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Relationship Between Pre-Incubation Egg Parameters from Old Breeder Hens, Egg Hatchability and Chick Weight

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Abstract: This experiment was carried out to determine the relationships between some of the physical parameters of the pre-hatched eggs and both chick weight and quality of old breeder hens. In this experiment, 450 hatching eggs obtained from 70 week old white Bovans layer parent stock were used. Three weight groups were formed, lightest being 55-60 g, medium being 61-65 g and heaviest being 66-70 g. Relationships between some of the physical parameters (weight, volume, density and shape index) of hatching eggs and chick weight and quality were investigated for each of the 3 weight groups. Correlations between chick weight and egg weight ($p<0.01$), egg volume ($p<0.01$) and egg density ($p<0.05$) were determined. Relationships between the shape index and chick weight and other physical egg parameters examined were not significant. Chick quality was not affected significantly by any of the physical egg parameters examined. Hatchability of fertile eggs for light, medium and heavy weight groups were 85.5, 86.0 and 83.4%, respectively, hatching yields were 82.7, 82.0 and 80.7%, respectively and fertility were 96.7, 95.3 and 96.7%, respectively. The effect of weight groups on hatchability of fertile eggs, hatch yield, fertility and early and late embryonic mortality was not significant.

Key words: Hatching eggs, physical egg parameters, chick weight, chick quality

INTRODUCTION

The productivity of a breeding operation can be measured by the number of quality eggs produced and the number of quality chicks obtained from these eggs.

The physical characteristics of the egg, the development stages of the embryo and satisfactory hatchability rate also play an important role in contributing to the outcome. Any defect in the physical specifications of an egg can have a negative effect on the healthy development of the embryo (Narushin and Romanov, 2002a). It was reported, by several researchers (Whiting and Pesti, 1983; Kirmizibayrak and Altinel, 2001) that egg size, egg weight and shape index have an important influence on overall hatchability. One of the easy ways to measure the physical characteristics of an egg is its weight. Egg weight has a direct impact on the weight of a chick and a positive correlation of 0.50-0.95 between egg and chick weights has been reported by various researchers (Kumar and Shingari, 1969; Pinchasov, 1991; Wilson, 1991). Narushin *et al.* (2002c) reported that egg weight has a higher impact on chick weight than the other physical characteristics.

Hatchery results are closely related to hatching egg weights and internal and external characteristics of hatching eggs (Smith, 2000). Tripathi *et al.* (1973) reported that egg weight had an insignificant impact on fertility and hatchery productivity. Narushin and Romanov (2002b) carried out a study on hatching eggs obtained from 3 separate flocks of layer breeder hens and reported that the hatchability of small fertile.

Eggs were higher than that of large eggs and consequently the lowest hatchability rates were obtained from large eggs. Although, Hagger *et al.* (1986) determined that the hatching yield differences among the 3 weight groups were not significant, the late embryonic mortality rate was higher with the large eggs.

Some researcher reported that while the hatching yield from very large eggs and the live weight of chicks hatched from small eggs and their survival rate was low (Asusquo and Okon, 1993; Smith, 2000). It was reported, that the hatching yield from medium sized poultry eggs was superior to the hatching yields of large and small eggs; the hatching yield of very large eggs and the weight and survival rate of chicks produced by very small eggs were poor (Asusquo and Okon, 1993; Smith, 2000). Smith (2000) reported that excessively large eggs hatch poorly, while small eggs hatch in too small, unthrifty chicks and recommended to incubate only average size eggs.

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This study is aimed to investigate the effect of some measurable physical parameters of hatching eggs on chick weight and quality in White Bovans old breeder hens in Turkey.

MATERIALS AND METHODS

The research material was 450 hatching eggs obtained from 70 weeks old White Bovans layer parent stock.

The hatching eggs were classified into three weight groups as low (55-60 g), medium (61-65 g) and heavy (66-70 g), by weighing with 0.01 g sensitivity level electronic scale (Precisa) and identified by the numbers at the day of collection.

Shape index, volume and the density of eggs were determined before being stored in the cold storage room for 4 days.

