j.Egypt.vet.med.Assoc 80, no 2. 261 – 276 (2020)

IMPACT OF INDOOR CLIMATE ELEMENTS ON MICROBIAL PROFILE OF INDOOR BROILER ENVIRONMENT AND ITS RETURN ON PERFORMANCE INDICES DURING WINTER IN UPPER EGYPT

By

Ahmed Mohamed Ahmed Sabaie, Fayez Mostafa Hasanien, Zakia A M Ahmed

Department of Veterinary Hygiene and Management, Faculty of Veterinary Medicine, Cairo University, Giza, Egypt.

ABSTRACT

The environment in the broiler house is a combination of physical and biological factors generating a complex dynamic system of interactions between birds, the husbandry system, temperature, and the aerial environment**.** The current field study was conducted in 2 broiler farms located in Upper Egypt to clarify the impact of an indoor climate element (ambient temperature Ta.C°, relative humidity RH%, and air movement AV m/sec.) on the survivability of microbial load (ML) in indoor air (IA) and on surfaces of abiotic environment components (AC) (drinkers, feeders, walls, and windows) . As well as on the performance indices PI (feed intake (FI), live body weight (LBW) g/w/bird, feed conversion rate (FCR), and mortality %). The obtained results revealed that, indoor ambient temperatures Ta.C° were the same means value despite of increased SD in farm 2. Higher relative humidity (RH %) was recorded in farm 2 despite of values in both farms still less than 60-70%. The higher recorded air velocity (AVm/sec) in farm 1 was within the recommended requirement**.** The bacteria load (BL CFU) from indoor abiotic environment components (AC) in farm 1 was higher than in farm 2 but FL CFU was higher in farm 1. No significant differences were recorded in means value BL CFU between two farms during 7-21 days but reported at 35 days. The mean difference value of BL CFU in farm 1 was significantly correlated within all ages (7-35 days) and in farm 2 between **7**, 35 days. The mean difference of FL CFU in farm 1 was significantly increased between 7-35 days and in farm2 between 7, 35 days only**.** The cumulative means values of indoor air microbial load (IA ML**)** confirmed a higher mean value of FL CFU was recorded in farm 1, and higher BL CFU in farm 2**.** Differences were noticed between two farms in performance indices (PI) where increased FI in farm 2, decreased FCR, decreased mortality %. Farm 2 performed well compared with farm 1 indicated by increased FI and improved FCR. A negative correlation was recorded between Ta.C° and all PI in farm 1. Ta.C significantly affected and correlated

with both FI in farm 2 and mortality %. RH% negatively correlated with all PI and significantly correlated with LBW and FCR in farm 1, while in farm 2 RH% was significantly correlated with FI only**.** Air movement (AV m/sec.) was negatively correlated with all PI and significantly correlated with the mortality rate in farm 1. Conclusion, during winter in Upper Egypt , the two farms didn't reveal significant difference in indoor climate elements but recorded in indoor air and abiotic components microbial profile which reflected on final performance indices mainly FCR and mortality rate in farm 2.

Key words:

Broiler, Climate elements (Cl.), Microbial load (ML), Performance indices (PI), Abiotic environment components (AC). Indoor air (IA), fungi load FL, bacteria load BL

INTRODUCTION

In connection with the physico-chemical properties of the air, the degree of contamination of the air can change diametrically within a few minutes (**Donderski *et al.*, 2005).**

Microorganisms count inside poultry farms air and monitoring of its emission from this building to the adjacent environment are important parameters for the assessment of the influence of poultry houses on the environmental pollution **(Matković *et al.*,2006).** In Switzerland the total number of fungi in poultry houses ranged from 2.0 $\times 10^7$ to 1.1 $\times 10^9$ CFU /m^3 ; whereas the number of bacteria was higher and ranged within 4.7 $\times 10^9$ to 4.2 $\times 10^{10}$ CFU /m^3 **(Radon *et al* ., 2002)**. The number of microorganisms (CFU/m3) in poultry houses ranged within: 1.7 $\times$ 10^3 - 8.8 $\times$ 10^3 for mesophilic bacteria **(karwowska,2005).** The number of bacteria in poultry houses ranged from 10^3 to 10^{10} CFU/m3 and the concentrations of fungi was from 2.5 x 10^1 to 4.9 x 10^6 CFU/m^3 **(Agranovski *et al.*,2007, Radon *et al.*,2002, Vučemilo *et al.*, 2007).** Microbial pollution is a key element of indoor air pollution. It is caused by hundreds of species of bacteria and fungi, in particular filamentous fungi (Mould), growing indoors when sufficient moisture is available **(WHO,2009).**The microbial community is known to have a key role during the rearing period of broilers**.** Each broiler farm revealed a specific microbial profile which varied with the age of the birds **(Bae *et al.*, 2017).** Climate plays a major role in the well-being and health of poultry .The climatic factors of interest include temperature, relative humidity, air composition, air velocity and movement **(Olanrewaju *et al*., 2006; Mendes *et al*, 2013; Holik, 2015).**The environment in the broiler house is a combination of physical and biological factors generating a complex dynamic system of interactions between birds, husbandry system,, temperature, and the aerial environment. Ventilation

