Kafkas Univ Vet Fak Derg
21 (4): 521-526, 2015
DOI: 10.9775/kvfd.2014.12867

Kafkas Universitesi Veteriner Fakultesi Dergisi
Journal Home-Page: http://vetdergi.kafkas.edu.tr
Online Submission: http://vetdergikafkas.org

Research Article

Effect of Different Housing Systems on Production and Blood Profile of Slow-Growing Broilers [1] [2]

Merve DİKTAŞ [1] Ahmet ŞEKEROĞLU [2] Mustafa DUMAN [3] Arda YILDIRIM [4]

[1] *This project was supported by the Commission Gaziosmanpaşa University Scientific Research Projects (Project No: 2010/75)*
[2] *This study had been presented at National Poultry Congress (3 - 5 October 2012, Izmir - Turkey)*

[1] Department of Animal Science, Faculty of Agriculture, University of Ataturk, TR-25240 Erzurum - TÜRKİYE
[2] Department of Animal Production and Technologies, Faculty of Agricultural Sciences and Technologies, University of Niğde, TR-51240 Niğde - TÜRKİYE
[3] Department of Laboratory and Veterinary Health, Bor Vocational School, University of Niğde, TR-51700 Bor, Niğde - TÜRKİYE
[4] Department of Animal Science, Faculty of Agriculture, University of Gaziosmanpaşa, TR-60250 Tokat - TÜRKİYE

KVFD-2014-12867 Received: 24.12.2014 Accepted: 09.02.2015 Published Online: 15.02.2015

Abstract

Present study was conducted to investigate the effects of deep litter system, free-range with fixed housing system and free-range with portable housing system in wheat stubble on performance, internal organ weights, blood parameters and tonic immobility of slow-growing broilers. A total of 270 Hubbard Isa Red-JA chicks were used in experiments. The experiment lasted for 61 days. Results showed that the body weight on 21st, 28th, 35th and 42th days of birds from free-range with portable housing system was significantly lower than of those kept in deep litter and free range with fixed housing system. The viability of broilers in free-range with portable housing system was lower than broilers in free-range with fixed housing and deep litter system in the days of 14-42 and 14-61, while there were not any differences between housing systems in days of 43-61. Housing systems had no significant effect on feed conversion ratio and internal organ weight. There were no significant differences in tonic immobility durations of housing systems and some blood parameters, except hematocrit values. In conclusion, the body weight in free-range with portable housing system was significantly lower until 42nd day of the experiment, but this difference was disappeared during the rest of rearing period. It could be concluded that rural producer can be involved in broiler production after wheat harvesting.

Keywords: *Slow-growing broiler, Blood parameters, Free Range Housing system, Growth performance*

Farklı Yetiştirme Sistemlerinin Yavaş Gelişen Etlik Piliçlerde Üretim ve Kan Profiline Etkisi

Özet

Bu çalışma; altlıklı yer sistemi, buğday anızında sabit kümesli serbest yetiştirme ve buğday anızında mobil kümesli serbest yetiştirme sistemlerinin yavaş gelişen etlik piliçlerin performansına, iç organ ağırlıklarına, kan parametrelerine ve tonik immobilite sürelerine etkisini araştırmak amacıyla yapılmıştır. Çalışmada toplam 270 adet Isa Red-JA pilici kullanılmıştır. Çalışma 61 gün sonunda bitirilmiştir. Araştırma sonuçlarına göre mobil kümesli serbest yetiştirme sistemindeki piliçlerin 21. 28. 35. ve 42. gün canlı ağırlıkları istatistiki olarak diğer sistemlerden düşük bulunmuştur. Mobil kümesli serbest yetiştirme sistemindeki piliçlerin yaşama gücü 14-42 ve 14-61 günlerden diğer sistemlerden düşük çıkarken 43-61 günlerde herhangi bir istatistiki farklılık gözlenmemiştir. Yetiştirme sistemi yemden yararlanma oranı ve iç organ ağırlıklarını etkilememiştir. Yetiştirme sistemleri arasında tonik immobilite süresi ve hematokrit değer dışında kan parametreleri açısından istatistiki farklılık gözlenmemiştir. Sonuç olarak; mobil kümesli serbest yetiştirme sistemindeki etlik piliçlerin canlı ağırlıkları 42. güne kadar düşük olmuş fakat bu farklılık kalan sürede ortadan kalkmıştır. Kırsal alanda buğday hasadı sonrası anızda etlik piliç yetiştiriciliğinin yapılabileceği söylenebilir.

