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Original Paper

Egg traits in Japanese quails

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The objective of this study was to compare some internal and external egg quality traits between two meat lines of Japanese quail (*Coturnix japonica*). Line 8 was the result of selection for high adult live body mass (three generations). Line 9 was the control. Birds were housed in four-stage cage technology at the NAFC-Research Institute for Animal Production Nitra. Feed mixture contained 11.7 MJ ME and 200.0 g crude protein. Feed and water were given *ad libitum*. Females of both lines had the same age. Egg-laying traits were observed daily during 5-day period. Eggs were analysed in the laboratory of the Slovak University of Agriculture in Nitra. The egg weight was significantly higher ($P \leq 0.001$) in selected line 8: 13.259 g vs. 12.203 g. The egg shell weight, egg width, length and shape index were also higher ($P \leq 0.001$) in selected line 8. The shell thickness on egg sharp region differed significantly ($P \leq 0.01$) between lines 8 and 9. However, the difference in overall shell thickness was insignificant. Eggshell percentages were 9.128 and 9.200 % in lines 8 and 9. Significant differences (from $P \leq 0.001$ to $P \leq 0.05$) were found in yolk weight, yolk width, yolk height and yolk percentage. In general, selected line 8 was of higher yolk values, except for yolk percentage 29.358 % vs. 30.292 %. Significant differences in albumen weight ($P \leq 0.001$), albumen width ($P \leq 0.01$) and albumen height ($P \leq 0.05$) were found. There was no significant ($P > 0.05$) difference in Haugh Unit (89.297 vs. 88.893).

Keywords: Japanese quail; egg; external quality; internal quality

1 Introduction

Japanese quail (*Coturnix japonica*) is the smallest species of poultry, which it kept in captivity for its egg and meat value. Currently, the species is widespread not only in Asia (homeland), but also in Europe and America. Japanese quail is a suitable model object of long-term selectable trials designed to improve the performance of poultry, mainly because of short generation interval (incubation period is 16 to 17 days), early sexual maturity (at 35 to 42 days) and early laying (begins at age of 42 to 49 days). Sufficient genetic variability in populations is a prerequisite for further progress in genetic characteristics associated with utility and metabolic indicators. Saatci et al. (2006) determined genetic parameters for egg production and live weight at different ages. Maternal effect had a greater impact on the variability of indicators of egg production than direct genetic effect. Research in meat is focused on development and stabilization by means of genetically determined growth, morphometric and metabolic indicators. Selection process is set to growth intensity in order to create hard types with a minimal adult live weight of 250 g.

Egg quality has been defined as egg characteristics that affect its acceptability by consumers (Stadelman, 1977). Egg quality is the most important price contributing factor in table and hatching eggs. The characteristics of egg quality have genetic basis. Economic success for a production flock is measured with total number of produced eggs (Monira et al., 2003). Egg quality is presented by egg weight, eggshell percentage, thickness and strength. Genetic differences in egg quality characteristics exist between species and between breeds, strains and families within the lines (Buss, 1982). Egg weight differs among 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. As egg quality affects acceptability by consumers; it is important that attention is paid to the problems of preservation and marketing of eggs. From the consumer view, egg weight is the most important quality trait. Among other characteristics, external factors including cleanliness, freshness, egg weight and eggshell weight are important in consumer's acceptability of shell eggs (Song et al., 2000; Adeogun and Amole, 2004;

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Dudusola, 2010). Effects of eggshell colour, spot colour and spottiness on internal and external egg quality were analysed by Alasahan et al. (2015). According to the authors, eggshell colour and spot colour in quail eggs were significantly affected by egg quality characteristics like eggshell percentage, shell index, albumen index, yolk index and Haugh Unit.

Internal quality of the egg begins to decline as soon as the egg is laid. The management and nutrition of the quail female do play a role in internal egg quality; egg handling and storage practices do have a significant impact on quality of eggs reaching the consumer (Gerber, 2012). The interior of eggs consists of the yolk and albumen. Interior characteristics such as yolk index, Haugh Unit and chemical composition are important in egg product industry as the demand for liquid egg, frozen egg, egg powder and yolk oil increases (Scott and Silversides, 2001).The effect of age on the egg quality of Japanese quail was investigated by Zita et al. (2013). Egg quality traits were significantly affected by the age of females, with exception of egg shape index and yolk colour. Effect of genotype on egg quality characteristics of Japanese quail was analysed by Hrnčár et al. (2014). The authors found significantly higher values for meat type in terms of all egg parameters ($P \leq 0.05$) when comparing with laying type. Eggshell integrity is important not only from economic point of view, but also with regard to human health safety (Genchev, 2012).

