HYGIENIC STATUS OF SOME EGG LAYING FARMS UNDER DIFFERENT HOUSING SYSTEMS

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SUMMARY

The hygienic status and moralities in four egg laying farms with different housing systems at Menoufia Governorate were monitored and evaluated. Two farms were of deep litter system while the other two farms belonged to cages system. The four farms were visited over a period of (42 weeks) and sixty samples from each of air, and water were collected and examined. The microclimatic conditions inside the investigated farms (ambient temperature, R. H., air speed and light intensities) were monitored and recorded. The mean values of ammonia concentrations (ppm) in the four farms were slightly above the recommended level. There were significant differences in CO2 percentages and NH_3 concentrations between the two deep litter farms and those of cages system. Concerning the total bacterial counts (CFU/l) of air in the investigated farms, the highest count was recorded in one of the cages system farms, followed by the two deep litter system farms. Total coliform count of air in the four farms showed a nearly similar trend. It was interesting to notice that the highest total bacterial and coliform counts of air ran parallel to the concentrations of NH_3 and CO_2 in these farms. Chemical examination of water samples collected from the four investigated farms indicated that the mean values of total hardness and orgnic matter content were above the guideline levels of the W. H. O. The mean values of chloride, sulphate, phosphate, nitrite and ammonia were below their permissible limits. Concerning the total bacterial, total coliform and fecal Streptococcal counts in water samples, there were no significant differences between water samples collected from deep litter system and cages farms. This mean that the management practice and sanitation of the watering systems in all farms regardless the housing system were not satisfactory. Various species of microorganisms were isolated from air and water in the examined farms. Total mortality rates in the examined farms were slightly lower in farms belonged to cages system than those belonged to the deep litter system. It can be concluded that regardless of the housing system, management, sanitation and biosecurity measures taken in each farm improve or reduce the hygienic status of the layer flock.

INTRODUCTION

Application of intensive production systems is necessary to satisfy the great demands of the increased human population in Egypt. Successful application of these programs depends not only on the genetic make-up of birds and their feeding but also basically on the standard of hygiene and efficient disease control. In addition to its role in transmission of diseases among chicken, the environment of birds is one of the main factors that affect their growth and wellbeing. Airborne emission of nitrogenous compounds as well as small particulate matter generated by poultry production are numerous and can be a health and performance issue for birds and their caretakers and environmental concern on both local and global scale. Air may also contain dust particles loaded with different types of microorganisms and such biological impurities of air may also suspended and disseminated in the surrounding *(Wilson and Miles, 1957)*. Consequently, infection may be easily introduced to birds as they are usually housed in closed places with high density so, the flock can be easily infected from an environmental source *(Curtis, 1983)*.

It is recommended that the water supply in regions where poultry are reared should be analyzed for mineral and microbial content to determine suitability for consumption *(Barton, 196 and King, 1996)*. In the current work, there was a trail to evaluate the hygienic conditions under which laying hens were intensively reared through different housing systems that are common in almost Egypt.

MATERIALS AND METHODS

The current work was carried out in 4 egg laying houses located at different regions at Menoufia Governorate (two were of deep litter system and the other two farms were of cages system).Full description of these farms was given in table (1).

Farm and location	Type	capacity	Stocking density	Breed	No.of of visits	Water source
Farm I Kamshish	Cages	7200	6 birds/cage	Red and white Lohman	6	Deep well
Farm II Sadat City	Deep litter	5400	10 birds/m2	White Lohman	7	Deep well
Farm III Tanbisha	Deep litter	7200	12 birds/m2	Iza Brown	6	Deep well
Farm IV Tanbisha	Cages	3000	6 birds/cage	Iza brown	6	Deep well

The investigated were visited regularly during the egg-laying season at different times for sample collection and monitoring the microclimatic conditions inside the houses. Sample collection started after introduction of the laying flocks into the production cycle at 22 nd. week till 78 th week of the bird's age.

Air samples:

A total of 60 air samples were collected from the investigated farm at regular intervals throughout the laying period. Air samples were collected by liquid impinger method according to *(Negulescu et al., 1961)* for detection of gaseous impurities (ammonia and CO2) and for bacteriological examination of air.

Water samples:

Sampling of water was carried out according to *W.H.O. (1971).* A total of 60 samples were collected from the investigated farms (main source, reservoir tanks and drinkers) under aseptic conditions. Each water sample was collected in two clean, sterile, colorless glass bottles of 1 liter capacity and transferred directly to the laboratory.