Anahtar sözcükler: *Yavaş gelişen etlik piliç, Kan parametreleri, Serbest yetiştirme sistemi, Büyüme performansı*

INTRODUCTION

Significant improvements have been achieved in poultry performance and yield through the developments in breeding, feeding, growing techniques and disease prevention [1,2]. This has led to reduction in chicken prices making its availability to everyone. However, sudden death syndrome and leg problems because of rapid growth on of

İletişim (Correspondence)
+90 535 8764343
ahmet.sekeroglu@nigde.edu.tr

respiratory and circulatory systems of broilers; and due to intensive housing systems attracted the reactions of highly sensitive publics of countries concerning about animal comfort and welfare [3]. Therefore, beside the performance of broilers, tonic immobility duration, blood parameters (heterophil/lymphocyte ratio) and internal organ weights are taken into consideration as the indicators of animal comfort and welfare [4-9]. Developments in animal rights and welfare bring important criticism about entire housing systems, including litter bed system, currently implemented in intensive poultry facilities [10,11]. Therefore, alternative housing systems taking normal behaviors and animal welfare into consideration have recently been emphasized. Free-range system is one of such alternative housing systems [10,12,13]. Free-range system allows chicken to stay on ground away from artificial atmospheres and to range at open spaces. Chickens commonly range over trashing grounds with left-over seeds. Such seed wastes cause significant losses sometimes reaching up to 20%. Wheat seed loss is around 3-4% in Turkey [14]. The demand for poultry grown rapidly and reached to slaughtering weight in a short time is decreasing in developed countries. On the other hand, organic and natural poultry housing systems have increased substantially as a result of the greater demand to natural broiler meat production [15].

There has been insufficient information on free-range with portable housing system after wheat harvest over wheat stubble lands. Accordingly, the objectives of the study reported here in were twofold: firstly, to compare the three different growing systems as of free-range with portable housing system (FRPH) in wheat stubble, free-range with fixed housing system (FRFH) and deep litter bed system (DLB) with regard to animals and environment and secondly, to examine the influence of different housing systems on performance, internal organ weight, tonic immobility duration and blood parameters of slow-growing broilers.

MATERIALS and METHODS

Experimental Birds, Feeding and Housing Systems

Animal material of the experiments was supplied from a commercial facility within the scope of a project supported by Gaziosmanpasa University Scientific Research Projects Committee (2010/75). Before the initiation of experiment, required permissions were obtained from Gaziosmanpasa University Local Ethics Committee on Experimental Animals (No: 2009-HADYEK-032) also performed in accordance with the internationally accepted principles for laboratory animal use and care. The experiment was performed between 07.07.2010 and 05.09.2010 after harvest of wheat. A total of 270 slow-growing one day-old Hubbard Isa Red-JA broiler chicks were used in experiments. A battery operated light was used for portable housing unit. Incandescent light bulb in DLB and FRFH system, and LED bulb in FRPH system was used for 24-hours per day. In the research, first 2 week; in all systems, 2 watt/m^2, for 15-61 days; in systems of DLB and FRFH, 2 watt/m^2, in system of FRFH, 2 watt/m^2 and in system of FRPH, 1 watt/m^2 light density was used. A 24 h lighting was provided in all three systems. A hang-feeder and waterer were placed into each replication of experiment. 10 cm depth of wood shavings were used as bedding material in DLB, indoor areas of FRFH and FRPH systems. In FRPH system, it is applied after 15 decar harvesting of wheat.

