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Original Research Article

Effects of Egg Weight on Chick and Organ Development, Growth and Slaughter Traits in Pekin Ducks

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ABSTRACT

This study was carried out to determine the effects of increased egg weight of pekin ducks on organ development, chick quality, growth traits, slaughter and carcass yield. A total of 405 one day old Pekin ducklings that have been hatched from light, medium and heavy hatching eggs, were used in the experiment. Egg weight were classified as "light" (<75 g), "medium" (76-82 g) and "heavy" (>83 g) by weighing with ±0.1 precision one by one. The chick hatching weight and leg length were found to be the highest in chicks hatched from heavy eggs, with values of 47.4 g and 227.8 mm compared to the chicks hatched from light and medium eggs (P<0.05). At 42 d of age, the body weight of ducks hatched from heavy eggs was 3195.0 g, compared to the ducks hatched from light and medium eggs (2879.6 and 2897.9 g, P=0.001). Any significant differences observed for feed conversion rate and mortality among the experimental groups (P>0.05). Slaughter weight, carcass weight were also the highest for ducks hatched from heavy eggs (P=0.004). In conclusion, increased egg weight affected chick hatching weight and growing performance in Pekin ducks.

Keywords: Pekin duck, Egg weight, Chick hatching weight, Growth traits, Slaughter characteristics

INTRODUCTION

Due to rapid growth in world population, duck meat has gained importance as a valuable animal protein source for human nutrition in recent years. Thus, the world production of duck meat has increased by 94,7% in the last decade (Wen *et al*., 2015), and reached to approximately 4.3 millions tonnes in 2014 (FAOSTAT, 2017). The biggest producer country of duck meat is China, and it produces more than 80% of duck meat all over the world (FAOSTAT, 2017). Guémené *et al.* (2011) stated that approximately 90% of total duck meat production is obtained from Pekin ducks, 4% of is produced by Muscovy ducks and the other 6% of is obtained from Mule ducks, especially for fatty liver production. Therefore, Pekin duck is one of the most popular meat-type duck strain for most of countries, for example China, Korea, England, France (Heo *et al*., 2015; Wen *et al*., 2015).

It is known that achievement in poultry production primarily depends on some factors, for example breeder age, egg weight, incubation conditions, feding and management during post-hatch period (Ipek and Sahan, 2002; Badowski *et al*., 2005; Weis *et al*., 2011). Except breeder age and egg weight, the other factors could be manipulated by human hand. But, these two factors including breeder age and egg weight are natural progression of hens. The progression of age differently reflects egg weight and egg composition in divergent bird species (chicken, turkey, duck etc.), strain and yield type (meat or egg type). In the production cycle of laying, birds start to lay small eggs. Then, egg size starts to increase in the later period of production cycle. This observed changes in egg weight have effect on egg composition and nutrient content, shell quality and subsequently embryo development and hatchling weight (Elibol and Brake, 2003; Tona *et al*., 2004; Joseph and Moran, 2005).

Due to a complex relationship between egg weight and hatchling weight and post-hatch growth perfomance (Tona *et al*., 2003; Careghi *et al*., 2005; Vieira *et al*., 2005; Romanini *et al*., 2013; Ipek and Sozcu, 2015), determining the effects of egg weight has importance for successful and profitable production. It is uncertain that how the variation in egg weight that obtained from the breeder flock at same age reflects to hatchling weight and also post-hatch growing performance in Pekin ducks. Therefore, the objective of this study is to determine the effects of increased egg weight of Pekin ducks on organ growth and chick development at hatch, growth traits and feed efficiency during post-hatch period, slaughter and carcass yield.

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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 2015-10/05).

The research was performed at the Research and Experimental Farm of the Department of Animal Science in Uludag University in Turkey. A total of 960 hatching eggs were collected were obtained from a breeder Pekin duck flock at 35-36 wk of age. The flock was kept under standard industry practices. Hatching eggs were collected and then classed into three weight categories: “light” (<75 g), “medium” (76-82 g) and “heavy” (>83 g), by weighing with ±0.1 precision. Eggs were incubated in fully automated ventilation, programmable incubator at 37.5°C temperature and a relative humidity of 55 to 60% during the first 24 d of incubation.

