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Phenotypic correlation between the weight and structure of eggs from light line hybrid laying hens

Tatjana Ždralić[1], Jelena Nikitović[2], Miroslav Lalović[1], Darko Vujičić[1]

[1]*University of East Sarajevo, Faculty of Agriculture, Vuk Karadžić 30, East Sarajevo*
[2]*University of Banja Luka, Faculty of Agriculture, Institute of Genetic Resources, Bulevar Vojvode Petra Bojovića 1A, Banja Luka*
Corresponding author: tatjana.zdralic@gmail.com

Abstract: Eggs are a unique product and serve to feed people of all ages. They have a very high nutritional value, because they contain a relatively high percentage of proteins, minerals, vitamins. Some researchers emphasize that eggs, in addition to high nutritional value, provide many health benefits, and have immunostimulating, therapeutic and functional properties, which makes them universal products.
Although the number of eggs (load capacity), food conversion and mortality are still considered to be the main indicators for calculating the production index or the economic performance of egg production, producers must increasingly take into account the quality of eggs in order to meet consumer demand. This means that special attention should be paid to egg structure (proportion and yield of shell, white and yolk), which we touched on in this paper.

Keywords: phenotypic correlations, egg weight, shell, white, yolk.

Introduction

Characteristics of egg structure and the proportion of egg components in the total egg weight are influenced by genetic and non-genetic factors.

The egg consists of three main parts: the yolk, the white and the shell. The yolk is located in the center of the egg, wrapped in a membrane, fixed by the

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chalazae (a thick part of the egg white). The egg white is wrapped with two membranes (inner and outer – thicker). The shell is the fixed part, made up of three layers, constituting 11% of the egg weight, and 98% of the shell consists of calcium (Jacqueline *et al*., 2000).

Egg weight is an important property, since all egg components depend on weight (Hartmann *et al*., 2000). When calculating the correlation between egg weight and egg components, Zhang *et al*. (2005), Rajičić *et al*. (2008) and Shi *et al*. (2009) showed that egg weight affects the absolute and percentage proportion of the shell, white and yolk.

Pandurević *et al*. (2010) conducted an experiment on two samples of eggs originating from 20 and 28-week-old layers. A statistically significant negative coefficient of correlation was found between egg weight and shell proportion in 20-week-old laying hens, whereas the correlation in 28-week-old laying hens was not significant. A negative coefficient of correlation was determined between egg weight and yolk proportion in both groups of laying hens; in older laying hens, it was statistically significant ($P<0.001$), whereas in younger laying hens no significance was confirmed ($P>0.05$). The proportion of the egg white increased, and it was statistically significant ($P<0.001$) in older layers, and statistically non-significant in younger laying hens.

The aim of this paper was to determine and test the phenotypic correlation between egg weight and egg components (shell, white, yolk) in four production stages – **A**ges of **H**ens (AH20, AH28, AH48, AH72) of the Lohmann Brown light hybrid line.

Material and Method

The experiment was perfomed on a commercial flock of Lohmann Brown light line hybrid laying hens.

During the experiment, special attention was paid to the four main production stages: 20 weeks of age – AH20 (start of load), 28 weeks of age – AH28 ("peak" – maximum), 48 weeks of age – AH48 (medium) and 72 weeks of age – AH72 (end of the production cycle).

According to the recommendations of the selectors (www.ltz.de), the grower of the light line hybrid Lohmann Brown, feeding stuffs, during the production cycle, should contain 2.750 and 2.800 kcal ME and 17.5% of crude proteins (carrying capacity below 5%) and 2.800 kcal ME and about 18.0% of crude proteins (carrying over 5%).

This food is used until reaching the maximum production (28 weeks of age), depending on the production of eggs and body weight, after which certain additives of the appropriate composition are added to the concentrate concentrates.

During the examined period all experimental groups were fed ad libitum with a standard diet, which composition is given in Table 1.

To determine the phenotypic correlation between egg structure and egg weight, the following tests and analyses were made.

During the production cycle, there were four control eggs and individual measurements (a total of 640 eggs), in 4 treatments with 160 replications (n). Therefore, individual measurements included 160 randomly sampled eggs (10 eggs from each row x 4 floor battery cages x 4 rows of battery cages).

Egg structure was analyzed in accredited laboratories.

Table 1: Composition of diet for laying hens

No.	Nutrition	%
1.	Maize	57
2.	Soybean meal	23
3.	Sunflower shot 33%	7
4.	Ca CO_3	9
5.	Dicalcium phosphate	2
6.	Methionine	1
7.	Premix	1
Total		100

The same number of eggs and individual characteristics of egg structure were determined for the four age groups of hens (AH20, AH28, AH48 and AH72). The following parameters i.e. indicators of egg structure were defined:

- Egg weight (g),
- The proportion of the shell in the egg (g, %),
- The proportion of the white in the egg (g, %),
- The proportion of the yolk in the egg (g, %).

Egg weight was measured on a special technical scale with an accuracy of 0.01 g.

Shell weight was measured on a technical scale with an accuracy of 0.01 g, together with egg mites and a small amount of the white that was left behind after the pouring of the egg content.

The yolk previously separated by the separator from the white was measured on a technical scale with an accuracy of 0.01 g.

Egg white weight was obtained by calculating the difference between egg weight and shell and yolk weights.

The proportions of the shell, yolk and the white in the egg were obtained by calculation.

Based on the results, the phenotypic correlation between egg weight and the main structural characteristics of the egg was determined.

