

Hygienic Conditions of Poultry Slaughterhouses in Sulaymaniyah Province

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I. Abstract

This cross-sectional study, conducted from March to May 2025 in two municipal poultry processing plants in Sulaymaniyah Province, Iraq (Sulaymaniyah and Ranya), evaluated hygiene practices and microbiological hazards. A total of 192 samples—including 144 tissue samples and 48 inner-carcass swabs—were collected from both commercial and backyard poultry. A 12-point checklist and worker surveys assessed hygiene compliance, while microbiological analyses determined total bacterial count (TBC), total coliform count (TCC), and the presence and resistance profile of *Escherichia coli*. Hygiene conditions were generally satisfactory, with 80% compliance in handwashing and 100% daily cleaning. However, notable gaps included suboptimal sterilization of knives post-evisceration (72% in Sulaymaniyah and 60% in Ranya) and inadequate prevention of floor-water contamination (68% and 64%, respectively). TBC and TCC varied significantly by cut, poultry type, and location ($p < 0.05$), with domestic poultry showing higher contamination. Inner-carcass regions in Sulaymaniyah showed lower TBC (up to \log_{10} 4.30) and TCC (\log_{10} 3.22) than outer-carcass areas. *E. coli* was detected in 86.45% of samples, with statistically significant variation by location ($X^2 = 5.38$, $p = 0.020$). Alarming, high antimicrobial resistance was observed, with *E. coli* isolates showing extreme resistance to ampicillin (98.79%), amoxicillin (95.78%), levofloxacin (94.57%), and several other antibiotics. The study highlights critical hygiene lapses and widespread multidrug resistance, particularly in backyard poultry. Key interventions should prioritize knife sterilization, water contamination control, HACCP-based monitoring, staff hygiene training, and integration of antimicrobial stewardship with surveillance programs.

Keywords : Slaughterhouse, Poultry Meat, Hygiene Practice, *E. coli*, Antimicrobial Resistance.

II. Introduction

Poultry meat plays an important role in the ordinary food intake of several areas across the globe such as Iraq whereby the meat is a major source of protein food (Albashr et al., 2024; Nooraldeen, 2025) This product is very beneficial economically, but also provides a common supply, thus being a significant source of vital nutrients (Faraj, 2023; Saewa et al., 2021). The technology used in processing the products at the slaughterhouses plays a crucial role in determining whether the products are suitable to be used by human beings (Jasim et al., 2023; Mawlood & Khidhir, 2018). The sources of pollution have also been identified to be slaughterhouses in different countries, especially where strict hygienic conditions are not strictly adhered to (Mawlood & Khidhir, 2018; Perez-Arnedo et al., 2021).

Recent studies have shown that dangerous meat is often attached to unsafe conditions, incompetent or non-competent workers, dirty tools, and poor supply of clean water (Botta et al., 2024). These problems are particularly intense in developing countries. Most of the poultry butchers in resource-deprived environments complain of a lack of formal hygiene training and the lack of basic infrastructure like hand-washing. The research in the developing world has found that there are higher levels of bacteria in meat samples than what was set in the international standards, and it is a sign of significant hygienic inadequacy in abattoirs and butcher stores (Kebede & Getu, 2023).

The contamination problems can be faced even in the highly developed food processing systems. In Europe, the foodborne pathogen *Arcobacter* spp. was commonly reported on surfaces and equipment, which proves that regular washing of equipment surfaces is not enough to be able to eliminate pathogens. Besides, this observation holds the view that hygiene practices can only confine and never eliminate biohazardous microorganisms (Botta et al., 2024).

Microbial contamination depends on the quality and degree of sanitary and hygiene in the handling, storage, transportation, and processing of meat (Obiukwu et al., 2025). Poor hygiene and sanitation such as poor handwashing, absence of protective equipment, dirty or unsterilized butchery equipment or surfaces, and unsanitary transportation or cold storage of meat place consumers at risk of microbial organisms. As a result, it spoils the products and incurs severe losses during the handling and processing process (Dharma et al., 2022).

Moreover, the intestinal contents may be contaminated even minimally and threaten the carcasses of poultry slaughtered. This is added to the lack of knowledge and use of the old methods in meat processing, handling and marketing leading to poor quality of meat. Hygiene and sanitation are among the most important value determinants, and their failure in the process of handling meat significantly increases the risk of food poisoning in consumers (Kebede & Getu, 2023).

Fresh meat is often sold in local markets and small and medium-sized butcheries of many low-income countries where hygiene and sanitation are either not implemented, not implemented sufficiently, or not implemented at all (Jaffee & Henson, 2024). Having poor hygienic conditions in some areas where meat is prepared, whereby the parts that have been slaughtered are sold in open markets where they are exposed to ambient temperatures, which spoil meat. The practices enhance chances of proliferation and dissemination of pathogenic microorganisms thus increasing the food safety risk (Gutema et al., 2021).

Sulaymaniyah poultry production is growing very fast; however, the lack of the systematic reviews of the real sanitary conditions in the local slaughterhouses is a long-term same problem (Neima et al., 2023). This gap derails the initiatives towards enhancing food safety and in managing pathogenic microorganisms that are harmful (Tagar & Ahmed, 2021).

