



**PREVALENCE OF *Bacillus cereus* ON FOOD HANDLERS' HANDS AND IN
SELECTED FOOD SOLD AT NIGHT MARKET IN NORTHERN PERAK,
MALAYSIA AND ITS ASSOCIATION WITH KNOWLEDGE, ATTITUDE AND
PRACTICE OF FOOD HANDLERS**

By

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**Thesis Submitted to the School of Graduate Studies, Universiti Putra
Malaysia, in Fulfilment of the Requirements for the Degree of Master of
Science**

November 2021

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

PREVALENCE OF *Bacillus cereus* ON FOOD HANDLERS' HANDS AND IN SELECTED FOOD SOLD AT NIGHT MARKET IN NORTHERN PERAK, MALAYSIA AND ITS ASSOCIATION WITH KNOWLEDGE, ATTITUDE AND PRACTICE OF FOOD HANDLERS

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The night market is a prominent place for various types of delightful food. However, the lack of proper equipment can promote the growth of various pathogenic bacteria including *Bacillus cereus* because of uncontrolled storage temperature. This bacterium can be commonly found in rice, flour and starchy-based food. The efficiency of food safety training that was taken by the food handlers can be observed by knowledge, attitudes, and practices (KAP) study. This research aimed to determine the prevalence of *B. cereus* in selected ready-to-eat (RTE) food in the night market in northern Perak; to determine the antibacterial resistance profiles of the isolates to common antibiotics; and to identify the association between KAP level with the food handlers' demographic characteristics and *B. cereus* hand carriage of the food handlers. Eighty-three RTE food and fifty-seven hands' swab samples of food handlers were collected from twenty-five stalls at night markets in Kamunting, Taiping, and Bukit Merah, Perak. Both food and swab samples were tested for aerobic plate count and *B. cereus* identification. Positive isolates of *B. cereus* were further analyzed for antimicrobial susceptibility testing. KAP survey were conducted among food handlers after food and hands' swab samples were collected. Data were analyzed using Minitab software to determine the prevalence of *B. cereus* and its association with the level of KAP among the food handler. Aerobic bacteria was detected from 89% of the food samples with a range of 10^2 - 10^6 CFU/g while 28% of them were contaminated with *B. cereus* with a range of 10^2 - 10^4 CFU/g. The percentage of *B. cereus* hand carriage detected was 42% from 57 respondents. *B. cereus* isolates detected from both food and hands' swab samples showed resistance to tetracycline, chloramphenicol and clindamycin. The result from the KAP survey of the food handlers showed moderate scores for knowledge (74%) and high scores for attitude (92%) and practices (82%). Significant differences were reported in marital status (p -value: 0.000) and working experience (p -value: 0.001) towards handling practices. Furthermore,

positive correlations were seen between attitude and practices score (p -value:0.000, r :0.681). On the other hand, the respondents' level of knowledge (p -value: 0.007) and practices (p -value: 0.006) were found to be significantly associated with *B. cereus* hand carriage whereas respondents with higher knowledge scores were found to be as *B. cereus* hand carriage. The findings concluded that a good knowledge score does not always portray the cleanliness of the food handlers. It is a call for authorities to emphasize food safety among food handlers especially at the night markets.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

**PREVALEN *Bacillus cereus* PADA SAMPEL SWAB TANGAN PENGENDALI
MAKANAN DAN DALAM MAKANAN YANG DIJUAL DI PASAR MALAM DI
UTARA PERAK, MALAYSIA DAN PERKAITAN DENGAN TAHAP
PENGETAHUAN, SIKAP DAN AMALAN PENGENDALI MAKANAN**

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Pasar malam merupakan tempat pengumpulan pelbagai makanan yang enak. Walaubagaimanapun, kekurangan fasiliti bagi mengawal suhu persekitaran tempat penyediaan makanan boleh menyebabkan pertumbuhan pelbagai jenis bakteria patogen termasuklah *Bacillus cereus*. Bacteria ini kebiasaannya dijumpai di dalam nasi, tepung dan makanan berkanji. Keberkesanan latihan pengendali makanan dalam membentuk amalan yang betul semasa pengendalian makanan diukur melalui kaji selidik pengetahuan, sikap dan amalan (KAP) pengendali makanan. Kajian ini bertujuan untuk menentukan prevalen *B. cereus* di dalam makanan sedia dimakan yang dijual di pasar malam di utara Perak; menentukan kadar kerintangan *B. cereus* terhadap antibiotik; dan mengkaji perkaitan di antara KAP pengendali makanan dengan faktor demografi dan pembawa *B. cereus*. Lapan puluh tiga sampel makanan sedia dimakan dan lima puluh tujuh sampel swab tangan pengendali makanan diambil daripada dua puluh lima gerai pasar malam di Kamunting, Taiping dan Bukit Merah, Perak. Sampel yang diambil dianalisis untuk kiraan bakteria aerobik dan *B. cereus*. Isolat *B. cereus* yang dikesan seterusnya dikaji tahap kerintangannya terhadap antibiotik. Kiraan bakteria aerobik dikesan daripada 89% sampel makanan dalam kadar 10^2 - 10^6 CFU/g sementara 28% *B. cereus* dikesan pada kadar 10^2 - 10^4 CFU/g. Peratusan responden yang dikesan sebagai pembawa bakteria *B. cereus* adalah sebanyak 42% daripada 57 orang responden. Isolat *B. cereus* yang dikesan daripada kedua-dua sampel makanan dan swab tangan menunjukkan kerintangan terhadap antibiotik *tetracycline*, *chloramphenicol* dan *clindamycin*. Selain itu, data kaji selidik KAP menunjukkan dapatan skor sederhana bagi pengetahuan (74%), manakala skor tinggi bagi sikap (92%) dan praktis (82%) pengendali makanan. Terdapat perbezaan yang signifikan di antara taraf perkahwinan ($p:0.000$) dan pengalaman bekerja ($p:0.001$) terhadap skor praktis. Perkaitan positif juga dilihat di antara skor sikap dan skor praktis ($p:0.000$, $r:0.681$). Skor pengetahuan ($p:0.007$) dan praktis ($p:0.006$) turut

menunjukkan perkaitan yang signifikan terhadap pembawa *B. cereus* di mana responden dengan skor pengetahuan yang lebih tinggi dikesan sebagai pembawa *B. cereus*. Data dari kajian ini merumuskan bahawa skor pengetahuan yang baik tidak semestinya menggambarkan tahap kebersihan diri pengendali makanan. Ia boleh membuka mata pihak berkuasa untuk lebih menitikberatkan tentang isu keselamatan makanan di kalangan pengendali makanan di premis penjualan makanan berskala kecil terutamanya premis pasar malam.



