLD BY STREET VENDORS AROUND CHOW KIT, KUALA LUMPUR

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ABSTRACT

Objective: Consumption of roadside food potentially increases the risk of foodborne diseases caused by pathogens. This study was carried out to determine the level of bacterial contamination in food sold by street vendors around Chow Kit area and its association with the vendor's level of cleanliness. **Methods**: A total of 30 food samples were analyzed to determine the total viable count, total coliform, *E. coli* and *S. aureus* counts, and presence of *Salmonella* sp. by using standard plate count method. Inspection of vendors' premise cleanliness were done based on the food premise inspection form used by the Ministry of Health with slight modifications. **Result:** About 87% of the samples showed presence of aerobic microorganisms' contamination with a mean total viable count of 4.07±0.63 Log CFU/g. There were 43% of the samples that showed presence of total coliform with an average of 4.19±0.89 Log CFU/g. Meanwhile, only two samples were found to be *E. coli* positive. *S. aureus* was detected in 33% of samples with an average of 3.88±0.86 Log CFU/g in the food. No *Salmonella* were found in all of the samples. The total viable count readings were in compliance with the guideline set by International Microbiological Specifications on Foods (ICMSF) although total coliform, *E. coli* and *S. aureus* exceeded this guideline. There was an overall weak negative correlation between the levels of bacterial contamination with the vendor's level of cleanliness. **Conclusion**: In conclusion, overall bacterial contamination in street foods sold around Chow Kit area is considerably high with total coliform, *E. coli* and *S. aureus* contamination on the food samples had exceeded the permissible limit based on the ICMSF standard. This study emphasizes that more food safety education for the food handlers and provision of the sanitary facilities at vending sites are needed.

Keywords: Street food, bacterial contamination, food safety

1. Introduction

Street food is defined as ready-to-eat food sold by street vendors at public places (FAO 2012). According to the Food and Agriculture Organization (2012), street food has been sold for thousands of years and can be found around the world. It is estimated that over 2.5 billion people around the world enjoy street food every day (Samapundo et al. 2016). In Malaysia, street food sale has generated a gross income of RM 7 trillion a year (Alimi 2016). This sales activity not only contributes to the country's economy but also supports the lives of millions of low-income people in the city (Samapundo et al. 2016). Furthermore, the street food menu is according to the community's culture in the area. Hence, street food plays an important role for a country and can enhance the travel sector around the world (Choudhury et al. 2011).

Although street food is a popular choice, it is often reported to be contaminated with pathogens and associated with foodborne illnesses (Das et al. 2010).

There are various factors that contribute to the contamination of street food. Among them is the food handling factor itself. Less knowledge about food safety among food handlers might increase the risk of food contamination and contribute to foodborne illness. In most developing countries, poor hygiene and handling of food, cross contamination, time and temperature abuse during storage and preparation are factors related to foodborne illness (Ismail et al. 2016). In Malaysia, all food handlers are required to be vaccinated against typhoid infections and attend a compulsory food handling course (Food Act 1983).

There are many types of bacteria that contribute to street food contamination. Foodborne diseases occur due to contamination from various pathogenic bacteria (Tambekar et al. 2008). Commonly known bacterial food pathogens in foods consist of *Bacillus cereus*, *Salmonella* sp., *Listeria monocytogenes*, *Staphylococcus aureus* and *Escherichia coli* (Cho et al. 2010). Tambekar et al. (2008) found that Indian traditional foods such as samosa, kachori and palakwada were contaminated by *E. coli*, *S. aureus* and *Salmonella sp.*

Chow Kit's location is in the heart of Kuala Lumpur where street food is aplenty (PPKB 2018). The common food sold consists of sweet cakes, fried foods, dishes and flavoured drinking water. The process of preparing street food is prone to poor environmental conditions compared to preparing food in the premises (Ismail et al. 2016). The environmental conditions in vendor area are among other factors contributing to the contamination of street food. Lack of facilities such as water connections, inefficient drainage systems and refrigerating facilities could be the major causes of food contamination sold by street vendors (Islam et al. 2015). Thus, this study aims to determine the level of bacterial contamination in food sold by street vendors around Chow Kit area. The correlation between the microbiological contamination and vendors' premise level of cleanliness were also determined.

