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Microbial Contamination of Chicken Meat in Traditional Markets, Indonesia

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ABSTRACT

Animal-derived foods, particularly chicken meat, are a vital source of high-quality protein for human nutrition. Chicken meat is highly perishable and prone to contamination by harmful and spoilage microorganisms, particularly when handled or stored without proper hygiene and temperature control. In Indonesia, traditional markets remain the primary outlets for fresh chicken meat, yet scientific data on microbial contamination at the local level are still limited. The present study aimed to evaluate the microbiological quality of chicken meat sold in traditional markets in West Sumatra, Indonesia. A cross-sectional observational study was conducted from July to September 2025. A total of 65 chicken meat samples were collected from traditional markets in Payakumbuh City (n = 34) and Lima Puluh Kota Regency (n = 31). Samples were analyzed for total plate count (TPC), coliform bacteria, *Escherichia coli*, and *Staphylococcus aureus* using established microbiological methods in accordance with Indonesian national standards and international guidelines. The present results revealed that chicken meat from Payakumbuh city exhibited a mean TPC of 2.4×10^6 CFU/g, exceeding the maximum permissible limit of $\leq 1 \times 10^6$ CFU/g established by the Indonesian national standard, whereas samples from Lima Puluh Kota Regency indicated a slightly lower TPC of 9.6×10^5 CFU/g. Coliform counts were recorded at 1.6×10^4 CFU/g in Payakumbuh city and 1.8×10^3 CFU/g in Lima Puluh Kota regency. Furthermore, *E. coli* contamination ranged from 1.5×10^3 to 2.5×10^3 CFU/g, while *S. aureus* levels ranged from 9.0×10^1 to 1.4×10^2 CFU/g. The high levels of microbial contamination observed in chicken meat sold in traditional markets in West Sumatra highlighted the importance of food safety concerns. Strengthening hygiene management, implementing effective cold chain systems, enhancing hygiene training for food handlers, and reinforcing regulatory oversight are strongly recommended to improve the microbiological quality of chicken meat and protect public health.

Keywords: Chicken meat, Microbial contamination, Traditional market

INTRODUCTION

As primary sources of high-quality protein, animal-derived foods, including meat, dairy, and eggs, are fundamental to fulfilling the population's nutritional needs. Among these foods, chicken meat is one of the most widely consumed protein sources worldwide due to its affordability, wide availability, and high nutritional value. However, chicken meat is highly susceptible to contamination by pathogenic microorganisms such as *Salmonella* spp., *Escherichia coli (E. coli)*, and *Staphylococcus aureus* (*S. aureus*) and spoilage microorganisms, including *Pseudomonas* spp. and *Lactobacillus* spp., which can compromise food safety and shorten shelf life. This susceptibility is attributed to the highly perishable nature of poultry meat, characterized by high moisture content and near-neutral pH, as well as inadequate hygienic practices during slaughtering, processing, handling, and distribution, particularly in traditional market systems (Zelpina et al., 2018; Rizaldi and Zelpina, 2020).

Microbial contamination in chicken meat can occur at multiple stages along the supply chain from slaughtering and processing to distribution and retailing in traditional and modern markets (Rizaldi and Zelpina, 2020). Several studies have reported high prevalence rates of pathogenic bacteria such as *Salmonella* spp., *E. coli*, and *S. aureus* in chicken meat sold in traditional markets (Wardhana et al., 2021). The presence of these bacteria not only deteriorates meat quality but also poses significant public health concerns through foodborne diseases such as salmonellosis, campylobacteriosis, staphylococcal food poisoning, and diarrheal infections caused by pathogenic *E. coli* (WHO, 2019). Contributing factors such as uncontrolled storage temperatures, humid market environments, and unhygienic handling equipment are considered the primary causes of increased microbial contamination (Nauta et al., 2021; Rizaldi and Zelpina, 2023).

