ERCİYES ÜNİVERSİTESİ VETERİNER FAKÜLTESİ DERGİSİ
Journal of Faculty of Veterinary Medicine, Erciyes University

Araştırma Makalesi / Research Article
17(3), 191-199, 2020
DOI: 10.32707/ercivet.828311

The Effects of Feeding Time and Stocking Density on Performance of Laying Hens

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Atıf yapmak İçin: Kahraman O, Balevi T, Dere S, Kurtoğlu V, Polat ES, Çam M, Arık HD. The effects of feeding time and stocking density on performance of laying hens. Erciyes Univ Vet Fak Derg 2020; 17(3): 191-199.

Summary: This study was carried out with 656 Hysex-Brown layer hen with 58 weeks old. 2 x 4 Multifactorial test setup was used. Egg production, daily feed consumption, feed conversion ratio, egg weight, damaged egg ratio, body weight and specific gravity datas were examined in laying hens fed at different times and raised at different stocking density. Hens placed in cages as 412.5 and 495 cm^2/hen and formed 8 groups and feeds were given at 06:00, 9:30, 06:00-06:30 and 09:30-13:30h. The trial was continued for 60 days. At the end of the experiment, it was determined that there was a statistically significant difference between the groups in terms of egg production, daily feed consumption and feed conversion ratio (P<0.05), and there was no difference in egg weight, damaged egg ratio, body weight and specific gravity (P>0.05). It was determined that egg production was the highest and feed consumption and feed conversion ratio was the lowest in groups with a frequency of 495 cm^2/chicken and fed at one time at 09:30h. Egg production was the lowest and feed conversion ratio was highest in groups with a frequency of 412.5 cm^2/hen and fed at 09:30-13:30h. It was also determined that feeding two times at 06:00h and 06:30h increased the feed consumption, but feeding one time at 09:30h decreased the feed consumption.
Key words: Laying hens, feeding time, performance, stocking density

Yemleme Zamanı ve Kafes Yoğunluğunun Yumurta Tavuklarında Performans Üzerine Etkisi

Özet: Bu araştırma 58 haftalık yaşta toplam 656 adet Hysex-Brown yumurtacı tavuk kullanılarak yürütüldü. Araştırmada 2 x 4 multifaktöriyel deneme düzeni oluşturuldu. Farklı zaman ve sıklıkta yetiştirilen tavuklarda yumurta verimi, günlük yem tüketimi, yemden yararlanma oranı, yumurta ağırlığı, hasarlı yumurta oranı, canlı ağırlık ve spesifik gravite verileri incelendi. Kafeslere 412.5 ve 495 cm^2/tavuk olacak şekilde yerleştirilen ve 8 grup oluşturulan tavuklara yemler saat 06:00, 09:30, 06:00-06:30; 09:30-13:30'da verildi. Deneme 60 gün sürdürüldü. Deneme sonunda gruplar arasında yumurta verimi, günlük yem tüketimi ve yemden yararlanma oranları bakımından istatistiksel farklılığın olduğu (P<0.05), yumurta ağırlığı, hasarlı yumurta oranı, canlı ağırlık ve spesifik gravite bakımından ise herhangi bir farklılığın olmadığı tespit edildi (P>0.05). Yerleşim sıklığı 495 cm^2/tavuk olan ve saat 09:30'da tek seferde yemlenen gruplarda yumurta veriminin en yüksek, yem tüketimi ve yemden yararlanma oranının ise en düşük olduğu tespit edildi. Yerleşim sıklığı 412.5 cm^2/tavuk olan ve saat 09:30-13:30'da yemlenen gruplarda yumurta veriminin en düşük, yemden yararlanma oranının ise en yüksek olduğu belirlendi. Ayrıca tavukları 06:00 ve 06:30'da olmak üzere iki öğünde yemlemenin yem tüketimini artırdığı, sabah saat 09:30'da tek seferde yemlemenin ise yem tüketimini azalttığı tespit edildi.
Anahtar kelimeler: Kafes yoğunluğu, performans, yemleme zamanı, yumurta tavuğu

