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Microbial Quality of Fresh Poultry Meat Samples Sold in Local Markets of Kota Kinabalu, Malaysia

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Abstract

This study aimed to assess and compare the microbial quality of broiler chicken meat sold at different types of market markets in Kota Kinabalu, Sabah, Malaysia. A total of 21 back-quarter chicken meat samples were collected from three supermarkets, two local wet markets, and two integrator-owned meat shops. Microbiological analyses were conducted to determine the total viable count (TVC), Enterobacteriaceae count (EC), Staphylococci count (SC), and the presence of Salmonella spp. The mean microbial loads were 4.67±0.15 $\log_{10}$ CFU/g for TVC, 4.14±0.16 $\log_{10}$ CFU/g for EC, and 3.85±0.17 $\log_{10}$ CFU/g for SC. Salmonella spp. were detected in 33.33% of the samples. Statistical analysis showed no significant differences ($p > 0.05$) in microbial loads across the different market types. Although all samples were within acceptable limits, the presence of Salmonella indicates potential food safety concerns. These findings suggest that regardless of the market type, consumers should maintain proper food handling and hygiene practices during storage and preparation to minimize the risk of foodborne illnesses.

Keywords: broiler meat, microbial quality, Salmonella, local markets, food safety

INTRODUCTION

Consumer awareness of food safety and quality has risen significantly, particularly regarding raw, perishable items such as meat, which are prone to contamination by pathogenic bacteria causing foodborne illnesses (Claudious et al., 2018). Independent market markets are increasingly competing with traditional markets by addressing these safety concerns. As microbial contamination is closely linked to meat freshness and shelf life, evaluating microbial loads offers a practical method for assessing quality (Maharjan et al., 2019; Kaur et al., 2021).

Microbiological testing is essential for ensuring food safety and identifying critical control points throughout the production chain. Regulatory food safety criteria guide product evaluation and require recall or withdrawal of non-compliant items (FSAI, 2011). During meat processing—slaughtering, cutting, and packaging—microbial contamination may arise from carcasses, water, surfaces, and equipment (Hinton et al., 2004). Poultry is especially vulnerable to contamination by over 30 microbial genera, including *Salmonella*, *Campylobacter*, *Listeria monocytogenes*, and *Escherichia coli* (Derman & Rose, 2007; Conner et al., 2001).

Foodborne disease outbreaks, such as salmonellosis and listeriosis, have been linked to poultry products (Prakesh et al., 2005; Lunden et al., 2003). Therefore, understanding pathogen prevalence from farm to market remains a priority in food safety research (Hue et al., 2011).

In Kota Kinabalu, Malaysia, 99.1% of surveyed consumers reportedly consume chicken weekly (Assis et al., 2015). With high poultry production—over 767 million broilers from 2,606 farms annually (FLFAM, 2017)—ensuring hygienic market conditions is critical. Traditional markets often sell unpackaged meat exposed to environmental contaminants and subject to cross-contamination through improper handling, unsanitized tools, and poor hygiene practices (Vindigni et al., 2007; Birhanu et al., 2017).

This study aimed to determine the total viable count (TVC), *Enterobacteriaceae* count (EC), and *Staphylococci* count (SC) in fresh broiler chicken from various market markets and to compare microbial loads across different market types in Kota Kinabalu, Malaysia.

MATERIALS AND METHOD

1. Preparation of Culture Media

(da Silva et al., 2013; Lab, M, 2012; Atlas and Snyder, 2006; Forbes et al., 2007; FDA, 2001a; FDA, 2001b; APHA, 2001; Zimbro et al., 2009; Holt et al., 1994).

1.1. *General Purpose Media*

Used for the cultivation and enumeration of a wide variety of microorganisms were Buffered Peptone Water (BPW), Tryptone Broth, Plate Count Agar (PCA).

1.2. *Selective and Differential Media for Enteric Bacteria*

Designed for the isolation and differentiation of enteric pathogens, especially *Salmonella* and *Shigella* were Tetrathionate Broth, Selenite Cysteine Broth, Xylose Lysine Deoxycholate (XLD) Agar, Hektoen Enteric Agar (HEA), MacConkey Agar.

1.3. *Selective Media for Gram-Positive Cocci*

Specialized for the detection of *Staphylococcus aureus* was Baird-Parker Agar.

