



Comparison of qualitative properties of eggs from hens reared in battery cages and free range system

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Abstract

The aim of this research was to determine the differences of some quantity properties of eggs from hens reared in two farming methods: battery cages system and free range system of rearing. Total 200 eggs were analyzed or a 100 eggs separately from both ways of hens rearing. The research was done in 2016. The eggshell strength was determined using an automated measuring device and the other parameters (egg mass, yolk color and Haugh units) were determined using the apparatus for automatically determining the internal quality of eggs. The eggs getting from battery cages system of rearing hens are characterized with higher eggshell strength compared to analyzed eggs form free ranged hens, but there is no significantly difference. Values for the mass of whole eggs are inversely with values for the eggshell strength at both methods of hens rearing. For the property yolk color, there is significantly differences between eggs from caged and free ranged laying hens ($t_{170.800} = 6.567$; $p < 0.05$). There is significantly differences between eggs form analyzed systems of hens lying for the parameter Haugh Units, too ($t_{194.786} = 6.767$; $p < 0.05$). The eggs form battery cages rearing hens are characterized with higher eggshell strength, higher values for the yolk color as well as higher Haugh units that mean better overall quality. Simultaneously, controlled way of hens rearing in battery cages systems decreases the risk of getting unsafe eggs.

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Introduction

The poultry industry in the Republic of Macedonia consists of two sub-sectors based on the rearing of chickens and matches the two main products obtained from it, i.e. the production of eggs and poultry meat production.

Primary activity of the Macedonian poultry industry is the production of eggs. It may be on three different levels: egg production on large farms (37% of the total number of hens, i.e. 80-100 thousand hens per farm; average production of 300 eggs/year), egg production of medium-sized farms, often family-owned (63% of hens, with an average capacity of 2-5 thousand per farm; average production of 108 eggs/hen/year) and the production of eggs from poultry kept in the backyard. Egg production in the Republic Macedonia is enough for its consumption needs.

Poultry products have an important role in daily human consumption. The basic element in poultry production is the rearing of quality parental flock. Rearing of a day-old chicks for egg production, which is a series of interrelated activities, is initial basis for vertically integrated processes of industrial production of eggs, in order to ultimately obtain a quality edible egg.

Egg industry worldwide is mostly based on the production of chicken eggs. But with population growth, in some countries, increasing emphasis is placed on the production of eggs from other birds (Moges *et al.*, 2010). In fact, eggs are the food that is widely used around the world, making it the egg industry significant segment of the global food industry (Holland *et al.*, 1989; Gleen *et al.*, 2002).

The use of eggs as food have been seen through different time periods, historical notes and records, and today is considered a significant segment of the daily diet (George *et al.*, 1995).

Average, most chicken's breeds can produce about 300 eggs per year. According to the genetic performance of hybrid hens reared in our country, the expected production of eggs for each hen reared for 365 days, should be about 300-310 eggs with excellent quality (Pavlovski *et al.*, 1994; Pavlovski *et al.*, 2004). The average weight of one egg should be 62.50 g.

Despite the fresh eggs, on the market of foodstuffs and raw materials for the food, there are other products like liquid egg or egg powder (Sim and Nakai, 1994; Prabakaran, 1998). It can be products containing whole egg and shell, or egg white and yolk together, or it can be produced as separate products (for example liquid yolk). The chemical composition of these products is different from that of fresh eggs in shell because of the specific technological procedures for its receiving.

Actually not only eggs as a food product, but also a large number of foodstuffs in which composed have eggs due to their beneficial properties and functions are an important segment in daily human consumption. Eggs are the only complete food intended for human use. Because of it, egg is a raw material used to prepare the most common, most respected, and often the highest-valued meals and various types of food products (Fellows and Axel, 1993; Stadelman and Cotterill, 1995).

Macedonian poultry industry meets the needs of the domestic market of eggs, but the profitability of the sector is not satisfactory because of weak regulation of fluctuations in market prices of eggs.

The aim of this research was to determine the differences of some quantity properties of eggs from hens reared in two farming methods: battery cages system and free range system of rearing.

