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Biosecurity and hygienic assessment of production systems in some poultry farms

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ABSTRACT

The development and implementation of a biosecurity plan in a poultry production are the main cause for its success. So, this study was carried out to monitor and evaluate the hygienic level of different poultry farms according to aerobic plate count and isolation of some hygiene indicator bacteria including Staphylococcus spp., Streptococcus spp. and Pseudomonas spp. A total of 2160 environmental, bird samples and swabs were collected from broiler chicken, layer chicken, breeder chicken and duck farms. Our results showed that, there is a negative relationship between the biosecurity level and the hygiene indicator bacteria. The aerobic plate count was mainly high in the environmental samples specially with low biosecurity levels. The highest prevalence of Staphylococcus spp., Streptococcus spp. and Pseudomonas spp. was 86.11 %, 70 % and 83.33 % of layer farm B, duck farm A and layer farm B, respectively while the lowest prevalence of Staphylococcus spp., Streptococcus spp. and Pseudomonas spp. was 52.22 %, 34.45 % and 32.22 % of breeder farm B, breeder farm A and broiler farm C, respectively. Finally, a good applied biosecurity strategy is the first way to protect poultry from bacterial colonization. As always, prevention is better than control, and investment in biosecurity and hygiene are the best ways for success stories in poultry production.

1. INTRODUCTION

Poultry production is a profitable industry which may cover the gap in public demand for animal protein, minimum maintenance requirements, fast financial outcome, easy marketing, easy control through the application of some preventive measures and provision of high-quality fertilizer (BAHS 2015). The housing systems of poultry in Egypt is naturally ventilated (opened) or artificially ventilated (closed) housing systems associated with different floor systems such as deep litter, slatted floor systems and battery (Sayeed et al., 2017; Sharma et al., 2018).

The biosecurity and hygienic level of the farms are critical points in poultry industry and should be a part of any poultry production system (Ashry and El Bahgy, 2019; Kustritz, 2022). The Food and Agriculture Organization (FAO) classifies poultry production system into four sectors based on their levels of biosecurity and strongly recommends the strict application of biosecurity measures as the most effective way to prevent and control the spread of infectious diseases (FAO 2020). The biosecurity level could be mapped to identify areas at high risk for the spread of diseases. This would be valuable in case of epidemic disease outbreaks and makes targeted surveillance strategies more achievable (Cuc et al., 2020).

The most common approach for routinely evaluation of hygiene practices applied in the poultry production cycle is the detection of APC and isolation of some hygiene indicator bacteria such as; Staphylococcus, Streptococcus and Pseudomonas that are commensals in the poultry environment (Lonc and Plewa, 2010; Mateus-Vargas et al., 2022).

Staphylococci are commensals and widely distributed, it can easily spread between different animal species including poultry. The sources of infection are mainly contaminated foods, water, aerosols, equipment, carriers and clinically infected birds as well as environment, where birds are crowded together. Staphylococci are one of the most common causes of bone and joints infections in poultry. *Staphylococcus aureus* is the principal cause of poultry staphylococcosis disease (Szafraniec et al., 2022).

Streptococcosis is of worldwide distribution in avian species, occurring as both acute septicemic and chronic infections. It is commonly found in various poultry environments (Abdullah 2010). Streptococcus spp. is one of the primary causes of respiratory infection with high economic and production losses in commercial poultry farms (Abbasi et al.,2020).

Pseudomonas is a ubiquitous microorganism in nature. It is one of the most important bacteria which attack commercial poultry, especially at young ages with great losses, embryos infection, septicemia in chick, enteric and respiratory infections with high mortality rate (Abd El-Ghany, 2021).

This work aimed to monitor and evaluate the hygienic level of different poultry farms according to APC and isolation of some hygiene indicator bacteria including Staphylococcus spp, Streptococcus spp. and Pseudomonas spp.

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2. MATERIAL AND METHODS

1.1. Poultry farms

The present study was carried out on twelve poultry farms (three broiler chicken, three-layer chicken, three breeder chicken and three duck farms). All farms located at Qalyubia Governorate, Egypt. The selection of the farms was based on their geographical location, variation in farm hygiene, housing system and the type of production (broilers, layers and breeders).

Sampling

A total of 2160 environmental and bird samples were collected from twelve poultry farms (n = 180 from each farm) along three visits per each farm and five samples were collected per each visit from feed stores, feeders, water sources, drinkers, source of litter, pen litter, droppings and air dust as well as swabs were taken from walls, birds' cloaca, worker's hands and wheels of vehicles (n = 15 of each from each farm). The collected sample were approved with Ethical Approval Number (BUFVTM 18-03-22).

Wall swabs

A total of 180 wall swabs were collected by using sterile swab containing buffer peptone water (BPW) from examined farms according to (Carrique and Davies, 2008).

Air dust samples

Air dust samples (180/ farms) were collected by using settle plate methods according to (Yang et al., 2014).

Feed and water samples

A total of 360 feed samples were collected in sterile plastic packages (180 samples from feed stores package and 180 samples from feeders) from different poultry farms. In addition to, a total of 360 water samples (180 from water sources that were collected by using sterile test tube and 180 from drinkers by using sterile syringe) according to (Metawea, 2003; Hyeon et al., 2019).

Litter samples

A total of 360 litter samples were collected from source of litter (180/farms) that obtained by using sterile plastic packages and (180/farms) from pen litter according to (Carrique and Davies, 2008).

Cloacal swabs

Cloacal swabs (180/farms) were collected by using sterilized cotton swabs containing BPW and inserted in the cloacae of broilers, breeders, layers and ducks then put in ice box according to (Saleha, 2002; Kmetova, 2009).

Droppings samples

Fresh droppings (180/farms) were collected aseptically from birds in sterile vials containing BPW using sterile cotton bud according to (Carrique and Davies, 2008; Kmetova, 2009; Ievy et al., 2020).

Hand swabs

A total of 180 hand swabs were collected from poultry worker's hands by using sterilized cotton swabs containing BPW (Hyeon et al., 2019).

Wheel swabs

Wheel swabs were collected from car wheels that entered to poultry farm. A total number of 180 samples per farms were collected using sterilized cotton swabs containing BPW (Hyeon et al., 2019).

1.2. Samples preparation.

The collected samples and swabs were preserved in a dry insulated ice box supplied with gel bags, to maintain the samples characters and retard any biological changes and transferred to the laboratory within 3hrs after collection. A 1gm of feed, litter and droppings samples were taken, separately grounded in a sterile manual blender that was cleaned and disinfected in between sample changing to prevent cross-contamination and mixed with sterile BPW according to (Soliman and Abdallah, 2020; Ievy et al.,2020).

1.3. Determination of aerobic plate count (APC)

The previously prepared samples were diluted ten- fold and 1 ml from each dilution was spread on sterile petri dishes and poured the plate count agar on it. The petri dishes were incubated aerobically at 37°C for 24 hrs. After the incubation period, APC was calculated according to (Zakki et al., 2017).

1.4. Enrichment of prepared samples.

Before bacterial isolation, the prepared samples with BPW were incubated aerobically at 37°C for 24 hrs.

1.5. Isolation of some hygienic indicator bacteria.

Isolation of Staphylococcus spp.

The enriched swabs and samples were cultured on Baird-Parker agar (BP) supplemented with egg yolk telluride emulsion and incubated at 37˚C for 48 hours. The colonies are showing the characteristic phenotype of Staphylococcus spp. (circular, black, convex with or without light halo on BP agar) according to (Sudershan et al., 2012).

Isolation of Streptococcus spp.

The enriched samples and swabs were cultured on Kenner faecal (KF) streptococcal agar and incubated aerobically at 37°C for 24 hours. The colonies appear as small pin point yellowish brown colony according to (Yashoda et al., 2001).

Isolation of Pseudomonas spp.

A loop-full of prepared enriched samples was streaked onto Pseudomonas agar base media (PABM) and incubated aerobically for 24 hours at 37°C. The purified colonies were large flat yellow colonies according to (Quinn et al., 2002; Eraky et al., 2020) and culture on Cetrimide agar and incubated aerobically for 24 hours at 37°C. The colonies appear as large yellow colonies with irregular growth and examined for pigment production (green fluorescent) and odor (fruity) according to (Sule et al., 2019).

