BURSA ULUDAĞ ÜNİVERSİTESİ ZİRAAT FAKÜLTESİ DERGİSİ,
2018, Cilt 32, Sayı 2, 123-130
(Journal of Agricultural Faculty of Bursa Uludag University) e-ISSN 2651-4044
http://dergipark.gov.tr/bursauludagziraat; http://www.uludag.edu.tr/ziraatdergi

Araştırma Makalesi/*Research Article*

Effect of Egg Weight on Eggshell Thickness, Pore Density and Chick Quality in Broiler Breeder Flock[a]

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Geliş Tarihi (Received): 26.06.2018; Kabul Tarihi (Accepted): 29.07.2018

Abstract: The objective of this research was to investigate the effect of egg weight on eggshell thickness, pore density and chick quality in broiler breeder flock. Additionally the correlations between the studied characteristics were calculated. Hatching eggs were collected from 40 wk old Ross 308 broiler breeder flock. The eggs were selected, weighed and numbered individually in light (54.71-58.88 g) and medium (58.24-60.62g) weighed egg groups. Eggs were incubated at 37.5°C and 55% RH in an incubator for 18 days. On 18th day eggs were individually weighed to calculate the egg mass loss. Then eggs were incubated at 37.0°C and 60% RH in a hatcher until hatch. At hatch chicks were weighed individually and chick length was measured. Additionally egg shell thickness and pore density was determined. Egg weight loss was found non-significant in both light and medium weighed egg groups (P>0.05). Egg weight had significant effect on eggshell thickness (P<0.05). Eggshell thickness was found higher in light weighed eggs than in medium weighed eggs (P <0.05) whereas, pore density was determined higher in medium weighed eggs (P<0.01). At hatch chick weight increased with the increased egg weight (P <0.05) while as chick length was not affected by egg weight. A significant correlations was observed between initial egg weight and average eggshell thickness (r= 0.551), chick weight (r=0.615), and also between average eggshell thickness and chick weight (r=0.484) in medium weighed eggs (P<0.05).

Keywords: Egg weight; Eggshell thickness; Pore density; Egg weight loss; Chick quality.

[a] Sabah, S. and Şahan, Ü. 2018. Effect of Egg Weight on Eggshell Thickness, Pore Density and Chick Quality in Broiler Breeder Flock. *Bursa Uludag Üniv. Ziraat Fak. Derg.*, 32 (2), 123-130.

Broiler Damızlık Sürüsünde Yumurta Ağırlığının Yumurta Kabuk Kalınlığı, Por Yoğunluğu ve Civciv Kalitesi Üzerine Etkisi

Öz: Bu araştırmada broiler damızlık sürüsünde yumurta ağırlığının kabuk kalınlığı, por yoğunluğu ve civciv kalitesi üzerine etkileri incelenmiştir. Ayrıca, incelenen özellikler arasında korelasyonlar hesaplanmıştır. Yumurtalar 40 haftalık yaştaki Ross 308 broiler damızlık sürüsünden elde edilmiştir. Yumurtalar tartılarak hafif ağırlık (54.71-58.88 g) ve orta ağırlık (58.24-60.62g) grubu olarak ayrılmış ve bireysel olarak numaralandırılmıştır. Yumurtalar 37.5°C sıcaklık ve 55% nispi nemde 18. gün süresince kuluçkalandırılmıştır. Yumurta ağırlık kaybını hesaplamak için kuluçkanın 18. gününde bireysel olarak tartılmıştır. Daha sonra yumurtalar çıkışa kadar 37.0°C sıcaklık ve 60% nispi nemde çıkım makinasında kuluçkalandırılmıştır. Çıkışta civcivler bireysel olarak tartılmış ve civciv uzunlukları ölçülmüştür. Buna ilave olarak kabuk kalınlığı ve por sayısı belirlenmiştir. Her iki grup arasındaki yumurta ağırlık kaybı önemli bulunmamıştır ($P>0.05$). Yumurta ağırlığının kabuk kalınlığı üzerine etkisi önemlidir ($P<0.05$). Hafif ağırlıktaki yumurtalarda kabuk kalınlığı orta ağırlıktaki yumurtalardan daha yüksek bulunmuştur ($P<0.01$) bununla birlikte, por yoğunluğu orta ağırlıktaki yumurtalarda daha fazla olduğu belirlenmiştir ($P<0.01$). Çıkışta yumurta ağırlığı arttıkça civciv ağırlığıda artmıştır ($P<0.05$), diğer yandan civciv uzunluğu yumurta ağırlığından etkilenmemiştir. Orta ağırlıktaki yumurtalarda başlangıç yumurta ağırlığı ile ortalama yumurta kabuk kalınlığı ($r=0.551$), civciv ağırlığı ($r=0.615$) ve ayrıca ortalama yumurta kabuk kalınlığı ile civciv ağırlığı ($r=0.484$) arasında pozitif korelasyonlar saptanmıştır ($P<0.05$).