On day 25 of incubation, eggs were transferred to the hatcher. In the hatcher, eggs were maintained at 37.0°C temperature and a relative humidity of 72% during hatching period. After the completing of hatching process, chicks were weighed with ±0.1 precision to determine the chick hatching weight.

A total of 45 one day old chicks (n:15 chicks per egg weight group) were sampled for chick body and leg length, residual yolk sac weight, dry matter of residual yolk sac weight and organ growth (gizzard, heart, liver, intestine; Ipek *et al*., 2014). Chick body length was measured from the tip of the beak to the tip of the middle toe by placing the chick face down on a flat surface and straightening the right leg (Hill, 2001; Nangsuay *et al*., 2011). Leg length was mesured from right knee joint to the tip of the middle toe (Willemsen *et al*., 2008). Then, the chicks were killed by cervical dislocation, and the residual yolk sac carefully separated from the chick body. The dry matter of the residual yolk sac weight was determined by drying over in temperature of 105˚ C during 24 hours in the drier (Nüve FN-500). The weight of residual yolk sac weight and internal organs (heart, liver, gizzard and intestine) and intestinal length were determined by ±0.01 g and cm precision.

For growth traits, a total of 360 one day old Pekin ducklings (120 ducklings per treatment groups) that have been hatched from light, medium and heavy hatching egg were used in the experiment. Ducklings were placed to a pens with a surface area of 2.0 × 2.0 m^2 to provide 30 chicks (n=4 pens/treatment), and weighed using a balance with ±0.1 g precision on the first day of the growing period. Wood shavings laid at a thickness of 8–10 cm on the floors of the pens were used as litter material. The ducklings received a starter diet (between 1-21 days) containing 22.51% crude protein and 12.31 MJ metabolizable energy, and a grower diet (from 22 days to the end of the experimental period) containing 20.07% crude protein and 12.79 MJ metabolizable energy recommended by National Research Council for ducks (NRC, 1994). Feed and water were offered ad libitum during the growing period. The chicks were exposed to 24 h of light at the first week and then 23 h of light and 1 h of darkness until the end of the experiment. Room temperature was 33 °C at 1 day of age and decreased gradually by 3 °C/week until they reached 20 °C. Room temperature was then maintained at 20 °C with 50%–60% relative humidity until the end of the experiment. Stocking density was applied approximately 0.13 m^2.

The live weight values were monitored per pen on a weekly basis until the end of the sixth week. The feed conversion ratio (FCR) was calculated on pen basis using the weekly live weight gains and feed consumption values. FCR was corrected for mortality. The mortality by pen was recorded daily during the experiment.

At 42 d of age, feed was withdrawn 12 h before slaughter process. A total of 90 ducks (30 ducks per treatment groups, 15 males and 15 females) were individually weighed to determine slaughter weight and then were slaughtered in the processing plant of the university farm. After slaughter, the ducks were bled for about five minutes, and then scalded in water at about 63ºC for 1 min., to facilitate plucking. The birds were defeathered manually (Kleczek *et al*., 2007). The carcass weight was measured after removing the head, feet, feathers, blood, and edible internal organs except lungs and kidneys. The carcass yield was calculated as a percentage of slaughter weight. The carcasses were then divided into pieces as breast, and thigh with drumstick according to the method described by Bogosavljevic-Boskovic *et al*. (2010). The breast was separated by perpendicularly cutting the ventral joints of ribs with the “rib” incision. The thighs and drumsticks were carefully separated from the carcass above the thigh, towards the hip joint and behind the pubic bone. The carcass pieces were then weighed by ±0.01 precision and calculated as percentage of carcass weight. The edible internal organs (gizzard, heart, liver) were individually weighed by ±0.01 precision.