Ambient temperature and air speed inside the examined layers houses were detected by using Thermoanemeter ( ). Relative humidity was determined by using hair hygrometer, while the light intensity was estimated by using light intensity meter ( ). Determination of CO2 and NH3 concentrations inside the investigated layers houses were carried out according to *Taylor (1958)* and *A.O.A.C. (1979),* respectively.

Water PH was determined by using PH meter. The concentrations of nitrate and sulphates in the examined water samples were determined according to *(A.P.H. A., 1975),* while ammonia, hardness and chlorides in water were determined according to *A.P.H.A. (1985).* The orgnic matter and phosphate contents in water samples were determined according to *W.H. O. (1971).*

Bacteriological examination of air and water samples:

1. Total bacterial count of air and water samples according to *(Cruickshank et al., 1980).*
2. M.P.N. of coliforms according to *A.P.H.A. (1985).*
3. Fecal Streptococcal counts according to *A.P.H.A. (1985).*
4. Isolation and identification of pathogenic and potentially pathogenic bacteria according to *Cruickshank (1975) and Finegold and Martin (1982).*

RESULTS AND DISCUSSION

The microclimatic conditions play a significant role in the survival and spreading of bacteria and other biological impurities that present in the environment of birds. Data presented in table (2) showed that the mean ambient temperature values in the four examined farms were (20.09 ± 0.45; 23.07± 1.15; 23.48 ± 1.44 and 23.93 ± 2.12 °C, respectively) with the highest value recorded in the 4th farm. The mean temperature values lied within the recommended range for laying hens. The average temperature values in the four examined farms were lower than those recorded by *Al-Azab (1997) and Rehab El-Zarka (2003)* who reported average indoor air temperatures inside some egg producing farms between (28-31 °C). *Deaton et al. (1978) and Farooq et al. (2002)* stated that environmental temperature was correlated with many measures of performance including feed and water consumption, body weight, weight gain, egg production, feed conversion and egg weight.

They claimed that a temperature range (12-26 °C) is suitable for hens during egg production. Very high and low humidities (greater than 90% 0eor less than 30%) are said to be detrimental to animal health *(Sainsbury and Sainsbury, 1979)*, although whether this is due to enhanced challenge from infectious agents and or a reduced resistance of the animal host *(Webster, 1981)*. From the results in table (2), the mean relative humidity values in the four examined farms were (65; 60.26 ± 1.56; 58.6 ± 1.41 and 57.4 ± 1.65 %, respectively). These values were nearly similar to those reported by *Rehab El- Zarka (2003),* but lower than those of *El-Azab (1997)* who recorded R.H. % between (60-92%) inside an egg laying house of battery system. *Yahav et al. (2004)* concluded that temperature is the main environmental factor affecting young and older laying hens, while the effect of R.H. is minor.

Data presented in table (2) revealed that the mean values of air speed in the four examined farms were (0.20 ±0.02; 0.59 ± 0.09; 0.40 ± 0.04 and 0.44 ± 0.04 m/s, respectively). Nearly similar results were recorded by *Samaha et al. (2002). Yahav, et al. (2004)* found that the connective heat loss increased significantly with increasing air velocity, whereas relative heat loss was not effective. They concluded that air speed of (2.0 m/s) at constant temperature of 35 °C and R.H. of 65% enable broilers to maintain proper performance together with efficient thermoregulation and water balance under harsh environmental conditions.

Light has a direct effect on bird's hormonal release, sleep patterns and activity. The results illustrated in table (20 showed that the mean values of light intensity in the four examined farms were (10.30 ± 0.87; 27.5 ± 2.09; 33.84 ± 2.12 and 28.34 ±1.72 lux, respectively). Much lower values of light intensity were recorded by *Rehab El-Zarka (2003). Sainsbury (1993)* proposed that the light intensity inside the layer house should be about 10-16 lux and if light intensity is weak, the birds will concentrate in certain areas which may lead to development of vices and diseases. Good indoor air quality depends on barn management, feeding and manure handling systems, the ventilation systems as well as on the overall cleanliness of the operation and the type of livestock. Ammonia is prevalent in most poultry houses especially during winter months. According to table (3), the highest concentration of ammonia was detected in the fourth farm (41.33 ± 2.86 PPM), followed by the 3rd farm (37.67 ± 2.12 PPM), then the 2nd farm (37.67 ± 2.17 PPM) and the first farm (25 ± 0.98 PPM). There were significant differences (P= 0.05) between the 1st, 2nd, 3rd and the 4th farm. These results agreed with those of *Samaha et al. (2002) and Rehab El- Zarka (2003).* Ammonia is considered as an irritant gas and readily impacts the eyes and respiratory tract. Ammonia can increase the susceptibility of the respiratory system to airborne pathogens. The recommended level for short-term exposure (15 minutes) is not greater than35 PPM *(Jester and Malone, 2002).* From table (3), it has been found that the mean values of CO_2 percentages in air of the four examined farms were (0.40 ± 0.03; 0.80 ± 0.09; 0.72 ± 0.05 and 0.88 ± 0.08%, respectively). Fairchild (2003) described that the same two events that

