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MICROBIOLOGICAL INTEGRITY OF CHICKEN MEAT PRODUCTS AND TRADITIONAL MARKETPLACE ENVIRONMENTS, EMPHASIZING FUNGAL INFECTION AND POSSIBLE MITIGATION STRATEGIES.

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ABSTRACT

This study determined the microbiological quality of chicken meat and contact surface swabs from two poultry marketplaces in the El-Menoufia governorate. A total of 190 samples were collected, including 50 minced chicken meat, 50 Panies, 50 Kofta, and 40 environmental swabs collected from workers' hands, knives, cutting tables, walls, machines, and refrigerators. Microbiological analysis was conducted to assess the total bacterial count (TBC), total coliform count (TCC), Enterobacteriaceae count (EBC), Staphylococcus count (TSC), and yeast and mould count (YMC). For minced chicken meat samples from stores A and B, the highest mean TBC values were 7.10±0.06 and 6.77±0.11, respectively. Minced meat from shop A had higher TCC levels; it was 3.69±0.15. Panie at shop A had the greatest EBC isolation rates (4.72±0.1), followed by kofta (4.69±0.0) and minced meat (4.12±0.25). Mold and yeast levels ranged from 4.02±0.05 to 4.92±0.03 log10 CFU/g, with shop A (The Panie having the highest count. Shop A samples had the greatest TCC (4.93±0.23) for cutting boards. There was a significant difference in the EBC for knives, cutting boards, and ground machine swabs in shop A (4.4±0.17, 4.28±0.19, and 4.16±0.17) compared to shop B ($P<0.05$). There is a statistically significant correlation between microbial counts in chicken products and environmental samples from two shops ($r = 0.558$, $p = 0.002$). *Aspergillus niger*, *flavus,* and *fumigatus; Fusarium; Penicillium; Mucor;* and *Dematiaceous* spp. were found. On the twelfth day, in vitro treatment with 2% anise and 2% cumin reduced mold counts by 50.55% and 34.41%, respectively. In conclusion, initial tests revealed high levels of contamination on workers' hands, clothing, and surfaces, necessitating rigorous cleaning and disinfection.

Keywords: Minced Chicken Meat, Panie, Walls, TBC, Anise, Cumin

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INTRODUCTION

Most poultry meat contains high-quality and easily digestible proteins. Broiler meat's biological value is exceedingly high because the ratio of essential amino acids in its white and red meat approaches the ideal formula recommended by the FAO/WHO for feeding people of varying ages (Saleeva *et al.,* 2018). There is a high level of hygiene and safety consideration when cutting, packaging, and distributing poultry meat, since it involves considerable manipulation of uncooked food. Micro-organisms are the primary cause of fresh meat spoilage, while physical and chemical factors are rare. The viability of chicken meat is strongly influenced by the initial microflora, which emphasizes the importance of the production process, manipulation, and storage (Enver *et al.,* 2021). In recent years, foodborne microbial contamination of meat has become a more serious public health threat (Badr *et al.,* 2016; Laban, & Khalefa, 2023; Khalefa *et al.,* 2025). The source of microbiological contamination may be the carcass itself, butcher utensils, cutting boards, walls, floors, air, and water that encounter the corpse (Darwish *et al.,* 2022; Darwish *et al.,* 2023).

In chicken meat, total coliform and fecal coliform counts may be used to differentiate between environmental and fecal contamination (Althaus *et al.,* 2017). According to Maharjan *et al.* (2019), the total aerobic plate count can be used to assess meat's sanitary status. The average *Staphylococcus* count indicates an insufficient level of temperature control, handling, and hygiene conditions. Globally, millions of people suffer from food contamination every year because of contaminated foods. There are various microorganisms in the food supply, including fungi (yeasts and molds), gram-negative bacteria, and gram-positive bacteria (Rawat, 2015). The most significant contributors to food degradation and corruption are fungi. These microorganisms produce various toxins that damage food texture and appearance through growth and mycelium formation (Asefa & Skaar 2013).

Filamentous fungi produce spores in an unfavourable environment to survive cold and dehydration. The main source of food storage space is refrigerators, where these spores can be dispersed. In the presence of favourable conditions (temperature and humidity), they rapidly transform from the spore state to the active form (Ibrahim *et al.,* 2021). Some yeasts can degrade and alter food, reducing their quality (Barth *et al.,* 2009; Dagno *et al.,* 2011).

Candida albicans and *C. parapsilosis* can cause invasive candidiasis in humans, and certain strains of these organisms can be transmitted through contaminated food. Food processing facilities may repeatedly contaminate meat products due to the formation of biofilms. The presence of biofilms enhances yeast's ability to survive antimicrobial agents, facilitates genetic exchange, and enhances the production of secondary metabolites (Pappas *et al.,* 2018).

In this study, the principal objectives were 1) to assess the hygienic-sanitary and microbiological characteristics of samples taken from chicken meat items and swabs taken from workers' hands, equipment, and work surfaces from two markets within the Menoufia government, in addition to detecting yeast and mold. 2) An in vitro experiment to assess the impact of 2% anise and 2% cumin on the total mold count.