In Indonesia, traditional markets remain the main distribution points for fresh chicken meat (Rizaldi and Zelpina, 2023). Several studies have demonstrated that sanitation levels in traditional markets in Indonesia are generally low, with limited cooling and cleaning facilities, which heighten the risk of microbial contamination (Rizaldi and Zelpina, 2023). Payakumbuh city and Lima Puluh Kota Regency, one of the regions in West Sumatra, Indonesia, with relatively high

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chicken meat consumption, still lack scientific data regarding the degree of microbial contamination in chicken meat sold in traditional markets. Accurately mapping this issue is critical to guide local food safety efforts and protect community health. Therefore, the present study aimed to identify and evaluate the level of microbial contamination in chicken meat sold in traditional markets in West Sumatra, Indonesia.

MATERIALS AND METHODS

Ethical approval

The present study was conducted in accordance with the institutional research ethics and biosafety protocols of Payakumbuh State Agricultural Polytechnic, Indonesia. No experimental animals were used in this study. All samples were obtained from commercial markets, and no direct handling, treatment, or intervention of live animals was involved.

Study area

This cross-sectional observational study was conducted between July and September 2025. Laboratory testing was conducted at the animal health and disease laboratory, Payakumbuh State Agricultural Polytechnic. Chicken meat samples were collected from traditional markets of Payakumbuh city and Lima Puluh Kota Regency, West Sumatra, Indonesia.

Sample collection

A total of 65 chicken meat samples were collected. Sampling was conducted without specific criteria for trader selection. Chicken thigh portions were collected from two traditional markets in Payakumbuh city (n = 34) and three traditional markets in Limapuluh Kota regency (n=31). Each fresh sample was placed in a sterile polyethylene bag, stored in an ice box at 4°C, and transported to the laboratory within 2 hours for microbiological analysis.

Determination of total plate count

The total aerobic mesophilic bacterial count was determined according to the Indonesian National Standard SNI 2897:2008 (BSN, 2008). Briefly, 25 g of chicken meat was aseptically transferred into a sterile stomacher bag containing 225 mL of buffered peptone water (BPW; Oxoid, UK) to obtain a 10^{-1} dilution and homogenised for 1-2 minutes using a Seward Stomacher 400. Subsequent serial decimal dilutions (10^{-2} to 10^{-3}) were prepared using BPW. From each dilution, 1 mL aliquots were aseptically inoculated in duplicate into sterile Petri dishes. This was followed by the addition of 15-20 mL of molten plate count agar (PCA; Oxoid, UK) that had been cooled to approximately 45°C. The plates were gently rotated in a figure-eight motion to ensure uniform distribution of the inoculum and allowed to solidify at room temperature. The plates were then incubated in an inverted position at 37°C for 24-48 hours. After incubation, plates containing 30-300 colonies were selected, and visible colonies were counted manually. The present results were calculated and expressed as colony-forming units per gram (CFU/g) of sample.

Enumeration of coliform bacteria

Coliform counts were determined via the pour plate method following the standard microbiological procedures (ISO 4832:2006; APHA, 2015). Twenty-five grams of minced chicken meat were aseptically homogenised in 225 mL of 0.1% buffered peptone water (Oxoid, UK) to obtain an initial 10^{-1} dilution, following ISO guidelines for sample preparation (ISO 6887-1:2017). Serial decimal dilutions (10^{-2} to 10^{-4}) were subsequently prepared by transferring 1 mL of the previous dilution into 9 mL of sterile BPW and mixing thoroughly using a vortex mixer. From each dilution, 1 mL aliquots were aseptically transferred into pre-labelled sterile Petri dishes. After inoculating each plate, 10-15 mL of molten VRBA (Oxoid, UK) at 44-46°C was poured and mixed by figure-eight rotation. Upon solidification, 3-4 mL of VRBA (45-48°C) was applied to prevent the spread of surface colonies. The plates were incubated in an inverted position at 37°C for 24 hours. After incubation, colonies exhibiting red to dark-purple coloration and surrounded by a precipitated bile zone were counted as presumptive coliforms, and the results were expressed as CFU/g of sample.

Isolation and identification of *Staphylococcus aureus*

A 0.1 mL aliquot from the 10^{-1} dilution was streaked on mannitol salt agar (MSA; Merck 1.05404.0500) and incubated at 35°C for 24 hours. Yellow colonies were presumptively identified as *S. aureus*. Suspected isolates were subjected to Gram staining, catalase, coagulase, and mannitol fermentation tests following standard bacteriological techniques (Savariraj, 2020). Gram-positive cocci arranged in grape-like clusters with positive catalase and coagulase reactions were confirmed as *S. aureus*. Microscopic examination was conducted using an Olympus CX21 (Japan) at 1000 × magnification.