1.6. Biochemical identification.

Biochemical identification of Staphylococcus spp.

The fresh separate colony was taken for biochemical tests such as Mannitol fermentation (positive expect *S. epidermidis*), Coagulase (negative expect *S. aureus*), Catalase (positive), Nitrate reduction (positive), Oxidase (negative). All of the biochemical test tubes were incubated at 37°C for 24 hours according to (Quddoumi et al., 2006).

Biochemical identification of Streptococcus spp.

Subculture separated fresh colonies were taken for performing Catalase test (negative), Simmon citrate test (positive), Indole test (negative), Urease test (negative), Methyl red test (positive), Nitrate reduction test (negative), H_2S production test (negative) and Gelatin hydrolysis test (positive). All tubes were incubated

aerobically for 24 hours at 37°C according to (Yashoda et al., 2001).

Biochemical identification of Pseudomonas spp.
A typical fresh separate colony was taken for Oxidase test (positive), Catalase test (positive), Urease test (positive), Simmon citrate test (positive), Indole test (negative), Triple sugar iron test (negative), Methyl red test (negative) and Voges proskauer test (negative)were incubated at 37 °C for 24 hours. The results were read according to (Hassan et al., 2008; Willey et al., 2011; Sule et al., 2019).

1.7. Statistical analysis
The statistical analysis was carried out using two-way ANOVA (analysis of variance) using SPSS, ver. 25. Multiple comparisons were carried out applying Duncan test. The significance level was set at < 0.05.

3. RESULTS

3.1. APC in the examined poultry farms
The percentage of APC in broiler chicken farms was the highest in the samples collected from farm A (log 7.18), followed by farm B (log 7.07), and farm C (log 6.8) (Table 1). Furthermore, the APC was measured at log 7.8, log 7.8, and log 6.99 in farms A, B, and C layer chicken farms, respectively (Table 2). While, the chicken breeder farm C had the highest percentage of APC (log 7.27) followed by farm A (log 7.2) and farm B (log 7.18) (Table 3). The percentage of APC in the duck farms was the highest in the examined samples of farm A (7.98), followed by farm B (7.94), and farm C (7.59) (Table 4).
There were significant differences between collected samples, the highest percentage of APC was found in pen litter samples of broiler chicken (log 10.68), layer chicken (log 10.77), breeder chicken (log 11.09) and duck farms (log 12.48). In contrast, the lowest percentages were found in water samples collected from broiler chicken (log 4.8), layer chicken (log 5.05), breeder chicken (log 5.2), and duck farms (4.98) (Table 1, 2 ,3 and 4).

3.2. Prevalence of Staphylococcus spp.
The prevalence of isolated Staphylococcus spp. from various poultry farms was (68.89%) in broiler chicken, (71.48%) in layer chicken, (59.63%), inbreeder chicken and (78.52 %) in duck farms. There was a highly significant difference between the prevalence of Staphylococcus in the examined samples of different poultry farms. The highest prevalence of Staphylococcus was found in the droppings samples, where it was 95.55% ,100%, 100% and 95.56% for broiler chicken, layer chicken, breeder chicken, and duck farms, respectively, as well as pen litter. (Table 5, 6, 7 and 8).
The prevalence of isolated Staphylococcus spp. in broiler chicken farms was the highest in samples collected from farm A (73.89 %), followed by farm B (71.11 %), and farm C (61.66%) (Table 5). In addition, the prevalence of Staphylococcus was 73.89%, 71.11 % and 61.66% in the farms A, B and C of layer chicken, respectively (Table 6). In the breeder chicken farms, the prevalence was 63.88 %, 52.22 %, and 62.78% in farm A, B and C, respectively (Table 7). The Staphylococcus prevalence was 85.55 %, 79.44 % and 70.56% in the examined samples of duck farm A, B, and C, respectively (Table 8). The *Staphylococcus aureus* was isolated from hand and wheel swabs in layer chicken farm B and wheel swabs in duck farm C. The prevalence was 7% for hand and wheel swabs of layer chicken farm B and 7% for wheel swabs in breeder duck farm C.

3.3. *Prevalence of Streptococcus spp*.
Prevalence of Streptococcus in the broiler chicken farms was the highest in samples collected from farm A (53.33 %), followed by farm B (51.11 %,), and farm C (45.56%) (Table 9). On the other hand, the prevalence of Streptococcus was 52.22 %, 68.89 %, and 36.67% in the layer chicken farms A, B and C, respectively (Table 10). In the breeder chicken farms, the prevalence was 34.45 %, 35.56 % and 42.78% in farm A, B and C, respectively (Table 11). Finally, the Streptococcus prevalence was 70 %, 68.89% and 63.89% in the examined samples of duck farms A, B and C, respectively (Table 12).
The isolated Streptococcus spp. from different poultry farm productions was (50%) in broiler chicken, (52.59 %) in layer chicken, (37.59%) in breeder chicken and (67.59%) in duck farms. There was a highly significant difference in the prevalence of Streptococcus spp. between different poultry farm productions. The highest prevalence of Streptococcus spp. was found in the dropping samples, where it was 95.56%, 88.89%, 82.22% and 97.78% in broiler chicken, layer chicken, breeder chicken, and duck farms, respectively. In contrast, the prevalence was the lowest in the water source samples, which were 4.44%, 0%, 0% and 46.67% in broiler chicken, layer chicken, breeder chicken and duck farms, respectively (Table 9,10,11 and 12).

3.4. Prevalence of Pseudomonas spp.
In the broiler chicken farms, the prevalence of Pseudomonas was the highest in samples collected from farm A (48.89 %), followed by farm B (47.22 %), and farm C (32.22%) (Table 13). Furthermore, in the layer chicken farms, prevalence of Pseudomonas was 70%, 83.33 %, and 70% in the farms A, B, and C, respectively (Table 14). In the breeder chicken farms, the prevalence was 49.45 %, 44.45 % and 51.11% of farms A, B, and C, respectively (Table 15). The prevalence of Pseudomonas in duck farms was 60 %, 63.89 %, and 59.44% in the examined samples of farms A, B, and C, respectively (Table 16).
Pseudomonas spp. was found in 42.78% of broiler chicken farm, 74.44% of layer chicken farm, 48.33% of breeder chicken farm, and 61.11% of duck farm. There was a highly significant difference in Pseudomonas spp. prevalence in the different samples of all farms. Pseudomonas spp. was most commonly isolated from drinker samples, with prevalence of 80%, 97.78%, 84.44%, and 93.33% in broiler chicken, layer chicken, and breeder chicken farms, respectively, as well as droppings samples. In contrast, the prevalence was the lowest in the feed stores were 4.44%, 31.11%, 0%, and 6.67% at broiler chicken, layer chicken, breeder chicken and duck farms, respectively (Table 13,14,15 and16).

Table 1 The prevalence of APC (mean ± SE) in different samples were collected from broiler chicken farms.

