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MICROBIOLOGICAL ASSESSMENT OF NOODLES SOLD AT RAMADAN BAZAAR IN KUCHING, SARAWAK, MALAYSIA

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ABSTRACT. *The Ramadan bazaar offers a diverse array of food options for many during the month of Ramadan. However, with the rising incidents of food poisoning, there are ongoing concerns about the microbiological quality of the food. This study investigates the microbial quality of various noodle types sold at the Ramadan bazaar in Kuching, Sarawak. A total of thirty-three (33) samples were collected from various locations and tested for Aerobic Plate Count (APC), coliforms, Escherichia coli, Staphylococcus aureus, Bacillus cereus, and Salmonella spp. Among the samples, 88%, 3%, 21%, 6%, and 16% exceeded acceptable limits for APC, coliforms, E. coli, S. aureus, and B. cereus, respectively, while none of the samples tested positive for Salmonella spp. Additionally, local noodle dishes such as Laksa Sarawak, Kolo mee, and mee Jawa showed the highest levels of contamination with E. coli, S. aureus, and B. cereus in this study. The presence of APC, coliforms, E. coli, S. aureus, and B. cereus indicates cross-contamination resulting from insufficient hygiene practices before and after the cooking process.*

KEYWORDS: Food safety, noodles, microbiological quality, Ramadan bazaar, street food.

INTRODUCTION

The Ramadan bazaar in Malaysia is an annual event held throughout the month of Ramadan, offering a diverse array of food options, from drinks to main dishes. Each state in Malaysia presents unique Ramadan bazaar dishes that reflect the local community's culture, all at affordable prices suitable for people of all ages and backgrounds. For instance, Sarawak is renowned for its delicious noodles, such as laksa Sarawak, kolo mee, and mee jawa, which are available at all Ramadan bazaars.

While food from the Ramadan bazaar is a popular choice, it is frequently associated with foodborne illnesses. The food sold is typically ready-to-eat and intended for takeaway, making it convenient for immediate consumption or breaking the fast. However, various factors can contribute to the contamination of Ramadan bazaar food, leading to foodborne illnesses. Key concerns include poor hygiene among food handlers, cross-contamination, and time and temperature abuse during storage. In 2023, the Malaysian Ministry of Health issued 2,188 notices totaling RM197,600 during inspections of 51,849 Ramadan bazaar premises across 640 localities nationwide. The violations mainly included the lack of food handler training, absence of anti-typhoid vaccinations, and non-compliance with food handler attire regulations. Additionally, 17 complaints regarding food at Ramadan bazaars were recorded, and only two reports of food poisoning were received involving food purchased at these bazaars (The Sun, 2023).

Additionally, Ramadan bazaar food samples were subjected to microbial analysis. The Kelantan State Health Department reported that one sample contained *S. aureus* in duck egg curry, while chicken-based dishes tested positive for *Salmonella* spp. (Berita Harian, 2022). Furthermore, Mat Zin *et al*. (2017) conducted microbiological analyses of meat samples from a Ramadan bazaar in Kelantan, Malaysia, which indicated unsatisfactory results for coliforms, *Staphylococcus* spp., *E. coli*, and *Salmonella*. In a separate incident, a food handler at a Ramadan bazaar in Limbang, Sarawak, was fined RM1,000 in October 2023 for selling food contaminated with pathogenic bacteria during the last Ramadan (Utusan Borneo, 2023). Although no food poisoning cases have been associated with food and drinks sold at all Ramadan bazaar stalls throughout Sarawak, there is still a potential risk of contamination from pathogenic bacteria, as demonstrated by the situation in Limbang, Sarawak. According to Abdul-Mutalib *et al*. (2015), foodborne diseases are prevalent in Malaysia, but many cases, especially minor ones, go unreported. Therefore, this study aims to assess the microbial quality of delicacy noodles sold at Ramadan bazaars in Kuching, Sarawak. Given that noodles are popular among consumers in Sarawak and may be at risk of contamination, this study focuses specifically on noodle samples. The findings from this research could provide valuable insights for regulatory agencies to implement necessary measures in the future.