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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

SD	Standard deviation
M	Mean
K	Knowledge
A	Attitude
P	Practice
CFU/g	Colony forming unit per unit gram
RTE	Ready-to-eat
DNA	deoxyribonucleic acid
RNA	ribonucleic acid
ISO	International Organization for Standardization
CSLI	Clinical and Laboratory Standards Institution
N	Total number
UV	Ultra violet
APC	Aerobic plate count
HIV/AIDS	human immunodeficiency virus/ acquired immunodeficiency syndrome

CHAPTER 1

INTRODUCTION

1.1 Background

Food is a necessity for life. However, craving for delicious food sometimes leads to less concern about the nutrition and safety of the food. Food safety remains a major concern around the globe. Nearly one in ten people in the world fall ill each year after eating spoiled food, causing 420,000 deaths of which nearly a third of all deaths are children under the age of five (Food and Drug Administration [FDA], World Health Organization [WHO]). According to the Centre for Disease Control and Prevention USA [CDC] (2017), symptoms of food poisoning may vary from mild to severe depending on the bacteria swallowed. In general, the infected person will only have minor diseases, lasting from few hours to several days. However, it may be more serious in children, pregnant women, and those who are older or have a weakened immune system which may cause them to be hospitalized, and certain illnesses contribute to long-term health problems or even death (WHO, 2013).

Previous studies showed a variety of ready-to-eat food contaminated with foodborne bacteria such as *Bacillus cereus*, *Listeria monocytogenes*, *Salmonella* and *Staphylococcus aureus* (Yu et al., 2020; Paudyal et al., 2017). Besides, food handlers are also found to be one of the sources of contamination (Lee et al., 2017; Okareh and Erhanon, 2015). Swab test on hand of the food handlers showed positive for various bacteria and norovirus (Segalo et al., 2020; Woh et al., 2017).

Training of the food handlers has been identified as one of the most effective way to increase the safety of food served, as training and education are essential to ensure workers have adequate awareness and knowledge to comply with food hygiene requirements (Ko, 2013). Knowledge, attitudes and practices (KAP) survey of food handlers is essential to examine the efficacy of training given as it can help to measure the success of initiatives done by health education and the ability to change behavior related to health (United State Agency for International Development [USAID], 2011).

1.2 Situation in Malaysia

Malaysia is well known as a nation with delicious cuisine where delicious food can be found almost everywhere, including in areas with a lack of adequate food preparation, storage and serving facilities such as at night market. The increasing trend of buying and eating night market foods is due to their location,

accessibility, and inexpensive prices especially among the people with lower income (Mazlan et al., 2017). However, the possibility of using low-quality raw materials and unhygienic food preparation could be a potential source of foodborne diseases (Soon, 2019; Alimi, 2016). Malaysia had reported an increase of food and water-borne diseases by 12% in 2019 (Department of Standard Malaysia, 2020). Numerous studies on contaminated local ready-to-eat (RTE) food have been linked to hand hygiene practices and poor handling practices of food handlers (Lee et al., 2017; Okareh and Erhahon, 2015; Fang et al., 2003). Some of the foods sold are ready to be consumed, thus long holding time for food prepared earlier and served on the counter at dangerous zone temperature increased the risk of food poisoning as bacteria can replicate faster at room temperature (Kalyoussef and Feja, 2014).

A food handling training program was introduced in Malaysia since 1996 and is compulsory for all food handlers to improve their basic understanding of food safety. In 2019, there were more than 300 Food Handler Training School in Malaysia (Food Safety Quality Program [FSQP] Annual Report, 2019). Nevertheless, there were food poisoning cases happen every year and 1,688 collected samples were found to be in violation of the Food Act 1983 and its regulations in 2019 (FSQP Annual Report, 2019). The training certificate of food handlers who violated the act is canceled and they must attend new training before they are allow to handle food. (Food regulation 2009). However, it is better to prevent than cure food poisoning in every aspect. Thus, the study of food handlers' knowledge, attitude, and practice (KAP) on food safety can provide a nationwide assessment for continuous consumer assurance of food safety.

Many previous studies on food safety knowledge in Malaysia have all focused on food premises with proper preparation, storage and serving facilities such as restaurants, school's canteen and university's cafes (Asmawi et al., 2018; Lee et al., 2017; Woh et al., 2016; Aziz and Dahan, 2013; Abdul Mutalib et al. 2012). Therefore, it is relevant to measure the extent of food safety knowledge, attitude and practices towards night market's food handlers due to the increased public food choice demand to varieties inexpensive ready-to-eat meals (Alimi, 2016). This study aimed to explore the socio-demographic characteristics of night market's food handlers and identify the basic knowledge on food safety, attitude towards food handling and food handling practices through a set of questionnaires.

