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Prevalence and quantitative load of *Escherichia coli* and *Staphylococcus aureus* in retail chicken meat from Jammu province, India

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Abstract

Aims: To determine the prevalence and quantitative load of *Escherichia coli* and *Staphylococcus aureus* in raw chicken meat from retail outlets in five districts of Jammu Province, India, and to assess inter-district differences as indicators of process and personal hygiene.

Methodology: A total of 200 raw chicken meat samples were collected from retail outlets (Jammu 65, Udhampur 40, Rajouri 40, Kathua 35, Samba 20). Approximately 10 g of meat from each carcass was aseptically excised, transported chilled, and processed using standard methods for isolation and enumeration of *E. coli* on MacConkey and EMB agar with biochemical confirmation, and *S. aureus* on Baird-Parker agar with DNase and coagulase tests; counts were expressed as log₁₀ cfu/g and analysed by ANOVA followed by Duncan Multiple Range Test (APHA, 1984; Duncan, 1955).

Results: *E. coli* was detected in 143 of 200 samples (71.5%), with an overall mean count of 4.44±0.07 log₁₀ cfu/g in positive samples; district-wise *E. coli* positivity ranged from 60.0% (Udhampur) to 85.0% (Samba), and mean counts from 2.68±0.12 log₁₀ cfu/g (Samba) to 4.84±0.09 log₁₀ cfu/g (Rajouri). *Staphylococcus aureus* was isolated from 116 samples (58.0%), with an overall mean count of 3.68±0.05 log₁₀ cfu/g; Jammu recorded the highest mean load (3.91±0.06 log₁₀ cfu/g) and Kathua the lowest (3.16±0.15 log₁₀ cfu/g). Inter-district differences in counts for both organisms were statistically significant ($p < 0.05$).

Conclusion: Retail chicken meat in Jammu Province shows a high prevalence and substantial quantitative load of *E. coli* and *S. aureus*, reflecting serious deficiencies in faecal and handler-related hygiene across the slaughter and retail continuum. Strengthening basic sanitation, water quality and personal hygiene practices at retail outlets is urgently needed to reduce contamination and foodborne risk.

Keywords: Chicken meat, *Escherichia coli*, *Staphylococcus aureus*, prevalence, bacterial load, retail hygiene, Jammu province

1. Introduction

Chicken meat is widely consumed because of its favourable nutrient profile, including high-quality protein and relatively low fat content compared with red meat (FAO, 2006) [6]. However, poultry products are frequently implicated in foodborne disease outbreaks when carcasses become contaminated with enteric and environmental bacteria during slaughter, processing and retail handling (Holt and Henson, 2000; Sousa, 2008) [11, 15].

Escherichia coli is routinely used as an indicator of faecal contamination and process hygiene in meat production, whereas *Staphylococcus aureus* generally reflects contamination from human skin, nasal carriage and the processing environment (Kumar *et al.*, 2001; Julqarnain *et al.*, 2022) [13, 12]. Both organisms may act as opportunistic pathogens, and enterotoxigenic strains of *S. aureus* are well-recognized causes of food poisoning when allowed to multiply and produce toxin in meat held at inappropriate temperatures (Sousa, 2008; Herve and Kumar, 2017) [15, 10].

In India, only a small fraction of poultry meat is processed under organised, regulated conditions; the majority is sold through informal or semi-formal retail outlets such as small butcher shops and open markets, where infrastructure for water supply, waste disposal and refrigeration is often inadequate (Kumar *et al.*, 2001; Mawia *et al.*, 2012) [13, 14]. Under these conditions, repeated opportunities exist for bacterial contamination and proliferation along the supply chain (Subratty and Gurib, 2003; Bersisa *et al.*, 2019) [16, 2].

Although studies from different parts of India and elsewhere have documented bacteriological quality issues in poultry meat, including high aerobic plate counts and frequent isolation of enteric and environmental bacteria, systematic district-wise data on the prevalence and load of *E. coli* and *S. aureus* in retail chicken meat from Jammu Province are limited (Chowdhary *et al.*, 2008; Mawia *et al.*, 2012) [4, 14]. Recent studies from Jammu Province have also reported bacteriological quality concerns and *Campylobacter* contamination in poultry meat (Gupta *et al.*, 2023; Gupta *et al.*, 2025) [8, 9].

