Acta Scientiarum. Animal Sciences
ISSN: 1807-8672
Editora da Universidade Estadual de Maringá - EDUEM

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Acta Scientiarum. Animal Sciences, vol. 43, e52738, 2021
Editora da Universidade Estadual de Maringá - EDUEM

DOI: https://doi.org/10.4025/actascianimsci.v43i1.52738

Available in: https://www.redalyc.org/articulo.oa?id=303168054052

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Acta Scientiarum

http://periodicos.uem.br/ojs
ISSN on-line: 1807-8672
Doi: 10.4025/actascianimsci.v43i1.52738

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Physical quality of eggs of four strains of poultry

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ABSTRACT. The layer poultry is an important activity for food production with high biological value. Measuring egg quality has great relevance to ensure safety and quality products for consumers. Thus, the objective was to evaluate the egg physical quality of four laying hen's strains. Were used 864 eggs from four laying hens' lines (Hisex Brown®, Hy-Line Brown®, Isa Label®, and Lohmann Brown®). The experimental design was completely randomized composed of four treatments (strains) with nine replications with four eggs each. Egg weight, egg diameter, egg length, specific gravity, yolk, albumen and shell weight and percentage, Haugh units, and shell thickness were evaluated. There was a significant difference for all parameters evaluated. The Hisex Brown® strain showed the best results for egg diameter, egg length, specific weight, albumen height, Haugh units, yolk weight, albumen%, shell weight, shell%, and shell thickness, while the Hy-Line Brown® produced bigger and heavier eggs, and Isa Label® presented the highest yolk%. The Hisex Brown® strain showed the better physical quality of eggs when compared to the other studied lines, the strain being indicated when the objective is to produce eggs with better internal and external quality.

Keywords: specific gravity; egg quality; haugh units.

Received on March 23, 2020.
Accepted on October 01, 2020.

Introduction

Layer poultry production is an activity that has evolved a lot in recent years, and currently to ensure the quality of eggs produced, several factors are considered, among them, it can be highlight sanity, genetics (differences between strains), management, nutrition, facilities, and some diseases (Bittencourt et al., 2019).

Chicken egg is one of the most complete foods when compared to other foods used for humans, providing consumers with an almost complete balance of essential nutrients such as proteins and amino acids of excellent biological value, vitamins, minerals, and fatty acids (Pascoal et al., 2008).

The consumption of eggs by the population depends on the quality of the product offered to consumers, determined by a set of characteristics that may interfere with the acceptance of the product on the market. The laying hens eggs, as well as other animal products is perishable and after laying begins to lose its internal quality, so measures must be taken to ensure the quality of the product (Barbosa, Sakomura, Mendonça, Freitas, & Fernandes, 2008).

The lineage and age of commercial laying hens influence internal and eggshell quality. The differences in color, size, shape, the texture of the eggshell, and the quality of albumen and yolk can be determined by the differences between breeds, lineages, families, and individuals (Barbosa et al., 2009).

The egg is formed by the shell, the shell membrane, yolk, and albumen, and the shell represents 10% of the total weight of the egg, the yolk 30%, and the albumen 60% (Fontenele-Neto, 2012). The eggshell is a unique structure, the result of an extraordinary evolution process, whose primary functions include the protection of the egg's internal content against mechanical injuries and invasions of microorganisms (Mazzuco, 2008).

The thickness of the shell, as well as the structure of the shell, are fundamental aspects in the quality of the egg since both affect its resistance, so eggs with thicker shell are more resistant to bacterial penetration than eggs with weak shell, therefore reduces breakage, being one of the main causes of contamination by microorganisms. As the weight of the egg increases, there is reduction in eggshell thickness, consequently, there is a loss of moisture to the environment (Giampauli, Pedroso, & Moraes, 2005).

Given the above, the objective of this study was to evaluate the egg quality of four laying hens' strains (Hisex Brown®, Hy-Line Brown®, Isa Label®, and Lohmann Brown®) and identify which genotype presents the best physical egg quality.

Material and methods

The local and experimental period

The experimental analyses were carried out in the Laboratory of Special Analyses of the Department of Animal Science of the Federal Institute of Education, Science, and Technology of the Southeast of Minas Gerais, Rio Pomba Campus, Minas Gerais State, Brazil, during 63 days divided into three periods of 21 days each. In each experimental period, three analyses were performed, which were from the 19th, 20th, and 21st days of each period.

Egg collection

Eggs were collected in farms in the Region of Rio Pomba and Viçosa located in the state of Minas Gerais, Brazil, the selected farms had the same food management, peak laying, and facilities, so as no influence occurred in the results of the experiment.

Fresh eggs were collected in the morning on the 19th, 20th, and 21st days of each period. All birds were at the peak of laying, at 34 weeks of age. Were used 864 eggs from four lineages laying hens (Hisex Brown®, Hy-Line Brown®, Isa Label®, and Lohmann Brown®).