A free feeding program was implemented as; 1st period (23.0 CP, 3000 Kcal/kg ME) chick feed during the days 1-10; 2^{nd} period (22.0% CP, 3000 Kcal/kg ME) broiler grower feed during the days 11-35; 3^{rd} period (20.0% CP, 3100 Kcal/kg ME) broiler developer feed for the days 36-53; 4^{th} period (18.0% CP, 3100 Kcal/kg ME) broiler finishing feed for the days 53-61.

Chicks were housed in litter bed ground system for the initial two weeks. The average live weights were determined and they were separated into treatments with 30 animals in each. Average chick weights were equal in each treatment.

Experiments were carried out in DLB, FRPH and FRFH systems of poultry units at Animal Science Department of Gaziosmanpaşa University Agricultural Faculty. Three replications were performed in each housing system and each replication had 30 birds. Therefore, 90 slow-growing broilers were used in each housing systems and a total of 270 animals were used in entire treatments. A space of 5.4 m^2 was allocated to each replication of DLB system; an indoor space of 5.4 m^2 and range space of 9.5 m^2 were allocated to each replication of FRFH; a portable housing space of 2.25 m^2 and a free-range space were allocated to each replications of FRPH system. The dimensions of portable housing unit are 1.8X1.25 m (LxW), with 1.9 m front height and 1.5 m rear height. There was natural ventilation system in each housing system. In FRFH and FRPH systems, birds were allowed to range between the hours 07:00-19:00 and they were housed indoor between the hours 19:00-07:00. Place of portable housings were replaced three times in a day.

Determination of Performance and Tonic Immobility of Birds

Birds were individually weighed weekly for determination of body weight. Weekly feed consumptions were also recorded regularly until the end of experiments and feed conversion ratios corresponding to feed consumption for unit increase in BW (g feed/g BWI) were calculated. Survival rates (%) of each replication were also calculated by recording number and day of deaths.

By the end of the 61 day period, 4 birds (2 male and 2 female) with a close weight to average were randomly selected from each replication. That sums 12 birds from

each housing system and 36 from the entire experiments. Initially, tonic immobility was assessed in selected birds. The test was conducted in a rectangular container with an open end. Tonic immobility was induced by inverting the hen on its side and applying manual restrain until the hen stops struggling. Then, the hen released after 15 sec. Tonic immobility was assumed for birds immobile and not righted itself within 10 sec of release. Tonic immobility duration was recorded from the moment the hen became immobile until the hen righted itself. The birds with a tonic immobility state after 5 trials are assumed as sensitive and graded with 0. Test period was limited to 10 min and tonic immobility duration of birds immobile and not righted within the 10 min was recorded as 600 sec [16].

Slaughtering Procedures, Non-Carcass Parts, Internal Organs and Assays of Blood Parameters

The birds were slaughtered without stunning under Turkish slaughter procedure by severing the throat and major blood vessels in the neck in local processing plant. Following the slaughter and blood release, wet defeathering and manual internal removal were performed. Relative weights (g/100 g BW) of heart, liver, spleen, abdominal fat and digestion system and length of small intestine (cm) were determined [17].

Blood samples were taken into vacuum tubes from *Vena cutaneae ulnaris* of selected birds. Serum was obtained by centrifuging blood samples at 3.000 rpm for 10 min. Serum samples were preserved at -20°C and immediately transferred to laboratory for analysis [18]. *In vitro* enzymatic colorimetric method was employed in glucoses, triglyceride and cholesterol measurements. Plasma protein levels were measured by a refractometer (Atago, SPR-N, Japan). Cyano methemoglobin and microhematocrit methods were respectively used for hemoglobin and hematocrit measurements [19]. May Grünwald-Giemsa method was employed to calculate leukocyte percents from stained frothily [6].