MATERIALS AND METHODS

1. Sample Collection:

The microbial risk associated with processed chicken meat was assessed by collecting 190 samples from two poultry markets in the El-Menoufia governorate. 150 samples of minced chicken meat, panie, and kofta (100 grams each) and 40 swab samples were obtained. The samples collected included ten

from workers' hands, six from knives, six from cutting tables, six from walls, six from mince machines, and six from refrigerator interior surfaces. A sterile swab was used to obtain environmental samples from a 1 cm^2 area. It had been soaked for one minute in 0.1% saline solution. The samples were obtained under aseptic conditions and represented the total quantity of poultry meat.

2. Sample Preparation.

Under aseptic conditions, 25 g of meat samples were transferred to a stomacher bag. The samples were then homogenized for two minutes using a Stomacher and diluted to 10^{-1} with 225 mL of peptone water. A series of dilutions were also performed after homogenization using sterile peptone water. To ensure swab samples were distributed evenly, each tube containing swab samples (10 mL of 0.1% saline water) was vortexed. One mL of the homogenized sample (both flesh and swab) was added to nine mL of diluent to produce a tenfold serial dilution. A 0.1 mL aliquot of bacteria was plated on various media at appropriate serial dilutions to determine the number of bacteria (Balcha & Gebretinsae, 2013; Basak *et al.,* 2021).

3. Microbiological examinations:

The microbiological investigation focused on the estimation of total bacterial count (TBC), total coliform count (TCC), Enterobacteriaceae count (EBC), *Staphylococcus c*ount (TSC), and yeast and mold count (YMC).

Total Bacterial Counts (TBC): Estimation the total number of microorganisms (ISO/TS, 2009). An aliquot of 0.1 mL was pipetted from the appropriate dilution and applied to standard plate count agar media (Difco Laboratories, USA). After inoculating the dishes, they were incubated at 35°C for 48–72 hours. An enumerator was used to count colonies between 30 and 300 on the plates following incubation. Results were expressed as CFU/g for meat products and CFU/cm^2 for environmental samples.

Total Coliform Count: A 0.1 mL aliquot from the appropriate dilution was pipetted and applied to violet-red bile agar. The total coliforms were determined by incubating the inoculated dishes at 32°C for 18–24 hours (APHA, 2012).

***Enterobacteriaceae Count*:** To enumerate the Enterobacteriaceae family members, 0.1 mL of the aliquot from the appropriate dilution was plated on MacConkey agar (Hi-Media, USA) supplemented with glucose and incubated at 35°C for 24 hours. The Enterobacteriaceae consisted of reddish purple/pink colonies (APHA, 2012).

Total Staphylococcus aureus count (TSC): A microbiologic procedure was used to isolate Staphylococcus using Baird Parker agar (Difco Laboratories, USA) incubated at 37°C for 24 hours. Identified Staphylococcus colonies are black, lustrous, and convex and surrounded by a clear halo zone, with a diameter of 1-1.5 mm. For the evaluation of suspected colonies, Gram stain, biochemical assays (e.g. catalase, mannitol fermentation, coagulase, DNase, and Voges-Proskauer (VP)), and serological testing were used (Quinn *et al.,* 2002).

Total Fungal Counts (yeast and mold): According to ISO 4833-1 (2013), duplicate plates of Sabouraud's dextrose agar media (Oxoid, UK) supplemented with chloramphenicol 100 mg/L were incubated in the dark at 25°C for 5-7 days to determine the total number of molds and yeast. The various fungal isolates that contaminated the chicken meat were identified using macro- and microscopic morphological features (Pitt and Hocking, 2009).

4. In vitro Experimental:

Products used: Anise 2% and Cucium 2% were bought from the National Research Centre's Botany Department in Giza, Egypt.

Experimental Procedure: There were three equal portions of minced chicken meat, each weighing 300 grams. As a control group, Group 1 was not treated. Group 2 received 2% anise, and Group 3 received 2% cumin. Each sample was then transferred to a new

polyethylene container and stored at 4°C for up to 12 days. During storage, meat samples were collected every three days to evaluate sensory and microbiological characteristics. We repeated the experiment three times.

Examination of the senses: Each sample was evaluated based on its overall acceptability, colour, and odour according to Pearson and Tauber (1984). At point (9), "excellent" is defined as a firm, tender consistency, a fleshy odour, and a brilliant red colour. A very good score at point (8), a good score at point (7), an acceptable score at point (6), an unacceptable score at point (5), and a decayed score at point (4) are characterized by a gray to greenish colour, a rancid odour, and a soft and slimy consistency.

Reduction percentage:

$$\text{Reduction \%} = \frac{\text{Initial load} - \text{New count}}{\text{Initial load}} \times 100$$

2.5. Statistical analysis

The SPSS program for Windows (Version 16) (SPSS Inc., Chicago, IL, USA) was employed to conduct the statistical analysis, which involved a one-way ANOVA with a Tukey post-hoc test. A significance level of $P<0.05$ was employed. The conversion of microbiological data to logarithmic form for the number of colony-forming units (CFU/g) was followed by the analysis of variance (ANOVA). Both the mean and the standard error were calculated.

