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Effects of Cage Location and Tier Level on Performance and Egg Quality Traits of Laying Hens

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Abstract: This experiment was conducted to determine the effects of cage location and tier level on performance and egg quality traits of laying hens. About 180 Lohmann layers at 50 weeks of age were placed into 3-tier cages as Top (T), Middle (M) and Bottom (B) tiers in cages Facing Window (FW) and Corridor side (C). Experiment lasted for 2 months. Egg production and feed consumption were recorded daily and egg quality was assessed biweekly. Cracked egg yield and feed conversion ratio from performance traits were not affected by cage location. But the effect of tier level on feed consumption was found to be significant ($p<0.045$). There were significant cage location by tier level interaction effects on feed consumption ($p<0.003$), egg production ($p<0.023$) and feed conversion ratio ($p<0.018$). Egg quality traits such as egg weight, shell strength, shell thickness, shell weight, yolk index, albumen index and Haugh unit were not affected by cage location, tier level and cage location by tier level interaction.

Key words: Laying hen, cage location, tier level, laying performance, egg quality

INTRODUCTION

Egg production generally takes place in confined or semiconfined housing systems depending on economic and environmental conditions. Although, there is a lot of liteture related to the effects of cage densinty and cage type on performance and egg quality parameters of laying hens, the influence of cage location and tier level is rarely considered. There are some studies related to the effect of various levels of tier level and cage location on laying performance and egg quality traits (Yildiz *et al*., 2006).

Cages are generally constructed in varying tiers. Because there is an unavoidable variation in light intensity among tiers in multitier cage systems, a balance is needed between providing sufficient light at the bottom tier and avoiding excessive light intensity at the top tier (Awoniyi, 2003). This could lead to compromised laying performance and egg weight because of variability in laying rate. Provision of homogeneous illumination to each tier is an inevitable in semiconfined laying hen houses. It was hypothesized that the lack of a homogeneous light intensity in multitier systems and each cage location in semiconfined laying hen houses adversely affects egg production and quality (Yildiz *et al*., 2006). Grover *et al*. (1972) reported a significantly higher hen day production and feed consumption in the upper tier of a Two-Tier System, production showed a non-signifacant opposite trend. Hurnick *et al*. (1974) reported that eggs for hens in an upper tier were significantly heavier and production was somewhat higher than for hens in lower tier. In contrast, Sefton (1976), measuring egg production in 60-64 weeks old birds, observed significantly higher production among the lower tiers.

A negative correlation between light intensity and shell thickness is reported by Abdelkarim and Biellier (1982). However, eggshell quality was reported to be independent of light intensity in other experiments involving hens (Leeson and Lewis, 2004). Pavlovski and Masic (1992) housed laying hens in individual cages as 3-tier with rows facing (light) or not facing (dark) windows and reported no differences in shape index. But experiments which have studied the effects of tier level and cage location on performance traits have not yielded consistent results.

Therefore, present study was conducted to determine the effects of cage location and tier level on laying performance and egg quality parameters in laying hens.

MATERIALS AND METHODS

This study was carried out at the Ataturk University Research and Application Farm in Erzurum city of Turkey. About 180 Lohmann layers with uniform body weight at 50 weeks of age were blocked into cages (48×45×45 cm, width x depth x height) as Top (T), Middle (M) and Bottom (B) tiers in cages Facing Window (FW) and Corridor side (C). Each treatment was replicated in 6 cages in each tier level of the each cage location each cage containing 5 ha. Experiment lasted for 2 months. The experimental diets were formulated as isolocaloric and isonitrogenous to meet NRC recommendations (NRC, 1994).

The experimental diet used in present study was obtained from a commercial feed mill in Erzurum. The experimental diet consisted of 58.62% corn, 27.35% soybean meal, 3.00% fullfatsoybean, 9.00% limestone, 1.15% dicalcium phosphate, 0.50% salt, 0.25% vitamin, 0.025% lysine and 0.05% methionine. The compound diet included 88.41% dry matter, 17.00% crude protein, 3.47% crude fibre, 6.63% ether extract, 3.90% Ca, 0.61% P, 0.36% methionin, 0.90% lysine, 0.21% tryptophane, 0.16% sodium, 1.93% linoleic acid and 2750 Mcal kg^{-1} metabolic energy on the feed basis. During the experimental period, laying hens were fed on *ad-libitum* once daily at 08:30 h and water which was available at all times was presented to hens through nipples. Hens were subjected to a 17 L (Light):7 D (Dark) cycle.

Egg production and feed consumption were recorded daily and egg quality was assessed biweekly. Egg production was expressed as hen-day egg production. Feed consumption of laying hens was calculated as daily feed consumption. Feed efficiency was calculated as kilogram of feed consumed per kilogram of egg produced. A sample of 2 eggs was randomly collected from each cage and 12 eggs from each group were taken to assess egg quality parameters such as shell strength, shell thickness, yolk index, albumen index and Haugh unit (Ergun *et al*., 1987).

Before determination of egg weight, sample eggs were stored for 24 h at room temperature. Except for egg weight other egg quality traits were determined using formulas and methods as reported by Ergun *et al*. (1987). Also, the Haugh unit, a measure of egg albumen quality was calculated with formula reported by Eisen *et al*. (1962) as:

$$\text{Haugh unit} = 100\times\log (H + 7.57 - 1.7\times W0.37)$$

Where:
H = Albumen height (mm)
W = Egg weight (g)

The data were subjected to analysis using a General Linear Model procedure of SAS (1998) for a completely randomized experimental design. Differences between means were determined by Duncan's multiple range test.