Parameters	Farm A		Farm B		Farm C		Total
	No. x10^4	Log No.	No. x10^4	Log No.	No. x10^4	Log No.	
Wall swabs	20500	8.30±0.07^{Da}	13950	8.13±0.06^{dB}	7400	7.86±0.05^{eC}	8.09
Air dust	19	5.27±0.02^{Ia}	12	5.06±0.02^{iB}	5	4.66±0.03^{Kc}	4.99
Feed stores	39	5.45±0.28^{Ha}	24	5.27±0.24^{hB}	9	4.92±0.12^{ijC}	5.21
Feed from feeders	5900	7.77±0.04^{Ea}	3900	7.59±0.04^{eB}	1900	7.27±0.04^{Fc}	7.54
Water source	7	4.80±0.06^{Ka}	7	4.82±0.05^{jA}	7	4.84±0.03^{Ja}	4.82
Drinkers	83000	8.92±0.04^{Ba}	73000	8.86±0.04^{bAB}	63000	8.80±0.04^{Bb}	8.86
Source of litter	49	5.68±0.05^{Ga}	31	5.48±0.05^{gB}	13	5.09±0.05^{Ic}	5.41
Pen litter	10000000	10.98±0.11^{Aa}	6050000	10.76±0.09^{aB}	2100000	10.32±0.03^{Ac}	10.68
Cloacal swabs	30000	8.48±0.02^{Ca}	22500	8.35±0.01^{cB}	15000	8.17±0.07^{Dc}	8.33
Droppings	77500	8.89±0.02^{Ba}	50750	8.70±0.03^{bB}	24000	8.37±0.06^{Cc}	8.65
Hand swabs	12	5.06±0.09^{Jb}	23	5.32±0.14^{ghA}	34	5.39±0.28^{Ha}	5.25
Wheel swabs	410	6.60±0.08^{Fa}	335	6.53±0.02^{fA}	260	6.32±0.22^{Gb}	6.48
Total		7.18		7.07		6.8	7.02

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

Table (2): The prevalence of APC (mean ± SE) in different samples were collected from layer chicken farms.

Parameters	Farm A		Farm B		Farm C		Total
	No. x10^4	Log No.	No. x10^4	Log No.	No. x10^4	Log No.	
Wall swabs	1566667	6.82±3.42^{Cc}	2656667	9.80±0.57^{bA}	200000	9.19±0.22^{aB}	8.6
Air dust	19	5.12±0.28^{Dc}	22	5.32±0.09^{dBC}	117	5.85±0.37^{dA}	5.43
Feed stores	15	5.14±0.10^{Da}	33	5.28±0.37^{dA}	16	5.15±0.14^{dA}	5.19
Feed from feeders	28000	8.29±0.30^{Bb}	405000	9.47±0.28^{bA}	9967	7.92±0.20^{bcB}	8.56
Water source	7	4.83±0.07^{Da}	15	5.13±0.14^{dA}	16	5.19±0.08^{dA}	5.05
Drinkers	30267	8.26±0.33^{Bb}	416333	9.39±0.36^{bA}	2300	7.36±0.04^{cC}	8.34
Source of litter	53	5.52±0.29^{Db}	3567	7.14±0.57^{cA}	91	5.94±0.10^{dB}	6.2
Pen litter	68433333	11.11±0.83^{Ab}	345333333	11.73±0.78^{aA}	822667	9.47±0.44^{aC}	10.77
Cloacal swabs	13933	8.02±0.22^{Bb}	49667	8.61±0.22^{bA}	11667	8.00±0.17^{bcB}	8.21
Droppings	55667	8.70±0.13^{Ba}	96667	8.97±0.07^{bA}	42333	8.60±0.11^{abA}	8.76
Hand swabs	62	5.74±0.16^{Da}	156	6.01±0.28^{dA}	57	5.19±0.52^{dB}	5.65
Wheel swabs	373	6.53±0.14^{Cb}	3753	7.39±0.33^{cA}	133	6.05±0.17^{dB}	6.65
Total		7		7.8		6.99	7.26

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

Table 3 The prevalence of APC (mean ± SE) in different samples were collected from breeder chicken farms.

Parameters	Farm A		Farm B		Farm C		Total
	No. x10^4	Log No.	No. x10^4	Log No.	No. x10^4	Log No.	
Wall swabs	1666000	9.59±0.64^{bA}	1075333	9.44±0.56^{bA}	2256667	9.65±0.72^{bA}	9.56
Air dust	7	4.83±0.12^{gA}	7	4.80±0.17^{gA}	7	4.83±0.07^{gA}	4.82
Feed stores	12	5.02±0.14^{gAB}	10	4.79±0.32^{gB}	14	5.10±0.12^{fgA}	4.97
Feed from feeders	102573	8.85±0.27^{cA}	93480	8.55±0.47^{cB}	111667	8.97±0.19^{cA}	8.79
Water source	18	5.24±0.10^{fgAB}	25	5.39±0.08^{fA}	11	4.99±0.15^{gB}	5.2
Drinkers	43067	8.42±0.33^{cAB}	28300	8.20±0.36^{cdB}	57833	8.57±0.32^{cA}	8.39
Source of litter	254	5.16±0.37^{eA}	413	6.36±0.40^{eA}	96	5.65±0.37^{efB}	5.72
Pen litter	69143333	11.12±0.66^{aA}	38536667	10.88±0.62^{aB}	99750000	11.27±0.68^{aA}	11.09
Cloacal swabs	8317	7.87±0.15^{dA}	8900	7.93±0.09^{dA}	7733	7.77±0.24^{dA}	7.85
Droppings	59167	8.74±0.12^{cAB}	46667	8.54±0.25^{cB}	71667	8.85±0.07^{cA}	8.71
Hand swabs	42	5.61±0.08^{efA}	38	5.50±0.19^{fA}	46	5.66±0.00^{eA}	5.59
Wheel swabs	84	5.91±0.08^{eA}	77	5.82±0.17^{efA}	90	5.95±0^{eA}	5.89
Total		7.20		7.18		7.27	7.21

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

Table 4 The prevalence of APC (mean ± SE) in different samples were collected from duck farms.

Parameters	Farm A		Farm B		Farm C		Total
	No. x104	Log No.	No. x104	Log No.	No. x104	Log No.	
Wall swabs	1753333	9.77±0.54^{Ca}	914667	9.60±0.44^{cA}	76000	8.88±0.01^{eB}	9.42
Air dust	48	5.65±0.12^{Ga}	52	5.70±0.07^{gA}	55	5.74±0.03^{eA}	5.69
Feed stores	63	5.69±0.25^{Ga}	37	5.51±0.18^{gA}	12	5.05±0.06^{fB}	5.42
Feed from feeders	2528333	9.90±0.55^{Ca}	1325417	9.73±0.46^{cA}	122500	9.08±0.06^{eB}	9.57
Water source	11	4.95±0.24^{Ia}	11	5.00±0.11^{hA}	10	5.00±0.03^{fA}	4.98
Drinkers	5766667	10.63±0.24^{Ba}	3188333	10.39±0.22^{bB}	610000	9.78±0.06^{bC}	10.26
Source of litter	1033	6.98±0.11^{Ea}	627	6.77±0.10^{eA}	220	6.34±0.04^{dB}	6.69
Pen litter	2106666667	12.76±0.62^{Aa}	1119083333	12.63±0.50^{aA}	131500000	12.07±0.15^{aB}	12.48
Cloacal swabs	14667	8.14±0.09^{dhB}	37833	8.57±0.04^{dA}	61000	8.79±0.04^{eA}	8.5
Droppings	37667	8.53±0.14^{dghB}	55833	8.75±0.03^{dAB}	74000	8.87±0.03^{eA}	8.71
Hand swabs	275	6.14±0.36^{Fa}	204	6.25±0.16^{fA}	132	5.71±0.56^{eB}	6.03
Wheel swabs	671	6.64±0.28^{Ea}	367	6.41±0.25^{efB}	63	5.78±0.1^{eC}	6.27
Total		7.98		7.94		7.59	7.84

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

Table 5 The prevalence of Staphylococcus spp. isolated from different samples in broiler chicken farms.

