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EFFECT OF GENOTYPE ON EGG QUALITY CHARACTERISTICS OF JAPANESE QUAIL (*COTURNIX JAPONICA*)

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ABSTRACT

A research was carried out to determine effect of different genotypes of Japanese quail (*Coturnix japonica*) in genetic resource on external and internal egg quality parameters. The birds were housed as 1 male and 3 females per cage of 0.12 m^2 area at Animal Production Research Centre Nitra and fed with a mixture of 9.0 MJ ME and 145.0 g of crude protein during the experiment. Feed and water were given *ad libitum*. Analysis of external and internal characteristics of Japanese quail eggs was performed in the laboratory of the Department of Poultry Science and Small Animal Husbandry at the Faculty of Agrobiology and Food Resources of the Slovak University of Agriculture in Nitra. This research was conducted to investigate the effects of genotype on egg weight, egg length, egg width, egg shape index, shell weight, percentage of shell, shell thickness, shell strength, albumen weight, percentage of albumen height, albumen width, albumen length, albumen index, Haugh unit, yolk weight, percentage of yolk, yolk height, yolk width, yolk index and yolk colour. We have found significantly higher values for meat type in terms of all egg parameters ($P \leq 0.05$). In case of shell parameters, we observed significant ($P \leq 0.05$) difference between genotypes only in shell weight in benefit of the meat type and significant ($P \leq 0.05$) higher value in shell strength for laying type. There were significant ($P \leq 0.05$) differences found between the genotypes in points of albumen height and albumen index for laying Japanese quail. The significant ($P < 0.05$) difference in benefit of the meat type was found in yolk weight, yolk percentage, yolk height and yolk index. For all other characteristics no significant differences in egg quality between the laying and the meat type of Japanese quail were observed.

Key words: Japanese quail; egg; external quality; internal quality

INTRODUCTION

The Japanese quail, *Coturnix japonica* is known to have been domesticated since the 12th century AD in Japan, mainly for its ability to sing. Intensive production of the species started in Japan in the 1920s. The first egg lines were then developed by selection. They were successfully introduced from Japan to America, Europe and Middle East between the 1930s and 1950s, where specific lines were bred for egg and meat production (Ashok and Prabakaran, 2012). Extensive research on *Coturnix japonica* has showed that it was a valuable animal for avian research (Baumgartner *et al*., 2007; Jung *et al*., 2009).

A Japanese quail, the smallest farmed avian species (Panda and Singh, 1990), is becoming popular in commercial poultry sector for meat and egg production. Distinct include rapid growth – enabling quail to be marketed for consumption at 5-6 wks of age, early sexual maturity - resulting in short generation interval, high rate of egg laying and much lower feed and space requirements than domestic fowl. The Japanese quail is a bird with a high production potential which can lay up to 350 eggs of 10-12 grams each, which means 20 times her body weight.

Egg quality has been defined as the characteristics of an egg that affect its acceptability by the consumers. Egg quality is the more important price contributing factor in table and hatching eggs. Therefore, the economic success of a laying flock solely depends on

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the total number of quality eggs produced (Monira *et al.*, 2003).

Egg quality is composed of those characteristics of an egg that affects its acceptability to consumers, it is therefore important that attention is paid to the problems of preservation and marketing of eggs to maintain the quality. 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). On the other hand, interior characteristics such as yolk index, Haugh unit, and chemical composition are also important in egg product industry as the demand for liquid egg, frozen egg, egg powder and yolk oil increases (Scott and Silversides, 2001).

The most studies of egg production in quail was in laying type of Japanese quails (Garcia *et al*., 2000; Ribeiro *et al*., 2003; Murakami *et al*., 2006; Araujo *et al*., 2007; Murakami *et al*., 2007), whilst there are few studies on the egg production potential in meat type of Japanese quails (Mori *et al*., 2005; Barreto *et al*., 2007).

From the point of view of consumers, egg weight is the most essential quality trait. In Japanese quails, this trait is related to genetic structure of flock (Rajkumar *et al*., 2009), sexual maturity (Kumar *et al*., 2000), production type (Panda and Singh, 1990), nutrition (Güçlü *et al*., 2008), the stage of production cycle (Yanakopolous and Tserveni-Gousi, 1986, Silversides and Scott, 2001; Nowaczewski *et al*., 2010), housing density (Bhanja *et al*., 2006) and other. Another important exterior trait is the egg shell integrity.

