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Weight and egg quality correlation relationship on different age laying hens

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Abstract

With the aim to determine the influence of Lohman Brown laying hen hybrids age and eggs weight on some characteristics of eggs quality-structure and their correlation relationship, experiment was conducted on two egg samples (160 + 160 = 320 eggs) derived from 20 weeks (the oviposition intensity - 18.29%) and 28 weeks (maximum oviposition - 95.69%) old hens. With laying hens aging there was statistically significant increase ($P < 0.001$) of average eggs weight from 46.15 up to 59.89 g. Similarly, the absolute proportion of shell, yolk and egg albumen in weight was significantly higher ($P < 0.001$) at 28 weeks old laying hens than in 20 weeks old laying hens. Percentage share of raw shell in eggs weight was almost similar in both age hens' groups (13.27 - 13.41%); yolk percentage share was significantly higher ($P < 0.001$) at older hens (25.90%) than at younger hens (23.60%), while the albumen percentage share in the egg weight situation was reversed, i.e. younger hens (lighter eggs) had a higher albumen percentage share (63.13%) from hens 28 weeks old (60.69%) ($P < 0.001$). At young laying hens (lighter eggs) phenotypic correlation coefficient between egg weight and crude shells percentage share was -0.425 ($P < 0.001$), the yolk percentage share -0.093 ($P > 0.05$) and percentage of albumen share 0.086 ($P > 0.05$). At 28 weeks old laying hens (heavier eggs) correlation coefficient between egg weight and percentage share of shell, yolk and albumen were: raw shell -0.142 ($P > 0.05$), egg yolk -0.776 ($P < 0.001$) and 0.534 egg albumens ($P < 0.001$).

Key words: Egg weight, egg quality traits, eggshell, yolk, albumen, correlation.

Introduction

Different factors affect consumption eggs quality, among which genotype and age of hens occupied an important place. Observed number of authors have questioned the quality of eggs produced by white eggs shell hens or brown eggs shell hens.

Most authors reported that brown eggs shell hens, usually laying bigger, respectively, heavier eggs [1, 4, 6, 8, 9, 23]. In addition, the egg form index at white hens eggs compared with brown hens was higher [4, 21] than a higher yolk share in white shell eggs [10, 25] and in the brown shell eggs [5].

Zita *et al.* [26] found that beside genotype, the age of laying hens affect on eggs quality. The authors concluded that there is, regardless of genetic origin (ISA Brown, Hisex Brown and Moravia BSL), with laying hens aging (from 20 to 60 weeks), increasing of eggs weight, weight and yolk relative share (%), while albumen and shell share decrease. Similar statements came from other authors [2, 7, 11-16, 18, 22]. Unlike previous authors that laying hens age do not significantly affect on eggs weight [24]. Van den Brand *et al.*[22] pointed that laying hens age affect on eggs form index decreasing.

Egg weight affect on absolute and percentage shell share, albumen share, yolk, egg form index and other eggs' characteristics (shell purity, shell and yolk color) [13, 17, 25]. The said statement was confirmed by calculating of correlation relationship between the eggs weight and pointed eggs characteristics.

In addition, Tůmová and Ebeid [19] and Tůmová *et al.* [20] conducted interesting studies. The aforementioned authors have examined, in addition to genotype (ISA Brown, Hisex Brown and Moravia), the impact of breeding system (cage and floor) and oviposition time (eggs were collected on 06:00, 10:00 and 14:00 h) on the eggs quality. Generally speaking, the breeding system had impact on eggs weight and quality, while the eggs collecting time, especially in cage breeding, had a significant influence.

The aim of this study was somewhat similar to the previous researches, with the difference on individual characteristics of eggs quality examination at Lohman Brown laying hen hybrids of different ages, i.e. laying hens of 20 weeks (egg production initial stage) and 28 weeks old laying hens (peak load - the maximum laying eggs intensity), as well as determinating the strength and statistical significance of characteristics connection by phenotypic correlation calculating.

Materials and Methods

Materials: Experimental material was a total of 320 eggs - 160 eggs from 20 weeks old hens and 160 eggs from 28 weeks old hens. Lohman Brown hens hybrids which laying brown-colored shell eggs were grown on private farm "Rakic Commerce" located in the Serbian Republic, Bosnia and Herzegovina. Laying hens were kept (placed) in cages and fed with food of particular composition (Table 1).

Table 1. Chemical composition of the mixture for feeding hens.

Parameters	Age (weeks)	
	20	28
ME, MJ	11.50	11.60
Crud protein, %	17.55	17.85
Calcium, %	3.60	3.50
Phosphorus, %	0.52	0.51

At the hens age of 20 weeks (egg production initial stage) and 28 weeks (peak load - the maximum laying eggs intensity), the random sample was taken by 160 eggs per each age stage. The eggs were packed and transported with air conditioning car to the experimental laboratory of the Faculty of Agriculture in Zemun - Belgrade University.

Methods: 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:

ESI = (egg width /egg length) x 100.

In order to determine the egg structure, each egg was broken after the measurement and then raw shell, yolk and egg albumen were also measured. The absolute measures were used for determination of shell, albumen and egg yolk share percentage of the egg weight.

