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PHENOTYPIC CORRELATIONS BETWEEN THE EGG WEIGHT, SHAPE OF EGG, SHELL THICKNESS, WEIGHT LOSS AND HATCHLING WEIGHT OF TURKEYS

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ABSTRACT

Eggs of turkey layers from the North Caucasian bronze (NCB) breed were investigated. Incubation eggs were monitored on days 9 and 15 to establish embryonic mortality rates. By the 25th day of incubation, before moving the eggs in the incubator, they were weighed to determine the weight loss by this moment. Thirty eggs, from which normal turkey poults have hatched, were randomly selected. The weight and thickness of eggshells were determined, the hatchlings were weighed and their relative weight from the egg was calculated. A moderate positive correlation was established between the weight of incubated hatched eggs of turkeys at 34 and 46 weeks of age and eggshells weight ($r = 0.51$ and $r = 0.50$, respectively). Eggshell thickness was proportional to the whole egg weight – heavier eggs had thicker shells ($r = 0.34$; $p < 0.05$). A substantial positive effect of egg weight on the hatchling weight was established ($r = 0.77$; $r = 0.65$ at $p < 0.001$). The observed correlations between the shape of eggs and turkey egg weight, shell weight, shell thickness of hatched eggs, weight loss during incubation, were low and negative. A positive correlation ($r = 0.52$) was demonstrated between the weight and thickness of eggshells in eggs produced by 34-week-old and from 46-week-old turkeys ($r = 0.68$; $p < 0.001$). A negative correlation (to $r = -0.80$) existed between weight loss during incubation and the absolute and relative weight of the hatchling.

Key words: turkey eggs; correlation; shape index; shell weight; shell thickness; loss of weight; hatchling turkeys weight

INTRODUCTION

Efficient selection in poultry farming depends on the knowledge about the relationships between the different productive traits. It is acknowledged that the different parameters characterizing egg quality influence the quality of hatched chickens.

Different authors (Brunson and Godfrey, 1953; Wilson, 1991; Narushin's and Romanov, 2002) have demonstrated the effect of egg weight and eggshell thickness on the egg weight loss during the incubation and the size of the hatchling.

The weight of hatchlings usually ranges between 62-76 % of egg weight and correlates strongly with it (Wilson and Harms, 1988; Bondarenko, 1989; Halaj and Veterani, 1998). The minimum proportions of hatchlings from incubated eggs recommended by Islam *et al*. (2008) are 64-66 %.

In an experiment with turkeys, Reinhart and Moran (1979) reported that hatchlings comprised 60-67 % of incubated egg weight. In our previous studies on turkeys, the ratio between hatchling weight and incubation egg weight was from 65.59 % to 72.19 % (Hristakieva *et al.*, 2008). Shanawany (1987) has calculated that the hatchling weight increased by 0.59 g for each 1 g increase in egg weight.

Numerous authors (Pinchasov, 1991; Wilson, 1991; Shashina, 1995; Khurshid *et al*. 2003; Abiola *et al.* 2008; Egbeyale *et al*. 2011) reported a positive relationship between the weight of egg set and the weight of hatchlings. The relative weight at hatch is largely dependent on the egg weight. In Japanese quails, Alkan *et al.* (2008) established a strong positive correlation between both traits ($r = 0.72$). Yamak *et al.* (2015), also reported a strong correlation ($r = 0.862$) between the egg

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weight and hatchling weight at $p < 0.01$.

Egg shape index is defined as the ratio between its width and its length. The importance of this parameter consists in the role of egg shape in the direction of turning during incubation and determination of embryo movements for nutrients utilization.

Previous studies (Ozcelik, 2002; Nowaczewski *et al.*, 2008; Yakubu *et al*., 2008 Kgwatalala *et al*. 2016) reported a weak correlation between the weight of eggs and egg shape index. Bernacki and Heller (2003) found strong positive correlation between the egg shape index and egg weight, suggesting that heavier egg were more rounded. The observed correlations between turkey egg shape index and egg weight were low and negative (Hristakieva, 2010).

According to Suk and Park (2001) and Ozcelik (2002), there was a positive relationship between the thickness and weight of his eggshell with whole egg weight. Harms *et al*. (1990) demonstrated that the eggshell weight and thickness was proportional (0.92-0.97) to the size of the whole egg. Both Zhang *et al*. (2005) and Wolanski *et al*. (2007) provided data about a strong correlation between eggshell weight and thickness. Sahan *et al*. (2003) found out a negative relationship ($r = -0.65$) between the eggshell thickness and the incubation egg weight loss in ostrich eggs. They reported the strongest weight loss of 13.03 % in eggs with the thinnest shells, while the respective values in shells of moderate and great thickness were 11.22 % and 10.36 %.

