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Original Research Article

Effects of Age at First Access to Range Area on Laying Performance and Some Egg Quality Traits of Free-range Laying Hens

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ABSTRACT

The aim of the study was to determine the effect of age at first range access to range area on laying performance and egg quality of free range layer chickens. Six hundred 16-week-old Lohman Brown layer pullets were randomly distributed into three experimental groups according to age at first range access as 18 (very early), 20 (early) and 22 weeks of age (coventional-late). Three experimental groups were monitored to collect the data from 24 to 72 weeks of age. Egg number, feed consumption, dead birds, cracked and floor eggs were recorded daily. Egg quality analysis was made to 10 week intervals from 30th to 70th weeks of age. Thirty freshly laid eggs from each group were collected in each analysing period and measured within 24 h. The floor eggs and survival rate of the birds were affected by the timing of the first access to range area (P<0.05). The age at first access to range area had no significant effect on all egg quality traits investigated. The laying period had significant effect on all egg quality parameters (P<0.001). There was no significant age at first access to range area x laying period interaction for all egg quality parameters.

Key Words: Free range, Layer chickens, Range using, Egg production, Egg quality

INTRODUCTION

The demand for naturally produced and welfare friendly animal products has been steadily increasing in the World (Bejaei and Cheng, 2010). This has led to an increase in the production of both free-range and organic eggs (Krawczyk and Gornowicz, 2010). Contrary to popular belief, non-cage housing system produce more welfare and health problems in laying hens such as feather pecking and keel bone damages (Harlander-Matauschek *et al*. 2015; Rodenburg 2015; Petek *et al.* 2015). In commercial laying hens, it is known that aspects associated with reduced welfare such as high fear, stress, and feather pecking can have negative effects on the production (De Has *et al*. 2013). The incidence of feather pecking tends to be reduced where birds make good use of the ranging areas available. It should therefore be a priority to encourage the birds use the range area as soon as possible after growth period (Petterson *et al*. 2016; Chielo *et al*. 2016). Access to range area as early as possible at the beginning of the laying period may be a useful tool to reduce negative effects on both welfare and productivity in free range table egg production and can be affect egg production and egg quality traits (Lampton *et al* 2013; Petek *et al*. 2015). It is unclear what effect free range production system might have on egg quality. Iqbal *et al*. (2016) reported that some egg quality traits can be influenced by range types or feed additives in free range egg production. In comparative studies, but not always, positive effects of free range are found on egg shell thickness and fat composition of the yolk (Van Niekerk, 2014). Ahammet *et al* (2014) reported that there were differences among rearing systems in some egg quality parameters. Samiullah et al (2014) showed that cage eggs were better in overall quality when directly compared with free range eggs. Egg quality traits are influenced by nutrient intake from foraging outdoors (Newberry (2017). One of the major factors determining the quality of eggshell are age and eggshell quality can be improved throughout optimization of genotype and housing system (Ketta and Tümova 2016). Although shell quality are not clearly influenced by housing system it seem to be more affected by producer management and other factors such as hen age and strains (Clerici et al. (2006). Considering these facts, we monitored the influence of early access to range area on pecking behaviour and plumage quality in whole laying period. Our preliminary results had shown that access to range area as early as possible may be useful to reduce the negative effect of feather pecking in free-range layer chickens (Petek *et al*. 2015). The current study was undertaken to determine the effects of age at first access to range area on egg production and selected egg quality traits in free-range layer chickens.

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MATERIALS AND METHODS

This study was performed at the Research and Experimental Farm of Uludag University in Bursa, Turkey. Experimental procedures were employed in accordance with the principles and guidelines set out by the Committee of Uludag University on animal care. At the beginning of the experiment, six hundred 16-week-old Lohman Brown layer pullets were randomly distributed into three experimental groups according to age at first range access. The birds allowed to range area first time at 18 (*very early, treatment I*), 20 (*early, treatment II*) and 22 weeks of age (*conventional-late; control*), respectively.

Management

The indoor and outdoor areas of the free-range housing unit were divided into three similar experimental pens (6×6 m). The indoor part of each pen consisted of litter as one-third of floor space and a slatted floor; white plastic slats, 100 × 60 cm. Birds in the groups were allocated equal space for feeders, drinkers and nest boxes. In the study, automatic group nest boxes (1 m^2 of nest space for every 100 hens), hanging tube feeders (each 30 cm in diameter with 10–15 kg capacity) and bell drinkers were provided for the birds in all groups. Mean stocking density within the groups was 6 birds per 1 m^2 indoor and 5 birds per 10 m^2 outdoor. All birds were fed with a standard layer diet containing 2700 kcal/kg metabolizable energy and 18 % crude protein until the end of the experiment (NRC, 1994). Water and feed were provided ad libitum. The birds were adopted for two weeks before allowing access to range area and allowed access to range area at the beginning of 18, 20 and 22 weeks of age in experiment I, experiment II and control groups, respectively. During the experimental period, birds in all groups had continuous access to outdoor range during daylight hours. The daily photoperiod consisted of 16 h of light and 8 h of darkness and the lighting intensity was arranged as 3.0 lx/m^2.