This paper aims to evaluate the existing state of hygiene in chicken slaughterhouses in the cities of Sulaymaniyah and Ranya, determine the risks involved, and justify the specific health-related measures of the population.

III. Materials and Methods :

Study Design and Sampling

The cross-sectional observational study will be conducted in the period between March and May 2025 in two municipal poultry abattoirs located in Sulaymaniyah and Ranya with the aim of evaluating the bacteriological safety and hygiene practices.

One hundred and ninety-two pieces were chosen randomly: 144 meat samples and 48 inner-carcass swabs. The specimen of meat was collected in three parts of anatomical parts, such as the breast, leg, and drumstick, which gave 48 meat samples in total. As a result, the carcasses of 24 domestic and 24 commercial chickens that were processed at the slaughterhouses in the two municipalities were represented. To perform microbiological analyses, 25g of each sample of meat transferred into 225 mL of buffered peptone water aseptically and homogenized for 15min (Maharjan et al., 2019).

Also, 48 swab samples were taken on the abdominal lining of 24 domestic and 24 commercial chickens processed at the same abattoirs. The swabs were put in sterile tubes with 9mL sterile water and peptone to help retrieve and transfer bacteria. Serial ten-fold dilutions of all meat homogenates and swab suspensions were performed, in which case 1 mL of the initial sample was placed on 9 mL of diluent. (Gurmu & Gebretinsae, 2013). The correct dilutions of the aliquots were inoculated onto selective and non-selective culture media to enumerate the total bacterial loads and coliform counts, respectively.

The samples were aseptically transferred in cold temperatures to the Microbiology Lab at the Research Centre, University of Sulaymaniyah, where a bacteriological analysis was performed immediately.

Hygiene Evaluation

The hygienic conditions of the slaughterhouses were measured through a 12-item checklist and slightly modified within the framework that is stipulated by . Unnecessary ones were eliminated and the rest of the items were clustered in three subscales: hygiene, facilities, and policy. The SCUDI device was in fact set to identify the dirty activities during the slaughtering process, all the way to the point of access by the customer. Measures were taken and documented as part of every sampling visit over a three-month period (March -May 2025). Besides using the checklist, a semi-structured questionnaire was also used to check on the physical structure of the slaughterhouses, the status and condition of equipment and check of food-hygiene measures and sanitary procedures. Every staff member at the two locations was considered fit to be part of the study and this led to the inclusion of 50 people. In addition, simple random sampling was used to sample 25 samples in each abattoir.

Microbiological Analysis

Microbiological safety and quality of the meat were determined through Total Bacterial Count (TBC) and Total Coliform Count (TCC). TBC was determined by the means of the total plate count technique, whereas TCC was determined by the means of violet Red Bile agar and MacConkey Agar.

Total bacterial count

Plate Count Agar using the conventional pour-plate method was used to determine the overall bacterial load of all the collected samples. Based on good serial dilutions, 1mL of each sample was aseptically transferred into sterilized petri dishes. The incubated plates were exposed to 37 o C temperature and incubated after 48 hrs (Terrones-Fernandez et al., 2023). After incubation, colony counts were performed on plates that produced between 30 and 300 colonies to meet the statistical requirements of the International Organization for Standardization (Lombard, 2010).

Total coliform count

A pipette was used to dispense 1mL of the homogenate at the appropriate dilution onto MacConkey Agar (Liofilchem, Italy). Characteristic reddish colonies were counted, which on unremarked plates were generally at least 0.5 mm in diameter following incubation of the isolate at 48 h at 37 o C (Richardson & Association, 1985). Isolation and Characterisation of E. coli

E. coli isolates were first identified by the morphology of the colony on the MacConkey agar. Lactose-fermenting colonies were pink, but non-fermenting colonies were non-coloured or cream, as reported before (Dadheech et al., 2016). The colonies that fermented lactose were selected and then purified by using the streak-plate technique. They were subsequently subcultured on EosinMethylene Blue agar (Liofilchem, Italy) and incubated at 24 h at 37 0 C (El-Mongy et al., 2017).

Testing of Antibiotic Sensitivity.

This Kirby-Bauer disc diffusion technique has been used as stated in the reference (JH, 2007) study. The test was conducted on Mueller-Hinton agar (Liofilchem, Italy), through the use of bacterial suspensions that were calibrated to a 0.5 McFarland standard. Plates inoculated were incubated at 37 0 C 18 to 24 hours to enable inhibition zones to form (Gayathiri et al., 2018). The antibiotic disks to be used were: Tetracycline (TE)10_{μg}, Gentamicin (CN)10_{μg}, Amoxicillin10_{μg}, Ampicillin10_{μg}, Neomycin (N)10_{μg}, Oxytetracycline (T)30_{μg}, Levofloxacin (LEV)5_{μg}, Tylosin (Ty)15_{μg}, Doxycycline (Do)10_{μg}. They were compared with the resistance and sensitivity levels of the institutional laboratory and clinical standards (Weinstein, 2018). The predefined interpretive criteria placed isolates into resistant, intermediate, or susceptible according to measured inhibition -zone diameters (Ahmed et al., 2024).

