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EGG WEIGHT INFLUENCE ON SOME EGG CHARACTERS AND HATCHLING BODY WEIGHTOF GIMMIZAH CHICKEN STRAIN

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ABSTRACT: The present experiment was carried out for studying the effect of egg size on egg shape index, egg volume, egg surface area, egg weight loss during incubation and their relations with chick body weight at hatch and at pull out. Eight hundred and fifty two hatching eggs obtained from Gimmizah chickens aged 49 weeks were divided into 6 groups based on egg weight with 5 grams differences namely as 1(<44), 2 (44- 48.99), 3 (49 – 53.99), 4 (54 – 58.99), 5 (59 – 63.99) and 6 (≥ 64.00). The obtained results showed that egg weight over 64 grams had the highest significant egg shape index compared to other egg weight groups. Moreover, eggs groups for weights between 59-63.99 and ≥ 64.00had significant increase on both egg volumes and egg surface areas compared to the rest egg groups. Also, negative correlations between egg weight and egg shape index were observed for egg groups < 44, and ≥ 64.00 grams. Moreover, highly significant correlations between egg weight and egg surface area were detected for groups of eggs weighing 44-48.99, 49-53.99, 54-58.99 and 59-63.99 grams. The accumulated egg weight loss% through the setting phase represented significant increase for eggs weighing more than 64 grams compared with those for all the rest egg categories. The increase of egg weight has a significant (p<0.001) influence on chick body weight either at hatch or at pull out as they increased with the increase of egg weight. Moreover, chick body weight loss % inside the hatcher was significantly decreased with the increase of egg weight. The correlations between egg weight and both of chick body weight at hatch are significant (p=0.001) among all experimental groups. The multiple regression equations implied the importance of egg weight and egg weight loss during incubation on chick body weight at hatch and at pull out. Thus, it could be concluded that separating hatching eggs basing on egg weight may be advisable to obtain the best hatchling weight.

Key Words: Egg weight - Egg loss - Chick body weight - Regression.

INTRODUCTION

The incubation process is one of the most important steps in economic poultry breeding. Egg weight is an important parameter that influences hatching process (Alabi et al., 2012). Also, Alabi et al. (2012) and Ashraf et al. (2016) showed the effect of egg weight on some physical egg parameters such as egg value, egg length, breadth and egg surface area.

Larger eggs had the greater surface area of the shell compared with smaller ones (Vleck, 1991). Egg weight loss is an important parameter for incubation and it has been used to estimate vital gas exchange (Rahn et al., 1979). Rate of water loss from the egg increases with size (Ar and Rahn, 1980). Also, Lourens et al. (2006) reported that small eggs produced has lowest egg weight loss compared to medium and large eggs. Whereas, Ulmer-Franco et al. (2010) reported that higher egg weight loss was produced from small sized eggs in Cobb broiler breeder hens and demonstrated that small eggs have a higher surface area to volume ratio, so higher amount of water loss from small sized eggs during incubation. There is a strong positive correlation between egg weight and hatching weight which is constant across species (Wilson, 1991). The phenotypic correlation between chicken egg weight and hatching weight is generally high ranging from 0.5 to 0.95 (Yannakopoulos, 1992). Chick body weight increase or decrease at hatch depends mainly on the egg size while chick body weight depends on dehydration for hatched chicks which stayed longer period in the hatcher (Wayatt et al., 1985; and Shahein and Wesam, 2013).

Therefore, the main objectives of this study were: 1-determining the effect of egg weight on egg shape index, egg volume, egg surface area, egg weight loss during incubation besides chick body weight at hatch and at pull out. 2-calculation the multiple regression coefficient of chick body weight at pull out through some incubation parameters.

MATERIALS AND METHODS

The present study was conducted at El-Sabahia Poultry Research Station, Alexandria, Animal Production Research Institute, Agriculture Research Center.

Eight hundred and fifty two hatching eggs produced from Gimmizah chickens aged 49 weeks were classified into 6 groups based on egg weight with 5 grams differences namely1 (<44 grams), 2 (44-48.99 grams), 3 (49 – 53.99 grams), 4 (54 – 58.99 grams), 5 (59 – 63.99 grams) and 6 (≥ 64.00 grams). The egg groups numbers and weights are presented in Table 1.

