Kafkas Univ Vet Fak Derg
19 (2): 283-289, 2013
DOI: 10.9775/kvfd.2012.7678

Journal Home-Page: http://vetdergi.kafkas.edu.tr
Online Submission: http://vetdergikafkas.org

RESEARCH ARTICLE

The Effects of Different Breeding Methods on Fattening Performance and Parameters Related to Slaughter, Carcass and Some Meat Quality in Broiler Chickens

Ekrem LACIN * Omer COBAN * Muhammet Irfan AKSU **
Nilufer SABUNCUOGLU * Huseyin DAS ***

* Department of Animal Science, Faculty of Veterinary Medicine, Atatürk University, TR-25240 Erzurum - TURKEY
** Department of Food Engineering, Faculty of Agricultural, Ataturk University, TR-25240 Erzurum - TURKEY
*** Vocational High School, Department of Veterinary, Gumushane University, TR-29100 Gumushane - TURKEY

Makale Kodu (Article Code): KVFD-2012-7678

Summary

The present study was aimed at the comparison of floor-based growth (FBG) and caged-based growth (CBG) systems in broiler production for growth performance and parameters related to slaughter, carcass and meat quality. Ninety one-day-old male Ross-308 chicks constituted the material of the study. It was determined that, in Groups FBG and CBG, the differences between body weight and cumulative body weight values were statistically very significant (P<0.01). The final body weights measured at the end of the trial and the mean body weight gain values in Groups FBG and CBG were determined as 2530 g - 2046 g and 2389.16 g - 1904.77 g, respectively. The end-trial final feed conversion rates of Groups FBG and CBG were determined as 1.82 and 1.88, respectively, and it was ascertained that the difference between the values of the two groups was statistically insignificant (P>0.05). While the hot and cold dressing percentages and the neck, wing, drumstick and tail percentages did not statistically differ between Groups FBG and CBG (P>0.05), values pertaining to breast meat displayed significant differences (P<0.05). It was determined that the L*, b* and C* values pertaining to breast meat and the L*, a*, b* and C* values pertaining to chicken drumsticks displayed statistically significant differences (P<0.05, P<0.01) between the trial groups.

Keywords: *Broiler, Floor-based breeding, Caged-based breeding, Carcass, Meat quality*

Farklı Yetiştirme Metotlarının Etlik Piliçlerde Besi Performansı, Kesim ve Karkas Özellikleri İle Bazı Et Kalite Parametreleri Üzerine Etkisi

Özet

Bu araştırma altlıklı yer sistemi (FBG) ve kafeste (CBG) yapılan etlik piliç yetiştiriciliğinin besi performansı, kesim, karkas ve bazı karkas kalite parametrelerinin karşılaştırılması amacıyla yürütülmüştür. Hayvan materyali olarak 90 adet bir günlük Ross-308 erkek broyler civciv kullanılmıştır. FBG ve CBG gruplarında canlı ağırlık ve kümülatif canlı ağırlık değerleri arasındaki farklılığın istatistiksel olarak çok önemli (P<0.01) olduğu saptanmıştır. Deneme sonu canlı ağırlık değerleri ile ortalama canlı ağırlık artışları FBG ve CBG gruplarında sarasıyla 2530 ve 2046 g ile 2389.16 ve 1904.77 g olarak tespit edilmiştir. Deneme sonu kümülatif yemden yararlanma değerleri FBG ve CBG gruplarında sırayla 1.82 ve 1.88 olarak bulunmuş ve aralarındaki farklılığın istatistiksel olarak önemsiz (P>0.05) olduğu tespit edilmiştir. FBG ve CBG gruplarında sıcak ve soğuk karkas randımanı ile boyun, kanat, but ve kuyruk oranlarına ait değerler arasında istatistiksel olarak farklılığın olmadığı (P>0.05), göğüs oranına ait değerler bakımından ise önemli (P<0.05) farklılıkların olduğu belirlenmiştir. Göğüs etinden elde edilen L*, b* ve C* değerlerinin ve but etinden elde edilen L*, a*, b* ve C* değerleri bakımından deneme grupları arasında önemli farklılıkların olduğu (P<0.05, P<0.01) tespit edilmiştir.

Anahtar sözcükler: *Etlik piliç, Yerde yetiştirme, Kafeste yetiştirme, Karkas, Et kalitesi*

INTRODUCTION

Broiler production has a privileged position in the livestock sector, owing to the very short period of production, the availability of intensive breeding, the low feed conversion rate of broiler chickens, the lower labour force required

İletişim (Correspondence)
+90 442 2315535
ekremlacin@hotmail.com

for broiler farms compared to other types of agricultural holdings and the nutritional value of chicken meat as a good protein source. When applying conventional broiler production methods, generally floor-based growth systems are preferred. In view of emerging demands related to the new animal welfare rules implemented in European Union Member States, some modifications have been made in floor-based growth systems (i.e. free range systems). Cage-based systems are aimed at increasing broiler production quantitatively and are of economic interest.