Shape index: The shape index of eggs was determined by the following formula:

$$\text{Egg shape index} = \left(\frac{\text{Short axis of egg}}{\text{Long axis of egg}}\right) \times 100$$

Egg volume: Egg volume was determined by immersing the eggs in a measuring cylinder filled with distilled water at the same temperature of eggs.

Egg density: The egg density was determined by the following formula:

$$\text{Egg density (g cm}^{-3}\text{)} = \frac{\text{Egg weight (g)}}{\text{Egg volume (cm}^3\text{)}}$$

Storage of eggs: The eggs were stored in 75% relative humidity at 14-16°C for 4 days before being placed into the incubator. After the storage and just before being placed into the incubator the eggs were fumigated with potassium permanganate-formalin mixture and pre-heated at 25°C for approximately 8 h.

Placing the eggs into the incubator: The eggs, which had been stored for 4 days in cold storage were placed into the incubator.

Transfer of eggs: After 18 days, the eggs were transferred from the incubator into the hatcher and each group of eggs was examined with a candling lamp for fertility and unfertile or abnormally developed eggs were removed. Eggs which had been removed at fertility control were broken onto a tray and identified for infertility or embryonic mortality. The fertile eggs were then placed one by one into the respectively numbered pouches made of wide meshed tulle large enough for the free movement of the chicks hatched and the openings of these pouches were stapled shut. The egg pouches were appropriately settled into the hatching tray and placed into the hatching machine.

Chick hatching: Hatching was completed on the 21st day. The chicks were carefully removed from the pouches and their weights were determined by using an electronic scale with a sensitivity of 0.01 g. Chick quality was determined by visual examination according to the criteria laid out by Tona *et al.* (2003). The relevant quality criteria consisted of the chick's activity level, dryness and cleanliness, absorption of the yolk sac, eyes (lively looks), legs (good posture, no redness and deformity), appearance of umbilical region (normal coloring, complete absorption of yolk sac), whether or not the chick carries any remaining membrane or yolk sac remnants. Eggs, which did not hatch were individually examined and separated and recorded according to late mortality or dead in shell.

Calculations and statistics:

$$\text{Hatching yield (\%)} = \left(\frac{\text{Number of chicks hatched}}{\text{Number of eggs placed in hatchery}}\right) \times 100$$

$$\text{Fertility rate (\%)} = \left(\frac{\text{Number of fertile eggs}}{\text{Number of eggs placed in hatchery}}\right) \times 100$$

$$\text{Hatchability (\%)} = \left(\frac{\text{Number of chicks hatched}}{\text{Number of fertile eggs placed in hatchery}}\right) \times 100$$

The statistical evaluations were carried out with Chi-square (χ^2), variance analysis and t-test, Duncan test was used to lay out the differences between the groups.

RESULTS AND DISCUSSION

The average weights, volume, density and shape indices of different weight groups are given in Table 1. Differences of egg weight and egg volume among the groups were significant ($p<0.001$).

Table 1: Average egg weight, volume, density, shape index values according to weight groups

	Groups					
	Light (55-60 g) n = 150		Medium (61-65 g) n = 150		Heavy (66-70 g) n = 150	
Characteristics	x	SEM	x	SEM	x	SEM
Egg weight (g)	57.95^{C}	0.100	62.76^{B}	0.110	67.15^{A}	0.120
Egg volume (cm^3)	55.67^{C}	0.170	59.83^{B}	0.130	63.96^{A}	0.160
Egg density (g cm^{-3})	1.04	0.002^{b}	1.05	0.002^{a}	1.05^{a}	0.002
Shape index (%)	77.28	0.210	77.18	0.500	76.29	0.210

^{a,b}: $p<0.01$; ^{A,B,C}: $p<0.001$; SEM: Standard Error of Mean

Table 2: Phenotypic correlations between various egg parameters and chick weight

Characteristics	Egg weight	Egg volume	Egg density	Egg shape index
Egg volume	0.95			
Egg density	0.11	-0.22		
Egg shape index	-0.70	-0.54	-0.48	
Chick weight	0.87	0.81	0.12	-0.24

Egg density was significantly lower for light weight group comparing to medium and heavy weight groups ($p<0.01$). The difference of egg density between medium and heavy weight groups was not significant. Shape index differences between the groups were not significant ($p>0.05$).