Anahtar Kelimeler: Yumurta ağırlığı; yumurta kabuk kalınlığı; por yoğunluğu; yumurta ağırlık kaybı; civciv kalitesi.

Introduction

Egg weight is an important quality parameter that greatly influences the egg composition and embryo growth, (Ng'ambi et al., 2013) hatching egg characteristics and broiler performance in broiler breeder flocks (Ulmer-Franco et al., 2010). Moreover, egg weight, eggshell characteristics and its composition are affected by age of the breeder (Tona et al., 2001). Egg contains approximately 58.5% of albumen, 31% yolk and 10.5% of shell (Cherian et al., 2002). Peebles et al. (2000) reported that when the flock age increase, weight of egg also elevates, thickness of shell decreases and the yolk sac percentage increase. Eggs of flock ages with different egg weight influences the eggshell quality, (İpek and Şahan, 2001) eventually affects the egg mass loss, hatchability performance and chick quality (Bamelis, 2003). With the increase of hen's age, shell thickness decreases, because total shell deposition after the first three months of laying period remains fairly constant while eggs continue to increases in size. This cause the shell to be spread thinner and shell quality to decline (Roland, 1988). Some researchers reported that thick eggshell assures the better use of nutrients by the developing embryo, acts as a strong barrier against the bacterial contamination (Sergeyeva, 1986, Roque and Soares, 1994). Generally pore size and the total number of the pore increases with egg mass, whereas pore density decreases (Tullet and Board, 1977). There is a relationship between egg weight, egg shell thickness and porosity (Tona et al., 2001). At hatch, chick weight, chick length and yolk free body weight are measured as an indicator of one day old chick quality (Willemsen et al., 2008). Egg weight also has positive effect on chick weight and chick length. The egg weight greatly influences the hatchability, hatching duration,

embryonic mortality, hatching weights and subsequent performance of chicks (Witt-De and Schwalbach, 2004; Alkan et al., 2008; Çağlayan et al., 2009; Alabi et al., 2012).The study was carried out to determine the effect of egg weight on eggshell thickness, pore density, egg weight loss and chick quality in 40 week old broiler breeder flock. Additionally the correlations was also calculated among the studied characters.

Materials and Methods

The care and use of animals was in accordance with the laws and regulations of Turkey and approved by the ethics committee of Uludag University (License Number 2018–05/01). A total of 40 hatched eggs were obtained from a commercial Ross 308 broiler breeder flock at 40 week of age. All eggs were weighed and numbered individually on an electronic balance with ± 0.01g precision. The eggs were classified in light (54.71-58.88 g) and medium weighed (58.24-60.62g) eggs. Eggs were stored at 16°C and 65% relative humidity for 3 days, then warmed to room temperature (22^{o}C) for 8 hours before incubation. Eggs were incubated at 37.5°C and 55% RH in an incubator (capacity egg setter T640 Çimuka Inc.) for 18 days. On 18th day eggs were individually weighed to calculate egg mass loss. Eggs were transferred to the trays (Çimuka Inc., Ankara, Turkey). Eggs were incubated at 37.0°C and 60% RH in a hatcher until hatch. During incubation period eggs were individually followed to determine egg shell thickness and pore density. At the end of the hatching, chicks were individually weighed and chick length was measured .Chick length was measured with a ruler by stretching from tip of beak to the tip of middle toe (Hill., 2001). Un-hatched eggs were broken and visually assessed for fertility and embryonic mortalities . Embryonic mortalities were separated into three groups: early term (1 to 7 day of incubation), mid-term (8 to 14 day of incubation), and late term (15 to 21 day of incubation) embryonic mortalities. Eggshells of each hatched and un-hatched eggs were removed and discretely stored in plastic bags for the measurement of thickness and pore size density.