The experimental design was completely randomized composed of four treatments (strains) with nine replicates with 24 eggs each.

Were evaluated the following egg quality parameters: egg weight (g); egg diameter (mm); egg length (mm); specific gravity (g cm^{-3}); albumen height (mm); weight (g) and percentage (%) of yolk; albumen and shell; and Haugh units.

Egg weight

The eggs of each repetition were weighed individually on an analytical scale with an accuracy of 0.001 g and then their weight was noted in a spreadsheet.

Diameter and Length

After weighing, the eggs were identified according to treatment and repetition, and then the diameter and length were measured utilizing a digital caliper (DIGIMESS®).

Specific gravity

Specific gravity was determined by sequential immersion of eggs in different saline solutions (NaCl) with density ranging from 1.060 to 1.095 g cm^{-3}, with an interval of 0.005 g cm^{-3} duly calibrated using a densimeter (OM-5565, Incoterm®) according to the methodology proposed by Oliveira and Oliveira (2013).

Albumen height

The eggs were broken on a clean and flat surface and then the height of the albumen was measured with a digital caliper (DIGIMESS®) according to the methodology proposed by Oliveira and Oliveira (2013).

Yolk, albumen and shell weight and percentage

The yolk of each egg was separated and weighed on an analytical scale with an accuracy of 0.001 g. The shell weight was obtained after washing and drying it in a forced air oven at 65°C for 48 hours. Albumen weight (g) was calculated as the difference between the weight of the entire egg and the combined weight of the yolk and eggshell (g).

Percentages of yolk, albumen, and eggshell were determined by the following formula: yolk (%) = [yolk weight (g)/egg weight (g)] × 100. Albumen and eggshell weights were substituted in the formula, as necessary.

Shell thickness

The shell thickness was measured using a digital micrometer (DIGIMESS®), after drying in an oven at 65°C for 48 hours. Three measurements were taken, these measurements being made at the two poles and in the middle of the egg. The shell thickness of each repetition was determined by the arithmetic mean of the measurements, according to the methodology proposed by Moraleco et al. (2019).

Haugh Units

After performing the albumen height measurement, the Haugh units (UH) was determined by following equation proposed by Haugh (1937): UH = 100 * log (h + 7.57 – 1.7 $W^{0,37}$; where: UH = Haugh unit; h = height of dense albumen (mm); and W = egg weight (g).

Experimental design

The design was used a completely randomized design with four treatments (Hisex Brown®, Hy-line Brown® Isa Label®, and Lohmann Brown®) with nine replicates of twenty-four eggs each.

Statistical analysis

The data were subjected to variance analysis and compared using the Tukey test at 5% probability using the SISVAR statistical program (Ferreira, 2011).

Results and discussion

A significant effect ($p < 0.05$) was observed for evaluated parameters of the four lines of laying hens studied: egg weight; egg diameter; egg length; specific gravity; albumen height; Haugh units; yolk, albumen and shell weight; yolk and shell percentage; and shell thickness (Table 1).

Table 1. Egg quality parameters from four laying hens' strain.

Variables	Strains				P-value	CV (%)
	Hisex Brown®	Hy-Line Brown®	Isa Label®	Lohmann Brown®		
Egg weight (g)	62.05 b	63.63 a	57.10 c	50.62 d	<0.05	1.01
Egg diameter (mm)	42.94 a	42.74 a	40.11 b	38.64 c	<0.05	0.78
Egg length (mm)	55.94 a	56.40 a	56.35 a	51.59 b	<0.05	0.92
Specific gravity (g cm^{-3})	1.087 a	1.079 b	1.070 d	1.074 c	<0.05	0.10
Albumen height (mm)	6.15 a	5.68 b	4.91 c	4.51 d	<0.05	4.23
Haugh units (%)	74.45 a	70.78 b	66.56 c	66.24 c	<0.05	2.88
Yolk weight (g)	16.93 a	16.90 a	17.21 a	14.21 b	<0.05	2.33
% yolk	27.28 c	26.56 c	30.14 a	28.07 b	<0.05	2.14
Albumen weight (g)	39.12 b	40.83 a	35.04 b	31.84 d	<0.05	3.47
% albumen	63.05 ab	64.17 a	61.37 c	62.90 b	<0.05	0.98
Shell weight (g)	6.00 to	5.90 a	4.85 b	4.57 c	<0.05	1.40
% shell	9.67a	9.27 a	8.49 b	9.03 ab	0.0064	4.73
Shell thickness (mm)	0.483 a	0.457 b	0.410 c	0.448 b	<0.05	2.69

Means followed by different letters on the line are different from the Tukey test ($p < 0.005$). CV = coefficient of variation (%).