Numerous studies have been conducted to demonstrate the advantages and disadvantages of floor-based and cage-based growth systems in broiler production. The assessment of the results of these studies has revealed significant contradictions between the findings obtained in different trials. Abrahamsson and Tauson [1] reported the main advantages of the use of cage-based growth systems in broiler production as high productivity, no contact with manure, and less aggressiveness and cannibalism among animals. On the other hand, Rodriguez et al.[2] and Santoso [3] indicated that the body weight gain and feed conversion rates (FCR) of broiler chickens raised in cages were poorer compared to broilers raised on floor. Furthermore, Swain et al.[4] suggested that neither cage-based nor floor-based growth systems had any effect on body weight gain, feed consumption or carcass traits in broiler production. While some researchers have claimed that cage-based growth systems enable better growth performance and a higher survival rate, and thus, provide economic advantage when compared to floor-based growth systems [5,6], some other researchers have reported that floor-based growth systems are more economical [7]. Duncan [8] has highlighted the inadequacy of physical space and behavioral restrictions as the major disadvantages of cage-based growth systems.

When evaluating the effects of cage-based and floor-based growth systems on broiler chickens, generally growth performance parameters are taken into consideration. The present study, in addition to growth performance parameters, also makes a comparison of slaughter and carcass traits, some stress and carcass quality parameters for the evaluation of floor-based and cage-based growth systems in broiler production.

MATERIALS and METHODS

Animals, Diets, and Experimental Design

The trial was conducted at the poultry unit of the Research Farm of Atatürk University, Faculty of Veterinary Medicine. Ninety one-day-old Ross-308 male broiler chicks constituted the material of the study. All chicks were raised in brooders (cages) between days 1-7 of the trial. After day 7, the animals were allocated to two trial groups, one which was subjected to a floor-based growth (FBG) system and the other to a cage-based growth (CBG) system. In Group CBG, the broiler chickens were maintained in cages until the end of the trial, whilst in Group FBG, as from day 7, the animals were raised on floor covered with wood chips of a depth of 10 cm. In both Group CBG and Group FBG, the stocking density was 0.083 m^2/broilers. Accordingly, Group FBG was divided into 5 subgroups, each of which was comprised of 12 broilers, whilst Group CBG was divided into 6 subgroups, each of which was comprised of 5 broilers. The animals included in the present study were fed on broiler chick feed between days 1-21 and were fed on broiler chicken feed between days 22-42. The laboratory analysis results and nutrient compositions of the starter and finisher feed rations are presented in *Table 1*. The chemical composition of the feeds used in this study was determined using the official method of the Association of Official Analytical Chemists [9]. The groups were subjected to 24 h of light, in other words, to a continuous lighting programme, until the end of the trial.

Determination of Body Weight, Feed Consumption, Uniformity and Survival Rate

Parameters related to body weight and feed consumption were determined by weekly weight measurements. Mortalities were recorded on a daily basis. In order to preserve the stocking density, in case of any mortality, a broiler chicken of the same age, selected from the stock, was introduced into the group. With an aim to determine uniformity, on day 42, each chicken was weighed individually and the measurements were recorded. The mean weights of the trial groups and variation coefficients were also calculated.

Determination of Tibial Dyschondroplasia

At the end of the trial, two chickens from each trial group were slaughtered and the left tibial bone was

Table 1. *The laboratory analysis results and nutrient compositions of the starter and finisher feed rations*

Tablo1. *Başlangıç ve bitirme yemlerinin besin madde kompozisyonları ve laboratuar analiz sonuçları*

Composition	Starter Diet	Finisher Diet
Dry matter (%)	91.86	91.84
Crude protein (%)	23.98	20.02
Crude fiber (%)	3.68	3.75
Crude ash (%)	7.91	8.19
Ether extract	7.23	9.56
Nitrogen-free extract (%)	49.06	50.32
Calcium (%)	1.50	1.50
Phosphorus (%)	0.70	0.65
Sodium (%)	0.30	0.30
NaCL (%)	0.35	0.35
Lysine (%)	1.20	1.00
Methionine (%)	0.50	0.40
Methionine + Cystine (%)	0.90	0.75
Metabolic energy (Kcal/kg)	3075	3200

incised longitudinally until the end of the epiphysis for the determination of its status for tibial dyschondroplasia. A millimetric calliper was used for the measurement of the lesions. The severity of tibial dyschondroplasia was scored as 0 if there were no lesions, 1 if the distal distribution area of the lesions was smaller than 0.5 cm, 2 if the size of the distal distribution area of the lesions ranged between 0.5 and 1 cm, and 3 if the distal distribution area of the lesions was larger than 1 cm [10].

