Effect of breed on some parameters of egg quality in laying hens

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The objective of this study was to compare some internal and external quality parameters of eggs between Oravka and Rhode Island Red laying hens. The flocks kept in National Agriculture and Food Centre – Research Institute of Animal Production Nitra (RIAP Nitra) were involved in the experiment. The females of both breeds were of the same age (11 months, 5th month of lay). Eggs were collected during three days consecutively (10 eggs per breed and day) and were analysed in the laboratory of Department of Poultry Science and Small Animal Husbandry at the Faculty of Agrobiology and Food Resources of Slovak University of Agriculture in Nitra. There were 11 females in each group and a total of 30 eggs in each group were analysed. The females were housed in outdoor unheated roofed wooden chicken coop with free range available; fed standard feed ad libitum. The average egg weight was significantly ($P \leq 0.01$) affected by breed. Females of Oravka breed were of heavier eggs (60.96 ± 0.56 g) than females of Rhode Island Red (57.60 ± 0.76 g). The significant differences were also found in egg width and egg length, however, no significant differences were found in egg shape index. The egg shell thickness significantly differed ($P \leq 0.01$) between Oravka and Rhode Island Red (367.78 ± 3.12 μm vs. 379.33 ± 2.49 μm). The albumen weight was significantly higher in Oravka breed (34.96 ± 0.58 g) than in Rhode Island Red breed (32.78 ± 0.73 g). No statistical differences were found in the remaining albumen characteristics. However, the slight difference ($P \leq 0.10$) was found in Haugh Unit (71.46 ± 1.64 HU for Oravka vs. 74.45 ± 1.53 HU for Rhode Island Red). With yolk characteristics, yolk weight and yolk colour significantly differed ($P \leq 0.01$) between Oravka breed (19.93 ± 0.23 g and 10.60 ± 0.09 oHLR) and Rhode Island Red breed (18.61 ± 0.20 g and 11.10 ± 0.20 oHLR). No statistical differences were found in the remaining yolk characteristics, except for a slight difference ($P \leq 0.10$) in yolk index (42.14 ± 0.50 % for Oravka and 40.31 ± 1.00 % for Rhode Island Red).

Keywords: females, Oravka, Rhode Island Red, egg

1. Introduction

In general, the characteristics of egg quality have genetic basis. Egg quality is factor which contributes for better economy price of fertile and table eggs. Egg quality was defined by Stadelman (1977) as characteristics important for consumers. Economic success for a production flock is measured with total number of produced eggs (Monira et al., 2003). Egg quality is presented by its weight, percentage of eggshell, thickness and strength of eggshell.

Genetic differences in eggshell quality characteristics exist between species, and between breeds, strains and families within the lines (Buss and Guyer, 1982). Egg weight is very different between various lines and eggshell thickness is under great influence of line (Pandey et al., 1986). Genotype has direct influence on egg weight and eggshell characteristics. Many studies showed that hens with coloured feathers lay bigger eggs than hens with white feathers (Halaj and Grofík, 1994; Vits et al., 2005; Halaj and Golian, 2011).

Egg quality is composed of those characteristics of an egg that affect its acceptability by consumers; it is therefore important that attention is paid to the problems of preservation and marketing of eggs to maintain the quality. From the point of view of consumers, egg weight is the most important quality trait. Among many quality characteristics, external factors including cleanliness, freshness, egg weight and shell weight are important in consumer's acceptability of shell eggs (Song et al., 2000; Adeogun and Amole, 2004; Dudusola, 2010).

Internal quality of the egg begins to decline as soon as the egg is laid. The management and nutrition of the hen do play a role in internal egg quality, egg handling and storage practices do have a significant impact on the quality of the egg reaching the consumer (Gerber, 2012). The interior of hen´s egg consists of the yolk and white or albumen. Interior characteristics such as yolk index, Haugh Unit, and chemical composition are also important in egg product industry as the demand for

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liquid egg, frozen egg, egg powder and yolk oil increases (Scott and Silversides, 2001).

