The Effect of Oviposition Time on Egg Quality Parameters in Brown Leghorn, Oravka and Brahma Hens

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Abstract
In this experiment with three pure chicken breeds the effect of oviposition on egg quality parameters was investigated. Laying hens of the Brown Leghorn, Oravka and Brahma from 20 to 64 weeks of age were housed in pens with deep litter. The collection time was at 6.00, 10.00 and 14.00 h. Eggs were gathered at the start, middle and end of the laying period. In Brown Leghorn time of oviposition had no significant ($P>0.05$) affected yolk percentage, yolk index and egg weight. However, in shell thickness, albumen index and Haugh Units we detected significant ($P<0.05$) differences among collection times. In Oravka hens, the time of oviposition had no significant ($P>0.05$) effect on egg weight, albumen index and Haugh Units. We recorded significantly ($P\leq0.05$) higher value of shell thickness in 06:00 h in comparison with 10:00 and 14:00 h, but other eggshell quality parameters as shell percentage and shell strength were no significantly ($P>0.05$) affected in the eggs laid at 6:00, 10:00 and 14:00 h. In Brahma, the egg weight, shell percentage, shell thickness and shell strength were significant ($P<0.05$) affected by time of oviposition.

Keywords: Brown Leghorn, Brahma, Oravka, egg quality, oviposition time

1. Introduction

The monitoring of egg quality characteristics is important mainly in terms of production economy. The attention is devoted especially to eggshell quality, because cracked eggshell presents higher losses for market-egg producers. Therefore, it is very important to evaluate the egg quality characteristics and factors affecting them. The genotype is one of the most important factors, influencing not only egg weight but also other egg characteristics [1].
Egg quality comprises a number of aspects related to the shell, albumen and yolk, and may be divided into external and internal quality. The external quality characteristics are evaluated on the basis of eggshell, its cleanness, shape and texture. The internal quality is based on the air cell size, albumen, yolk quality and the presence of blood and meat spots [2].
Egg quality is influenced by many internal and external factors, of which genotype, housing system and time of oviposition are of major importance [3].
Time of oviposition plays a vital physiological role in determining eggshell quality because the amount of deposited shell is a linear function of time spent in the shell gland after plumping, and therefore thickness. Numerous studies indicated that eggs laid early in the morning were heavier than eggs laid during the later periods of the day [4-8].

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The aim of this study was to evaluate the effect of oviposition time in three pure chicken breeds Brown Leghorn, Oravka and Brahma on selected parameters of egg quality.

2. Materials and methods

Three experiments were carried out to investigate the effect time of oviposition on egg quality parameters in three types of pure breeds – light (Brown Leghorn), medium (Oravka) and heavy (Brahma).

Laying hens of the three breeds were housed in pens with deep litter. The collection time was at 6.00, 10.00 and 14.00 h. Eggs were gathered at the start, middle and end of the laying period. We used 90 eggs for each breed (30 eggs for each oviposition time) for assessment of egg quality.
The hens were fed *ad libitum* with feed mixture HYD-10 with identical content during analyzed period. Nutritional value of diet is shown in Table 1. Fresh clean water was supplied daily.

Table 1. Nutritional value of complete feed mixture

Nutrient	Unit	HYD-10
Crude protein	g/kg	158.06
ME	MJ/kg	11.32
Lysine	g/kg	8.07
Methionine and cistine	g/kg	7.02
– from that methionine	g/kg	3.87
Calcium	g/kg	35.13
Phosphorus	g/kg	5.48
Sodium	g/kg	2.17
Manganese	mg/kg	148.79
Selenium	mg/kg	0.38
Copper	mg/kg	18.74
Zinc	mg/kg	102.27
Vitamin A	i.u./kg	10000
Vitamin D_3	i.u./kg	2500
Vitamin K	mg/kg	21.27

Eggs were individually weighed to the nearest 0.01 gram on a laboratory scale Owa labor (VEB Wägetechnik Rapido, Germany). Eggs were individually measured, then the length and width of each egg was measured and based on that the eggs shape index was calculated by the formula (egg width /egg length) x 100.
Using the individual weight of each egg percent yolk, percent albumen and percent shell were determined.
The device measures Haugh Units by the method of [9].
The quality of eggshell was observed strength (N/cm^2), thickness (μm) and percentage of eggshell (%). Eggshell thickness was measured with a shell thickness micrometer. The eggshell strength was determined manually using an Egg Crusher device (VEIT Electronics, Czech Republic).
All data were analyzed by one-way ANOVA analysis of variance using SAS program (SAS, 2003). Duncan's multiple range test is used to differentiate groups means.

3. Results and discussion

From Table 2 resulted that in Brown Leghorn hens, time of oviposition had no significant ($P>0.05$) affected egg weight and most of egg quality parameters.
Differences among collection time and egg weight were not significant but the heaviest eggs we recorded at 10:00 and 14:00 h.
Time of oviposition had no significant ($P>0.05$) effect on shell quality parameters except shell thickness. In the morning (06:00 h) collection time, significantly ($P<0.05$) higher compared with eggs laid in 10:00 and 14:00.
The Haugh Units were lower in eggs laid at 06:00 h and they are significantly ($P<0.05$) increased at 10:00 and 14:00 h.
We detected no significant ($P>0.05$) differences in yolk percentage and yolk index between eggs laid early in the morning and those laid late in the afternoon.