RESULTS

Table (1) shows the microbial count in chicken meat products (log10 CFU/g). The highest mean TBC values were obtained from minced chicken meat samples from shops A and B, which were 7.10±0.06 and 6.77±0.11, respectively. Because of the different counts observed in the kofta samples from shops A and B, P=0.006 indicates a significant difference between the counts in the two samples. There was a higher level of TCC isolation from minced meat from shop A (3.69±0.15). Panie was the most frequently isolated source of EBC in shop A (4.72±0.1), followed by kofta (4.69±0.0) and minced meat (4.12±0.25). The *Staphylococcus* counts were 4.50±0.14 log10 CFU/g in the Panie at shop A and 3.75±0.23 log10 CFU/g at shop B, representing a significant difference ($P<0.05$), followed by Kofta from shop A at 4.69±0.0 and 3.95±0.17 from shop B ($P<0.05$). Mold and yeast counts varied between 4.02±0.05 and 4.92±0.03 log10 CFU/g, with the greatest count of 4.92±0.03 log10 CFU/g occurring in the Panie at shop A.

A microbial count of the environmental samples (walls, knives, cutting boards, mince machines, refrigerators) from the two shops was assessed (Table 2). Wall swaps gave the highest mean values of TBC (5.53±0.23) in shop A and (4.05±0.29) in shop B, with significant differences (P= 0.018). The next highest values were found in cutting boards (5.25±0.19 and 4.81±0.11) Log10 CFU/cm² from both shops A and B. In both the cutting board and the minced machine samples, shop A had the greatest TCC, (4.93±0.23) for the cutting boards and (3.99±0.12) for the minced machine. The results indicate that EBC was significantly higher in the knives, cutting boards, and minced machine samples from shop A (4.44±0.17, 4.28±0.19, and 4.16±0.17) than in those from shop B ($P<0.05$). According to the results, shops A and B contained the highest levels of TSC (5.54±0.12 and 4.49±0.16) log10 CFU/cm², respectively (P=0.008). Further, YMC levels of 6.06±0.23 and 4.6±0.32 (P=0.021) were the highest. Possibly, this is due to the unsanitary practices used in shop A's carcass handling.

Table 1: Microbial count in chicken meat products from the examined two shops, expressed in log 10 CFU/g mean ± standard error

	Shop	TBC	TCC	EBC	TSC	YMC
Minced chicken meat	A	7.10±0.06	3.69±0.15 [a]	4.12±0.25	4.07±0.20	4.52±0.23
	B	6.77±0.11	2.62±0.33b	3.76±0.13	3.95±0.10	4.23±0.18
	P-Value	0.058	0.041*	0.45	0.618	0.395
Panie	A	7.08±0.07[a]	3.44±0.12 [a]	4.72±0.1 [a]	4.50±0.14 [a]	4.92±0.03 [a]
	B	6.24±0.12[b]	2.53±0.26 [b]	3.2±0.25 [b]	3.75±0.23 [b]	4.16±0.03 [b]
	P-Value	0.003*	0.033*	0.034*	0.05*	000*
Kofta	A	6.86±0.07 [a]	3.55±0.23	4.69±0.0 [a]	4.43±0.13 [a]	4.34±0.06 [a]
	B	6.09±0.12 [b]	2.90±0.32	3.95±0.17 [b]	3.35±0.30 [b]	4.02±0.05 [b]
	P-Value	0.006*	0.172	0.042*	0.03*	0.015*

CFU/g: colony-forming unit per gram of product SE: standard error
TBC: Total bacteria count/ TCC: Total coliform count/ EBC: *Enterobacteriaceae* count/ TSC: Total Staphylococci count/ YMC: Yeasts and molds
Columns with different letters, a and b, are significantly different at **P*<0.05.

Table 2: Microbial count of the environmental samples (walls, knives, cutting boards, mincing machines, refrigerators) from the two shops examined. Values are ± standard error (Log10 CFU/cm²).

Environmental samples	Shop	TBC	TCC	EBC	TSC	YMC
Walls	A	5.53±0.23[a]	3.4±0.19 [a]	2.72±0.20 [a]	5.54±0.12 [a]	6.06±0.23 [a]
	B	4.05±0.29[b]	1.38±0.09 [b]	1.47±0.21 [b]	4.49±0.16 [b]	4.6±0.32 [b]
	P-Value	0.018*	0.001*	0.013*	0.008*	0.021*
Knives	A	4.26±0.27	2.34±0.12 [a]	4.44±0.17	4.22±0.32	4.28±0.16 [a]
	B	3.64±0.12	1.67±0.11 [b]	3.81±0.18	3.53±0.07	3.27±0.17 [b]
	P-Value	0.108	0.018*	0.066	0.105	0.014*
Cutting Boards	A	5.25±0.19	4.93±0.23	4.28±0.19 [a]	4.22±0.06 [a]	3.36±0.31
	B	4.81±0.11	4.32±0.18	3.52±0.06 [b]	3.91±0.07 [b]	3.00±0.33
	P-Value	0.128	0.111	0.02*	0.035*	0.484
Minced Machine	A	4.46±0.21 [a]	3.99±0.12 [a]	4.16±0.17 [a]	3.71±0.14	3.81±0.13
	B	3.59±0.19 [b]	3.59±0.047	3.36±0.19 [b]	3.25±0.15	3.30±0.19
	P-Value	0.041*	0.038*	0.038*	0.095	0.097
Refrigerators	A	2.36±0.12 [a]	1.86±0.14	2.36±0.18 [a]	2.33±0.16 [a]	3.66±0.19 [a]
	B	1.49±0.23 [b]	1.25±0.20	1.42±0.16 [b]	1.54±0.06 [b]	2.22±0.17 [b]
	P-Value	0.029*	0.074	0.02*	0.012*	0.005*

