Journal of Current Veterinary Research

ISSN: 2636-4026

Journal home page: http://www.jcvr.journals.ekb.eg

Animal health & Zoonotic disease

Assessment of Zoonotic Pathogenic Bacteria in the Cattle Slaughterhouses and the Efficacy of Some Disinfectants: A Public Health Perspective from Menoufia Governorate, Egypt.

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ABSTRACT

The process of cleaning and disinfecting the slaughterhouse, the animals, the surroundings, and the hands of the employees is an critical control point for excellent hygiene and biosecurity procedure. The aerobic bacteria: *Staphylococcus aureus*, *Escherichia coli*, and *Salmonella* sp. were counted in the current investigation to evaluate the contamination of the abattoir and its consequences. 600 samples were gathered in all, including 150 samples per knife, 150 samples per floor, 150 samples per workers' hands, and 150 samples per wall. All the swabs were obtained from three abattoirs in the Menoufia governorate (Menouf, Tala, and El-Shohadaa). Aerobic bacteria results showed that the walls of the abattoirs had the greatest values, followed by the floors, knives, and hands of the workers. A total occurrence rate of 73.5% (441/600) of *S. aureus* was obtained from all the samples collected from all the slaughterhouses, whereas a total occurrence rate of 52.33% (314/600) of *E. coli* was recorded from all the samples from all the slaughterhouses. Additionally, the overall value of *Salmonella* sp. in all slaughterhouses was 23% (138/600). No discernible difference between the occurrence rates of the pathogenic bacteria and the climatic conditions at the time of sampling was found. Furthermore, Hydrogen peroxide was the most efficient disinfectant after using disinfectants on all the evaluated samples. The real state of contamination in the slaughterhouses' environment and the impact of disinfectants were shown

by the microbiological analysis of the samples that were collected in the current investigation.

Keywords: Zoonoses, Slaughterhouses, Disinfectants, Menoufia governorate, Pathogenic bacteria.

INTRODUCTION

Worldwide, foodborne zoonotic illnesses are a major and pervasive public health issue that lead to human illness (Aimon et al., 2021; Eissa, 2024a, b, c; Salman et al., 2024b; Eissa et al., 2025; Elrefaey and Eissa, 2025; Ramzy et al., 2025). Since meat has been a major source of protein in the average person's diet for around 2.6 million years, humans are regarded as omnivores. By 2050, it is predicted that meat consumption would have increased by 460–570 million metric tons (Birgani et al., 2022). According to the annual European Union (EU) One Health Zoonoses report, the consumption of livestock products tainted with bacterial pathogens that are naturally found in the gut of food-producing animals caused a 44% increase in foodborne outbreaks in the EU in 2022 compared to 2021 (EFSA and ECDC, 2023). It is believed that these illnesses are mostly prevalent in animals and slaughterhouses, where they might spread from animals to humans and jeopardize the safety of food (Ali and Alsayeqh, 2022). Food security, quality, and safety are therefore worldwide issues (Birgani et al., 2022; Zain Eldeen et al., 2024).

The main goal of slaughterhouses is to produce meat fit for human consumption, where the official veterinary inspector (OVI) makes sure that all of the slaughter procedures are conducted in a sanitary manner in compliance with good manufacturing practices (Mrdovic et al., 2017; Nasr and Eissa, 2025a, b). Also, a post-mortem inspection is performed to evaluate the carcass and viscera, as this prevents the spread of diseases and breaks the cycles of transmission (Berardinelli et al., 2014). In spite of foodborne illnesses can spread from the abattoir through the processing and distribution network, including retail locations, and eventually impact the final consumer, it is considered a crucial link in the supply chain (Mrdovic et al., 2017). Therefore, strict hygienic measures at slaughterhouses, during distribution and storage at retail locations, and during sales are necessary to ensure the quality and safety of meat to protect public health (Salman et al., 2024b; Eissa and Nasr, 2025).