Eggshells were washed and dried for 24 hours at room temperature. A micrometer was used for the measurement of the broad end, equator and narrow end of individual eggs and lastly the eggshell mean was calculated, with the help of ball-point caliper having reading of 0.01 mm (Ahmad and Balander., 2003).The thickness of eggshell measurements were conducted by excluded the membranes that were adhered to the eggshell. Same eggshell pieces were used to measure the mean pore density of eggs. Eggshell pieces were dipped in NaOH solutions (5% (gram/litre) for 5 minutes to remove all shell membrane or other adhered materials. Furthermore, for the magnification of pores, eggshell sections were dipped in concentrated nitric acid for about 15 seconds. By using aqueous Methylene Blue dye (0.5 g 89 % dye in 1 L of 70 % ethanol) the surface of the eggshells were tinted following drying (Board and Halls., 1973). Only large pores were counted using a stereomicroscope with a magnification of ×40. The counting field was 0.50 cm^{2}, and representing three regions (broad end, equator and narrow end) of each eggshells were counted. For the measurement of average values, estimated values were multiplied by 2 that expressed the pore density per centimeter.

Statistical Analysis

Data were analyzed using descriptive Statistics, t-Test: two-sample as summing equal variances using Minitab (2013). The Pearson correlation was used to determine the correlation of different parameters of eggshell and chick characteristics Minitab (2013). P value of <0.05 was considered for significant differences among groups.

Results and Discussion

The present study showed, percentage of fertility in light weighed eggs was found to be 95% and in medium weighed eggs was found to be100%, while as hatchability of light weighed eggs was found to be 90% and in medium weighed eggs was found to be 95%. In both light and medium weighed eggs only one early embryonic death was observed whereas there was not found any mid and late embryonic deaths.

Eggshell characteristics of hatched eggs (light and medium) of 40 week old flocks are presented in Table 1. In the study mean of initial egg weight was found 56.76 g in light and 59.42 g in medium weighed eggs of 40-wk old broiler breeder flock (P < 0.01).

Table 1. Average of eggshell characteristics and chick quality in light and medium weighed eggs (40-wk-old)

Parameters	Light	n	Medium	n	P value
Initial egg weight, g	56.76 ± 1.14	20	59.42 ± 0.79	20	0.000**
Shell thickness, mm	0.35 ± 0.01	20	0.33 ± 0.01	20	0.007*
Pore density, pores/cm^2	25.1 ± 2.9	20	30.4 ± 2.7	20	0.000**
Egg mass loss, %	9.96 ± 1.49	20	10.29 ± 1.21	20	0.369
Chick weight, g	41.31 ± 1.25	18	42.46 ± 1.79	19	0.025*
Chick length, cm	19.14 ± 0.43	18	18.79 ± 1.70	19	0.380

Means within main effect without a common superscripts are different at $P < 0.05$; $P < 0.01$
**: $P < 0.01$; *: $P < 0.05$

Eggshell plays a vital role in the exchanging gases (oxygen and carbon dioxide) across the shell wall, for the respiration of embryo (Ar and Rahn., 1985). Various studies showed that eggshell quality is predisposed by factors like age, strain, housing system and by feeding balanced diet along with the supplements and essential minerals (Venglovska et al., 2014; Coutts and Wilson., 2007; Butcher and Miles., 2009). The mean of eggshell thickness in light weighed eggs (0.35mm) and in medium weighed eggs (0.33mm) was found to be significant (P <0.05). The results were in accordance with Gahri et al. (2015) who showed in light weight (52.62-55.65) eggs and in average weight (57.15-60.15) by increase of egg weight the shell thickness is reduced. Araujo et al. (2017) also measured egg shell thickness in three different regions and the average was found to be 0.31mm in 35-wk broiler breeder. A hen egg has a limited capacity to deposit calcium in the shell and to spread the same amount of calcium over a large surface area of the egg (Rajkumar et al., 2009).