Statistical analysis: In fact, in both egg groups (the first lighter eggs - from 20 weeks old hens; other heavier eggs - from 28 weeks old hens) eggs weight (g), egg form index (%), the raw shell share (g; %), albumen (g; %) and yolk share (g; %) were determined. The usual variation statistical indicators were calculated for all of them: the average value ($\bar{X}$), standard error of mean ($S\bar{X}$), standard deviation (S) and coefficient of variation (CV). Determined differences between the characteristics of eggs produced by 20 and 28 weeks old hens were tested with Student's t-test, and the phenotypic correlation coefficients (r_p) between egg weight and tracked egg quality characteristics were calculated by standard form [27].

Results and Discussion

Data shown in Table 2 confirms that laying hens age and therefore the eggs production intensity increase the egg weight, as well as quality characteristics - eggs structure. In laying hens at the beginning of egg production (20 weeks of age, the laying intensity of 18.26%), an average eggs weight was 46.15 g (small eggs - S) and when the hens achieve maximum egg production (28 weeks of age, the laying intensity of 95.24%) average eggs weight was 59.89 g (medium eggs - M). Established difference in eggs weight was statistically significant ($P < 0.001$). The hens that were 28 weeks old and realize maximum egg load, compared with hens in the beginning of the production process (20 weeks old), produced eggs of larger length and width, as well as of higher egg form index, respectively of more proper egg shape ($P < 0.001$). There was not significant ($P > 0.05$) difference regard the cleanliness and egg shell color.

Heavier eggs from older hens had significantly greater absolute weight of the shell, albumen and egg yolk than smaller eggs of younger hens clusters. However, the percentage share of the shell, albumen and yolk showed a somewhat different regularity. Namely, the eggs of younger hens had significantly ($P < 0.001$) higher egg albumen share percentage (63.13 - 60.69%), while eggs originated from older hens had a higher yolk (25.90 - 23.60%) and shell share percentage (13.41 - 13.27%). In addition, at the hens on the start of egg production, yolk color was somewhat lighter than in eggs from hens that were in the stage of maximum eggs production.

The results in Table 2 are substantially similar to the researches mentioned in the beginning of this study. However, quite similar results to ours in three different genotypes of laying hens were given (ISA Brown, Hisex Brown and Moravia BSL) [26]. The authors stated that beside the genotype, significant influence on the eggs quality was shown on laying hens age. Regardless of genotype, with laying hens aging the weight of eggs and yolk percentage in egg was increased, while the shell percentage and albumen in the egg weight was reduced. In contrast to these studies, in our work only the shell percentage share in egg weight was slightly higher in heavier eggs of older hens, but this difference was not statistically significant ($P > 0.005$). This could be justified by the fact that our study included two periods (20 weeks and 28 weeks old hens), while these aforementioned cases included three stages of the production cycle (from 20 - 26; 36 to 42 and 54 to 60 weeks). All the above presented shows that between the hens age and eggs weight exist some connection, as well as among the eggs weight and some individual quality characteristics - the eggs structure, i.e. cause one another.

Most studies present that the hens laying aging increase the eggs weight, the absolute share of the basic parts of an egg (shell,

Table 2. The average values and variability of egg traits.

Traits	Week of laying	$\bar{x}$	$S\bar{x}$	S	C.V.	Significance
Egg weight (g)	20 - S	46.15	0.34	4.27	9.25	***
	28 - M	59.89	0.33	4.12	6.88	
Egg length	20 - S	51.80	0.14	1.76	3.40	***
(mm)	28 - M	55.87	0.30	3.84	6.87	
Egg width	20 - S	39.99	0.13	1.63	4.08	***
(mm)	28 - M	43.93	0.12	1.50	3.42	
Egg shape	20 - S	77.25	0.26	3.25	4.21	***
index (%)	28 - M	78.67	0.23	2.95	3.75	
Egg cleanlines	20 - S	4.44	0.06	0.71	15.99	NS
	28 - M	4.67	0.04	0.54	11.56	
Eggshell colour	20 - S	4.21	0.06	0.76	18.05	NS
	28 - M	4.62	0.05	0.63	13.64	
Yolk colour	20 - S	7.11	0,16	2,08	29,25	**
	28 - M	6.33	0.16	2.02	31.91	
Eggshell	20 - S	6.12	0.06	0.79	12.91	***
weight (g)	28 - M	8.03	0.06	0.72	8.97	
Eggshell	20 - S	13.27	0.11	1.36	10.25	NS
content (%)	28 - M	13.41	0.07	0.86	6.41	
Albumen	20 - S	29.16	0.24	3.08	10.56	***
weight (g)	28 - M	36.40	0.25	3.17	8.71	
Albumen	20 - S	63.13	0.17	2.16	3.42	***
content (%)	28 - M	60.69	0.17	2.12	3.49	
Yolk weight (g)	20 - S	10.88	0.11	1.45	13.33	***
	28 - M	15.47	0.05	0.67	4.33	
Yolk content	20 - S	23.60	0.13	1.67	7.08	***
(%)	28 - M	25.90	0.11	1.36	5.25	

S - Small eggs; M - Medium eggs; ***P < 0.001; **P < 0.01; *P < 0.05; NS - non significant.

albumen and yolk) and even slightly egg form index. Thus, Zhang *et al.* [25] found a statistically significant correlation among egg weight and albumen, yolk and shell weight and the correlation coefficient ranged from 0.67 to 0.97, while Djekić *et al.* [3] found a statistically significant correlation coefficient ($P < 0.05$) between egg weight and egg form index $r_p = 0.772$.