CFU/cm²: colony-forming unit per cm² of contact surface SE: standard error
TBC: Total bacteria count/ TCC: Total coliform count/ EBC: *Enterobacteriaceae* count/ TSC: Total Staphylococci count/ YMC: Yeasts and molds

Columns with different letters, a and b, are significantly different at **P*<0.05.
The microbial count of chicken meat items and environmental samples from the two shops have a significant Pearson correlation *(r)* (Table 3). The TBC of environmental samples and TCC of meat products (r=0.558, P=0.002), EBC (r=0.581, P=0.001), and YMC from processed meat (r=0.524, P=0.004) display a high correlation.

Table 3: Pearson bivariate correlation coefficient (*r*) of Microbial count of the chicken meat products and Environmental samples from the examined two shops

			Microbial count in chicken meat products from the examined two shops				
			TBC	**TCC**	**EBC**	**TSC**	**YMC**
Microbial count in Environmental samples from the	TBC	*r*	1	.558**	.581**	0.128	.524**
		P-value		0.002	0.001	0.275	0.004
	TCC	*r*		1	.471*	.395*	-.010-
		P-value			0.01	0.028	0.481
	EBC	*r*			1	0.094	0.074
		P-value				0.331	0.366
	TSC	*r*				1	.462*
		P-value					0.011
	YMC	*r*					1

r: Pearson Correlation

**. Correlation is significant at the 0.01 level. *. Correlation is significant at the 0.05 level.

Figure (1) illustrates the microbiological counts of hand samples taken from examined workers. It indicated the mean bacterial count for workers in shop A was 3.75±0.21, which was higher than that of shop B at 3.11±0.09. TCC was 2.89±0.06 for hand swabs from shop A, and the count of Enterobacteriaceae was 4.23±0.12 for hand swabs from shop A. TSC was 6.22±0.09 at shop A and 5.11±0.06 at shop B. Hand swabs from shop A exhibited the greatest total mold and yeast count, which was 4.19±0.10. The total mold and yeast count was the highest at shop A (4.19±0.10 log CFU/ml).

Various fungal isolates were identified from various sources, including *Aspergillus niger, Aspergillus flavus, Aspergillus fumigatus, Fusarium* spp., *Penicillium* spp., Mucor, and *Dematiaceous* spp. (Fig. 2).

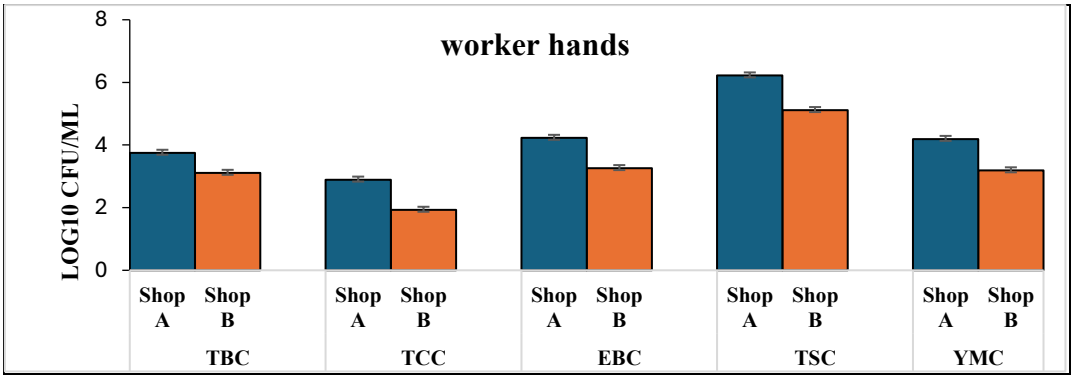

Fig. 1: Microbiological counts of the examined worker hand swabs. Values are the mean ± standard error (log10 cfu/ml).

Fig. 2: Macroscopical colony fungal strains isolated from chicken meat product and different environmental swabs on a Sabouraud's Dextrose Agar (SDA) plate. A) *Aspergillus flavus.* B) *Aspergillus Fumigatus.* C) *Aspergillus Niger*

Figure (3) demonstrates the prevalence of fungal isolates in various environmental swabs from the two shops under examination. The wall contained *Aspergillus fumigatus, Aspergillus flavus, Aspergillus niger, Mucor, Candida* spp., and *Geotrichum*, with an incidence of 30%, 10%, 20%, 10%, 30%, and 10%, respectively. In knives, *Aspergillus fumigatus, Aspergillus flavus, Aspergillus niger, penicillin,* and *Alternaria* spp. were isolated at a rate of 20%, 30%, 10%, 20%, 40%, and 10%, respectively. Cutting board isolates of *Aspergillus fumigatus, Aspergillus flavus, Aspergillus niger, Candida,* and *Penicillin* had respective incidences of 20%, 30%, 10%, and 20%. In refrigerators, 10%, 10%, 30%, and 10% of *Aspergillus fumigatus, Penicillium, Candida,* and *Cladosporium* were isolated, respectively.

