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Effect of egg weight of broiler breeder on egg characteristics and hatchery performance

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Abstract

The objective of this study was to determine the effects of egg weight on hatching egg characteristics, fertility and hatchability using a commercial Ross-308 broilers breeder. Three egg weight categories were selected for this trial based on the average egg weight determined from a sample of 100eggs. The egg weight categories were: small 52.62-55.65g, average 57.15-60.15g, and large 61.65-64.65g, average 57.15-60.15g, and large 61.65-64.65g. All eggs were individually weighed.. All eggs deemed to be non-viable were broken open to assess fertility and if fertile approximate day of embryonic mortality. On day 18 eggs were transferred to a 12960 egg capacity Games way Hatcher. At 487.5 hours of incubation, eggs were monitored every 5 hours to determine time of hatching. At 21.5 day of incubation, all chicks were removed from the Hatcher. Any non-hatched remaining were broken open to determined approximate day of embryonic morality, all data were analyzed using the General Linear Models procedure of SAS. Any percentage data were transformed prior to analysis using Arch-Sine transformations. Probability was assessed at $p<0.05$. Heavy eggs had a greater proportion of albumen than small and average eggs. Small eggs had a greater proportion of wet yolk than H eggs, but small eggs did not differ from average eggs in the proportions of wet yolk. No differences were found in egg ship index, fertility and hatchability between egg sixes. The percentage of egg weight loss at transfer decreased as egg size increased. Embryonic morality increased as egg weight increased.

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Introduction

Most of the energy needed for the embryonic development is taken from the fat stores of the yolk, the relative water content of the egg will increase during incubation unless water is lost because for every gram of fat burned an almost equal mass of metabolic water is generated (Rahn *et al.*, 1979). Egg weight loss during incubation is almost entirely due to water diffusion through the shell. Researchers indicated that incubation egg weight losses are a function of egg characteristics (shell structure, membrane structure, and initial egg weight) and interacting incubation conditions (temperature, humidity, and air velocity) (Christensen and Mccorkle, 1982). Studies revealed that the variation in chick weight at hatch is a function of egg weight loss. Under commercial conditions, eggs are produced by flocks of different ages but incubated under standard incubation conditions. Eggs laid by young hens, however, differ in eggshell quality and albumen from those produced by old hens (King'ori, 2011).
It has been suggested that the decrease in viability of the embryo may be caused by changes in the embryo or by changes in certain physical aspects of the egg (Becker, 1960).

It was showed that the breeder factors which affect hatchability include strain, health, nutrition and age of the flock, egg size, weight and quality, egg storage duration and conditions, egg sanitation, and season of the year (Tona *et al.*, 2007). Age of the breeders affects hatchability, because it is related to the quality of hatching egg such as the internal egg composition or ratio, egg weight, and shell quality, whereby the incubation condition and the development of the chick embryo are influenced (Joseph and Moran, 2005). There is a positive correlation between egg weight before incubation, hatch weight and subsequent performance in various kinds of birds (Wondmeneh *et al.*, 2011). Day old chicks weight is directly related to the hatchable egg size (Farooq *et al.*, 2001).

Researchers was studied various hybrids and they were indicated that the embryonic mortality in three weight groups of small, medium and big was different significantly (Rashid *et al.*, 2013). Another reports also (Alabi *et al.*, 2012- Çağlayan *et al.*, 2009) confirmed the correlation between egg size and embryonic mortality.

The objective of this study was to determine the effects of egg weight on hatching egg characteristics, fertility and hatchability using a commercial Ross 308 broilers breeder flock.

Materials and methods

Location of the research

This research was conducted in Uremia Zarrinpar hatching. The studied eggs were 308 commercial Ross broilers breeder flock with age 35 weeks and in their first cycle of production. The eggs were held for three days at 18 ^{oc} and humidity of 60-70%. It should be indicated that the percentage of weekly production was 84.4%.

Selection of the eggs

About four thousands eggs were prepared and among them 12 cartons were selected randomly and the broken and dirty, bloody, wrinkled, shapeless and white and etc were removed. The eggs with cracks and thin shells were separated. The room temperate was 19-20 ^{oc} and humidity was 60% and gird was conducted manually.

The mean weight of eggs were calculated and then the eggs were distributed in 3 groups (432 eggs, each group contains 144 eggs) each with 4 replicate (each replicate contains 36 eggs). Light weight eggs were 3-6 grams lighter than mean eggs weight, Average weight eggs were ±1.5 grams of mean egg weight and heavy weight eggs were 3-6 grams heavier than mean egg weight.