Total Aerobic Plate Count (TAPC), which shows the overall bacterial burden in meat, is a useful method for food safety monitoring (Bersisa et al., 2019). Critical pathogenic bacteria like *Staphylococcus aureus* (*S. aureus*), *Escherichia coli* (*E. coli*), and *Salmonella* sp. are primarily found in foodstuffs of animal origin, where the processing environment's poor hygiene and disinfection practices are the primary cause of the elevated risk of infection (Chinemerem Nwobodo et al., 2022; Salman et al., 2024a, b; Eldin et al., 2025). These

pathogens are among the bacteria that can cause local and even systemic human illnesses and are the main foodborne risks linked to fresh meat (Bersisa et al., 2019; Eissa and Harb, 2023). When infected meat is consumed by people, *S. aureus*, because of its enterotoxins, are the main cause of food poisoning (Das et al., 2019; Salman et al., 2024a). Moreover, when *E. coli* and/or *Salmonella* sp. are found in the food intended for human consumption, it indicates fecal contamination and inadequate processing cleanliness (Atnafie et al., 2017; Takele et al., 2018; Eldin et al., 2025).

Slaughterhouse hygiene practices are affecting the quality of meat as well as the level of contamination caused by a variety of sources, including contaminated water, surfaces, equipment, working environments, and aerosols (Laban et al., 2021; El-Khadry et al., 2025). Building on this efficacy, the current study's goal was to demonstrate the certain level of contamination followed by verifying and confirming the efficiency of different disinfectants used for disinfection in the slaughterhouses in Menoufia governorate, Egypt.

MATERIAL AND METHODS

1. Study cites and sample collection:

Three large-capacity cattle slaughterhouses in Menoufia governorate of Egypt were the sites of the current study. Menouf was home to slaughterhouse A, Tala to slaughterhouse B, and El-Shohadaa to slaughterhouse C. Between August 2024 and September 2025, a total of 600 swab samples (200 per slaughterhouse) of sterile cotton-tipped swabs moistened with peptone water broth (Microxpress Pvt. Ltd., India) were collected from these three slaughterhouses, totaling 150 sets of swabs from slaughtering and skinning knives, 150 hand swabs from butchers and other abattoir employees, 150 wall swabs, and 150 floor swabs (50 from each slaughterhouse) were gathered. According to Awaad et al. (2024), all swabs were collected and transported in an ice box (2–5°C) to the Zoonoses laboratory at the Faculty of Veterinary Medicine, University of Sadat City, Egypt, for examination. Immediately after collection, the swabs were placed in sterile tubes with 5 ml of buffered peptone water (Microxpress Pvt. Ltd., India). An Ethical Approval Number was issued for the obtained samples (VUSC-009-1-25).

2. Isolation of particular hygiene indicator microorganisms and their biochemical identification.

2.1. Staphylococcus aureus isolation and biochemical identification:

In order to isolate *S. aureus*, in accordance with Salman et al. (2024a), Baird Parker agar (BPA) supplemented with egg yolk telluride emulsion (Difco Laboratories, Detroit, Michigan, USA) was used and incubated for 48 hours at 37 ˚C. In addition, the coagulase test (negative except for *S. aureus*) and the catalase test (positive) were used for the biochemical identification of *Staphylococcus* sp. (Salman et al., 2024a, b).

2.2.E. coli isolation and biochemical identification:

According to Salman et al. (2024b), *E. coli* sp. were isolated on Eosin Methylene Blue (EMB) agar (Oxoid, Basingstoke, UK) and cultured for 24 hours at 37 °C. According to Salman et al. (2024b), the TSI (Triple Sugar Iron) test (Acid/Acid, Gas), the Simmon Citrate test (negative), the Urease test (negative), and the Indole test (positive) were used for the biochemical identification of *E. coli*.

2.3. Salmonella sp. isolation and biochemical identification:

Samples were cultured aerobically for 24 hours at 37 °C in buffered peptone water (BPW) (Microxpress Pvt. Ltd., India). 9 ml of Rappaport Vassiliadis (RV) broth (Oxoid, Basingstoke, UK) was inoculated with 1 ml from the pre-enrichment tubes, and the mixture was incubated aerobically for 24 hours at 42 °C. According to Eldin et al. (2025), a loop full of selectively enriched broth was streaked separately over *Salmonella-Shigella* (SSA) agar (Oxoid, Basingstoke, UK) and incubated for 24 hours at 37 ºC. According to Eldin et al. (2025), the TSI test (alkaline/acid, positive H2S, and positive gas generation), the urine test (negative), and the Indole test (negative) were used for the biochemical identification of *Salmonella* sp.