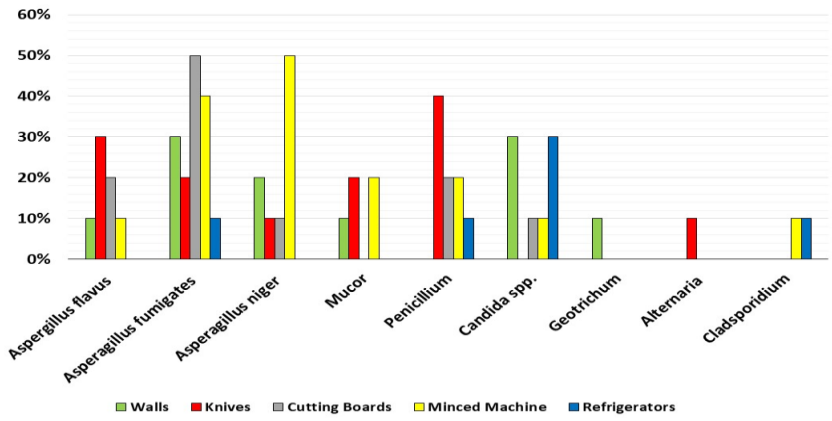

Fig. 3: Prevalence of fungal isolates in different environmental swabs from the two examined shops.

The prevalence of fungal isolates in various categories of chicken meat products from the two shops under investigation is illustrated in Figure (4). In minced chicken meat, *Aspergillus fumigatus, Aspergillus flavus, Aspergillus niger, Mucor, Candida* spp., *Geotrichum,* and *Penicillin* were isolated with rates of 24%, 20%, 12%, 8%, 4%, and 8%, respectively. In chicken Panie, *Aspergillus fumigatus, Aspergillus flavus, Aspergillus niger, Geotricum,* and *Candida* spp. were isolated with an incidence of 16%, 16%, 16%, 4%, and 8%, respectively. In Kofta, isolates of *Aspergillus fumigatus, Aspergillus flavus, Candida*, and *Penicillium* had respective incidences of 4%, 12%, 4%, and 4%. The maximum *aspergillus* isolation percentage was observed in minced meat, followed by Panie and Kofta.

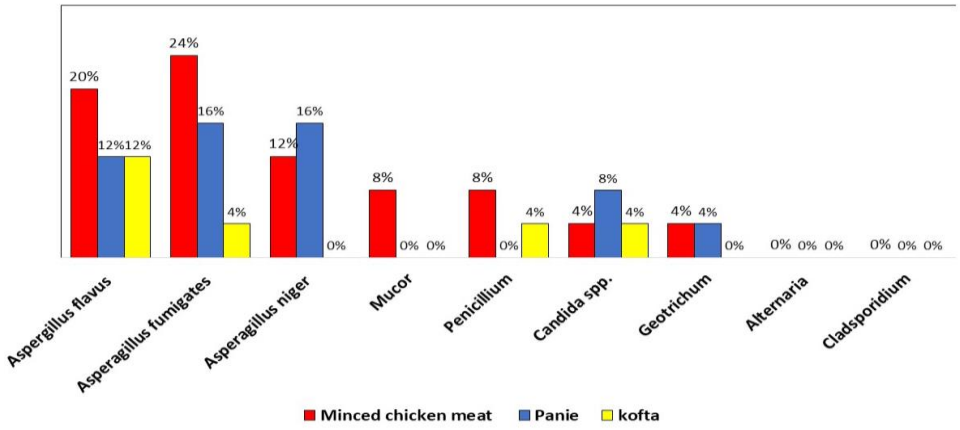

Fig. 4: Prevalence of fungal isolates in different categories of chicken meat products from the two shops examined.

Different procedures (Anise 2% and Cumin 2%) were examined to determine their impact on the total mold count of minced meat samples. Based on Table (4), the results of the control groups were 4.54±0.30, 4.65±0.65, and 5.78±0.26, respectively, with samples spoiling the following. When minced meat was treated with 2% anise, the total mold and yeast were reduced, and the shelf life of the meat was extended for the 1st, 3rd, 6th, 9th, and 12th days, respectively, to 4.47±0.29, 3.32±0.43, 3.11±0.24, 2.65±0.11, and 2.21±0.09. Cumin 2% exhibited 4.59±0.32, 3.78±0.48, 3.54±0.21, and 3.01±0.16, respectively. According to Figure (5), Anise 2% reduction percentages were 25.7%, 30.42%, 40.71%, and 50.55% on the third, sixth, ninth, and twelfth days, respectively. In contrast, Cumin 2% had reduction percentages of 17.64%, 22.87%, and 34.41%. Aside from the treated samples, which maintained stability for 13 days, all sensory attributes decreased during storage. As shown in Table (5), the treated groups found minced chicken meat acceptable for 13 days, while untreated samples were deemed unacceptable beginning on the sixth day.