Parameters	Farm A			Farm B			Farm C			Total		
	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%
Wall swabs	15	12	80.00±0.00 ^{bcdA}	15	9	60.00±5.77 ^{dB}	15	8	53.33±5.77 ^{deB}	45	29	64.44^{d}
Air dust	15	13	86.67±8.66 ^{abcAB}	15	12	80.00±11.55 ^{bcB}	15	14	93.33±5.77 ^{abA}	45	39	86.67^{abc}
Feed stores	15	4	26.6±2.897^{fB}	15	6	40.00 ±0.00^{eA}	15	2	13.33 ±13.33^{fC}	45	12	26.67^{f}
Feed from feeders	15	15	100.00±0.00 ^{Aa}	15	13	86.67 ±5.77^{abB}	15	13	86.67±5.77 ^{abB}	45	41	91.11^{ab}
Water source	15	3	20.00±0.00 ^{Fb}	15	5	33.33±5.77 ^{eA}	15	0	0.00±0.00 ^{fC}	45	8	17.78^{f}
Drinkers	15	14	93.33±5.77 ^{abA}	15	12	80.00 ±5.77^{bcB}	15	10	66.66 ±5.77^{cdC}	45	36	80.00^{bcd}
Source of litter	15	10	66.67 ±5.77^{deA}	15	11	73.33±11.55 ^{bcA}	15	8	53.33±11.55 ^{deB}	45	29	64.44^{d}
Pen litter	15	15	100.00±0.00 ^{Aa}	15	15	100.00^{aA}	15	15	100.00^{aA}	45	45	100.00^{a}
Cloacal swabs	15	13	86.67±5.77 ^{abcB}	15	15	100.00^{aA}	15	9	60.00±0.00 ^{deC}	45	37	82.22^{bc}
Droppings	15	15	100.00 ±0.00^{aA}	15	15	100.00^{aA}	15	13	86.66±11.55^{abB}	45	43	95.55^{ab}
Hand swabs	15	8	53.33±2.89 ^{Ea}	15	5	33.33±11.55 ^{eB}	15	7	46.66±11.55 ^{eA}	45	20	44.44^{e}
Wheel swabs	15	11	73.33±2.89 ^{cdAB}	15	10	66.66±11.55 ^{cdB}	15	12	80.00±0.00 ^{bcA}	45	33	73.33^{cd}
Total	180	133	73.89^{A}	180	128	71.11^{A}	180	111	61.66^{B}	540	372	68.89

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

Table 6 The prevalence of Staphylococcus spp isolated from different samples inlayer chicken farms.

Parameters	Farm A			Farm B			Farm C			Total		
	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%
Wall swabs	15	13	86.67±6.67^{abA}	15	13	86.67±13.33^{abA}	15	10	66.67±6.67^{deB}	45	36	80.00^{abc}
Air dust	15	12	80±11.55^{Bb}	15	14	93.33±6.67^{aA}	15	12	80.00±20.00^{bcdB}	45	38	84.44^{abc}
Feed stores	15	5	33.33±6.67^{dB}	15	11	73.33±6.67^{bcA}	15	2	13.33±13.33^{Gc}	45	18	40.00^{e}
Feed from feeders	15	13	86.67±6.67^{abB}	15	15	100.00±0.00^{aA}	15	11	73.33±6.67^{cdeC}	45	39	86.67^{abc}
Water source	15	1	6.67±6.67^{eB}	15	3	20.00±11.55^{eA}	15	0	0±0^{Hb}	45	4	8.89^{f}
Drinkers	15	10	66.67±20^{Cb}	15	15	100.00±0.00^{aA}	15	8	53.33±13.33^{efB}	45	33	73.33^{cd}
Source of litter	15	10	66.67±6.67^{cB}	15	15	100.00±0.00^{aA}	15	8	53.33±17.64^{efC}	45	33	73.33^{bc}
Pen litter	15	15	100.00±0.00^{aA}	15	15	100.00±0.00^{aA}	15	13	86.67±11.55^{abcB}	45	43	95.55^{ab}
Cloacal swabs	15	14	93.33±6.67^{abAB}	15	15	100.00±0.00^{aA}	15	13	86.67±6.67^{abcB}	45	42	93.33^{ab}
Droppings	15	15	100.00±0.00^{aA}	15	15	100.00±0.00^{aA}	15	15	100.00±0.00^{Aa}	45	45	100.00^{a}
Hand swabs	15	7	46.67±17.64^{cA}	15	10	66.67±24.04^{dB}	15	6	40.00±23.09^{Fb}	45	23	51.11^{de}
Wheel swabs	15	8	53.33±24.04^{cC}	15	14	93.33±6.67^{aA}	15	10	66.67±17.64^{deB}	45	32	71.11^{cd}
Total	180	123	68.33	180	155	86.11	180	108	60	540	386	71.48

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

Table 7 The prevalence of Staphylococcus spp isolated from different samples in breeder chicken farms.

Parameters	Farm A			Farm B			Farm C			Total		
	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%
Wall swabs	15	12	80.00±11.55^{abcA}	15	12	80.00±11.55^{abA}	15	11	73.33±12.02^{bcA}	45	35	77.78^{bc}
Air dust	15	13	86.67±6.67^{abA}	15	11	73.33±6.67^{bA}	15	13	86.67±6.67^{abA}	45	37	82.22^{abc}
Feed stores	15	3	20.00±11.55^{efA}	15	3	20.00±11.55^{cdA}	15	0	0.00^{dB}	45	6	13.33^{d}
Feed from feeders	15	11	73.33±17.64^{bcAB}	15	10	66.67±6.67^{bB}	15	12	80.00±11.55^{abcA}	45	33	73.33^{bc}
Water source	15	6	40.00±11.55^{deA}	15	0	0.00^{dB}	15	0	0.00^{dB}	45	6	13.33^{d}
Drinkers	15	10	66.67±17.64^{bcA}	15	9	60.00±30.55^{cdA}	15	10	66.67±17.64^{bcA}	45	29	64.45^{c}
Source of litter	15	13	86.67±13.33^{abA}	15	6	40.00±23.09^{cC}	15	9	60.00±11.55^{cB}	45	28	62.22^{c}
Pen litter	15	13	86.67±13.33^{abB}	15	13	86.67±13.33^{abB}	15	15	100.00^{aA}	45	41	91.11^{ab}
Cloacal swabs	15	14	93.33±6.67^{abAB}	15	13	86.67±6.67^{abB}	15	15	100.00^{aA}	45	42	93.33^{ab}
Droppings	15	15	100.00^{Aa}	15	15	100.00^{aA}	15	15	100.00^{aA}	45	15	100.00^{a}
Hand swabs	15	5	33.33±24.04^{Ea}	15	2	13.33±6.67^{dB}	15	3	20.00±5.77^{dB}	45	10	22.22^{d}
Wheel swabs	15	0	0.00^{Fb}	15	0	0.00^{dB}	15	10	66.67±13.33^{bcA}	45	10	22.22^{d}
Total	180	115	63.88^{A}	180	94	52.22^{A}	180	113	62.78^{A}	540	282	59.63

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

Table 8 The prevalence of Staphylococcus spp isolated from different samples in duck farms.

Parameters	Farm A			Farm B			Farm C			Total		
	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%
Wall swabs	15	14	93.33±6.67^{Aa}	15	12	80.00±10.00^{bB}	15	14	93.33±3.33^{abA}	45	40	88.89^{ab}
Air dust	15	15	100.00±0.00^{Aa}	15	15	100.00^{aA}	15	14	93.33±3.33^{abA}	45	44	97.78^{a}
Feed stores	15	8	53.33±6.67^{Ca}	15	8	53.33±6.67^{dA}	15	7	46.67±3.33^{efA}	45	23	51.11^{de}
Feed from feeders	15	15	100.00±0.00^{Aa}	15	15	100.00^{aA}	15	12	80.00±11.55^{bcdB}	45	42	93.33^{ab}
Water source	15	11	73.33±6.67^{Ba}	15	2	13.33±6.67^{eC}	15	4	26.67±6.67^{dB}	45	17	37.78^{e}
Drinkers	15	15	100.00^{Aa}	15	15	100.00^{aA}	15	14	93.33±3.33^{abA}	45	44	97.78^{a}
Source of litter	15	11	73.33±6.67^{Ba}	15	11	73.33±20.28^{bcA}	15	8	53.33±13.33^{eB}	45	30	66.66^{cd}
Pen litter	15	15	100.00±0.00^{Aa}	15	15	100.00^{aA}	15	15	100.00^{aA}	45	45	100.00^{a}
Cloacal swabs	15	14	93.33±6.67^{Aa}	15	13	86.67±6.67^{abA}	15	11	73.33±6.67^{cB}	45	38	84.44^{abc}
Droppings	15	15	100.00^{Aa}	15	15	100.00^{aA}	15	13	86.67±3.33^{abcB}	45	43	95.56^{ab}
Hand swabs	15	8	53.33±6.67^{Ca}	15	9	60.00±0.00^{cdA}	15	5	33.33±33.33^{fdB}	45	22	48.89^{e}
Wheel swabs	15	13	86.67±13.33^{abA}	15	13	86.67±13.33^{abA}	15	10	66.67±6.67^{deB}	45	36	80.00^{bc}
Total	180	154	85.55^{A}	180	143	79.44^{A}	180	127	70.56^{B}	540	424	78.52

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter

Table 9 The prevalence of Streptococcus spp was isolated from different samples in broiler chicken.