Table 2. Effect of oviposition time on egg quality parameters of Brown Leghorn hens

Parameter	6:00	10:00	14:00
Egg weight (g)	62.68±8.38	63.16±9.01	62.99±9.13
Egg shape index (%)	76.62±13.76	76.41±14.11	76.21±12.59
Percentage of shell (%)	10.35±1.76	10.44±1.85	10.42±1.90
Shell strength (N/cm^2)	30.54±2.09	30.46±2.17	30.43±1.98
Shell thickness (μm)	398.84±89.75^a	392.29±85.29^b	391.99±86.38^b
Percentage of albumen (%)	61.88±8.97	61.78±8.32	61.82±9.01
Albumen index (%)	6.82±1.45^b	7.37±1.67^a	7.39±1.87^a
Haught Units	68.69±7.38^b	71.99±8,65^a	72.21±8.92^a
Percentage of yolk (%)	26.39±3.08	26.14±2.83	26.11±2.29
Yolk index (%)	47.29±4.63	47.88±5.03	47.68±4.88

Values shown are mean ± SD (standard deviation)
^{a,b} means in a row with different superscript differ significantly (P<0.05)

In the second experiment with Oravka hens, the time of oviposition had no significant (P>0.05) effect on egg weight (Table 2). We recorded the heaviest eggs at 10:00 and 14:00 h.

Similarly with Brown Leghorn, we recorded significantly (P≤0.05) higher value of shell thickness in the morning (06:00 h) collection time in comparison with eggs laid in 10:00 and 14:00 h. The other eggshell quality parameters as shell percentage and shell strength were no significantly (P>0.05) affected in the eggs laid at 6:00, 10:00 and 14:00 h.

In contrast to Brown Leghorn hens, in eggs of Oravka no significant (P>0.05) differences among albumen index and Haugh Units by time of oviposition were not recorded. Albumen quality parameters were lower in eggs laid in the morning (06:00 h) and they increased at 10:00 and 14:00 h.

As shown in Table 3, in experiment with Brahma hens, the egg weight was significant (P<0.05) affected by time of oviposition. In contrast with Brown Leghorn and Oravka, heaviest eggs were laid in 06:00 h and the egg weight at 10:00 and 14:00 h were similar.

Table 3. Effect of oviposition time on egg quality parameters of Oravka hens

Parameter	6:00	10:00	14:00
Egg weight (g)	56.86±8.92	57.49±9.23	57.36±8.73
Egg shape index (%)	75.91±12.96	75.54±13.41	75.19±12.29
Percentage of shell (%)	10.22±1.79	10.24±1.95	10.25±1.98
Shell strength (N/cm^2)	29.32±2.02	29.44±2.21	29.49±2.28
Shell thickness (μm)	374.49±85.39^a	381.42±85.97^b	381.88±85.38^b
Percentage of albumen (%)	61.78±8.59	61.68±8.23	61.89±9.31
Albumen index (%)	6.81±1.42	6.89±1.76	6.92±1.98
Haught Units	70.99±7.54	71.14±7,69	71.39±8.04
Percentage of yolk (%)	26.28±2.89	26.24±2.07	26.31±2.57
Yolk index (%)	47.39±4.94	47.73±5.43	47.58±4.25

Values shown are mean ± SD (standard deviation)
^{a,b} means in a row with different superscript differ significantly (P<0.05)

In case of Brahma were egg shell quality parameters as shell percentage, shell thickness and shell strength significantly (P<0.05) higher in the afternoon eggs. It is opposite tendency in comparison with Brown Leghorn hens where eggs laid in the morning had significantly (P<0.05) higher shell thickness, while other parameters were not affected by oviposition.

In contrast to Brown Leghorn hens, in eggs of Brahma hens no significant (P>0.05) differences between albumen index and Haugh Units were determined. Albumen quality characteristics were lower in eggs laid in the morning (06:00 h) and they increased at 10:00 and 14:00 h.

Based on the results of these experiments, it can be concluded that in Brown Leghorn and Oravka, the heaviest eggs were laid later in the morning and in the afternoon. These our results are not in accordance with the results of [10, 11], who recorded that afternoon eggs were lighter than morning eggs. Moreover, [4, 7] showed that egg mass significantly declined with oviposition time.

In case of Brahma, heavy type hens laid the heaviest eggs in the morning, what is in agreement with [12] which determined similar results in broiler breeders.

We recorded significant differences in all egg shell measurements in Brahma hens. Higher shell quality was in eggs laid in the afternoon. In Brown Leghorn and Oravka, shell thickness was significantly higher in eggs laid in 6:00 h. These findings are not consistent with those of [10, 13], who indicated that shell quality of eggs laid in the morning is not as good as that of those laid in the afternoon.