1.3 Problem Statement

According to the Department of Statistics Malaysia, food poisoning cases showed an increasing rate of 24% in 2019 compared to 2018. Furthermore, in 2014, there was a case of food poisoning involved three stalls in the night market at Terengganu, Malaysia, which caused 101 patients hospitalized, while a five years old boy had died. Ready-to-eat food involved and tested positive for

pathogenic bacteria were red fried rice, white fried rice, fried *kueytiow* (flat rice noodles) and fried noodle (Environmental Health Conference, 2014). Studies done in several states in Malaysia by Ali et al., (2017); Jawad and Mutalib (2016) and Sandra et al., (2012) found a high prevalence of *Bacillus cereus* in rice dishes, curry and meat dishes. The long holding period at ambient temperature favoured the survival and germination of *Bacillus* spores which may be responsible for the high load of *Bacillus* spp. isolated in ready to eat foods (Alimi, 2016). Perak has been top five states with the highest food poisoning cases in Peninsular Malaysia along with Johor, Selangor, Kedah and Kuala Lumpur (FSQP Annual Report, 2018).

Previous studies found an increasing number of foodborne pathogens showed resistance ability towards the various type of antibiotics (New et al., 2017; Woh et al., 2017 and Rosenquist et al., 2005). Isolates of *Bacillus cereus* demonstrated 100% resistance to penicillin G, oxacillin, ampicillin, amox/clavulanic acid and cefotaxime beta-lactam antibiotics (Penido et al., 2013). The incidence of resistant strains to these antibiotics may be an alarm since beta-lactam antibiotics are frequently used to treat *B. cereus*-related food poisoning. Another study found that some of these strains of bacteria were also resistant to most antibiotics such as tetracycline, vancomycin, gentamicin, nalidixic acid, and nitrofurantoin (Ali et al., 2017), making it more challenging to treat the bacterial infection. Although usually, food poisoning can heal on its own, some cases may require antibiotics therapy to target specific bacteria, in addition to rehydration treatment. Antibiotic treatment can reduce the duration of symptoms and can inhibit bacteria in older adults, newborns, and weakened immune patients (NIDDK, 2019; Switaj et al., 2015).

Jeffrey et al. (2016) discovered that the leading factor to food poisoning is the uncertainty of the food handlers towards the authorities' minimum health needs and practices. The presence of the microorganism on the food handlers' hand swab showed inappropriate hygiene activities (Woh et al., 2017; Lee et al., 2017; Okareh and Erhahon, 2015). A research carried out by Tan et al (2013) reported that food handlers with higher education levels had shown significantly higher personal hygiene practices than those who completed elementary and secondary education. As for the night market, the stall owner tends to recruit someone with diverse educational qualifications to assist in the process of food handling, which can be challenging to track. Therefore, knowledge, attitude and practise (KAP) study is needed to assess their routine activities along with knowledge and attitude while handling food.

1.4 Hypothesis

- i. There is a high prevalence of *B. cereus* in food and hands' swab of food handlers at night market.
- ii. There is a high prevalence of *B. cereus* strains that are resistant to antibiotics.
- iii. There is an association between knowledge, attitude and practice of the food handlers with its socio-demographic backgrounds.
- iv. There is an association between knowledge, attitude and practice of the food handlers and the prevalence of *B. cereus* hand carriage.

1.5 Objectives

General objective for this study is to determine prevalence of *B. cereus* in food and on food handlers' hands at the night market in northern Perak and its association with KAP of food handlers. Meanwhile, specifically, it seeks

- i. determine the prevalence of *B. cereus* in ready-to-eat foods and on hands' swab of food handlers at the night markets.
- ii. determine the prevalence of strains that are resistant to common antibiotics among the isolates.
- iii. identify the level of knowledge, attitudes, and practices and its association with socio-demographic characteristics of food handlers and,
- iv. determine the association between knowledge, attitude and practices of the food handlers and *B. cereus* hand carriage.

REFERENCES

- Ababio, P.F., Taylor, K.D.A., Swainson, M. and Daramola, B.A. (2016). Effect of good hygiene practices intervention on food safety in senior secondary schools in Ghana. *Food Control*, 60, 18–24.
- Abayneh, M., Tesfaw, G., Woldemichael, K., Yohannis, M. and Abdissa, A. (2019). Assessment of extended-spectrum β -lactamase (ESBLs) - Producing *Escherichia coli* from minced meat of cattle and swab samples and hygienic status of meat retailer shops in Jimma town, Southwest Ethiopia. *BMC Infectious Diseases*, 19(1): 1–8.
- ABC News. (March 2016). Food poisoning cases potentially linked to enlighten night noodle market in Canberra. Retrieved from <https://www.abc.net.au/news/2016-03-11/food-poisoning-cases-linked-to-enlighten-night-noodle-market>
- Abdullah Sani, N. and Siow, O.N. (2014). Knowledge, attitudes and practices of food handlers on food safety in food service operations at the Universiti Kebangsaan Malaysia. *Food Control*, 37(1): 210–217.
- Abdul-Mutalib, N.A., Abdul-Rashid, M.F., Mustafa, S., Amin-Nordin, S., Hamat, R.A. and Osman, M. (2012). Knowledge, attitude and practices regarding food hygiene and sanitation of food handlers in Kuala Pilah, Malaysia. *Food Control* 27(2): 289-293.
- Akabanda, F., Hlorts, E.H. and Owusu-kwarteng, J. (2017). Food safety knowledge, attitudes and practices of institutional food-handlers in Ghana. *BMC Public Health*. 17(1): 1-10.
- Aklilu, E., Tukimin, E.B., Daud, N.B.A. and Kyaw, T. (2016). Enterotoxigenic *Bacillus cereus* from cooked chicken meat: A potential public health hazard. *Malaysian Journal of Microbiology*. 12(1): 112-115.
- Ali, A.E., Msarah, M.J. and Sahilah, A.M. (2017). Environment contaminant of *Bacillus cereus* isolated from ready to eat meat curry collected at various locations in Malaysia. *International Food Research Journal*, 24(6): 2640–2644.
- Alimi, B.A. (2016). Risk factors in street food practices in developing countries: A review. *Food Science and Human Wellness*, 5(3): 141–148.
- Al-Kandari, Dina, Al-abdeen, Jumanah, Sidhu and Jiwan. (2019). Food safety knowledge, attitudes and practices of food handlers in restaurants in Kuwait. *Food Control*, 103: 10.1016
- Alqurashi, N.A., Priyadarshini, A. and Jaiswal, A.K. (2019). Evaluating food safety knowledge and practices among foodservice staff in Al Madinah Hospitals, Saudi Arabia. *Safety*, 5(1): 1–19.