The selected eggs were fumigated in 25^{oc} with 70 percent humidity for 20 minutes, then the eggs were transferred into preheating room. Dependent on the age of egg according to the factory protocol the eggs were heated for 4-6 hours in the temperature of 25-26^{oc}. The aim was prevention of evaporation and

thermal and humidity shock. The systems used were hatching system of James-way model PT100 in several stages. The capacity of the each system is 7760 eggs with 6 fans, two heaters 3kw for heating and 4 nozzle fans for humidity and 12 racks carrying eggs. The eggs were moved one hour into right and left with angle of 45° with wind system. After 18 days incubation, the eggs were transferred to the hatching system with temperature of 37°C and humidity of 86.5%.

For comparison between groups, percent of fertile eggs, percent of egg weight loss, hatchability percent, mortality rate in early stage, middle stage and late stage, egg shape index, egg shell resistance and thickness, egg yolk index, wet weight of yolk and albumen were recorded.

Results

Egg weight effects on embryonic mortality

The influence of egg weight on embryonic mortality and the amount of weight lost during incubation is summarized in Table 1. As it is seen embryonic mortality of eggs during incubation in the studied eggs is significant ($p<0.05$).

Table 1. The effect of egg weight on embryonic mortality and the egg weight loss during incubation.

Groups	primary stage mortality	middle stage mortality	Late stage mortality	Egg weight loss (%)
Light weight	3.9450[ab*]	0.6725[a]	2.8450[a]	12.5625[a]
Average weight	2.9600[a]	0.6900[a]	3.6325[a]	12.1250[ab]
Heavy weight	4.6825[b]	0.6700[a]	6.3800[b]	11.6275[b]
Sig.	p<0.01	p>0.05	p<0.01	p<0.01

*Different letters indicate statistically difference between groups.

Egg weight effects on Egg Quality

Basically, egg quality is as an important factor in the poultry industry and it is economically important as the quality of the eggs and the reproductive system. According to the results that was indicated in table 2 regarding to the effect of egg weight on the yolk index it is observed that there is a significant difference in yolk index among the groups ($p<0.05$). It was showed there was not a significant difference in egg shape index in egg weight groups ($p>0.05$).

We observed significant differences in egg shell thickness among different egg weight groups according to table 2 ($p<0.01$) and it was showed by increase of weight and volume of the egg in age range the shell thickness is reduced.

Table 2. The effect of egg weight on the egg qualitative characteristics.

Groups	Yolk index	Egg Shape Index	Egg shell thickness
Light wt.	40.7175[a]	75.0325[a]	0.3225[a]
Average wt.	40.5025[a]	74.9975[a]	0.3200[a]
Heavy wt.	43.6175[b]	75.2500[a]	0.2850[b]
Sig.	p<0.01	p>0.05	p<0.01

*Different letters indicate statistically difference between groups.

In Table 3 some other egg quality parameters were studied. The wet weight of the eggshell, yolk and albumen in egg weight groups showed significant differences ($p <0.05$).

Effect of egg weight on fertility and hatchability

Effect of egg weight on fertility and hatchability is shown in Table 4. For the studied traits in this section there was no significant difference between egg weight groups ($p>0.05$).

Discussion

Egg weight is one of the most influential factors in hatchability (King'ori, 2011). The effect of egg weight on hatchability is an important economic trait in domestic fowl. There is a positive correlation between egg weight before incubation, hatch weight and subsequent performance in various kinds of birds (Wondmeneh *et al.*, 2011). Day old chicks weight is directly related to the hatchable egg size (Farooq *et al.*, 2001). Heritability of 55% in egg weight is considered as a determinant factor for the breeding farms to produce eggs. Researchers indicated that the hatch weight is usually in the range of 62 to 78 percent of the egg weight (Wilson, 1991).

Table 3. The effect of egg weight on some egg qualitative characteristics.

Groups	Eggshell resistance	Eggshell wet weight (%)	Yolk wet weight (%)	Albumen wet weight (%)
Light wt.	3.9850^{a}	31.1475^{a}	11.5825^{a}	57.2700^{ab}
Average wt.	3.8325^{a}	31.8575^{b}	11.3625^{a}	56.7800^{a}
Heavy wt.	2.6725^{b}	31.4650^{ab}	10.7275^{b}	57.8075^{b}
Sig.	p<0.05	p<0.05	p<0.05	p<0.05

The influence of egg weight on embryonic mortality and the amount of weight loss during incubation is summarized in Table 1. As it is indicated embryonic mortality of eggs during incubation in the studied eggs is significant (p<0.05). The findings of this study are consistent to the results of some researchers (Elibol and Brake, 2008- Rashid *et al.*, 2013- Tona *et al.*, 2004). Abdul Rashid and *et al* studied the Fayoumi and Desi hens and their hybrids and found that embryonic mortality in three weight groups of small, medium and big of these races has significant difference (Rashid *et al.*, 2013). Another reports also (Alabi *et al.*, 2012- Çağlayan *et al.*, 2009) has confirmed the correlation between egg size and embryonic mortality.