Sample Collection and Measurements

At the end of the trial, the birds were held for 10-12 h without food and water prior to determining their final body weights. Two birds from each subgroup were randomly chosen as having body weights nearest to the average body weight of their own groups, slaughtered via a neck cut, bled for 120s, and semi-scalded 54°C for 30s before mechanical plucking. The birds were eviscerated manually, washed, and allowed to drain for 10 min [11]. After eviscerating, carcasses were stored at 3°C for 24 h, and then the carcasses were dissected [12-14].

Analysis for pH and Thiobarbituric Acid Reactive Substances (TBARS)

The pH values of the samples were determined using a pH meter (SCHOTT L 6880, Lab StarpH). The pH value was measured using a direct probe by thrusting the probe into the breast fillets. To determine TBARS values, 1 g of ground breast meat sample was taken from each breast fillet of each treatment, and 6 mL TCA solution was added (7.5% TCA, 0.1% EDTA, 0.1% 1-propyl gallate). The mixture was homogenised for 20-30s by Ultra-Turrax and was then filtered over Whatman one. Next, 1 mL 0.02 M ThioBarbituric acid solution was added to the 1mL filtrate. This mixture was kept in a boiling water bath for 40 min. It was then cooled and centrifuged at 2.000 rpm for 5 min. Finally, absorbance was measured at 532 nm (Shimadzu, UV 160), and TBARS values were determined using the standard coefficient as µmol malonaldehyde/kg.

Determination of Colour Values

A Minolta model colorimeter (CR-200, MinoltaCo, Osaka, Japan) was used for the colour measurement of the breast fillet samples, with a white tile as a reference [L* = 0, darkness; L* = 100, lightness (darkness/lightness); a*; + a* = red, -a* = green and b*; + b = yellow, -b = blue; hue = h* = $\tan^{-1}(b^*/a^*)$; and chroma = C* = $(a^{*2} + bb^{*2})^{1/2}$].

Statistical Analysis

The data obtained in the present study was analysed using the SPSS [15] software, such that a comparison of the use of the two different growth systems in broiler production was made for growth performance and parameters related to slaughter, carcass and meat quality. Differences between the trial groups were determined using the t test. For the assessment of the differences observed in survival rate and tibial dyschondroplasia, the Kruskal-Wallis test, which is a nonparametric statistical method, was employed.

RESULTS

The body weight and cumulative body weight values of Groups FBG and CBG are shown in *Table 2*. The evaluation of the values presented in *Table 2* demonstrate that, the body weight and cumulative body weight values of the trial groups, which were determined by weekly measurements, significantly differ from each other (P<0.01).

The feed consumption, feed conversion, cumulative feed consumption and cumulative feed conversion values of Groups FBG and CBG are shown in *Table 3*. The final cumulative feed consumption values of Groups FBG and CBG were determined as 4339.56 g and 3585.61 g, respectively. The investigation of weekly feed consumption and cumulative feed consumption values revealed that, excluding the first week of the trial, throughout the remaining time period, the broilers included in Group FBG consumed a greater amount of feed than those included in Group CBG, and it was ascertained that this difference was statistically very significant (P<0.01).

In Groups FBG and CBG, the maximum and minimum body weights and variation coefficients were determined as 2960.00 - 2790.00 g, 2000.00 - 1250.00 g and 7.68% - 16.55%, respectively.

Parameters pertaining to the carcass traits of Groups FBG and CBG are presented in *Table 4*. With an aim to determine slaughter and carcass traits, broiler chickens with

Table 2. *The live weight and cumulative body weight values of groups FBG and CBG, measured each week*
Tablo 2. *FBG ve CBG gruplarının haftalık ve kümülatif canlı ağırlık değerleri*

Weeks	Live Weight (g)				P<[1]
	Floor Breeding		Cage Breeding		
	Mean	SD	Mean	SD	
1	141.00	0.00	141.33	2.94	NS
2	350.40	5.68	282.83	9.13	**
3	770.00	21.05	677.50	26.77	**
4	1186.20	13.70	985.66	70.55	**
5	1827.20	49.65	1431.50	103.91	**
6	2530.16	74.28	2046.11	62.68	**
1-2	209.40	5.68	141.50	9.13	**
1-3	629.00	21.05	544.50	26,77	**
1-4	1045.20	13.70	852.66	70.55	**
1-5	1686.20	49.65	1298.50	103.91	**
1-6	2389.16	74.28	1904.77	61.00	**

[1] *Statistical significance, ** P<0.01,* ***NS:*** *Non-significant,* ***SD:*** *Standard Deviation*

Table 3. *The weekly feed consumption, feed conversion rate, cumulative feed consumption and cumulative feed conversion ratio values of groups FBG and CBG*
Tablo 3. *FBG ve CBG gruplarının haftalık yem tüketimi, yemden yararlanma, kümülatif yem tüketimi ve kümülatif yemden yararlanma değerleri*