Eggshell colour has always received more attention from the consumer than it deserves. Eggshell colour does give an indication of the breeding history of the hen. White eggs are produced commercially by lines derived principally from the White Leghorn breed, whereas brown eggs are produced by hens derived from a number of dual-purpose breeds, including Barred Plymouth Rock, Rhode Island Red, Rhode Island White, Australorp, New Hampshire, Oravka, and others. These dual-purpose breeds were kept in farm flocks in the last century, and brown eggs have been perceived by the consumer to be more natural or healthy than white eggs (Scott and Silversides, 2000)

National Agriculture and Food Centre – Research Institute of Animal Production Nitra (RIAP Nitra) deals with question of conservation of poultry genetic resources Oravka and Rhode Island Red breed for many years.

Oravka and Rhode Island Red are dual-purpose breeds kept for eggs and meat production. Oravka is of yellowish-brown colour and of rectangular body frame. The live weight of adult females is 2.2 to 2.7 kg and of males is 2.8 to 3.3 kg. About 170 to 180 eggs per female and year are produced. The egg shell is brownish. The egg weight is 50–55 g (Hrnčár, 2008; Hrnčár et al., 2010).

Rhode Island Red was originally bred in Adamsville, a village which is part of Little Compton, Rhode Island. Animals have a rectangular and long or oblong body. They are a medium-heavy bird, with roosters weighing up to 3.5 kg and hens 2.5 kg. Birds lay medium to dark brown eggs. About 180 to 200 eggs per female and year are produced. The minimum hatching egg weight is 55–66 g (Weis and Hrnčár, 2009).

The objective of this study was to compare some internal and external quality parameters of eggs between Oravka and Rhode Island Red laying hens.

2. Material and methods

Eggs quality of two different breeds: Oravka (OR) and Rhode Island Red (RI) were measured. The females were kept in National Agriculture and Food Centre – Research Institute of Animal Production Nitra (RIAP Nitra); the females of both breeds were of the same age (11 months, 5th month of lay). Eggs were collected during three days consecutively (10 eggs in each breed and day). The eggs were analysed in the laboratory of Department of Poultry Science and Small Animal Husbandry at the Faculty of Agrobiology and Food Resources of Slovak University of Agriculture in Nitra. There were 11 females in each group and a total of 30 eggs from each group were analysed. The females were housed in outdoor unheated roofed wooden chicken coop with free range. They were fed

standard feed mixture for laying hens' *ad libitum* (Table 1) and had water by automatic drinking system available.

Egg weight was individually determined to 0.01g accuracy using a laboratory scale Owa Labor (VEB Wägetechnik Rapido, Germany). Egg length (along the longitudinal axis) and egg width (along the equatorial axis) were measured with a micrometer. Egg shape index was calculated as the ratio of egg width to egg length (%) by method of Anderson et al. (2004).

After the eggs were broken, egg shells were washed with water and dried in order to clean the remaining albumen. Following Andreson´s procedure, shell weight (with membrane) was measured using a laboratory scale Owa Labor (VEB Wägetechnik Rapido, Germany) and the percentage proportion of the shell in the egg was determined. Shell thickness (with membrane) was measured at the sharp poles, blunt poles and equatorial parts of each egg. Shell thickness was obtained from the average values of these three parts.

The albumen weight was calculated from the difference between the egg weight, and the yolk and shell weight. The percentage proportion of the albumen in the egg was also determined. Albumen index (%) was determined according to Alkan et al. (2010) on the basis of the ratio of the albumen height (mm) measurement taken with a micrometer to the average of width (mm) and length (mm) of this albumen with 0.01mm accuracy × 100. Individual Haugh Unit score (Haugh, 1937) was calculated using the egg weight and albumen height. The Haugh Unit values were calculated for individual egg using the Haugh equation (Monira et al., 2003):

$$HU = 100 \log (H - 1.7w^{0.37} + 7.6)$$

where:
HU – Haugh Unit
H – observed height of albumen in mm
w – weight of egg in g

Yolk weight with 0.01 g accuracy was determined using a laboratory scale Owa Labor (VEB Wägetechnik Rapido, Germany) and its percentage proportion was calculated. Yolk index (%) on the basis of the ratio of the yolk height (mm) to the yolk width (mm) was measured according to Funk (1948) using micrometer with 0.01 mm accuracy. Yolk colour was determined with La Roche scale.