Pore structure is greatly affected by egg weight (Tullett and Deeming., 1982). In this study mean of pore number in light weighed eggs was found 25.1 pores/cm^2 and in medium

ones was found 30.4 pores/cm^2 (P<0.01). In accordance with Tullett and Deeming. (1982) that showed within any group of eggs, there is a difference in the egg weight and pore density. While as Rahn et al. (1981) found contradictory results by showing no change in pore dimension with the increase in egg weight in 20 week breeder flocks.

Mean of egg weight loss was not found significant (P > 0.05) in light weighed eggs it was observed to be 9.96% and in medium eggs it was observed 10.29%. Our results are in accordance with the Iqbal et al. (2016) who found non-significant difference in egg weight loss of small (60.05)and medium (65.03) egg weight groups in 45 week broiler breeder flock.

Medium sized eggs are being chosen for attaining better results of hatchability (Abiola et al., 2008; Gonzalez et al., 1999). Scientists revealed that there is a positive relationship between egg size and chick weight (Abiola et al., 2008; Senapati et al., 1996, Meijerhof, 2006). Egg weight affects both day old chick weight and growth performance. Furthermore egg weight also influences the market weight of broilers (Olutunmogun., 2018; Ramaphala and Mbajiorgu, 2013). As the egg weight increase, chick weight also increases. In the study a significant mean value was shown by chick weight, medium weighed eggs displayed higher chick weight 42.46 g than light weighed eggs, 41.31 g (P<0.05). Rashid et al. (2013) reported that in three rural breeds (Fayoumi, Desi and Crossbred (RIR ✕ Fayoumi) large sized eggs (>45g) gained higher chick weight than those of small sized eggs (<41g). Similar results were obtained by Ng'ambi et al. (2013) in other poultry species. Iqbal et al. (2016) revealed significant effect of egg size on chick weight,chick length and chick yield.

In the current study mean of chick length was not found significant (P>0.05) in light weighed eggs it was observed to be 19.14 cm and in medium eggs it was 18.79 cm.

Table 2. Correlations of egg shell chracteristics in light and medium weighed eggs of 40 week old broiler breeder flock

Egg weight	Parameters	Mass loss, %	Shell thickness, mm	Pore density, pores/cm^2	Chick weight, g	Chick length, cm
Light	**Initial weight**	-0.151^{NS}	0.071^{NS}	0.160^{NS}	0.017^{NS}	0.111^{NS}
	Mass loss	-	0.378^{NS}	-0.268^{NS}	-0.039^{NS}	0.300^{NS}
	Shell thickness	-	-	-0.291^{NS}	0.420^{NS}	-0.558*
	Pore density	-	-	-	0.326^{NS}	-0.243^{NS}
	Chick weight	-	-	-	-	-0.172^{NS}
Medium	**Initial weight**	0.114^{NS}	0.551*	-0.303^{NS}	0.615*	0.179^{NS}
	Mass loss	-	-0.138^{NS}	-0.133^{NS}	-0.272^{NS}	0.203^{NS}
	Shell thickness	-	-	-0.459*	0.484*	0.028^{NS}
	Pore density	-	-	-	-0.190^{NS}	0.186^{NS}
	Chick weight	-	-	-	-	0.180^{NS}

**: $P < 0.01$; *: $P < 0.05$; NS: Not Significant

The correlation of both light and medium weighed egg's shell characteristics are displayed in Table 2. There was not found any correlation between initial egg weight, mass loss,eggshell thickness, pore density, chick length and chick weight in light weighed eggs, whereas significant correlation was found in medium weighed egg between initial egg weight and eggshell thickness (r =0.551) and also in between initial egg weight and chick weight (r=0.615) respectively. At the same time positive correlation was found in eggshell thickness and chick weight (r=0.484). Farooq et al. (2001) reported a positive correlation between egg weight, eggshell weight and thickness. Chick mass is indicator for the day-old chick quality. Chick weight is the most widely used indicator for day-old chick quality evaluation (Decuypere et al., 2002). Vieira et al. (2005) found high chick weight in larger eggs as compared to smaller eggs in 40- weeks-old Ross-38 breeders.

The study concluded, during the selection of eggs, instead of selecting light and large weighed eggs, mostly medium weighed eggs should be preffered in every broiler breeder flocks. As medium weighed eggs showed better hatching performance therefore, it is suggested that there should be uniformity in broiler breeder flocks, for attaining the better hatching performance and chick quality.

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