Statistical Analyses

Experiments were carried out in completely randomized design and SPSS [20] software was used for statistical analysis of the data. The differences between groups were determined by one-way ANOVA test. Duncan multiple range test was used to compare treatment means [21].

RESULTS

Effects of housing system on performance characteristics, internal organ weights and blood parameters and tonic immobility duration of slow-growing broilers are given in *Table 1, 2,* and *3,* respectively.

The FRPH system on 21st, 28th, 35th and 42nd days of body weight was lower significantly than those other systems (P<0.05). Body weight of housing systems on initial (14th

Table 1. *Effects of housing systems on performance of slow-growing broilers*
Tablo 1. *Yetiştirme sisteminin yavaş gelişen etlik piliç performansına etkisi*

Parameter	Free-range with Portable Housing	Free-range with Fixed Housing	Deep Litter Bed System	SEM	P
Body weight (BW), g					
Initial (14th day)	281.54	281.74	281.63	1.46	NS
21st day	489.87^{b}	520.83^{a}	529.94^{a}	2.92	*
28th day	785.26^{b}	832.57^{a}	843.34^{a}	5.27	*
35th day	1116.35^{b}	1194.54^{a}	1208.61^{a}	8.09	*
42nd day	1390.12^{b}	1508.10^{a}	1498.48^{a}	10.28	*
49th day	1776.84	1841.27	1832.44	13.59	NS
56th day	2136.49	2194.13	2178.44	16.59	NS
61st day	2375.00	2471.61	2427.21	19.59	NS
Feed conversion ratio, g feed /g weight gain					
14-42 day	1.87	1.80	1.80	0.00	NS
43-61 day	2.38	2.17	2.27	0.72	NS
14-61 day	2.08	1.98	2.05	0.03	NS
Viability, %					
14-42 day	86.67^{b}	100^{a}	100^{a}	3.68	**
43-61 day	93.89	94.44	94.44	1.99	NS
14-61 day	81.11^{b}	94.44^{a}	94.44^{a}	3.81	**

SEM: *Standard Error of the Mean;* ***a-b*** *different letters in the same line indicate significant difference between means;* ******* *P<0.05;* ******** *P<0.01;* ***NS:*** *non-significant (P>0.05)*

day), 49th, 56th and 61st days were ordered respectively from higher to lower as FRFH, DLB and FRPH system, however significant (P>0.05) differences were not observed among treatments. Effects of housing systems on FCR's (14-42, 43-61 and 14-61 days) were not significant (P>0.05). While the effect of housing systems on viability (%) of 14-42nd day and 14-61st day was significant (P<0.01), effects were not significant (P>0.05) on viability of 43-61st day *(Table 1)*.

Effects of housing systems on internal organ (digestive system, heart, gizzard, spleen, abdominal fat, liver) weights and length of small intestine of slow-growing broilers were insignificant (P>0.05) *(Table 2)*.

Lower blood cholesterol levels in FRPH system and lower blood triglyceride and glucose levels in FRFH system were observed the difference between housing systems were not significant (P>0.05). The difference between housing systems with regard to total protein content of plasma were not significant (P>0.05). The difference between housing systems with regard to white corpuscle (heterophil, eosinophile, basophile, lymphocyte, monocyte, Heterophil (H)/Lymphocyte (L)) ratios were not significant (P>0.05). Effect of housing systems on hematocrit values was significant (P<0.05).Tonic immobility durations of FRFH was higher than FRPH and DLB systems *(Table 3)* but there were no significant (P>0.05) difference between these systems *(Table 3)*.