The data were subjected to analysis of variance using SAS (1998), utilizing ANOVA procedures for balanced data. Analyses for percentage data were conducted after square root of arc sine transformation of the data. Significant differences among treatment means were determined by the Duncan's multiple range test. Growth performance and slaughter yield parameters were analyzed using the general linear model (GLM) procedure. Total mortality were calculated per pen and were analyzed using chi-square tests. Data are presented as means ± SE.

RESULTS AND DISCUSSION

The effects of egg weight on chick development and organ growth at hatch in Pekin ducks are presented in Table 1. Chick hatching weight was found to be the highest with a value of 47.4 g in chicks hatched from heavy eggs, compared to light and medium eggs (39.8 g and 43.5 g, respectively, P=0.001). Similarly, chick body and leg length were found to be the highest in chicks of heavy eggs, compared to the chicks of light and medium eggs (P<0.05). The present study found a positive trend between egg weight and hatching weight, body length. This finding were similar to Badowski *et al*. (2005) who reported a positive and highly significant correlation between these parameters. Decuypere and Bruggeman (2007) stated that a higher chick length was observed in heavier eggs. This could be originated from relative nutritional composition of yolk and albumen, and also yolk utilisation of embryos (Tullett and Deeming, 1982).

Table 1. The effects of egg weight on chick growth and organ development at hatch in Pekin ducks.

Variables	Experimental groups			P-Value
	Light	Medium	Heavy	
Chick growth[1]				
Chick hatching weight (g) [2]	39.8 ± 1.1 [c]	43.5 ± 0.3 [b]	47.4 ± 0.3 [a]	0.001
Chick body length (mm)	213.3 ± 6.0 [b]	219.4 ± 4.1 [ab]	227.8 ± 1.9 [a]	0.021
Leg length (mm)	51.5 ± 1.8 [b]	53.6 ± 1.9 [b]	57.2 ± 0.7 [a]	0.012
Residual yolk weight (g)	1.8 ± 0.5	2.6 ± 0.8	2.7 ± 0.4	0.202
RYW (% of CHW)	4.5 ± 1.3	6.0 ± 1.9	5.6 ± 0.8	0.402
Dry matter of residual yolk (%)	48.3 ± 4.0 [a]	44.5 ± 0.1 [a]	42.1 ± 1.1 [b]	0.050
Organ development[1]				
Heart (g)	0.44 ± 0.05	0.52 ± 0.04	0.48 ± 0.02	0.080
Heart (% of CHW)	1.1 ± 0.1	1.2 ± 0.1	1.0 ± 0.1	0.145
Liver (g)	1.8 ± 0.3	1.7 ± 0.1	1.8 ± 0.2	0.989
Liver (% of CHW)	4.4 ± 0.8	4.0 ± 0.2	3.7 ± 0.4	0.327
Gizzard (g)	1.9 ± 0.3 [b]	1.9 ± 0.2 [b]	2.4 ± 0.1 [a]	0.021
Gizzard (% of CHW)	4.7 ± 0.7	4.5 ± 0.3	4.9 ± 0.1	0.347
Intestine (g)	1.8 ± 0.2 [b]	2.0 ± 0.1 [ab]	2.2 ± 0.1 [a]	0.047
Intestine (% of CHW)	4.5 ± 0.6	4.5 ± 0.3	4.7 ± 0.1	0.790
Intestine (mm)	490.1 ± 16.1 [b]	504.4 ± 16.2 [b]	552.9 ± 20.9 [a]	0.012

[1] For chick growth parameters except chick hatching weight and organ development, 15 ducklings per experimental groups were randomly sampled at hatch.

[2] For chick hatching weight, all of hatched chicks were weighed.

[a,b,c] Differences in letters within rows indicates significant differences among the experimental groups.