2. Materials and Method

2.1. Sampling method

This study was conducted at 15 selected stalls around Chow Kit. A total of 30 food samples were collected for laboratory analysis. The inclusion criteria for stall selection were those stalls selling sweet cakes (*kuih*) and fried snacks. Additionally, other criteria for stall selection are the food preparation was done at the stall and two types of food were sampled from stalls selling more than 4 types of food. Food sold such as fruits, nuts and side dishes were the exclusion criteria for stall selection in this study. Food samples were placed in a cool box and maintained at 4°C and were taken to the laboratory to be analysed.

Twenty-five grams of each collected food samples were weighed and transferred to a sterile bag containing 225 ml of sterilized 0.1% (v/v) buffered peptone water (BPW; Merck, Germany). Samples were then homogenised using a stomacher (MiniMix 100PCC Lab Blender, Interscience France) for 2 mins. Ten ml of the homogenized samples were taken out to be used for enrichment steps for detection of *Salmonella* spp. and the remaining samples were used for detection and enumeration of total viable count (TVC), total coliform, *E. coli* and *Staphylococcus aureus.*

2.2. Sample analysis

Microbiological analyses were performed according to Zulfakar et al. (2017) with some modifications. A 10-fold series dilution were performed on the homogenized samples. One hundred microliters of appropriately diluted samples were plated in triplicates on selected media; Total Viable Count - Plate Count Agar (Merck, Germany), Coliform and *E. coli* – Chromocult Coliform Agar (Merck, Germany) and *S. aureus* – Mannitol Salt Agar (Merck, Germany). All plates were incubated at 37°C for 24 hours.

For detection of *Salmonella* spp., 90ml of BPW were added to the sample and incubated at 37°C for 20 hours. Following incubation, 1 ml sample were transferred into 10 ml of Rappaport-Vassiliadis Soya (RVS) (Merck, Germany) broth and vortex thoroughly before incubated at 41.5°C for 24 hours for selective enrichment process. After incubation, a loopfull of the enriched broth was then streaked onto Xylose Lysine Deoxycholate (XLD) agar (Merck, Germany) and incubated at 37°C for 24 hours. Detection of *Salmonella* sp. was recorded by the presence of red colonies with black centers.

Presumptive bacterial colonies isolated (for *E. coli* and *Salmonella* spp.) were then subjected to a series of biochemical tests for conformation. All data were expressed as log CFU/cm2 except for the detection of *Salmonella* spp. where it was reported as percentage of presence/absence of the bacteria.

2.3 Vendors' premise inspection

The food vendor inspection was done by using Ministry of Health's Premises Inspection Form (KKM) with

some modifications. There are 8 parts that were taken into account namely food, food operators, equipment and utensils, water supply, drainage system, hand washing facilities, garbage disposal, food waste and others. The total number of marks for this inspection is 100. The prescribed mark was rejected if a part does not meet the predetermined features. Inspection scores are also rated on the part which is green with a score of more than 75% which meant it comply with the criteria of vendor inspection. The yellow rating is between 65-75% which meant it does not comply with the criteria of vendor inspection and the red rating has a score of less than 65% which meant it does not comply with the criteria of vendor inspection and need further action.

2.4 Statistical analysis

Data obtained were analyzed using SPSS version 23.0. Descriptive analysis was used to determine the number of plate count (TVC), total coliform, *E. coli*, *Salmonella* sp. and S*. aureus* in the food sold at the vendors around Chow Kit. One sample T test was used to compare the bacterial contamination levels of the food samples with the International Commission on Microbiological Specifications on Foods (ICMSF 1986) standard. Spearmen Rho correlation test was used to correlate the bacterial contamination levels between selected foods sold at Chow Kit vendors with the vendor's premise level of cleanliness. Results were considered significant when $p<0.05$, unless otherwise stated.