1.4. *Biochemical Characterization Media*

Used for determining microbial metabolic capabilities were Methyl Red-Voges Proskauer (MR-VP) Broth, Triple Sugar Iron (TSI) Agar, Lysine Iron Agar (LIA), Simmons' Citrate Agar.

2. Preparation of samples

A total of 21 chicken meat samples were randomly collected from various market markets between October 2018 and January 2019, with one fresh back-quarter sample taken per market per visit. Samples were transported chilled (0–4°C) to the Universiti Malaysia Sabah laboratory and processed on the same day. Twenty-five grams of chicken skin was aseptically cut, placed in a stomacher bag with 225 ml of 0.1% BPW, and homogenized for 2 minutes.

3. Microbial Enumeration

Serial dilutions (up to 10^{-5}) were prepared, and 100 µl of each was spread on specific media for microbial counts: Plate Count Agar for TVC, MacConkey Agar for EC, and Baird-Parker Agar for SC. Plates were incubated at 37°C for 24 h. Colonies were counted manually (25–250 CFU/plate) and expressed as CFU/g.

4. *Salmonella* Detection

Pre-enrichment: Homogenized samples were incubated at 37°C for 18 h in BPW to resuscitate injured *Salmonella*.

Enrichment: One ml of the pre-enrichment broth was transferred to Tetrathionate and Selenite Cysteine broths, incubated at 37°C for 24 h.

Isolation: A loopful from each enrichment broth was streaked on XLD and HEA, then incubated at 37°C for 24 h. Typical *Salmonella* colonies appeared with characteristic color changes and black centers.

5. Biochemical Identification

Suspected colonies were tested using TSI and LIA media. Typical *Salmonella* produced red slants/yellow butts (TSI) and purple butts (LIA), with or without H_2S. Colonies with characteristic reactions were further confirmed using methyl red, indole, and citrate tests, following FDA guidelines. Isolates with typical *Salmonella* colony characteristics were further tested with methyl-red test, indole test, and citrate test.

RESULTS AND DISCUSSION

1. Total Viable Count (TVC)

The total plate count (TPC), an indicator of food hygiene, measures aerobic mesophilic microorganisms—including both pathogenic and nonpathogenic species—growing at 20–45 °C. Plate Count Agar (PCA), a non-selective medium, was used for this analysis. A total of 21 poultry meat samples were collected from supermarkets, wet markets, and integrator-owned shops in Inanam, Likas, Bandaraya Kota Kinabalu, and Sulaman (Sabah, Malaysia).

Initial bacterial growth was assessed using PCA, MacConkey Agar (MCA), and Baird-Parker Agar (BPA) (Figure 1), with further confirmation on Hektoen Enteric Agar (HEA) and Xylose Lysine Deoxycholate (XLD) Agar (Figure 2).

The microbial loads ranged from 2.63 to 5.79 $\log_{10}$ CFU/g for TVC, 1.95 to 5.38 $\log_{10}$ CFU/g for Enterobacteriaceae (EC), and 2.61 to 5.06 $\log_{10}$ CFU/g for Staphylococci (SC) (Figures 3 and 4). All values were below the accepted safety threshold of 6.00 $\log_{10}$ CFU/g, indicating acceptable microbial quality.

The mean TVC was 4.67 ± 0.15 $\log_{10}$ CFU/g, reflecting both endogenous microflora and contamination introduced during slaughter and processing (Hinton & Cason, 2007; Berrang et al., 2001; Cason et al., 2007). Contaminants may originate from feathers, feet, and intestinal content, as well as external sources such as processing water, equipment, and personnel, making cross-contamination a key concern during meat handling.

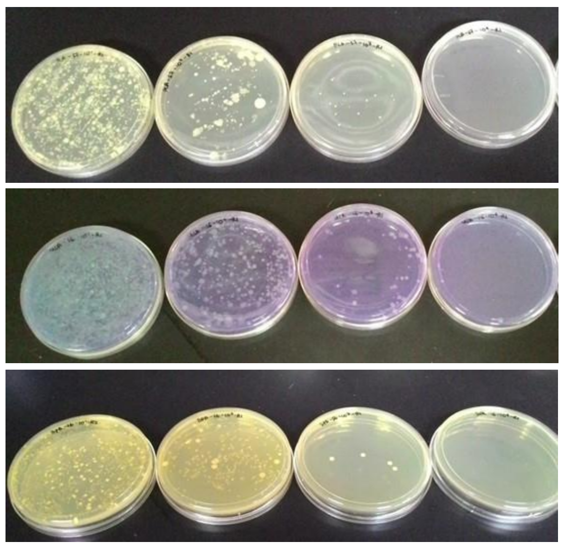

Fig. 1. Plate Count for PCA (*above*), MCA (*middle*) and BPA (*below*).