Weeks	Feed Consumption (g)				P<[1]	Feed Efficiency				P<[1]
	Floor Breeding		Cage Breeding			Floor Breeding		Cage Breeding		
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
1-2	244.14	15.95	222.28	7.13	NS	1.16	0.06	1.57	0.20	**
2-3	707.28	31.01	504.93	16.59	**	1.69	0.11	1.26	0.11	**
3-4	723.29	54.46	560.36	46.83	**	1.74	0.15	1.86	0.30	NS
4-5	1198.28	21.61	970.36	41.44	**	1.87	0.09	2.20	0.29	*
5-6	1466.57	43.82	1327.74	82.18	**	2.09	0.15	2.18	0.27	NS
1-2	951.42	19.50	727.21	8.72	**	1.52	0.07	1.34	0.11	**
1-3	1674.71	53.95	1287.51	69.97	**	1.60	0.05	1.52	0.14	NS
1-4	2872.99	64.91	2257.87	84.86	**	1.70	0.03	1.75	0.16	NS
1-5	4339.56	104.46	3585.61	122.75	**	1.82	0.05	1.88	0.07	NS

*[1] Statistical significance, ** P<0.01, * P<0.05,* ***NS:*** *Non-significant;* ***SD:*** *Standard Deviation*

Table 4. *Parameters pertaining to the carcass characteristics of groups FBG and CBG*
Tablo 4. *FBG ve CBG gruplarının karkas özelliklerine ait parametreler*

Parameters	Carcass Characteristic				P<[1]
	Floor Breeding		Cage Breeding		
	Mean	SD	Mean	SD	
Pre slaughter weight (g)	2435.50	106.31	2048.50	167.30	**
Hot carcass weight (g)	1791.60	77.91	1504.70	141.04	**
Cold carcass weight (g)	1775.00	78.92	1486.20	141.14	**
Hot carcass yields (%)	73.57	1.33	73.49	1.69	NS
Cold carcass yields (%)	72.89	1.27	72.49	1.69	NS
Ratio of neck (%)	5.65	1.00	5.78	0.50	NS
Ratio of wing (%)	10.91	0.69	11.36	0.87	NS
Ratio of whole legs (%)	38.30	1.67	38.93	2.55	NS
Ratio of tail (%)	1.08	0.21	1.25	0.23	NS
Ratio of whole breast (%)	44.06	1.13	42.68	2.23	*

*[1] Statistical significance, ** P<0.01, * P<0.05,* ***NS:*** *Non-significant;* ***SD:*** *Standard Deviation*

Table 5. *Parameters pertaining to slaughter characteristics of groups FBG and CBG*
Tablo 5. *FBG ve CBG gruplarının kesim özelliklerine ait parametreler*

Parameters	Slaughter Characteristic				P<[1]
	Floor Breeding		Cage Breeding		
	Mean	SD	Mean	SD	
Ratio of blood (%)	4.34	0.45	3.74	0.51	**
Ratio of feather (%)	5.52	0.44	5.15	0.48	NS
Ratio of head (%)	2.52	0.29	3.15	0.32	**
Ratio of noneatable organ weights (%)	5.01	0.59	5.24	0.98	NS
Ratio of gizzard (%)	2.14	0.33	2.31	0.46	NS
Ratio of liver (%)	1.79	0.15	1.93	0.22	NS
Ratio of foot (%)	4.09	0.22	4.66	0.40	NS
Ratio of heart (%)	0.56	0.09	0.69	0.10	**

*[1] Statistical significance, ** P<0.01,* ***NS:*** *Non-significant;* ***SD:*** *Standard Deviation*

Table 6. *The tibial dyschondroplasia scores and survival rate values of groups FBG and CBG*
Tablo 6. *FBG ve CBG gruplarının tibial diskondroplazi skoru ve yaşama gücü değerleri*

Treatment Groups	TD[1]		P<[3]	SR[2] (%)		P<[3]
	Mean	SD		Mean	SD	
Floor Breeding	0.44	0.72	NS	100.00	0.00	*
Cage Breeding	0.33	0.50		94.40	23.20	

*[1] Tibial Dyschondroplasia, [2] Survival rate, [3] Statistical significance, * P<0.05,* ***NS:*** *Non-significant;* ***SD:*** *Standard Deviation*

values closest to the final mean body weight were selected from each trial group. Excluding baseline body weights, values pertaining to Group FBG were greater than those pertaining to Group CBG for all time points. Therefore, the differences observed between the two groups for the mean values of preslaughter body weight, hot carcass weight and cold carcass weight were statistically very significant (P<0.01).

Parameters pertaining to slaughter traits of Groups FBG and CBG are shown in *Table 5*. It was ascertained that, the differences between the two trial groups for feather, inedible organ weights, and gizzard, liver and feet percentages were statistically insignificant (P>0.05).