Table 4: Effect of different treatments (Anise 2% and Cumin 2%) on total mold count of chicken meat product. Values expressed as log 10 (cfu/g) mean ±standard error.

Groups/storage period	Control	Anise 2%	Cumin 2%	*P* value
1st day	4.54±0.30	4.47±0.29	4.59±0.32	0.618
3rd day	4.65±0.65[a]	3.32±0.43[c]	3.78±0.48[b]	0.041*
6th day	5.78±0.26 [a]	3.11±0.24[c]	3.54±0.21 [b]	0.025*
9th day	S	2.65±0.11	3.01±0.16	0.097
12th day	S	2.21±0.09	S	S
13th day	S	S	S	S

[a, b, c] Means in the same row with a different letter indicate a significant difference; **p*-value <0.05 is significant.
S: Spoiled

Table 5: Assessment of different treatments (2% anise and 2% cumin) on samples through sensory evaluation.

Group	Days	Color	Odor	Appearance	Overall acceptability	consistency	Grade
Control	Zero-day	8	8	8	9	8	8
	3rd day	7	7	8	8	7	7
	6th day	5	6	5	6	5	5
	9th day	4	4	4	4	4	4
	12th day	4	4	4	4	4	4
	13th day	4	4	4	4	4	4
Anise 2%	Zero-day	8	9	8	8	9	8
	3rd day	7	8	8	8	7	8
	6th day	7	7	7	7	6	7
	9th day	6	6	7	7	6	6
	12th day	6	6	6	6	6	6
	13th day	4	4	4	5	4	4
Cumin 2%	Zero day	8	9	8	8	9	8
	3rd day	8	7	8	7	8	7
	6th day	7	7	7	8	8	7
	9th day	7	6	6	7	6	6
	12th day	5	6	5	5	5	5
	13th day	4	4	4	4	4	4

Excellent at point (9), very good at point (8), good at point (7), acceptable (6), unacceptable (5), and spoiled (4).

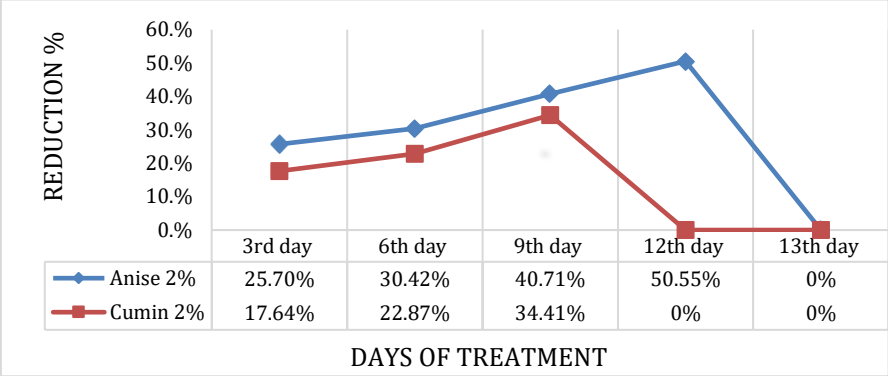

Fig. 5: Reduction % of the two treatments (Anise 2% and Cumin 2%) on total mold count of chicken meat products along the studied days.

DISCUSSION

Poultry meat can be contaminated with variable microorganisms, including those capable of spoiling meat during chilled storage and certain food borne pathogens. Handling raw meat, undercooking, or mishandling cooked products can cause illness in humans (Mead, 2004). During the production of poultry flesh, the raw materials microflora are transformed into the final product, where that microflora plays a crucial role in ensuring sustainability (Marmion *et al.,* 2021). This study analyzed the microbiological quality of chicken meat products. The findings showed elevated TBC levels in minced meat with 7.10±0.06 log10 CFU/g and coliforms at 3.69±0.15 log10 CFU/g. The highest number of *Enterobacteriaceae, Staphylococcus*, mold, and yeasts was detected in Panie at shop A with 4.72±0.11, 4.50±0.14, and 4.92±0.03 log10 CFU/g, respectively. Similar findings were reported by El Matary and Zaki (2016), who found the average yeast count in chicken panie ranged from 1.8 to 8.2, with a maximum yeast count of 10^4. Microbial counts from meat products differ significantly between shops A and B (P<0.05), with shop A having a greater number of microbes. Among the most contaminated items, chicken minced meat ranked first, followed by Panie and then kofta. It is possible that the increased contamination of chicken minced meat is a result of the incorporation of poor-quality raw chicken meat and unsanitary practices during different stages of production and transportation. This finding is consistent with those of Mahmoud and El-Taher (2001) and Kagambega *et al.* (2012). The methods used for processing, distributing, and storing poultry meat, as well as the health of the animals at slaughter, play a significant role in determining the presence of bacteria in the meat (Hardy *et al.,* 2013). According to Gonzalez-Fandos and Herrera (2014), poultry will deteriorate when mesophilic counts reach 8 to 9 log10 CFU/g. Additionally, *Staphylococcus aureus* is ranked third on the list of the most common food borne diseases in the world. Chicken skin often contains Staphylococci bacteria (Laban *et al.,* 2025; Khalefa *et al.,* 2025).