The software package SPSS - Statistical Package for Social Sciences (http://spss.en.softonic.com/) was used for statistical analysis.

The strength of the correlation was discussed using the Roemer-Orphal classification. Testing the statistical significance of the obtained correlation coefficients was performed by t-test.

Results and discussion

Egg weight is a significant feature. Each egg component depends on the same (Hartmann *et al*., 2000). In support of this, in Table 1, the coefficients of the phenotypic correlation between egg weight (AH20, AH28, AH48, AH72) and the structural components of the egg.

Table 2: Coefficients of phenotypic correlation between egg weight and the proportion of the shell, yolk and white.

Indicators	AH	r_{xy}	$t_{exp.}$
Proportion of the shell (g)	AH_{20}	0.096^{ns}	1.212
	AH_{28}	0.659***	11.013
	AH_{48}	0.416***	5.750
	AH_{72}	0.662***	11.102
Proportion of the shell (%)	AH_{20}	- 0.425***	5.901
	AH_{28}	$- 0.142^{ns}$	1.803
	AH_{48}	- 0.786***	15.981
	AH_{72}	-0.665***	10.031
Proportion of the white (g)	AH_{20}	0.821***	18.075
	AH_{28}	0.901***	26.106
	AH_{48}	0.947***	37.056
	AH_{72}	0.975***	55.154
Proportion of the white (%)	AH_{20}	0.086^{ns}	1.085
	AH_{28}	0.534***	7.938
	AH_{48}	0.754***	14.428
	AH_{72}	0.688***	11.916
Proportion of the yolk (g)	AH_{20}	0.810***	17.361
	AH_{28}	0.607***	9.600
	AH_{48}	0.738***	13.747
	AH_{72}	0.213**	2.740
Proportion of the yolk (%)	AH_{20}	-0.093^{ns}	1.174
	AH_{28}	- 0.776***	15.464
	AH_{48}	- 0.701***	12.355
	AH_{72}	-0.639***	10.442

r_{xy} - coefficient correlation; $_{ns}$ - P> 0.05; ** - P <0.01; *** - P< 0.001

The results in Table 2 show that, in young laying hens (AH20), the correlation coefficient between egg weight and the shell was r_{xy} = 0.096 and was not statistically significant (P>0.05). In older laying hens, the correlation coefficients showed stronger correlations between these two traits (moderate and strong), and the significance was at P<0.001.

All calculated correlation coefficients were positive. The coefficients of the phenotypic correlations between egg weight and the shell content were negative for all periods, strong to very strong, and statistically significant at P <0.001, except for the production maximum (AH28), for which the calculated coefficient (r_{xy} = -0.142) was not significant (P>0.05) and correlation strength was very weak.

Positive correlation coefficients were determined between egg weight and the weight of the white, as well as between egg weight and the weight of the yolk, and they were all statistically significant (P<0.01 and P<0.001, respectively).

Almost all coefficients showed strong to very strong correlation. The coefficients calculated for the weights of the whites indicated the strongest correlation, more precisely, complete correlation (0.901; 0.947; 0.975).

The data in Table 1 show that young laying hens did not have significant (P>0.05) correlation coefficients between egg weight and the proportion of the egg white (r_{xy} = 0.086) and the proportion of the yolk (r_{xy} = -0.093). With increasing age of laying hens, the coefficients were significant at P<0.001, strong to very strong, positive between egg weight and the proportion of the egg white, and negative between egg weight and the proportion of the yolk.

The relationship between egg weight and egg components were, for the most part, statistically significant in Zhang *et al*. (2005), Johnston and Gous (2007), Rajičić *et al*. (2008), Đekic *et al*. (2009), and Lukaš *et al*. (2009).

Similar studies were carried out by Shi *et al*. (2009), where the correlation coefficients and their significance were approximately similar to the results of the present research. Negative coefficient of correlation (r_{xy} = -0.261) was found between egg weight and the proportion of the shell, as well as between egg weight and the proportion of the yolk (r_{xy} = -0.534). The coefficient of correlation between egg weight and the proportion of the egg white was positive (r_{xy} = 0.603).

Conclusion

For the purpose of defining the correlation of the properties of the structure of eggs for consumption and the mass of the eggs, we can conclude the following:

Within each production period, between the eggs weight and the proportion of the shell, statistically significant (P<0.001) negative coefficients of phenotypic correlation were determined, except for eggs at the maximum load capacity (AH28), when a negative coefficient (r_{xy} = 0.142) was also determined statistically confirmed (P>0.05). This means that within each age group, the weight of the eggs increased with the relative proportion of the shell.

In contrast to the proportion of the shell, the relative share of white egg in the egg weight in all four production phases increased with an increase in the weight of the eggs. The determined correlation coefficients were statistically significant ($P<0.001$), except for the laying hens at the beginning of the production of eggs (AH20) when correlation coefficient ($r_{xy} = 0.08^{ns}$) was not established between the egg weight and the proportion of egg whites.

The relative share of yolks in the egg weight was similar to that of the shell, i.e. with the increase in egg weight, the proportion of yolks decreased. In all stages of the production process between the egg weight and the percentage of yolks, statistically significant ($P<0.001$) negative coefficients of correlation were determined, except for AH20 when the value of the coefficient was r_{xy} = - 0.093 and was not statistically significant ($P>0.05$).

Generally, during the experimental period on a commercial flock (laying hens) of the light line hybrid Lohmann Brown between eggs weight and its structural components (of the shell, the yolk and egg white) in the individual stages of the production process was determined by a certain correlation connection.

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