Introduction

There are many nutrition and management factors affecting the egg production and quality (Owings, 1981). Feeding the hens in different times of the day and cage density affect production considerably (Taherkhani et al., 2010; Asghar Saki et al., 2012; Soltanmoradi et al., 2014). Cage density means that cage space per bird is decreased when bird numbers are increased per cage, whereas bird population per se means a change in space with increasing bird numbers per cage (Asghar Saki et al., 2012). There are conflicting results about effects of cage density on poultry production. Reduced cage space has been reported to decrease egg production, egg weight, and feed consumption and increase mortality (Rodenburg et al., 2005). Dorminey and Arscott, (1971), Leeson and Summers, (1984) and Mtileni et al., (2007) reported that eggs produced by birds kept at the high stocking density were heavier than those produced by birds at the low stocking density. However, Anderson and Adams (1992) observed no effect of stocking density (221, 249, 277, and 304 cm^2 per bird) on body weight when cage population and feeder and drinker spaces were held constant. Asghar Saki et al., (2012) reported that egg weight did not significantly increase by reducing the cage density of hens from 3 to 2 hens per cage. Same results were repor-

Geliş Tarihi/Submission Date : 28.01.2020
Kabul Tarihi/Accepted Date : 16.06.2020

ted in other studies (Sohail et al., 2004; Onbasılar and Aksoy, 2005).

Spesific gravity may serve as an indicator of egg shell quality and is affected by changing the feeding time (Farmer et al.,1983; Bootwalla et al.,1983; Harm,1991; Rozempolska-Rucińska et al., 2011). Egg production and body weight are also affected by feeding time (Harms,1991). According to Iqbal et al. (2017), the egg weight influences specific gravity which reduce with the egg weight increase.

There is not sufficient data about how many times laying hens should be fed in day to optimize profit (Oyedeji et al,. 2007). Samara et al. (1996) gave the whole feed to the first group at 07.00h, and to the second group at 18.00h and to the third group at twice a day of which one at 07.00h and the other one at 18.00h. it was found that egg production percentages in the groups were 78.57% ,64.29% and 72.43% in sequence and daily feed consumptions were 151.7, 142.6 and 148.3g respectively. In this study, it was aimed to investigate the effects of feeding time and stocking density on egg production, feed consumption, feed conversion ratio, egg weight, damaged egg rate, body weight and specific gravity of layer hens.

Materials and Method

Animals

A total of 656 58-week-old Hysex-Brown layer hybrids, which were obtained from University of Selcuk, Faculty of Veterinary Medicine, Animal Husbandry and Research Unit, were used in this study. The number of birds were determined according to following sampling calculation:

$$n = \frac{t^2 pq}{d^2}$$

Experimental design

This research was carried out by using 2 x 4 factoriel design (2 different stocking density and 4 different feeding time). The animals were randomly allocated into eight groups according to feeding time and stocking density; each of the first four groups, consisting of 8 replicates of 10 layers, were placed into eight cages equaling to 495 cm^2 per hen. Each of the second four groups, consisting of 7 replicates of 12 layers, was placed into seven cages equalling to 412 cm^2 per hen. Dimension of each cages used in the study were 55x45x40 cm. Hens were distributed randomly among the different compartments of the cage system. Totally the distribution resulted in 120 cages and 656 laying hens. Experimental period was 60 days.

Daily feed requirements of the birds in 1st and 5th groups were fed once a day at 06.00h. 2nd and 6th groups were fed at 09:30h once a day. Birds in 3rd and 7th groups were given twice in early morning at 06:00 and 06:30h. 4th and 8th groups were fed twice a day at 09:30 and 13:30h, allocating equal feed amounts in each of the meal time.

Hen-day egg production

Before trial, the hen-day egg production was recorded for 10 days. Egg production were then recorded daily at the same time and calculated as total number of eggs collected divided to total number of hens per day in each group. The collected eggs were classified as "normal" or "damaged; the latter included the following: broken eggs (an egg with broken shell and destroyed membrane), cracked eggs (an egg with broken shell but intact membrane), the eggs without shell (an egg without shell but with intact membrane).

Egg weight and specific gravity

Egg weight and specific gravity were determined monthly using the methods described by Hamilton (1982) and Hempe et al. (1988).