plays a key role in this scenario. Adequate ventilation rates provide the most effective method of controlling temperature within the hen house. They allow for controlling the relative humidity and can play a key role in alleviating the negative effects of high stocking density and of wet litter **(Bianchi *et al* ., 2015).**

If the temperature remains within the range of 25ºC to 30ºC, air velocity of 0.1 m/s to 0.2 m/s can be maintained, but if the temperature goes beyond that an increase in air velocity will help aid convectional cooling. Furthermore, at air velocity of 0.1 m/s to 0.2 m/s the movement pattern of air can be easily controlled through building design and ventilation within the building **(Hulzebosch ,2004).** Heat stress causes production losses in the intensive poultry production industry, particularly in hot, resource limited regions of Africa and Asia **(Bhadauria *et al.*, 2014).** The target temperature for best broiler performance changes during a grow-out, typically from around 30°C on day 1 to near 20°C or lower at harvest time, depending on bird size and other factors. (**Ross 2010).** The optimum temperature for best performance ranges between 18 and 22 °C for growing broiler chickens **(Charles 2002, Ross 2010, EFSA, 2010).**During the winter, the mortality rate of broiler breeders during this period was significantly higher compared with the other months**. Pereira *et al.* (2010).**

The first day the temperature on chick level should be 30 °C. During the rearing period the temperature is lowered according to the guidelines of the breeding companies. At 27 days of age the temperature should be around 20 °C. **(EFSA, 2010)**. Ambient temperatures significantly influence the survivability and performance of the poultry production **(Ayo-Enwerem *et al.*, 2017**). In rural areas of developing countries, it is likely that rural poultry is adversely affected (i.e. stressed) by extreme environmental conditions, as birds continue to interact with the local environment during scavenging, and farmers have less capacity to control their living environments **(Nyonia *et al.*, 2018).** Climate change may affect poultry production in several ways. By the incidence of extreme temperature events **(Lamarca *et al.*, 2018).** As the ambient temperature increased to 34°C, the mortality due to heat will be higher in broilers by 8.4%. **Ahaotu *et al.*, (2019).**

The effect of humidity on the thermal regulation of chickens depends on age and air temperature **(Lin *et al*. 2005).** During the whole breeding cycle, the relative humidity should be maintained at a value between 60% and 70% **(Ross 2009, Ross 2010, EFSA 2010, and EFSA 2012).** Temperature and relative humidity influence the thermal comfort of the birds.

A relative humidity of 60-70% in the house is necessary in the first 3 days .Relative humidity above 70% can occasionally be reached with high stocking densities during winter, when the ventilation rate may be reduced to retain heat and save energy**.** A relative humidity of 60-70% in the house is necessary in the first three days **(ROSS, 2009).** The effect of humidity depends mainly on factors within the building but also on outside humidity. Examples of important factors in the building are stocking density, live weight of the birds, ventilation rate, indoor temperature, number,type and management of drinkers, water consumption and water spillage **(Bianchi *et al* .,2015).**

The current field study was conducted in two broiler farms located in Sohage governorate (upper Egypt) during December - January 2019 to figure out the impact of indoor broiler climate element (ambient temperature (Ta.C$^{\circ}$), relative humidity (RH%) and air movement (AV m/sec.) on the survivability of microbial load (ML) on surfaces of indoor abiotic environment components (AC)(drinkers, feeders,walls and windows) where birds are in direct contact with consequent effects on performance indices (feed intake g/w/bird, live body weight (LBW) g/w/bird, feed conversion rate (FCR), and l mortality %) .

Materials and Methods:

Study area:

The study was carried out in Upper Egypt; in Sohag governorate .The study period was during (December - January) 2019 in winter. The study was conducted in 2 broiler farms in two different areas in Sohag governorate, farm 1 and 2. Location of farm 1 was in Maragha, while location of farm 2 was in Gehina, Wind direction in all farms was from north to south .Floor area of farm 1 was 100 m^2 while farm 2 was 325 m^2.The breed of farm 1 and 2 was (Ross 308).