Statistical analysis

The effect of poultry species, type of cuts to be made, and the site of slaughterhouse was tested through a three-way analysis of variance in SAS/STAT 9.1. The data, which is arranged in Microsoft Excel, assumed poultry species, cut type, and location of slaughterhouse as the independent variables and bacterial load as the dependent variable. Main and interaction effects were investigated. A significance level of 5 per cent was used and where necessary, post-hoc multiple-comparison tests were carried out through the Duncan procedure (Delwiche & Slaughter, 2019). The Chi-square test of independence was used to determine the distribution of contamination of the different sample types and under hygienic conditions in E. coli. The test is a non-parametric test, which is regularly used to test whether observed frequencies differ significantly from the expected frequencies given the assumption of independence, thus it is applicable when dealing with categorical data (Hazra, 2023).

Result

Table 1 summarizes the hygienic behaviors of the poultry slaughterhouse workers in Sulaymaniyah and Ranya, each site having 25 respondents respectively. In Sulaymaniyah and Ranya, 84.0 and 80.0 percent of workers, respectively, reported satisfactory environmental hygiene. In both sites, 80.0% of the workers washed their hands after slaughter. In Sulaymaniyah and Ranya, the use of a footbath was observed in 80.0 and 68.0 percent of the workers, respectively. In Sulaymaniyah, 88.0%, and in Ranya, 80.0% of workers had health certificates and protective clothing were regarded as clean in 84.0% and 80.0% of the instances, respectively.

In Sulaymaniyah and Ranya, knife sterilization was noted after evisceration in 72.0 and 60.0 percent of workers, respectively. All workers at both locations (100%) reported daily cleaning and disinfection. In Sulaymaniyah and Ranya, routine inspections were performed in 92 and 88 percent of the facilities, respectively. In 96 percent

of cities, both clean and dirty were found to be separated physically in the slaughterhouses. The slaughtering of carcasses on the floor was mentioned by 68.0% of employees in Sulaymaniyah and 64.0% in Ranya.

Chi-square tests indicated no statistically significant differences between the two slaughterhouse sites in terms of environmental hygiene ($\chi^2 = 0.000$, $p = 1.000$), handwashing behaviors ($\chi^2 = 0.000$, $p = 1.000$), the use of footbaths ($\chi^2 = 0.416$, $p = 0.519$), possession of health certificates ($\chi^2 = 0.149$, $p = 0.700$), or the cleanliness of protective clothing

Table 1. Meat handling practice of workers in Sulaymaniyah and Ranya city slaughterhouse (n = 25)

Viabie	Categories	Ranya city Frequency N (%)	Sulaymaniyah City Frequency N (%)
Environmental Cleanliness and Disinfection	Good	20(80)	21(84)
	Poor	5(20)	4(16)
Handwashing After Slaughter	Yes	20(80)	20(80)
	No	5(20)	5(20)
Use of Footbath	Yes	17(68)	20(80)
	No	8(32)	5(20)
Health Certificate	Yes	20(80)	22(88)
	No	5(20)	3(12)
Gloves, Mask, Head Cover, Boots, Protective Clothes	Yes	25(100)	25(100)
	No	0(0)	0(0)
Hygienic Condition of Coat	Good	20(80)	21(84)
	Poor	5(20)	4(16)
Available Adequate Water in the Slaughterhouse	Good	25(100)	25(100)
	Poor	0(0)	0(0)
Cleaning and Sterilization of Knives Post-Skinning and Evisceration	Yes	15(60)	18(72)
	No	10(30)	7(28)
Regularity of Cleaning and Sanitization	Every day	25(100)	25(100)
	Twice per week	0(0)	0(0)
	Third Weekly	0(0)	0(0)
Inspection	Yes	22(88)	23(92)
	No	3(12)	2(8)
Distinguishing Between Clean and Dirty	Yes	24(96)	24(96)
	No	1(4)	1(4)
Interaction Between Offal, Carcasses, and Flooring Surfaces	Yes	16(64)	17(68)
	No	9(36)	8(32)

Total Bacterial Count (TBC).

Table 2 and Figure 2 show the log₁₀ total plate counts (TPC; cfu/g) of various anatomical parts, sampling sites, and poultry types. Carcass parts, locations, and poultry categories differed significantly in TPC (p < 0.05). In all cut types, domestic poultry had more microbial loads than commercial poultry. The peak values of TPC were found on inner-carcass samples and domestic poultry at Sulaymaniyah, attained 4.30 log₁₀ cfu/g. However, they were lower in drumstick and breast samples, especially in commercial poultry. Commercial breeds of breast samples in Sulaymaniyah had the lowest TPC (3.12 log₁₀ cfu/g).

The use of lowercase superscript letters will denote statistically significant differences (p < .05) between poultry cuts and types in each location. Overall, TPCs of samples taken at Ranya were greater than those of Sulaymaniyah.