DISCUSSION

Current findings about body weight do not comply with the results of studies [22-25] indicating lower body weights for free-range systems than litter bed systems and comply with the findings of studies [15,26,27] reporting insignificant effects of housing systems on live weights. Feed conversion ratio findings of this study are contrary

Table 2. *The effect of different housing systems on some internal organ weights in slow growing broilers*
Tablo 2. *Yavaş gelişen etlik piliçlerde farklı yetiştirme sistemlerinin bazı iç organ ağırlıkları üzerine etkisi*

Parameters	Free-range with Portable Housing	Free-range with Fixed Housing	Deep Litter Bed System	SEM	P
Internal organ weights, g/100 g BW					
Digestive system	6.34	6.20	5.99	0.08	NS
Hearth	0.50	0.46	0.45	0.01	NS
Gizzard	2.04	1.91	1.81	0.07	NS
Spleen	0.14	0.15	0.14	0.01	NS
Abdominal fat	3.01	2.95	3.06	0.12	NS
Liver	1.49	1.51	1.49	0.02	NS
Length of small intestine, cm	133.50	137.17	133.42	1.95	NS

SEM: *Standard error of the mean;* ***NS:*** *non-significant (P>0.05)*

Table 3. *The effect of housing system on blood parameters and tonic immobility duration in slow-growing broiler*
Tablo 3. *Yetiştirme sisteminin yavaş gelişen etlik piliçlerde kan parametreleri ve tonik immobilite süresi üzerine etkisi*

Parameters	Free-range with Portable Housing	Free-range with Fixed Housing	Deep Litter Bed System	SEM	P
Cholesterol, mg/dL	108.85	109.65	114.46	3.11	NS
Triglyceride, mg/dL	34.42	31.50	33.74	0.89	NS
Glucose, mg/dL	207.05	203.23	217.74	4.54	NS
Plasma protein, g/dL	3.47	3.66	3.64	0.06	NS
Hemoglobin, g/dL	9.31	9.82	9.60	0.20	NS
Hematocrit, %	29.75[a]	31.33[b]	31.50[b]	0.30	*
Heterophil, %	39.70	44.55	40.75	1.14	NS
Eosinophil, %	2.80	3.27	3.63	0.21	NS
Basophil, %	2.90	1.64	2.13	0.33	NS
Lymphocyte, %	50.30	45.91	48.75	1.16	NS
Monocyte, %	4.30	3.64	4.75	0.18	NS
H/L ratio	0.81	0.99	0.87	0.05	NS
Tonic immobility duration, s	112.92	163.83	137.00	21.11	NS

SEM: *Standard Error of the Mean;* ***NS:*** *non-significant (P>0.05);* ***a-b*** *different letters in the same line indicate significant difference between means; * P<0.05*

to finding of studies [15,22,25-28] reporting significant impacts of housing systems on feed conversion ratios and indicating lower ratios for free-range systems. However, insignificant differences between housing systems were similar to finding of Sekeroglu et al.[24]. Viability rate in FRPH were lower than the other systems. Such a low viability rate was mainly due to out-season extreme temperatures and predatory animals. The rate was lower than those of earlier studies [24,26-30].

Since spleen and liver weights can easily be determined at slaughter, these weights are commonly used as an indicator for immunity levels of poultry [7]. Spleen is a lymphoid organ and a weight decrease is observed in spleen [7,8] and a weight increase is observed in liver weights under stress conditions [31]. With regard to spleen and liver weights in present study, the differences between housing systems were not found significant. Insignificant impacts of housing systems on relative weights of heart, gizzard, digestive system, spleen and liver and length of small intestine were in compliance with the findings of Sekeroglu et al.[24]. Effect of housing systems on relative abdominal fat weight was not significant and FRFH system had lower values than the other systems. Such findings comply with the findings of Sekeroglu et al.[24]. However, current findings are different from the outcomes of the researches indicating significant impacts of housing system on relative abdominal fat weight and reporting lower weights for free-range systems [22,25].