require oxygen (bird respiration and combustion of propane for heating) are also major producers of carbon dioxide. High carbon dioxide content not only increase the rate of respiration but also responsible for spreading of respiratory infections due to reduction of the body resistance and damage of cilia of the respiratory tract *(Anderson and Bread, 1967).*

Bacteria in the air of poultry housing are assumed to have an impact on the health of humans and poultry as well as on the environment. *Wathes et al. (1983)* stated that two things must be considered in studying microbial air pollution, first the majority of bacteria colony forming unit particles are not in themselves pathogenic, secondary that bacterial particles do not necessarily need to be viable to produce an immune response or embarrass the respiratory tract. Table (4) represented the total bacterial, total coliform (M.P.N.) and Streptococcal counts in the air of the four examined layer farms.

The total bacterial count was ($1.41 \times 10^5 \pm 6.58 \times 10^4$; $2.44 \times 10^6 \pm 1.44 \times 10^6$; $2.43 \times 10^7 \pm 1.30 \times 10^7$ and $3.81 \times 10^7 \pm 3.33 \times 10^6$ cfu/l in the four farms, respectively). From the outgoing results, it was clear that the highest bacterial count was detected in the fourth farm, followed by the 3rd farm, the 2nd and the 1st farms, respectively. There were significant differences in the total bacterial counts ($p= 0.05$) between the 4th and the 3rd farms in part and the 1st and 2nd farms in another part. It seemed that the system of housing had no big influence on the bacterial count of air in the examined farms rather than the stocking density of hens. *Draz and Samaha (1992) and Samaha et al. (2002)* recorded slightly lower values. On the other hand, *Sotohy (1989)* and *Seedrof and Hartung (2003)* recorded relatively higher total bacterial counts (cfu/m3) in air of broiler houses.

The coliform group of bacteria may be from the intestine of man and animals and can consider as a reliable index of fecal pollution *(Cruickshank, et al., 1975).* From table (4), it was noticed that the mean values of (M.P.N.) of fecal coliforms in air of the examined farms were (22.17 ± 8.84; $2.56 \times 10^2 \pm 1.49 \times 10^2$; $4.98 \times 10^2 \pm 2.18 \times 10^2$ and $4.15 \times 10^2 \pm 1.84 \times 10^2$, respectively).The highest M.P.N. of fecal coliforms was recorded in the 3rd farm, followed by the 4th, then the 2nd and the 1st farms. The obtained results were higher than those reported by Drab and *Samaha (1992) and Rehab El-Zarka (2003).* The number of coliforms in air of poultry houses is correlated to their number in litter, biological activity of birds and stocking density *(Hojovec and Fischer, 1968 and Lovett et al., (1971).*

Table (4) showed the mean fecal Streptococcal counts in air of the four farms were (1.7 ± 0.21; 6.45 ± 1.92; 7.09 ± 2.07 and 5.33 ± 1.49 bacteria/ l, respectively). There was significant differences between fecal Streptococcal counts in the 1st farm and the other three farms at (P+ 0.05) which may indicated a better air quality in the first farm which reflected in lower counts of viable bacteria, (M.P.N.) of fecal coliforms and Streptococci. The obtained

results were lower than those of *Samaha et al. (2002) and Rehab El-Zarka (2003)*. Table (5) represented the results of chemical examination of water samples collected from the four examined farms. The mean values of PH in water samples were slightly higher than the range of the W.H.O. (7.0-8.5). Table (5) showed that the mean values of total hardness in water samples from the four examined farms were (257.5 ± 2.98; 366.25± 6.88; 368.75 ± 4.26 and 772.5 ± 9.46, respectively). All samples had higher values than that of the guideline value (100 mg/l) as previously recommended by the *W.H.O. (1984)*. Hard water used in poultry farms has an adverse effect on health by causing watery feces, leg deformities, loss of body weight and lowering production *(Waggoner et al., 1985)*. The mean values of orgnic matter content in water samples collected from the four farms (table. 5) were (42.5 ± 4.78; 30 ± 4.08; 32.5 ± 4.08 and 42.5 ± 4.78 mg/l, respectively).