Table 2. Log₁₀ Total Plate Count Load (cfu/g) in Poultry from Domestic and Commercial Birds Collected from Sulaymaniyah and Ranya City Abattoirs

Type of Cut	Type of Poultry	Ranya City Abattoir	Sulaymaniyah City Abattoir
Breast	Domestic	3.67 gh ± 0.03	3.44 ij ± 0.02
	Commercial	3.34 jk ± 0.02	3.12 k ± 0.02
Leg	Domestic	4.07 b ± 0.03	3.85 f ± 0.03
	Commercial	3.73 g ± 0.03	3.47 ij ± 0.03
Drumstick	Domestic	3.96 de ± 0.02	3.94e ± 0.02
	Commercial	3.64 gh ± 0.03	3.56 hi ± 0.03
Inner Carcass	Domestic	4.27 ^a ± 0.03	4.30 a ± 0.03
	Commercial	4.01 cd ± 0.02	4.02 c ± 0.03

*Means represented by distinct lowercase letters within the same group signify a statistically significant difference (p < 0.05).

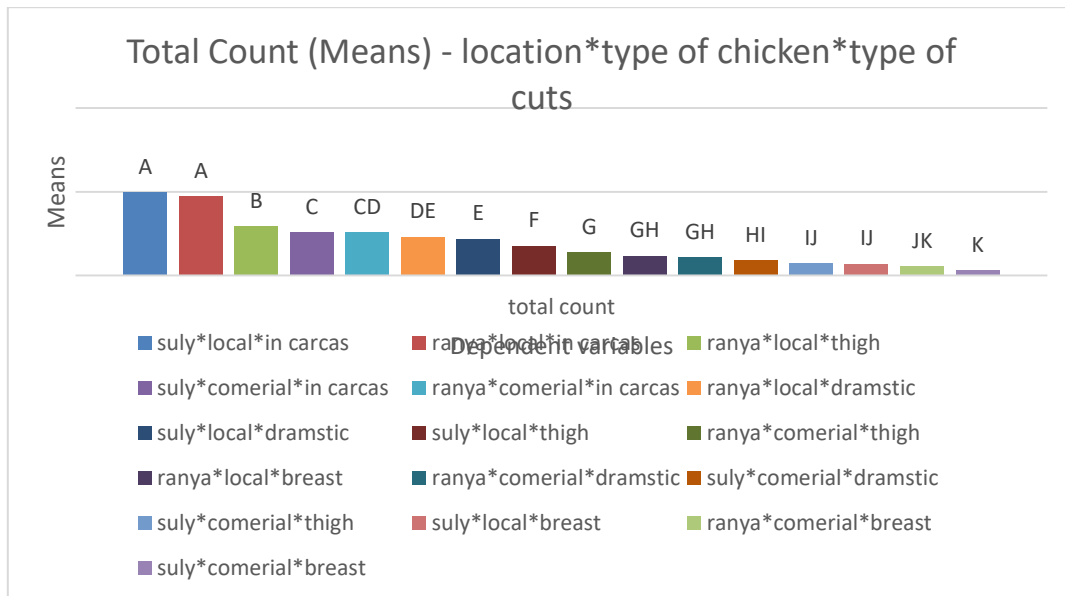


Figure 2. Assessment of Total Bacterial Load in Poultry Meat: Influence of Cut Type, Poultry Origin, and Slaughterhouse Location



Total coliform count

A summary of the log₁₀ total coliform count (cfu/g) of different poultry cuts, slaughterhouse location, and different types of poultry is presented in Table 3 and Bar Chart 3. The statistically significant differences ($p \leq 0.05$) were found between the anatomical sites, type of poultry, and sampling sites. The highest coliform contamination was always obtained in inner-carcass samples, with the highest contamination rate (3.22 log₁₀ cfu/ g) in the domestic poultry of Sulaymaniyah and then the domestic poultry of Ranya (3.07 log₁₀ cfu /g). The sample of breast and drumstick had lower numbers, particularly in commercial poultry. The minimum was noticed in breast samples of Sulaymaniyah (2.03 log₁₀ cfu/ g).

Table 3 contains lower-case superscript letters that denote statistically significant differences ($p < 0.05$) between poultry cuts and categories in each of the sampling locations. In general, the coliform levels in domestic poultry were higher than those in commercial poultry, as well as the coliform levels in Sulaymaniyah than in Ranya.

Table 3. Log₁₀-transformed to coliform count in chicken samples from backyard and commercial birds of abattoirs in Sulaymaniyah and Ranya cities.

Type of Cut	Type of Poultry	Ranya City Abattoir	Sulaymaniyah City Abattoir
Breast	Domestic	2.35 ij ± 0.02	2.60 fg ± 0.02
	Commercial	2.23 ij ± 0.04	2.03 j ± 0.08
Leg	Domestic	2.71 ef ± 0.03	2.58 gh ± 0.03
	Commercial	2.45 hi ± 0.04	2.27 ij ± 0.05
Drumstick	Domestic	2.75 e ± 0.03	2.63 fg ± 0.02
	Commercial	2.41 I ± 0.05	2.46 hi ± 0.04
Inner Carcass	Domestic	3.07 b ± 0.03	3.22 a ± 0.03
	Commercial	2.87 d ± 0.04	3.01 c ± 0.03

Means with different lowercase letters within the same column differ significantly ($p \leq 0.05$)