- American Society for Microbiology. Kirby-Bauer Disk Diffusion Susceptibility Test Protocol. 8 December, 2009.
- Andrew, W. (1992). Manuals of Food Quality Control. Microbiological Analysis. Food and Drug Administration. *FAO Food Nutrition Paper*, 4(4 Rev. 1):1-338.
- Asmawi, U.M.M., Norehan, A.A., Salikin, K., Rosdi, N.A.S., Munir, N.A., Basri, N.B.M., Selamat, M.I. and Nor, N.M. (2018). An assessment of knowledge, attitudes and practices in food safety among food handlers engaged in food courts. *Current Research in Nutrition and Food Science*, 6(2): 346–353.
- Aygun, F.D., Aygun, F. and Cam, H. (2016). Successful Treatment of *Bacillus cereus* Bacteremia in a Patient with Propionic Acidemia. *Case Reports in Pediatrics*, 2016: 1–2.
- Aziz, S.A.A. and Dahan, H.M. (2013). Food handlers' attitude towards safe food handling in school canteens. *Procedia - Social and Behavioral Sciences*, 105: 220–228.
- Bacteriological Analytical Manual: *Bacillus cereus*. (January 2012), 1–9.
- BC Centre for Disease Control. (2016). Pasteurized and raw milk. HealthLinkBC, March (03),1–2. Retrieved from <https://www.healthlinkbc.ca/hlbc/files/documents/healthfiles/hfile03.pdf>
- Beyene, G., Mamo, G., Kassa, T., Tasew, G. and Mereta, S.T. (2019). Nasal and Hand Carriage Rate of *Staphylococcus aureus* among Food Handlers Working in Jimma Town, Southwest Ethiopia. *Ethiopian Journal of Health Science*. 29(5): 605-612.
- Bilung, L.M., Jaraee, J. and Vincent, M. (2018). Detection, genetic diversity and antibiotic resistance profiles of *Bacillus cereus* isolated from sago processing plants in Malaysia. *Malaysian Journal of Microbiology*. 14: 320–324.
- Bilung, L.M., Tesfamariam, F., Andriesse, R., San, F.Y.K., Ling, C.Y. and Tahar, A.S. (2018). Presence of *Bacillus cereus* from local unhusked (rough) rice samples in Sarawak, Malaysia. *Journal of Sustainability Science and Management*, 13(1): 181–187.
- Biokar Diagnostic. COMPASS *Bacillus*. :1-2. Detection and enumeration of *Bacillus cereus* group in human and animal food products. Retrieved from <http://www.biokar-diagnostics.com>
- Bolton, E. (33 November, 2009). Guidelines for assessing the microbiological safety of ready-to-eat foods placed on the market. Health Protection Agency, London.

- Bou-Mitri, C., Mahmoud, D., El Gerges, N. and Jaoude, M.A. (2018). Food safety knowledge, attitudes and practices of food handlers in lebanese hospitals: A cross-sectional study. *Food Control*, 94(June): 78–84.
- Canada.ca. (21 December, 2021). Food safety for people with a weakened immune system. Retrieved from <https://www.canada.ca/en/health-canada/services/food-safety-vulnerable-populations/food-safety-people-with-weakened-immunesystem.html>
- Carlin, F., Fricker, M., Pielaat, A., Heisterkamp, S., Shaheen, R., Salonen, M.S., Svensson, B., Nguyen-the, C. and Ehling-Schulz, M. (2006). Emetic toxin-producing strains of *Bacillus cereus* show distinct characteristics within the *Bacillus cereus* group. *International Journal of Food Microbiology*, 109(1):132-138.
- Catedral, H. (2018). The Food Safety Culture of a Night Market. *Journal of Economics and Business*. 1(4): 429-440.
- Centers for Disease Control and Prevention (CDC). (12 December, 2016). *Listeria* (Listeriosis). Retrieved from <https://www.cdc.gov/listeria/faq.html>
- Centers for Disease Control and Prevention (CDC). (5 December, 2019). *Salmonella*. Retrieved from <https://www.cdc.gov/salmonella/general/index.html>
- Centers for Disease Control and Prevention (CDC). (May 2021). Fruit and Vegetable Safety. Retrieved from <https://www.cdc.gov/foodsafety/communication/steps-healthy-fruits-veggies.html>
- Centers for Disease Control and Prevention Diseases (2017). Pathogens transmitted by food contaminated by infected persons who handle food, and modes of transmission of such pathogens. Retrieved from <https://www.cdc.gov/foodsafety>
- Centers for Disease Control and Prevention Diseases. (2020). Food Safety. Retrieved from <https://www.cdc.gov/foodsafety/cdc-and-food-safety.html>.
- Centers for Disease Control and Prevention Diseases. (March 5, 2021). Norovirus, Retrieved from <https://www.cdc.gov/norovirus/about/transmission.html>
- Centers for Disease Control and Prevention. (2019). Antibiotic resistance threats in the United States. Retrieved from https://www.cdc.gov/drugresistance/biggest_threats.html
- Chen, D., Li, Y., Lv, J., Liu, X., Gao, P., Zhen, G., Zhang, W., Wu, D., Jing, H., Li, Y., Zhao, Y., Ma, X., Ma, H. and Zhang, L. (2019). A foodborne outbreak of gastroenteritis caused by Norovirus and *Bacillus cereus* at a university in the Shunyi District of Beijing, China 2018: A retrospective cohort study. *BMC Infectious Diseases*, 19(1): 1–6.