Feed consumption and feed conversion ratio

Prior to the experiment, enough amounts of the feed for the each subgroup were supplied. Feed and water were given ad libitum to the hens throughout the 60-day experimental period. During the experiment, a hen was given 130 g feed everyday. Subgroups of the first four groups were given totaly 1300 g feed/day. Subgroups of the second four groups were given totaly 1560 g feed/day. Feed consumption and feed conversion ratio were determined at 7 day intervals. Every week, residual of the feed in all groups were collected and weighed to determine daily feed intake in corresponding periods. Feed conversion ratio was calculated by dividing total feed amount consumed to the total egg weight.

Measurement of the body weight

In the beginning and at the end of the experiment, the subgroups were weighed to determine the difference of changing body weight of the animals during the study.

Nutrient composition of experimental diet

Crude protein, dry matter, ash, crude cellulose, ether extract, Ca and P values of the experimental diet were determined by chemical analysis (AOAC, 2003). Methionine+Cysteine and lysine values of the diet were formulated to meet the NRC, (1994) requirements of layers.

Statistical analysis

For discrete and continuous variables, descriptive statistics (mean, standard deviation, median, minimum value, maximum value, and percentile) were given. Repeated measures of analysis of variance was analysed by Mauchy's sphericity test and Box's Test of Equality of Covariance Matrices. For comparisons of means of repeated measures Repeated Measures Analysis of Variance was used. If parametric tests (factorial design for repeated measures analysis) dos not provide the preconditions, Greenhouse-Geisser (1959) correction or Huynh-Feldt (1976) correction was used for corrections to the Degrees of Freedom or Friedman Test. The Corrected Bonferroni test was used for multiple comparisons. For the significance level of the tests, P<0.05 and P<0.01 were accepted. The statistical software IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp. was used for calculations.

Results

Ingredient composition, nutrient analysis results and metabolizable energy of the diet are shown in table 1 and 2.

The lowest egg production (67.09%) was found in the 8th subgroup; the highest egg production (76.28%), was found in the 2nd subgroup. In the second period (30-60 days), egg production of the subgroups were found between 67.78% and 75.21% (P>0.05) which the lowest and highest subgroups were the same with previous period. In the 0-60d period evaluation of egg production, the lowest (67.44%) and highest (75.75%) subgroups were significantly different (P<0.05) (Table 3).

When feed consumption and feed conversion ratio of the groups evaluated, there were significant differences between the subgroups (P<0.05). Feeding times did not effect feed consumption and feed conversion ratio (P>0.05). But different stocking density with different feeding times effected performance of hens in 0-30, 30-60 and 0-60 days test periods (Table 4).

Egg weight and specific gravity parameters evaluated at 1st, 30th and 60th days of the trial and were not affected by stocking density and different feeding times in a day (P>0.05) (Table 5).

Table 1. Ingredient composition of the diet on dry matter basis

Ingredients	%
Corn grain	20.31
Wheat grain	48.13
Soybean meal	15.50
Fish meal	1.00
Oil (vegetable)	2.50
Limestone	9.50
Dicalcium phospate	1.40
Salt	0.25
Vitamin-premix[1]	0.25
Mineral-premix[2]	0.10
Methionin	0.06

[1] Per 2.5 kg of vitamin premix contains 3.6 mg vitamin A, 0.05 mg vitamin D3, 30 mg vitamin E, 3 mg vitamin K3, 3 mg vitamin B1, 6 mg vitamin B2, 5 mg vitamin B6, 0.015 mg vitamin B12, 25 mg niacin, 0.04 mg biotin, 8 mg karotenoid, 1 mg folic acid, 300 mg choline chloride, 50 mg vitamin C.
[2] Per kg of mineral premix contains 80 mg Mn, 35 mg Fe,50 mg Zn, 5 mg Cu, 2 mg I, 0.4 mg Co, 0.15 mg Se.

Table 2. The metabolizable energy and nutrient composition of diet (%)

ME, kcal/kg*	2758
Dry matter	90.41
Crude protein	15.53
Ash	8.22
Crude cellulose	5.56
Ether extract	3.26
Ca	3.48
P	0.60
Methionine+Cysteine**	0.54
Lysine**	0.74

*: Obtained by calculation. **: Formulated values to meet the nutrient requirements of poultry (NRC, 1994)

Damaged egg results were not significantly different between all groups(P>0.05). In the first period (0-30 days) average egg production of the groups were found out between 67.09% and 76.28% (P>0.05).