The maximum permissible limit of orgnic matter in surface water was recorded to be (8 mg/l) *(Water quality Standard, 1971). W.H.O. (1971)* indicated that the presence of a high content of orgnic matter in water reported to have a hygienic significance since it was considered as the principal microbial load and can be taken as an index of fecal pollution.
Table (5) showed that the mean values of chloride in water samples from the four farms were (110 ± 4.08; 78 ± 2.04; 113.75 ± 4.78 and 100 ± 1.08 mg/l, respectively). *Ali (1988) and El-Olemy et al. (1989)* recorded nearly similar results. The chloride content in all the examined samples were lower than the permissible limit (250 mg/l) as recorded by *(N.C.S.U., 1987)*.

The data shown in table (5) revealed that the means of sulphate content in water samples from the four farms were (117.25 ± 1.10; 156.25 ± 2.4; 113.76 ± 4.78 and 87.5 ± 3.22 mg/l, respectively). *Samuel and Osman (1983)* stated that sulphate may cause detectable taste at a concentration above 600 mg/l, it may have a laxative effect. The mean values of phosphate content in the examined water samples from the four layer farms were (0.01± 0.0002; 0.11 ± 0.014; 0.014 ± 0.0016 and 0.139 ±0.004 mg/l, respectively). These data agreed nearly with those of *Ali (1988), Mubarak (1989) and Zaki et al. (2002)*. The mean values of nitrate in water sample from the four investigated farms were (28.5 ± 0.64; 37 ± 1.08; 37.25 ± 1.43 and 41.5 ± 0.64 mg/l, respectively). The determined nitrate concentrations in the examined samples were slightly higher than the permissible limit (25 mg/l) as recorded by (N.C.S.U., 1987). The mean values of nitrites in the examined water samples from the four farms were (0.30 ± 0.04; 0.60 ± 0.04; 0.39 ±0.02 and 0.48 ± 0.01 mg/l, respectively). These values are lower than the permissible limit (4.0 mg/l) as previously cited in the Water Quality Guidelines for poultry *(N.C.S.U., 1987)*. The mean values of ammonia content in the four farms were (0.182 ± 0.003; 0.147 ± 0.006; 0.007 ± 0.005 and 0.13 ±0.004 mg/l, respectively). Ammonia should not exceed the level of 0.5 mg/l *(W.H.O., 1984)*.

From the results in table (6), the mean values of the total bacterial count (cfu/ml) in water samples collected from the four examined farms were

($2.48 \times 10^7 \pm 2.14 \times 10^7$; $2.69 \times 10^7 \pm 1.65 \times 10^7$; $3.82 \times 10^8 \pm 3.55 \times 10^8$ and $1.98 \times 10^7 \pm 1.05 \times 10^7$, respectively). There was a significant difference at (P= 0.05) between the mean total bacterial count in water from the 3rd farm and that of the other three farms. It was of interest that the means of the total bacterial count in water from the 2nd and 3rd farms (deep litter system) was slightly higher than that from the 1st and 4th farms (cages), which may be due to contamination of drinkers water with the droppings of birds and litter. These results were higher than those estimated by *El-Wakeel (1987), Ali (1988) and El-Olemy et al. (1989).* The means of total coliform count (M.P.N.) in the examined water samples from the four farms were ($6.30 \times 10^3 \pm 2.01 \times 10^2$; $3.10 \times 10^2 \pm 1.33 \times 10^2$; $1.01 \times 10^3 \pm 2.10 \times 10^2$ and $9.88 \times 10^2 \pm 2.32 \times 10^2$, respectively). It was clear that the highest (M.P.N.) values were determined in water samples obtained from the 3rd farm, which coincided with the same trend of the total bacterial counts. This indicated that the water hygienic quality in these farms might be the inferior.