Data

The control and experimental groups were monitored to assess the laying performance and egg quality of the birds from 16 to 72 weeks of age. Egg number, feed consumption, dead birds, cracked and floor eggs were recorded daily. All egg production traits were calculated on the basis of hen-housed (North and Bell 1990). Eggs were collected in different stages of lay for egg quality analysis 10 week intervals from 30^{th} to 70^{th} weeks of age. Thirty freshly laid eggs from each group were collected randomly late afternoon in each analysing period and were kept in room temperature overnight for evaluation in next day in the Egg Quality Laboratory at the University of Uludag. In total, 450 eggs (150 eggs per experimental group) were analysed. Eggs were weighed; length and breadth were measured. The egg shape index was determined from these measurements according to Anderson *et al.* (2004) as given with the formula; *width/length x 100*. Shell strength was measured using a cantilever system by applying increased pressure to the broad pole of the shell (Balnave and Muheereza, 1997) and recorded as Newton (N) force required to crack the shell surface. After all eggs were broken on to a flat surface, the height of the albumen was measured with a tripod micrometer. The color of the yolk was determined using the DSM color fan (Anonymous, 2004). Shell thickness (without inner and outer shell membranes; membranes were removed manually) was measured at three areas (broad end, middle portion and narrow end of the shell), by using a micrometer (Mitutuyo Corporation, 0.01-20 mm, Kawasaki, Japan) according to Chowdhury (1990). Haugh unit was calculated from the records of albumen height and egg weight using the following formula (Anonymous, 2003):

$HU = 100.Log (H-1.7W^{0.37}+7.6)$

where,

HU= Haugh unit

H=Albumen height (mm)

W =Egg weight (g)

One way ANOVA was used to analyse the egg production, feed consumption, cracked and floor eggs data. Chi-square test was used to the survival rate in the groups. All egg quality traits were analysed according to the General Lineral Model. Differences in mean values were determined using Duncan's multiple comparison

test (Snedecor and Cochran, 1989). All statistical analysis was performed using SPSS version 13.00 (SPSS Inc., 2004).

RESULTS

Laying performance of the birds in the experimental groups is showed in Table 1. There were no significant differences for the rate of lay, cracked egg ratio and daily feed consumption per bird between the groups. It was found that significant differences for the floor egg ratio in the groups ($P<0.05$). Survival rate in the treatment II and control groups was significantly better than treatment I ($P<0.05$).

Table 1: Effect of age at first access to range area on hen-housed laying performance (mean±SEM)

Parameter	Treatment I	Treatment II	Control	*p value*
Rate of lay, %	77.61±3.79	80.32±4.88	81.87±4.73	*0.797*
Rate of cracked eggs, %	1.16±0.16	1.22±0.26	1.56±0.40	*0.587*
Rate of floor egss, %	$0.86±0.25^{ab}$	$0.77±0.19^{b}$	$1.61±0.32^{a}$	*0.050*
Feed consumption/hen/d, g	113.81±7.3	114.71±8.4	120.55±11.2	*0.824*
Survival rate, %	88.00^{a}	93.00^{b}	92.50^{b}	*0.050*

Some of the interior and exterior egg quality traits of the birds in control and experimental groups are presented in Table 2. Effects of age at first access to range area on all egg quality traits investigated were found no significant. Whereas all egg quality traits were significantly affected by the laying period ($P<0.001$).There were no significant age at first access to range area x laying period interaction for all interior and exterior egg quality traits.

Table 2: Some interior and exterior egg quality traits in the groups (mean ± SEM).

Groups	Egg Weight (g)	Egg-shape index (%)	Breaking strength (N)	Shell thickness ($mmx10^{-2}$)	Haugh Unit	Yolk Color score (DSM)
Age at first access to range area (AFARA)						
Treatment I	64.9±1.22	78.9±0.30	44.9±0.80	38.1±0.33	86.7±0.87	11.7±0.07
Treatment II	63.9±0.06	79.0±0.31	45.3±0.81	37.4±0.32	84.9±0.86	11.6±0.08
Control	65.0±0.89	78.3±0.32	44.6±0.82	37.9±0.34	85.5±0.87	11.7±0.08
Laying period (LP)*						
1 (Early lay)	$61.4±0.62^{c}$	$80.3±0.36^{a}$	$47.2±0.95^{a}$	$37.8±0.40^{a}$	$93.4±1.01^{a}$	$10.2±0.9^{b}$
2 (Peak lay)	$63.8±0.61^{bc}$	$79.2±0.37^{ab}$	$45.9±0.96^{a}$	$33.9±0.41^{b}$	$86.2±1.03^{a}$	$10.7±0.96^{b}$
3 (Mid lay)	$64.6±0.69^{b}$	$78.7±0.41^{b}$	$44.2±1.06^{a}$	$38.7±0.45^{a}$	$80.7±1.15^{b}$	$11.9±0.1^{a}$
4 (Late lay)	$66.9±0.68^{ab}$	$78.4±0.42^{b}$	$46.3±1.07^{a}$	$37.3±0.46^{a}$	$87.6±1.16^{a}$	$12.9±0.12^{a}$
5(Very late lay)	$66.4±0.76^{a}$	$77.2±0.45^{c}$	$40.9±1.18^{b}$	$41.3±0.49^{a}$	$80.7±1.26^{b}$	$12.7±0.13^{a}$
ANOVA						
AFARA	0.277	0.248	0.855	0.313	0.319	0.561
LP	0.001	0.001	0.001	0.001	0.001	0.001
AFARA X LA	0.280	0.473	0.820	0.075	0.075	0.247

*Laying period 1,2,3,4 and 5 represents 30, 40, 50, 60 and 70 weeks of age, respectively.