At the beginning and the ending days of the trial the birds were weighted. There were not significant difference of body weight changes between the groups (P>0.05) (Table 6).

Table 3. Egg production rate and damaged egg rate of the subgroups (Mean±SE)

Subgroups/Factors	Egg production, %			Damaged egg*, %		
	0-30	30-60	0-60	0-30	30-60	0-60
	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$
1	74.29±2.01	70.79±2.87	72.54±1.75^{ab}	1.74±0.51	2.42±0.96	2.08±0.54
2	76.28±1.17	75.21±1.59	75.75±0.97^{a}	1.62±0.38	0.75±0.28	1.88±0.25
3	72.25±2.22	68.48±3.43	70.37±2.04^{bc}	2.04±0.51	2.03±0.70	1.76±0.43
4	73.74±1.55	72.49±1.99	73.11±1.25^{a}	2.03±0.51	1.94±0.52	1.99±0.36
5	68.80±2.31	70.20±1.86	69.50±1.46^{bc}	2.38±0.62	1.97±0.56	2.17±0.41
6	72.54±2.08	68.77±2.83	70.66±1.76^{bc}	1.55±0.45	1.32±0.41	1.44±0.30
7	71.93±2.30	71.70±2.14	71.82±1.54^{abc}	2.25±0.35	1.75±0.42	2.00±0.27
8	67.09±2.38	67.78±2.13	67.44±1.57^{c}	1.28±0.16	1.13±0.38	1.21±0.73
SD. 1	74.14±0.89	71.75±1.29	72.94±0.79	1.72±0.24	1.78±0.33	1.75±0.20
SD. 2	70.18±1.14	69.68±1.12	69.92±0.80	1.88±0.23	1.55±0.22	1.72±0.16
Total	72.29±0.73	70.78±.87	71.53±0.57	1.80±0.16	1.68±0.21	1.74±0.13
***P*-value**	>0.05	>0.05	**<0.05**	>0.05	>0.05	>0.05
FT1	71.73±1.58	70.51±1.73	71.12±1.16	2.04±0.40	2.21±0.57	2.12±0.34
FT2	74.54±1.18	72.20±1.65	73.37±1.02	1.59±0.29	1.02±0.24	1.30±0.19
FT3	72.09±1.57	70.04±2.04	71.06±1.28	1.85±0.31	1.89±0.41	1.87±0.26
FT4	70.76±1.48	70.38±1.50	70.56±1.044	1.69±0.31	1.58±0.34	1.64±0.23
Total	72.29±0.73	70.78±0.87	71.53±0.57	1.80±0.16	1.68±0.21	1.74±0.13
***P*-value**	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05

1: 06.00h: 495 cm^2/hen, **2**: 09.30h: 495 cm^2/hen **3**: 06.00-06.30h: 495 cm^2/hen **4**: 09.30-13.30h: 495 cm^2/hen **5**: 06.00h: 412.5 cm^2/hen **6**: 09.30h: 412.5 cm^2/hen **7**: 06.00-06.30h: 412.5 cm^2/hen **8**: 09.30-13.30h: 412.5 cm^2/hen **Damaged egg*:** Broken, cracked or shelless eggs **SD. 1:** 495 cm^2/hen stocking density **SD. 2:** 412.5 cm^2/hen stocking density **FT1:** Once daily feeding at 06.00h **FT2:** Once daily feeding at: 09.30h **FT3:** Twice daily feeding at 06.00-06.30h **FT4:** Twice daily feeding at 09.30-13.30h **a, b, c:** Means within column with no common superscripts differ significantly (P<0.05).

Table 4. Feed consumption and feed conversion ratio of the subgroups (Mean±SE)