Parameters	Farm A			Farm B			Farm C			Total		
	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%
Wall swabs	15	7	46.67±5.77 ^{cdeB}	15	11	73.33±5.77 ^{bA}	15	2	13.33±11.55^{fC}	45	20	44.44^{cd}
Air dust	15	9	60.00±10.00 ^{bcdA}	15	10	66.67±5.77 ^{bcA}	15	6	40.00±11.55^{deC}	45	25	55.56^{cd}
Feed stores	15	3	20.00±0.00^{fgA}	15	2	13.33±13.33^{dA}	15	0	0.00^{fB}	45	5	11.11^{af}
Feed from feeders	15	12	80.00±5.77^{abB}	15	14	93.33±11.55 ^{abA}	15	11	73.33±11.55^{bB}	45	37	82.22^{ab}
Water source	15	2	13.33±5.77 ^{gA}	15	0	0.00^{dB}	15	0	0.00^{fB}	45	2	4.44^{f}
Drinkers	15	12	80.00±10.00 ^{abA}	15	11	73.33±5.77 ^{bA}	15	6	40.00±10.00 ^{deC}	45	29	64.44^{bc}
Source of litter	15	6	40.00±5.77 ^{defA}	15	3	20.00±20.00^{cdB}	15	7	46.67±5.77^{cdA}	45	16	35.56^{da}
Pen litter	15	13	86.67^{abA}	15	12	80.00±11.55 ^{abA}	15	12	80.00±0.00 ^{abA}	45	37	82.22^{ab}
Cloacal swabs	15	12	80.00±10.00 ^{abA}	15	12	80.00±10.00 ^{abA}	15	13	86.67±5.77 ^{abA}	45	37	82.22^{ab}
Droppings	15	15	100.00±0.00 ^{Aa}	15	13	86.67 ±5.77^{abB}	15	15	100.00^{aA}	45	43	95.56^{a}
Hand swabs	15	5	33.33 ±11.55 ^{efA}	15	6	40.00±10.00 ^{cA}	15	3	20.00±0.00 ^{eB}	45	14	31.11^{da}
Wheel swabs	15	0	0.00^{Gb}	15	2	13.33±13.33^{dA}	15	3	20.00±20.00 ^{efA}	45	5	11.11^{af}
Total	180	96	53.33^{A}	180	92	51.11^{A}	180	82	45.56^{A}	540	270	50

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

Table 10 The prevalence of Streptococcus spp. was isolated from different samples in layer chicken farms.

Parameters	Farm A			Farm B			Farm C			Total		
	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%
Wall swabs	15	9	60.00±29.91^{efC}	15	12	80.00±11.55^{abA}	15	10	66.67±13.33Ab	45	31	68.89bcd
Air dust	15	7	46.67±24.04^{deB}	15	11	73.33±6.67^{bcA}	15	4	26.67±6.67^{cdC}	45	22	48.896
Feed stores	15	2	13.33±11.55^{fgB}	15	6	40.00±11.55^{dA}	15	2	13.33±13.33^{Db}	45	10	22.22^{ef}
Feed from feeders	15	8	53.33±29.06^{cdeB}	15	15	100.00±0.00^{aA}	15	5	33.33±33.33^{cdC}	45	28	62.22^{bcd}
Water source	15	0	0±0^{Ga}	15	0	0±0^{eA}	15	0	0±0^{Ea}	45	0	0.00^{f}
Drinkers	15	6	40.00±23.09^{defB}	15	10	66.67±6.67^{cdA}	15	0	0±0^{Ec}	45	16	35.56^{de}
Source of litter	15	11	73.33±17.64^{bcB}	15	14	93.33±6.67^{aA}	15	6	40.00±11.55^{Bc}	45	31	68.89^{abc}
Pen litter	15	100	100.00±0.00^{aA}	15	15	100.00±0.00^{aA}	15	12	80.00±0.00^{Ab}	45	42	93.33^{a}
Cloacal swabs	15	9	60.00±11.55^{cdeB}	15	13	86.67±13.33^{abA}	15	6	40.00±11.55^{bcC}	45	28	62.22^{bcd}
Droppings	15	14	93.33±6.67^{abA}	15	13	86.67±13.33^{abA}	15	13	86.67±13.33^{Aa}	45	40	88.89^{ab}
Hand swabs	15	9	60.00±30.55^{cdeA}	15	8	53.33±29.06^{cdA}	15	2	13.33±6.67^{Db}	45	19	42.22^{cde}
Wheel swabs	15	4	26.67±17.64^{fB}	15	7	46.67±17.64^{dA}	15	6	40.00±30.55^{bcA}	45	17	37.78^{de}
Total	180	94	52.22	180	124	68.89	180	66	36.67	540	284	52.59

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

Table 11 The prevalence of Streptococcus spp. was isolated from different samples in breeder chicken farms.

Parameters	Farm A			Farm B			Farm C			Total		
	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%
Wall swabs	15	6	40.00±20^{cdB}	15	8	53.33±13.33^{bA}	15	8	53.33±8.82^{cdeA}	45	22	48.89^{cde}
Air dust	15	7	46.67±24.04^{bcA}	15	4	26.67±13.33^{eB}	15	6	40.00±11.55^{eA}	45	17	37.78^{de}
Feed stores	15	0	0.00^{eA}	15	0	0.00^{dA}	15	0	0.00^{Fa}	45	0	0.00^{f}
Feed from feeders	15	8	53.33±6.67^{bA}	15	6	40.00±11.55^{bcB}	15	6	40.00±11.55^{eB}	45	20	44.44^{cde}
Water source	15	0	0.00^{eA}	15	0	0.00^{dA}	15	0	0.00^{Fa}	45	0	0.00^{f}
Drinkers	15	7	46.67±29.06^{bcB}	15	8	53.33±6.67^{bAB}	15	9	60.00^{cdA}	45	24	53.33^{cd}
Source of litter	15	4	26.67±17.64^{dB}	15	6	40.00±23.09^{bcA}	15	6	40.00±0.00^{Ea}	45	16	35.56^{e}
Pen litter	15	9	60.00±30.55^{bB}	15	12	80.00±0.00^{aA}	15	12	80.00±0.00^{abA}	45	33	73.33^{ab}
Cloacal swabs	15	8	53.33±13.33^{bcB}	15	8	53.33±6.67^{bB}	15	10	66.67±20.28^{bcA}	45	26	57.78^{bc}
Droppings	15	12	80.00±0.00^{aA}	15	12	80.00±0.00^{aA}	15	13	86.67±6.67^{Aa}	45	37	82.22^{a}
Hand swabs	15	1	6.67±6.67^{eA}	15	0	0.00^{dA}	15	0	0.00^{Fa}	45	1	2.22^{f}
Wheel swabs	15	0	0.00^{eB}	15	0	0.00^{dB}	15	7	46.67±14.53^{deA}	45	7	15.56^{f}
Total	180	62	34.45^{B}	180	64	35.56^{AB}	180	77	42.78^{A}	540	203	37.59

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

Table 12 The prevalence of Streptococcus spp. isolated from different samples in duck farms.