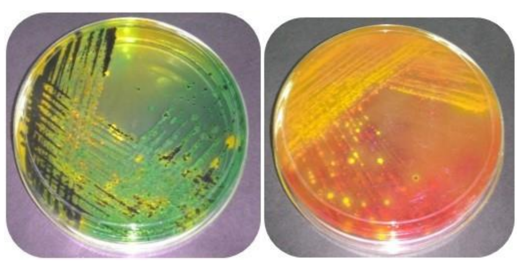

Fig. 2. Isolates of *Salmonella sp.* on HEA (*left*) and XLD Agar (*right*).

The maximum bacterial count observed in this study was 6.2×10^4 CFU/g, which is well below the spoilage threshold of 10^7 CFU/g, indicating that the chicken meat sold across all market types in this city was of good microbiological quality. Notably, market 7 consistently had the lowest colony counts among all sampling points (Figure 3).

The mean TVC observed in this study was lower than those reported in several other countries. For instance, Edris et al. (2015) reported 7.94 $\log_{10}$ CFU/g in El-Qalyubia, Egypt, while Hemmat et al. (2015) recorded 6.18 ± 0.67 $\log_{10}$ CFU/g. Similarly, Omorodion and Odu (2014) found 5.96 $\log_{10}$ CFU/g in Nigeria, Bhandari et al. (2013)

reported 7.24 $\log_{10}$ CFU/g in Nepal, and Haleem et al. (2013) recorded 6.35 $\log_{10}$ CFU/g in Iraq.

In Saudi Arabia, Azhar et al. (2013) reported that meat products often had higher bacterial loads, including total viable count, *Pseudomonas*, fecal *Streptococcus*, and coliforms, especially during the summer season.

In less developed countries like India, even higher TVC levels have been observed, such as 6.75 ± 0.04 $\log_{10}$ CFU/g (Singh et al., 2014) and 6.12 $\log_{10}$ CFU/g (Ramya et al., 2015). According to Saikia and Joshi (2010), this may be attributed to the fact that most market meat shops in India do not operate under sanitary or hygienic conditions.

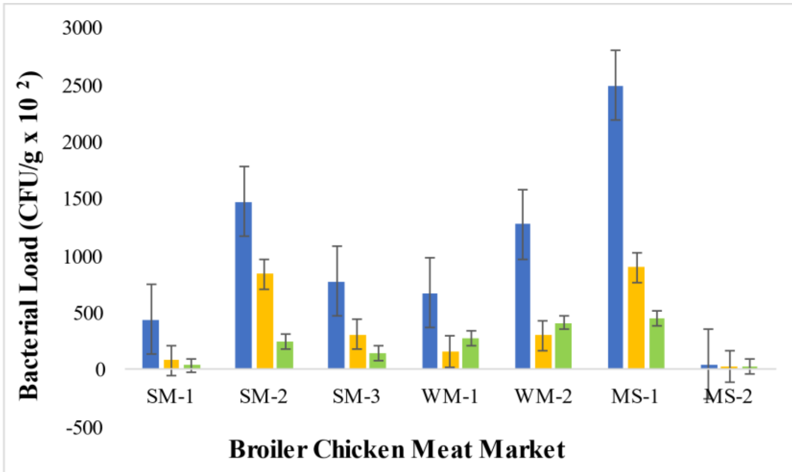

Fig. 3. Total TVC, EC and SC of broiler chicken meat from different markets.

Despite the country's hot and humid climate, this study recorded a lower bacterial load compared to regional data, such as the 11.1 $\log_{10}$ CFU/g reported by Huong et al. (2009) in Vietnam. In Indonesia, market poultry meat often exceeds the national TVC standard of $<10^6$ CFU/g (Diga et al., 2014; Hajrawati et al., 2016; Sartika et al., 2016; Resva & Sunita, 2018). The reduced bacterial load in this study may reflect the implementation of GMP and HACCP in local broiler processing plants (Rejab et al., 2012), whereas higher levels reported elsewhere likely result from poor sanitation and hygiene practices.