Subgroups/Factors	Feed consumption			Feed conversion ratio		
	0-30	30-60	0-60	0-30	30-60	0-60
	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$
1	117.74±1.78^{abc}	121.03±0.97^{ab}	119.38±1.03^{ab}	2.40±0.06^{bc}	2.71±0.09	2.56±0.06^{abcd}
2	112.58±1.36^{d}	118.48±1.33^{b}	115.53±1.03^{c}	2.27±0.05^{c}	2.50±0.07	2.39±0.04^{d}
3	119.67±1.21^{ab}	122.38±1.09^{a}	121.03±0.83^{a}	2.50±0.07^{ab}	2.78±0.13	2.64±0.08^{abc}
4	113.72±1.67^{cd}	120.54±1.19^{ab}	117.13±1.13^{bc}	2.33±0.04^{bc}	2.61±0.07	2.47±0.05^{cd}
5	120.90±1.43^{a}	123.10±0.62^{a}	121.00±0.79^{a}	2.65±0.09^{a}	2.70±0.07	2.68±0.05^{ab}
6	114.39±1.40^{cd}	121.03±0.99^{ab}	117.71±0.99^{bc}	2.35±0.05^{bc}	2.70±0.08	2.52±0.06^{bcd}
7	120.58±1.30^{a}	123.13±0.93^{a}	121.85±0.81^{a}	2.44±0.07^{bc}	2.64±0.06	2.54±0.05^{abcd}
8	115.48±1.25^{bcd}	119.84±0.79^{ab}	117.66±0.81^{b}	2.66±0.40^{a}	2.76±0.08	2.71±0.06^{a}
SD. 1	115.93±0.81	120.61±0.59	118.27±0.52	2.38±0.03	2.65±0.05	2.51±0.03
SD. 2	117.83±0.73	121.78±0.44	119.80±0.45	2.52±0.04	2.70±0.04	2.61±0.03
Total	116.82±0.55	121.15±0.38	118.98±0.35	2.45±0.03	2.67±0.03	2.56±0.02
***P*-value**	**<0.05**	**<0.05**	**<0.05**	**<0.05**	>0.05	**<0.05**
FT1	119.21±1.17	122±0.61	120.60±0.67	2.52±0.05	2.71±0.06	2.61±0.04
FT2	113.42±0.97	119.67±0.86	116.55±0.73	2.31±0.04	2.60±0.05	2.45±0.04
FT3	120.090±0.88	122.73±0.72	121.41±0.58	2.47±0.05	2.71±0.08	2.59±0.05
FT4	114.54±1.06	120.21±0.73	117.38±0.71	2.48±0.05	2.68±0.05	2.58±0.04
Total	116.82±0.55	121.15±0.38	118.98±0.35	2.45±0.02	2.67±0.03	2.56±0.02
***P*-value**	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05

1: 06.00h: 495 cm^2/hen, **2**: 09.30h: 495 cm^2/hen **3**: 06.00-06.30h: 495 cm^2/hen **4**: 09.30-13.30h: 495 cm^2/hen **5**: 06.00h: 412.5 cm^2/hen **6**: 09.30h: 412.5 cm^2/hen **7**: 06.00-06.30h: 412.5 cm^2/hen **8**: 09.30-13.30h: 412.5 cm^2/hen **SD. 1:** 495 cm^2/hen stocking density **SD. 2:** 412.5 cm^2/hen stocking density **FT1:** Once daily feeding at 06.00h **FT2:** Once daily feeding at: 09.30h **FT3:** Twice daily feeding at 06.00-06.30h **FT4:** Twice daily feeding at 09.30-13.30h **a, b, c:** Means within column with no common superscripts differ significantly (P<0.05).

Table 5. Egg weight and spesific gravity of the subgroups(Mean±SE)

	Egg weight, g			Spesific gravity, g/cm^3		
	First day	30th day	60th day	First day	30th day	60th day
Subgroups/Factors	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$
1	64.80±0.67	65.77±0.69	65.29±0.91	1.083±0.001	1.080±0.001	1.083±0.001
2	63.72±0.76	65.21±0.88	64.47±0.80	1.081±0.001	1.081±0.001	1.083±0.001
3	64.96±0.82	64.50±1.26	64.73±0.67	1.080±0.001	1.084±0.003	1.080±0.001
4	63.96±0.83	64.79±1.32	64.38±1.24	1.082±0.001	1.085±0.003	1.086±0.004
5	65.15±0.90	64.74±0.91	64.95±0.90	1.080±0.001	1.080±0.001	1.082±0.001
6	63.66±0.74	65.45±0.79	64.56±0.90	1.080±0.001	1.081±0.001	1.082±0.002
7	64.00±0.95	64.84±0.85	64.42±0.96	1.081±0.001	1.080±0.001	1.081±0.001
8	64.09±0.79	63.66±0.74	63.88±0.94	1.081±0.001	1.080±0.001	1.083±0.001
SD. 1	64.36±0.38	65.07±0.53	64.98±0.46	1.08±0.001	1.082±0.001	1.082±0.001
SD. 2	64.47±.42	64.67±0.41	65.67±0.46	1.08±0.001	1.081±0.001	1.082±0.001
Total	64.41±0.28	64.88±0.34	65.3±0.33	1.08±0.000	1.081±0.000	1.082±0.001
***P*-value**	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05
FT1	64.96±0.55	65.29±0.56	65.41±0.64	1.08±0.001	1.082±0.001	1.083±0.001
FT2	63.69±0.53	65.32±0.59	64.40±0.59	1.08±0.001	1.081±0.001	1.083±0.001
FT3	64.98±0.62	64.65±0.78	66.11±0.57	1.08±0.001	1.081±0.001	1.081±0.001
FT4	64.02±0.57	64.26±0.78	65.30±0.79	1.08±0.001	1.082±0.001	1.084±0.001
Total	64.41±0.28	64.88±0.34	65.30±0.33	1.08±0.000	1.081±0.000	1.082±0.001
***P*-value**	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05