- Choi, S., Kim, H., Kim, Y., Kim, B., Beuchat, L.R. and Ryu, J.H. (2014). Fate of *Bacillus cereus* and naturally occurring microbiota on milled rice as affected by temperature and relative humidity. *Food Microbiology*, 38: 122–127.
- Chon, J., Kim, J., Lee, S., Hyeon, J. and Seo, K. (2012). Toxin profile, antibiotic resistance, and phenotypic and molecular characterization of *Bacillus cereus* in Sunsik. *Food Microbiology*, 32(1): 217–222.
- Chueh, Y.N., Du, T.H., Lee, C.J., Liao, Y.S., Chiou, C.S., Chang, J.C., Lin, C.W., Lee, T.F. and Su, C.P. (2020). Investigation of a salmonellosis outbreak linked to French toast sandwich with the use of surveillance camera, Taiwan 2018. *Epidemiology and Infection*, 148: 1–8.
- Control Union Certification. FSSC 22000 - Food Safety System Certification. Retrieved from <https://certifications.controlunion.com/en/certification-programs/certification-programs/fssc-22000-food-safety-system-certification>
- Cui, Y., Liu, X., Dietrich, R., Märklbauer, E., Cao, J., Ding, S. and Zhu, K. (2016). Characterization of *Bacillus cereus* isolates from local dairy farms in China. *FEMS Microbiology Letters*, 363(12): 1–6.
- Department of Standard Malaysia. (2020). Compendium of environment statistics Malaysia 2020, Retrieved from <https://www.dosm.gov.my>.
- Department of Standard Malaysia (DOSM). July 2020. Household Expenditure Survey Report by State and Administrative District Perak 2019. Retrieved from https://www.dosm.gov.my/v1/uploads/files/1_Articles_By_Themes/Prices/HIES/HES-Report/HES_Perak.pdf
- Ercoli, L., Gallina, S., Nia, Y., Auvray, F., Primavilla, S., Guidi, F., Pierucci, B., Graziotti, C., Decastelli, L. and Scuota, S. (2017). Investigation of a Staphylococcal Food Poisoning Outbreak from a Chantilly Cream Dessert, in Umbria (Italy). *Foodborne Pathogens and Disease*, 14(7): 407–413.
- Fiedler, G., Schneider, C., Igbinsosa, E.O., Kabisch, J., Brinks, E., Becker, B., ..., and Franz, C. (2019). Antibiotics resistance and toxin profiles of *Bacillus cereus*-group isolates from fresh vegetables from German retail markets. *BMC Microbiology*, 19(1): 1–13.
- Food Act 1983. Retrieved from <http://extwprlegs1.fao.org/docs/pdf/mal27309.pdf>
- Food allergies. (15 April 2019). Retrieved from <https://www.nhs.uk/conditions/food-allergy>
- Food allergies. (5 May 2021). Retrieved from <https://www.fda.gov/food/food-labeling-nutrition/food-allergies>
- Food and Drug Administration. (2012). Bad Bug Book, foodborne pathogenic microorganisms and natural toxins. Second edition. *Bacillus cereus* and other *Bacillus* species, 92-95.

- Food and Drug Association. (September 2011). A need-to-know guide for those who have been diagnosed with HIV/AIDS. Retrieved from <https://www.fda.gov/consumers/free-publications-women/hiv-and-aids-medicines-help-you>
- Food hygiene regulation 2009. (November 27, 2020). Retrieved from <https://www.fmm.org.my/images/articles/GS1%20Malaysia/Presentation%20FMM%20Food%20Hygiene.pdf>
- Food Poisoning in Malaysia. Retrieved from <https://www.malaysia-traveller.com/food-poisoning-in-malaysia.html>
- Food Safety and Quality Program, Annual Report 2019, Malaysia Ministry of Health. Retrieved from <https://fsq.moh.gov.my>.
- Food Standards Australia & New Zealand (FSANZ). (February 2018). Food recalls. Retrieved from <https://www.foodstandards.gov.au/industry/foodrecalls/pages/default.aspx>
- Food Standards Australia New Zealand (FSANZ). (September 2018). Compendium of microbiological criteria for food.
- Foodborne Pathogens. (3 May 2020). Retrieved from <https://www.fda.gov/food/outbreaks-foodborne-illness/foodborne-pathogens>
- FoodSafety.gov. Bacteria and Viruses. Retrieved from <https://www.foodsafety.gov/food-poisoning/bacteria-and-viruses>
- Foodsafety.gov. (21 October, 2021). People at Risk: Children Under Five. Retrieved from <https://www.foodsafety.gov/people-at-risk/children-under-five>
- Gdoura-Ben Amor, M., Jan, S., Baron, F., Grosset, N., Culot, A., Gdoura, R., Gautier, M. and Techer, C. (2019). Toxigenic potential and antimicrobial susceptibility of *Bacillus cereus* group bacteria isolated from Tunisian foodstuffs. *BMC Microbiology*. 19(1): 1–12.
- Gholam-Mostafaei, F.S., Alebouyeh, M. and Zali, M.R. (2017). Prevalence, molecular diversity, and antimicrobial resistance patterns of pathogenic bacteria isolated from medical foods, food staff, cooking instruments, and clinical samples in a teaching hospital in Tehran, Iran. *Archives of Clinical Infectious Diseases*, 12(3): 62421.
- Granum, P.E. and Lund, T. (1997). *Bacillus cereus* and its food poisoning toxins. *FEMS Microbiology Letters*, 157(2): 223–228.
- Guinebretiere, M.H., Girardin, H., Dargaignaratz, C., Carlin, F. and Nguyen-The, C. (2003). Contamination flows of *Bacillus cereus* and spore-forming aerobic bacteria in a cooked, pasteurized and chilled zucchini purée processing line. *International Journal of Food Microbiology*, 82(3): 223–232.