3. Results

3.1. Bacterial counts

The presence of total viable count, total coliform, *E. coli*, *S. aureus* and *Salmonella* spp. are summarized in Table 1. On total viable count, the highest contamination was seen with 87% of the total sample. The mean presence of total viable count in street food sold at Chow Kit vendors was 4.07 ± 0.63 Log CFU/g. Total coliforms were found at 43% of the total samples with a mean of 4.19 ± 0.89 Log CFU/g. Meanwhile, *E. coli* was found only in 6% of the total samples and had a mean of 4.40 ± 1.97 Log CFU/g. *S. aureus* had a contamination of 33% of the total samples with a mean of 3.88 ± 0.86 Log CFU/g. *Salmonella* spp. was not detected in any sample.

Table 1: Total microorganism of total viable count, total coliform, *E. coli*, *S. aureus* and *Salmonella* spp. in street vended food in Chow Kit.

Type of micro-organisms (n=30)	No. (%)[1]	Mean[2] ± standard deviation
Total viable count	26 (87)	4.07 ± 0.63
Total coliform	13 (43)	4.19 ± 0.89
E. coli	2 (6)	4.40 ± 1.97
S. aureus	20 (33)	3.88 ± 0.86
***Salmonella* spp.**	Not detected	-

[1]Number of positive samples.
[2]Mean of total microorganisms stated in Log CFU/g unit.

3.2. Comparison of microbiological contamination level with ICMSF guideline for microbiological limit

One sample T test was used to compare bacterial contamination levels in street food around Chow Kit with the International Commission on Microbiological Specifications for Foods (ICMSF 1986) standard for ready-to-eat foods. Based on the standard, the mean of total viable count in street food from Chow Kit vendors did not exceed the standard set by ICMSF which is not more than Log 7 CFU/g. The mean of total coliform*, E. coli* and *S. aureus* in street food sold in vendors around Chow Kit however exceeded the standards set by the ICMSF. The mean total coliform and *S. aureus* in food sold at Chow Kit vendors exceeded the 4 Log CFU/g standard set by the ICMSF. Based on the T test of samples, there was a significant difference ($p<0.05$) between the total coliform and *S. aureus* in street food sold from Chow Kit vendors and standards set by the ICMSF. For *E. coli*, only two samples were contaminated by these bacteria. The mean of *E. coli* presence exceeded the standard set by the ICMSF of more than 2 Log CFU/g. These results showed that the mean value of *E. coli* on both samples had a significant difference ($p<0.05$) with the standard values set by the ICMSF. No *Salmonella* sp. was present in any street food samples sold at the vendors around Chow Kit. According to the standards set by the ICMSF, *Salmonella* spp. cannot be present in the food.

3.3. Bacterial contamination on street food and the vendor's level of cleanliness around Chow Kit

Table 2 shows the level of bacterial contamination in street food and the vendor's level of cleanliness around Chow Kit based on vendor inspection. Majority of the vendors have red rating after doing the inspection while three of the vendors had yellow rating and only one vendor had green rating. Spearmen Rho correlation test was used to determine the correlation between bacterial contamination levels in street food sold around Chow Kit with the vendor's level of cleanliness around Chow Kit.

Based on the Spearmen Rho correlation test, data analysis showed that there was a weak negative relationship between the vendor's level of cleanliness with the mean total coliform in street food sold at Chow Kit ($r = -0.33$, $p > 0.05$) and the mean presence of *E. coli* in the food sold at Chow Kit vendors ($r = -0.440$, $p < 0.05$). However, there was a very weak positive relationship between the vendor's level of cleanliness and the mean of total viable count on street food sold at Chow Kit ($r = 0.08$, $p > 0.05$).