The tibial dyschondroplasia scores *(Table 6)* of Groups FBG and CBG were 0.44 and 0.33, respectively, and the groups did not statistically differ from each other for this parameter (P>0.05). In terms of survival rate *(Table 6)*, it was observed that no mortality occurred in Group FBG until the end of the trial, whilst the survival rate of Group CBG was determined as 94.4%.

The L*, a*, b*, C* and H* values of the skinless leg and breast meat of Groups FBG and CBG are shown in *Table 7*.

Table 7. *The L*, a*, b*, C* and H* values of the skinless leg and breast meat of Groups FBG and CBG*
Tablo 7. *FBG ve CBG gruplarının derisiz göğüs ve but etlerinin L*, a*, b*, C* ve H* değerleri*

CP[1]	Breast				P<[2]	Thigh				P<[2]
	Floor Breeding		Cage Breeding			Floor Breeding		Cage Breeding		
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
L*	54.49	4,35	51.81	3.35	**	58.20	2.37	53.11	8.29	**
a*	3.12	1.48	3.53	1.26	NS	4.05	1.54	6.11	5.68	*
b*	6.48	2.36	7.86	2.19	**	5.54	2.28	7.75	2.85	**
C*	7.28	2.45	8.91	1.95	**	6.90	2.06	9.62	2.17	**
H*	64.35	10.99	66.40	7.86	NS	53.09	14.73	54.23	13.99	NS

*[1] Colour Parameters, **L* :** lightness (0 = black; 100 = white), **a* :** redness (– = green; + = red), **b* :** yellowness (– = blue; + = yellow), **H* :** hue, **C* :** liveliness, [2] Statistical significance, ** P<0.01, * P<0.05, **NS:** Non-significant; **SD:** Standard Deviation*

Table 8. *The pH and thiobarbutiric acid reactive substances values of breast meat in groups FBG and CBG*
Tablo 8. *FBG ve CBG gruplarının göğüs etinden elde edilen pH ve tiabarbütirik asit reaktif substans değerleri*

Treatment Groups	pH		P<[2]	TBARS[1]		P<[2]
	Mean	SD		Mean	SD	
Floor Breeding	6.14	0.11	**	13.79	1.22	NS
Cage Breeding	5.95	0.21		13.77	2.05	

*[1] Thiobarbutiric acid reactive substances (mmol malonaldehyde kg^{-1}), [2] Statistical significance, ** P<0.01, **NS:** Non-significant; **SD:** Standard Deviation*

The differences observed between the trial groups for the a* and H* values of breast meat were statistically insignificant (P>0.05), whilst the differences observed for the L*, b* and C values were statistically very significant (P<0.01).

The pH values of breast meat in Groups FBG and CBG (*Table 8*) were determined as 6.14 and 5.95, respectively.

The TBARS values determined in Groups FBG and CBG are presented in *Table 8*. Accordingly, the TBARS values of Groups FBG and CBG were determined as 13.79 and 13.77 mmol malondialdehyde kg^{-1}, respectively, and the two groups did not differ from each other statistically.

DISCUSSION

The final body weights and mean body weight gains of Groups FBG and CBG were determined as 2530 g - 2046 g and 2389.16 g -1904.77 g, respectively. It was ascertained that, the body weight and mean body weight values of Group FBG were significantly higher than those of Group CBG. The review of previous literature reports has revealed that a consensus has not been reached on this issue, and that to date; very different results have been obtained. In agreement with the findings of the present study, Hypes et al.[16] (CBG 1.832 - FBG 1.911 g), Türkyılmaz et al.[17] (CBG 2168.4 - FBG 2261.1 g) and Fouad et al.[7] (CBG 1616.27 - FBG 1862.52 g) reported that the final body weight of broiler chickens was higher in Group FBG compared to Group CBG and that this difference was statistically significant. On the other hand, Elibol [18] (CBG 1792 - FBG 1745 g), Reece et al.[19] and Andrews et al.[20] indicated that the final body weights of Group CBG were higher than those of Group FBG and that the two groups differed from each other significantly. Furthermore, Andrews [21] (CBG 1572 - FBG 1573 g), Andrews et al.[22] (CBG 1513 - FBG 1485 g), and Athar et al.[23] (CBG 2000 - FBG 1910 g) indicated that Groups FBG and CBG did not display any statistically significant difference from each other in terms of final body weights.