The aim of this research was to establish the relationships between the weight and the shape of incubation eggs, the weight and thickness of the eggshells, the weight loss during incubation and the weight of the hatchling in turkeys at 34- and 46-weeks of age.

MATERIAL AND METHODS

The study was carried out in the breeding turkey farm of the Selection, population genetics, reproduction and technologies of poultry and rabbits research department at the Agricultural Institute – Stara Zagora in 2016.

Eggs from turkey layers from the North Caucasian Bronze (NCB) breed were investigated. The birds were reared at the breeder farm on deep permanent litter at a population density of 3 birds.m^{-2}. They were fed a standard ration containing metabolizable energy – 12.55 MJ.kg^{-1}, crude protein – 18.10 %, calcium – 2.87 %, available phosphorus – 0.49 %. Average daily feed intake was 300 g. The turkey layers were artificially inseminated twice a week with 0.025 ml fresh semen, undiluted.

Incubation of eggs was done in "Optima" incubators. Every incubation egg was numbered and weighed. Monitoring for embryonic death was performed on days 9 and 15. By the 25th day of incubation, eggs were weighed before being moved to the incubator to determine incubation weight loss by the equation:

Egg weight loss during incubation to 25 d of incubation (%) = $(EW_1-EW_2)/EW_1*100$,

Where: EW_1- egg weight prior to the incubation;

EW_2- egg weight by the 25th day of incubation before moving to the hatch

Eggs were placed in special egg plates with partitions to determine the individual hatch of each of the poults. Randomly, 30 eggs from which normal viable birds have hatched, were selected. The eggshell weight and thickness were determined, hatchlings were weighed and their relative weight from the whole egg weight was calculated.

Table 1: Weight and shape of incubation eggs, eggshell weight and thickness, weight loss during incubation and hatchling weights for eggs of 34- and 46-week-old turkey layers (mean ± SD)

Parameters	Eggs of 34-week -old turkeys		Eggs of 46-week -old turkeys	
	x ± SD	Coefficient of variation (%)	x ± SD	Coefficient of variation (%)
Egg weight(g)	82.04 ± 0.760	5.10	84.22 ± 0.780	4.99
Shape index (%)	74.25 ± 0.490	3.65	71.57 ± 0.600	4.54
Shell weight (g)	6.73 ± 0.100	8.02	7.24 ± 0.080	6.21
Shell thickness (mm)	0.39 ± 0.005	5.13	0.38 ± 0.005	5.26
Egg weight loss during incubation at 25 d of incubation (%)	9.96 ± 0.250**	13.86	12.47 ± 0.420	17.96
Chicks weight (g)	55.93 ± 0.780	7.63	54.45 ± 0.740	7.34
Chicks weight (%)	68.16 ± 0.620*	4.94	64.59 ± 0.660	5.48

*$p < 0.05$; ** $p < 0.01$

The statistical analysis of data was performed with Excel 2003- ANOVA using the following statistical tests: Descriptive Statistics, t-Test: two-Sample Assuming Equal Variances, Correlation. The statisticall significance of correlation coefficients was determined using the Students'T criterion and the formula: $S_{rp} = 1\text{-}r_p^2/\sqrt{n-2}$; $T = r_p/S_{rp}$, where: r_p - correlation, S_{rp}- standart error of correlation (Zhelyazkov and Tsvetanova, 2002).

RESULTS AND DISCUSSION

Table 1 presents the average values of incubation eggs' weight and shape, the eggshell weight and thickness, weight loss during incubation and hatchlings' weight for turkeys aged 34 and 46 weeks. There were no statistically significant differences between turkeys at both studied ages with respect to egg weight and shape, shell weight and thickness, and hatchling weights. Higher percentage of weight loss during incubation – 12.47 % was exhibited by turkeys at 46 weeks of age compared to 9.96 % for eggs laid by younger turkeys. Hence, the relative hatchling weight was by 3.57 % lower in the eggs of 46-week-old birds. Robel (1981) and Soipes (1992) also reported differences in weight loss during incubation related to the age of layers. Coefficients of variation of egg weight and shape, shell weight and thickness for turkeys at 34 and 46 weeks of age were comparable to those reported by Oblakova (2005) for turkey eggs and by Kul and Seker (2004) in Japanese quail eggs. The highest coefficient of variation was observed for the egg weight loss during 25-day incubation – 17.96 % for eggs of 46-week-old birds and 13.86 % for eggs of 36-week--old layers.