- Healthline. (1 August 2017). 10 Signs and Symptoms of Food Poisoning. Retrieved from <https://www.healthline.com/health/is-food-poisoning-contagious>
- Institute For Digital Research And Education. Statistical consulting: What does cronbach alpha mean?. Retrieved from <https://stats.idre.ucla.edu/spss/faq/what-does-cronbachs-alpha-mean/>
- Ishak, N.K. and Latif, R.A. (n.d.). Typology of night markets in Malaysia. *Journal of Case Research in Business and Economics Typology*. 1–10.
- Ismail, F.H., Chik, C.T., Muhammad, R. and 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: 290–298.
- Jaafar, N.M., Nur, S. and Jaafar, A. (2017). Comparative study of consumers' knowledge and attitudes towards food safety and purchase intention of night market foods containing poultry in low and high food poisoning cases states. *Malaysian Applied Biology Journal*, 46: 131–141.
- Jackson, K.A., Gould, L.H., Hunter, J.C., Kucerova, Z. and Jackson, B. (2018). Listeriosis outbreaks. *Centers for Disease Control and Prevention*, 24(6): 1116–1118.
- Jawad, N. and Mutalib, S.A. (2016). Identification of *Bacillus cereus* isolates from cooked rice by biochemical test and 16s rDNA sequences. *International Journal of ChemTech Research*, 9(3): 469–475.
- Jeffree, M., (2016). Waterborne food poisoning outbreak of *Bacillus cereus* in primary school Sabah East Malaysia. *Journal of Advanced Research In Medicine* 2349-7181(3): 22-29.
- Kalyoussef, S. and Feja, K.N. (2014). Foodborne Illnesses. *Advances in Pediatrics*, 61(1): 287–312.
- Ko, W.H. (2013). The relationship among food safety knowledge, attitudes and self-reported HACCP practices in restaurant employees. *Food Control*, 29(1): 192–197.
- Lee H.K., Abdul Halim H., Thong K.L. and Chai L.C. (2017). Assessment of food safety knowledge, attitude, self-reported practices, and microbiological hand hygiene of food handlers. *International Journal of Environmental Research and Public Health*. 14(1): 55.
- Leong, K.N., Chow, T.S., Wong, P.S., Hamzah, S.H., Ahmad, N. and Ch'Ng, C.C. (2015). Case report: Outbreak of human brucellosis from consumption of raw goats' milk in Penang, Malaysia. *American Journal of Tropical Medicine and Hygiene*, 93(3): 539–541.

- Lim, T.P., Chye, F.Y., Sulaiman, M.R., Suki, N.M. and Lee, J.S. (2016). A structural modeling on food safety knowledge, attitude, and behaviour among Bum Bum Island community of Semporna, Sabah. *Food Control*, 60: 241–246.
- Liu, Z., Zhang, G. and Zhang, X. (2014). Urban street foods in Shijiazhuang city, China: Current status, safety practices and risk mitigating strategies. *Food Control*, 41(1): 212–218.
- López, A.C., Minnaard, J., Pérez, P.F. and Alippi, A.M. (2015). A case of intoxication due to a highly cytotoxic *Bacillus cereus* strain isolated from cooked chicken. *Food Microbiology*, 46: 195–199.
- Ma, L., Chen, H., Yan, H., Wu, L. and Zhang, W. (2019). Food safety knowledge, attitudes, and behavior of street food vendors and consumers in Handan, a third tier city in China. *BMC Public Health*. 19: 1128.
- Marzano, M.A. and Balzaretto, C.M. (2013). Protecting child health by preventing school-related foodborne illnesses: Microbiological risk assessment of hygiene practices, drinking water and ready-to-eat foods in Italian kindergartens and schools. *Food Control*. 34(2): 560-567.
- Mazlan, S., Eleesha, N., Meran, S., Hanum, M., Kamal, M. and Ramli, N. (2017). Decision to visit night market from Malaysian customer perspective. *Journal of Tourism*, 9(2): 143–152.
- McLauchlin, J., Jørgensen, F., Aird, H., Charlett, A., Elviss, N., Fenelon, D., Fox, A., Willis, C. and Amar, C.F.L. (2017). An assessment of the microbiological quality of liver-based pâté in England 2012-13: Comparison of samples collected at retail and from catering businesses. *Epidemiology and Infection*, 145(8): 1545–1556.
- Microbiology Society. (May 2020). Understanding bacteria and challenges in microbiology. Retrieved from <https://microbiologysociety.org/publication/past-issues/why-microbiology-matters/article/understanding-bacteria-and-challenges-in-microbiology.html>
- Nasrolahei, M., Mirshafiee, S., Kholdi, S., Salehian, M. and Nasrolahei, M. (2017). Bacterial assessment of food handlers in Sari City, Mazandaran Province, north of Iran. *Journal of Infection and Public Health*, 10(2): 171–176.
- National Antibiotic Guideline 2014. Ministry of Health. Retrieved from www.moh.gov.my.
- National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), (2019). Treatment for Food Poisoning. Retrieved from <https://www.niddk.nih.gov/health-information/digestive-diseases/food-poisoning/treatment>