Management:

Floor system of the two farms was deep litter with concrete floor and the type of litter material was Wood shavings.The type of housing for two farms was semi closed house. The kind of feeding system for all farms was manual with plastic tube feeders. The kind of drinking system was automatic in farms 1 with nipple drinkers with drip cups for farm 1 and manual in farm 2 with fountain drinkers. Ventilation in all houses was mechanical with cross ventilation; cooling pads in one end and exhaust fans in the opposite side. Bird carcasses were collected daily and disposed in burial pits for all farms. For better litter management, good source of litter material as wood shavings with a proper depth ranged 5 - 10 cm.

Sampling and measures:

1-Determination of indoor climate elements (microclimate)

Air temperature, relative humidity and air velocity

House microclimate parameters and environmental conditions were monitored in accordance with the methodology of animal hygiene studies **(Kolacz and Dobrazanski 2006)**.

Air Temperature was measured by dry bulb thermometer, relative humidity was measured by dry Bulb hygrometer and air velocity was measured by anemometer (PROSKIT MT - 4615) Anemometer with accuracy 30~40 m / s.

2-Measurement of microbial load of indoor air

Total bacterial count and total fungal Count log CFU/m^3 air**)**

Microbial air contamination was determined by the sedimentation method, using *Petri* dishes with nutrient culture media for bacteria and fungi growth. Air samples were collected at six different sites indoor of each farm. The plates were left for 15 minutes before collection. The airborne bacteria collected on agar medium were incubated at 37ºC for 1 day, and airborne fungi were incubated on Sabourad's medium at 25ºC for 5 days. The number of microbial colonies on plates was determined with a Colony Star Counter. The number of grown Colonies was converted into colony forming units (CFU) according to the formula **(Ogórek and Pląskowska, 2011):** $X= (\alpha \times 1000)/V$ where: α - the number of grown colonies, V - volume of sampled Air.

3-Microbial load (ML) of broiler environment abiotic components (drinkers, feeders, walls and windows).

Swabbing method (Sanderson *et al.*, 2002).

A-Swab samples were collected by removing a sterile swab from a sterile tube, moistening it by inserting it into a second tube which contained a sponge soaked with sterile 1.5 ml of phosphate buffered saline (PBS) at pH 7.2.

b- The selected surface was swabbed by moving the swab back and forth across the surface with several horizontal strokes, then several vertical strokes. The swab was rotated during sampling to ensure that, the entire surface of the swab was used.

C-After sampling, the swab was returned to its pre-labeled sampling tube containing appropriate amount of liquid media.

4-Determination of bird performance indices:

A-Calculation of Live body weights and body weights gain of birds (LBW, BWG/bird/g/w)

Average body weight according to **(Lei and Van-Beek, 1997).**Average weekly weight gain was measured according to **(Yalcin *et al.*, 1998).**Weighing birds was by digital scale. In the seventh day birds were bulk weighed. After the seventh day, birds were individually weighed.1% sample of birds was taken**.** Average body weight was calculated by dividing total weight of all birds by number of all birds weighed.

b- Calculation of feed intake (FI).

The average feed intake /bird / day in grams (FI) was calculated by subtracting the weight of Feed left from the amount of feed offered each day with attention to collect any spilled feed **(Dagas and Claveria 2008).**

C- Calculation of Feed Conversion Rate (FCR)

FCR was calculated by dividing total feed intake by total weight gain. FCR was measured Weekly **(Dagas and Claveria 2008).**

d- Mortality rate

Mortality rate was calculated by dividing total dead birds by total number of birds at time of Housing .The mortality rate was recorded weekly throughout study period **(Novel *et al.*,2009).**

5-Statistical analysis:

The data concerning house microclimate parameters and microbial contamination levels were verified statistically by a one-factor analysis of variance. The statistical analysis of data involved the determination of arithmetic means ($\bar{x}$). The significance of differences between the mean values of the investigated parameters was determined by Duncan's test. Calculations were performed using Statistic 8.0 PL software. **(Wojcik *et al.*, 2010).**

RESULTS AND DISCUSSION

The microbial community is known to have a key role during the rearing period of broilers**.** Each broiler farm revealed a specific microbial profile which varied with the age of the birds **(Bae *et al.*, 2017).**