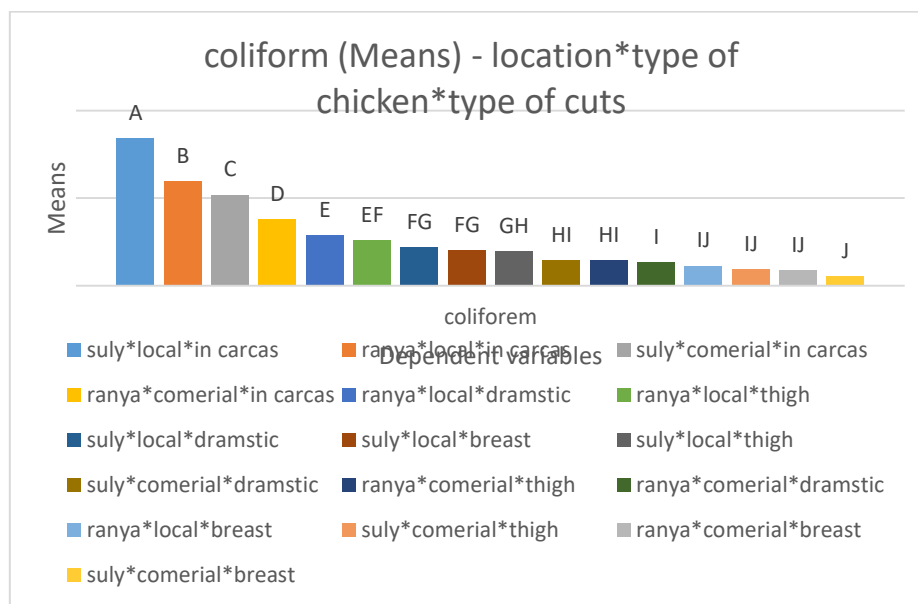


Figure 3. Comparative analysis of coliforms in poultry meat: Effect of cutting method, bird type, and abattoir location



Isolation and Characterization of E. coli.

Table 4 presents the prevalence of Escherichia coli in poultry carcasses in the Sulaymaniyah and Ranya slaughterhouses. The rate of detection varied greatly depending on the location of the slaughterhouse, carcass parts, and type of poultry. E. coli-positive samples of domestic chicken in Sulaymaniyah abattoir were higher in proportions in breast meat and inner-carcass swabs, and lower in leg and drumstick samples. The same pattern was noted in commercial chickens in the same facility, with the highest occurrence of the samples of the breast compared to the other samples of the leg, drumstick, and inner-carcass.

The general level of E. coli was lower at the Ranya abattoir than in Sulaymaniyah. All the breast samples of domestic chickens were positive, whereas leg, drumstick, and inner-carcass samples showed a reduced detection. Breast samples once again recorded the highest positivity rates in commercial chicken, with less frequent contamination in the drumstick samples.

Chi-square test of Independence was used to determine a significant difference between the prevalence of E. coli in the two locations ($X^2 = 5.38$, 1df, $p = 0.020$), which means that there was a difference in the levels of contamination due to the geographical location.

Table 4. Prevalence of E.coli in Different Parts (Sections) of the Chicken Breed Domestic and Commercial Carcasses at Sulaymaniyah and Ranya Cites Slaughterhouses

Location	Type of chicken	Type of Sample	No. of Samples	No. of Positive Escherichia coli	Percentage
Sulaymaniyah city slaughterhouse	domestic	breast	12	12	% 100
		leg	12	12	% 100
		drumstick	12	11	%91.66
		Inner carcass	12	12	% 100
	Commercial	breast	12	12	% 100
		leg	12	10	%83.33
		drumstick	12	10	%83.33
		Inner carcass	12	10	%83.33
Ranya city slaughterhouse	Domestic	breast	12	12	% 100
		leg	12	11	%83.33
		drumstick	12	9	%75
		Inner carcass	12	9	%75
	Commercial	breast	12	10	%83.33
		leg	12	9	%75
		drumstick	12	8	%66.66
		Inner carcass	12	9	%75
Total			192	166	%86.45



Antimicrobial resistance

Table 5 gives antimicrobial susceptibility patterns of 166 Escherichia coli isolates from poultry carcasses. The isolates were characterized by high rates of resistance to a number of antimicrobial agents in domestic and commercial flocks. Resistance was highest to ampicillin (98.79%), amoxicillin (95.78%), and levofloxacin (94.57%). Gentamicin (92.77%), tetracycline (90.96%), tylosin (90.36%), and oxytetracycline (89.15%), resistance was also strong. The neomycin resistance was different in various regions of the carcass, and the general percentage was 54.81. Isolates were found to have developed resistance to doxycycline in 60.24 per cent of the isolates, and the lowest resistance was reported to ciprofloxacin at 30.12 per cent.

The chi-square tests indicated that the level of antimicrobial resistance in the carcass parts did not significantly differ with each antimicrobial used ($p > 0.05$). Regular high resistance was seen in all isolates of breast, leg, drumstick, and inner carcass tissues to gentamicin ($\chi^2 = 2.83, p = 0.419$) and tetracycline ($X^2 = 3.20, p = 0.362$). Similarly, there was no significant difference in neomycin resistance across tissues, although all breast isolates had complete resistance ($X^2 = 0.31, p = 0.959$).