According to the extent of its damage, eggs could be divided into three groups – with broken external and internal cracks. Egg shell integrity is important not only from economic point of view, but also with regard to human health safety (Genchev, 2012).

This study was designed to determine the effect of genotype on some internal and external quality characteristics of Japanese quail eggs.

MATERIAL AND METHODS

The study was performed in the laboratory of the Department of Poultry Science and Small Animal Husbandry at the Faculty of Agrobiology and Food Resources of Slovak University of Agriculture in Nitra. In the experiment we used the eggs laying type and meat type of Japanese quail obtained from the experimental farm at Animal Production Research Centre Nitra in Lužianky.

Interior and exterior parameters of eggs quality were evaluated at 20 weeks of age, within 24 h of collection. We analysed thirty eggs at each evaluation time. Throughout the study, 35 birds were maintained in normal environmental conditions and housed in the proportion 1 male/3 females per cage of 0.12 m^2 area. During the egg production period, Japanese quails were fed *ad libitum* commercial feed mixture HYD-10 for laying hens and quails (Tekro, Slovak Republic). Nutritional value of diets is shown in Table 1.

Table 1: Nutritional value of complete feed mixture HYD-10

Nutrient	Unit	HYD-10
Crude protein	g/kg	min. 145.0
ME	MJ/kg	min. 9.0
Lysine	g/kg	min. 5.0
Methionine and cistine	g/kg	min. 5.0
– from that methionine	g/kg	min. 2.0
Calcium	g/kg	min. 27.0
Phosphorus	g/kg	min. 4.0
Sodium	g/kg	min. 1.0
Manganese	mg/kg	min. 50.0
Iron	mg/kg	min. 70.0
Copper	mg/kg	min. 50.0
Zinc	mg/kg	min. 40.0
Vitamin A	i.u./kg	min. 8000
Vitamin D_3	i.u./kg	min. 1500

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 length (%) by the 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 this 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 egg shell strength was determined manually using an Egg Crusher device (VEIT Electronics, Czech Republic).

The albumen weight was calculated from the difference between the egg weight, and the yolk and shell weight and the percentage proportion of the albumen in the egg was determined. Albumen index (%) was determined by the method of Alkan *et al.* (2010) on the basis of the ratio of the thick albumen height (mm) measurement taken with a micrometer to the average of width (mm) and length (mm) of this albumen with 0.01mm accuracy. Haugh unit was calculated according to the procedure of Haugh (1937).

Yolk weight with 0.01 g accuracy was determined using the laboratory scale Owa Labor (VEB Wägetechnik Rapido, Germany) and its percentage proportion was calculated.

Yolk index (%) was measured on the basis of the ratio of the yolk height (mm) to the yolk width (mm) by the method of Funk (1948) using micrometer with 0.01mm accuracy.

Yolk colour was determined with the scale of Hoffman La Roche (Hoffman–La Roche, Switzerland).

The evaluated variables were submitted to analysis of variance using Statistical Analysis System software package (SAS, 2003). The significance of differences between the genotypes was tested by the Tukey's test at the levels of significance.

RESULTS AND DISCUSSION

Exterior and interior quality characteristics of eggs have also been investigated in several studies on quails (Yanakopolous and Tserveni-Gousi, 1986; Uluocak *et al*., 1995; Altan *et al*., 1998; Minvielle *et al*., 2002; Mignon-Grasteau and Minvielle, 2003; Bardakçıoğlu *et al*., 2005).

Egg weight is among the most important parameters not only for consumers, but for egg producers as well (Genchev, 2012). In our experiment, average egg weight was significantly ($P \leq 0.05$) affected by the quail type. The eggs meat type of Japanese quail weighed 13.06 g in average, similarly to that reported by Mori *et al*. (2005) and Santos *et al.* (2011). Whereas the eggs laying type of Japanese quail weighed 11.48 g in average, what is consistent with those obtained by Garcia *et al*. (2000), Kadam *et al*. (2006), Murakami *et al*. (2006), Oliveira *et al.* (2007) and Murakami *et al.* (2008). Our results correspond to the findings by Gonzales (1995). The egg shape index was significantly ($P \leq 0.05$) influenced by the genotype in benefit of meat type. In contrast, in the shell strength we found statistically significant value for laying type in comparison with meat type of Japanese quail.