The egg lengths and widths for each egg were measured with the aid of digital calipers for detection of egg shape index with the formula of $\frac{\text{Eggwidth}}{\text{Egglength}} \text{X } 100$

The egg volume (EV) was determined using the equation derived by Narushin (1997):

$EV = (0.6057 – 0.0018B)\ LB^2$.

Where, B is egg breadth and L is egg width.

The egg surface (S) was measured according the equation reported by Narushin (1997):

$S = (3.155-0.0136L+0.0115B)LB$

Where length (L) and maximum breadth (B)

All egg were incubated in forced draft-type incubator (Egyptian made) at 99.5 F° temperature (T) and 55% relative humidity (RH) in the setter and 98.6 F° (T) and 65% (RH) in hatcher unit. At 0, 7, 14, and 18 days of incubation, all eggs were individually weighed (grams) for each egg among the egg groups, the percentages of egg weight loss for incubation intervals (0-7, 8-14, 15-18 and 0-18) per each egg weight group were calculated.

Chicks that had fully emerged from eggs were removed, wing banded, weighed to the nearest 0.1 gm and recorded as chick body weight at hatch then placed again to the incubator after recording the time of hatch. The chicks were left in the incubator until servicing time (termination of incubation). All chicks were weighed again at the time of removal from the hatcher and termed as chick weight at pull out. Chick body weight loss percentage during incubation was calculated as follows: -

$$\text{chickweightloss\%} = \frac{(\text{chickweightathatch} - \text{chickweightatpullout}\ )}{\text{chickweightathatch}} \times 100$$

Statistical Analysis:

Data were statistically analyzed using according to IBM SPSS program for Windows, version 20.0, released2011. Means differences were tested by Duncan's New Multiple Range tests (1955) at the $p \leq 0.05$ (*), $p \leq 0.01$ (**) and $p \leq 0.001$ (***) level of significance.

The Flowing model was used:

$Y_{ij} = \mu + H_i + e_{ij}$

Where,

Y_{ij} = observed traits

μ = the overall mean

H_i = effect of egg weight

e_{ij} = random error

• Multiple linear regression was performed on the studied parameters to determine the most influencing parameters on chick body weight at pull - out. The model for the multiple linear regressions was as follows:

$Y = a + b_1X_1 + \ldots\ldots + b_nX_n$

Where,

Y = Response variable (chick body weight at pull - out),

a = Intercept,

b = Partial regression coefficient,

X = Independent variables (egg weight before setting in the include, egg weight at 18 day of incubation, egg shape index, egg volume, egg surface area, egg weight loss%, chick body weight at hatch, and chick body weight loss %).

• Path coefficient: standardized partial of regression coefficients were calculated. It was to involve a direct comparison of values to reflect the importance relative of independent variables (X) to explain variation in the dependent variable (Y). The path coefficient from an explanatory variable (X) to a response variable (Y) as described by Mendes et al. (2005) is shown below:

$$P_{Y.X_i} = b_i \frac{S_{Xi}}{S_Y}$$

Where,

$P_{Y.X_i}$= path coefficient from X_i to Y (i = parameters affecting),

b_i= partial regression coefficient,

S_{Xi} = standard deviation of X_i,

S_Y = standard deviation of Y.

• Coefficient of determination (R^2) was calculated as follows:

$$R^2 = \frac{\text{Sum squares due to regression}}{\text{Totalsumsquares}}$$

RESULTS AND DISCUSSION

Data of Table 2 showed the effect of Gimmizah egg weight on egg shape index, egg volume, egg surface area and the correlations among these traits. Egg weight over 64 grams had the highest significant egg shape index compared to eggs of other weights. Whereas, other egg weight groups had no significant influence on egg shape index. Moreover, eggs groups for weights between 59-63.99 and