The evaluated variables were submitted to analysis of variance (ANOVA) using Statistical Analysis System software package (SAS, 2009) and *t*-test to determine existence and level of statistical significant differences between examined factors.

$$y_i = \mu + B_i + e_i$$

where:
y_i –   characteristic of egg quality traits
μ –   intercept
B_i –   the effect of breed (i = OR and RI)
e_i –   random error (N, 0)

Table 1   Nutritional value of complete feed mixture for laying hens (NPL 2)

Nutritient	Unit	NPL 2
Crude protein	g kg⁻¹	min. 200.0
ME	MJ kg⁻¹	min. 11.7
Lysine	g kg⁻¹	min. 7.5
Methionine and Cysteine	g kg⁻¹	min. 6.0
– from that Methionine	g kg⁻¹	min. 3.5
Calcium	g kg⁻¹	min. 35.0
Phosphorus	g kg⁻¹	min. 5.0
Sodium	g kg⁻¹	min. 1.6
Manganese	mg kg⁻¹	min. 60.0
Iron	mg kg⁻¹	min. 40.0
Copper	mg kg⁻¹	min. 6.0
Zinc	mg kg⁻¹	min. 40.0
Vitamin A	i.u. kg⁻¹	min. 15 000
Vitamin D₃	i.u. kg⁻¹	min. 2 000

ME – metabolic energy

3. Results and discussion

Egg quality characteristics of chickens have been investigated in several studies (Scott and Silversides, 2000; Scott and Silversides, 2001; Roberts 2001; Monira et al., 2003; Anderson et al., 2004; Roberts, 2010; Kocevski et al., 2011; Cath et al., 2012).

The results of exterior egg quality characteristics of two different breeds of Oravka and Rhode Island Red laying hens are given in Table 2.

Egg weight is among the most important parameters not only for consumers, but for egg producers as well (Genchev, 2012). In our experiment, the average egg weight was significantly ($P \leq 0.01$) affected by the breed. The Oravka breed eggs were heavier (60.96 ± 0.56 g) than Rhode Island Red breed eggs (57.60 ± 0.76 g). Generally, Rhode Island Red eggs are heavier than Oravka eggs (Hanusová et al., 2011; Hanusová et al., 2012; Hanusová et al., 2013). In our experiment it was opposite. It depends on many factors, mainly genetic and feed effects. The similar egg weight in Rhode Island Red breed found Monira et al. (2003) i.e. 57.20 g.

The egg size is influenced by hen's breed, genetic factors, age of laying hen, season, climatic conditions, nutrition, egg account in series and individuality of laying hens. There were significant differences in egg weight and length between experimental breeds, but there were no significant differences in egg shape.

Egg shell quality in laying hens is influenced by a range of factors including strain of chicken, age of birds, nutrition including protein source, moult status, water quality, general stress, heat stress, disease, housing, production system, environmental contaminants and use of proprietary products. The most important quality traits of the egg shell are its strength and thickness. There were significant ($P \leq 0.01$) differences between the breeds for egg shell thickness. The egg shell thickness values in Oravka and Rhode Island Red (367.78 ± 3.12 μm and 379.33 ± 2.49 μm respectively) were somewhat higher in comparison to Monira et al. (2003) in Rhode Island Red and lower in Oravka in comparison to Hrnčár et al. (2013).

The results of interior egg quality characteristics of two different breeds Oravka and Rhode Island Red are given in Table 3.

The egg internal quality is influenced by factors such as egg storage, bird strain and age, induced moult, nutrition, ingestion of contaminants, disease.