DISCUSSION

Raising chicken in a free range system has been considered the chance of chicken welfare and it is getting popular in table egg production due to consumer interest in welfare friendly products and the banning of conventional wire cages across the European Union in the beginning of 2012. But, hens under free range housing experience a larger stress factors affecting egg production, egg quality, poultry behaviour and welfare compare with caged or barn-kept hens (Chielo *et al*., 2016; Campbell, 2017a). Present study was designed to observe the

laying performance and egg quality of chicken under a free range system and compare the results obtained from birds access to the range area first time in different ages.

The study showed that total egg production, cracked egg ratio and daily feed consumption of layers in control and two different treatment groups were not significantly affected by the timing of the first access to range area. Radu-Rusu *et al.* (2014) the cage-free system influenced hens to produce eggs with a higher nutritive value than in the other systems. Campbell *et al*.(2017b) showed that there were no effects of outdoor stocking density on average hen-day egg production, egg weight, shell breaking strength and shell thickness in free range egg production. Dikmen *et al*. (2016) reported that the hen day egg production, feed intake and egg mass of hens were higher in free range system. In this study, birds in control group (access the range area the latest) had significantly more floor eggs because probably spent more time inside the house at the beginning of the laying period. Similarly, Dikmen *et al.* (2016) showed that dirty egg ratio of hens was higher in free-range system. An egg laid outside the nest is a high risk of damage and dirty egg ratio. In practise, the effect of housing system on feed consumption is important and more feed was consumed by the hens in free range systems compare to cage system (Hughes and Dun, 1982).

Feed quality, environment and layer age play a significant role on laying performance and most of the egg quality traits (Petek *et al*. 2004; Beyer, 2005; Molnar *et al*. 2016). A young pullet produces smaller eggs with strong egg shells (Kim *et al*. 2014). Generally, egg weight increase with increasing flock age and a similar trend was observed in the present study. As the hen ages, the shells thin, and the albumen begins to weaken (Roberts *et al.* 2013). Buitenhuis *et al*. (2004) reported that significant additive genetic correlations were found between severe feather pecking and eggshell strength in adult hens. Sekeroglu *et al*. (2010) found that the free-range system had some advantages when compared to deep litter and cage systems in terms of hen housed egg yield, egg shape index and cracked egg ratio. Dikmen *et al*.(2017) reported that free range eggs better for many egg parameters. Generally, there are six main factors affecting internal egg quality; disease, storage period, temperature, humidity and handling (Coutts and Wilson, 2007). In general, yolk color in free range lighter than the other system because of foraging and thus eating less of the provided diet. As expected, the yolk color was significantly affected by flock age, with a higher intensity of yolk color observed for the late lay and very late lay (Samiullah *et al*., 2014). A desirable egg shell should be thick enough to resist transportation and handling shock. Similar with the other findings, hen age affected the majority of egg quality measurements (Campbell *et al*. 2017b). Contrary to expectation, there was a linear increase in shell thickness values with increasing flock age may indicate that the hen accumulated more calcium during grazing area. As expected, age significantly affected the breaking shell strength and the values decreased with increasing flock age (Samiullah *et al*. 2017). Poor eggshell quality has been of major economic concern to commercial table egg producers. In general, exterior egg quality is judget on the basis of texture, colour, shape, soundness and cleanliness (Anonymous, 2000). Krawczyk and Gornowics (2010) reported that eggs from free-range layers were characterized by lower total weight, and thinner shells. Compare to cage and litter housing the eggs of free-range birds were characterized by the highest weight of shell, (which had the greatest thickness) and density (Lewko and Gornowicz (2011). Assesment of different kinds of shell irregularities can be used as an idicator of environmental stress (Reynard and Savory 1999) and hence may serve as an indicator of welfare status of birds (Sherwin *et al.* 2010).

Freshness, which is mainly evaluated by Haugh unit, is the main determinant of table egg internal quality. In the study, haugh unit varied in flock age, significantly. The effects of bird age at first access to range area on Haugh Unit was found no significant. Samiullah et al (2017), Krawczyk and Gornowics (2010) reported that a significant higher Haugh Unit of eggs produced in the free range system. As a result of egg shape index; eggs in all groups can be described as round egg (Sarıca and Erensayın, 2009).

CONCLUSIONS

In the study, all internal and external egg quality measured influenced by laying period or bird age. Whereas, early or late access to range area had no significant effect on all egg quality traits. Laying period x timing interaction for all egg quality traits was found not significant. In order to reduce floor eggs under free-range conditions, layers should be access to range area as early as possible.

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