Detection of *Escherichia coli*

One millilitre of the 10^{-1} dilution was inoculated onto eosin methylene blue agar (Oxoid, UK) and incubated at 37°C for 24 hours. Colonies displaying a metallic green were considered presumptive *E. coli*. Confirmation was carried out by Gram staining and indole, methyl red, Voges-Proskauer, and citrate biochemical tests (Oxoid, UK). An identification was based on Gram-negative rods that tested positive for indole and methyl red, but negative for Voges-Proskauer and citrate (Wardhana, 2021).

Statistical analysis

All data were analyzed descriptively using Micrososoft® Excel, version 2020, and presented as percentages. Microbial counts were tabulated and interpreted according to microbiological quality standards for raw poultry meat.

RESULTS AND DISCUSSION

The present results indicated that the total plate count (TPC) of chicken meat sold in traditional markets in Payakumbuh city was 2.4×10^6 CFU/g, whereas samples from Lima Puluh Kota Regency demonstrated a lower TPC of 9.6×10^5 CFU/g (Table 1). Coliform levels were 1.6×10^4 CFU/g in Payakumbuh and 1.8×10^3 CFU/g in Lima Puluh Kota, while *S. aureus* counts were recorded at 9×10^1 CFU/g and 1.4×10^2 CFU/g, respectively. In addition, *E. coli* contamination was observed at 1.5×10^3 CFU/g in Payakumbuh and 2.5×10^3 CFU/g in Lima Puluh Kota. These findings indicated that most chicken meat samples exceeded the maximum permissible microbial contamination limits established by the Indonesian National Standard (SNI 7388:2009), which set the TPC limit at $\leq 1 \times 10^6$ CFU/g.

Table 1. Average of total plate, coliform, *Staphylococcus aureus*, and *Escherichia coli* count in chicken meat sold in traditional markets in West Sumatra, Indonesia, 2025

Traditional market	Number	Total plate count	Coliform	*Staphylococcus aureus*	*Escherichia coli*
		--------------CFU/g----------------			
Payakumbuh City	34	2.4×10^6	1.6×10^4	9×10^1	1.5×10^3
Lima Puluh Kota Regency	31	9.6×10^5	1.8×10^3	1.4×10^2	2.5×10^3
Total	65				

The high TPC values reflected a decline in the microbiological quality of chicken meat, which might have been associated with unhygienic handling practices and inadequate cold chain management during processing, transportation, and retail display. According to the Indonesian National Standard for fresh chicken meat (SNI 7388:2009), the maximum permissible limit for TPC is $\leq 1 \times 10^6$ CFU/g. Therefore, TPC values exceeding this threshold indicate that the chicken meat failed to meet national microbiological safety standards. These findings are supported by a study in traditional markets where raw chicken meat often showed total aerobic bacterial counts well above recommended limits, with values frequently ranging from ~3.6×10^5 to over 1.7×10^6 CFU/g under open display and improper storage conditions, largely due to inadequate hygiene and lack of cold chain control (Nurmasytha et al., 2021).

Elevated Coliform counts indicated fecal contamination occurring during post-harvest handling, particularly as a result of inadequate sanitation practices during slaughtering, washing, and retail handling of chicken meat (ICMSF, 2018). Coliform bacteria were used as primary hygiene indicators because their detection suggests contamination from fecal matter via water, equipment, or surfaces (Latifah et al., 2025). A study conducted in Malaysia reported that 72% of chicken meat samples obtained from wet markets, defined as traditional open-air markets where fresh meat is sold without refrigeration, exceeded the permissible Coliform limit of 1×10^3 CFU/g, primarily due to poor hand hygiene and the use of untreated water during processing (Rahman et al., 2022).

The detection of *S. aureus* was particularly concerning, as this bacterium was known to produce heat-stable enterotoxins capable of causing food poisoning even after cooking (Kadariya et al., 2020). According to the FAO/WHO microbiological guidelines, the acceptable limit for *S. aureus* in chicken meat products was $\leq 1 \times 10^2$ CFU/g (FAO/WHO, 2021); however, several samples analyzed in the present study exceeded or were close to this threshold. The occurrence of such contamination strongly suggests inadequate hygiene practices during slaughtering, handling, and retail processes. In line with this observation, a study conducted in Bandung, Indonesia, reported that 38% of market workers harbored *S. aureus* on their hands, underscoring the critical role of food handlers as a primary source of contamination in traditional market settings (Putri et al., 2022).