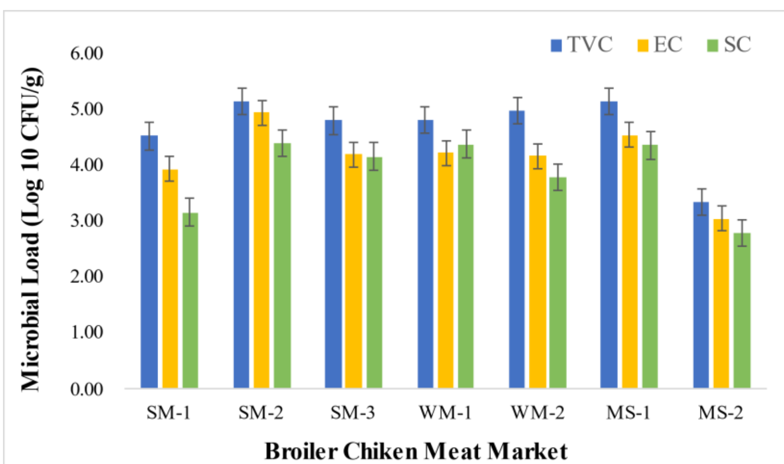

Fig. 4. TVC, EC and SC of broiler chicken meat from different markets in log10 CFU/g.

2. Enterobacteriaceae Count (EC)

The mean EC in this study was 4.14 ± 0.16 $\log_{10}$ CFU/g. Among the sampled markets, market 7 had the lowest EC, while market 2 had the highest. This suggests no significant difference in EC despite variations in the sources of chicken (slaughtering and processing locations) (data not shown). When compared with other studies, the EC observed in this study was similar to that reported by Saikia and Joshi (2010) in Northeast India (4.30 $\log_{10}$ CFU/g). However, it was lower than studies conducted in Turkey (6.44 ± 0.35 $\log_{10}$ CFU/g) by Vural et al. (2006), in India (6.27 $\log_{10}$ CFU/g) by Rindhe et al. (2008), and in Nepal (8.5 $\log_{10}$ CFU/g) by Bhandari et al. (2013). Conversely, the EC was higher than in studies from Spain (2.58–3.53 $\log_{10}$ CFU/g) by Capita et al. (2002), Croatia (2.00–4.17 $\log_{10}$ CFU/g) by Kozacinski et al. (2006), and Egypt (3.91 ± 0.96 $\log_{10}$ CFU/g) by Hemmat et al. (2015) (Table 1).

2. Staphylococci Count (SC)

The mean SC observed in this study was 3.85 ± 0.17 $\log_{10}$ CFU/g, which is comparable to the findings of Vural et al. (2006) (3.64 ± 1.71 $\log_{10}$ CFU/g) and Sengupta et al. (2012) (3.7 $\log_{10}$ CFU/g). This count is slightly lower than those reported in several other countries: Iraq (4.1 ± 0.091 $\log_{10}$ CFU/g) by Haleem et al. (2013); India (4.46 $\log_{10}$ CFU/g) by Joshi and Joshi (2010); Bangalore, India (4.4 $\log_{10}$ CFU/g) by Ruban and Fairoze (2011); Nepal (6.5 $\log_{10}$ CFU/g) by Bhandari et al. (2013); and Iran (4.80 $\log_{10}$ CFU/g) by Javadi and Shafarmasaei (2011). However, it was higher than counts reported by Singh et al. (2014) in India (3.35 ± 0.10 $\log_{10}$ CFU/g) and Hemmat et al. (2015) in Egypt (3.50 ± 1.68 $\log_{10}$ CFU/g) (Table 1).

Table 1. A case study report of Salmonella contamination in chicken meat sold in markets.