Phenotypic correlations between various physical egg parameters and chick weight are shown in Table 2. The highly significant ($p<0.01$) positive correlations were found between egg weight and egg volume (0.095), egg weight and chick weight (0.87), egg volume and chick weight (0.81), while some significant ($p<0.05$) positive correlation was found between egg weight and egg density (0.11), egg density and chick weight (0.12). Negative correlation between egg volume and egg density (-0.22) was found to be highly significant ($p<0.01$), while the negative correlations between egg weight and shape index (-0.70), egg volume and shape index (-0.54), egg density and shape index (-0.48) and shape index and chick weight (-0.24) were not significant.

Hatching parameters according to the egg weight groups are given in Table 3. No significant differences were found between the groups regarding fertility and infertility, early and late mortality, discarded and quality chicks, hatchability rate and hatch yield. However, the differences were not significant, the early embryonic mortality was highest (4.9%) in light weight group, while the late embryonic mortality was highest (12.1%) in heavy weight group. While no significant differences were observed between the groups regarding discarded and quality chick rate, higher ratio of quality chicks (97.6%) produced from medium weight eggs and higher ratio of discarded chicks (8.9%) produced from light weight eggs was noticeable.

In Table 4, the impact of egg weight, egg volume, egg density, egg shape index and chick weight on chick quality according to egg weight groups and none of the differences between egg weight groups were found to be statistically significant.

Physical parameters: In this research, we found that the significant correlations between chick weight and egg weight (0.87), egg volume (0.95) ($p<0.01$), egg density (0.12) ($p<0.05$). This result is supported by the findings of various researchers (Kumar and Shingari, 1969; Whiting and Pesti, 1983; Hagger *et al.*, 1986; Kirmizibayrak and Altinel, 2001; Esen and Ozcelik, 2002; Narushin and Romanov, 2002a, b). The study showed that egg weight had a more profound impact on chick weight than egg volume and the positive sided correlation found between egg weight, volume (0.50) and density (0.02) is similar to those reported by Narushin *et al.* (2002c). Pinchasov (1991) reported a positive correlation (0.89) between egg weight and hatching weight. Skewes *et al.* (1988) reported that the high (0.88) correlation between chick weight and egg weight in bobwhite quail. Saatci *et al.* (2005) reported a significant positive correlation (0.72) between egg weight and hatching weight in native Turkish geese. Same researchers reported that there was no relationship between shape index and egg weight and hatching weight. While the study revealed that shape index value was not important for hatching eggs, showed similarities with those findings of Esen and Ozcelik (2002) and Kumar and Shingari (1969), it was also in line with the findings of Poyraz (1989), who reported a negative correlation between egg weight and shape index (-0.85). Esen and Ozcelik (2002) carried out a study on quail eggs and reported that shape index value had no significance on the quality criteria of hatching eggs.

Hatching characteristics: Fertility and infertility ratio values among all weight groups in the study were similar. Early phase embryonic mortality rates in the weight groups were sequenced as 4.9, 3.4, 2.7%. Saar *et al.* (2002) reported that similar findings they were indicated a significant influence of the egg weight on the frequency of early embryonic mortality: small eggs have a higher early embryonic mortality than medium or large eggs. Late

Table 3: Hatchability parameters for egg weight groups

Characteristics		Egg weight groups: Light (55-60 g) (n = 150)	Medium (61-65g) (n = 150)	Heavy (66-70 g) (n = 150)	χ^2
Fertility rate	No. eggs	145.0	143.0	145.0	
	(%)	96.7	95.3	96.7	0.489
Infertile egg	No. eggs	5.0	7.0	5.0	
	(%)	3.3	4.7	3.3	
Early embryonic mortality	No. eggs	7.0	5.0	4.0	3.462
	(%)	4.9	3.4	2.7	
Late embryonic mortality	No. eggs	8.0	10.0	18.0	
	(%)	5.6	6.8	12.1	
Discarded chick	No. chicks	11.0	3.0	9.0	4.794
	(%)	8.9	2.4	7.4	
Quality chick	No. chicks	113.0	120.0	112.0	
	(%)	91.1	97.6	92.6	
Hatchability rate	(%)	85.5	86.0	83.4	0.419
Hatch yield	(%)	82.7	82.0	80.7	0.209