Surfaces that encountered the carcass, such as walls and cutting boards, also demonstrated elevated counts of bacteria, coliforms, and Enterobacteriaceae. These results agreed with Todd's (2023) study, which concluded that over 90% of hygiene issues in the food industry can be attributed to inadequate personal hygiene. Laban & Khalefa (2023) claim that increased contamination in butcher shops may be the result of unclean walls, dirty cutting boards, improper handling, and lack of awareness regarding hygienic practices. Further, Stoica *et al.* (2014) have pointed out that microbial hazards in animal carcasses are inevitable because of microorganisms in the surrounding environment, on animals, and on surfaces in contact with the carcass. The wall swaps in shop A had the highest

average TBC values (5.53±0.23), while shop B had values of 4.05±0.29, with a significant difference (*P*=0.018). The cutting boards had average TBC values of 5.25±0.19 and 4.81±0.11 log10 CFU/cm² from samples from shop A and shop B, respectively. Swabs from knives, cutting boards, and mincing machines from shop A had significantly higher EBC levels than those from shop B (*P*<0.05). The highest TSC came from walls, 5.54±0.12 and 4.49±0.16 log10 CFU/cm² in shops A and B, respectively (*P*=0.008), with YMC being highest on walls in both shops A and B, 6.06±0.23 and 4.6±0.32 (*P*=0.021). It is necessary to evaluate the total number of colonies, Staphylococcus count, mold count, and yeast count throughout the life cycle of the product, including growth, processing, handling, and storage.

There is a statistically significant correlation between the microbial counts in chicken meat products and the environmental samples from the two shops. Observations such as these are consistent with Kozačinski's (2003) recommendation that the product environment and employee handling could potentially cause contamination. Contact between human hands and meat products is associated with decent-quality meat. Ensure that workers who work with food in production and trade practice proper hand hygiene. The contamination of food can be transmitted by pathogenic microorganisms transmitted by workers' hands and surfaces touched by workers' hands and food (Enver *et al.,* 2021). Additionally, Karahmet *et al.* (2017) found that the environment and workers' hands are the primary sources of contamination of fresh chicken meat, since their initial sampling revealed the presence of microorganisms on workers' hands. Daily cleaning and disinfection of food contact surfaces is necessary. The frequency of cleaning other areas depends on the level of contamination. However, to prevent contamination risk, it is recommended to do so regularly.

The levels of mold and yeast ranged from 4.02±0.05 to 4.92±0.03 log10 CFU/g, with the highest count of 4.92±0.03 log10 CFU/g found in Panie at shop A. The highest counts in both shops A and B were 6.06±0.23 and 4.6±0.32 log10 CFU/cm². The presence of fungal isolates such as *Aspergillus fumigatus, Aspergillus flavus, Aspergillus niger, Mucor, Penicillium* sp., *Candida* spp., and *Geotrichum* was detected in various samples. The most common isolates from environmental swabs are *Aspergillus fumigatus* and *Aspergillus niger.* In two examined shops, various types of fungi were found in chicken meat products, including *Aspergillus fumigatus, Aspergillus flavus*, *Aspergillus niger, Mucor, Candida* spp., *Geotrichum,* and *Penicillin*. The prevalence rates were 24%, 20%, 12%, 8%, 4%, 4%, and 8%, respectively, in minced chicken meat. The percentage of aspergillus isolation was highest in minced meat, followed by Panie and then Kofta. Ajiboye *et al.* (2011) also found *Aspergillus niger, Aspergillus flavus, Penicillium* sp., and *Rhizopus* sp. in dried meat samples sold at the Oja-Oba market in Ilorin, Nigeria. Zakki *et al.* (2017) also found *Aspergillus niger, A. fumigatus, A. flavus, Penicillium chrysogenum, Rhizopus stolonifer, Fusarium equiseti,* and *F. avenaceum* in chicken meat sold in Lahore City, Pakistan. The differences in mold and yeast levels may be due to hygiene practices, as well as the type and quantity of additives in the production of chicken products (Ouf *et al.,* 2010; Sharaf & Sabra, 2012). El-Matary and Zaki (2016) also discovered 10^5 mold and yeast isolates from 4 genera in Panie samples.

Based on this study, food spoilage fungi persist in chicken meat products. This can lead to them potentially contaminating other foods, producing toxins, and posing health hazards to consumers. In the food industry, continuous and strict adherence to personal hygiene measures as well as cleanliness of work clothing, is necessary to prevent meat contamination during production and

processing. The industry poses a significant risk of microbiological and physical hazards. Based on the findings, sanitation concerns exist in fresh chicken meat distribution at retail. These dangers can be reduced and hopefully eliminated by establishing a HACCP system, including precondition programs (GHP, GMP), as reported by Raeta *et al.* (2012).