Contradictory to the findings of the present study, Fouad et al.[7] reported the total feed consumption values of broiler chickens included in Groups FBG and CBG as 3096.48 g and 3139.46 g, respectively, and indicated the absence of any statistical difference between the trial groups. In parallel with the findings of Fouad et al.[7], Athar et al.[23] reported the feed consumption values of Groups CBG and FBG as 4.46 kg and 4.43 kg, respectively, and noted that the difference between the two groups was statistically insignificant. In a study conducted by Zahoa et al.[24], in which the effect of three different types of cage floor (wire, plastic and bamboo) on the growth performance of broiler chickens was investigated, the differences between the feed consumption values of the trial groups was found to be statistically insignificant, and these values were reported as 3.41 kg, 3.28 kg and 3.21 kg for the groups raised in cages with wire, plastic and bamboo floors, respectively.

In the present study, the feed conversion rates in Groups FBG and CBG during the time intervals between days 7-14, 14-21 and 28-35 were determined as 1.16-1.57, 1.69-1.26 and 1.87- 2.20, respectively, and it was ascertained that the difference between the groups was statistically significant. Furthermore, the cumulative feed conversion rates of Groups FBG and CBG were determined as 1.82 and 1.88, respectively, and the difference between the groups was statistically insignificant (P>0.05). In agreement with the findings of the present study, the final mean feed conversion rates of broiler chickens included in Groups CBG and FBG were reported as 2.18 and 2.14, respectively, by Welch et al.[25]; 1.71 and 1.71, respectively, by Türkyılmaz et al.[17]; 1.97 and 1.72,

respectively, by Fouad et al.[7]; and 2.23 and 2.32, respectively, by Athar et al.[23]. These researchers indicated that no statistical difference was observed between the groups for this parameter. Reece et al.[19] reported that the feed conversion rates of broiler chickens raised on floor were better than those of broilers raised in cages. Akpobome and Fanguy [26], on the other hand, reported that the feed conversion rates of broiler chickens raised in cages were better than those of broilers raised on floor. Furthermore, Hypes et al.[16] determined that, until day 42, the feed conversion rates of male broilers raised in cages and on floor were 2.047 and 2.115, respectively, and that the difference between the two groups was statistically significant. Zahoa et al.[24] indicated that the effect of three different types of cage floors (wire, plastic and bamboo) on the feed conversion rates of broiler chickens was statistically insignificant.

Group FBG showed a higher uniformity level in terms of final body weights, in comparison to Group CBG.

Hot and cold dressing percentages and neck, wing, drumstick and tail percentages did not differ statistically between Groups FBG and CBG (P>0.05). The breast meat percentages of Groups FBG and CBG were determined as 44.06% and 42.68%, respectively, and the difference between the two groups was found to be statistically significant. Türkyılmaz et al.[17] reported the hot dressing percentages of broiler chickens raised on floor and in cages as 69.6% and 71.4%, respectively, while Athar et al.[23] reported the same values as 68.9% and 67.60%, respectively. In both studies, the values of the different groups did not differ from each other statistically.

Blood, head and heart percentages of Groups FBG and CBG were 4.34% - 3.74%, 2.52% - 3.15% and 0.56% - 0.69%, respectively, and the differences between the trial groups were statistically very significant (P<0.01). The rate values belonging heart and liver were found to be similar as the results reported by Yildiz et al.[27]

In terms of survival rate *(Table 6)*, it was observed that no mortality occurred in Group FBG until the end of the trial, whilst the survival rate of Group CBG was determined as 94.4%. The difference observed between the trial groups for survival rate was statistically significant. Moreover, Andrews and Goodwin [28], Elibol [18], Türkyılmaz et al.[17] and Fouad et al.[7] reported that the difference between the mortality rates of broiler chickens raised in cages and on floor was statistically insignificant.

The assessment of the values obtained for chicken drumsticks revealed that, excluding the H* value, the two groups differed from each other significantly for the L*, a*, b* and C* values. The pH values of breast meat in Groups FBG and CBG were determined that the difference between the groups for this parameter was statistically very significant. Wariss et al.[29] reported that meat pH values were affected, to a greater extent, from applications employed prior to slaughter. The pH value of meat is the most significant parameter, which affects the shelf life of this food product. Meat with high pH values has a shorter shelf life, as microbial activity reaches a maximum level at high pH levels. In this respect, lower pH values having been determined for the meat of broilers included in Group CBG can be considered as an advantage. Yetişir et al.[30] reported the pH value of breast meat of broiler chickens as 5.837. Furthermore, the L*, a* and b* values they determined for skinless breast meat were 55.765, 4.334 and 7.204, respectively. For breast meat, Quio et al.[31] reported the L*, a* and b* values as 49.6, 3.3 and 4.9, respectively, Goksoy et al.[32] reported the L*, a* and b* values as 62.23, 3.41 and 5.60, respectively, whilst Ponsano et al.[33] reported the L*, C* and H* values as 60.6, 11.25 and 68.5, respectively. Northcutt [34] reported that the colour of chicken meat was affected by multiple factors, including age, sex, genotype, feed, intramuscular fat distribution, water content of meat, preslaughter conditions and processing techniques, while Fletcher [35] noted sex, age, breed, management techniques, chemical processing and deep freezing conditions as factors influential on meat colour. Based on the findings obtained in the present study, it is suggested that the particular growth system used for production also affects the colour parameters of poultry meat. Petracci et al.[36] reported for poultry meat that, dark meat colour and meat pH value were significantly correlated with each other, and also indicated that lower pH values were correlated with lighter meat colour. The assessment of the parameters obtained for chicken drumsticks and breast meat in the present study demonstrated that the L* values of Group FBG were higher and thus, it was observed that the meat of this group was of darker colour. This was attributed to Group FBG having higher pH values than those of Group CBG. The TBARS values determined in Groups FBG and CBG are presented in *Table 8*. Analyses performed for the detection of thiobarbituric acid-reactive substances (TBARS) are frequently employed for the detection of the malondialdehyde content of meat, which is an indicator of bad taste in meat. Owing to the high level of polyunsaturated fatty acids it contains, poultry meat is very sensitive to oxidative damage. Aksu et al.[37] reported the TBARS value for male Ross 308 broiler chickens as 14.11 mmol malondialdehyde kg^{-1}. The TBARS value previously reported by Aksu et al.[37] is higher than the TBARS values determined in the present study for Groups FBG and CBG.