Table 4. The effect of egg weight on fertility and hatchability.

Groups	Hatching for total incubated eggs	Hatching (%)	Hatching for total fertile eggs (%)	Egg fertility (%)
Light wt.	83.3300	81.2800	83.7225	91.5000
Average wt.	84.0225	85.1625	86.3525	93.000
Heavy wt.	80.7025	80.1550	83.7750	94.6650
Sig.	(p>0.05)	(p>0.05)	(p>0.05)	(p>0.05)

Researchers (Elibol and Brake, 2008) by study on the three egg weight groups concluded that there is no significant difference among weight groups concerning to embryonic mortality in the early and middle of incubation, but the egg weight groups showed a significant difference that embryonic mortality was high in the heavy eggs than average ones and it was high in average eggs than light ones. These differences in comparing the weights of the eggs have been interpreted due to gas exchange. One 70 g egg has 27 percent embryo larger than an egg with 55 grams but it is less than 8 percent level for the exchange of respiratory gases (Peebles and Brake, 1987).

Also in Table 1 the effect of egg weight on egg weight loss during incubation is shown. Based on the results obtained by increasing the amount of weight lost during the incubation period, egg weight was increased (p<0.05).

These results are consistent with reports of researchers, that they were indicated with increasing egg weight, the egg weight loss also increases, which was due to egg weight, egg size and more pore existence over the shell eggs (Tona *et al.*, 2001).

The results of this research regarding to the effect of the egg weight and weight loss during incubation are consistent to the results of various researchers (Weis

et al., 2011). Deeming (1995) has shown that egg weight loss of less than 10 percent, or more than 20 percent of initial weight, will have a lower hatch (Deeming, 1995).

Tables 2 and 3 show the results of egg quality different parameters influence egg weight. Basically, egg quality is as an important factor in the poultry industry and it is economically important as the quality of the eggs and the reproductive system. Some of poultry egg quality traits have a significant and direct impact on the price of commercial flocks, in eggs processing, shell weight, albumen and yolk according to their ratio that determine the price of the product (Alkan *et al.*, 2010- Jatoi *et al.*, 2013).

According to the results of table 2 regarding to the effect of egg weight on the yolk index it is observed that there is a significant difference in yolk index among the groups ($p<0.05$). Also it was showed there was no significant difference in egg shape index in egg weight groups ($p>0.05$).

This result is similar to previous reports, by study on four groups of egg weight, reported that the goose egg weight, have no significant effect on the egg shape index (Saatci *et al.*, 2005).

We observed significant differences in egg shell thickness among different egg weight groups according to table 2 ($p<0.05$) since by increase of weight and volume of the egg in age range the shell thickness is reduced.

The produced eggs in the early of the cycle were smaller and lighter relative to the end of production, but they had thick shell that is related to calcium amount in the body of the hen.

In Table 3 some other egg quality parameters were studied. The wet weight of the yolk and wet weight of albumen in egg weight groups showed significant differences ($p<0.05$). These results are consistent with reports by other researchers (Onbaşılar *et al.*, 2011- Ulmer-Franco *et al.*, 2010- Wolanski *et al.*, 2004).

Studies on three groups of egg weight (light, average and heavy) showed that the loss of wet weight of albumin and yolk is significant (Ulmer-Franco *et al.*, 2010). Also it was studied showed that increase of egg weight leads to increase of yolk and albumen (Reidy *et al.*, 1994). It was confirmed that there was correlation between egg gain increase and egg yolk weight increase (Kaminska and Skraba, 1991).

Table 3 shows that shell strength and wet weight among groups showed significant differences ($p<0.05$).

Researchers reported a positive correlation between eggs weight, shell weight and thickness that the results are consistent with our research (Farooq *et al.*, 2001).

Of course, other results depicts that egg weight has a direct correlation with quality of the shell and shell strength and shell weight (Choi *et al.*, 1983).

Effect of egg weight on fertility and hatchability is shown in Table 4. In this section the results for the traits egg weight were not found among groups ($p>0.0$).

This result is similar to previous studies in Canada that they studied on three groups by light, average and heavy weight in commercial broiler chicken eggs in two strains. A study on three groups of egg weight indicated they were not significant differences in fertility traits (Alabi *et al.*, 2012).

Conclusion

It seems that as it was observed in this research and other researchers' results showed eggs with average weight are economical for hatchability and production of egg.

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