The mean values of the fecal Streptococcal count in water samples collected from the four farms were (4.84 ± 1.16; 3.69 ± 0.88; 16.57 ± 3.88 and 7.92 ± 1.26 cfu/ml, respectively). These results agreed with those of *Mubarak (1989) and Rehab El-Zarka (2003).* The higher mean values of (T.F.S.) count were also attained in water samples collected from the third farm which was coincided with the results of the (T.B.C.) and (M.P.N.) of coliforms in the same farm. This meant that water in this farm was bacteriologically unfit and might affect the health and performance of the laying hens.

Demonstration of pathogenic and potentially pathogenic microorganisms in air and water would constitute the most direct proof of dangerous contamination, since air and water can act as vehicles of disease transmission to man and animals. Staphylococcus aureus was isolated from air samples of the four layer farms (table 7) in the incidence percentages of (1.19; 1.59; 1.99 and 0.79, respectively). On the other hand, it was isolated from water samples of the four examined farms (table 8) in the following percentages (1.52; 1.90; 1.90 and 1.14, respectively). *Ola Basha (1994)* and *(1997)* recorded similar results. Staph. aureus is a common cause of synovitis and arthritis which is a septicaemic Staphylococcal infection localized in the joints and tendon sheaths leading to bumble foot *(Devries et al., 1975).*

Staph. epidermidis was isolated from air samples of the four layers farms in the incidence percentages of (1.99; 3.81; 2.78 and 2.39, respectively). Moreover, it was isolated from water samples in the same farms in the percentages of (2.67; 3.81; 3.81 and 3.05, respectively). These results coincided with those of *Sotohy (1989)* but higher than that obtained by *Ola Basha (1997).* The incidence percentages of Streptococcus fecalis in air samples of the four examined farms were (1.59; 1.19; 1.99 and 1.19, respectively). The incidence percentages of Streptococcus faecalis in the four farms were (1.52; 3.81; 3.81 and 1.90, respectively). These results were

slightly higher than that recorded by *Sotohy (1989) and Rehab El-Zarka (2003).* The presence of these organisms inside poultry houses indicates bad hygiene. It causes streptococcal septicemia of chicken with losses up to 50%. E. coli was isolated from air samples in the four farms (table 7) with the incidence percentages of (1.59, 2.39; 1.99 and 1.19, respectively). On the other hand, it was isolated from water in the water samples in the four farms with the incidence percentages of (1.90; 2.29; 2.29 and 1.52, respectively). These results were lower than those obtained by *Sotohy (1989) and Ola Basha (1997).*

Klebsiella Pneumonae was isolated from the air of the four farms at the percentages of and (1.19; 1.99; 1.59 and 0.39, respectively). It is also isolated from water samples in the four farms (table 8) at the percentages of (1.90; 2.29; 3.05 and 1.14, respectively). These results were similar to those of *Sotohy (1989).* From the hygienic point of view, the presence of this pathogen in the air and water of poultry houses is considered as an evidence of pollution with orgnic matter derived from animal origin.

Proteus vulgaris was isolated from air samples in the four investigated farms at the incidence percentages of (0.39; 0.79; 1.19 and 0.39, respectively). Correspondingly, it was isolated from water samples in the same farms at the percentages of (0.38; 0.76; 0.76 and 0.0, respectively). These results agreed with those of *Rehab El-Zarka (2003)* but lower than those of *Sotohy (1989).* Proteus mirabilis, rettergi and morganii were also isolated from air and water samples at varying percentages. Proteus spp. have been incriminated with many other organisms in the case of pneumonia, septicemia, peritonitis, enteritis, retained yolk sac and chronic respiratory disease *(Sotohy, 1989).*

Shigella flexneri was isolated from the air of the 2nd, 3rd and 4th farms at the incidence percentage (0.39) with a total incidence percentage of (1.19). The incidence percentage of Shigella flexneri in water samples from the four farms were (0.38; 0.76; 1.14 and 0.0, respectively). These results were nearly similar to those of *Ola Basha (1997)* and *Rehab El-Zarka (2003).* Other coli aerogenes were isolated from air and water samples in the four examined farms at various incidence percentages: Citrobacter diversus; Citrobacter freundii; Enterobacter coloacae; Enterobacter liquefaciens, Serratia Spp. and Provedencia spp. Since these organisms are considered as members of enterobacteriaceae, their presence indicate fecal pollution *(W.H.O., 1971).*