Data recorded in (Tables 1,2 and 3) showed the final means value of ML and that at different ages of abiotic environment components (drinkers, feeders, walls, and window swabs) in the investigated farms revealed that, the total viable bacteria colony-forming unit CFU from site 1 (122.44 ±SD 84.58) was higher than in site 2 (17.75± SD 21.76) and fungi in site 1 (17.63 ±SD 25.26) compared with site 2 (3.94± SD 7.49) respectively

through study season. Besides t, data in (Table 4) showed that no significant difference was recorded in means value bacterial load between two sites during 7-21 days but reported only at 35 days (t. 4.79 at P ≤ 0.01**)**.** Meanwhile, significant differences were noticed in FL CFU at 21 and 35 days (t. 2.581 at P ≤ 0.01** and t. 2.07 at P ≤ 0.04* respectively**).** The number of bacteria in poultry houses ranged from 10^3 to 10^{10} CFU/m3, and the concentrations of fungi were from 2.5 x 10^1 to 4.9 x 10^6 CFU/m3 **(Agranovski *et al.*, 2007, Radon *et al.*, 2002, Vučemilo *et al.*, 2006, 2007).**

Results in (Table 5) showed that**,** the mean BL cfu difference (-64.688-*) in site1 was significantly correlated between 7, 35 days (P ≤.004) and between 21, 35 days (-48.688-* at P ≤.025)**.** The mean BL CFU difference in site 2 was significantly correlated between **7**, 35 days (33.813* at P ≤.021) and between 21, 35 days (52.688* at P ≤.001).The mean FL cfu difference in site 1 (-47.125-* at P ≤.035) was significantly increased between 7, 21 days, and between 21, 35 days (57.500* at P ≤.011). The mean FL CFU difference (17.063 at P ≤.062) was significantly correlated between 7, 35 days. The number of bacteria in poultry houses ranged from 10^3 to 10^{10} CFU/m3 and the concentrations of fungi were from 2.5 x 10^1 to 4.9 x 10^6 CFU/m^3 **(Agranovski *et al.*, 2007, Radon *et al.*, 2002, Vučemilo *et al.*, 2006, 2007).** Aerial contamination with bacteria in the range of 3.1–6.4 log10 CFU /m^3 in broiler houses, fungal concentration in broiler was determined at 4.0–5.9 log10 CFU /m^3. Microbial contamination levels are influenced by various factors, including bird species, stocking density, season, and ventilation system, microclimate, and litter quality. Bacterial and fungal counts varied between weeks of the rearing period, most likely due to changes in dust levels and ventilation efficiency. Bacterial counts were lowest in week 3 (4.6 log10 CFU /m^3) and highest at the end of rearing (5.3 log10 CFU /m^3). Fungal counts were lowest at the beginning of the experiment (4.2 log10 CFU /m^3) and highest in weeks 2 and 5 (4.7 log10 CFU /m^3 (**Witkowska and Sowińska, 2017)**.

Results are shown in (Table 6) confirmed a higher mean value of BL CFU in indoor air was recorded in farm 2 (198.8, 314.4) compared with farm 1 (115.4, 251.7) at 7, 21 days respectively but higher in farm 1(342.8) at 35 days only. The mean value of IA FL was higher in site 1 (146.0, 306.7, 318.6) compared with farm 2 (112.8, 182.6, 245.0) during the rearing cycle (7, 21, 35 days) respectively.

Data recorded the cumulative means value of indoor air (IA ML**)** in **(Table 7)** confirmed a

higher mean value of FL CFU was recorded in farm 1 (295.9) and higher BL CFU in farm 2 (283.9). The differences in means value between the two farms might be attributed to the differences in daily management practices and specific microbial profiles of each farm. The environment in the broiler house is a combination of physical and biological factors generating a complex dynamic system of interactions between birds, husbandry system, temperature, and the aerial environment **(Bianchi *et al* ., 2015).** Each broiler farm revealed a specific microbial profile which varied with the age of the birds **(Bae *et al.*, 2017).**

Results recorded in the (Table 8), indoor climate elements indicated the same means value of Ta.C° despite increased ±SD in farm 2 (±SD 1.636) which might indicate various individual readings inside this site with non-homogenized thermal profile of indoor Ta.C°. Ambient temperatures significantly influence the survivability and performance of poultry production **(Ayo-Enwerem *et al.*, 2017**). Higher RH% was recorded in site 2 (52.50% ±SD 8.292**)** despite values in both farms still less than 60-70% which required for good bird health and performance according to **Ross (2009, 2012) and EFSA (2010, 2012)** during the whole breeding cycle, the relative humidity should be maintained at a value between 60% and 70%. The higher recorded AV m /sec in farm 1 (.100 ±SD.141) was within the recommended requirement. The AV m/sec and Ta.C° values in farm 1 were agreed with that recommended by **Hulzebosch (2004),** they reported that**,** if the temperature remains within the range of 25ºC to 30ºC, air velocity of 0.1 m/s to 0.2 m/s can be maintained. In addition, adequate ventilation rates provide the most effective method of controlling temperature within the henhouse. They allow for controlling the relative humidity and can play a key role in alleviating the negative effects of high stocking density and of wet litter **(Bianchi *et al* ., 2015).**