MATERIALS AND METHOD

2.1 Sample Collection and Preparation

The sampling process included six Ramadan bazaars across three different locations in Kuching, Sarawak, Malaysia: Kuching North (18 samples), Kuching South (5 samples), and Padawan (10 samples). A total of 33 samples, consisting of eight different types of noodles (Figure 1), were collected aseptically during the month of Ramadan for laboratory analysis. Each sample was assigned a unique serial number, transported to the laboratory in a cool box, and kept at a temperature of 4 °C. The samples were either analyzed immediately or stored in a refrigerator and tested within 24 hours post-collection. All analyses were conducted following standard methods, assessing for APC, coliforms, *E. coli*, *S. aureus*, *B. cereus*, and *Salmonella* spp.

2.2 Microbiological analysis

A 10-fold serial dilution was carried out on the homogenized samples, followed by plating 1 mL of the appropriate dilutions in triplicate on selected media. This study utilized five standard methods

for microbiological analysis: (1) AOAC International Official Method 990.12:2002 for Aerobic Count Plate (AOAC, 2002a), (2) AOAC International Official Method 991.14:2002 for Coliform and E. coli Plate (AOAC, 2002b), (3) AOAC International Official Method 2003.07 for Staph Express Count Plate (AOAC, 2003), (4) ISO 7932:2004 (E) for the enumeration of presumptive *B. cereus* by colony-count technique at 30°C, and (5) ISO 6579:2002 (E) for detecting *Salmonella* spp. The contamination levels of APC, coliforms, *E. coli*, *S. aureus*, *B. cereus*, and *Salmonella* spp. were compared to the standard guidelines outlined in the Food Standard Australia New Zealand (FSANZ) Compendium of Microbiological Criteria for Food (2022).

2.3 Statistical Analysis

All statistical analyses were conducted using IBM's Statistical Packages for Social Science (SPSS) Version 26. Descriptive analysis was employed to assess the counts of aerobic plate count (APC), coliforms, *E. coli*, *S. aureus*, *B. cereus*, and *Salmonella* spp. in the food sold at the Ramadan bazaar in Kuching, Sarawak, Malaysia.

RESULTS AND DISCUSSION

3.1 Microbiological Analysis

The bacterial counts for APC, coliforms, *E. coli*, *S. aureus*, and *B. cereus* in the noodles sold at the Ramadan bazaar in Kuching are summarized in Table 1. Samples from the Ramadan bazaar in Kuching North exhibited the highest contamination levels for APC, coliforms, *E. coli*, and *S. aureus*, with mean values of 5.188 ± 0.445 log CFU/g, 4.246 ± 0.695 log CFU/g, 2.343 ± 0.910 log CFU/g, and 2.205 ± 0.489 log CFU/g, respectively. In contrast, Padawan's samples demonstrated the highest contamination level of B. cereus, recorded at a mean value of 3.156 ± 0.848 log CFU/g. Notably, *Salmonella* spp. was not detected in any of the noodle samples analyzed in this study. The variation in bacterial loads can be attributed to several factors, including environmental conditions and hygiene practices (Amare *et al*., 2019; Nguendo, 2018). For instance, the Ramadan bazaar in Kuching South was equipped with adequate hand washing facilities, whereas both Kuching North and Padawan had only one water source available for each bazaar. This limited access led food handlers to prepare water in buckets or large bottles for handwashing and utensil cleaning, resulting in inadequate hygiene practices. Furthermore, it is important to note that many food handlers were observed using bare hands while handling food, which may further increase the risk of cross-contamination.