3. Assessment of disinfectants activity on walls and floors of the slaughterhouses under examination (disinfectant resistance testing):

In addition to collecting the study samples, the current analysis evaluated the disinfecting efficacy of three widely used, reasonably priced, widely accessible, and broad spectrum disinfectants: 1% hydrogen peroxide (H2O2), 1% hypochlorus acid (HoCl), and 1% quaternary ammonium compounds (QACs) (6th October 3rd Industrial Area, Egypt), as reported by Walia et al. (2017) and Salama et al. (2024). Walls were categorized into 4 groups (each group measured 20 cm), group 1 (G1) was left as a control group (no disinfection added, to estimate the total bacterial count before disinfection), group 2 (G2) was used for measuring hypochlorous acid 1% activity, group 3 (G3) was for quaternary ammonium compounds 1%, and group 4 (G4) was for hydrogen peroxide 1%. For the purpose of measuring the total bacterial count (TBC) on nutrient agar (Microxpress Pvt. Ltd., India) for 24 hours at 37 °C, careful observation was conducted by taking swabs from each group alone. The swabs were taken after contact time with the examined disinfectants (0, 5, 10, and 20 minutes) where compared with the control group (Walia et al., 2017; Salama et al., 2024).

4. Statistical analysis:

Using SPSS, version 27 (IBM Corp., 2013), a two-way ANOVA was used for statistical analysis. The significance level was set at $P<0.05$, and the Duncun test was used for multiple comparisons. The logarithm of colony forming units per square centimeter (log10 CFU/cm2) was used to express

the results in accordance with Morshdy et al. (2022). Furthermore, percentages were computed to describe the infection frequency in accordance with Eissa et al. (2025) and Zain Eldeen et al. (2024).

RESULTS

1. The outcomes of specific hygienic indicator bacteria's isolation and biochemical identification.

1.1.According to location:

Table (1): Occurrence of *S. aureus* by isolation and biochemical identification in slaughterhouse A (in Menouf), slaughterhouse B (in Tala), and slaughterhouse C (in El-Shohadaa):

Samples	**Slaughterhouse A**		**Slaughterhouse B**		**Slaughterhouse C**		**Total (No.= 150 per sample type)**	
	No.	**%**	No.	**%**	No.	**%**	No.	**%**
Hand swabs (No.= 50 per slaughterhouse)	17	**34**	16	**32**	36	**72**	69	**46**
Floor swabs (No.= 50 per slaughterhouse)	38	**76**	35	**70**	42	**84**	115	**76.67**
Wall swabs (No.= 50 per slaughterhouse)	48	**96**	36	**72**	49	**98**	133	**88.67**
Knife swabs (No.= 50 per slaughterhouse)	43	**86**	35	**70**	46	**92**	124	**82.67**
Total of all slaughterhouses (No.= 600)	146/200	**73**	122/200	**61**	173/200	**86.5**	441/600	**73.5**