Data showed in the (Table 9), means differences were noticed between two sites in performance indices where increased FI in site 2 (667.6g Vs. 647.0 g), decreased FCR (1.7 Vs. 1.(8, decreased mortality % (.63 Vs. 1.34), these results still within recommended values for this breed in both sites (Ross 308). .Site 2 performed well compared with site 1 indicated by increased FI and FCR.

Results in (Table 10) indicated that, the negative correlation recorded between Ta.C and all performance indices in farm 1**.** As well as, the mortality rate in farm 2. Ta.C significantly affected and correlated with both FI in farm 2 ($r=.974$ $P \leq .009$), mortality % ($r=.966$, $P \leq .012$). Relative humidity, RH% negatively correlated with all PI and significantly correlated

with LBW and FCR in farm 1 (r=.811, P ≤.-.068 and r=.948, P ≤.-.018 respectively), while in farm 2 RH% was significantly correlated with FI only (r=.912, P ≤.031). Air movement (AV m/sec.) was negatively correlated with all PI and significantly correlated with the mortality rate in site 1 (r= .911, P ≤. -.032). Controlling the physical microenvironment in broiler production houses is an important element in optimizing the production process. Ventilation rate should be minimal in cold weather **(Boni and Paes, 2000).** Temperature and relative humidity influence the thermal comfort of the birds **(Ross, 2009).**

RESULTS

Table (1): Means value ±SD microbial load of indoor abiotic components in broiler farms during winter.

ML. / AC.	Farm 1				Farm 2			
	Bacteria CFU		Fungi CFU		Bacteria CFU		Fungi CFU	
	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD
Drinker	112.00	82.79	107.41	92.25	59.83	46.48	40.29	19.00
Feeder	54.42	49.30	25.66	20.92	24.33	18.377	6.14	3.42
Wall	74.83	44.51	37.66	22.33	64.00	59.794	27.00	24.25
Window	97.33	66.81	25.50	23.44	38.17	37.716	1.75	1.22

***The mean values must multiply by 10^2**

ML = microbial load AC= abiotic components

Table (2): Means value ±SD of bacteria load of indoor abiotic components in broiler farms during winter (7-35ds).

BL / Age /d	Farm 1		Farm 2	
	Mean	±SD	Mean	±SD
7	57.75	36.55	51.56	36.58
21	73.75	46.46	70.44	54.78
35	122.44	84.58	17.75	21.76

BL = bacteria load

Table (3): Means value ±SD of fungi load of indoor abiotic components in broiler farms during winter (7-35ds).

FL / Age /d	Farm 1		Farm 2	
	Mean	±SD	Mean	±SD
7	28.00	32.36	21.00	40.88
21	75.13	97.93	11.38	13.16
35	17.63	25.26	3.94	7.49

FL= Fungi load

Table (4): Significant differences in microbial load of abiotic components between broiler farms in winter.

BL CFU	Means	±SD	t-test for Equality of Means		
Farm 1	57.75	36.55	T	Diff.	Sig. (2-tailed)
Farm 2	51.56	36.58			
Farm 1.2 BLCFU	Equal variances		0.479	30	0.63

a-Bacteria load in winter (7 ds).

a.Bacteria load in Winter (21 ds)

BL CFU	Means	±SD	t-test for Equality of Means		
Farm 1	73.75	46.46	T	Diff.	Sig. (2- tailed)
Farm 2	70.44	54.78			
Farm 1.2 BLCFU	Equal variances		0.184	30	0.85

a.Bacteria load in winter (35 ds)

BL CFU	Means	±SD	t-test for Equality of Means		
Farm 1	122.44	84.58	T	Diff.	Sig. (2 tailed)
Farm 2	17.75	21.76			
Farm 1.2 BLCFU	Equal variances assumed		4.79	30	0.01**

a.Fungi load in winter (7 ds)

FL CFU	Means	±SD	t-test for Equality of Means		
Farm 1	28.00	32.36	T	Diff	Sig. (2-tailed)
Farm 2	21.00	40.88			
Farm 1.2 FL CFU	Equal variances		0.537	30	0.59

b-Fungi load in winter (21 ds)

FL CFU	Means	±SD	t-test for Equality of Means		
Farm 1	75.13	97.93	T	Diff.	Sig. (2- tailed)
Farm 2	11.38	13.16			
Site1.2 Fungi	Equal variances		2.581	30	0.01**

b-.Fungi winter (35 ds).