The detection of *E. coli* confirmed the occurrence of fecal contamination, as *E. coli* has been widely recognized as a specific indicator organism for fecal exposure in food of animal origin (Jay et al., 2005; ICMSF, 2018). The observed *E.*

coli counts ranging from 10^3 to 10^4 CFU/g in chicken meat samples from Payakumbuh and Lima Puluh Kota exceeded the maximum allowable limit of 1×10^2 CFU/g established by the Indonesian National Standard (SNI 7388:2009; Badan Standardisasi Nasional, 2009). These results were consistent with the findings of Karisma et al. (2021), who reported *E. coli* contamination levels of up to 2.8×10^3 CFU/g in non-refrigerated chicken meat from Surabaya, Indonesia. Rahman et al. (2020) further demonstrated that *E. coli* contamination frequently occurred during the washing of carcasses and evisceration processes in slaughter and processing facilities with inadequate hygienic practices.

Recent studies indicate that bacterial contamination, particularly by *E. coli*, remains a significant issue in poultry meat sold in traditional markets across Indonesia. A study conducted in traditional markets in Banyuwangi, East Java, reported that 20% of raw chicken meat samples were contaminated with *E. coli* at levels exceeding recommended microbiological limits, reflecting inadequate hygienic conditions during handling and sale (Wibawati et al., 2024). These findings suggest that improper sanitation practices during slaughtering, washing, and retail display contribute substantially to microbial contamination. In addition, a broader assessment of coliform contamination in animal-based foods sold in traditional markets demonstrated widespread presence of coliform bacteria, including *E. coli*, which is commonly used as an indicator of poor hygiene and fecal contamination. The study emphasized that the use of non-potable water, unclean equipment, and insufficient personal hygiene among vendors significantly increased the risk of microbial contamination in poultry meat (Latifah et al., 2025). Overall, these findings highlight persistent challenges in ensuring food safety within traditional poultry supply chains in Indonesia. Limited sanitation infrastructure, inadequate access to clean water, and low levels of hygiene awareness among market workers continue to exacerbate microbial hazards. Strengthening hygiene practices, improving market sanitation facilities, and implementing routine microbiological monitoring are therefore essential to reduce the public health risks associated with contaminated poultry products (Wibawati et al., 2024; Latifah et al., 2025). From the public health perspective, the presence of *E. coli* and *Salmonella* spp. posed a significant threat to foodborne diseases. The World Health Organization (WHO) reported that more than 150 million cases of gastroenteritis occurred annually in the Southeast Asia region due to unsafe consumption of contaminated animal-based food products (WHO, 2021). In Indonesia, data from the Ministry of Health of the Republic of Indonesia indicated that approximately 24% of reported food poisoning cases were associated with the consumption of improperly handled chicken meat, emphasizing the public health risks related to poultry products (Ministry of Health of the Republic of Indonesia, 2023).

Microbial contamination not only poses health risks but also reduces shelf life and organoleptic quality in chicken meat. Charoensuk and Thammacharoenpong (2021) reported that each 1-log increase in TPC corresponds to an approximate one-day reduction in the shelf life of fresh poultry meat stored at ambient temperature. This relationship reflected the rapid proliferation of spoilage microorganisms under non-refrigerated conditions, which accelerates sensory deterioration and limits the acceptable storage duration of raw chicken meat in traditional market settings. Therefore, the observed TPC levels exceeding 10^6 CFU/g indicated that chicken meat in traditional markets had a severely limited shelf life and was likely unsafe for consumption beyond 12 hours post-slaughter under ambient temperature. High TPC values reflected rapid microbial growth, strongly influenced by the lack of temperature control and inadequate hygiene during post-slaughter handling and retailing. According to the international guidelines, fresh poultry meat with microbial loads approaching or exceeding 10^6 CFU/g was considered to be at the upper acceptable limit for microbiological quality and was associated with accelerated spoilage and increased food safety risks (ICMSF, 2011; FAO, 2011). Several studies have demonstrated that, without refrigeration, poultry meat in traditional markets typically undergoes a rapid increase in bacterial counts within 8-12 hours after slaughter, rendering the product unsafe or unacceptable for consumption beyond this period (James et al., 2006).