Table2: Bacterial contamination of street food and vendor's premise level of cleanliness

Vendor	Vendor's level of cleanliness (%)	Total viable count	Total coliform	*E. coli*	*S. aureus*
G1	68 (K)	3.70	0	0	0
G2	26 (M)	4.10	2.09	0	2.87
G3	36 (M)	4.26	0	0	5.53
G4	55 (M)	5.07	4.18	0	3.48
G5	39 (M)	3.71	1.50	0	3.83
G6	68 (K)	4.26	0	0	0
G7	76 (H)	2.88	2.63	1.45	2.93
G8	68 (K)	4.47	1.93	1.50	0
G9	64 (M)	2.32	0	0	0
G10	46 (M)	2.47	0	0	3.51
G11	47 (M)	3.70	0	0	3.70
G12	47 (M)	3.92	4.06	0	1.85
G13	41 (M)	4.32	3.37	0	4.07
G14	63 (M)	3.47	3.01	0	3.46
G15	46 (M)	3.69	0	0	0

Color indication:

Comply	>75%
Not comply	65-75%
Not comply and need further action	<65%

4. Discussion

Total viable count, total coliform, *E. coli*, *S. aureus* are often used as indicator organisms in determining the hygiene level of food handling practices (Nik Rosmawati et al. 2014). In this study the total viable count, total coliform, *E. coli* and *S. aureus* were identified in street food sold by vendors around Chow Kit. Parameters for total viable count were used in this study to determine microbial load that have contaminated the food sold by Chow Kit vendors. Meanwhile, the parameters for total coliform and *E. coli* were used to determine the contamination of feces in the food. The parameters for *S. aureus* and *Salmonella* spp. aimed to identify pathogenic microorganisms that may have contaminated food.

The total viable count can provide information on the quality of the food as well as identify problems during storage and handling during the food preparation (Center for Food Safety 2014). Based on food standards set by the International Commission on Microbiological Specifications for Foods (ICMSF), the total viable count did not exceed the standard set but is at the boundary between 4 Log CFU/g to 7 Log CFU/g. This study also showed contamination of total viable count was the highest i.e. 87% compared to other parameters and only four samples did not show any contamination of total viable count. Studies from Al Mamun, Rahman and Turin (2013) also showed a high number of total viable counts, of nearly half of the samples (44.5%) contaminating street food around schools in Dhaka, Bangladesh. Most food that had this total viable count contamination consists of fried food and sweet cakes. This type of food is eaten immediately after cooking processes such as frying and steaming. Food handlers should focus on each process starting from the quality of the raw materials. Fried food and sweet cakes need batter made from flour. High contamination of microorganisms can be avoided by using freshly prepared batter and chilling the batter to 10°C before they are used for frying (Mukprasirt et al. 2001). Mukprasirt et al. (2001) also reported that bacterial contamination was higher in the non-chilled batter than the chilled batter. Additionally, other factors that control bacterial contamination in food are pH of the batter. The batter that has a slightly acidic pH does not support the growth of microorganisms. Limited facilities at Chow Kit vendors such as the absence of refrigeration can contribute to high bacterial contamination of food sold around Chow Kit.

Total coliform detection is often widely used to measure the effectiveness of hygiene programs in a food handling area. The total coliform is also an indicator of fecal contamination in food products. The presence of this group of bacteria can indicate the presence of pathogenic bacteria in the food (Lues & Van Tonder 2007). According to the standard set by ICMSF, the mean coliform presence is at an alarming level if it exceeded the standard of more than 4 Log CFU/g and 43% of the food sample studied here was contaminated by this total coliform. Total coliform contamination of street food in Brazil and Korea also showed high contamination of these bacteria (Mosupye & Holy 2001; Chung, Kim & Ha 2010). Therefore, awareness of food hygiene among food handlers like washing hands after going to the toilet and before start handling the food is important to reduce the amount of total coliform contamination in the food. Study by Das & Rath (2010) also showed the presence of high total coliform in the food samples taken. The high presence of total coliform may indicate high levels of pathogenic bacteria present in the food (Das & Rath 2010). The presence of total coliforms in street food also illustrated the poor environment during processing, handling, distribution and contamination after handling the food (Cho et al. 2011).

One of the factors for total coliform contamination in food is contamination of the stool or the use of unclean water that causes contamination to food. Another factor that contributes to the total coliform contamination in food is from the washing water used to wash the kitchen utensils or direct contact either hands of the food handler. These bacteria have potential to divide more when food is left at ambient temperature for a long time (Nemo et al. 2015). Street food at Chow Kit vendor will usually be cooked in the morning and left at ambient temperature until evening, until the vendor close for that day. This can be a contributing factor to the high total coliform contamination of foods sold in Chow Kit. In addition, not only is the food left at ambient temperature for a long time but the food is left uncovered whereby the risk of contact to the food from the hand of the food handler or the buyer itself is high.