Parameters	Farm A			Farm B			Farm C			Total		
	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%
Wall swabs	15	14	93.33±6.67^{abA}	15	15	100.00^{aA}	15	14	93.33±5.77^{abA}	45	43	95.55^{a}
Air dust	15	9	60.00±11.55^{eB}	15	12	80.00±11.55^{bcA}	15	8	53.33±3.33^{dB}	45	29	64.44^{cd}
Feed stores	15	5	33.33±13.33^{eA}	15	1	6.67±6.67^{gB}	15	4	26.67±6.67^{eA}	45	10	22.22^{f}
Feed from feeders	15	12	80.00±0.00^{bA}	15	13	86.67±13.33^{abcA}	15	12	80.00±11.55^{bcA}	45	37	82.22^{bc}
Water source	15	8	53.33±5.77^{cdA}	15	7	46.67±17.64^{eAB}	15	6	40.00±10.00^{dB}	45	21	46.67^{e}
Drinkers	15	13	86.67±6.67^{abA}	15	11	73.33±6.67^{cdB}	15	11	73.33±3.33^{cB}	45	35	77.78^{bc}
Source of litter	15	6	40.00±11.55^{dB}	15	11	73.33±13.33^{cdA}	15	7	46.67±6.67^{dB}	45	24	53.33^{de}
Pen litter	15	15	100.00^{aA}	15	15	100.00^{aA}	15	14	93.33±13.33^{abA}	45	44	97.78^{a}
Cloacal swabs	15	14	93.33±5.77^{abA}	15	12	80.00±20.00^{bcB}	15	14	93.33±5.77^{abA}	45	40	88.89^{abc}
Droppings	15	15	100.00^{aA}	15	14	93.33±6.67^{abA}	15	15	100.00^{Aa}	45	44	97.78^{a}
Hand swabs	15	9	60.00±11.55^{eA}	15	9	60.00±30.55^{deA}	15	7	46.67±5.77^{dB}	45	25	55.56^{de}
Wheel swabs	15	6	40.00±11.55^{dA}	15	4	26.67±17.64^{fB}	15	3	20.00±20. 00^{eB}	45	13	28.89^{f}
Total	180	126	70.00^{A}	180	124	68.89^{A}	180	115	63.89^{A}	540	365	67.59

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

Table 13 The prevalence of Pseudomonas spp. was isolated from different samples in broiler chicken farms.

Parameters	Farm A			Farm B			Farm C			Total		
	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%
Wall swabs	15	12	80.00±11.55 ^{aA}	15	9	60.00±10.00^{cB}	15	8	53.33±12.02^{abcB}	45	29	64.44^{bc}
Air dust	15	9	60.00±0.00 ^{bC}	15	10	66.67 ±11.55^{bcA}	15	6	40.00±30.55^{cdB}	45	25	55.56^{c}
Feed stores	15	0	0.00^{f}	15B	2	13.33± 6.67^{eA}	15	0	0.00^{eB}	45	2	4.44^{e}
Feed from feeders	15	4	26.67±6.67^{deB}	15	6	40.00±11.55 ^{dA}	15	2	13.33±13.33^{eC}	45	12	26.67^{d}
Water source	15	6	40.00±5.77^{cdA}	15	4	26.67±26.67 ^{deB}	15	5	33.33± 11.55^{dAB}	45	15	33.33^{d}
Drinkers	15	14	93.33±17.64^{aA}	15	12	80.00±0.00 ^{abB}	15	10	66.67±11.55^{aC}	45	36	80.00^{a}
Source of litter	15	2	13.33±13.33^{efA}	15	2	13.33±13.33^{eA}	15	0	0.00^{eB}	45	4	8.89^{e}
Pen litter	15	12	80.00±5.77 ^{aA}	15	10	66.67±6.67 ^{bcB}	15	6	40.00±11.55^{cdC}	45	28	62.22^{c}
Cloacal swabs	15	8	53.33±17.64 ^{bcAB}	15	9	60.00±0.00^{cA}	15	7	46.67±11.55 ^{bcB}	45	24	53.33^{c}
Droppings	15	12	80.00±10.00 ^{aB}	15	14	93.33±5.77^{aA}	15	9	60.00±0.00^{abC}	45	35	77.78^{ab}
Hand swabs	15	3	20.00±0.00 ^{efA}	15	2	13.33±6.67^{eA}	15	0	0.00^{eB}	45	5	11.11^{e}
Wheel swabs	15	6	40.00± 0.00c^{dA}	15	5	33.33±33.33d^{A}	15	5	33.33±33.33^{dA}	45	16	35.55^{d}
Total	180	88	48.89^{A}	180	85	47.22^{A}	180	58	32.22^{B}	540	231	42.78

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter

Table 14 The prevalence of Pseudomonas spp. was isolated from different samples in layer chicken farms.

Parameters	No of samples	No of + ve	Farm A	No of samples	No of + ve	Farm B	No of samples	No of + ve	Farm C	No of samples	No of + ve	Total
Wall swabs	15	8	53.33±29.06^{defB}	15	14	93.33±6.67^{aA}	15	14	93.33±6.67^{abA}	45	36	80.00^{abc}
Air dust	15	10	66.67±17.64^{cdeB}	15	14	93.33±6.67^{aA}	15	9	60.00±11.55^{deB}	45	33	73.33^{abc}
Feed stores	15	6	40.00±20.00^{fA}	15	6	40.00±23.09^{dA}	15	2	13.33±13.33^{Fb}	45	14	31.11^{d}
Feed from feeders	15	11	73.33±26.67^{bcdB}	15	14	93.33±6.67^{aA}	15	10	66.67±23.09^{Ec}	45	35	77.78^{bc}
Water source	15	11	73.33±13.33^{bcdB}	15	13	86.67±20.00^{abA}	15	13	86.67±13.33^{abcA}	45	37	82.22^{abc}
Drinkers	15	15	100.00±0.00^{aA}	15	15	100.00±0.00^{aA}	15	14	93.33±6.67^{abA}	45	44	97.78^{ab}
Source of litter	15	8	53.33±17.64^{defB}	15	13	86.67±6.67^{abA}	15	10	66.67±6.67^{cdB}	45	31	68.89^{bc}
Pen litter	15	15	100.00±0.00^{aA}	15	15	100.00±0.00^{aA}	15	15	100.00±0.00^{Aa}	45	45	100.00^{a}
Cloacal swabs	15	12	80.00±11.55^{abcB}	15	14	93.33±6.67^{aA}	15	14	93.33±30.67^{bcdC}	45	40	88.89^{abc}
Droppings	15	15	100.00±0.00^{aA}	15	15	100.00±0.00^{aA}	15	15	100.00±0.00^{Aa}	45	45	100.00^{a}
Hand swabs	15	7	46.67±29.06^{efA}	15	7	46.67±24.04^{cdA}	15	2	13.33±13.33^{Fb}	45	16	35.56^{d}
Wheel swabs	15	8	53.33±26.67^{defB}	15	10	66.67±17.64^{bcA}	15	8	53.33±24.04^{deB}	45	26	57.78^{cd}
Total	180	126	70	180	150	83.33	180	126	70	540	402	74.44

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

Table 15 The prevalence of Pseudomonas spp. was isolated from different samples in breeder chicken farms.

Parameters	Farm A			Farm B			Farm C			Total		
	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%
Wall swabs	15	6	40.00±23.09^{dA}	15	4	26.67±13.33^{dB}	15	5	33.33±17.64^{fAB}	45	15	33.33^{d}
Air dust	15	9	60.00±11.55^{cA}	15	7	46.67±17.64^{bcB}	15	9	60.00±11.55^{cdA}	45	25	55.56^{bc}
Feed stores	15	0	0.00^{fA}	15	0	0.00^{fA}	15	0	0.00^{gA}	45	0	0.00^{e}
Feed from feeders	15	5	33.33±6.67^{deB}	15	7	46.67±6.67^{bcA}	15	6	40.00±5.77^{efAB}	45	18	40.00^{cd}
Water source	15	10	66.67±33.33^{bcA}	15	6	40.00±23.09^{cdB}	15	9	60.00±11.55^{cdA}	45	25	55.56^{bc}
Drinkers	15	12	80.00±20.00^{abB}	15	12	80.00±11.55^{aB}	15	14	93.33±6.67^{aA}	45	38	84.44^{a}
Source of litter	15	9	60.00±11.55^{cA}	15	3	20.00±11.55^{deB}	15	8	53.33±27.28^{deA}	45	20	44.44^{cd}
Pen litter	15	10	66.67±13.33^{bcB}	15	12	80.00±11.55^{aA}	15	11	73.33±27.28^{bcAB}	45	33	73.33^{ab}
Cloacal swabs	15	13	86.6±6.67^{aA}	15	9	60.00±0.00^{bB}	15	12	80.00±0.00^{abA}	45	34	75.56^{a}
Droppings	15	10	66.67±33.33^{bcC}	15	14	93.33±6.67^{aA}	15	12	80.00±11.55^{abB}	45	36	80.00^{a}
Hand swabs	15	3	20.00±11.55^{efA}	15	1	6.67±6.67^{efB}	15	0	0.00^{gB}	45	4	8.89^{e}
Wheel swabs	15	2	13.33±13.33^{fB}	15	5	33.33±6.67^{cdA}	15	6	40.00±23.09^{efA}	45	13	28.89^{d}
Total	180	89	49.45^{A}	180	80	44.45^{A}	180	92	51.11^{A}	540	261	48.33

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

Table 16 The prevalence of Pseudomonas spp. isolated from different samples in duck farms.