1: 06.00h: 495 cm^2/hen, **2**: 09.30h: 495 cm^2/hen **3**: 06.00-06.30h: 495 cm^2/hen **4**: 09.30-13.30h: 495 cm^2/hen **5**: 06.00h: 412.5 cm^2/hen **6**: 09.30h: 412.5 cm^2/hen: **7**: 06.00-06.30h: 412.5 cm^2/hen **8**: 09.30-13.30h: 412.5 cm^2/hen **SD. 1:** 495 cm^2/hen stocking density **SD. 2:** 412.5 cm^2/hen stocking density **FT1:** Once daily feeding at 06.00h **FT2:** Once Daily feeding at 09.30h **FT3:** Twice daily feeding at 06.00-06.30h **FT4:** Twice daily feeding at 09.30-13.30h

Table 6. Body weights of the subgroups at the begining and end of the experiment(Mean±SE)

	Initial body weight, g	Eventual body weight, g
Subgroups/Factors	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$
11	1817.50±26.08	1787.50±31.15
12	1800.00±19.46	1726.25±17.62
21	1776.88±20.15	1753.75±35.70
22	1800.00±34.47	1718.13±40.69
31	1770.29±24.47	1706.00±21.22
32	1786.29±28.67	1701.14±16.23
41	1792.43±37.28	1740.29±14.80
42	1758.43±14.48	1682.00±54.36
SD. 1	1798.59±12.51	1746.41±16.17
SD. 2	1776.86±13.21	1707.36±15.24
Total	1788.45±9.12	1728.18±11.37
***P*-value**	>0.05	>0.05
FT1	1795.47±18.46	1749.47±21.61
FT2	1793.60±16.39	1714.53±12.11
FT3	1784.13±19.76	1747.47±19.67
FT4	1780.60±19.74	1701.27±32.49
Total	1788.40±9.12	1728.18±11.37
***P*-value**	>0.05	>0.05

11: 06.00h: 495 cm^2/hen **12**: 06.00h: 412.5 cm^2/hen **21**: 09.30h: 495 cm^2/hen **22**: 09.30h: 412.5 cm^2/hen **31**: 06.00-06.30h: 495 cm^2/hen **32**: 06.00h-06.30h: 412.5 cm^2/hen **41**: 09.30-13.30h: 495 cm^2/hen **42**: 09.30-13.30h: 412.5 cm^2/hen **SD. 1**: 495 cm^2/hen stocking density **SD. 2**: 412.5 cm^2/hen stocking density **FT1**: Once daily feeding at 06.00h **FT2**: Once daily feeding at 09.30h **FT3**: Twice daily feeding at 06.00-06.30h **FT4**: Twice daily feeding at 09.30-13.30h