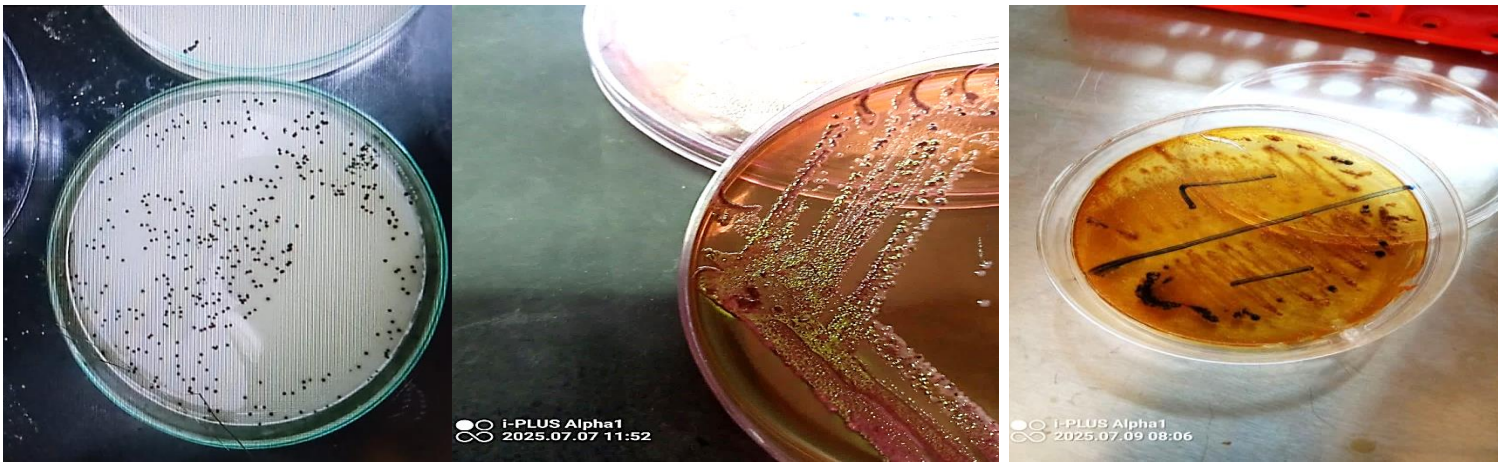
Table (2): Occurrence of *E. coli* by isolation and biochemical identification in slaughterhouse A (in Menouf), slaughterhouse B (in Tala), and slaughterhouse C (in El-Shohadaa):

Samples	**Slaughterhouse A**		**Slaughterhouse B**		**Slaughterhouse C**		**Total (No.= 150 per sample type)**	
	No.	**%**	No.	**%**	No.	**%**	No.	**%**
Hand swabs (No.= 50 per slaughterhouse)	13	**26**	8	**16**	14	**28**	35	**23.33**
Floor swabs (No.= 50 per slaughterhouse)	32	**64**	19	**38**	33	**66**	84	**56**
Wall swabs (No.= 50 per slaughterhouse)	37	**74**	30	**60**	39	**78**	106	**70.67**
Knife swabs (No.= 50 per	31	**62**	26	**52**	32	**64**	89	**59.33**

slaughterhouse)								
Total of all slaughterhouses (No.= 600)	113/200	**56.5**	83/200	**41.5**	118/200	**59**	314/600	**52.33**

Table (3): Occurrence of *Salmonella* sp. by isolation and biochemical identification in slaughterhouse A (in Menouf), slaughterhouse B (in Tala), and slaughterhouse C (in El-Shohadaa):

Samples	**Slaughterhouse A**		**Slaughterhouse B**		**Slaughterhouse C**		**Total (No.= 150 per sample type)**	
	No.	**%**	No.	**%**	No.	**%**	No.	**%**
Hand swabs (No.= 50 per slaughterhouse)	4	**8**	2	**4**	6	**12**	12	**8**
Floor swabs (No.= 50 per slaughterhouse)	9	**18**	7	**14**	13	**26**	29	**19.33**
Wall swabs (No.= 50 per slaughterhouse)	15	**30**	14	**28**	25	**50**	54	**36**
Knife swabs (No.= 50 per slaughterhouse)	12	**24**	11	**22**	20	**40**	43	**28.67**
Total of all slaughterhouses (No.= 600)	40/200	**20**	34/200	**17**	64/200	**32**	138/600	**23**



[A] **[B]** **[C]**

Figure (1): Isolation of specific hygienic indicator bacteria in three slaughterhouses in Menoufia governorate, Egypt. **[A]:** Showing black or grey-black colonies of *Staphylococcus aureus* with a surrounding clear, and opaque halo on Baird Parker agar (BPA) medium, **[B]:** Showing blue-black colonies of *Escherichia coli* with green metallic sheen on Eosin Methylene Blue (EMB) agar medium, and **[C]:** Showing opaque or colorless colonies of *Salmonella* sp. on Salmonella-Shigella (SSA) agar medium.