Eggs from Hy-Line Brown® strain present higher weight, which led to a significant reduction ($p < 0.05$) in specific gravity. The greater egg weight of this strain can be attributed to the greater weight of the albumen compared with other evaluated strains.

Specific gravity is an estimate of the amount of eggshell deposited and is related to its percentage (Brunelli et al., 2010). According to Avila, Penz Júnior, Rosa, and Guidoni (2001), heavier eggs have less specific gravity and poorer shell quality. The reduction in the specific gravity of the egg can be explained by decreasing the shell thickness, resulting in lower resistance to breaking strength.

However, it was observed that the Hisex Brown® strain, despite having the second-highest egg weight, it was observed that the shell quality was significantly ($p < 0.05$) higher than eggs produced by the Hy-Line Brown®, Isa Label®, and Lohmann Brown® hens, evidenced by greater specific gravity (1.087 g cm^{-3}) and shell thickness (0.483 mm). According to Scott (1995), the value of 1.080 g cm^{-3} is a reference point for good eggshell quality.

Eggs from Hy-Line Brown® strain had higher albumen weight, but there was no increase in the Haugh units. The Haugh Unit is a measure for evaluating egg internal quality that relates albumen height with egg weight (Brunelli et al., 2010). Therefore, higher Haugh units means better egg quality.

It was found that Hisex Brown® laying hens produced ($p < 0.05$) eggs with higher quality, demonstrated by the increase in the Haugh units. This can be explained by the improvement in eggshell quality evidenced by this strain, since eggs with a thicker shell ensure greater protection of the internal content, thus providing a longer shelf life of this product and preserving health consumer when purchasing these eggs at supermarkets.

The eggs of laying hens strains presents variation in albumen height. The differences in color, size, shape, the texture of the eggshell, and in the quality of albumen and yolk, can be determined by the differences between races, lineages, families, and individuals (Carvalho et al., 2007). Several studies show that the albumen height differs between strains. Carvalho et al. (2007) found that the Babcock B300® strain had an albumen height higher than Hisex® strain, similar to the results observed by Scott and Silversides (2000) that observed difference in albumen height between ISA-White® and ISA-Brown® hens lineages.

According to the United States Department of Agriculture (USDA, 2000), by Quality Control Program for Eggs for Consumption, recommend that eggs of excellent quality (AA) must present Haugh units (UH) greater than 72; high-quality eggs (A) between 55 to 72 HU; medium quality eggs (B) greater than 30 HU; and, finally, low-quality eggs below 30 HU.

The eggs produced by the Hisex Brown® hens presented HU value greater than 72, thus, according to the EGG - Grading Manual (USDA, 2000), standard, they would be classified as excellent quality eggs, whereas eggs produced by Hy-Line Brown®, Isa Label®, and Lohmann Brown® strains presented values between 55 to 72 HU, being characterized as high-quality eggs.

When the results of this work (Table 1) are compared with the data presented in the management manual of the differents strains studied, it turns out that the egg weight of Hisex Brown® lineage at the age of 37 weeks reached the standards (62.4 g) established by the lineage manual as well as Hy-Line Brown® hens (61.3 g). The egg weight of Lohmann Brown® laying hens at 30 weeks did not reach egg weight (61.4 g) established by the manual though. The Haugh units of Hy-Line Brown® strain were below settled by manual (90 HU).

Valentim et al. (2019) compared the performance of two laying hens' strains (Hisex Brown® and Black Avifran®) and did not found significant differences for egg weight, albumen weight, yolk weight and shell weight, albumen percentage, yolk percentage and shell percentage, marketable eggs, specific gravity and egg production between these two lineages analyzed.

According to the results found in the present research, the Hisex Brown® strain showed better eggshell quality, thus this provided higher internal egg quality. According to Eberhart et al., (2021) the shell quality is the main concern of the poultry industry, due to economic losses caused by changes in this constituent of the egg.

The eggshell should be strong to maximize the number of whole eggs that arrives for consumers. Eggs with low-quality shells have less resistance during industrial processing and do not reach the consumer with a minimum of quality, causing losses to the producer (Arruda, Gouveia, Lisboa, Lima Abreu, & Abreu, 2019).

Almeida et al. (2019) compared egg quality between native hens to laying hens lineages and reported that the difference among egg size and egg shape are the factors that most distinguish these genetic groups.

According to Valentim et al. (2019), genetics and breeding researches are necessary to know phenotypes, lines, breeds, and patterns, to find which categories are more efficient for each production system, since these variables are intrinsically related to their zootechnical performance characteristics.

Conclusion

The Hisex Brown® laying hen strain showed better physical egg quality when compared to the other studied strains, thus this strain is indicated when the objective is to produce eggs with better internal and external quality.

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