CHW: chick hatching weight

RYW: residual yolk weight

Parallelly to the findings mentioned above, dry matter of residual yolk was differed among the experimental groups, whereas the weight and percentage of residual yolk were similar. Interestingly, the lowest dry matter content of residual yolk was observed in chicks obtained from heavy chicks (P=0.050). These findings showed that there is a reverse relation between dry matter content of residual yolk and chick hatching weight. So, heavier chicks had less dry matter in their residual yolk sac. Consequently, yolk dry matter consumption and accumulation by chicks at hatch could show changes in different egg size.

Hatchling weight is an important indicator for one-day old chick quality and also performance at market age (Wyatt *et al*., 1985; Decuypere *et al*., 2002). It could be accepted as a conjecture that chick weight and length could have a positive correlation with egg weight. Similar results were also obtained in other poultry species, including in indigenous Venda chickens (Ng'ambi *et al*., 2013), Japanese quail (*Coturnix coturnix japonica;* Dudusola, 2013), rural breeds (Fayoumi, Desi and crossbred (Rhode Island Red × Fayoumi), Rashid *et al*., 2013).

The variation in hatchling weight and dry matter content of residual yolk affacted the organ development at hatch. As seen Table 1, some internal organ weights of chicks were affected by egg weight. Chicks hatched from heavy eggs had more developed organs including heavier gizzard and intestine and also longer intestine, compared to other chicks hatched from light and medium eggs.

Recently, chick quality also has been accepted as an indicator for hatchling quality and also growing performance (Mukhtar et al., 2013). It is known that there is a correlation between chick weight at hatch and body weight at market age (Tona *et al*., 2003). The effects of egg weight on growth traits in Pekin ducks are shown in Table 2. The body weight of chicks showed significant differences among the experimental groups during the growing period. The chicks hatched from heavy eggs had the highest body weight until the end of the experiment (P<0.01). At 42 d of age, the body weight of ducks hatched from heavy eggs was heavier, compared to the ducks hatched from light and medium eggs (P=0.001).

Table 2. The effects of egg weight on growth traits in Pekin ducks.

Variables	Experimental groups			P-Value
	Light	Medium	Heavy	
Body weight				
Day 1	41.79 ± 4.44 [c]	45.54 ± 1.38 [b]	55.26 ± 2.79 [a]	0.001
Day 7	160.2 ± 6.8 [c]	167.7 ± 2.7 [b]	185.8 ± 1.0 [a]	0.001
Day 14	550.2 ± 20.9 [b]	553.7 ± 10.5 [b]	601.0 ± 15.1 [a]	0.002
Day 21	1072.7 ± 45.2 [b]	1096.6 ± 34.3 [b]	1164.6 ± 53.1 [a]	0.001
Day 28	1700.0 ± 21.7 [b]	1718.0 ± 74.4 [b]	1917.0 ± 52.6 [a]	0.003
Day 35	2319.6 ± 151.5 [b]	2317.9 ± 64.1 [b]	2545.0 ± 38.1 [a]	0.001
Day 42	2879.6 ± 140.0 [b]	2897.9 ± 78.1 [b]	3195.0 ± 68.1 [a]	0.001
Body weight gain				
Days 1-7	118.5 ± 8.7 [b]	122.2 ± 2.7 [b]	130.5 ± 2.9 [a]	0.010
Days 7-14	389.9 ± 14.7 [b]	386.0 ± 11.4 [b]	415.3 ± 14.9 [a]	0.006
Days 14-21	522.5 ± 51.9	542.9 ± 36.4	563.5 ± 55.2	0.345
Days 21-28	627.3 ± 55.7 [b]	621.4 ± 85.5 [b]	752.4 ± 87.0 [a]	0.012
Days 28-35	619.6 ± 145.9	599.9 ± 95.1	628.0 ± 75.3	0.225
Days 35-42	560.0 ± 131.9	580.0 ± 92.2	650.0 ± 93.9	0.320
Cumulative feed consumption	6116.7 ± 76.4 [b]	6092.7 ± 17.6 [b]	6769.3 ± 20.0 [a]	0.010
Feed conversion rate	2.12 ± 0.10	2.10 ± 0.12	2.12 ± 0.11	0.352
Total mortality (%)	5.0% (6/120)	3.33% (4/120)	5.83% (7/120)	0.556
	Chi-square= 0.864			

n: 4 replicate pens/experimental groups (30 ducks/pen).