Table 2 presents the calculated correlations between weight and shape of incubation eggs, eggshell weight and thickness, weight loss during incubation and hatchling weights for eggs of 34- and 46-week-old turkey layers. For both studied ages, the weight of incubation eggs correlated weakly and positively (r = 0.11 and r = 0.13)

Table 2: Correlations between weight and egg parameters

Parameters	Egg weight (g)	Shape index (%)	Shell weight (g)	Shell thickness (mm)	Egg weight loss to 25 d of incubation (%)	Chicks weight (g)	Chicks weight (%)
Egg weight (g)							
eggs of 34-week -old turkeys	-	0.13	0.51***	0.34*	-0.31	0.77***	0.14
eggs of 46-week -old turkeys	-	0.11	0.50***	0.34*	0.01	0.65***	-0.04
Shape index (%)							
eggs of 34-week -old turkeys	-	-	-0.14	-0.20	0.14	-0.01	0.12
eggs of 46-week -old turkeys	-	-	0.31	0.39*	-0.04	0.07	-0.08
Shell weight (g)							
eggs of 34-week -old turkeys	-	-	-	0.52***	0.38*	0.28	-0.09
eggs of 46-week -old turkeys	-	-	-	0.68***	0.16	0.17	-0.20
Shell thickness (mm)							
eggs of 34-week -old turkeys	-	-	-	-	-0.23	0.23	0.002
eggs of 46-week -old turkeys	-	-	-	-	-0.15	0.09	-0.17
Egg weight loss to 25 d (%)							
eggs of 34-week -old turkeys	-	-	-	-	-	-0.45***	-0.36
eggs of 46-week -old turkeys	-	-	-	-	-	-0.59***	-0.80***
Chicks weight (g)							
eggs of 34-week -old turkeys	-	-	-	-	-	-	0.74***
eggs of 46-week -old turkeys	-	-	-	-	-	-	0.73***
Chicks weight (%)							
eggs of 34-week -old turkeys	-	-	-	-	-	-	-
eggs of 46-week -old turkeys	-	-	-	-	-	-	-

*$p < 0.05$; ***$p < 0.01$

to egg shape. This is in line with our previous studies on the correlation between shape index and weight of eggs from three studied lines of turkeys (Hristakieva, 2010). The correlation between egg weight and shell weight was moderate to strong ($r = 0.50$ and $r = 0.51$) at $p < 0.001$. The investigations of Choi *et al.* (1983) and Oblakova (2006) provide evidence that the eggshell weight was positively influenced by the weight of the whole egg. The observed correlation coefficients among the other studied traits showed that the weight of incubation eggs and hatchling weight exhibited the strongest correlation $r = 0.65$ and $r = 0.77$ respectively, at $p < 0.001$. These results are comparable with those of other researchers (Abiola *et al*., 2008; Alkan *et al*., 2008; Egbeyale *et al*., 2011; Yamak *et al*., 2015).

A highly significant positive correlation as found out between the weight and thickness of investigated eggshells from layers at 34 weeks of age ($r = 0.52$ vs $r = 0.68$) in eggs from turkeys at 46 weeks of age. This is important for determination of eggshell strength in breeder eggs.

It should be noted that the weight loss during incubation (by the 25th day) correlated negatively (up to $r = -0.80$) with both absolute and relative hatchling weights, hence the lower the egg weight loss, the higher the hatchling weight.

A negative relationship was observed between egg weight loss during incubation and eggshell thickness in younger turkeys: $r = -0.23$ as compared to $r = -0.15$ in older birds. In ostrich eggs, these traits also correlated negatively (Sahan *et al.*, 2003).

CONCLUSION

Positive correlation was established between the weight of incubated hatched eggs of turkeys at 34 and 46 weeks of age and eggshells weight ($r = 0.51$ and $r = 0.50$, respectively). Eggshells thickness was proportional to the whole egg weight – heavier eggs had thicker shells ($r = 0.34$; $p < 0.05$). Substantial positive effect of egg weight on the hatchling weight was established ($r = 0.77$; $r = 0.65$ at $p < 0.001$). The observed correlations between the shape and weight of eggs, shell weight, shell thickness of hatched eggs and weight loss during incubation were low and negative. Positive correlation ($r = 0.52$) was demonstrated between the weight and thickness of eggshells in egg produced by 34 –week--old and 46-week- -old turkeys ($r = 0.68$; $p < 0.001$). Negative correlation (up to $r = -0.80$) existed between weight loss during incubation and absolute and relative weight of the hatchling.

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