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Modeling Microbial Contamination in Retail Poultry Meat: The Role of Poultry Technology and Hygienic Practices Using Regression and Correlation Approaches

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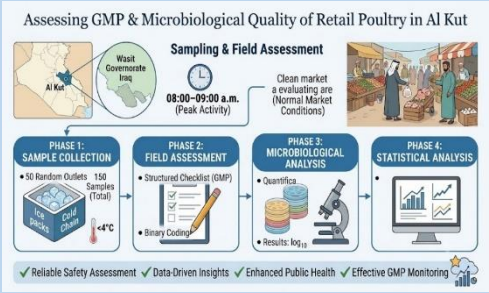
Abstract: This study examined the microbiological quality and the hygienic status of retail poultry meat in Wasit Governorate, Iraq, including the association between hygiene-related factors and indicators of bacterial contamination. One hundred and fifty samples were taken in 50 retail outlets, and the samples were analyzed to determine the total aerobic plate count (APC), coliform, *Escherichia coli*, *Salmonella spp*., and *Staphylococcus aureus*. The findings showed that there was a high prevalence of pathogenic bacteria, with *Salmonella* and S. aureus detected in 88% and 92% of samples, respectively, with strong implications on public health. The hygienic practices differed significantly in terms of microbial loads ($p < 0.05$). In particular, the sterilized cutting tools minimized the number of APC, coliforms, and *E. coli* to 1.40, 1.10, and 1.02 log 10 CFU/g, respectively, compared to 2.45, 2.15, and 1.67 log 10 CFU/g, respectively, for non-sterilized tools. Similarly, the stainless-steel surface, correct waste disposal, and low temperatures of less than 5 degrees C were linked to a minimal level of bacterial loads in contrast to wood/plastic surfaces, waste disposition, and increased temperatures. Several regression models were found to explain the level of contamination with cutting tools (having the highest, 0.942, p-value = 0.001), surfaces, waste management, and control of temperature. Correlation analysis also proved that hygienic practices and pathogen occurrence were critically negatively related, especially between cutting tools and *Salmonella* (r = -0.90) and S. aureus (r = -0.88). Overall, the results indicated that poor hygiene practices in stores are one of the key factors in the microbial contamination of products, and the adoption of simple sanitary measures is significant in enhancing the safety of poultry meat and alleviating foodborne risks in local markets.



Keywords: Poultry Technology, Microbiological Quality, Food Safety, Hygienic Practices, Poultry Meat Contamination.

Introduction

Fresh poultry meat is one of the most commonly used sources of animal protein in the world but is also extremely susceptible to bacterial contamination during slaughtering, processing, and retail distribution (1–4).This contamination is often associated with indicator and pathogenic bacteria, in particular, *Salmonella spp*. and *Escherichia coli*, which are serious causes of foodborne diseases in case of insufficient hygienic control (5,6). Foodborne pathogens pose a major threat to global public health, causing a wide range of illnesses, from gastroenteritis to life-threatening acute systemic infections, as well as long-term chronic complications such as arthritis and neurological disorders (7). World Health Organization reports indicate that approximately 600 million people become ill annually after consuming contaminated food, resulting in about 420,000 deaths. (7). The Centers for Disease Control and Prevention (CDC) also emphasizes the clinical importance of detecting specific pathogens such as *E. coli*, *Staphylococcus aureus*, and *Salmonella spp*., given their frequent role in foodborne illness outbreaks, which necessitates urgent hygiene interventions to reduce health risks within the community (8).

Good Manufacturing Practices (GMP) are defined as the basic operational and environmental conditions necessary for producing safe food, focusing on key pillars such as worker hygiene, equipment maintenance, and process control (9–11). Previous studies indicate that processed carcasses in controlled environments at industrial plants have lower total aerobic bacterial counts (APC), reduced *E. coli* levels, and lower pathogen prevalence than processed or sold carcasses in wet markets or in informal retail markets (1,12,13).

Conversely, wet market and informal retail poultry meat and giblets have a tendency to show a high microbial load, such as coliforms, *E. coli*, *Staphylococcus aureus*, and *Salmonella spp*., which are often above acceptable microbiological contaminat ion levels, and thus present a real health risk ((2,14–16). These results highlight the changeability of the microbial risk through the processing and marketing chain, which is highly affected by hygienic measures, environment, and handling.