Escherichia coli is used as an indicator for the presence of fecal contamination in determining the hygiene of a food product (Health Protection Agency 2009). *E. coli* was available only in two samples i.e. presence in 6% of street food sold at Chow Kit stalls but the mean *E. coli* contamination exceeded the standard set by ICMSF. Cho et al. (2011) in Korea showed that the presence of *E. coli* in street food was about 3%, slightly lower than this study. While another study by See (2016) also found that the presence of *E. coli* in 5 out of 30 street food samples in Kampar, Perak; slightly higher than this study. The presence of *E. coli* in the food indicates that there is direct or indirect fecal contamination (Center for Food Safety 2014). Food handlers are most likely not practicing good personal hygiene practices where they might not wash their hands after going to the toilet and before handling the food. This act can be the contributor of *E. coli* contamination in the two samples. According to Center for Food Safety (2014), the lack of hygiene during food handling and improper storage are among the primary factors for *E. coli*'s presence in food. Food samples contaminated by *E. coli* were fried tempeh and *apam balik*. Soybeans are the main ingredients in making tempeh, whereby it is made from fermentation of soy beans and this process can be the factor of bacterial contamination if it is not well operated. Such fermentation process alone might contribute to the bacterial growth and if the manufacturing process is not well-managed bacteria such as *E. coli* can further contaminate the tempeh. *Apam balik* are cooked by using ingredients such as flour and are filled with peanut powder and cornstarch. Then, they are packed in plastic bags and left at ambient temperature until the end of the stall operation. The moist cornstarch texture could be the factor of *E. coli* contamination in the turnover pancakes, given that bacteria multiply rapidly on a moist surface and are supported by being left at ambient temperature for long periods.

5. Conclusion

In conclusion, overall bacterial contamination in street foods sold around Chow Kit area is considerably high with total coliform, *E. coli* and *S. aureus* contamination on the food samples had exceeded the permissible limit based on the ICMSF standard. There were weak negative correlations seen between Chow Kit street food vendors' cleanliness rating and level of bacterial contamination in street food sold. This study suggests that more food safety education for the food handlers and provision of the sanitary facilities at vending sites are needed to maximize the safety of the street food thus protecting the consumers from possible foodborne illnesses.

References

Abdul-Mutalib, N.A., Nordin, S.A., Osman, M., Ishida. N., Tashiro, K., Sakai, K., Tashiro, M., Shirai, Y. 2015. Pyrosequencing Analysis of Microbia Community and Food-Borne Bacteria on Restaurant Cutting Board in Seri Kembangan, Malaysia, and Their Correlation with Grades of Food Premises. International Journal of Food Microbiology 200(2015): 57-65.

Alimi, B.A. 2016. Risk factors in street food practices in developing countries. Food Science and Human Wellness 5(2016): 141-148.

Al Mamun, M, Rahman, S.M.M., Turin, T.C. 2013. Mircrobiological Quality of Selected Street Food Items Vended by School-Based Street Food Vendors in Dhaka, Bangladesh. International Journal of Food Microbiology 166(2013): 413-418

Centre for Food Safety. 2014. Microbiological Guidelines for Food. Food and Environmental Hygiene Department.

Cho, J.I., Cheung, C.Y., Lee, S.M., Ko, S.I., Kim, K.H., Hwang, I.S., Kim, S.H., Cho, S.Y., Lim, C.J., Lee, K.H., Kim, S.K. & Ha, S.D. 2011. Assessment of Microbial Contamination Levels of Street-Vended Foods in Korea. Journal of Food Safety 31(2011): 41-47.

Choudhury, M., Mahanta, L., Goswami, J., Mazumder, M. & Pegoo, B. 2011. Socioeconomic profile and food safety knowledge and practice of street food vendors in the city of Guwahati, Assam, India. Food Control 22: 196-203.