Discussion and Conclusion

Egg production

It was generally found out that egg productions of the subgroups of 5 hens in each cage (495 cm^2/hen) were higher than that of the subgroups with 6 hens (412 cm^2/hen) in each cage, similar to some research findings (Connor and Burton,1975; Al-Rawi et al., 1976; Mench et al., 1986; Teng et al., 1990; Nagarajan et al., 1991; Lee and Moss,1995) and different from the some others (Kivimae,1976; Mathew et al.,1979). In a study by Mench et al. (1986) hens were put in cages as 1394 cm^2/hen, 1394 cm^2/2 hens, 2788 cm^2/2 hens cage spaces, it was stated that in the group with 1394 cm^2/hen floor space, egg production was found to be the highest. Asghar Saki et al. (2012) also reported that egg production was significantly lower in the group 4 hens per cage (500 cm^2) than 1 hen per cage (2000 cm^2). Sarica et al. (2008) found the similir results with Asghar Saki et al. (2012). They also observed the most egg production in the group having 2000 cm^2 cage allowance per hen. But in a study conducted by Kivimae (1976), it was found that increasing cage space from 450 to 900 cm^2/hen didn't have an important effect on egg production. Canibalismus was not seen in this sudy. When studies are evaluated it can be said that being more hens in a unit space in the cages decreases the egg production. Insuffcient feeding caused by reduced feeding space and stocking density are might be the reasons of reduction of egg production.

There was no significant relationship between egg production and different feeding times or frequencies during the day similar to the results of Bootwalla et al. (1983) and Samara et al. (1996). Samara et al. (1996) found that egg production was decreased when feed total ration were split into two portions as morning and evening feeding. When fed afternoon (16:00h), reduction of egg production in broiler breeder hens were reported (Harms et al., 1991). This decrease might be due to changing ovulation time when fed afternoon (Wilson and Keeling, 1991). But in a study by Balnave (1977) resricted evening feeding of White Leghorns in individual cages was found to increase egg production and Moradi et al. (2013) reported that until 38 wk of age, total hen-day egg production in the broiler breeder hens fed twice and thrice a day was greater.

Feed consumption and feed conversion ratio

In every period of the this study, statistically significant differences were determined among the subgroups in point of feed consumption which were similar to the findings of Lee and Moss (1995) and Teng et al. (1990). At the end of the test, it was found that, when the feed was given at 09:30h to the subgroups with 5 hens, the feed consumption decreased to 115.53 g to compare feeding in early morning. In the subgroups included 6 hens in cages, the lowest feed consumption (117.66 g) was found in the 8^{th} subgroup. The highest feed consumption (121.85 g) was found in the subgroup 7. feeding the hens in the morning before the sun rising once a day at 06:00 h increased the feed consumption average 4 g compared to subgroups fed once a day at 09:30 h instead of feeding the hens at 06.00 h, feeding them twice in the morning as giving half of feed at 06:00 h and the other half of it at 06:30 h.caused average 2 g increases in feed consumption. On the other hand, feeding the hens twice a day as giving half of feed at 9:30 h and the other half of it at 13.30 h caused average 2 g decreases in feed consumption. Similar results were found even in the groups of 6 hens in the cages with respect to feed consumption. Another study has shown that feeding laying hens the required quantity of feed once in a day as against the usual practice of either feeding twice or thrice in day generally resulted in a better laying performance (Oyedeji et al., 2007).

Teng et al. (1990) reported that being more hens in a unit decreased the feed consumption. In this study being more hens in a unit and feeding the hens twice in the morning increased feed consumption and feeding at 09:30h decreased feed consumption. In every periods of the test, the lowest feed consumption rates were obtained from the 2nd subgroup and the highest feed consumption rates were from the 8th subgroup. Feed conversion ratio tended to be decreased as stocking density increased. This result was similar to the findings of Lee and Moss (1995) and Mathew et al. (1979). On the other hand, it was different from the some other results (Kivimae, 1976; Mench et al., 1986). In a test done by Lee and Moss (1995) it was stated that being more hens in a unit floor space in cages, feed conversion ratio tented to be lower. In some other studies (Kivimae,1976; Mench et al.,1986), increasing cage floor space didn't have any effect on feed conversion ratio of laying hens. In a study conducted by Mathew et al. (1979) hens were allocated 450, 600 and 900 cm^2/hen floor space, in the lower stocking density group feed conversion ratio was lower. In this study, generally being more hens in cages caused an increase in feed conversion ratio, feeding the hens at 09:30h in the morning caused a decrease in the feed conversion ratio.