In Brown Leghorn and Oravka, we recorded similar results in yolk percentage with [2, 14] and in the Haugh Units as with [10, 14].

Table 4. Effect of oviposition time on egg quality parameters of Brahma hens

Parameter	6:00	10:00	14:00
Egg weight (g)	59.96±8.92[a]	57.24±9.36[b]	57.36±9,79[b]
Egg shape index (%)	75.54±12.09	75.24±13.41	75.19±12.29
Percentage of shell (%)	10.09±1.72[a]	10.49±1.96[b]	10.53±2.08[b]
Shell strength (N/cm^2)	29.09±2.22[a]	29.86±2.67[b]	29.88±2.89[b]
Shell thickness (μm)	358.92±86.91[a]	381.42±85.97[b]	381.88±85.38[b]
Percentage of albumen (%)	61.69±8.91	61.55±8.37	61.59±9.13
Albumen index (%)	6.78±1.43	6.82±1.68	6.83±1.80
Haught Units	69.79±7.41	69.42±7.32	69.77±7.84
Percentage of yolk (%)	26.18±2.48	26.39±2.11	26.43±2.78
Yolk index (%)	46.21±4.59	46.43±5.30	46.52±4.95

Values shown are mean ± SD (standard deviation)
[a,b] means in a row with different superscript differ significantly ($P<0.05$)

4. Conclusions

The results of our experiments show differences among Brown Leghorn, Oravka and Brahma in the effect of oviposition on parameters of egg quality. For instance, egg weight was the highest in the 6:00 in Brahma hens, whereas in Brown Leghorn and Oravka at 10:00. In case of egg shell quality we recorded similar tendency in Brown Leghorn and Oravka. In Brahma, we recorded highest values of egg shell quality parameters in 6:00. In Haugh Units and yolk index were highest in Brown Lghorn in 10.00 and 14:00, Oravka and Brahma had a similar values in collection times.

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References

1. Zita, L., Tůmová, E, Štolc, L., Effects of Genotype, Age and Their Interaction on Egg Quality in Brown-Egg, Acta Veterinaria Brno, 78, 2009, 85-91
2. Tůmová, E., Zita, L., Hubená, M., Skřivan, M., Ledvinka, Z., The effect of oviposition time and genotype on egg quality characteristics in egg type hens, Czech Journal of Animal Science, 52, 2007, 1, 26-30
3. Tůmová, E., Skřivan, M., Englmaierová, M., Zita, L., The effect of genotype, housing system and egg collection time on egg quality in egg type hens, Czech Journal of Animal Science, 54, 2009, 1, 17-23
4. Choi, J. H., Miles, R. D., Arafa, A. S., Harms, R. H., The influence of oviposition time on egg weight, shell quality and blood phosphorus, Poultry Science, 60, 1981, 824-828
5. Arafa, A. S., Harms, R. H., Miles, R. D., Christmas, R. B., Choi, J. H., Quality characteristics of eggs from different strains of hens as related to time of oviposition, Poultry Science, 61, 1982, 842 -847
6. Lee, K. D., Choi, J. H., Interrelationships among time of oviposition, egg weight, shell weight, and rate of production of laying hens, Poultry Science, 64, 1985, 2256-2258
7. Novo, R. P., Gama, L. T., Soares, M. C., Effects of oviposition time, hen age and extra dietary calcium on egg characteristics and hatchability, Journal of Applied Poultry Research, 6, 1997, 335-343
8. Patterson, P. H., The relationship of oviposition time and egg characteristics to the daily light: dark cycle, Journal of Applied Poultry Research, 6, 1997, 381-390
9. Haugh, R. R. The Haugh Unit for measuring egg quality, The U.S. Egg & Poultry Magazine, 43, 1937, 552-555, 572-573
10. Pavlovski, Z., Vitorović, D., Skrbić, Z., Vracar, S. Influence of limestone particle size in diets for hens and oviposition time on eggshell quality, Acta Veterinaria Beograd, 50, 2000, 37-42

11. Aksoy, T., Yilmaz, M., Tuna, Y. T. The effect of oviposition time on egg quality and the possibility of estimating egg shell weight using a formula in commercial layers, Turkish Journal of Veterinary and Animal Sciences, 25, 2001, 811-816
12 Zakaria, A. H., Plumstead, P. W., Romero -Sanchez, H., Leksrisompong, N., Osborne, J., Brake, J. Oviposition pattern, egg weight, fertility, and hatchability of young and old broiler breeders, Poultry Science, 84, 2005, 1505-1509
13. Oguike, M. A. Influence of oviposition time on some functional properties of eggshell of the domestic fowl kept in warm humid tropics, Nigerian Journal of Animal Production, 22, 1995, 1-4.
14. Tůmová, E., Ebeid, T. Effect of time of oviposition on egg quality characteristics in cages and in a litter housing system, Czech Journal of Animal Scince, 50, 2005, 129-134.