RESULTS AND DISCUSSION

The daily feed consumption (g/day), egg production (%), cracked egg yield (%), egg weight (g) and feed conversion ratio (kg feed consumed per kg egg produced) results from the groups are shown in Table 1.

The effects of tier level and location by tier level interaction on feed consumption were found significant ($p<0.045$ and $p<0.003$). Daily feed consumption of hens for M and B tiers at location FW and for tier B was higher than those of T and M tiers at location FW and C. There were significant cage location and cage location by tier level interaction effects on egg production ($p<0.056$ and $p<0.023$). Hens at location FW had greater egg production than hens at C. Egg production for hens at tier M was also, greater than for hens at T and B tiers. Also, egg production for hens at tier B was higher than those of T and M tiers. Egg production at location C was the lowest at tier B and decreased from tier M to B. The average egg production values were 84.61, 87.93 and 84.19% for tiers T, M and B at location FW; 83.71, 78.28 and 85.39% for those at location C, respectively. In agreement with this experiment, Vovensy (1990) reported great variability among the groups caged at different tier levels facing windows and located at corridore. Hens at location FW had higher egg production than hens at locations C. Egg

Table 1: The effects of cage location and tier level on performance traits of laying hens

Experimental groups	Feed consumption (g day^{-1})	Egg production (%)	Cracked egg yield (%)	Egg weight (g)	FCR (kg feed kg^{-1} egg)
Cage facing window					
T	106.39^{b}	84.61^{a}	1.230	67.52	1.587^{b}
M	114.56^{a}	87.93^{a}	0.370	68.77	1.666^{a}
B	112.74^{a}	84.19^{ab}	0.830	69.13	1.635^{ab}
Mean	111.23	85.57	0.810	68.48	1.629
Cage located at corridor side					
T	109.42^{ab}	83.71^{ab}	0.790	67.54	1.622^{ab}
M	103.81^{b}	78.28^{b}	0.430	66.99	1.552^{b}
B	112.74^{a}	85.39^{a}	0.380	66.65	1.694^{a}
Mean	108.66	82.46	0.530	67.06	1.623
SEM	1.8100	1.600	0.350	0.760	0.029
ANOVA					
Location effect (L)	0.1270	0.056	0.322	0.052	0.813
Tier effect (Ti)	0.0450	0.711	0.194	0.898	0.129
L x Ti	0.0030	0.023	0.691	0.346	0.018

Table 2: The effects of cage location and tier level on egg quality parameters of laying hens

Experimental groups	Egg weight (g)	Shell strength (kg cm^{-2})	Shell thickness (mm×10^{-2})	Shell weight (g)	Yolk index (%)	Albumen index (%)	Haugh unit
Cage facing window							
T	64.55	1.390	0.370	7.850	33.20	8.450	81.06
M	68.99	1.200	0.380	8.220	32.02	8.410	81.09
B	66.04	1.040	0.390	7.790	35.61	8.760	82.22
Cage located at corridor side							
T	63.22	0.990	0.370	7.460	32.60	6.870	77.68
M	66.97	1.140	0.390	8.210	32.72	8.100	80.58
B	64.87	1.190	0.380	8.100	32.49	7.880	80.83
SEM	1.800	0.130	0.010	0.240	4.480	0.610	2.230
ANOVA							
Location effect (L)	0.312	0.335	0.981	0.875	0.790	0.080	0.362
Tier effect (Ti)	0.086	0.834	0.262	0.080	0.935	0.512	0.650
L x Ti	0.895	0.154	0.411	0.390	0.918	0.588	0.816

production for hens at tier M was higher than for hens at tiers T and B at location FW whereas the egg production for hens at tier B was higher than those of T and M tiers at C. Cracked egg yield was not affected by tier level and cage location. Cage location ($p<0.052$) but not tier level affected egg weight. Hens at location FW produced heavier eggs than that of location C. The effect of tier level and location on egg production in the studies reported by some researhers is not consistent (Abdelkarim and Biellier, 1982; Cavalchini *et al.*, 1976).

The study reports on performance parameters were in agreement with the results obtained from present study. The data on egg quality parameters such as egg weight, shell strength, shell thickness, shell weight, yolk index, albumen index and Haught unit are shown in Table 2.

There were no difference in response to cage location and T, M and B tier levels. The effects of cage location, tier level and cage location by tier level interaction on egg quality trairs such as egg weight, shell strenght, shell thickness, shell weight, yolk index, albumen index and Haugh unit were not significant in present study. A negative correlation between light intensity and eggshell thickness is reported (Abdelkarim and Biellier, 1982). However, eggshell quality was reported as independent of light intensity or cage location and tier level in other studies including hens (Leeson and Lewis, 2004). Pavlovski and Masic (1992) housed laying hens in individual cages as 3-tier with rows facing or not facing windows and reported no differences in shell weight. As albumen index value increased, Haught unit also increased. Albumen structure is one of the main characteristics for internal quality and is used for Haugh unit's calculation (Eisen *et al.*, 1962).

Silversides and Scott (2001) reported that albumen index and Haugh unit are important egg quality criteria and do not change by management and dietary manipulation. In agreement with the present study, no differences in egg sell quality traits were reported by Pavlovski and Masic (1992) in hens subjected to light intensity. The studies related to the effects of cage location and tier level on egg quality parameters were in agreement with the results obtained from present study.

CONCLUSION

Although, the effects of cage location and tier level on feed conversion ratio, the most important factor from performance parameters and egg quality traits were not significant there was significant cage location by tier level interaction effect on feed conversion ratio, they represent a real concern to the poultry industry.

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