Chung, M.S., Kim, C.M, Ha, S.D, Detection and Enumeration of Microorganisms in Ready-To-Eat Foods, Ready-To-Cook Foods And Fresh-Cut Produce in Korea. 2010. Journal of Food Safety 30(2010): 480-490.

Cortese, R.D.M., Veiros, M.B. & Feldman, C. 2016. Food safety hygiene of vendors during the chain of street food production in Florianopolis, Brazil. Food Control 62(2016): 178-186.

Das, A., Nagananda, G.S., Bhattacharya, S., & Bhardwaj, S. 2010. Microbiological quality of street-vended Indian chaats sold in Bangalore. Journal of Biological Sciences 10(3): 255-260.

Das, M. & Rath, C.C. Bacteriology of Most Popular Street food (Panipuri) and Inhibitory Effect of Essential Oils on Bacterial Growth. J. Food Sci Technol 49(5): 564-571.

FAO. 2012. Selling Street and Snacks Foods. United Nations: Food and Agriculture Organization

Food Act 1983 (Malaysia) (Act 281)

Health Protection Agency. 2009. Guidelines for Assesing the Microbiological Safety of Ready-to-Eat Foods Placed on the Market. London: Health Protection Agency. November 2009.

ICMSF, 1986. Microorganisms in Foods 2, Sampling for Microbiological Analysis: Principles and Specific Applications. Canada: University of Toronto Press.

Islam, S., Nasrin, N., Rizwan, F., Nahar, L., Bhowmik, A., Esha, S.A., Talukder, K.A., Akter, M., Roy, A. & Ahmed, M. 2015. Microbial contamination of street vended foods from a university campus in Bangladesh. Southeast Asian J Trop Med Public Health 46 (3).

Ismail, F.H., Chik, C.T., Muhammad, R., Yusoff, N.M. 2016. Food safety knowledge and personal hygiene practices amongst mobile food handlers in Shah Alam, Selangor. Procedia- Social and Behavioral Sciences 222(2016): 290-298

Lues, J.F.R. & Van Tonder, I. 2007. The Occurrence of Indicator Bacteria on Hands and Aprons of Food Handl`ers in the Delicateseen Sections of a Retail Group. Food Control 18(4): 326-332

MOH. 2006. The Third National Health and Morbidity Survey: load of Illness

Mosupye, F.M. & Holy, A.V. 2000. Microbiological Hazard Identification and Assessment of Street Food Vending in Johannesburg, South Africa. International Journal of Food Microbiology 61(2000): 137-145

Mukprasirt, A., Herald, T.J., Boyle, D.L., Boyle, E.A. 2001. Physicochemical and Microbiological Properties of Selected Rice Flour-Based Batters for Fried Chicken Drumsticks. Poultry Science Association.

Nemo, R., Bacha, K. & Ketema, T. 2015. Microbiological Quality and Safety of Some Street Foods in Jimma Town, Southwestern Ethiopia. African Journal of Microbiological Research 11(14): 574-585

Nik Rosmawati, N.H., Manan, W.M., Noor, I.N.J. & Nik Nurain, N.H. 2014. Evaluation of Environmental Hygiene and Microbiological Status of Selected Primary School Canteens. Health and The Environmental Journal 5(3): 110-127

Perbadanan Pembangunan Kampong Bharu (PKB). 2018. Raja Bot Market(ChowKit). http://www.pkb.gov.my/raja-bot-market-chow-kit/?lang=en [14 February 2018].

Samapundo, S. Cam Thanh, T.N., Xhaferi, R., Devlieghere, F. 2016. Food safety knowledge, attitudes and practices of street food vendors and consumers in Ho Chi Minh city, Vietnam. Food Control (2016).

Tambekar, D.H., Jaiswal, V.J., Dhanorkar, D.V., Gulhane, P.B. & Dudhane, M.N. 2009. Microbial quality and safety of street vended fruit juices: A case study Amravati Amravati City, Bangladesh. Journal of Food Safety 10: 72-76.

Zulfakar, S.S., Baharudin, N & Abu Bakar, N.F. 2017. Bacterial contamination on beef sold at selected wet markets in Selangor and Kuala Lumpur. Journal of Agricultural Science 9(13): 89-95