Parameters	Farm A			Farm B			Farm C			Total		
	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%	No of samples	No of +ve	%
Wall swabs	15	9	60.00±11.55^{bcA}	15	9	60.00±23.09^{cdA}	15	10	66.67±3.33^{cA}	45	28	62.22^{cd}
Air dust	15	11	73.33±13.33^{bB}	15	15	100.00^{aA}	15	12	80.00±11.55^{bB}	45	38	84.44^{ab}
Feed stores	15	0	0.00^{fB}	15	1	6.67±6.67^{fAB}	15	2	13.33±13.33^{fA}	45	3	6.67^{g}
Feed from feeders	15	6	40.00±0.00^{dB}	15	10	66.67±13.33^{cA}	15	7	46.67±6.67^{dB}	45	23	51.11^{de}
Water source	15	11	73.33±6.67^{bA}	15	11	73.33±13.33^{bcA}	15	10	66.67±13.33^{cA}	45	32	71.11^{bc}
Drinkers	15	15	100.00^{aA}	15	13	86.67±6.67^{abB}	15	14	93.33±33.33^{abAB}	45	42	93.33^{a}
Source of litter	15	2	13.33±13.33^{efB}	15	4	26.67±13.33^{eA}	15	3	20.00±11.55^{efAB}	45	9	20.00^{fg}
Pen litter	15	14	93.3±3.333^{aA}	15	14	93.33±6.67^{aA}	15	15	100.00^{aA}	45	43	95.55^{a}
Cloacal swabs	15	14	93.33±6.67^{aA}	15	15	100.00^{aA}	15	11	73.33±5.77^{cB}	45	40	88.89^{ab}
Droppings	15	15	100.00^{aA}	15	14	93.33±6.67^{aA}	15	14	93.33±13.33^{abA}	45	43	95.55^{a}
Hand swabs	15	3	20.00±10.00^{eC}	15	7	46.67±24.04^{dA}	15	5	33.33±33.33^{deB}	45	15	33.33^{ef}
Wheel swabs	15	8	53.33±3.33^{cdA}	15	2	13.33±13.33^{efC}	15	4	26.67±13.33^{efB}	45	14	31.11^{f}
Total	180	108	60.00^{A}	180	115	63.89^{A}	180	107	59.44^{A}	540	330	61.11

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.
A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter

4. DISCUSSION

way for significant limitation of disease contact risks. The high level of biosecurity may be related to the absence or low prevalence of many important infectious poultry diseases. Producers should be aware that there is a great need to maintain good biosecurity measures and understand the barriers towards biosecurity application (Greening et al., 2020).

Our results showed that there is a negative relationship between the number of APC and biosecurity levels of different poultry farms (Soliman and Abdallah, 2020). APC was the highest in the samples collected from pen litter, water from drinkers and feed from feeders, this is may be due to dropping contamination and also, droppings samples, that is a good media for microbial growth and multiplication regarding to moisture content, its nutrient and organic matter content (Gençoğlan and Gençoğlan, 2017; Singh et al., 2018; Emmanuel-Akerele and Adamolekun, 2021).

In contrast, APC was the lowest in samples collected from water sources, this is due to the chlorination treatment of water and also lowest feed samples from feed stores due to heat treatment during pelleting process and in some what addition of some organic acid (Emmanuel-Akerele and Adamolekun, 2021).

The prevalence of Staphylococcus was the highest in duck farms followed by layer chickens, broiler chicken's farms and the lowest prevalence was found in the breeder chickens farms which had high biosecurity measures (Hamed et al., 2021).

Our results showed that the highest prevalence of Staphylococcus was in pen litter and droppings reached up to 100% , this is may be due to contamination of pen litter by droppings, dust, skin and nasal secretions that may act as primary sources of Staphylococcus spp. (Ritz et al., 2014)), The lowest prevalence was found in water sources that might be attributed to the sanitization process of water (Jeffery, 2005) as well as in feed from feed stores due to heat treatment during pelleting process and addition of organic acid (Jones, 2002).

In previous, the high percentage of all isolated Staphylococcus spp. was indicator to bad hygiene level. While, only presence of Staphylococcus aureus is often attributed to bad hygiene level of farm (Hatakka et al., 2000**).**

The highest prevalence of Streptococcus was found in duck farms (67.59 %) specially farm A (70%) which had low biosecurity measures. In contrast, the lowest prevalence was found in breeder chicken farms (37.59 %) that had high biosecurity measures (Lonc and Plewa, 2010).

The highest prevalence of Streptococcus spp. was reported in droppings and cloacal swabs, as Streptococcus spp. is normal inhabitant of intestine and mucosal flora of poultry as well as in pen litter contaminated with bird droppings (Abdullah, 2010).

Prevalence of Pseudomonas was the highest in layer chicken, followed by duck and breeder chicken farms, while the lowest was found in broiler chicken farms (42.78 %), this might be attributed to the age factor and its short cycle leading to low prevalence in environmental samples than in breeder farms (Lonc and Plewa, 2010).

The highest prevalence was isolated from drinkers, dust and to some extent in water sources as its commensal bacteria in humid environment and soil, in addition to samples from droppings and pen litter due to its high moisture content that considered good media for Pseudomonas growth (Mena and Gerba, 2009), while the lowest prevalence was found in samples from feed stores regarding to heat treatment during the pelleting process and addition of organic acid to poultry feed (Jones, 2002).

5. CONCLUSION

In conclusion, the application and implementation of biosecurity measures in the poultry farms are essential for the success of poultry production and should be a part of any poultry production to improve overall flock health, increase production, improve farm profitability and prevent entrance of diseases and obtain high product quality.