Additionally, recent meta-analyses compiling data among various countries reveal that poultry in general, but especially traditional/traditional-market-derived poultry, has a noticeable

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contamination prevalence rate of about 30-45 percent *E. coli*, 20-30 percent *Salmonella spp*., and other notable levels of other spoilage or opportunistic bacteria—a prevalence that is by far greater than that of processed-plant products (17). This discrepancy suggests that the retail environment (regulated or uncontrolled) is one of the most influential forces that define the safety of meat.

Since in places such as the Middle East—and in Iraqi provinces such as Wasit in particular—the distribution of poultry proceeds by a combination of more or less controlled processing facilities and looser markets or small-scale retailers, a comparative bacteriological evaluation is critical. Thus, the purpose of the study is to compare the level of microbial contamination of fresh chicken carcasses and retail cuts in sales points, which are GMP-compliant and non-compliant in the Wasit Governorate.

Materials and Methods

Sample Collection

Fifty retail poultry outlets were randomly selected in the main local markets in Al Kut, Wasit Governorate, Iraq. Three samples were collected from each outlet, and a total of 150 samples were to be taken. Sampling was conducted between 1 and 30 June 2025.

The samples were obtained in the morning between 08:00 and 09:00 a.m. which is the busiest purchasing hour in the local Iraqi markets particularly in the purchase of fresh food products. This sampling period was taken to evaluate the hygienic handling behavior under the normal market operating conditions and the high consumer activity to make a realistic assessment of good manufacturing practices and sanitary conditions in the poultry meat retail points.

The samples were collected aseptically and moved to the laboratory in sterile containers in insulated boxes with ice packs to ensure that the temperature of the samples does not exceed 4°C before analysis by microbiological means.

Field Assessment Tool

A structured checklist was used to determine the level of satisfactory manufacturing practices (GMP) in the retail outlets of the poultry meat. The checklist was based on the international food safety standards that are issued by the Codex Alimentarius Commission and the International Organization of Standards (18).

The assessment tool contained some major hygienic and operational indicators: (i) surface (Stainless Steel, Plastic, Wood), (ii) cutting tools: Sterilization is defined as the use of hot water or chemical disinfectants between tasks While cleaning refers to the removal of visible residues with clean water, tools containing visible organic residues or those used repeatedly without intervention are described as unclean.(Sterilized, Washed and Cleaned, Unclean), (iii) display practices (Designated Area, Non-Designated Area), (iv) temperature control on displaying meat (Below 5 degrees C, Above 5 degrees C), (v) waste management practices (Disposed, Accumulated), and (vi) personal hygiene Compliance is precisely defined as the simultaneous use of clean gloves and head coverings, and the absence of jewelry, in accordance with the Iraqi standard (IQS No 2270/2006) and Codex Alimentarius - CXC 1-1969. Non-compliance is recorded in the absence of any of these elements. (Compliant, non-compliant).

Qualitative inspections also registered the overall cleanliness of the stores, and this could influence the microbiological quality of the poultry of the meat they sell. To allow the data to be readily analyzed by us, we coded every checklist parameter as a binary variable, compliant = 1, and non - compliant = 0.

Microbiological Analysis

Laboratory microbiological tests were conducted with culture media provided by Oxoid (UK). All the microbiological work was conducted in line with internationally accepted guidelines as suggested by the International Organization of Standardization (ISO) and the American Public Health Association (APHA)(19).

Hygiene Indicators

Plate Count Agar (PCA; Oxoid) was used to quantify the number of aerobic plates, and incubated plates were kept at 30°C during 48-72 h according to the standard procedures (19). Coliform bacteria and *Escherichia coli* enumeration were done on Violet Red Bile Lactose (VRBL) agar and Tryptone Bile X-glucuronide (TBX) agar based on the methodology outlined by(20). All the microbiological counts were represented as the logarithmic values (log 10 CFU/g) before statistical analysis to normalize the value distribution.