Type of antibiotic	(Resistance Rate %)				
	Breast (N = 46)	Leg (N = 42)	Dramatic (N = 38)	Inner Carcass (N = 40)	Total (N = 166)
Tetracycline	43(93.47)	40(95.23)	35(92.10)	34(85)	151(90.96)
Gentamicin	45(97.82)	39(92.85)	34(89.47)	36(90)	154(92.77)
Amoxicillin	45(97.82)	40(95.23)	35(92.10)	39(97.5)	159(95.78)
Ampicillin	46(100)	41(97.61)	37(97.36)	40(100)	164(98.79)
Neomycin	26(100)	24(57.11)	20(52.63)	21(52.5)	91(54.81)
Oxytetracycline	39(84.78)	37(88.09)	36(94.73)	36(90)	148(89.15)
Levofloxacin	43(93.47)	40(95.23)	37(97.36)	37(92.5)	157(94.57)
Tylosin	43(93.47)	40(95.23)	32(84.21)	35(87.5)	150(90.36)
Doxycyclin	27(58.69)	26(61.90)	23(60.52)	24(60)	100(60.24)
Ciprofloxacin	11(23.91)	13(30.95)	11(28.94)	10(25)	50(30.12)

Table 5. Antibiotic resistance of positive Escherichia coli.



IV. Discussion

The hygiene practices in the Sulaymaniyah poultry slaughterhouse show that employees tend to follow the necessary guidelines, such as washing their hands, involving the use of footbaths, and carrying out routine cleaning. One-third of the workers failed to clean cutlery properly, and this may result in the survival of pathogenic microorganisms, including, but not limited to, those of *E. coli* and *Salmonella* (Ogunlade, 2024).

The occasional touch of the body or visceral sections to the floor is indicative of an apparent severe hygiene deficiency that can affect the safety of meat. Also, the risk is heightened by contamination of protective items, which was detected in 16% of instances, since such items can contain and transmit bacterial communities (Boloan et al., 2025).

The hygiene assessment parameters at the poultry slaughterhouse in Rayna were rated as excellent in most cases, such as good handwashing habits, use of protective clothing, and availability of clean water, which are required compulsory parameters of food safety regulations (Kang et al., 2021).

The hygiene evaluation of the poultry slaughterhouse in Rayna showed that the main standards were mostly high, particularly in hand washing, wearing protective clothing, and supply of running water, which are critical elements of compliance with food safety standards (Tagar & Ahmed, 2021).

Major gaps were identified: less than two-thirds of the workers stated they use footbaths, and even a smaller fraction stated that they disinfect their knives on a regular basis. The techniques are also applicable in microbiological quality control to safeguard against possible contamination by bacteria and pathogens like *Salmonella* or *Staphylococcus aureus* (Mousa et al., 2021).

However, unfortunately, 64 percent of workers said that body parts (or offal), sometimes, were in contact with the floor, which, in case of inefficient cleaning, could contribute to the spread of various pathogenic microorganisms (Botta et al., 2024). It has been noted that even after cleaning, certain organisms (e.g., *Arcobacter* spp.) are able to contaminate surfaces and equipment; as such, appropriate control of the process is required (Kebede & Getu, 2023).

Cleaning of human and environmental surfaces is a routine activity and spatial separation between clean (airline) and dirty (processing hall) zones is ensured; however, outbreak of carrion in the tools and inefficient carcass handling remain the main threats. A proper mitigation effort will involve conducting regular training programs and overall control practices, which will include safe meat production procedures, systematic risk evaluations, and critical control point (CCP) systems (Nurye & Demlie, 2021).

The current descriptive research revealed that there were differences in the level of contamination of bacteria in domestic and commercial chickens in the two cities analyzed, Sulaymaniyah and Rayan. The counts of microbes on the commercial poultry samples of Rayan (that is, breast, leg, and drumstick), were significantly greater than those considered to be found on backyard birds. This difference is likely explained by the fact that commercial activities require a lot of processing: the issue of hygiene becomes even more problematic when large amounts of product are to be produced in a short time frame, especially when the equipment that is supposed to disinfect products is not properly disinfected (Garcia et al., 2021).

Domestic poultry processed in Sulaymaniyah, on the contrary, had high contamination rates, especially among legs and drumsticks. These conclusions can be attributed to an informal slaughter production system, which is low-intensity and has a small-scale communal system. The sanitary inadequacies of the attendants, the training of the workers, and supervisory control also add to this association (Gebeyehu & Tsegaye, 2022).

As a follow-up to these observations, the present study revealed a high difference in the total number of plates per body part, poultry species, and source of sample; the household-based poultry always had a greater microbial burden than the commercial one. This tendency is consistent with the studies that preceded it, suggesting that on-farm small-scale facilities, which usually lack a well-developed infrastructure related to biosecurity and hygiene, are more contaminated with bacteria (Thames et al., 2022). In addition, the samples of

inner carcass in the domestic market in Sulaymaniyah had very high bacterial loads (4.30 log₁₀ cfu/g), indicating contamination during evisceration and minimal penetration of antimicrobials into the interior surfaces (Obe et al., 2023) .

Breast and drumstick samples, especially commercial ones, on the other hand, had significantly reduced bacterial counts. The lowest total viable count (TPC) of 3.12 log₁₀ cfu/g was observed in Sulaymaniyah commercial breast meat, which is probably the result of better hygiene measures and specific antimicrobial treatment (Hauge et al., 2023) . Interregional differences in hygiene, water quality, and handling practices were more significant in Ranya than in Sulaymaniyah, which supports the values of TPC (Rosamilia et al., 2025).