Pseudomonas aeurogenosa was isolated from air samples of the four layers farms at the incidence percentages of (2.78; 3.58; 3.98 and 3.18, respectively). *Ola Basha (1997) and Rehab El-Zarka (2003)* obtained similar results. Our results revealed the isolation of Salmonella spp. in air samples obtained from the 2nd and 3rd layer farms at the incidence percentage of (0.39) with a total incidence percentage of (0.78). Salmonella spp. was isolated from water samples in the same farms (deep litter farms) with

incidence percentage of (0.39) and a total incidence percentage of (0.78). These results agreed with those of *Sotohy (1989)* but lower than those of *Ola Basha (1997) and Rehab El-Zarka (2003).* It can be concluded that there is a close relationship between the microclimatic conditions and the bacterial population inside the layer house. Regardless of the housing system, management, sanitation and biosecurity measures taken in each farm are of paramount importance to improve or reduce the hygienic condition of the laying flock.

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Table (2) Micro-climatic data of the examined layer farms

Farm	Item	Minimum	Maximum	Mean ± SE	DMRT
Farm 1 (Cages)	Temperature °C	18.1	24	20.09 ± 0.45	B
	R.H.%	60	70	Average 65%	-
	Air speed (m/s)	0.10	0.30	0.20 ± 0.02	C
	Light intensity (lux)	3	17	10.30 ± 0.87	C
Farm 2 (deep litter)	Temperature °C	15.5	29.1	23.07 ± 1.15	A
	R.H.%	48.4	68.5	60.29 ± 1.56	A
	Air speed (m/s)	0.20	1.30	0.59 ± 0.09	A
	Light intensity (lux)	13	55	27.5 ± 2.09	B
Farm 3 (Deep litter)	Temperature °C	14.60	33.40	23.48 ± 1.44	A
	R.H.%	47.3	67.3	58.6 ± 1.41	Ab
	Air speed (m/s)	0.20	0.80	0.40 ± 0.04	B
	Light intensity (lux)	16	65	33.84 ± 2.12	A
Farm 4 (Cages)	Temperature °C	14.3	34.3	23.93 ± 1.47	A
	R.H.%	47.40	67.3	57.4 ± 1.65	B
	Air speed (m/s)	0.20	0.80	0.44 ± 0.04	B
	Light intensity (lux)	10	51	28.34 ± 1.72	b

DMRT = Duncan's multiple range test

Table (3) Ammonia (PPM) and CO2 (%) concentrations in the air of the examined layer farms

Farm	Item	Minimum	Maximum	Mean ± SE	DMRT
Farm 1 (cages)	Ammonia	20	30	25 ± 0.98	C
	CO2	0.12	0.60	0.40 ± 0.03	B
Farm 2 (deep litter)	Ammonia	25	55	37 ± 2.17	B
	CO2	0.10	1.40	0.80 ± 0.09	A
Farm 3 (deep litter)	Ammonia	25	55	37.67 ± 2.12	Ab
	CO2	0.50	1.20	0.72 ± 0.05	A
Farm 4 (cages)	Ammonia	25	60	41.33 ± 2.86	A
	CO2	0.45	1.40	0.88 ± 0.08	a

Table (4) Total bacterial count (cfu/l), total coliform count (M. P. N.) and fecal Streptococcal count of the examined air samples from the layer farms

Farm	Item	Minimum	Maximum	Mean ± SE	DMRT
Farm 1 (cages)	T.B.C.	7×10^2	6×10^5	$1.41 \times 10^5 \pm 6.58 \times 10^4$	c
	T.C.C.	2	1.10×10^2	22.17 ± 8.84	b
	T.F.S.	1	3	1.7 ± 0.21	b
Farm 2 (deep litter)	T.B.C.	4×10^3	1.40×10^7	$2.44 \times 10^6 \pm 1.44 \times 10^6$	b
	T.C.C.	2	1.80×10^3	$2.56 \times 10^2 \pm 1.49 \times 10^2$	a
	T.F.S.	1	20	6.45 ± 1.92	a
Farm 3 (deep litter)	T.B.C.	7×10^3	1.20×10^8	$2.43 \times 10^7 \pm 1.30 \times 10^7$	a
	T.C.C.	2	1.80×10^3	$4.98 \times 10^2 \pm 2.18 \times 10^2$	a
	T.F.S.	1	25	7.09 ± 2.07	a
Farm 4 (cages)	T.B.C.	1.2×10^4	4.70×10^8	$3.81 \times 10^7 \pm 3.33 \times 10^7$	a
	T.C.C.	2	1.80×10^3	$4.15 \times 10^2 \pm 1.84 \times 10^2$	a
	T.F.S.	2	15	5.33 ± 1.49	a