Pathogen Detection

Qualitative detection of *Salmonella spp*. (presence/absence) was conducted on 25 g of each of the poultry meat samples after standard enrichment and selective enrichment. The cultures were streaked on selective media such as Xylose Lysine Deoxycholate (XLD) agar and Hektoen Enteric agar, following the instructions of the International Organization of Standards (21). According to the (22), standard procedures, the *Staphylococcus aureus* was detected on the Baird-Parker agar and incubated at 37°C for 24–48 h. The coagulase test was also used to confirm suspected colonies. The presence of these pathogens was later taken as a marker to determine the correlation between the microbial contamination and the extent of hygienic practice, specifically personal hygiene, in the assessed retail facilities.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics (Version 26). The compliance tests associated with Good Manufacturing Practices (GMP) were coded to numerical variables to make it easier to analyze statistically. Microbial loads (log 10 CFU/g) were summarized using descriptive statistics (Mean ± SD). Variations in hygienic practices in bacterial contamination were determined with the help of proper comparative tests and correlations between hygienic factors and microbial indicators were determined with the help of Pearson Correlation. Moreover, Multiple Regression analysis was used to determine the most significant hygienic factors that influence the bacterial contamination on poultry meat samples. The level of statistical significance was taken to be $(P < 0.05)$.

Results and Discussion

Figure 1 shows the prevalence of hygienic practices and occurrence of pathogenic bacteria in retail outlets of poultry meat. The findings revealed that Stainless steel surfaces were the most used (42%), secondly plastic (40%), with only 18% of the retail outlets being wooden. On cutting tool, 90% of outlets reported using washed tools and cleaned, and only 10% sterilized and none of the no outlets reported using unclean tools. The display practices showed that 66% of the outlets employed non-designated display practices, and 34% employed designated display areas. The evaluated temperature control showed that 76% of outlets operated at temperatures above 5°C, and only 24 % of the temperatures were lower than 5°C.

Observations on the waste management revealed that in 44 outlets, the management of the waste was inadequate compared to 56 outlets that handled the waste properly. In only 8% of outlets hygiene compliance was present whereas 92% had poor compliance with hygiene practices. Microbiological screening showed that there was high prevalence of pathogenic bacteria in which Salmonella was found in 88 percent of the samples and *Staphylococcus aureus* were found in 92 % of the samples.

The results indicate inadequate hygienic practices in the retail poultry meat setting that might cause high rates of microbial contamination. The prevalence of stainless-steel surfaces that are witnessed in the present study is usually said to be positive since these materials are non-porous and thus easier to disinfect than wood which has the ability of harboring microorganisms within its porous framework. In the past, researchers have highlighted that surface materials are also significant in cross-contamination within food processing premises(23).

Nevertheless, even though most of the surfaces were made of stainless-steel, the fact that the prevalence of pathogenic microorganisms, including Salmonella and *Staphylococcus aureus*, were extremely high, indicates the presence of other predisposing factors, especially, low personal hygiene and insufficient temperature control, that might have contributed to the microbial contamination. Lack of hygienic behaviour in the workers has been widely identified as one of the greatest contributors of foodborne pathogens in retail food outlets (24). In addition, inappropriate temperature control in storage may cause the growth of bacteria in fresh poultry meat faster, which will result in foodborne disease (25).

The presence of Salmonella and S. aureus is due to poor sanitation, cross-contamination, and inappropriate temperature regulation during the food chain. The same has been observed in poultry retail research in developing countries, as they have less infrastructure, and food safety practices are not followed as well, which predisposes them to microbial contamination (7,26). These results indicate that there is a strong necessity to enhance food safety systems implementation and more stringent control over hygienic measures in the retail outlets of poultry meat.