≥ 64 had significant increase of both egg volume and egg surface area compared to the rest egg groups. In addition, group of eggs between 44-48.99 represented the lowest significant values of egg volume and egg surface area compared to the others groups. Also, negative correlations between egg weight and egg shape index were observed for egg groups ≥ 44, 59-63.99 and ≥ 64.00 grams. Also, there were highly significant correlation between egg weight and egg volume among all groups except that group weighing ≥ 64.00 grams. Moreover, highly significant correlations between egg weight and egg surface area were detected for groups of eggs weighing 44-48.99, 49-53.99, 54-58.99 and 59-63.99 grams. Conflicting data were reported in the literature regarding the effect of egg weight on egg shape index as Saatci et al. (2005) mentioned that egg weight had no significant effect on the egg shape index. Alasahan and Copur (2016) found no effect of egg shape index on hatching weight. Also, Alabi et al. (2012) reported that egg weight did not affect egg shape index. Whereas, Hicks (1958) stated that differences between hens with respect to shape index are known to be heritable and related to egg size. Recently, Ashraf et al. (2016) mentioned that egg length and breadth varied significantly between heavy, medium and light weights. The increase of egg volume with the increase egg weight and its positive correlation in the current study is in accordance with the results of Alabi et al. (2012). Also, Malago and Baitilwake (2009) reported a positive correlation between egg weight and volume Moreover, Ashraf et al. (2016) mentioned that higher egg volume and surface area are observed in heavy egg weight category followed by medium and light ones.

Data of Table 3 represented the effect of egg weight on egg weight loss through different intervals of incubation and their phenotypic correlations. The increased trend of weight loss percentage with the increase of egg weight is observed in the data of this table among all experimental intervals. The accumulated egg weight loss through the setting phase represented significant increase of egg weight loss% increase for eggs weighing more than 64 grams compared with those for all the rest egg categories. The obtained results of increasing egg weight loss% with the increase of egg weight are keeping with the result of Tona et al. (2003) and Caglayan et al. (2009) who reported that egg weight loss increases with the increase of egg weight. While, Ulmer-Franco et al. (2010) stated that the percentage of egg weight loss decreased as egg size increased in Cobb 500 broiler breeder hen. In addition Abanikannda et al. (2011) reported very low negative and non-significant correlation between egg size and egg weight loss up to the 18^{th} day of incubation and indicated that weight loss was slower in bigger eggs compared to relatively smaller eggs.

Effects of egg weight on hatched chick body weight and chick weight loss percentage and their correlations are presented in Table 4. The increase of egg weight has a significant ($p<0.05$) influence on chick body weight either at hatch or at pull out as they increased with the increase of egg weight. Moreover, chick body weight loss % was significantly ($p<0.05$) decreased with the increase of egg weight except that of eggs weighing 44 – 48.99 grams. The correlations between egg weight and both of chick body weight at hatch or at pull out are highly significant ($p=0.001$) among all experimental groups. Whereas, there are no significant correlations between egg weight and chick weight loss% inside the hatcher.

The current results of increasing either chick body weight at hatch or at pull out with egg weight increase are in accordance with the previous reports by different authors who supported importance of egg weight for producing large chick weight. Tullett and Burton (1982) mentioned that variation of chick weight at hatch is influenced primarily by egg weight and egg weight loss during incubation. Also, Wilson (1991) reported that weight of chicks at hatch is affected by several factors including egg size.

Furthermore, it is also known that heavier eggs contain more nutrients that the small eggs and hence, developing embryos from heavier eggs contain more nutrients than small ones and developing embryos from heavier eggs tend to have more nutrients for their growth requirements (Williams, 1994). Abiola (1999) reported that egg size typically affects hatching size because the main effect of egg size lies in the mass of the residual yolk sac that the chick retains at hatching. Different research workers supported our results regarding the positive correlation between egg weight and chick weight (Shanawany, 1987; Abiola et al., 2008; and Oscar Ramaphala, 2013). Chick weight loss is determined by two main factors firstly the chick weight at hatch and secondly the amount of time they are held in the hatcher and this notion is in accordance with those previously reported by Wayatt et al. (1985).

It is concluded from the current results that sorting the eggs by weight prior to incubation might be advantageous in obtaining best hatchling weight.