The detection of APC in all samples, with an overall mean value of 5.035 ± 0.622 log CFU/g, suggests that the noodles sold at the Ramadan bazaar in Kuching, Sarawak, were contaminated with various pathogens. APC serves as an indicator of the overall bacterial contamination level in food and beverage samples, reflecting the hygiene and sanitation conditions at the point of sale, as noted by Mohd Nawawee *et al*. (2019) and Salamandane *et al*. (2021). Additionally, it is a valuable tool for monitoring food processing, as the results can indicate the cleanliness of food handling and retail storage practices (Upadhyaya *et al*., 2017). Furthermore, foods with elevated APC levels are considered potentially harmful, even if specific pathogens have not been identified (Reda *et al*., 2017). Therefore, these findings clearly indicate that the noodles sold at the Ramadan bazaar in Kuching, Sarawak, were prepared under poor hygiene practices by food handlers.

In this study, coliform was detected in all samples, with an overall mean value of 3.974 ± 0.763 log CFU/g. While coliform bacteria are generally harmless to humans, they can sometimes be associated with serious waterborne diseases (Thi *et al*., 2021). The water used for food preparation and utensil cleaning can serve as a potential source of contamination, especially since food handlers often use recycled water for washing and cleaning purposes.

As a subgroup of fecal coliform, *E. coli* also acts as an indicator of sanitary conditions (Reda *et al*., 2017) and was found across all locations in this study. The mean E. coli count observed aligns with previous findings by Mumu et al. (2021), who reported E. coli levels in noodles from street food carts ranging from 102 CFU/g to 103 CFU/g. Additionally, E. coli has also been isolated in noodles by Tamilnila *et al*. (2018) and Siddabathuni (2019). The presence of *E. coli* in food indicates potential failures in heat processing or faecal contamination resulting from poor hygiene practices among food handlers (Amare *et al*., 2019).

S. aureus, recognized as the most prevalent pathogen found on hands (Amare *et al*., 2019; Woh *et al*., 2017), was identified in this study, highlighting the likelihood of cross-contamination due to inadequate hand washing practices among food handlers. Hand and utensil washing emerged as a significant risk factor in this context. Since the vending sites were located at a distance from the water source, many food handlers at the Ramadan bazaar relied on buckets to store water for washing their hands and utensils. Furthermore, the repetitive use of water from these buckets can heighten the risk of cross-contamination, facilitating the transfer of pathogens to food products (Birgen *et al*., 2020). Similarly, studies by Tamilnila *et al*. (2018) and Siddabathuni (2019) also reported the presence of *S. aureus* in noodles. In contrast, Mumu *et al*. (2021) did not detect S. aureus contamination but isolated other bacteria, such as *Klebsiella* spp. and *Pseudomonas* spp. Other research has shown that the isolation of S. aureus is frequent in cooked foods, including meat, rice, and fried snacks (Birgen *et al*., 2020; Vadesh & Neel, 2017; Abd Rahim *et al*., 2019).

Previous studies have indicated that B. cereus is present in various food items, including cooked rice and fried snacks (Saba *et al*., 2019; Fahani *et al*., 2019; Khasnabis *et al*., 2017). In this study, B. cereus was detected in 21% of the samples, yielding a total mean value of 3.276 ± 0.837 log CFU/g. However, it was not found in samples collected from the Ramadan bazaar in Kuching South. *B. cereus* is a gram-positive, spore-forming, and motile rod-shaped bacterium commonly found in food and soil. This bacterium produces two types of toxins (Yeo *et al*., 2018). According to Fahani *et al*. (2019), leftover food stored in the refrigerator for sale the following day can lead to toxin production, which poses a risk of food poisoning.

In this study, no *Salmonella* spp. were detected in any of the noodles sold at Ramadan bazaars in Kuching, Sarawak. This finding aligns with the research conducted by Mumu *et al*. (2021), which also found no Salmonella spp. in noodle samples from Dhaka City, India. Similarly, Salamandane *et al*. (2021) noted that the presence of *Salmonella* is not commonly found in cooked foods, but it is frequently observed in street foods due to post-contamination. Conversely, Tamilnila *et al*. (2018) reported that street food noodles in Thanjavur City, India, were potentially contaminated with *Salmonella* spp. due to extremely poor environmental conditions.