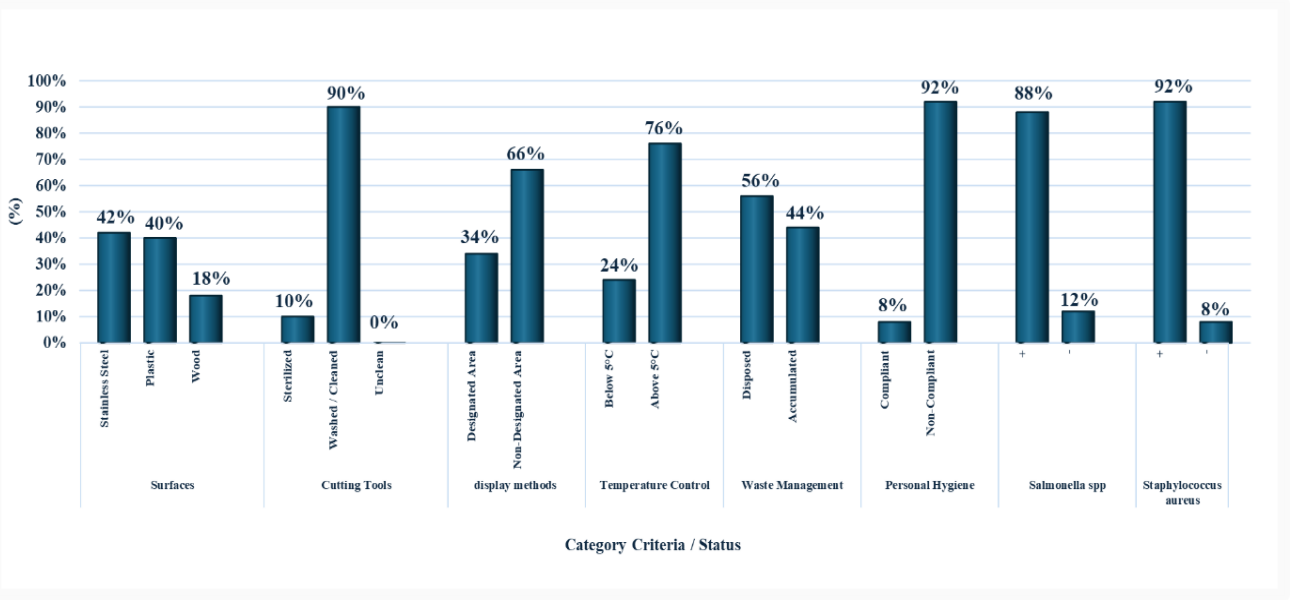

Figure (1): Hygienic compliance indicators and prevalence of pathogenic bacteria in poultry meat retail outlets in Al Kut city.

The outcomes of the Multiple Regression analysis revealed that several hygienic practices had a strong effect on the level of bacterial contamination in samples of poultry meat. Table 1, Table 2, and Table 3 indicate that cutting tools had the greatest impact on microbial contamination with standardized coefficients (Beta) of 0.940, 0.942, and 0.898 of total aerobic bacteria, coliforms, and *Escherichia coli* amount respectively ($P < 0.001$). The Beta values were also significant with Beta values bein g between 0.068 and 0.111 ($P < 0.001$) and this indicated that the cleaning of the surfaces was strongly associated with the level of bacteria. In the same way, the bacterial contamination was highly related to the waste management practices ($P = 0.001$), and Beta values ranged between 0.043 and 0.068. There was also a statistically significant fact of temperature control during meat display on microbial loads ($P < 0.05$). Conversely, there were no statistically significant differences ($P > 0.05$) in display practices and personal hygiene between the three microbial indicators with bacterial contamination.

The findings of the Multiple Regression analysis were that some hygienic practices had a significant impact on bacterial contamination on poultry meat samples. Cutting tools among the investigated factors portrayed the greatest impact on microbial contamination in all the bacterial indicators, such as total aerobic bacteria, coliforms and *Escherichia coli*. The implication of this finding is that the poor sanitation of cutting tools can serve as a significant cause of cross-contamination in handling poultry meat. The same has been observed in recent studies, which have emphasized that contaminated cutting tools and processing equipment are significant pathogen reservoirs of foodborne pathogens in poultry meat retail settings (27).

The present study also displayed a strong correlation between surface hygiene and the level of microbial contamination. Microorganisms may be transferred on the food contact surface of contaminated environments through handles of meat products, especially in cases where cleaning and sanitation are not performed properly. Past studies have also shown that microbial persistence on processing surfaces may pose a significant risk of contamination of poultry meat supply chains (28).

Another major factor which influenced bacterial loads was the waste management practices. Poor management of organic waste like blood and feathers can provide good environmental conditions that would lead to the growth and propagation of bacteria. More or less the same results were noted by (29), who stated that environmental contamination and inadequate sanitation can enhance the possibility of bacterial contamination throughout the poultry production and retail chain.

Microbial contamination was also related strongly to temperature control during the displaying of meat in this study. Poultry meat should not be kept at improper temperatures as this can promote bacterial proliferation and exposure to foodborne infections. Recent research has also affirmed that poor temperature control during storage and retail display can be a major cause of growth of the pathogenic bacteria in poultry products (30).