The objective of this study was to compare some internal and external quality traits of eggs between two meat lines of Japanese quail (*Coturnix japonica*).

2 Material and methods

Eggs quality traits of Japanese quail were investigated in birds housed in four-stage cage technology (proportion 1 male and 3 females per cage of 315 cm^2 per animal) in the NAFC – Research Institute for Animal Production Nitra; the females of both lines were of the same age (25 weeks). Feed mixture contained 11.7 MJ ME and 200.0 g crude protein (Table 1). Feed and water were given *ad libitum*. The design consisted of two meat lines of Japanese quail. Line 8 was the result of selection for high adult live body mass (three generations). Line 9 was the control. Egg-laying traits (interior and exterior) were analysed daily during 5-day period. Analyses were done in the laboratory of the Department of Poultry Science and Small Animal Husbandry (Slovak University of Agriculture in Nitra). A total, 130 and 117 eggs in lines 8 and 9 were analysed. Handling, egg storage conditions and storage period were the same in both lines.

Egg weight was individually determined to 0.01 g 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 calculated. 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 as the difference between the egg weight, and the yolk and shell weight. The percentage proportion of the albumen in the egg was calculated. 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 as follows (Monira et al., 2003):

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

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 (%) calculated 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 0.01mm accuracy. Yolk colour was determined with La Roche scale.
Statistical analysis (basic statistics and comparison of differences between two meat lines of Japanese quail was done using T-Test procedure in SAS (SAS Institute Inc., 2009).

Table 1 Nutritional value of complete feed mixture for Japanese quails

Nutrients	Unit	NPL 2 (min.)
Crude protein	G kg^{-1}	200.0
Metabolic energy	MJ kg^{-1}	11.7
Lysine	g kg^{-1}	7.5
Methionine and Cysteine	g kg^{-1}	6.0
– from that Methionine	g kg^{-1}	3.5
Calcium	g kg^{-1}	35.0
Phosphorus	g kg^{-1}	5.0
Sodium	g kg^{-1}	1.6
Manganese	mg kg^{-1}	60.0
Iron	mg kg^{-1}	40.0
Copper	mg kg^{-1}	6.0
Zinc	mg kg^{-1}	40.0
Vitamin A	i.u. per kg	15 000
Vitamin D_3	i.u. per kg	2 000

3 Results and discussion

External egg quality traits in two different meat lines of Japanese quail are given in Table 2. Egg weight is among the most important parameters not only for consumers, but also for egg producers (Genchev, 2012). In this study, the egg weight was significantly higher in selected line 8 ($P \leq 0.001$). The eggs in this line weighed 13.259 ±0.097 g, similar to those reported by Mori et al. (2005), Santos et al. (2011) and Zita et al. (2013) in meat lines of Japanese quail. The egg weight of control line was 12.203 ±0.119 g, similar to that reported by Alasahan et al. (2015).

Higher egg weight in selected line 8 resulted in statistically ($P \leq 0.001$) higher egg shell weight. The egg width, length and shape index were also significantly ($P \leq 0.001$) higher in selected line 8. The shell thickness on sharp region of egg differed significantly ($P \leq 0.01$) between lines 8 and 9. However, the difference in overall shell thickness was insignificant. The egg shell thickness values 257.2 and 258.6 µm in lines 8 and 9 were somewhat higher in comparison to findings of Kostova et al. (1993), Gonzales (1995), Altan et al. (1998), Orhan et al. (2001) and Zita et al. 2013 who reported values from 181 to 220 µm. Eggshell percentages were 9.128 and 9.200 % in lines 8 and 9 i.e. lower than Taha (2011), Sari et al. (2012) and Zita et al (2013) reported. Alasahan et al. (2015) and Hrnčár et al. (2014) also found lower egg shell percentages (8.74 and 8.89 %).

Internal quality traits are given in Table 3. Japanese quail eggs have higher proportions of yolk than chicken eggs (Fletcher et al., 1983; Zita et al., 2013, Hanusová et al., 2013). Significant differences between lines 8 and 9 were found in yolk weight, yolk width ($P \leq 0.001$) yolk high ($P \leq 0.01$) and yolk percentage ($P \leq 0.05$). In general, selected line 8 was of higher yolk values, except for yolk percentage: 29.358 vs. 30.292 %. Similar results were found by Nowaczewski et al. (2010) and Zita et al. (2013). Alasahan et al. (2015), Hrnčár et al. (2014), Sari et al. (2012) and Taha (2011) found higher yolk percentages in Japanese quail. Yolk index values in this study (43.22 and 45.86 %) were in agreement with data reported for yolk index in quail (Orhan et al., 2001; Erensaymn and Camci, 2002).