3.2 Comparison of Bacterial Count with Microbiology Standard

Table 2 illustrates the contamination levels of APC, coliform, *E. coli*, *S. aureus*, *B. cereus*, and *Salmonella* spp. in noodles, in comparison to the Food Standard Australia New Zealand (FSANZ) Compendium of Microbiological Criteria for Food (2022). According to the table, 12% of the total samples were classified as marginal, while 88% were deemed unsatisfactory concerning APC contamination. The elevated bacterial counts in the noodles may be attributed to the addition of gravy and condiments, such as chopped spring onions or chilies, after cooking. Previous studies have also reported high levels of APC contaminants exceeding 5.0 Log CFU/g in various food types, including cooked meat, fried snacks, vegetables, and beverages (Mehboob & Abbas, 2019; Mohd Nawawee *et al*., 2019; Alem *et al*., 2020; Thi *et al*., 2021).

Most of the samples (97%) were classified as having a marginal level of coliform contamination, while only 3% were deemed unsatisfactory. This finding contrasts with several studies that have reported significantly higher levels of unsatisfactory coliform counts in various food types, including sandwiches, beverages, cooked rice, and fried snacks (Mohd Nawawee *et al*., 2019; Abd Rahim et al., 2019; Salamandane *et al*., 2021). According to Mohd Nawawee *et al*. (2019), the presence of these bacteria may result from direct contact with the hands or bodies of food handlers, or from the use of unboiled water during food preparation. Furthermore, a high presence of coliforms in food suggests unsanitary environmental conditions during processing, handling, distribution, and potential contamination after food handling (Abd Rahim *et al*., 2019).

For *E. coli* contamination, 73% of the total samples were categorized as satisfactory, followed by 6% at a marginal level and 21% classified as unsatisfactory. In a study by Abd Rahim *et al.* (2019), only two samples tested positive for *E. coli*, and both exceeded the acceptable standards. The contributors to *E. coli* contamination in their samples were related to food handlers failing to adhere to proper hygiene practices, such as washing their hands after using the bathroom and before handling food. According to Mumu *et al*. (2021), *E. coli* levels in cooked foods that exceed the permitted food safety standard limit suggest that many food handlers do not engage in good food handling practices, such as smoking, serving food without gloves, or neglecting hair and mask protection. Additionally, the lack of regular oversight by relevant food safety authorities further exacerbates the non-compliance of food safety practices among food handlers.

For *S. aureus* contamination, nearly half of the total samples were classified as satisfactory (46%), while 48% were at a marginal level. Only 6% of the samples were deemed unsatisfactory for S. aureus contamination. In a study by Abd Rahim *et al*. (2019), 33% of the total samples sold in Chow Kit, Kuala Lumpur, were found to be contaminated with S. aureus, with a total mean value exceeding 4 Log CFU/g. Another study by Afreen *et al*. (2019) reported that 100% of street drinks were classified as unsatisfactory for S. aureus contamination. They identified several risk factors associated with S. aureus contamination, including the type of juice, vending site, water source, food covering, serving food with bare hands, and inadequate washing of equipment.

In this study, 79% of the total samples were classified as satisfactory for B. cereus contamination, with 6% at a marginal level and 16% deemed unsatisfactory. In a study conducted in Ghana by Saba *et al*. (2019), a higher proportion of unsatisfactory food samples was reported, particularly among enclosed vendors, with fried rice having the highest number of unsatisfactory samples.