T.B.C. = Total bacterial count T. C. C. = Total coliform count
T. F. S. = Total fecal Streptococcal count

Table (5) Results of Chemical examinations of water samples collected from the four investigated layer farms

Item		Farm 1	Farm 2	Farm 3	Farm 4
PH	Average	8.6 - 8.7	8.5 – 8.73	8.5 – 8.65	8.6 – 8.7
	Mean ± SE	8.63 ± 0.023	8.63 ± 0.05	8.56 ± 0.03	8.64 ± 0.02
Hardness	Average	250 – 264	350 – 380	360 – 380	780 - 800
	Mean ± SE	257.5 – 2.98	366.25 ± 6.88	368.75 ± 4.26	772.5 ± 9.46
Orgnic matter	Average	30 – 50	20 – 40	20 – 40	30 –50
	Mean ± SE	42.5 ± 4.78	30 ± 4.08	32.5 ± 4.08	42.5 ± 4.78
Chloride	Average	100 – 120	70 – 80	110 –120	90 – 110
	Mean ± SE	110 ± 4.08	75 ± 2.04	113.75 ± 4.78	100 ± 1.08
Sulphate	Average	115 –120	150 – 160	115 – 120	80 – 95
	Mean ± SE	117.25 ± 1.10	156.25 ± 2.4	113.75 ± 4.78	87.5 ± 3.22
Phosphate	Average	0.01 – 0.011	0.155 – 0.176	0.01 – 0.02	0.13 – 0.15
	Mean ± SE	0.01 ± 0.0002	0.166 ± 0.004	0.014 ± 0.002	0.14 ± 0.004
Nitrate	Average	27 – 30	35 – 40	35 – 41	40 – 43
	Mean ± SE	28.5 ± 0.64	37 ± 1.08	37.25 ± 1.43	41.5 ± 0.64
Nitrite	Average	0.20 – 0.40	0.50 – 0.70	0.35 – 0.47	0.46 – 0.51
	Mean ± SE	0.30 ± 0.04	0.60 ± 0.04	0.39 ± 0.027	0.48 ± 0.01
Ammonia	Average	0.175 – 0.191	0.130 – 0.160	0.06 – 0.08	0.12 – 0.14
	Mean ± SE	0.182 ± 0.003	0.147 ± 0.006	0.07 ± 0.005	0.13 ± 0.004

Table (6) Total bacterial count (cfu), total coliform count (M. P. N.) and fecal Streptococcal count per ml of the examined water samples from the layer farms

Farm	Item	Minimum	Maximum	Mean ± SE	DMRT
Farm 1 (cages)	T.B.C.	3.30×10^2	2.80×10^8	$2.48 \times 10^7 \pm 2.14 \times 10^7$	B
	T.C.C.	19	1.80×10^3	$6.30 \times 10^2 \pm 2.01 \times 10^2$	Ab
	T.F.S.	1	15	4.84 ± 1.16	B
Farm 2 (deep litter)	T.B.C.	1.10×10^4	1.90×10^8	$2.69 \times 10^7 \pm 1.65 \times 10^7$	B
	T.C.C.	5	1.80×10^3	$3.1 \times 10^2 \pm 1.33 \times 10^2$	B
	T.F.S.	1	11	3.69 ± 0.88	b
Farm 3 (Deep litter)	T.B.C.	7×10^3	5×10^9	$3.82 \times 10^8 \pm 3.55 \times 10^8$	A
	T.C.C.	6	1.80×10^3	$1.01 \times 103 \pm 2.10 \times 10^2$	A
	T.F.S.	3	50	16.57 ± 3.88	A
Farm 4 (cages)	T.B.C.	1.20×10^4	1.40×10^8	$1.98 \times 10^7 \pm 1.05 \times 10^7$	B
	T.C.C.	7	1.80×10^3	$9.88 \times 10^2 \pm 2.3 \times 10^2$	A
	T.F.S.	3	20	7.92 ± 1.26	B

DMRT = Duncan's multiple range test

Means followed by similar letter are not significantly different at P= 0.05 within the same microbiological count

Table (7) incidence percentages of pathogenic and potentially pathogenic bacteria isolated from air samples in the four examined farms