The present study, which was aimed at the comparison of floor-based and cage-based growth systems in broiler production for growth performance and parameters related to slaughter, carcass and carcass quality, demonstrated that, in terms of growth performance, broiler chickens raised using the floor-based growth system reached a mean body weight of 2530.16 g at the end of the trial by consuming a mean feed amount of 4339.56 g, while broiler chickens raised using the cage-based growth system reached a mean body weight of 2046.11 g by consuming a mean feed amount of 3585.61 g. The present study demonstrated

that, in view of current feed and poultry meat prices alone, although the cage-based and floor-based growth systems did not statistically differ from each other in terms of feed conversion rates, the profitability of the floor-based growth system was 15.65% greater than that of the cage-based growth system. Furthermore, the breast meat percentages of the broilers raised on floor were greater than those of the broilers raised in cages. In the present study, it was determined that the pH values of meat obtained from broiler chickens raised on floor were higher. This is also considered as a major reason for the difference observed in the present study between the two groups for the colour of chicken leg and breast meat.

REFERENCES

1. Abrahamsson P, Tauson R: Aviary systems and conventional cages for laying hens. Effects on production, egg quality, health and bird location in three hybrids. *Acta Agricult Scand, Section A,* 45, 191-203, 1995.

2. Rodriguez B, Valdivie M, Dieppa O: Body damages associated with high stocking densities of broiler chickens in cages. *Cuban J Agr Sci,* 39, 61-66, 2005.

3. Santoso U: Effects of house type and early feed restriction on performance and fat deposition in unsexed broilers. *J Ilmu Ternak Dan Vet,* 7, 84-89, 2002.

4. Swain BK, Sundaram RNS, Barbuddhe SB, Nirmale AV: Influence of cage and deep litter rearing systems on the performance of broilers. *Indian J Anim Sci,* 79, 467-469, 2002.

5. Wang SU, Zhang X, Huang BL, Sheng F, Li K, Ren S: Comparsion among differenet broiler-rearing technical crafts. *Transactions of the Chinese Society of Agricultural Engineering,* 13, 96-98, 1997.

6. Awoniyi TAM: The effect of housing on layer-chicken's productivity in the 3-tier cage. *Int J Poult Sci,* 2, 438-441, 2003.

7. Fouad MA, Abdel AH, Razek AH, Badawy EM: Broilers welfare and economics under two management alternatives on commercial scale. *Int J Poult Sci,* 7, 1167–1173, 2008.

8. Duncan IJH: The pros and cons of cages. *World's Poult Sci J,* 57, 381-390, 2001.

9. AOAC: Official Methods of Analysis. 15 ed., Association of Official Analytical Chemists, (Washington, D.C.), 1990.

10. Huff W: Evaluation of tibial dyschondroplasia during aflatoxicosis and feed restriction in young broiler chickens. *Poult Sci,* 59, 991-993, 1980.

11. Yalcin S, Ozkan S, Acıkgoz Z, Ozkan K: Effect of dietary methionine on performance, carcass characteristics and breast meat composition of heterozygous naked neck (Na/Na+) birds under spring and summer conditions. *Br Poult Sci,* 40, 688-694, 1999.

12. Mathes M, Möllerherm L, Krell U: Geflügel. (Deutscher Fachverlag GmbH, Frankfurt), 1997.

13. Pingel H, Wicke M, Lengerken GV: Gewinnung und Qualitöt von Geglügelfleisch. **In,** Branscheid W, Honikel KO, Lengerken GV, Troeger K (Eds): Qualitöt von Fleisch und Fleischwaren. pp. 301-334, Deutscher Fachverlag, Germany. 1998.