Materials and methods

For the purposes of this research, as a material for work were used eggs obtained from hens reared in free range system and eggs from hens reared in battery cages system. Farm equipped with battery cage system was in the village Kuchkovo near the city of Skopje and the farm with indoor/floor rearing system was located in the village of Marino near the city of Skopje. Total 200 eggs were analyzed or a 100 eggs separately from both ways of hens rearing. The research was done in 2016. The parameters like eggshell strength, mass of whole eggs, egg yolk color and number of haugh units were analyzed.

The analyses of the qualitative properties of eggs were carried out in the Laboratory for control of egg marketing quality in the Institute of Animal Biotechnology at the Faculty of Agricultural Sciences and Food.

Eggshell strength measuring

The eggshell strength was determined using an automated measuring device (Eggshell Force Gauge), which carried out impartially breaking and grading. In general, the Eggshell Force Gauge measures the force in using force pressure dynamometer that measures the force in kilograms or grams per cm².

Egg mass, yolk color and Haugh units measuring

This parameters were determined using the apparatus for automatically determining the internal quality of eggs (Egg multi tester EMT 5200, Robotmation Co. Ltd., Tokyo, Japan). Egg mass is measured on scale (installed on the machine) measuring on 2 decimals of g, albumen height is measured digitally in millimeters; yolk color is measured on the base of

reflection photometer basis and express on a scale units based on Roche Color Fan Leader (1-15) for expressing the intensity of yolk color and haugh units are calculated automatically by the machine software based on the formula:

$$HU = 100 \log_{10} (h - 1.7W^{0.37} + 7.6)$$

$$HU = 100 \log_{10} (h - 1.7 W^{0.37} + 7.56),$$

where HU = Haugh unit; h = height of the albumen (mm), and W = egg weight (g)

Statistical analysis

Presented data were statistic analyzed with independent samples test (t-test) using SPSS program.

Results and Discussion

The properties eggshell strength, mass, yolk color and haugh units are key indicators of the overall eggs quality. Most often, the eggshell strength shows depending on the mass of eggs, and yolk color associated with hen's nutrition, i.e. how hens are reared (George *et al.*, 1995; Nys, 2000).

Table 1. Minimal and maximal values for analyzed properties of the eggs from both rearing systems of laying hens.

Property	Eggshell strength (g/cm ²)		Egg mass (g)		Yolk color		Haugh units	
	min	Max	min	max	min	max	min	max
Method of rearing								
Free range system	1.89	5.34	43.40	72.20	8.40	15.90	37.00	97.50
Battery cages system	1.30	5.40	45.50	62.40	11.00	15.90	42.50	100.50

External features of the eggs have a significant impact on the perception by consumers, and based on it are offering opinions for the quality of eggs. On preserving and maintaining the quality characteristics of eggs, major role has the type of packaging they come on the market and the way of transport and storage (Sacharow and Griffin, 1980; Crosby, 1981; Fellows and Axel, 1993).

Minimal and maximal values of the measured parameters

The eggshell strength from the eggs of free range reared hens has the minimal value of 1,89 g/cm²,

but its maximum value is 5,34 g/cm² compared to the eggs from the battery cages system of rearing hens where the minimum value for this property is 1,30 g/cm² and the maximum is 5,40 g/cm² (Table 1).

Clerici *et al.* (2006) found that the value for eggshell strength depended on the housing system of lying hens, and it is higher in cages system. On the other hand, Anderson *et al.* (2004) reported that in the past, the eggs have had weaker shell which values depended on many factors.

The minimal mass of eggs from free range system of rearing hens is 43,40 g and the maximal is 72,20 g. The eggs getting from hens of battery cages system have higher minimum value

for the mass (45,40 g) and lower maximum value (62,40 g) compared to the mass of eggs from free ranged hens.

Table 2. Average values for analyzed properties of the eggs from both laying hens rearing systems.