Item	Farm 1		Farm 2		Farm 3		Farm 4		Total	
Microorganism	No of isolates	%	No of isolates	%	No of isolates	%	No of isolates	%	No of isolates	%
Staph. Aureus	3	1.19	4	1.59	5	1.99	2	0.79	14	5.5
Staph epidermids	5	1.99	8	3.81	7	2.78	6	2.39	26	10.3
Stept. faecalis	4	1.59	3	1.19	5	1.99	3	1.19	15	5.9
Strept. intermediumm	2	0.80	4	1.59	5	1.99	1	0.39	12	4.7
E. coli	4	1.59	6	2.39	5	1.99	1	1.19	18	7.1
Kleb. Pneumonae	3	1.19	5	1.99	4	1.59	3	0.39	13	5.1
Kleb. aerogenes	2	0.79	3	1.19	4	1.59	1	0.39	10	3.9
Proteus vulgaris	1	0.39	2	0.79	3	1.19	1	0.39	7	2.7
Proteus mirabilis	1	0.39	3	1.19	3	1.19	2	0.79	10	3.9
Proteus rettergi	4	1.59	5	1.99	3	1.19	2	0.79	14	5.5
Proteus morganii	-	-	2	0.79	1	0.39	-	-	3	1.19
Shigella flexenrii	-	-	1	0.39	1	0.39	1	0.39	3	5.5
Citrobacter diversus	1	0.39	2	0.79	3	1.19	2	0.79	8	3.1
Citrobacter freundii	1	0.39	3	1.19	4	1.59	2	0.79	10	3.9
Enterobacter coloacae	3	1.19	5	1.99	6	2.39	4	1.59	18	7.1
Enterobacter liquefaciens	4	1.59	3	1.19	5	1.99	2	0.79	14	5.5
Serratia spp.	2	0.79	3	1.19	2	0.79	1	0.39	8	3.1
Provedencia spp	3	1.19	4	1.59	4	1.59	2	0.79	13	5.1
Pseudomonas aeurgenes	7	2.78	9	3.58	10	3.98	8	3.18	34	13.5
Salmonella spp.	-	-	1	0.39	1	0.39	-	-	2	0.78
Total									251	100

Table (8) incidence percentages of pathogenic and potentially pathogenic bacteria isolated from water samples in the four examined farms

Item	Farm 1		Farm 2		Farm 3		Farm 4		Total	
Microorganism	No of isolates	%	No of isolates	%	No of isolates	%	No of isolates	%	No of isolates	%
Staph. Aureus	4	1.52	5	1.90	5	1.90	3	1.14	17	6.46
Staph epidermids	7	2.67	10	3.81	10	3.81	8	3.05	35	13.34
Stept. faecalis	4	1.52	10	3.81	9	3.43	5	1.90	28	10.66
Strept. intermediumm	1	0.38	2	0.76	2	0.76	2	0.76	7	2.66
E. coli	5	1.90	6	2.29	6	2.29	4	1.52	21	8
Kleb. Pneumonae	5	1.90	6	2.29	8	3.05	3	1.14	22	8.39
Proteus vulgaris	1	0.38	2	0.76	2	0.76	-	-	5	1.90
Proteus mirabilis	2	0.76	3	1.14	2	0.76	-	-	8	3.05
Proteus rettergi	1	0.38	1	0.38	2	0.76	1	0.38	5	1.90
Proteus morganii	-	-	-	-	3	1.14	1	0.38	6	2.29
Shigella flexenrii	1	0.38	2	0.76	3	1.14	-	-	6	2.29
Citrobacter diversus	3	1.14	4	1.52	5	1.90	2	0.76	14	5.34
Citrobacter freundii	1	0.38	4	1.52	2	0.76	2	0.76	9	3.43
Enterobacter coloacae	7	2.67	9	3.43	8	3.05	3	1.14	27	10.30
Enterobacter liquefaciens	3	1.14	5	1.90	2	0.76	1	0.38	11	4.19
Serratia spp.	1	0.38	3	1.14	2	0.76	1	0.38	7	2.67
Provedencia spp	3	1.14	4	1.52	5	1.90	2	0.76	14	5.34
Pseudomonas aeurgenes	8	3.05	12	4.58	10	3.81	5	1.90	35	13.35
Salmonella spp.	-		1	0.38	1	0.38	-	-	2	0.76
Total									262	100