Display behaviors and personal hygiene on the other hand did not exhibit statistically significant relationships with bacterial contaminations in the regression analyses. This is either due to the comparative consistency in observed practices in the sampled retail outlets or due to the greater effect of other sources of contamination like cutting tools and surfaces. However, the visibility of such pathogenic bacteria in poultry meat as Salmonella and *Staphylococcus aureus* remains a significant issue in the social health of the population, especially in shops where hygienic control can be rather weak (31). Overall, these results suggest that more hygienic handling, especially the cleaning of cutting tools and food contacts surfaces, the proper management of waste, and temperature maintenance at retail outlets selling poultry meat are vital factors to improve the situation.

Table (1): Multiple regression analysis showing the effect of hygienic practices on total bacteria in poultry meat samples.

Variable	Unstandardized Coefficients (B)	Standardized Coefficients (β)	P. Value
Constant	0.301		
Cutting tools	1.002	0.940	<0.001
Surfaces	0.030	0.068	<0.001
Waste management	0.028	0.043	0.001
Temperature control	0.026	0.035	0.011
Display	0.017	0.025	0.144
Personal hygiene	- 0.012	- 0.010	0.580

Table (2): Multiple regression analysis showing the effect of hygienic practices on Coliforms bacteria in poultry meat samples.

Variable	Unstandardized Coefficients (B)	Standardized Coefficients (β)	P. Value
Constant	0.004		
Cutting tools	1.002	0.942	<0.001
Surfaces	0.030	0.070	<0.001
Waste management	0.028	0.043	0.001
Temperature control	0.027	0.037	0.007
Display	0.014	0.021	0.211
Personal hygiene	- 0.013	- 0.011	0.517

Table (3): Multiple regression analysis showing the effect of hygienic practices on *E. coli* bacteria in poultry meat samples.

Variable	Unstandardized Coefficients (B)	Standardized Coefficients (β)	P. Value
Constant	0.327		
Cutting tools	0.602	0.898	<0.001
Surfaces	0.030	0.111	<0.001
Waste management	0.028	0.068	0.001
Temperature control	0.027	0.058	0.007
Display	0.014	0.033	0.206
Personal hygiene	- 0.013	- 0.018	0.514

Tables 4-7 provide the comparative analysis of the level of bacterial contamination of the poultry meat samples based on the various hygienic practices. The findings showed the existence of significant differences ($P < 0.05$) in microbial loads in relation to the state of sanitation of cutting equipment, the surface composition, waste disposal systems and temperature regulation in meat display. Table 4 demonstrates that processed poultry meat with sterilized cutting tools had much fewer microbes than those washed and dried. The average numbers of aerobic bacteria reduced to 2.45 log 10 CFU/g on the tools washed to 1.40 log 10 CFU/g on the sterilized tools. Other comparable reductions were found in the coliform bacteria and *Escherichia coli*. With respect to surface composition (Table 5), the stainless-steel surfaces were found to be much less contaminated with bacteria than were wood and plastic surfaces. The average aerobic count of the plate on stainless steel was 2.16 log 10 CFU/g, but greater counts were obtained on wood and plastic surfaces. Table 6 shows that appropriate disposal of waste materials decreased the rate of contamination by microbes greatly. The bacterial loads of retail outlets that had accumulated waste were greater than the bacterial loads of the outlets where the waste was cleared on a regular basis. In a similar manner, temperature control was also important with respect to the level of contamination of bacteria (Table 7). There was a significant increase in microbial loads of samples that were kept in temperatures above 5 ºC than those that were kept in temperatures below 5 ºC which proves the significance of proper refrigeration in the control of bacterial growth in poultry meat.

The findings of the current research indicate the high influence of hygienic behavior on the level of microbial contamination in the retail atmosphere of poultry meat. The fact that the number of bacteria was greatly reduced when sterilized cutting tool was used highlights the need to ensure good sanitation of equipment in cross-contamination prevention. The cutting tools have often been cited as sources of microbial transfer that are critical during the meat processing and retail handling. According to recent research, it has been also stated that infected equipment may play a significant role in pass-on of foodborne pathogens in poultry meat supply chains (27).

Another factor that had a significant effect on bacterial contamination was the surface composition. There were very low loads of microbes on stainless steel surfaces as compared to wooden and plastic surfaces. This observation can be explained by the reason that stainless steel is not porous and hence can be washed and disinfected easily as opposed to porous substances like wood. The same has been observed in research on assessments of hygienic conditions in poultry processing plants (28).