- National Institutes of Health. (01 September 2021). Allergen. Retrieved from <https://medlineplus.gov/ency/article/002229.htm>
- National Organization for Rare Disorders. (April 2017). Heavy metal poisoning. Retrieved from <https://rarediseases.info.nih.gov/diseases/6577/heavy-metal-poisoning>
- National Organization for Rare Disorders. Heavy Metal Poisoning. Retrieved from <https://rarediseases.org/rare-diseases/heavy-metal-poisoning/>
- Natural toxins in food. (9 May 2018). Retrieved from <https://www.who.int/news-room/fact-sheets/detail/natural-toxins-in-food>
- Navaneethan, Y. and Effarizah, M.E. (2021). Prevalence, toxigenic profiles, multidrug resistance, and biofilm formation of *Bacillus cereus* isolated from ready-to eat cooked rice in Penang, Malaysia. *Food Control*, 121(March 2020), 107553.
- Nkhebenyane, J. and Thekisoe, O. (2021). Street food handlers' food safety knowledge, attitudes and self-reported practices and consumers' perceptions about street food vending in Maseru, Lesotho. *British Food Journal*. 123(13): 302-316.
- Okareh, O.T. and Erhahon, O.O., (2015). Microbiological assessment of food and hand-swabs samples of school food vendors in Benin City, Nigeria. *Food and Public Health*, 5(1): 23–28.
- Olleveant, N.A., (1999). Tukey Multiple Comparison test. *Journal of Clinical Nursing*, 8: 299-304.
- Omemu, A.M. and Aderoju, S.T. (2008). Food safety knowledge and practices of street food vendors in the city of Abeokuta, Nigeria. *Food Control*, 19(4): 396–402.
- Osaili, T.M., Al-Nabulsi, A.A. and Allah Krasneh, H.D. (2018). Food safety knowledge among foodservice staff at the universities in Jordan. *Food Control*, 89: 167–176.
- Osmani, A., Aquilanti, L. and Clementi, F. (2018). *Bacillus cereus* foodborne outbreaks in mass catering. *International Journal of Hospitality Management*, 72(May 2017): 145–153.
- Pamela Hunter. (n.d). Margin of error and confidence levels made simple. Retrieved from <https://www.isixsigma.com/tools-templates/sampling-data/margin-error-and-confidence-levels-made-simple/>
- Papadopoulou, C., Economou, E., Zakas, G., Salamoura, C., Dontorou, C. and Apostolou, J. (2007). Microbiological and pathogenic contaminants of seafood in Greece. *Journal of Food Quality*, 30(1): 28–42.

- Paudyal, N., Anihouvi, V., Hounhouigan, J., Matsheka, M. I., Sekwati-Monang, B., Amoah-Awua, W., Atter, A., Ackah, N.B., Mbugua, S., Asagbra, A., Abdelgadir, W., Nakavuma, J., Jakobsen, M. and Fang, W. (2017). Prevalence of foodborne pathogens in food from selected African countries – A meta-analysis. *International Journal of Food Microbiology*, 249: 35–43.
- Penido, A., Mendes, P., Campos, I. and Mendes, L. (2013). Enterotoxigenic *Bacillus cereus* from cooked chicken meat: A potential public health hazard. *Malaysian Journal of Microbiology*. 9(2): 166-175.
- Rane, S. (2011). Street Vended Food in Developing World: Hazard Analyses. *Indian Journal Microbiology*, 51(1): 100–106.
- Rosenquist, H., Smidt, L., Andersen, S.R., Jensen, G.B. and Wilcks, A. (2005). Occurrence and significance of *Bacillus cereus* and *Bacillus thuringiensis* in ready-to-eat food. *FEMS Microbiology Letters*, 250(1): 129–136.
- Rosmawati, N.N., Manan, W.W., Izani, N.N. and Nurain, N.N. (2014). Evaluation of environmental hygiene and microbiological status of selected primary school canteens. *Health and the Environment Journal*, 5(3): 110–127.
- Rouzeau-Szynalski, K., Stollewerk, K., Messelhäusser, U., and Ehling-Schulz, M. (2020). Why be serious about emetic *Bacillus cereus*: Cereulide production and industrial challenges. *Food Microbiology*, 85(February 2019): 103279.
- Samapundo, S., Cam Thanh, T.N., Xhaferi, R. and Devlieghere, F. (2016). Food safety knowledge, attitudes and practices of street food vendors and consumers in Ho Chi Minh city, Vietnam. *Food Control*, 70: 79–89.
- Sandra, A., Afsah-Hejri, L., Tunung, R., Tuan Zainazor, T.T.C., Tang, J.Y.H., Ghazali, F.M. and Son, R. (2012). *Bacillus cereus* and *Bacillus thuringiensis* in ready-to-eat cooked rice in Malaysia. *International Food Research Journal*, 19(3): 829–836.
- Šegalo, S., Maestro, D., Obradović, Z. and Jogunčić, A. (2020). Nasal carriage rate and antimicrobial resistance pattern of *Staphylococcus aureus* among the food handlers in Canton Sarajevo, Bosnia and Herzegovina. *Journal of Health Sciences*, 10(2): 139–146.
- Setia, M.S., Mumbai, N. and Mumbai, N. (2016). Methodology series module 3: Cross-sectional studies. *Indian Journal of Dermatology*. 61(3): 261–264.
- Severi, E., Booth, L., Johnson, S., Cleary, P., Rimington, M., Saunders, D., Cockcroft, P. and Ihekweazu, C. (2012). Large outbreak of *Salmonella enteritidis* PT8 in Portsmouth, UK, associated with a restaurant. *Epidemiology and Infection*, 140(10): 1748–1756.