The contamination of coliform, particularly that of *Escherichia coli*, differed greatly between the poultry cuts, production systems, and the locations of the slaughterhouses. A high bacterial count was recorded in the domestic poultry carcasses of Sulaymaniyah, which had a TPC of 3.22 log₁₀ cfu /g. This fact suggests the possibility of the domestic poultry production system being deficient in terms of hygienic management and sanitary control measures compared to the commercially operated facilities, which may increase the risk of microbial contamination.

Poor hygiene, use of water whose origin is contaminated wells, hand evisceration, and lack of robust cold chain in small-scale or household slaughterhouses are possible causes of the increased levels of contamination recorded. These findings complement international findings that hold that interventions in non-hygienic environments result in higher levels of *E. coli* in the chicken processing facilities, thus advocating the essential role of sanitation and temperature regulation throughout the food supply chain (DANDRAWY et al., 2025).

There was a geographical difference: the samples of Sulaymaniyah showed an increased level of contamination compared to Ranya. This small fluctuation can be a result of the variation in the protocols of the slaughterhouse, which affect the integrity of skin, sanitation of the environment, personal hygiene practices, or the effectiveness of the training interventions. Also, the environmental temperature and humidity were different in sites (Zhang & Xie, 2021) .

The second sample, which was made to depict the inner carcass, demonstrated observable counts of coliform, which are normally used as a food-safety indicator and are quite alarming at such levels. The international standards recommend remedial action and disposal of the affected goods at these levels (Authority et al., 2022). In order to curb microbiological hazards in household poultry products, it is essential to introduce wide-scale interventions such as health education, water purification, and introduction of bioproducts or treatments that have the ability to disrupt biofilms (DANDRAWY et al., 2025) .

The presented results have been demonstrated by other studies previously. It has been mentioned in (Gebeyehu & Tsegaye, 2022) that microbial hazards could be increased by poor hygiene in small-scale or informal environments, caused by the lack of worker training and poor sanitation practices. In addition, the tests that Ranya conducted revealed that the commercial poultry leg was highly contaminated compared to the domestic bird leg. Such findings suggest that formal institutions also can make hygiene lapses, which is primarily due to inconsistent cleaning practices (Kanko et al., 2023). On average, *E.coli* in commercial poultry were less. This observation is consistent with the findings of (Garcia et al., 2021) who came up with better microbiological results in poultry reared using formal, controlled means than those reared using informal ones. The rise in bacterial loads in the carcasses, especially those caused by domesticated chickens, could be due to lacking effective gut contents removal, and poor internal sanitation, which all play a significant role in faecal contamination as one of the critical factors (Perez-Arnedo et al., 2021).

The results of the present study indicate that poultry carcasses slaughtered in Sulaymaniyah and Ranya were severely contaminated, particularly with domestic hens, which had significantly higher counts than those in The findings of the current research showed that the carcasses of poultry slaughtered at Sulaymaniyah and Ranya had been contaminated seriously, especially in domestic hens, which had a high bacterial count compared to commercial hens. This analogy, therefore, highlights the significance of the slaughterhouse sanitary regime and proper management of sites in the processing plants as these components can adjust the probability of microbial contamination. These correlations are important as evidenced by a number of other reports. The role of

biosecurity and facilitation measures has also been mentioned by a few authors because the lack of disinfection mechanisms or extreme environmental conditions, including extreme changes in temperature, might lead to similar contamination patterns (Kromann & Jensen, 2022).

The high proportion of contaminated samples with *Escherichia coli*, specifically in the samples of the breast muscle, is a severe danger to the overall health of the population since there is the possibility of the transmission of bacteria by means of undercooked poultry meat. Thus, the issues provided above vividly provide evidence of the need to introduce strict food safety control measures across the industrial chain. In addition, due to the increased global alert on the issue of poultry production based on antimicrobial-resistant *E. coli* strains, regular monitoring is critical to inform the corrective actions and risk assessment to support measures to reduce food contamination (Rosamilia et al., 2025). Responding to the growing worldwide alarm over AMR *Escherichia coli* strains linked to poultry production, the introduction of systematic surveillance programmes to determine the prevalence and resistance trends of bacteria is invaluable, since this is the basis of risk assessment and the formulation of effective strategies to counter foodborne infections (Oliveira et al., 2024).

The commercial issue of antibiotic-resistant *Escherichia coli* isolates on chicken carcasses has become a commercial concern. The prevalence of resistance to the widely used antibiotics ampicillin (98.79%), amoxicillin (95.79%), and levofloxacin (94.57%) suggests possible abuse or misuse in poultry production (Zhang et al., 2021).

Major resistance to gentamicin (GE), tetracycline (TE) and tylosin (TYL) was reported making it difficult to cure poultry infections using the traditional approach (Rosamilia et al., 2025). The rate of total resistance was noted as 100 percent in breast samples with neomycin (NEO), with the resistance rate being 54.81 percent (Tan et al., 2023). The reduced resistance in other tissues could be an indication of poor drug distribution. The lowest resistance of 30.12 percent was observed with neomycin, and the resistance of the drug to human therapeutics is medically dangerous (Organization, 2022).