The level of bacterial contamination was also greatly contributed by the waste management practices. The buildup of organic matter-like blood, feathers and meat residues may result in the creation of good sources of microbial growth and contamination of the environment. It has been found that a lack of sanitation and improper waste disposal may contribute to the growth of microbial burden in food retail settings (29).

Maintaining a consistent temperature throughout the meat display process was also discovered to have a substantial impact on the levels of bacterial contamination. In comparison to samples kept at temperatures lower than 5 degrees Celsius, poultry meat that was stored at temperatures greater than that exhibited increased levels of microorganisms. Fresh poultry meat must be refrigerated in the appropriate manner in order to prevent the growth of bacteria and to preserve its microbiological quality. Studies that investigated the presence of microorganisms in the supply chains of poultry meat yielded findings that were comparable to those reported by (30) (32). Although the results revealed some shortcomings in the application of hygiene and handling practices, the microbial counts remained within the limits of Iraqi standards IQS No. 2270/2006 (APC<6.0, Coliforms/*E. coli* <3.0 log10 CFU/g). This confirms current safety but highlights the urgent need for stricter good manufacturing practices to protect consumers. Also, these findings, taken as a whole, provide further evidence that improved hygienic measures, such as the appropriate cleanliness of cutting instruments, the utilization of hygienic surface materials, efficient waste management, and stringent temperature control, are necessary for lowering the instances of

bacterial contamination in retail locations that deal with poultry meat.

Table (4): Comparative Analysis of Bacterial Contamination Levels Based on Cutting Tools (Mean ± SD).

microorganisms (log10 CFU/g)	Cutting Tools		P. Value
	Sterilized	Washed & cleaned	
Aerobic Plate Count	1.40a ± 0.24	2.45b ± 0.21	<0.001
Coliforms	1.10a ± 0.29	2.15b ± 0.22	<0.001
Escherichia coli	1.02a ± 0.31	1.67b ± 0.37	<0.001

Means with different superscripts within the same row are significantly different (P < 0.05).

Table (5): Comparative Analysis of Bacterial Contamination Levels Based on Surface Composition (Mean ± SD).

microorganisms (log10 CFU/g)	Surfaces			P. Value
	Stainless Steel	Plastic	Wood	
Aerobic Plate Count	2.16^{a} ± 0.43	2.47^{b} ± 0.51	2.51^{b} ± 0.48	0.001
Coliforms	1.86^{a} ± 0.32	2.16^{b} ± 0.30	2.21^{b} ± 0.22	0.001
Escherichia coli	1.47^{a} ± 0.26	1.69^{b} ± 0.22	1.73^{b} ± 0.35	<0.001

Means with different superscripts within the same row are significantly different (P < 0.05).

Table (6): Comparative Analysis of Bacterial Contamination Levels Based on Waste management (Mean ± SD).

Microorganisms (log10 CFU/g)	Waste management		P. Value
	Disposed	Accumulated	
Aerobic Plate Count	2.23^{a} ± 0.63	2.49^{b} ± 0.21	0.004
Coliforms	1.93^{a} ± 0.21	2.19^{b} ± 0.35	0.004
Escherichia coli	1.52^{a} ± 0.20	1.71^{b} ± 0.27	<0.001

Means with different superscripts within the same row are significantly different (P < 0.05).

Table (7): Comparative Analysis of Bacterial Contamination Levels Based on Temperature control (Mean ± SD).

Microorganisms (log10 CFU/g)	Temperature control		P. Value
	Below 5°C	Above 5°C	
Aerobic Plate Count	2.13^{a} ± 0.25	2.41^{b} ± 0.31	0.007
Coliforms	1.83^{a} ± 0.22	2.11^{b} ± 0.18	0.006
Escherichia coli	1.45^{a} ± 0.19	1.65^{b} ± 0.31	0.002

Means with different superscripts within the same row are significantly different (P < 0.05).

Table 8 shows the correlation matrix constructed as a result of the Pearson correlation analysis that shows the correlations of the hygienic practices with the presence of the pathogenic bacteria in the sampled poultry meat. The findings indicated that there were some strong relations (P < 0.05). There was a strong positive correlation among the variables of hygienic practice themselves. As an example, surface hygiene was significantly correlational with the display practices (r = 0.74, P < 0.01) and waste management (r = 0.78, P < 0.01). In the same manner, personal hygiene was closely related to cutting tools (r = 0.88, P < 0.01), which suggests that hygienic behaviors at the retail setting will be performing together. Conversely, pathogenic bacteria (*Salmonella and Staphylococcus aureus*) exhibited strong negative relations with the majority of hygienic factors. As an example, the personal hygiene (r = 0.79, P < 0.01) had a strong negative correlation with Salmonella and cutting tools (r = 0.90, P < 0. 01).