FL CFU	Means	±SD	t-test for Equality of Means		
Farm 1	17.63	25.26	T	Diff.	Sig. (2-tailed)
Farm 2	3.94	7.49			
Farm 1&2Fungi	Equal variances assumed		2.07	30	0.04*

Table (5): Impact of age on mean differences in microbial load of indoor abiotic component (ML AC) in broiler farms during winter.

Dependent Variable			Mean Diff (I-J)	SR	Sig.
Farm 1 BLCFU	Visit-1	Visit-2	-16.000	21.064	.451
		Visit-3	-64.688-*	21.064	.004
	Visit-2	Visit-1	16.000	21.064	.451
		Visit-3	-48.688-*	21.064	.025
	Visit-3 (35d)	Visit-1	64.688*	21.064	.004
		Visit-2	48.688*	21.064	.025
Farm 2 BLCFU	Visit-1	Visit-2	-18.875	14.160	.189
		Visit-3	33.813*	14.160	.021
	Visit-2	Visit-1	18.875	14.160	.189
		Visit-3	52.688*	14.160	.001
	Visit-3	Visit-1	-33.813-*	14.160	.021
		Visit-2	-52.688-*	14.160	.001
Farm 1 FLCFU	Visit-1	Visit-2	-47.125-*	21.675	.035
		Visit-3	10.375	21.675	.635
	Visit-2	Visit-1	47.125*	21.675	.035
		Visit-3	57.500*	21.675	.011
	Visit-3	Visit-1	-10.375	21.675	.635
		Visit-2	-57.500-*	21.675	.011
Farm 2 FLCFU	Visit-1	Visit-2	9.625	8.899	.285
		Visit-3	17.063	8.899	.062
	Visit-2	Visit-1	-9.625	8.899	.285
		Visit-3	7.438	8.899	.408
	Visit-3	Visit-1	-17.063	8.899	.062
		Visit-2	-7.438	8.899	.408

***. The mean difference is significant at the 0.05 level.**

Table (6): Mean values ±SD of indoor air microbial load (IA ML) in investigated farms during winter at 7 days old.

IA ML / Farm	Farm 1				Farm 2			
	Bacteria		Fungi		Bacteria		Fungi	
	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD
7 days	115.4	101.7	146.0	116.6	198.8	116.4	112.8	94.9
21 days	251.7	106.8	306.7	83.7	314.4	97.6	182.6	136.7
35 days	342.8	54.3	318.6	66.9	318.9	128.8	245.0	97.1

Table (7): The cumulative mean values ±SD of indoor air microbial load in broiler farms during winter.

IA ML / Farm	Farm 1				Farm 2			
	Bacteria		Fungi		Bacteria		Fungi	
	Mean	±SD	Mean	±SD	Mean	±SD	Mean	±SD
	249.4	145.3	295.9	118.5	283.9	125.6	144.0	102.9

Table (8): Total means ±SD values of indoor climate elements (CL) in the investigated broiler farms during winter.

Farm / CL	Farm 1		Farm 2	
	Mean	±SD	Mean	±SD
Ta.C°	26.00	.3536	26.10	1.636
RH%	48.00	3.259	52.50	8.292
AV m/s	.100	.141	.040	.08944

CL= climate elements.

Table (9): Mean values ±SD of Performance Indices in broiler farms during winter at 35 days.

Farm / PI	Farm 1		Farm 2	
	Mean	±SD	Mean	±SD
FI	647.0	4276.	667.6	316.7
LBW	1111.8	6728.	1100.6	761.40
FCR	81.	.87	1.7	.74
Mort. %	1.34	.79	.63	.47

Table(10): Correlations(spearmanrho)between indoor climate elements (CL) and performance indices (PI) in broiler farms during winter.