3.3 Distribution of *E. coli, S. aureus* and *B. cereus* in different types of noodles

Figure 2 illustrates the distribution of *E. coli* (9 isolates), *S. aureus* (21 isolates), and B. *cereus* (7 isolates) across eight types of noodles. The popular local noodle, mee jawa, exhibited the highest levels of contamination, followed by kolo mee and laksa Sarawak. This indicates that these dishes are particularly susceptible to contamination due to the variety of ingredients used in their preparation. These noodles are typically served with gravy and various condiments, such as meat, sliced spring onions, chilies, bean sprouts, and fried onions. The addition of such condiments increases the risk of contamination from inadequate personal hygiene and poor food handling practices. Food handlers often use their bare hands to add these condiments, raising concerns about hand hygiene due to the limited access to handwashing facilities at Ramadan bazaars. Previous research has shown that bacterial counts on food handlers' hands can exceed safe levels (Lee *et al*., 2017), and poor handwashing habits are a significant risk factor for microbial contamination (Afreen *et al*., 2019). While disposable gloves can effectively help prevent cross-contamination when used correctly, they should not replace handwashing (Trafialek *et al*., 2018; Afreen *et al*., 2019). Additionally, the use of clean tongs, forks, or spoons during food handling is recommended (Birgen *et al*., 2020). Therefore, it is essential to emphasize proper hand hygiene and effective handwashing techniques, particularly for new, young, and inexperienced food handlers (Anowai *et al*., 2019).

Nevertheless, there are additional risk factors for microbial contamination identified in this study. Although the Ramadan bazaar in Kuching South is equipped with good handwashing facilities, *S. aureus* contamination is still evident in nearly all samples collected there. The gravy used for the noodles can also pose a contamination risk if it is not stored and handled properly by food handlers. This gravy is typically made with coconut milk or chili paste and is often prepared in advance at home. Inadequate handling practices and improper storage of coconut milk may contribute to cross-contamination. Previous studies by Nurul *et al*. (2017) and Sari *et al*. (2019) have reported the presence of *E. coli* and *S. aureus* in coconut milk, attributing this to a lack of personal protective equipment and poor storage practices.

In addition, fried noodles, including fried mee hoon, fried kolo mee, and fried kuetiau, were also found to be contaminated with E. coli, S. aureus, and B. cereus. Typically, these fried noodles are left uncovered during sale, exposing them to flies and dust, which contributes to contamination. Furthermore, cooked foods held for extended periods may create conditions conducive to the growth and multiplication of pathogenic microorganisms, potentially leading to infections and intoxication upon consumption (Amare et al., 2019; Mwove et al., 2019).

A previous study by Tamilnila *et al*. (2018) reported the presence of *E. coli*, *S. aureus*, *Salmonella* spp., and *Clostridium* in street noodles sold in India, highlighting that the risk of contamination significantly increases in very poor environmental conditions where these foods are produced and served. They noted a lack of adequate garbage disposal facilities and clean water sources for drinking and cleaning purposes. Similarly, Siddabathuni (2019) found that 21 bacterial pathogens, including *S. aureus, Proteus* spp., and *E. coli,* were isolated from 79% of contaminated noodle samples in India. This contamination was linked to vendors' poor hand hygiene, the use of contaminated water for food preparation without proper handwashing, and utensil contamination from pathogens carried by flies originating from nearby sewage and garbage. Thus, both studies from India by Tamilnila *et al*. (2018) and Siddabathuni (2019) underscore that extremely poor

environments and inadequate facilities at food premises are significant contributors to food contamination.

CONCLUSION

Based on the findings of this study, it can be concluded that the noodles sold at Ramadan bazaars in Kuching, Sarawak, were potentially contaminated with pathogenic microorganisms such as *S. aureus* and *B. cereus*. The presence of these bacteria in food poses potential health risks to consumers. Furthermore, microbial analysis indicated that contamination levels in certain noodle samples exceeded the established standards. Therefore, this study recommends that more effective health education and food handling training be implemented for food handlers at Ramadan bazaars in Kuching, Sarawak, Malaysia. Additionally, information and training programs are essential for consumers to raise awareness about food safety, thereby protecting them from possible foodborne illnesses.

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