It was reported that serum glucose, cholesterol and triglyceride levels in chicken vary between 130-260 mg/dl; 125-211 mg/dl and 36-211 mg/dl, respectively [32,33]. Güneş et al.[18] claimed that different housing systems had the effect on serum glucose levels, while other reported no such effect [34]. Our findings are similar to work that of Kumar et al.[34], who concluded that glucose levels were not affected by housing systems and glucose levels in groups was within the range of values reported [32]. The results agree with those initial studies [18,24,35,36] who found no significant effect of housing system on serum cholesterol. Besides, cholesterol levels in the current study were slightly lower than that of the range value reported by Altuntaş and Fidancı [32]. Serum triglyceride levels was found to be slightly lower than that of the range value determined by Masek et al.[33]. In addition, this study found no significant changes between housing systems on serum triglyceride levels and the results was in agreement with that in the literature [37]. In contrast, Sekeroglu et al.[24] observed a significant decrease in serum triglyceride concentration compared to conventional system. There was not any significant effect of housing system on plasma protein content because total protein content of plasma is related to amount and quality of protein intake [38]. The blood hemoglobin level in chicken varies between 9.8-13.5 mg/dl [32]. In this study, hemoglobin concentration of chickens kept in FRFH system was found between the normal values, while other systems were slightly lower. However, this agrees with Olaniyi et al.[39], who indicated that housing systems have no significant differences on hemoglobin concentration. Variations in Heterophil (H)/Lymphocyte (L) ratios and leukocyte counts are considered as stress factor [1,6,31]. In general, lymphocyte, eosinophil, monocyte counts and hematocrit values decrease and basophil, heterophil and counts increase under stress conditions [1]. Heterophil (H)/Lymphocyte (L) ratio of 0.2 indicates low, 0.5 medium and 0.8 high stress levels [6]. Although there were significant differences between housing systems with regard to Heterophil (H)/Lymphocyte (L) ratio, animals were exposed to under high stress. Hematocrit values vary with the ambient temperature at which birds are reared. The exposure of chickens to high temperatures causes a decrease in blood hematocrit values [1]. Therefore decreased hematocrit values had been expected with increasing temperatures. Also the current findings of this study about tonic immobility duration were similar to finding of Campo et al.[40].

In conclusion; while broilers of FRPH system had significantly lower body weights than FRFH and DLB systems until the 42nd day, the difference between the housing systems decreased during the upcoming days. Present study may enlighten the regulations to be performed in broiler production. Further research can be carried out by taking animal welfare and customer preferences into consideration as it was in developed countries. Outcomes of present study revealed that rural producers can do broilers production after wheat harvest.

REFERENCES

1. Altan Ö, Altan A, Çabuk M, Bayraktar H: Effects of heat stress on some blood parameters in broiler. *Turk J Vet Anim Sci*, 24, 145-148, 2000.

2. Simons P: The future of world poultry industry. *Yutav-97 International Poultry Exposition, May 14-17,* Istanbul, Turkey, 1997.

3. Appleby MC, Menc JA, Hughes BO: Poultry behavior and welfare. Cabi Publishing, Oxfordshire, UK, 2004.

4. Campo JL, Gil MG, Dávila SG, Muñoz I: Effect of lighting stress on fluctuating asymmetry, heterophil-to-lymphocyte ratio, and tonic immobility duration in eleven breeds of chickens. *Poult Sci,* 86, 37-45, *2007.*

5. Gallup GG: Tonic immobility as a measure of fear in domestic fowl. *Anim Behav,* 27, 316-317, 1979. DOI: 10.1016/0003-3472(79)90159-3

6. Gross WB, Siegel HS: Evaluation of the heterophil to lymphocyte ratio as a measure of stress in chickens. *Avian Dis*, 27, 972-979, 1983. DOI: 10.2307/1590198

7. Pope CR: Pathology of lymphoid organs with emphasis on immunosupression. *Vet Immunol Immunopathol,* 30, 31-44, 1991. DOI: 10.1016/0165-2427(91)90006-X

8. Ravindran V, Thomas DV, Thomas DG, Morel PC: Performance and welfare of broiler as affected by stocking density and zinc bacitracin supplementation. *Anim Sci J,* 77, 110-116, *2006*. DOI: 10.1111/j.1740-0929.2006.00327.x

9. Türkyılmaz MK, Nazlıgül, Dereli E, Ulutaş PA: The effects of acute noise on fear and some stress parameters in broilers. *Kafkas Univ Vet Fak Derg,* 17, 957-962, 2011. DOI: 10.9775/kvfd.2011.4855

10. Altan A, Bayraktar H: Kümesler ve donanımları. **In,** Türkoğlu M,

Sarıca M (Eds): Tavukçuluk Bilimi: Yetiştirme Besleme Hastalıklar. 2nd ed., 185-238, Bey Ofset, Ankara, 2004.