PI / Cl..	Farm 1								Farm 2							
	FI/g		LBW/g		FCR		Mort. %		FI		LBW		FCR		Mort. %	
	r.	Sig.	r.	Sig.	r.	Sig.	r.	Sig.	r.	Sig.	r.	Sig	r.	Sig	r.	Sig.
Ta.C°	.467	-.204	.242	-.322	.560	-.164	.231	-.329	.974	.009	722	-.10	.55	-.17	.97	-.012
RH%	.476	-.19	.81	-.07	.948	.018	.349	.260	.912	.031	.679	.12	.89	-.04	.59	-152
AV m/s	.325	.27	.51	.19	.52	.18	.910	-.03	.42	. 23	.63	.14	.23	. 42	.15	.593

****. Correlation is significant at the 0.01 level (2-tailed).**

***. Correlation is significant at the 0.05 level (2-tailed)**

PI. Performance indices **Cl. Climate elements**

Acknowledgement:

The authors acknowledge the Faculty of Veterinary Medicine, Cairo University, for manifold support to this work which was graciously been done in the department of veterinary hygiene and management. We are grateful to all the staff. The authors did not receive any funds for this study.

Conflict of interest: The authors declare that they have no competing interests.

REFERENCES

Agranovski, V.; Reponen, T and Ristovski, Z. (2007): Survey of bioaerosol emissions from Australian poultry buildings. European Aerosol Conference. Salzburg, Abstract, 28.

Ahaotu EO, Patricio De los Ríos, Ibe LC and Singh RR (2019): Climate Change in Poultry Production System - A Review. . Acta Scientific Agriculture 3.9: 113-117.

Ayo-Enwerem, C.M, Ahaotu, E.O, Nwogu, C.M and Esukpa, M (2017): Hematology and Serum Biochemistry of Starter Broilers Fed Diets Containing Red Sandalwood (Pterocarpus santolinoides) Leaf Meal. Direct Research Journal of Veterinary Medicine and Animal Science. 2 (4): 111-114.

Bae Y, Koo B, Lee S, Mo J, Oh K. and Mo I P. (2017) : Bacterial diversity and its relationship to growth performance of broilers. Korean J. Vet Res (2017) 57(3): 159 -167.

Baêta FC and Souza CF.(2010): Ambiência em edificações rurais: conforto animal.2ed.Viçosa:UFV. p.269

Bhadauria P, Kataria J.M, Majumdar S, Bhanja S.K, Divya and Kolluri G. (2014): Impact of Hot Climate on Poultry Production System-A Review. Journal of Poultry Science and Technology | October-December, 2014 | Vol 2 | Issue 4 | Pages 56-63.

Bianchi B*, Giametta F, La Fianza G, Gentile A and Catalano P. (2015): Microclimate measuring and fluid-dynamic simulation in an industrial broiler house: testing of an experimental ventilation system. Veterinaria Italiana 2015, 51 (2), 85-92.

Boni, I. J and Paes, AOS. (2000): Climatização de aviários: Aquecimento e Refrigeração para Matrizes (Climatization of broiler breeder's housing: heating and cooling). In: Curso sobre Equipamentos Avícolas para o Setor de Corte; São Paulo. Brazil. P 47-65. (In Portuguese).

Charles D.R. (2002): Responses to the thermal environment. In Poultry environment problems, A guide to solutions (D.A. Charles and A.W. Walker, eds). Nottingham.

Dagaas, C.T and Claveria, J.N. (2008): On farm performance of broilers subjected to 40 % level of feed restriction on the third week of age. Philippine J. Vet. Anim. Sci., 34(2): 177-186**.**

Donderski W., Walczak M and Pietrzak M. (2005): Microbiological Contamination of Air within the City of Toruń. Polish Journal of Environmental Studies Vol. 14, No. 2, 223-230**.**

European Food Safety Authority (EFSA). (2010): Animal welfare risk assessment guidelines on housing and management (EFSA Housing Risk) (Question No EFSA-Q-2009-00844). www.efsa.europa.eu/publications.

European Food Safety Authority (EFSA). (2012): Opinions on the welfare of broilers and broiler breeders. Supporting Publications: EN-295. www.efsa.europa.eu/ publications.

Holik V. (2015): Management of laying hens under tropical conditions begins during the rearing period. Lohmann Information, 50: 16- 23.

Hulzebosch J. (2004): What affects the climate in poultry houses World Poultry, 20: 36-38.

Karwowska E. (2005): Microbiological Air Contamination in Farming Environment. Pol. J. Environ. Stud. 2005; 14 (4):445-449.

Kołacz R. and Dobrzański Z. (2006): Hygiene and welfare in farm animals. Wyd. AR Wrocław, (In Polish).

Lamarca DSF, Pereira DF,Magalhães MM. and Salgado DD. (2018): Climate Change in Layer Poultry Farming:Impact of Heat Waves in Region of Bastos, Brazil. Brazilian Journal of Poultry Science Revista Brasileira de Ciência Avícola ISSN 1516-635X Oct-Dec 2018/v.20 /n.4/657-66.