[a,b,c] Differences in letters within rows indicates significant differences among the experimental groups.

The body weight gain of ducks hatched from heavy eggs was found to be the highest between 1-7, 7-14 and 21-28 days of growing period (P<0.05). On the other hand, cumulative feed consumption was also found to be the highest with a value of 6769.3 g in ducks hatched from heavy eggs, compared to other ducks hatched from light and medium eggs (P=0.010). These findings clearly showed that heavier ducklings consumed more feed and subsequently grew more than the lighter ones. It is similar with previous reseach of El-Hanoun *et al*. (2012). However, any significant differences observed for feed conversion rate and mortality among the experimental groups (P>0.05).

The effects of egg weight on slaughter and carcass yield in Pekin ducks are presented on Table 3. As expected, slaughter weight was found to be the highest in ducks obtained from heavy eggs with a value of 3156.7 g (P=0.001). In paralel to findings slaughter weight, carcass weight was also the highest for ducks hatched from heavy eggs (P=0.004). Contrarily to our findings, Kleczek *et al.* (2007) found any significant differences for carcass weight between egg weight groups in Muscovy ducks. However, carcass yield was found to be similar among the experimental groups (P=0.346). A similar carcass yield was also observed by Kleczek *et al*. (2007). Whereas the percentage of breast was the highest in ducks obtained from heavy eggs with a value of 38.81% (P=0.027), the percentage of thigh and dumstick was the highest with a value of 40.16% in the ducks obtained from light eggs (P=0.001). Similarly, Halevy et al. (2004) found a higher breast muscle weight in broilers hatched from heavy eggs. On the other hand, the weight of heart and gizzard were found to be the lowest in ducks obtained from light eggs with values of 11.05 and 52.78 g, respectively (P<0.001).

Table 3. The effects of egg weight on slaughter and carcass yield in Pekin ducks.

Variables	Experimental groups			P-Value
	Light	Medium	Heavy	
Slaughter weight (g)	2729.0 ± 144.3 [b]	2824.0 ± 125.2 [b]	3156.7 ± 107.1 [a]	0.001
Carcass weight (g)	2011.2 ± 162.0 [b]	1994.2 ± 124.4 [b]	2289.2 ± 64.3 [a]	0.004
Carcass yield (%)	73.70 ± 4.70	70.61 ± 2.90	72.55 ± 1.97	0.346
Breast (%)	35.77 ± 1.83 [b]	37.54 ± 1.76 [ab]	38.81 ± 0.77 [a]	0.027
Thigh drum (%)	40.16 ± 0.70 [a]	35.17 ± 1.33 [b]	35.73 ± 1.17 [b]	0.001
Liver (g)	49.6 ± 5.21	47.7 ± 6.20	54.2 ± 5.68	0.223
Heart (g)	11.05 ± 1.27 [c]	14.2 ± 0.86 [b]	17.2 ± 0.91 [a]	0.002
Gizzard (g)	52.78 ± 0.71 [c]	62.72 ± 8.62 [b]	83.57 ± 3.66 [a]	0.001

n: 30 ducks per treatment groups (15 males, 15 females).
[a,b,c] Differences in letters within rows indicates significant differences among the experimental groups.

CONCLUSIONS

As a conclusion, the present results showed that increasing of egg weight caused an increment for chick growth and body weight at market age. Heavier ducks consumed more feed and had a higher salughter weight, but any significant differences observed for feed efficiency. Also, increasing of slaugher weight caused an increasing effect for breast yield. This may have some importance for consumers' preference for breast or thigh meat. Therefore, increasing of egg weight in Pekin ducks could provide advantage to produce heavier carcass, but still an uncertainty for breast yield.

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