Egg weight is genetically linked to all three of the major components: shell, albumen, and yolk. Washburn

Table 2   Exterior egg quality parameters in two different breeds

Parameter	Oravka (n = 30) $\overline{x} \pm s_{\overline{x}}$	Rhode Island Red (n = 30) $\overline{x} \pm s_{\overline{x}}$	Significance
Egg weight in g	60.96 ± 0.56	57.60 ± 0.76	***
Egg width in cm	4.32 ± 0.03	4.21 ± 0.02	***
Egg length in cm	5.72 ± 0.05	5.62 ± 0.03	*
Egg shape index in %	75.71 ± 0.90	74.96 ± 0.36	
Shell weight in g	6.07 ± 0.04	6.21 ± 0.06	*
Shell percentage in %	9.98 ± 0.10	10.83 ± 0.16	***
Shell thickness in μm	367.78 ± 3.12	379.33 ± 2.95	***

* $P \leq 0.10$, ** $P \leq 0.05$, *** $P \leq 0.01$
n – number of analysed eggs, $\overline{x}$ – average, $s_{\overline{x}}$ – standard error

Table 3   Interior egg quality parameters in two different breeds

Parameter	Oravka (*n* = 30) $\overline{x} \pm s_{\overline{x}}$	Rhode Island Red (*n* = 30) $\overline{x} \pm s_{\overline{x}}$	Significance
Albumen weight in g	34.96 ± 0.58	32.78 ± 0.73	**
Albumen percentage in %	57.26 ± 0.52	56.74 ± 0.59	
Albumen index in %	68.74 ± 2.69	72.32 ± 3.00	
Albumen height in mm	54.67 ± 2.02	56.67 ± 2.05	
Albumen width in mm	79.81 ± 0.73	79.15 ± 1.16	
Haugh Unit (HU)	71.46 ± 1.64	74.45 ± 1.53	*
Yolk weight in g	19.93 ± 0.23	18.61 ± 0.20	***
Yolk percentage in %	32.76 ± 0.48	32.43 ± 0.48	
Yolk height in mm	17.63 ± 0.17	16.97 ± 0.43	
Yolk width in mm	41.90 ± 0.26	42.10 ± 0.28	
Yolk index in %	42.14 ± 0.50	40.31 ± 1.00	*
Yolk colour (°HLR)	10.60 ± 0.09	11.10 ± 0.20	***

* $P \leq 0.10$, ** $P \leq 0.05$, *** $P \leq 0.01$

n – number of analysed eggs, $\overline{x}$ – average, $s_{\overline{x}}$ – standard error

(1990) showed that the link between egg weight and albumen weight is higher than those between egg weight and shell or yolk weight. Fletcher et al. (1981) and Fletcher et al. (1983) showed that as egg size increases, so does the percentage of albumen.

The albumen weight was significantly higher in Oravka breed (34.96 ± 0.58 g) as compared to Rhode Island Red breed (32.78 ± 0.73 g) ($P \leq 0.05$). Albumen height and Haugh Unit measure the viscosity of the thick albumen. The Haugh Unit in Oravka breed were lower (71.46 ± 1.64 HU) than in Rhode Island Red breed (74.45 ± 1.53 HU), ($P \leq 0.10$). Hrnčár et al. (2013) found the similar Haugh Unit in fresh Oravka eggs. Monira et al. (2003) found lower Haugh Unit for fresh Rhode Island Red eggs as compared to our experiment. No statistical differences were found in remaining albumen characteristics.

From yolk characteristics of eggs, the breed significantly affected yolk weight ($P \leq 0.01$) and yolk index ($P \leq 0.10$). Yolk index values in Oravka and Rhode Island Red were 42.14 ± 0.50 % and 40.31 ± 1.00 %, respectively. The yolk colour was also affected by the breed. The Rhode Island Red breed had darker yolk colour than Oravka ($P \leq 0.01$).

4.   Conclusions

According to the results of experiment we can conclude statistically significant differences in external and internal egg quality between the different dual purpose laying hens of Oravka and Rhode Island Red breed. The Oravka breed eggs were heavier than eggs of Rhode Island Red breed. The differences were found for egg, shell, albumen and yolk weights. The albumen weight was higher in Oravka breed compared with Rhode Island Red breed.

The Haugh Unit in Oravka was lower than in Rhode Island Red. Oravka had a little higher yolk index values than Rhode Island Red. The yolk colour was affected by the breed too. The Rhode Island Red laying hens were of darker yolk colour than those of Oravka.

5.   Acknowledgement

6.   References

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