14. Barbut S: Poultry Products Processing. An Industry Guide. CRC Press, USA, 2002.

15. Statistical Packages for the Social Sciences: SPSS for Windows release 10.01. SPSS Inc., Chicago, 1996.

16. Hypes WA, Carpenter GH, Peterson RA, Jones WT: Productive performance of conventional floor-reared broilers high density cage brooded broilers. *J Appl Poult Res,* 3, 238-243, 1994.

17. Turkyilmaz MK, Nazligul A, Bardakcioglu HE: The effect of the floor and cage rearing systems on some production traits and livestock economics in broilers. *J Vet Sci,* 18, 99-105, 2002.

18. Elibol O: Comparison of broiler raising in cages with floor system in regard to some important characteristics. *PhD Thesis,* University of Ankara, Grad. Sch. of Nat. and Appl. Sci., 1991.

19. Reece FN, Deaton JW, May JD, May KN: Cage versus floor rearing of broiler chickens. *Poult Sci,* 50, 1786-1790, 1971.

20. Andrews LD, Seay RL, Harris GC, Nelson GC: Flooring materials for caged broilers and their effect upon performance. *Poult Sci,* 53, 1141-1146, 1974.

21. Andrews LD: Cage rearing of broilers. *Poult Sci,* 51, 1194-1197, 1972.

22. Andrews LD, Nelson GS, Harris GC, Goodwin TL: Performance of five strains of broilers in a four-tier cage system with plastic mat floors. *Poult Sci,* 54, 54-58, 1975.

23. Athar MA, Pervez E, Asghar MN, Asghar AM, Zoyfro V: Effect of cage and floor rearing and their mutual transfer on the performance of broiler chicken. *Pakistan J Agr Res,* 11, 192-196, 1990.

24. Zhao FR, Geng AL, Li BM, Shi ZX, Zhao YJ: Effects of environmental factors on breast blister incidence, growth performance and some biochemical indexes in broilers. *J Appl Poult Res,* 18, 699-706, 2009.

25. Welch SW, Metcalfe PF, Wesley R: Broilers in cages. *World's Poult Sci J,* 27, 132-142, 1970.

26. Akpobome GO, Fanguy RC: Evaluation of a cage floor system for production of commercial broilers. *Poult Sci,* 72, 274-280, 1992.

27. Yildiz G, Koksal BH, Sizmaz O: Effects of dietary boric acid and yeast *(Saccharomyces cerevisiae)* supplementation on performance, carcass traits and some blood parameters of broilers. *Kafkas Univ Vet Fak Derg*, 17 (3): 429-434, 2011.

28. Andrews LD, Goodwin TL: Performance of broilers in cages. *Poult Sci,* 52, 723-728, 1973.

29. Wariss PD, Wilkins LJ, Knowles TG: The influence of ante-mortem handling on poultry meat quality. **In,** Richardson RI, Mead GC (Eds): *Poultry Meat Science. Poultry Sci, Symposium Series,* 25, 223-230, 1999.

30. Yetisir R, Karakaya M, Ilhan F, Yilmaz MT, Ozalp B: Effects of different lighting programs and sex on some broiler meat quality properties affecting consumer preference. *J Anim Prod,* 49, 20-28, 2008.

31. Quio M, Fletcher DL, Northhcutt JK, Smith DP: The relationship between raw broiler breast meat color and composition. *Poult Sci,* 81, 422-427, 2002.

32. Goksoy EO, Aksit M, Kırkan S: The effects of organic acid and organum onites supplementations on some physical and microbial characteristics of broiler meat obtained from broilers kept under seasonal heat stress. *Kafkas Univ Vet Fak Derg*, 16 (Suppl-A): S41-S46, 2010.

33. Ponsano EHG, Pinto MF, Garcia-Neto M, Lacava PM: Performance and color of broilers fed diets containing Rhodocyclus gelatinosus biomass. *Rev Bras Cienc Avic,* 6, 237-242, 2004.

34. Northcutt JK: Factors affecting poultry meat quality. Cooperative Extension Service Bulletin 1157. The University of Georgia College of Agric. and Env. Sci., 1997.

35. Fletcher DL: Poultry meat colour. **In,** Richardson RI, Mead GC (Eds): *Poultry Meat Science. Poultry Sci. Symposium Series,* 25, 159-175, 1999.

36. Petracci M, Bianchi M, Betti M, Cremonini, M, Laghi AL, Cavani C, Pallucci G: Realtionships between raw broiler breast meat colour and low-resolution NMR relaxation properties. *Proceedings of the XXII World's Poultry Congress,* June 8-13, Istanbul, 2004.

37. Aksu T, Aksu MI, Yoruk MA, Karaoglu M: Effects of organically-complexed minerals on meat quality in chickens. *Br Poult Sci,* 52, 558-565, 2011.