The yolk colour was not affected by line. The significant differences in albumen weight ($P \leq 0.001$), albumen width ($P \leq 0.01$) and albumen height ($P \leq 0.05$) were found between lines 8 and 9. The higher Haugh unit and yolk index, the more desirable egg interior quality (Adeogun and Amole, 2004). Nevertheless, these authors found no significant ($P > 0.05$) difference in Haugh Unit between laying and meat types. Haugh Unit values were found 89.297 and 88.893 in lines 8 and 9. This agreed with values (85.53 to 95.21) reported in literature (Altan et al., 1998; Türkmut et al., 1999; Nowaczewski et al. 2010; Taha, 2011; Sari et al., 2012; Hrnčár et al., 2014 and Alasahan et al., 2015). Zita et al. (2013) investigated the effect of age on the quail egg quality. Haugh Unit values in females old 20 to 25 weeks ranged from 85.98 to 87.13, whereas younger females (age of 13 weeks) had higher value of Haugh Unit (90.50). Quail eggs analysed in this study had higher proportions of albumen than those found by Sari et al. (2012), Zita et al. (2013), Hrnčár et al. (2014) and Alasahan et al. (2015).

Table 2 Exterior egg quality parameters in two different lines of Japanese quail

Parameter	Line 8 $\bar{x}\pm s_{\bar{x}}$ n = 130	Line 9 $\bar{x}\pm s_{\bar{x}}$ n = 117	Significance
Egg weight in g	13.259 ±0.097	12.203 ±0.119	+++
Egg width in cm	2.659 ±0.008	2.598 ±0.008	+++
Egg length in cm	3.487 ±0.016	3.317 ±0.019	+++
Egg shape index in cm	1.312 ±0.007	1.277 ±0.007	+++
Egg shape index (%)	76.451 ±0.388	78.575 ±0.420	+++
Shell weight in g	1.211 ±0.010	1.122 ±0.011	+++
Shell percentage (%)	9.128 ±0.022	9.200 ±0.036	-
Shell thickness – blunt region (µm)	252.500 ±1.461	251.800 ±1.505	-
Shell thickness – sharp region (µm)	263.300 ±1.550	269.100 ±1.573	++
Shell thickness–equatorial region (µm)	257.200 ±1.553	258.600 ±2.432	-
Average shell thickness (µm)	257.600 ±1.489	259.800 ±1.489	-

+ P ≤ 0.05 ++ P ≤ 0.01 +++ P ≤ 0.001 - not significant
n – number of analysed eggs, $\bar{x}$ – mean, $s_{\bar{x}}$ – standard error

Table 3 Interior egg quality parameters in two different lines of Japanese quail

Parameter	Line 8 $\bar{x}\pm s_{\bar{x}}$ n = 130	Line 9 $\bar{x}\pm s_{\bar{x}}$ n = 117	Significance
Albumen weight in g	8.157 ±0.070	7.379 ±0.090	+++
Albumen percentage (%)	61.475 ±0.434	60.643 ±0.557	-
Albumen height (mm)	4.669 ±0.064	4.462 ±0.070	+
Albumen width (mm)	40.723 ±0.178	40.000 ±0.194	++
Albumen index (%)	114.900 ±1.653	111.800 ±1.839	-
Haugh Unit	89.297 ±0.355	88.893 ±0.376	-
Yolk weight (g)	3.891 ±0. 042	3.684 ±0.040	+++
Yolk percentage (%)	29.358 ±0.258	30.292 ±0.281	+
Yolk height (mm)	14.962 ±0079	14.658 ±0.080	++
Yolk width (mm)	25.208 ±0.133	24.470 ±0.141	+++
Yolk index (%)	59.505 ±0.376	60.170 ±0.473	-
Yolk colour (LR)	6.585 ±0.090	6.658 ±0.092	-

+ P ≤ 0.05 ++ P ≤ 0.01 +++ P ≤ 0.001 - not significant
n – number of analysed eggs, $\bar{x}$ – mean, $s_{\bar{x}}$ – standard error

4 Conclusions

The analysis showed statistically significant differences in external and internal egg quality traits between different meat lines of Japanese quail. The selected line had heavier eggs than the control line. The significant differences were found in egg, shell, albumen and yolk weights. The albumin ratio showed better value in selected line. In contrast, the control line showed better values of shell and yolk ratios. Further research considering variation among individual females is needed.

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