Property Method of rearing	Eggshell strength (g/cm ²)	Egg mass (g)	Yolk color	Haugh units
Free range system	3.68	59.85	12.50	60.12
Battery cages system	3.91	55.54	13.44	74.10
Average value for both systems of rearing	3.80	57.70	12.97	67.11

The yolk color has the minimal value of 8,40 in the free range system and 11,00 in the battery cages system of hens rearing. The maximal value for this property is 15,90 in both of rearing systems.

has the minimum value of 37,00 and the maximum value is 97,50. On the other hand, eggs from battery cages system of rearing hens are characterized with minimal value for Haugh units of 42,50 but the maximal one is 100,50.

The Haugh units in the eggs from free ranged hens

Table 3. New system for egg classification according the mass.

Egg mass	European Union mark	Macedonian mark
> 73 g	Extra Large (XL)	Extra Large
73 - 63 g	Large (L)	Large
63 - 53 g	Medium (M)	Medium
< 53 g	Small (S)	Small

Comparison of obtained results between two methods of hens rearing

The eggs getting from battery cages system of rearing hens are characterized with higher eggshell strength (3.91 g/cm²) compared to analyzed eggs from free ranged hens (3.68 g/cm²) (Table 2). Values for the mass of whole eggs are inversely with values for the eggshell strength at both methods of hens rearing. Namely, the average mass of eggs from free ranged hens is 59.85 g, but the egg from caged hens has the average mass of 55.54 g. According to that, the lower average mass of these eggs results with higher value for the eggshell strength.

According to the new classification based on egg mass, compliance to Macedonian marks, as an extra large eggs are market those with higher mass of 73 g, but as a small eggs are marked those with lower mass of 53 g (Table 3).

According to Kocevski *et al.*, (2015), it was noticed that eggs in L and XL weight classes were mixed with eggs weighting less than the minimum weight for these classes, or more precisely in L class eggs several pieces of M weight class were notified and in XL weight class some percent of L class eggs were monitored.

Table 4. Statistical analysis (t-test).

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Eggshell strength	8,948	,003	(1,856)	198	,065	(,22324)	,12025	(,46038)	,01390
			(1,856)	180,800	,065	(,22324)	,12025	(,46052)	,01404
Mass of whole eggs	6,414	,012	6,839	198	,000	4,31300	,63063	3,06938	5,55662
			6,839	178,481	,000	4,31300	,63063	3,06854	5,55746
Egg yolk color	11,834	,001	(6,567)	198	,000	(,94100)	,14330	(1,22359)	(,65841)
			(6,567)	170,800	,000	(,94100)	,14330	(1,22387)	(,65813)
Haugh Units	1,795	,182	(6,767)	198	,000	(10,25300)	1,51513	(13,24086)	(7,26514)
			(6,767)	194,786	,000	(10,25300)	1,51513	(13,24116)	(7,26484)

The values for yolk color in the eggs form free range system of rearing hens is 12.50 compared to the eggs from battery cages system of rearing hens (13,44). The higher value for this property in the eggs from battery cages system is a result of adding different kinds of colored pigments in the blend feeding of hens.

Analyzed eggs form caged hens are characterized with higher haugh units value (74.10) compared to the analyzed eggs form free ranged hens (60.12), wherein the higher Haugh units value is indicator for better egg quality.

Belayavin and Wells (1987) found that the eggs obtained from hens which are rearing in controlled conditions have better quality properties.

Results of the statistical analysis

From Table 4, there is no significantly difference for the property eggshell strength between the eggs from cage system and the eggs from free range system of hens rearing. On the other hand, can be seen that there is significantly differences for the property egg mass between eggs from caged and free ranged laying hens ($t_{178.481} = 6.839; p < 0.05$). The eggs from free range system have higher average mass for 5.55 g compared to the eggs from cages system. For the property yolk color, there is significantly differences between eggs from caged and free ranged laying hens ($t_{170.800} = 6.567; p < 0.05$).

There is significantly differences between eggs form analyzed systems of hens lying for the parameter haugh Units, too ($t_{194.786} = 6.767; p < 0.05$).

Conclusion

It can be concluded that the eggs form battery cages rearing hens are characterized with higher eggshell strength, higher values for the yolk color as well as higher Haugh units that mean better overall quality. Simultaneously, controlled way of hens rearing in battery cages systems decreases the risk of getting unsafe eggs.

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