6. REFERENCES

1. Abbasi, A.G., Abro, S.H., Kamboh, A.A., Kalhoro, D.H., Mazari, M. Q., Arain, M.B. and Depar, S.H., 2020. Epidemiological studies on bacterial respiratory infections in commercial poultry of district Hyderabad, Sindh, Pakistan. Pure and Applied Biology (PAB), 9(2), 1253-1265.
2. Abdullah, I.N., 2010. Isolation and identification of some bacterial isolates from table egg. Al-Anbar J. Vet. Sci., 3 (2), 59-67.
3. Abd El-Ghany, W. A., 2021. Pseudomonas aeruginosa infection of avian origin: Zoonosis and one health implications. Veterinary World, 14(8), 2155-2159.
4. Ashry, N.M. and El Bahgy, H.E.K., 2019.Effect of Different Hygienic levels on Salmonella and Antimicrobial Resistance in Layer Cages System. American-Eurasian J. Agric. & Environ. Sci., 19(5), 350-356.
5. Carrique-Mas, J.J. and Davies, R.H., 2008. Sampling and bacteriological detection of Salmonella in poultry and poultry premises'. Rev. sci. tech., 27(3), 665-677.
6. Cuc, N.T.K., Dinh, N.C., Quyen, N.T.L., Tuan, H.M., 2020. Biosecurity level practices in pig and poultry production in Vietnam. Adv. Anim. Vet. Sci, 8(10), 1068–1074.
7. Eraky, R.D., Abd El-Ghany, W.A. and Soliman, K.M., 2020. Studies on Pseudomonas aeruginosa Infection in Hatcheries and Chicken. Journal of the Hellenic Veterinary Medical Society, 71(1),1953-1962.
8. Emmanuel-Akerele, H., and Adamolekun, P., 2021. Microbiological Assessment of Poultry Droppings, Water and Soil Under Deep Litter (Dl) And Battery Cage (Bl) Systems Within Lagos, Nigeria. Malaysian Journal of Applied Sciences, 6(1), 80-98.
9. FAO, 2020. FAO Viet Nam urges improved application of biosecurity along poultry production chain. http://www.fao.org/vietnam/news/detail-events/en/c/1098535/
10. Gençoğlan, S., and Gençoğlan, C., 2017. The effect of the litter materials on broiler chickens welfare and performance. Turkish Journal of Agriculture-Food Science and Technology, 5(12), 1660–1667.
11. Greening, S.S., Mulqueen, K., Rawdon, T.G., French, N.P. and Gates, M.C., 2020. Estimating the level of disease risk and biosecurity on commercial poultry farms in New Zealand. New Zealand Veterinary Journal, 68(5), 261–271.
12. Hamed, E.A., Abdelaty, M.F., Sorour, H.K., Roshdy, H., AbdelRahman, M.A.A., Magdy, O. and Badr, H.,2021. Monitoring of Antimicrobial Susceptibility of Bacteria Isolated from Poultry Farms from 2014 to 2018. Veterinary Medicine International, 2021.
13. Hassan, S.H.A., Abskharon, R.N.N., Gad El-Rab, S.M.F. and Shoreit, A.A.M., 2008. Isolation, characterization of heavy metal resistant strain of Pseudomonas aeruginosa isolated from polluted sites in Assiut city, Egypt. Journal of Basic Microbiology, 48(3), 168-176.
14. Hatakka, M., Björkroth, K. J., Asplund, K., Mäki-Petäys, N. and Korkeala, H.J.,2000. Genotypes and enterotoxicity of Staphylococcus aureus isolated from the hands and nasal

cavities of flight-catering employees. Journal of food protection, 63(11), 1487-1491.
15. Hyeon, J. Y., Mann, D. A., Wang, J., Kim, W. K. and Deng, X.,2019. Rapid detection of Salmonella in poultry environmental samples using real-time PCR coupled with immunomagnetic separation and whole genome amplification. Poultry science, 98(12), 6973-6979.
16. Ievy, S., Islam, S., Sobur, A., Talukder, M. and Rahman, B., 2020. Molecular Detection of Avian Pathogenic Escherichia coli (APEC) for the First Time in Layer Farms in Bangladesh and Their Antibiotic Resistance Patterns. Microorganisms, 8(7), 1021.
17. Jeffrey, J.S., 2005. Sanitation: Disinfection basics for poultry flock. Extension Poultry Veterinarian, University of California, Davis file://E:/sanitation: Disinfection Basics for poultry flocks.
18. Jones, F.T., 2002. Feed mill HACCP and pathogen reduction strategies http://www.aganscpurdue.edu/poultry/multistate/multistate%20poultry%20meeting%20preceedings%20F.J.pdf.
19. Kmetova, M., 2009. Antibiotic resistance of Escherichia coli isolated from poultry and poultry environment of Bangladesh. Internet Journal of food safety, 11, 19-23.
20. Kustritz, M. R., 2022. Biosecurity. In: Veterinary Preventive Medicine. University of Minnesota Libraries Publishing.
21. Lonc, E. and Plewa, K., 2010. Microbiological Air Contamination in Poultry Houses, Polish J. of Environ. Stud. 19 (1), 15-19.
22. Mateus-Vargas, R.H., Butenholz, K., Volkmann, N., Sürie, C., Kemper, N. and Schulz, J., 2022. Boot Swabs to Evaluate Cleaning and Disinfection Success in Poultry Barns. Agriculture, 12(1), 57.
23. Mena, K.D. and Gerba, C.P., 2009. Risk Assessment of Pseudomonas aeruginosa in water. Rev Environ Contam Toxicol, 201, 71-115.
24. Metawea, Y. F. 2003. Some epidemiological studies on Salmonella in poultry farms, Ph. D Thesis, Animal, Poultry Hygiene and Ecology, Fac. Vet. Med. (Moshtohor), Zagazig University.
25. Quddoumi, S.S., Bdour, S.M. and Mahasneh, A.M., 2006. Isolation and characterization of methicillin-resistant Staphylococcus aureus from livestock and poultry meat. Annals of microbiology, 56(2), 155-161.
26. Quinn, P.J., Markey, B.K., Carter, M.E., Donnelly, W.J.C. and Leonard, F.C., 2002. Veterinary microbiology and microbial disease. Blackwell science.
27. Ritz, C.W., Fairchild, B.D. and Lacy, M.P., 2014. Litter quality and broiler performance. Extension Poultry Scientists. UGA extension. Bulletin, Athens. p1267.
28. Saleha, A. A., 2002. Isolation and Characterization of Campylobacter jejuni from Broiler Chickens in Malaysia, International Journal of Poultry Science, 1(4), 94-97.
29. Sayeed, M.A., Smallwood, C., Imam, T., Mahmud, R., Hasan, R.B., Hasan, M., Anwer, M.S., Rashid, M.H. and Hoque, M.A., 2017. Assessment of hygienic conditions of live bird markets on avian influenza in Chittagong metro, Bangladesh. Prev. Vet. Med. 142, 7–15.
30. Sharma, D., Singh, N.K., Singh, H., Joachim, A., Rath, S.S., and Blake, D.P., 2018. Discrimination, molecular characterization and phylogenetic comparison of porcine Eimeria spp. in India. Vet. Parasitol., 255, 43–48.
31. Singh, P., Mondal, T., Sharma, R., Mahalakshmi, N., and Gupta, M., 2018. Poultry waste management. Int. J. Curr. Microbiol. App. Sci, 7(08), 701-712.
32. Soliman, E.S. and Abdallah, M.S., 2020. Assessment of biosecurity measures in broiler's farms in the Suez Canal area–Egypt using a seasonal prevalence of Salmonellosis. Veterinary World, 13(4), 622-632.
33. Sule, I.O., Olorunfemi, A.A. and Otori, A.O., 2019. Mycological and Bacteriological Assessment of Poultry Droppings from Poultry Pens within Ilorin, Kwara, Nigeria., Science World Journal, 14(4), 11-16.
34. Sudershan, R.V, Kumar, R.N., Kashinath, L., Bhaskar, V. and Polasa, K., 2012. Microbiological Hazard Identification and Exposure Assessment of Poultry Products Sold in Various Localities of Hyderabad, India. , 2012, 736040.
35. Szafraniec, G. M., Szeleszczuk, P. and Dolka, B., 2022. Review on skeletal disorders caused by Staphylococcus spp. in poultry. Veterinary Quarterly, 42(1), 21-40.
36. Willey, J.M., Sherwood, L.M. and Woolverton, C.J., 2011. Prescott Microbiology. 8th edition, McGraw-Hill companies, New York. 1070pp.
37. Yang, Z., Aarnink, A.J.A., de Jong, M.C.M. and Koerkamp, P.W.G.G., 2014. Airborne microorganisms from livestock production systems and their relation to dust. Cri. Rev. Environ. Sci. Technol., 44: 1071–1128.
38. Yashoda, K.P., Sachindra, N.M., Sakhare, P.Z. and Narasimha R.A.O., 2001. Microbiological quality of broiler chicken carcasses processed hygienically in a small-scale poultry processing unit. Journal of Food Quality 24, 249-259.
39. Zakki, S.A., Qureshi, R., Hussain, A., Ghias, W., Sharif, M. and Ansari, F., 2017. Microbial quality evaluation and prevalence of bacteria and fungus in different varieties of chicken meat in Lahore. RADS Journal of Pharmacy and Pharmaceutical Sciences, 5(1), 30-37.