All differences between groups were insignificant

Table 4: Effect of various physical egg parameters on chick weight and chick quality

Characteristic		Egg weight groups: Light (55-60 g) (n = 150) x	SEM	p-value	Medium (61-65 g) (n = 150) x	SEM	p-value	Heavy (66-70 g) (n = 150) x	SEM	p-value
Egg weight (g)	Discarded	57.39	0.34	0.114	63.55	0.200	0.311	67.21	0.560	0.794
	Quality	58.04	0.12		62.73	0.130		67.07	0.140	
Egg volume (cm^3)	Discarded	55.36	0.54	0.654	61.00	0. 58	0.210	63.89	0.680	0.974
	Quality	55.67	0.21		58.81	0.150		63.87	0.190	
Egg density (g cm^{-3})	Discarded	1.04	0.01	0.421	1.04	0.010	0.621	1.05	0.006	0.941
	Quality	1.04	0.00		1.05	0.002		1.05	0.002	
Egg shape index (%)	Discarded	77.93	0.99	0.361	78.74	1.110	0.159	77.00	1.007	0.324
	Quality	77.17	0.24		77.41	0.610		76.16	0.230	
Chick weight (g)	Discarded	38.60	0.66	0.178	42.06	2.220	0.396	44.27	0.620	0.555
	Quality	37.94	0.14		41.18	0.160		43.75	0.170	

All differences between groups were insignificant

phase embryonic mortality rates of the groups were determined to sequence 5.6, 6.8 and 12.1%, with the highest value in the heavy weight group. In a similar study carried out by Hagger *et al.* (1986), heavy weight eggs had the highest late embryonic mortality rate. However, no significant differences were found to exist among the groups regarding early and late embryonic mortality rates. Hatchability rate was found to sequence as 85.5, 86.0 and 83.4% for the groups. The low hatchability rate can be contributed to the progressive 70 week age of the breeding flock. Although, the hatchability rates of medium sized eggs were numerically superior to those of large and small sized eggs, this bears no statistical significance. While the differences are insignificant the lowest hatchability rate which was determined for large eggs is in line with the reporting of various researchers (Asusquo and Okon, 1993; Smith, 2000; Narushin *et al.* 2002c). Again no significant statistical differences were determined among the groups regarding hatch yield. The insignificance of egg weight on fertility and hatch yield is similar to the findings of Tripathi *et al.* (1973).

Chick quality: The average egg weight and chick weight values determined in the study for the weight groups (light, medium, heavy) are 57.95 and 38.00 g; 62.76 and 41.20 g; 67.15 and 43.79 g, respectively. It is anticipated that light eggs produce small chicks and heavy eggs produce large sized chicks. The situation is similar to the findings reported by other researchers (Asusquo and Okon, 1993; Smith, 2000). Although, it bears no statistical significance, the fact that the average live weight of discarded chicks is higher than that of quality chicks can be attributed to the fact that the discarded chicks had not dried properly and their bodies were bloated.

CONCLUSION

As a result it was concluded that physical egg parameters such as weight, volume and density of eggs were most important factors affecting hatchability and chick weight, while shape index was an insignificant egg quality criteria parameter for hatching. Egg weight had a major impact on chick weight and although, light eggs produced smaller chicks and heavy eggs produced larger chicks, the impact of chick weight on chick quality was

not significant. Although, the difference between groups regarding rate of fertility, hatchability and hatch yield are close to the importance line, they were deemed to be insignificant. It is a reality that hatching progress and obtaining the healthy chicks are essential for poultry industry, therefore, it can be concluded that fertilized 55-70 g eggs with flawless interior and exterior traits should be used in the industry.

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