Staphylococcus aureus has recently become a growing problem with multi-drug resistance, which is why it is feared that it can soon become resistant to almost all classes of antibiotics. Detection of *E. coli* in chicken meat implies that there is a failure of the national antibiotic stewardship policies in poultry farms. The food chain can also lead to the transmission of pathogens of treated birds, which could result in the reintroduction of carcinogenic substances that could have their origin in the mitochondria back into consumers. This observation is consistent with surveillance surveys which were implemented earlier this year in Asia and Africa and found that the overwhelming majority of live poultry contained colistin-resistant *E. coli* (Authority et al., 2022). A survey conducted in a slaughterhouse in Dar es Salaam showed that three or more classes of antibiotic-resistant *Escherichia coli* were found in 69.3 percent of *E. coli* isolates obtained in raw chicken meat and cloacal swabs.

V. Conclusion

The current study has shown significant gaps in hygienic management and food safety measures at poultry slaughterhouses in Sulaymaniyah and Ranya. Routine sanitation measures, the use of personal protective equipment, and the provision of potable water were often reported, but various control points that pose a high risk, namely, the cleanliness of equipment after evisceration and the avoidance of carcass contact with floor surfaces, were not adequately covered. Microbiological tests showed that contamination with *Escherichia coli* was very high (86.4% of the processed samples); the isolated samples showed a wide range of resistance to commonly used antimicrobial agents, with 98.7% resistance to ampicillin, 95.7% to amoxicillin, and 94.5% to levofloxacin.

There were considerable differences in domestic and commercial poultry contamination rates and also between the two slaughter houses, which indicates heterogeneity in terms of hygiene practices and biosecurity implementation. Such outcomes underline the importance of designing the improvement of sanitary measures, systematic overseeing of antimicrobial stewardship, and strengthening the poultry processing process in order to reduce microbial risks and limit the spread of antimicrobial-resistant bacteria throughout the food chain.

VI. References

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الحالة الصحية في مسالخ الدواجن بمحافظة السليمانية

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الملخص

أجريت هذه الدراسة المقطعية خلال الفترة من مارس إلى مايو 2025 في مصنعين بلديين لمعالجة الدواجن في محافظة السليمانية، العراق (السليمانية ورائية)، بهدف تقييم ممارسات النظافة والمخاطر الميكروبيولوجية. جُمعت 192 عينة شملت 144 عينة نسيجية و48 مسحة من التجويف البطني لجثث الدواجن، من دواجن تجارية وأخرى منزلية. تم استخدام قائمة تحقق مكونة من 12 نقطة، إلى جانب استبيانات للعمال لتقييم مدى الالتزام بممارسات النظافة، كما أُجريت تحاليل ميكروبيولوجية لتحديد العدد الكلي للبكتيريا (TBC) ، وعدد القولونيات الكلي (TCC)، والكشف عن الإشريكية القولونية وتحديد نمط مقاومتها للمضادات الحيوية. أظهرت النتائج أن الظروف العامة للنظافة كانت مرضية إلى حد كبير، حيث بلغت نسبة الالتزام بغسل اليدين 80%، والتنظيف اليومي 100%. ومع ذلك، ظهرت ثغرات ملحوظة في تعقيم السكاكين بعد نزع الأحشاء (72% في السليمانية و60% في رائية)، وفي منع تلوث الذبائح بمياه الأرضية (68% و64% على التوالي). كما أظهرت قيم TBC وTCC فروقاً ذات دلالة إحصائية تبعاً لنوع القطعة ونوع الدجاج وموقع المعالجة ($p < 0.05$) ، وكانت نسب التلوث أعلى في الدواجن المنزلية. أظهرت الأجزاء الداخلية من الجثث في السليمانية مستويات تلوث أقل (TBC حتى $\log_{10} 4.30$ و TCC حتى $\log_{10} 3.22$) مقارنة بالأجزاء الخارجية. تم الكشف عن E. coli في 86.45% من العينات، مع اختلاف إحصائي ملحوظ حسب الموقع ($X^2 = 5.38, p = 0.020$). كما لوحظت مقاومة مرتفعة للمضادات الحيوية، حيث أظهرت العزلات مقاومة شديدة للأمبيسيلين (98.79%)، والأموكسيسيلين (95.78%)، والليفوفلوكساسين (94.57%)، وعدة مضادات أخرى. تؤكد الدراسة وجود فجوات حرجة في ممارسات النظافة وانتشار واسع لسلاسل E. coli المقاومة لعدة أدوية، خاصة في الدواجن المنزلية. توصي الدراسة بإجراءات تدخلية تتضمن تعقيم السكاكين الإلزامي، منع التلوث بمياه الأرضية، تطبيق أنظمة رقابة HACCP ، تدريب العاملين على النظافة الشخصية، وتكامل برامج ترشيد استخدام المضادات الحيوية مع جهود المراقبة الوبائية.الكلمات

الدالة : المسالخ ,لحوم الدواجن , صحة لحوم, الاشرىكية القولونية, مقاومة المضادات الميكروبية.