Certain spices, herbs, and plant extracts have also been reported to possess strong antioxidant properties. There are some plant extracts and/or essential oils that possess antimicrobial and antioxidant properties, as they contain bioactive compounds such as phenolic acids, aldehydes, and flavonoids, according to Mendes *et al.* (2024). Adding 2% anise and cumin to minced meat samples resulted in a reduction in the total mold and yeast count compared to the 2% treatment. As a result, anise shortened the meat's shelf life, decreasing molding and yeast growth from 4.47±0.29 on the 1st day to 2.21±0.09 on the 12th day. Meanwhile, cumin at 2% showed a reduction from 4.59±0.32 to 3.01±0.16 from the first day to the end of the experiment. Figure 4 displays the results of the treatment after 12 days. Based on Figure 5, anise 2% decreased the count by 50.55%, while cumin 2% decreased the count by 34.41%. Based on Verma *et al.'s* (2023) findings, cumin showed a lower peroxide value and lower FFA concentrations than control meat samples. A significant difference was found between groups that received treatment and other control groups, with a significance level of $P<0.05$. Similarly, Fathi-Achachlouei *et al.* (2021) noted a decrease in yeast and mold populations beginning on day 6 at an anise concentration of 0.9%. A notable effect was observed in the preservation of chicken fillets after the use of anise essential oil.

CONCLUSION

In the present study, the results showed that the hazards are similar or equivalent, and that the significant aspects are always related to the personnel hygiene and sanitation of buildings and equipment. During repeated testing, it was found that fresh poultry meat samples, hand swabs, and containers used to preserve meat for sale performed better than those used for food preservation in the past. Retailers should continue to perform product controls until microbiological analysis results are credible. As indicated by the swabs obtained during the initial test from workers' hands, clothes, and surfaces, poor hygiene was prevalent. Therefore, it is necessary to perform thorough cleaning, washing, and disinfection, especially on hot days when germs multiply more rapidly.

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السلامة الميكروبيولوجية لمنتجات لحوم الدجاج والبيئة المحيطة في محلات بيع اللحوم، مع التركيز على العدوى الفطرية والاستراتيجيات المحتملة للتخلص منها

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هدفت هذه الدراسة إلى تحديد الجودة الميكروبيولوجية للحوم الدجاج ومسحات الأسطح الملامسة لها في سوقين للدواجن بمحافظة المنوفية. تم جمع اجمالي ١٩٠ عينة، شملت ٥٠ عينة من لحم الدجاج المفروم، و٥٠ عينة من البانيه، و٥٠ عينة من الكفتة، بالإضافة إلى ٤٠ مسحة بيئية تم جمعها من أيدي العاملين، والسكاكين، وطاولات التقطيع، والجدران، والآلات، والثلاجات. تم إجراء التحليل الميكروبيولوجي لتقييم العدد الكلي للبكتيريا، العدد الكلي للقولونيات ،عدد بكتيريا المعوية، عدد المكورات العنقودية، عدد الخمائر والعفن . بالنسبة لعينات لحم الدجاج المفروم من المتجرين (أ) و (ب)، كانت أعلى القيم المتوسطة للعدد الكلي للبكتيريا هي ٧,١٠±٠,٠٦ و٦,٧٧±٠,١١ على التوالي. سجل لحم الدجاج المفروم من المتجر (أ) مستويات أعلى من القولونيات حيث بلغت ٣,٦٩±٠,١٥. سجل البانيه في المتجر (أ) أعلى معدلات عزل لبكتيريا الإنتيروباكتر ٤,٧٢±٠,١، تلاه الكفتة ٤,٦٩±٠,٠ ثم اللحم المفروم ٤,١٢±٠,٢٥. تراوحت مستويات العفن والخمائر بين ٤,٠٢±٠,٠٥ إلى ٤,٩٢±٠,٠٣ ، وكان البانيه في المتجر (أ) الأعلى من حيث العدد.سجلت عينات المتجر(أ) أعلى عدد للقولونيات على ألواح التقطيع ٤,٩٣±٠,٢٣ .كما وُجد فرق معنوي في عدد بكتيريا الإنتيروباكتر في مسحات السكاكين، وألواح التقطيع، وآلات الفرم في المتجر (أ) ٤,٤±٠,١٧، ٤,٢٨±٠,١٩ و٤,١٦±٠,١٧ على التوالي مقارنة بالمتجر(ب) ($p<0.05$.وُجد ارتباط معنوي إحصائي بين أعداد الميكروبات في منتجات الدجاج والعينات البيئية من المتجرين ($r = 0.558$، ($p = 0.002$). تم عزل الفطريات التالية: اسبرجلس فيوميجاتس, اسبرجلس فلافس, اسبرجلس نيجر, فيوزيريم, بنسيليم, ميوكر, وأنواع Dematiaceous. في اليوم الثاني عشر، أدى العلاج المختبري باستخدام ٢٪ من اليانسون و٢٪ من الكمون إلى تقليل أعداد العفن بنسبة ٥٠,٥٥٪ و٣٤,٤١٪ على التوالي. تُبرز هذه الدراسة مخاوف كبيرة تتعلق بمستويات عالية من التلوث على أيدي العاملين صناعة لحوم الدواجن، وتؤكد أن ضعف مستوى النظافة بين العاملين والمعدات يؤدي إلى تلوث ميكروبيولوجي، مما يستدعي تطبيق إجراءات صارمة للتنظيف والتطهير.