11. Antalyali AA: Avrupa Birliği ve Türkiye'de hayvan refahı uygulamaları. *T.C. Tarım ve Köy İşleri Bakanlığı, Dış İlişkiler ve Avrupa Birliği Koordinasyon Dairesi Başkanlığı, AB Uzmanlık tezi,* 170. Ankara, 2007. http://www.tarim.gov.tr/ABDGM/Belgeler/%C4%B0DAR%C4%B0%20%C4%B0%C5%9ELER/uzmanl%C4%B1k%20Tezleri/AhmetAntalyali.pdf, *Accessed:* 20.12.2014

12. Şekeroğlu A, Sarica M: Organic broiler production. *5. National Animal Science Congress*, 05-08 September, Van, Turkey, 111, 2007.

13. Şekeroğlu A, Sarica M: Village poultry as a production system. *J Poult Res,* 9, 41-47, 2010.

14. Sessiz A, Pekitkan FG, Turgut MM: Harvest losses, causes, measuring methods and ways of reducing. *Agricultural Mechanization 23. National Congress,* 6-8 September, Çanakkale, Turkey, 229-234, 2006.

15. Fanatico AC, Pillai PB, Cavitt LC, Owens CM, Emmert JL: Evaluation of slower-growing broiler genotypes grown with and without outdoor access: Growth performance and carcass yield. *Poult Sci*, 84, 1321-1327, 2005. DOI: 10.1093/ps/84.8.1321

16. Jones RB: Tonic immobility reaction of the domestic fowl: A review. *World Poultry Sci J,* 42, 82-96, 1986. DOI: 10.1079/WPS19860008

17. Demir E, Şekeroğlu A: Effects of extruded full-fat soybean fermacto and yucca extract on broiler chickens. *J Poult Res*, 2, 31-35, 2000.

18. Gunes N, Polat U, Petek M: Investigation of changes in biochemical parameters of hens raised in alternative housing systems. *Uludağ Univ Ver Fak Derg,* 21, 39-42, *2002*.

19. Merk E: Clinical Laboratory Merck. 11th Edition of Medico-Chemical Investigation Methods. West Germany, 1974.

20. SPSS: Statistical Package in Social Sciences for Windows. Statistical Innovations Inc., Chicago, USA, 2010.

21. Efe E, Bek Y, Şahin M: SPSS'te çözümleri ile istatistik yöntemler II. 51-61, Kahramanmaraş Sütçü İmam Üniversitesi Rektörlüğü Bilgisayar Araştırma ve Uygulama Merkezi (BAUM), Yayın No: 10, Kahramanmaraş, 2000.

22. Dou TC, Shi SR, Sun HJ, Wang KH: Growth rate, carcass traits and meat quality of slow-growing chicken grown according to three raising systems. *Anim Sci Pap Rep,* 27, 361-369, *2009*.

23. Pavlovski Z, Škrbić Z, Lukić M, Petričević V, Trenkovski S: The effect of genotype and housing system on production results of fattening chickens. *Biotechnol Anim Husbandry*, 25, 221-229, 2009. DOI: 10.2298/BAH0904221P

24. Sekeroglu A, Sarica M, Demir E, Ulutas Z: Effects of housing systems on growth performance, blood plasma constituents and meat fatty acids in broiler chickens. *Pak J Biol Sci*, 12, 631-636, 2009.