Three zoonotic pathogens (*S. aureus*, *E. coli*, and *Salmonella* sp.) were successfully isolated from three slaughterhouses in the Menoufia governorate (Menouf, Tala, and El-Shohadaa) as indicated in tables (1, 2, and 3) and figure (1). In swabs taken from butchers' hands, floors, walls, and knives, the overall occurrence rates of *S. aureus* were 46% (69/150), 76.67% (115/150), 88.67% (133/150), and 82.67% (124/150), respectively, of the three slaughterhouses.

The overall incidence rates of *E. coli* in the three slaughterhouses were 59.33% (89/150) in knife swabs, 70.67% (106/150) in wall swabs, 56% (84/150) in flooring, and 23.33% (35/150) in hand swabs. Additionally, *Salmonella* sp. was found in all three slaughterhouses at a rate of 8% (12/150) in hands, 19.33% (29/150) in floors, 36% (54/150) in walls, and 28.67% (43/150) in knives.

1.2.According to the prevailing climatic conditions:

Table (4): Occurrence of *S. aureus* by isolation and biochemical identification in slaughterhouse A (in Menouf), slaughterhouse B (in Tala), and slaughterhouse C (in El-Shohadaa) according to prevailing climatic conditions:

Samples	**Slaughterhouse A**				**Slaughterhouse B**				**Slaughterhouse C**			
	Warm climate		**Cold climate**		**Warm climate**		**Cold climate**		**Warm climate**		**Cold climate**	
	No.	**%**	No.	**%**	No.	**%**	No.	**%**	No.	**%**	No.	**%**
Hand swabs (No.= 50 per slaughterhouse)	11	**22**	6	**12**	9	**18**	7	**14**	21	**42**	15	**30**
Floor swabs (No.= 50 per slaughterhouse)	24	**48**	14	**28**	19	**38**	16	**32**	26	**52**	16	**32**
Wall swabs (No.= 50 per slaughterhouse)	29	**58**	19	**38**	25	**50**	11	**22**	30	**60**	19	**38**
Knife swabs (No.= 50 per slaughterhouse)	26	**52**	17	**34**	20	**40**	15	**30**	29	**58**	17	**34**
P-value	0.984^{NS}				0.568^{NS}				0.978^{NS}			

^{NS}: Non-Significant.

Table (5): Occurrence of *E. coli* by isolation and biochemical identification in slaughterhouse A (in Menouf), slaughterhouse B (in Tala), and slaughterhouse C (in El-Shohadaa) according to prevailing climatic conditions:

Samples	**Slaughterhouse A**				**Slaughterhouse B**				**Slaughterhouse C**			
	Warm climate		**Cold climate**		**Warm climate**		**Cold climate**		**Warm climate**		**Cold climate**	
	No.	**%**	No.	**%**	No.	**%**	No.	**%**	No.	**%**	No.	**%**
Hand swabs (No.= 50 per slaughterhouse)	9	**18**	4	**8**	6	**12**	2	**4**	9	**18**	5	**10**
Floor swabs (No.= 50 per slaughterhouse)	20	**40**	12	**24**	11	**22**	8	**16**	22	**44**	11	**22**
Wall swabs (No.= 50 per slaughterhouse)	24	**48**	13	**26**	19	**38**	11	**22**	27	**54**	12	**24**
Knife swabs (No.= 50 per slaughterhouse)	22	**44**	9	**18**	17	**34**	9	**18**	21	**42**	11	**22**
P-value	0.898^{NS}				0.861^{NS}				0.983^{NS}			

^{NS}: Non-Significant.

Table (6): Occurrence of *Salmonella* sp. by isolation and biochemical identification in slaughterhouse A (in Menouf), slaughterhouse B (in Tala), and slaughterhouse C (in El-Shohadaa) according to prevailing climatic conditions:

Samples	**Slaughterhouse A**				**Slaughterhouse B**				**Slaughterhouse C**			
	Warm climate		**Cold climate**		**Warm climate**		**Cold climate**		**Warm climate**		**Cold climate**	
	No.	**%**	No.	**%**	No.	**%**	No.	**%**	No.	**%**	No.	**%**
Hand swabs (No.= 50 per slaughterhouse)	3	**6**	1	**2**	2	**4**	0	**0**	4	**8**	2	**4**
Floor swabs (No.= 50 per slaughterhouse)	6	**12**	3	**6**	5	**10**	2	**4**	10	**20**	3	**6**
Wall swabs (No.= 50 per slaughterhouse)	11	**22**	4	**8**	9	**18**	5	**10**	16	**32**	9	**18**
Knife swabs (No.= 50 per slaughterhouse)	9	**18**	3	**6**	7	**14**	4	**8**	13	**26**	7	**14**
P-value	0.976^{NS}				0.764^{NS}				0.869^{NS}			

^{NS}: Non-Significant.