Egg weight

During the experiment egg weight means in the subgroups were found between 63.88 and 65.29 g, and were statistically identical. In some studies (Kivimae, 1976; Mench et al.,1986; Harms, 1991, Wilson and Keeling, 1991), increasing cage floor space for the layer hens didn't have any important effect on egg weight. But Connor and Burton, (1975) reported that increasing hen number in a unit space in the cage affected egg weight a little. But in another research

(Mathew et al.,1979), used cages of 450, 600 and 900 cm^2/hen unit space, egg weight was reported to be higher in the lower stocking density group. There are some results that decreased floor densities causes a reduction in egg weight and feed consumption (Onbasilar and Aksoy, 2005; Jalal et al., 2006). On the other hand Sarica et al. (2008) reported no significant difference of egg weights between the 4 different cage density (2000, 1000, 667 and 500 cm^2 per hen). In this study, different feeding time didn't affect egg weight similar to the results of Samara et al. (1996).

Egg quality

At the end of the experiment, it was determined that damaged egg rates of the 8 subgroups were 2.08%, 1.88%, 1.76%, 1.99%, 2.17%, 1.44% , 2.00% and 1.21%. The highest damaged egg rate was found out in the 5th subgroup. More number of hens in the subgroups might have increased the rate of damaged eggs. The eggs were weighed in water and air and in every period of the test. There was not statistically significant difference amongst the subgroups in point of spesific gravity. Similar to these results Al-Ruwi-BA. (1976) formed 4 groups including 4, 8, 14 and 28 of leghorn hens and 412, 824, 1442 and 2884 cm^2/hen floor space for each hen. They reported that there wasn't any significant difference in the egg quality by increasing the group capacity. Mench et al. (1986) and Wilson and Keeling (1991) also didn't find any difference in egg qualities of groups in different cage spaces. Sarica et al. (2008) did not report any cracked and broken egg ratio difference between the 4 different stocking density groups. Also changing the feeding time of broiler breeder hens from morning to evening didn't have significant effect on specific gravity (Mench et al., 1986; Wilson and Keeling, 1991; Samara et al., 1996). But Soltanmoradi et al. (2014) concluded that feeding broiler breeder hens twice or three times per day improves the egg quality. Farmer et al. (1983) and Bootwalla et al. (1983) resulted that feeding one time in afternoon (16:00h) increased spesific gravity. Contrast to our results, Wilson and Keeling (1991) concluded that damaged egg rates weren't affected by changing feeding times.

Body weight

There was not any significant differences between the subgroups in terms of body weights. During the test there was not any mortality in the subgroups, Nagarajan et al. (1991) fed quails between 6 and 26 weeks age periods as 150, 180, 210 and 250 cm^2/quail cage floor space and reported that when the cage floor space increased, mortality rate had decreased. Mortality rate had also increased when the animal number per cage increased without changing the cage floor space. Sarica et al. (2008) studied with 2000 and 1000 cm^2 space allowances and they suggested that the higher body weights can be explained by higher feed consumption and water intake thanks to the greater feeding area and nipple. Onbasilar and Aksoy, (2005) also reported that increasing the number of hens per cage from 1 to 5 decreased body weights of Hy-Line Brown genotypes. Feeding time did not have any effect on body weights in this study but Harms, (1991) found that feeding broiler breeder hens at 16:00 h resulted significant body weight loss to compare feeding at 08:00 h.The differences of the results between studies can be attributed to breed, group size and number of groups regarding to floor space.

As a result; in this study it was found that egg production rate was highest in the groups of 495 cm^2/hen cage floor space and the groups were fed at 09:30h once a day, while feed consumption and feed conversion ratio were lowest. In the group of 412.5 cm^2/hen cage floor space, and given half of feed at 09:30 h and the other half of it at 13:30 h, egg production rate decreased and feed conversion ratio increased.

Egg production weren't affected significantly by changing feeding time. Splitting the daily feed into 2 portion in early morning was found to increase feed consumption. It seems to be converse relationship between stocking density and feed conversion rate but it wasn't statistically important. Egg weight, egg quality and body weight were affected by changing neither stocking density nor feeding time. Furthermore, time and labour used in feeding hens twice in a day can be saved if hens are fed their feed requirement once daily. Therefore, for optimum laying performance and to control feed waste associated with ad libitum feeding of laying hens, as well as saving time and labouring expended in feeding hen two times daily, we suggest that feeding laying hens the required feed quantity once in a day.

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