25. Wang KH, Shi SR, Dou TC, Sun HJ: Effect of a free-range raising system on growth performance, carcass yield, and meat quality of slow-growing chicken. *Poult Sci,* 88, 2219-2223, 2009. DOI: 10.3382/ps.2008-00423

26. Fanatico AC, Pillai PB, Hester PY, Falcone C, Mench JA, Owens CM, Emmert JL: Performance, livability, and carcass yield of slow- and fast-growing chicken genotypes fed low-nutrient or standard diets and raised indoors or with outdoor. *Poult Sci,* 87, 1012-1021, 2008. DOI: 10.3382/ps.2006-00424

27. Sarica M, Sekeroglu A, Demir E, Suicmez M, Dincer F: The comparisons of deep litter, cage and free sistems in broiler production under welfare conditions. *XXII Worlds Poultry Congress, June 8-13,* İstanbul, Turkey, 354, 2004.

28. Castellini C, Mugnai C, Dal Bosco A: Meat quality of three chicken genotypes reared according to the organic system. *Ital J Food Sci*, 14, 411-412, 2002.

29. Lewis PD, Perry GC, Farmer LJ, Patterson RLS: Responses of two genotypes of chicken to the diets and stocking densities typical of UK and "Label Rouge" production systems. I. Performance, behaviour and carcass composition. *Meat Sci,* 45, 501-516, *1997*. DOI: 10.1016/S0309-1740(96)00084-8

30. Sauveur B: Les criteresetfacteurs de la qualite despoulets Label Rouge. *Inra Prod Anim,* 10, 219-226, 1997.

31. Puvadolpirod S, Thaxton P: Model of physiological stress in chickens 1. Response parameters. *Poult Sci*, 79, 363-369, 2000. DOI: 10.1093/ps/79.3.363

32. Altıntaş A, Fidancı UR: Evcil hayvanlarda ve insanda kanın biyokimyasal normal değerleri. *Ankara Üniv Vet Fak Derg,* 40, 173-186, 1993.

33. Mašek T, Severin K, Horvatek D, Janicki Z, Konjević D, Slavica A, Mikulec Ž: Serum parameters of intensively reared common pheasant *(Phasianus colchicus)* during fattening. *Arch Geflügelk,* 71, 135-138, 2007.

34. Kumar V, Verma RK, Kumar S, Singh SK, Singh RK: Effect of different management system on haemato-biochemical profile in quail. *Vet World,* 3, 291-292, 2010

35. Pavlik A, Pokludova M, Zapletal D, Jelinek P: Effects of housing systems on biochemical ındicators of blood plasma in laying hens. *Acta Vet Brno,* 76, 339-347, 2007. DOI: 10.2754/avb200776030339

36. Al-Aqil A, Zulkifli I: Changes in heat shock protein 70 expression and blood characteristics in transported broiler chickens as affected by housing and early age feed restriction. *Poult Sci,* 88, 1358-1364, 2009. DOI: 10.3382/ps.2008-00554

37. Erisir Z, Poyraz O, Onbasilar EE, Erdem E, Kandemir O: Effect of different housing systems on growth and welfare of pekin ducks. *J Anim Vet Adv*, 8,235-239,2009.

38. Eggum BO: Protein Metabolism in Farm Animals. Evaluation, Digestion, Absorption, and Metabolism. 1-25, Oxford Science Publications, Berlin, 1989.

39. Olaniyi OA, Oyenaiya OA, Sogunle OM, Akinola OS, Adeyemi OA, Ladokun OA: Free range and deep litter housıng systems: effect on performance and blood profile of two strains of cockerel chickens. *Trop Subtrop Agroecosystems,* 15, 511-523, 2012.

40. Campo JL, Prieto M T, Dávila, MG: Effects of housing system and cold stress on heterophil-to-lymphocyte ratio, fluctuating asymmetry, and tonic immobility duration of chicken. *Poult Sci,* 87, 621-626, 2008. DOI: 10.3382/ps.2007-00466