Effective control efforts should prioritize improvements in distribution chains and comprehensive hygiene training for workers, as these factors play a critical role in determining microbial contamination levels in poultry meat. Inadequate temperature control, prolonged transportation time, and poor handling practices during distribution can accelerate bacterial growth and increase TPC. Implementing good hygiene practices (GHP) and hazard analysis and critical control point (HACCP) systems notably improved sanitation and process control in Vietnamese traditional markets, with studies demonstrating reductions in TPC of up to 80% (Nguyen and Pham, 2023). These systems (GHP and HACCP) help identify critical contamination points and ensure consistent monitoring and corrective actions throughout the supply chain. In addition, local government authorities play a crucial role in strengthening food safety by enforcing market inspection policies, improving regulatory compliance, and ensuring adherence to hygiene criteria among meat vendors (Azis et al., 2024). Educating consumers on safe meat selection (evaluating colour, texture, and storage) supported regulatory measures. This increased awareness encourages safer purchases and places indirect pressure on vendors to maintain higher hygiene standards (Indrawan et al., 2021). Collectively, coordinated interventions involving producers, authorities, and consumers are essential to sustainably reduce microbial contamination in traditional poultry markets. Integrated cold chain systems and hygiene training for small-scale poultry enterprises have been shown to improve microbial safety by maintaining low storage temperatures and enhancing hygienic practices at critical points during post-slaughter handling, storage, and distribution, thereby helping reduce the growth and proliferation of spoilage and pathogenic microorganisms in chilled poultry meat (Necidová et al., 2024; Abdullah et al., 2025). The implementation of an integrated cold chain maintains poultry meat at low temperatures, thereby inhibiting the growth of mesophilic bacteria and reducing the risk of microbial proliferation during transportation and retailing stages (James et al., 2006; FAO, 2011). In addition, hygiene training increases staff awareness and ensures compliance with GHP. Key practices such as personal hygiene, equipment sanitation, and preventing cross-contamination are essential for microbial control in small-scale poultry processing environments (Todd et al., 2010). Previous studies have demonstrated that the combined application of cold chain management and hygiene education significantly reduces TPC and coliform levels more effectively than either intervention alone (James et al., 2006; Todd et al., 2010). Therefore, integrating temperature control with targeted hygiene training represented a practical and effective strategy to improve microbiological safety and quality of poultry meat in micro-scale production systems.

CONCLUSION

The present study indicated that the level of microbial contamination in chicken meat sold in traditional markets in West Sumatra, Indonesia was relatively high, as evidenced by total plate count levels of 2.4×10^6 CFU/g in Payakumbuh City and 9.6×10^5 CFU/g in Lima Puluh Kota Regency, with several samples exceeding the maximum permissible limit of 1×10^6 CFU/g set by the Indonesian National Standard (SNI 7388:2009). The detection of *Escherichia coli* (1.5×10^3-2.5×10^3 CFU/g) and *Staphylococcus aureus* (9.0×10^1-1.4×10^2 CFU/g) indicated that sanitary and hygiene principles were not adequately followed during slaughtering, washing, and storage. Therefore, strengthening hygiene management, enforcing adequate handling practices, and implementing cold chain systems are strongly recommended to improve the hygienic quality of chicken meat and to safeguard consumer health in traditional market settings.

DECLARATIONS

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Authors' contributions

Engki Zelpina, Prima Silvia Noor, Yurni Sari Amir, and Suliha conducted the research, collected and analyzed the data, and drafted the manuscript. Engki Zelpina and Prima Silvia Noor reviewed and edited the manuscript. All authors have read and approved the final edition of the manuscript.

Competing interests

The authors have not declared any conflict of interest.

Ethical considerations

Ethical issues, including plagiarism, consent to publish, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy, have been checked by all the authors. No AI tools were used for preparing the current study.

Availability of data and materials

The data to support the present study's findings are available upon reasonable request to the corresponding author.

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