Tables 4, 5, and 6 showed that, despite higher occurrence rates during warm climates compared to cold climates, there was no correlation between the occurrence of any of the pathogens under investigation and the variations in the year-round prevailing climatic conditions (August 2024 to September 2025).

Table (7): Effect of hyopchlorus acid (HoCl), quaternary ammonium compounds (QACs), hydrogen peroxide (H_2O_2) on walls and floors of the examined slaughterhouses:

Time/min.	**Total Bacterial Count (TBC)**	
Group number	**Mean±SE**	**Log reduction**
Group 1 (Control group)		
Zero	6.30±0.0a	0.6
5 min	6.26±0.009ab	
10 min	6.28±0.00ab	
20 min	6.24±0.011b	
P value	.004	
Group 2 (Hypochlorus acid 1%)		
Zero	6.30±0.0a	1.65
5 min	4.78±0.006b	
10 min	4.67±0.01c	
20 min	4.65±0.012c	
P value	.000	
Group 3 (QACs 1%)		
Zero	6.30±0.0a	1.27
5 min	5.01±0.029b	
10 min	4.96±0.011b	
20 min	5.03±0.043b	
P value	.000	
Group 4 (Hydrogen peroxide 1%)		
Zero	6.30±0.0a	2.16
5 min	4.42±0.064b	
10 min	4.32±0.012b	
20 min	4.14±0.014c	
P value	.000	