In addition, the phenotypic correlations were calculated between the eggs weight produced by two age groups (20 and 28 weeks) and examined egg quality traits (Table 3).

Compared to the previous authors, our study showed a similar correlation relationship between the tracked eggs features, except at the younger laying hens, where correlation coefficient between egg weight and egg shell weight was 0.096 and was not statistically significant ($P > 0.05$) (Table 3).

Table 3. Correlation coefficients between egg weight and egg quality.

Traits	r_{20}	Significance	r_{28}	Significance
Egg length (mm)	-0.215	**	0.605	***
Egg width (mm)	0.618	***	0.641	***
Egg shape index (%)	0.087	ns	0.116	ns
Egg cleanlines	0.045	ns	-0.096	ns
Eggshell colour	0.015	ns	-0.118	ns
Yolk colour	0.675	***	-0.022	ns
Eggshell weight (g)	0.096	NS	0.659	***
Eggshell content (%)	-0.425	***	-0.142	NS
Albumen weight (g)	0.821	***	0.901	***
Albumen content (%)	0.086	NS	0.534	***
Yolk weight (g)	0.810	***	0.607	***
Yolk content (%)	-0.093	NS	-0.776	***

In addition, in both age groups of laying hens negative correlation coefficients (-0.425; -0.142) among eggs weight and shell shares percentage were determined, with the difference that at the younger hens correlation coefficient was statistically significant ($P < 0.001$) and at older hens, respectively, heavier eggs, correlation coefficient was not statistically confirmed ($P > 0.05$). Correlation relationship at yolk share percentage in egg weight was reversed. The correlation coefficient among egg weight and yolk share percentage of 20 weeks old laying hens was -0.093 and not statistically significant ($P > 0.05$), while the 28 weeks old hens had also negative correlation coefficient (-0.776) but it was statistically significant ($P < 0.001$).

A similar study was conducted at the average egg weight of 54.736 g, divided into three groups of weights [17]. Fortified correlation coefficients and their significance were roughly similar to where we came in our research, especially in heavier eggs produced by 28 weeks old hens. Between egg weight and percentage share of the shell it was determined the negative correlation coefficient ($r_p = -0.261$*), as well as the percentage yolk share ($r_p = -0.534$**) and between egg weight and percentage of albumen share correlation coefficient was positive ($r_p = 0.603$**). Different correlation relationship between egg weight and shell share percentage, yolk and albumen was identified by Zita *et al.* [26]. Specifically, between egg weight and percentage share of the shell and albumen the authors found negative and between egg weight and yolk percentage share, the positive correlation relationship.

Conducted research presents that increasing of hens age from 20 (egg production initial stage) to 28 weeks (maximum eggs production) increases the eggs weight, albumen share percentage in egg and egg form index, while reduces the shell share percentage and egg yolk in total egg weight.

Conclusions

In order to determine the eggs quality characteristics produced by laying hens of different ages, research was carried on 320 eggs from which 160 eggs were produced by 20 weeks old hens (egg production at initial stage 18.29%) and 28 weeks old hens (maximum egg production 95.69%). In this period hybrids Lohman Brown hens were fed with the same food and kept in the cage (battery) system. Older hens, compared to the younger, were produced heavier eggs and percentage albumen share in egg weight was lower, the proportion of shell similar, but higher yolk share percentage.

With the correlation relationship between the eggs weight and weight of individual egg components, statistically significant phenotypic correlation coefficients were determined. However, in younger hens, or lighter eggs, between the eggs weight and the percentage shell shares in the weight of the eggs, statistically significant ($P < 0.001$) negative correlation coefficient ($r_p = -0.425$) was found and at older hens (heavier eggs), correlation coefficient ($r_p = 0.142$) was also negative but not statistically significant ($P > 0.05$). Negative correlation coefficients were established among the egg weight and the percentage yolk shares in both groups of eggs, just as the correlation coefficient derived from the eggs of older hens (-0.776) was statistically significant ($P < 0.001$), whereas eggs from younger hens correlation coefficient (-0.093) was not statistically confirmed ($P > 0.05$). At 20 weeks and 28 weeks old hens in the produced eggs, the percentage albumen share was increasing with eggs weight increasing, except that the coefficient of correlation in the older hens of 0.534 was statistically significant ($P < 0.001$) and at younger hens correlation coefficient of 0.086 was not statistically confirmed ($P > 0.05$).

Viewed as a whole it can be said that 28 weeks old laying hens exercise the maximum of laying capacity and compared with 20 weeks old hens produce bigger eggs, of satisfactory quality and optimal shape or structure of the egg, i.e. the laying hens age is in appropriate correlation relationship with laying intensity and eggs quality.

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