Lei, S., and Van Beek, G. (**1997**)**:** Influence of activity and dietary energy on broiler performance, carcass yield and sensory quality. Br. Poult. Sci**.**

Lin H., Zhang H.F., Jiao H.C., Zhao T., Sui S.J., Gu X.H., Zhang Z.Y. Buyse J and Decuypere E (2005): The thermoregulation response of broiler chickens to humidity at different ambient temperatures I. One-week-age. Poult Sci, 84, 1166-1172.

Matković,K.;Vučemilo, M.;Vinković,B.;Šeol,B.;Pavičić,Ž.;Matković, S.; Tofant,A and Matković, S. (2006): Effect of microclimate on bacterial count and airborne emission from dairy barns on the environment. Annals of Agricultural and Environmental Medicine, 13, 349-354**.**

Mendes A, Moura D, Nääs I, Morello G, Carvalho T, Refatti R and Paixão S. (2013): Minimum ventilation systems and their effects on the initial stage of turkey production. Brazilian Journal of Poultry Science; 15 (1):7- 13.

Novel, D., Ng'Ambi J., Norris D., and Mbajiorgu C. (2009): Effect of different feed restriction regimes during the starter stage onproductivity and carcass characteristics of male and female Ross308 broiler chickens. Int. J. Poult. Sci 8:35-39.

Nyonia N. M. B, Graba S. and. Arche E. R. M. (2018): Heat stress and chickens: climate risk effects on rural poultry farming in low-income countries. Climate and Development, 2018 https://doi.org/10.1080/17565529.2018.1442792.

Ogórek R and Pląskowska E (**2011):** The mycological analysis of air in selected public rooms. Preliminary study Medical Mycology; 18(1):24-29**.**

Olanrewaju HA, Thaxton JP, Dozier WA, Purswell J, Roush WB and Branton SL. (2006): A review of lighting programs for broiler production. International Journal of Poultry Science; 5 (4):301-308.

Pereira DF, Vale MM, Zevolli BR and Salgado DD. (2010): Estimating mortality in laying hens as the environmental temperature increases. Brazilian Journal of Poultry Science; 12(4):265-271.

Radon K., Danuser B., Iversen M., Monso E., Weber Ch., Hartung J., Palmgren U and Nowak D. (2002): Air contaminants in different European farming environments. Ann. Agric. Environ. Med. 9, 41.

Ross, (2010): Environmental Management in the Broiler House. www.thepoultrysite . com.

Ross. (2009): Broiler Management Manual. Www. thepoultrysite.com

Sanderson, W.T., Hein, M.J., Taylor, L., Curwin, B.D., Kinnes, G.M., Seitz, T.A., Popovic,T., Holmes, H.T., Kellum, M.E., McAllister, S.K., Whaley, D.N., Tupin, E.A., Walker, T., Freed, J.A., Small, D.S., Klusaritz, B. and Bridges, J.H. (2002) Surface Sampling Methods for Bacillus anthracis Spore Contamination. Emerging Infectious Diseases 8(10), 1145-1151**.**

Tao, X. and H. Xin. (2003): Acute synergistic effects of air temperature, humidity, and velocity on homeostasis of market–size broilers. Trans. ASAE 46 (2): 491-497

Vučemilo M., Vinković B and Matković K. (2006): Influence of broiler age on airborne pollutant content in poultry house. Krmiva. 48, 3.

Vučemilo, M.; Matković, K.; Vinković, B.; Jakšić, S.; Granić, K and Mas, N. (2007): The effect of animal age on air pollutant concentration in a broiler house. Czech Journal of Animal Science. 52, 6 170-174.

WHO, (2009): WHO guidelines for indoor air quality: dampness and mould. ISBN 978 92 890 4168 3

Witkowska D and Sowińska J. (2017): Identification of Microbial and Gaseous Contaminants in Poultry Farms and Developing Methods for Contamination Prevention at the Source, Poultry Science, Chapter 3**.**

Wójcik A, Chorąży Ł, Mituniewicz T, Witkowska D, Iwańczuk-Czernik K and Sowińska J. (2010): Microbial Air Contamination in Poultry Houses in the Summer and Winter. Polish J. of Environ. Stud. Vol. 19, No. 5 1045-1050

Yalcin, S., Ozkan S., Aikgoz Z., and Ozkan K. (1998): Influence of dietary energy on bird performance, carcass parts yield and nutrient composition of breast meat of heterozygous naked neck broilers reared at natural optimum and summer temperatures. Br. Poult. Sci., 39:633-638.