City, Country	Occurrence (%)	Samples size (N)	Reference
Thailand (southern)	67.5	40	Lertworapreecha *et. al.* (2013)
Bangkok, Thailand	5.26	209	Akbar and Anal (2013)
Yangon, Myanmar	97.9	141	Moe *et al.* (2017)
Vietnam	45.9	1000	Ta *et al.* (2012)
Vietnam	48.7	300	Ta *et al.* (2014)
Ho Chi Minh, Vietnam	65.3	30	Nguyen *et al.* (2016)
Singapore	18.1	270	Zwe *et al.* (2018)
China	41.6	1595	Zhu *et al.* (2014)
China	33.8	480	Huang *et al.* (2016)
Yangzhou, China	33.8	240	Li *et al.* (2017)
South Korea	41.8	165	Shang *et al.* (2018)
India (northern)	9.43	742	Sharma *et al.* (2019)
Chitwan, Nepal	46.2	26	Bhandari *et al*. (2013)
Accra, Ghana	10.8	200	Pesewu *et al.* (2018)
Trinidad	14.26	450	Khan *et al.* (2018)
Guatemala	34.3	300	Jarquin *et al.* (2015)
Colombia	27	1003	Donado-Godoy *et al.* (2012)
Croatia	10.76	474	Hengl *et al.* (2016)
Ireland	5.1	510	Madden *et al.* (2011)
Russia	31.5	698	Alali *et al.* (2012)
London, UK	4	877	Meldrum and Wilson (2007)
Maryland, USA	3	132	Oscar (2013)
Australia	43.3	859	Pointon *et al.* (2008)
Georgia	42.2	315	Guran *et al.* (2017)

3. Bacterial Load in Chicken Meat by Market Type

Chicken meat from supermarkets, wet markets, and integrator-owned meat shops showed mean TVC values of 4.81 ± 0.14, 4.89 ± 0.14, and 4.24 ± 0.46 $\log_{10}$ CFU/g, respectively. EC values were 4.34 ± 0.19, 4.18 ± 0.17, and 3.79 ± 0.46 $\log_{10}$ CFU/g, while SC values were 3.89 ± 0.21, 4.07 ± 0.33, and 3.56 ± 0.43 $\log_{10}$ CFU/g, respectively. No statistically significant differences ($p > 0.05$) were observed among the market types for TVC, EC, or SC, indicating comparable microbial quality across all sources (Table 2).

Table 2. Comparison of bacterial load in broiler chicken collected from different market.

	Supermarket	Wet market	Meat shop	F value	Note*
Total viable count (TVC)	4.81±0.14	4.89±0.14	4.24±0.46	1.74	NS
Enterobacterial count (EC)	4.34±0.19	4.18±0.17	3.79±0.46	1.03	NS
Staphylococci count (SC)	3.89±0.21	4.07±0.33	3.56±0.43	0.61	NS

NS = non-significant ($p > 0.05$)

Microbial Quality by Market Type

This study found no significant differences ($p > 0.05$) in the microbial quality of poultry meat from integrator-owned shops, supermarkets, and wet markets, as evidenced by similar mean values of TVC, EC, and SC—indicating generally acceptable hygienic conditions across all market types, consistent with Adu-Gyamfi et al. (2012). All samples were collected in the morning shortly after markets opened, likely minimizing bacterial growth. This aligns with Lawan et al. (2011), who observed significantly higher bacterial counts in evening samples due to prolonged exposure. However, findings from other studies remain mixed: while Moustafa et al. (2017) reported higher contamination in local markets, Capita et al. (2002) and Wang et al. (2013) noted lower microbial loads in wet markets, likely due to shorter display durations despite ambient temperature exposure.

Prevalence of *Salmonella* in Market Chicken

Salmonella was detected in 7 out of 21 chicken meat samples (33.3%), including those from supermarkets (3/9), wet markets (2/6), and meat shops (2/6). Although limited in scope, these results underscore ongoing public health risks. Global prevalence varies widely, from 20.8% to 72.7% (Thung et al., 2016; Modarressi & Thong, 2010), influenced by surveillance rigor, hygiene practices, and processing standards. In Sabah, persistent contamination may point to enforcement gaps or processing weaknesses, exacerbated by the region's tropical climate. In contrast, countries like Singapore report lower prevalence (18.1%) due to robust food safety systems (Zwe et al., 2018). Effective control of *Salmonella* hinges on strict hygiene protocols, regulatory compliance, and consumer-level practices such as thorough cooking (≥100°C) and reheating (≥74°C), as the bacteria can survive freezing but not adequate heat treatment (Jajere, 2019).

CONCLUSION

This study found that the microbial quality of broiler chicken sold in supermarkets, wet markets, and integrator-owned shops in Kota Kinabalu, Sabah, was generally within acceptable limits, with no significant differences across market types. However, the detection of *Salmonella* in one-third of the samples underscores ongoing public health concerns and the need for stringent hygiene throughout the supply chain. Despite the tropical climate, relatively low microbial counts suggest adherence to good manufacturing practices (GMP) and HACCP protocols. Nevertheless, consumers should continue to follow safe food handling and thorough cooking practices to minimize the risk of foodborne illness.

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