Similarly, *Staphylococcus aureus* showed high negative correlations with cutting tools (r = -0.88, P < 0.01), personal hygiene (r = -0.95, p = 0.01). Also, a good positive correlation was noted among *Salmonella*, Staphylococcus contamination (r = 0.79, P < 0.01).

The correlation analysis demonstrated that there were significant correlations between hygienic practices and existence of pathogenic bacteria in retail poultry meat environment. The negative correlations between hygienic factors and bacterial contamination also show that better hygienic practices correlate with lower occurrence of foodborne pathogens.

The correlation between hygiene of cutting tools and Salmonella occurrence was found to be strongly negative, which implies that the use of contaminated equipment could be a critical factor of cross-contamination during poultry meat handling. The equipment and utensils in the meat processing are also often cited as sources of potential microbial contamination in retail meat environments. The same results have been observed in recent studies conducted to examine the pathways of contamination in the poultry meat supply chain (26,27). Personal hygiene also revealed a high negative association with the two pathogens, especially with *Staphylococcus aureus*. Such an outcome is unsurprising, as the given bacteria is often linked to the skin of humans, as well as the cavities of noses and incorrect handling habits. Poor hygiene of the workers may consequently lead to transmission of Staphylococcus from food handlers to meat products. Other studies have pointed out that food handlers are considered one of the most common sources of Staphylococcus contamination of retail meat settings (31). Moreover, the positive relationship found between Salmonella and Staphylococcus contamination indicates that the conditions of the environment and lack of hygiene can enable the existence of various pathogens in the same state. Research on the contamination of poultry meat has also stated that the presence of various foodborne pathogens can occur due to poor sanitation conditions in retail marketplaces (28). Overall, these results demonstrate that hygienic methods such as equipment sanitation, efficient waste disposal, and rigorous body hygiene can play a crucial role in mitigating the risk of microbial contamination in retail outlets of poultry meat.

Table (8): Pearson correlation matrix among hygienic factors and pathogenic bacteria.

Variable	1	2	3	4	5	6	7	8
1. Surfaces	1							
2. Cutting tools	0.34*	1						
3. Display	0.74**	0.46**	1					
4. Temperature control	0.58**	0.28*	0.78**	1				
5. Waste management	0.78**	0.29*	0.63**	0.49**	1			
6. Personal hygiene	0.30*	0.88**	0.41**	0.18	0.26	1		
7. *Salmonella*	-0.38**	-0.90**	-0.51**	-0.36**	-0.32*	-0.79**	1	
8. *Staphylococcus*	-0.30*	-0.88**	-0.41**	-0.18	-0.26	-0.95**	0.79**	1

Conclusion

The researchers have revealed that microbial contamination of poultry meat in retail stores in Wasit Governorate is quite high because of poor hygiene habits. *Salmonella and Staphylococcus* aureus have high prevalence rates that may create a risk to the health of the population. The statistical analysis has shown that cutting tools, surfaces, waste management, and temperature control have a significant influence on the contamination level and cutting tools impact it most. Better hygiene measures (stainless steel, sterilized tools, proper waste disposal, and refrigeration at a temperature below 5°C) helped in reducing the number of bacteria. These results indicate that more effort should be made to improve food safety monitoring, educate food handlers, and implement sanitation

and temperature control systems to guard the health of the consumers.

Disclosure Statement

- **Ethics approval and consent to participate:** Not applicable
- **Consent for publication:** Not applicable
- **Availability of data and materials:** The raw data required to reproduce these findings are available in the body and illustrations of this manuscript, and the research is not derived from a master's thesis or doctoral dissertation.
- **Author's contribution:** The authors confirm contribution to the paper as follows: study conception and design: Ali Ahmed Khalaf , theoretical calculations and modeling: Mustafa Adnan Idan ; data analysis and validation, Ali Ahmed Khalaf , draft manuscript preparation: , Zina Rashid Khirija Al-Badri . All authors reviewed the results and approved the final version of the manuscript.
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