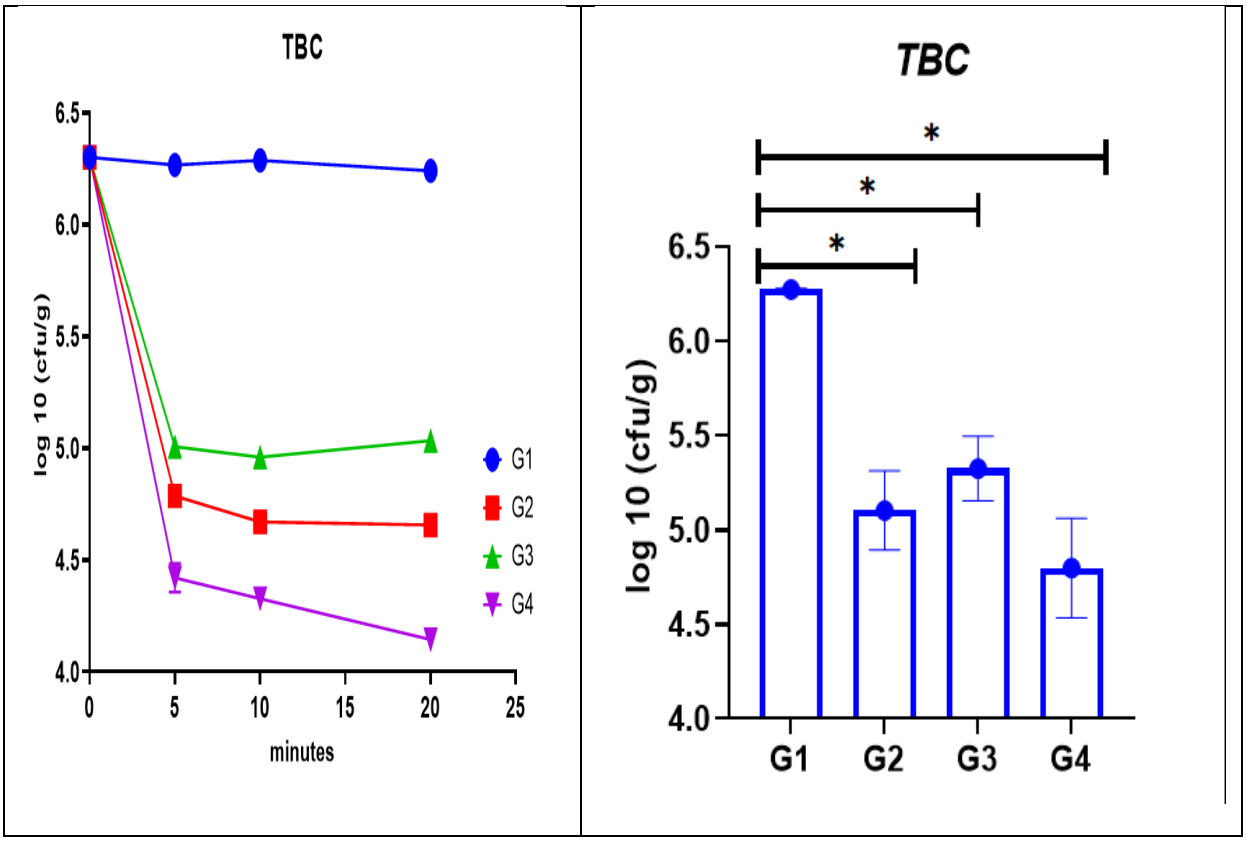


Figure (2): Statistical analysis of different disinfectants on walls and floors of the examined slaughterhouses. **G:** Group, **TBC:** Total bacterial count.

The effects of the three investigated disinfectants (1% hydrogen peroxide, 1% quaternary ammonium compounds, and 1% hydrochlorus acid) applied to the walls and floors of the slaughterhouses under investigation at the same concentration and for the same contact times (0, 5, 10, and 20 minutes), were shown in table (7) and figure (2). 1% hydrogen peroxide had the greatest impact on the total bacterial count (TBC) of the slaughterhouses' walls and floors, followed by 1% hypochlorous acid and 1% quaternary ammonium compounds.

DISCUSSION

Global interest and concern in food safety is growing (Salman et al., 2024a; Eissa et al., 2025; Eldin et al., 2025; Ramzy et al., 2025). Controlling every step of the slaughterhouse process, from the animals' arrival to the meat's extraction, is the aim of veterinary inspection services (Awaad et al., 2024). Furthermore, a high level of animal health requirements must be met by primary production animals intended for human consumption in order to ensure the hygienic and healthful nature of meat. Additionally, sanitary and preventive measures must be applied in slaughterhouses (García-Díez et al., 2023).

Due to the possibility of cross-contamination at different processing stages, such as animal slaughter, flaying, evisceration, deboning, and carcass transportation, meat can become contaminated with a wide range of zoonotic pathogenic bacteria, which can have detrimental effects on public health (Ras, 2019; Eissa and

Nasr, 2025). Assessing the pathogenic zoonotic bacteria that could be spread through various parts of the three primary slaughterhouses in the Menoufia governorate (Menouf, Tala, and El-Shohadaa) was the goal of the current study.

The present study succeeded in isolating three pathogenic bacteria (*S. aureus*, *E. coli*, and *Salmonella* sp.) where the findings were declared in tables (1, 2, and 3), and figure (1). From the published Egyptian studies that concerned the pathogenic bacteria in slaughterhouses, Awaad et al. (2024) presented through their study in Qalyubia, Menoufia, and Cairo governorates that the overall occurrence of *S. aureus* was 88.33% where floor swabs showed the highest occurrence rate of 100%, they also showed an overall *E. coli* occurrence rate of 39.58% where the highest occurrence rate was 60% among walls. Moreover, they reported an overall occurrence rate of 2.29% of *Salmonella* sp. where skinning knives showed a higher occurrence of 8.33% than that 1.67% of floors.

Furthermore, In Sharkia governorate, Nabawy et al. (2016) illustrated occurrence rate of 58.4% (73/125) of *E. coli* where workers hands showed 52% (13/25) of *E. coli* occurrence in comparison with 40% (10/25) among knives. In addition, they showed an occurrence rate of 4.8% (6/125) of *Salmonella* sp. where the occurrence rate was higher 4% (1/25) among hand swabs than that 0% (0/25) among knives. Moreover, in Sharkia governorate, Morshdy et al. (2022) declared that *S. aureus* was the highest pathogen in occurrence rate 29% (29/100) where floors showed an occurrence rate of 40%.