This study therefore aimed to (i) estimate the prevalence of *E. coli* and *S. aureus* in raw chicken meat sold at retail outlets in five districts of Jammu Province, (ii) quantify their bacterial loads, and (iii) evaluate inter-district variation as an indicator of differences in process and personal hygiene.

2. Materials and Methods

2.1 Study area and sampling design

The study was conducted in five districts of Jammu Province—Jammu, Udhampur, Rajouri, Kathua and Samba—which together encompass a range of urban and semi-urban retail environments. Retail outlets included small butcher shops and local markets where freshly dressed chicken carcasses are sold directly to consumers.

A total of 200 raw chicken meat samples were collected using a cross-sectional sampling design: Jammu (n = 65), Udhampur (n = 40), Rajouri (n = 40), Kathua (n = 35) and Samba (n = 20). At each selected outlet, approximately 10 g of skeletal muscle tissue was aseptically excised from freshly dressed carcasses using sterile instruments.

2.2 Sample transport and preparation

Each sample was placed into a sterile, labelled container indicating district, outlet code, date and time of collection. Samples were transported to the laboratory in insulated ice boxes containing ice packs to maintain a temperature close to 4 °C and thereby minimize bacterial multiplication during transit.

On arrival in the laboratory, samples were processed within 2-3 hours of collection. Meat was homogenized in sterile normal saline to obtain a primary suspension, and ten-fold serial dilutions were prepared for microbiological analysis (APHA, 1984) [1].

2.3 Isolation and enumeration of *Escherichia coli*

For enumeration of *E. coli*, appropriate dilutions of the sample homogenate were spread-plated on MacConkey agar and incubated at 37 °C. After incubation, pink, lactose-fermenting colonies were counted as presumptive *E. coli*. Representative colonies were subcultured onto Eosin Methylene Blue (EMB) agar, and those exhibiting a characteristic metallic sheen were selected for biochemical confirmation (Kumar *et al.*, 2001) [13].

Biochemical identification of *E. coli* included Catalase, Indole, Methyl Red, Voges-Proskauer, Citrate utilisation, Triple Sugar Iron, Nitrate reduction and sugar fermentation tests, following standard procedures (APHA, 1984; Kumar *et al.*, 2001) [1, 13]. Confirmed counts were expressed as log₁₀ colony forming units per gram (log₁₀ cfu/g) of meat for positive samples.

2.4 Isolation and enumeration of *Staphylococcus aureus*

For *S. aureus*, suitable dilutions were plated on Baird-Parker agar and incubated at 37 °C (Julqarnain *et al.*, 2022) [12].

Grey-black, shiny, convex colonies with surrounding clear zones were counted as presumptive *S. aureus*. Selected colonies were subjected to DNase and tube coagulase tests, and isolates positive in both tests were considered confirmed *S. aureus* (Herve and Kumar, 2017; Julqarnain *et al.*, 2022) [10, 12].

Counts of confirmed *S. aureus* were expressed as log₁₀ cfu/g for positive samples.

2.5 Statistical analysis

All bacterial counts were log₁₀-transformed prior to statistical analysis. District-wise mean counts and standard errors were calculated for *E. coli* and *S. aureus*. Analysis of variance (ANOVA) was used to assess differences between districts, and where significant effects were detected, Duncan Multiple Range Test was applied for post-hoc comparison of means at a significance level of $p < 0.05$ (Duncan, 1955) [5].

3. Results and Discussion

3.1 Prevalence of *Escherichia coli* and *Staphylococcus aureus*

E. coli was isolated from 143 of 200 retail chicken meat samples, giving an overall prevalence of 71.5%. District-wise *E. coli* positivity was 78.4% in Jammu, 60.0% in Udhampur, 72.5% in Rajouri, 62.8% in Kathua and 85.0% in Samba.

Staphylococcus aureus was detected in 116 samples, corresponding to an overall prevalence of 58.0%. *S. aureus* positivity by district was 63.0% in Jammu, 55.0% in Udhampur, 62.5% in Rajouri, 45.7% in Kathua and 60.0% in Samba.

The high prevalence of *E. coli* indicates extensive faecal contamination of carcasses and meat cuts, likely occurring during slaughter, evisceration and subsequent handling (Kumar *et al.*, 2001; Wahbah, 2019) [13, 17]. Similar ranges of *E. coli* occurrence have been reported in poultry meat from other regions, underscoring the need for improved process hygiene (Wahbah, 2019; Mawia *et al.*, 2012) [17, 14].