Table 2: The mean values of the exterior egg quality parameters in Japanese quails

Parameter	Laying type	Meat type
Egg weight (g)	11.48 ± 1.72	13.06 ± 2.05^b
Egg width (mm)	25.71 ± 0.75	26.94 ± 0.77^b
Egg length (mm)	33.52 ± 1.89	34.46 ± 1.92^b
Egg shape index (%)	76.70 ± 0.67	78.18 ± 0.69^b
Shell weight (g)	1.02 ± 0.05	1.16 ± 0.07^b
Shell percentage (%)	8.88 ± 0.26	8.89 ± 0.25
Shell thickness (mm)	0.25 ± 0.11	0.23 ± 0.10
Shell strength (N.cm^{-2})	6.59 ± 1.35^a	6.46 ± 1.37

Values shown are mean ± SD (standard deviation)
a, b values in rows with no common superscripts differ significantly ($P<0.05$)

Table 3: The mean values of the interior egg quality parameters in Japanese quails

Parameter	Laying type	Meat type
Albumen weight (g)	6.75 ± 0.24	7.52 ± 0.31[b]
Albumen percentage (%)	58.78 ± 0.55	58.39 ± 0.52
Albumen length (mm)	50.14 ± 0.49	49.82 ± 0.44
Albumen height (mm)	4.82 ± 0.14[a]	4.16 ± 0.10
Albumen width (mm)	38.27 ± 0.61	38.31 ± 0.58
Albumen index (%)	10.12 ± 0.38[a]	9.45 ± 0.32
Haugh Unit	87.28 ± 0.49	87.56 ± 0.51
Yolk weight (g)	3.72 ± 0.11	4.28 ± 0.14[b]
Yolk percentage (%)	32.43 ± 0.48	35.84 ± 0.56[b]
Yolk height (mm)	11.19 ± 0.12	12.11 ± 0.14[b]
Yolk width (mm)	25.88 ± 0.15	26.41 ± 0.17
Yolk index (%)	43.22 ± 0.31	45.86 ± 0.28[b]
Yolk colour (°LR)	4.30 ± 0.84	4.40 ± 0.86

Values shown are mean ± SD (standard deviation)

a, b values in rows with different superscripts differ significantly (P<0.05)

Higher egg weight in the meat type of Japanese quail caused statistically (P≤0.05) higher egg shell weight. The most important quality traits of the egg shell are its strength and thickness. There were no significant (P>0.05) differences between the genotypes for egg shell thickness. The egg shell thickness values in this research (0.22 and 0.23 mm) were somewhat higher in comparison to Kostova *et al.* (1993), Gonzales (1995), Altan *et al*. (1998) and Orhan *et al.* (2001), who reported values from 0.19 to 0.22 mm. In case of shell strength we observed similar values (6.47, respectively 6.46 $N.cm^{-2}$). Compared to hens' eggs, those from quail had poorer shell quality, as judged by shell thickness and shape (Fletcher *et al*., 1983; Zita *et al.*, 2013).

Quail eggs have higher proportions of yolk than those from hens (Fletcher *et al*., 1983; Zita *et al*., 2013). From yolk characteristics of eggs, the genotype significantly (P≤0.05) affected yolk weight and yolk index for the meat type of quail. Yolk index values in this study (43.22, respectively 45.86 %) were in agreement with the data reported for yolk index in quail in the literature (Orhan *et al*., 2001; Erensaymn and Camci, 2002). The yolk colour was not affected by the genotype.

The significantly (P≤0.05) higher albumen index for laying Japanese quail was in accordance with albumen height differences. There was no significant (P>0.05) difference determined between the laying and meat type for the Haugh Unit. The Haugh Unit values in this study (87.28 and 87.56) were in agreement with the data reported in literature for Haugh Unit, such as 85.53-95.21 in quail (Altan *et al*., 1998; Türkmut *et al*., 1999). The higher the Haugh unit and yolk index, the more desirable is the interior quality of the egg (Adeogun and Amole, 2004). Quail eggs have lower proportions of albumen than those from hens (Fletcher *et al*., 1983; Zita *et al*., 2013).

CONCLUSION

According to the results obtained in this work we can conclude that for several parameters of the external and internal egg quality statistically significant differences between the laying and meat type of Japanese quail were observed. The most significant differences in benefit of the meat type were recorded for egg, shell, albumen and yolk weights and also for the ratio of each parts of the egg. In contrast, the laying type showed a better value of the egg strength and albumen parameters. The genotype along with nutrition, health, age, maintenance, storage condition of eggs and storage period can affect characteristics of egg quality.

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