- Shilla, J. (2011). Survey beta lactamase production and resistance pattern into beta lactame antibiotics in *Bacillus cereus* strain isolated from staff hands and hospital environment in Iran. *African Journal of Microbiology Research*, 5(19): 2980–2985.
- Soon, J.M. (2019). Rapid Food Hygiene Inspection Tool (RFHiT) to assess hygiene conformance index (CI) of street food vendors. *LWT - Food Science and Technology*.113(April 2019): 108304.
- Sornchuer, P. and Tiengtip, R. (2021). Prevalence, virulence genes, and antimicrobial resistance of *Bacillus cereus* isolated from foodstuffs in Pathum Thani Province, Thailand. *Pharmaceutical Sciences Asia*, 48(2): 194–203.
- Sumarjan, N., Salehuddin, M.Z.M., Salleh, M.R., Zurinawati, M., Hafiz, M.H.M., Faez, S.B.H. and Artinah, Z. (2013). Hospitality and Tourism: Synergizing creativity and innovation in research. *CRC Press- Technology and Engineering*. 327-329
- Sun, Y.M., Wang, S.T. and Huang, K.W. (2012). Hygiene knowledge and practices of night market food vendors in Tainan City, Taiwan. *Food Control*, 23(1): 159–164.
- Switaj, T.L., Winter, K.J. and Christensen, S.R. (2015). Diagnosis and Management of Foodborne Illness. *American Family Physician*. 92(5):358-365.
- Tallent, S.M., Knolhoff, A., Rhodehamel, E.J., Harmon, S.M. and Bennett, R.W. (2019). BAM Chapter 14: *Bacillus cereus*, 1–10.
- Tan, S.L., Bakar, F.A., Abdul Karim, M.S., Lee, H.Y. and Mahyudin, N.A. (2013). Hand hygiene knowledge, attitudes and practices among food handlers at primary schools in Hulu Langat district, Selangor (Malaysia). *Food Control*, 34(2): 428–435.
- Tavakol, M. and Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, 2: 53–55.
- The Star. (March 2014). Food poisoning. Retrieved from <https://www.thestar.com.my/news/nation/2014/03/03/pasar-malam-food-poisoning-boy-death>
- Tirloni, E., Bernardi, C., Ghelardi, E., Celandroni, F., Cattaneo, P. and Stella, S. (2019). *Bacillus cereus* in fried rice meals: Natural occurrence, strain dependent growth and haemolysin (HBL) production. *Lwt - Food Science and Technology*, 114(2019): 108393.
- Tirmizi, L.I.T., Son, R., New, C.Y. and Brand, H. (2018). The effectiveness of food handler training programs in Malaysia and Ireland to prevent food-borne disease. *Food Research*, 2(3): 247-257.

- Toh, P.S. and Birchenough, A. (2000). Food safety knowledge and attitudes: Culture and environment impact on hawkers in Malaysia.: Knowledge and attitudes are key attributes of concern in hawker food handling practices and outbreaks of food poisoning and their prevention. *Food Control*, 11(6): 447–452.
- Torkar, K.G. and Bedenić, B. (2018). Antimicrobial susceptibility and characterization of metallo- β -lactamases, extended-spectrum β -lactamases, and carbapenemases of *Bacillus cereus* isolates. *Microbial Pathogenesis*, 118(March): 140–145.
- Tusgul, S., Prod'hom, G., Senn, L., Meuli, R., Bochud, P.Y. and Giulieri, S.G. (2017). *Bacillus cereus* Bacteraemia: Comparison Between Haematologic and Nonhaematologic Patients. *New Microbes and New Infections*, 15: 65–71.
- US Food Safety and Inspection Service (FSIS). (2020). Foodborne Illness and Disease. Retrieved from <https://www.fsis.usda.gov/food-safety/foodborne-illness-and-disease>
- US National Library of Medicine. (31 August, 2016). National Institutes of Health. Viral Infections. Retrieved from <https://medlineplus.gov/viralinfections.html>
- Woh, P.Y., Thong, K.L., Behnke, J.M., Lewis, J.W. and Mohd Zain, S.N. (2016). Evaluation of basic knowledge on food safety and food handling practices among migrant food handlers in Peninsular Malaysia. *Food Control*, 70(2016): 64–73.
- Woh, P.Y., Thong, K.L., Lim, Y.A.L., Behnke, J.M., Lewis, J.W. and Mohd Zain, S.N. (2017). Microorganisms as an indicator of hygiene status among migrant food handlers in Peninsular Malaysia. *Asia-Pacific Journal of Public Health*, 29(7): 599–607.
- World Health Organization. (2013). Advancing food safety initiatives: Strategic plan for food safety including foodborne zoonoses 2013-2022.
- World Health Organization. (June 2011). Five keys to growing safer fruits and vegetables: promoting health by decreasing microbial contamination, Trial edition for field testing. Retrieved from https://www.who.int/foodsafety/consumer/5keys_growing_trial_edition.pdf
- World Health Organization. WHO Estimates of the global burden of foodborne diseases: Foodborne diseases burden epidemiology reference group 2007-2015. Retrieved from http://apps.who.int/iris/bitstream/handle/10665/199350/9789241565165_eng.pdf

- World Health Organization (WHO). (2014). Knowledge, attitudes, and practices (KAP) surveys during cholera vaccination campaigns: Guidance for oral cholera vaccine stockpile campaigns. Retrieved from [https://www.who.int/publications/m/item/knowledge-attitudes-and-practices-\(kap\)-surveys-during-cholera-vaccination-campaigns-guidance-for-oral-cholera-vaccine-stockpile-campaigns](https://www.who.int/publications/m/item/knowledge-attitudes-and-practices-(kap)-surveys-during-cholera-vaccination-campaigns-guidance-for-oral-cholera-vaccine-stockpile-campaigns)
- Yu, S., Yu, P., Wang, J., Li, C., Guo, H., Liu, C. and Ding, Y. (2020). A study on prevalence and characterization of *Bacillus cereus* in ready-to-eat foods in China. *Frontiers in Microbiology*, 10(January 2020): 1–11.
- Zhang, Z., Feng, L., Xu, H., Liu, C., Shah, N. P., and Wei, H. (2016). Detection of viable enterotoxin-producing *Bacillus cereus* and analysis of toxigenicity from ready-to-eat foods and infant formula milk powder by multiplex PCR. *Journal of Dairy Science*, 99(2): 1047–1055.
- Zulfakar, S.S., Abd. Hamid, N.H. and Sahani, M. (2018). Microbiological Assessment of Food Contact Surfaces in Residential College Cafeterias at a Local University in Malaysia. *Jurnal Sains Kesihatan Malaysia*, 16(02): 33–38.
- 3M Microbiology. (2003). 3M Quick Swab: Wet Swabbing Method. Retrieved from <https://multimedia.3m.com/mws/media/241138O/quick-swab-reminders-for-use.pdf>