The widespread presence of *S. aureus* highlights the important role of human handlers and the processing environment as sources of contamination, particularly where personal protective equipment and hand hygiene are inadequate (Julqarnain *et al.*, 2022; Herve and Kumar, 2017) [12, 10]. Comparable prevalence of *S. aureus* in retail poultry meat has been documented in India and neighbouring countries, supporting the view that handler-related contamination is a common issue in informal markets (Julqarnain *et al.*, 2022; Herve and Kumar, 2017) [12, 10].

3.2 Quantitative load of *Escherichia coli*

Among *E. coli*-positive samples, the overall mean count was 4.44 ± 0.07 log₁₀ cfu/g. Rajouri recorded the highest mean *E. coli* load at 4.84 ± 0.09 log₁₀ cfu/g, whereas Samba had the lowest mean count at 2.68 ± 0.12 log₁₀ cfu/g; intermediate values were observed in Jammu, Udhampur and Kathua.

Analysis of variance showed highly significant differences in *E. coli* counts between districts, and Duncan Multiple Range Test indicated that Samba differed significantly from the other four districts, which did not differ significantly among themselves.

These findings suggest that although *E. coli* contamination is common across all districts, the intensity of contamination varies, possibly reflecting differences in slaughterhouse

sanitation, evisceration practices, water quality, and the duration and conditions of meat display (Subratty and Gurib, 2003; Bersisa *et al.*, 2019) ^[16, 2]. High counts such as those observed in Rajouri may indicate prolonged exposure to ambient temperature or more severe faecal contamination events, whereas lower mean counts in Samba could reflect shorter retail display times or better temperature control, despite a high proportion of positive samples.

3.3 Quantitative load of *Staphylococcus aureus*

For *S. aureus*-positive samples, the overall mean count was $3.68 \pm 0.05 \log_{10}$ cfu/g. Jammu exhibited the highest mean *S. aureus* load at $3.91 \pm 0.06 \log_{10}$ cfu/g, while Kathua showed the lowest at $3.16 \pm 0.15 \log_{10}$ cfu/g; counts in Samba were statistically similar to those in Kathua. Duncan's test indicated that Kathua and Samba differed significantly from Rajouri, Udhampur and Jammu.

The elevated *S. aureus* counts in Jammu may be related to more crowded urban markets, higher turnover and repeated handling of carcasses and meat portions without consistent use of gloves or regular handwashing (Mawia *et al.*, 2012; Julqarnain *et al.*, 2022) ^[14, 12]. Lower counts in Kathua could be linked to less intensive handling or less congested retail environments, though the prevalence there remained substantial.

The combination of high prevalence and moderate to high counts of *S. aureus* is of concern because toxin-producing strains can cause food poisoning even when viable cell counts decline after cooking if toxin has already accumulated in the meat (Sousa, 2008; Herve and Kumar, 2017) ^[15, 10]. Poor temperature control and extended display at ambient temperatures thus may amplify public health risks associated with this organism.

3.4 Public health implications

Taken together, the data demonstrate that consumers purchasing raw chicken meat from retail outlets in Jammu Province are frequently exposed to meat contaminated with *E. coli* and *S. aureus* at levels indicative of poor hygienic conditions. Similar observations of high bacterial loads and hygiene-related indicators have been reported in meat from informal markets elsewhere, reinforcing the need for interventions along the entire supply chain (Sousa, 2008; Bersisa *et al.*, 2019; Chowdhary *et al.*, 2008) ^[15, 2, 4].

Although this study did not characterise virulence determinants or antimicrobial resistance patterns, the indicator organisms measured here provide a strong signal that hygienic practices at slaughter and retail require substantial improvement. Routine microbiological monitoring of retail poultry, implementation of simple but effective hygiene measures (such as provision of potable water, regular cleaning and disinfection of equipment, and use of protective clothing), and public education on safe handling and thorough cooking of chicken meat are all warranted to reduce foodborne risks (Cavitt, 2003; Mawia *et al.*, 2012) ^[3, 14].

4. Conclusion

Retail chicken meat sold through informal and semi-formal markets in five districts of Jammu Province showed high prevalence and substantial quantitative loads of *Escherichia coli* and *Staphylococcus aureus*, with significant inter-district variation. The results highlight serious deficiencies in slaughter hygiene, personal hygiene of

handlers and temperature control during storage and display. Focused interventions to improve basic hygiene, together with regular microbiological surveillance of retail poultry meat, are urgently required to protect consumer health in this region.

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