In other parts of the world, a high occurrence rate of *S. aureus* 68% (204/300) was recorded in slaughterhouses in Nigeria (Ekpono et al., 2024). However, Cheng et al. (2025) reported a very low occurrence rate of 7.07% of *S. aureus* in slaughterhouses in China. Furthermore, Rasul et al. (2025) mentioned a very high occurrence rate of 94.8% (237/250) of *E. coli* in slaughterhouse in Iraq where knives and hands showed 100% (40/40) *E. coli* occurrence rate for each. The slaughterhouse is important as a surveillance center for the different occupational (i.e., workplace infections) zoonotic agents as described in the European Union One Health 2021 zoonoses report (EFSA, 2021), as the majority of them can be controlled by implementing good manufacturing practices in both the food industry and the slaughterhouse (Ferreira et al., 2021).

The current study revealed that the slaughterhouse C (in El-Shohadaa) was the highest in all occurrence rates of pathogenic bacteria other than other slaughterhouses (in Menouf and Tala), which would be explained by the fact that the slaughterhouse C was the biggest one with a more animal capacity than others. As well, slaughterhouse C was the least one in hygienic scoring where little attention was paid for routine cleaning and disinfection, and delayed transmission of carcasses after slaughtering process.

All these insights revealed the effectiveness of the hygiene protocols adopted in these facilities was crucial to mitigate the risks of microbiological contamination and ensure compliance with food safety standards (Ovuru et al., 2024).

Furthermore, occurrence rates of different pathogens were higher among wall swabs in comparison with other samples' swabs, which were somewhat similar to Soliman et al. (2016) and Portillo-Alarcon et al. (2025). In slaughterhouses, the contact between carcasses and the surrounding walls and floors is often considerable. Although water spraying is applied, it only partially removes microbial contamination and organic residues from the floors. Wall sanitation, however, is generally inadequate, as minimal amounts of water are used and proper scrubbing with brushes or equivalent tools is rarely performed. Consequently, this inadequate cleaning practice prolongs microbial contact time and facilitates microbial persistence and growth on wall surfaces (Carter et al., 2021). As well, lactic acid, released during rigor mortis, has been proven to be an effective single intervention against microbial indicators in floors, hands, and knives (Carter et al., 2021).

Regarding the effect of the prevailing climatic conditions during sampling, no statistical difference was declared between occurrence rates of different pathogens and season of collection in agreement with Arabi et al. (2014) and Salman et al. (2024b). On the contrary, Eldin et al. (2025) reported that occurrence rates of different pathogens were higher during cold climate than during warm climate. The detected non-significant statistical relationship between season and occurrence rates would be referred to the fact that these pathogens were evenly distributed all the time during the year (Eldin et al., 2025).

Finally, the current investigation revealed that the disinfectant H_2O_2 1% had the best effect on total bacterial count (TBC) of walls and floors of the examined slaughterhouses followed by HoCl 1% and QACs 1%. The obtained findings were similar to those of Ahmed et al. (2024) otherwise that of Soliman et al. (2016). H2O2 was distinguished by a wide range of action mechanisms involving DNA damage, inner membrane damage, and oxidation of microbial core proteins, so be more effective against pathogenic bacteria in slaughterhouses (i.e., in presence of organic matter) (Setlow and Christie, 2021).

CONCLUSION

The public's health may be seriously threatened by the variety and abundance of microbial populations found in slaughterhouses. Limiting and preventing the transmission of infections and associated contaminating genes (virulence factors and antibiotic resistance genes) from the food supply chain to the consumer requires effective control techniques. This study showed promising findings for the use of H_2O_2 disinfectant as a highly effective and sustainable advanced disinfection approach, either alone or in conjunction with a

slaughterhouse's regular disinfection procedure. We suggest investigating this sustainable disinfection method further in the future, with particular emphasis on more harmful bacterial species.

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