Data of Table 5 represent the multiple regression value (R^2) and the contribution present of the studied parameters such as egg weight, egg shape index, and egg surface area with chick body weight at hatch and at pull out. Multiple linear regression analysis gives the amount by which the dependent variable (hatched chick weight at pull out) increases when studied independent variables are changed (EW_1 and EW_{18}), egg shape index, egg surface area, and chick body weight at hatch. The contribution for each independent variable in chick body weight at pull out through the mentioned results in Table 5 is variable depending on the variables sharing in this equation. The contribution of egg weight before setting in the incubator (EW_1) is magnitude to 17% when the equation comprised some characters of eggs such as egg shape index and egg surface area. While, introducing some variables in the equation such as EW18 and chick body weight at hatch could be the reason for decreasing the contribution of $EW_1$to 5 or 6 %.

Highest significant (R^2) value was observed for the equation of EW_1 and hatch chick body weight as independent variables, while the lowest R^2 value was detected for the equation of EW_1, egg shape index and egg surface area as independent variables.

The equation No2 magnified the contribution of chick body weight at hatch to 94% as main independent factor on chick body weight at pull out.

These equations implies the importance of egg weight loss during incubation through weighing the eggs at 18th day of incubation and the highly influence of chick body weight at hatch on chick body weight at pull out. Different researches were conducted on the regression equation between egg weight and hatched chick weight as Shanawany (1987) mentioned a significant regression between egg weight and hatching weight for all domestic birds. Also, Tserveni-Gousi and Yannakopoulos (1990) mentioned that every 1 gram increase in pheasant eggs will result in a 0.7262 gram increase in chick weight.

Alasahan and Copur (2016) reported that regression equation of hatching weight was increased by 0.5 gram for every 1 gram increase in egg weight. Moreover, Caglayan et al. (2009)mentioned that regression equation between chick weight and egg weight is quite important.

CONCLUSION

It is evident from the current results that egg weight had a main influence on hatchling body weight, other factors such as egg weight loss and chick weight loss during incubation should be taken into consideration as additional factors which contribute for maximizing chick body

Table (1): Egg weight distribution among the experimental groups

Egg groups	Egg number	Egg weight (mean± SE)
< 44	8	41.83 ± 0.65
44 - 48.99	226	46.74 ± 0.12
49 - 53.99	346	51.17 ± 0.09
54 - 58.99	214	55.40 ± 0.14
59 - 63.99	52	60.36 ± 0.32
≥ 64.00	6	64.83 ± 0.40
Total	852	51.19 ± 0.40

Table (2): Effect of egg weight on egg shape index, egg volume, egg surface area and their correlations

Egg weight group	Egg shape index	Egg volume (cm^3)	Egg surface area(cm^2)	r1	r2	r3
< 44	76.62± 1.60^{B}	40040±703.50^{E}	5644.84±73.4^{E}	-0.224	0.547***	0.233
44 - 48.99	76.97 ± 0.24^{B}	43529±206.16^{D}	5966.4±18.5^{D}	0.041	0.616***	0.618***
49 - 53.99	76.52 ± 0.15^{B}	46897±131.92^{C}	6274.73±11.79^{C}	0.004	0.578***	0.574***
54 - 58.99	77.94 ± 0.27^{B}	50128±227.89^{B}	6550.84±19.9^{B}	0.022	0.602***	0.616***
59 - 63.99	76.48 ± 0.85^{B}	55227±614.20^{A}	6998.98±52.1^{A}	-0.183	0.632**	0.541**
≥ 64.00	79.11± 1.58^{A}	54499±25330^{A}	6913.52±52.1^{A}	-0.344	0.344	0.344

A-E Means in the same column with noncommon superscripts differ significantly ($p<0.001$).
** : Significant at ($p< 0.01$); *** : Significant at ($p< 0.001$).
r_1 :Correlation between egg weight and egg shape index
r_2 :Correlation between egg weight and egg volume
r_3 : Correlation between egg weight and egg surface area

Table (3): Effect of egg weight on egg weight loss through different intervals of incubation and their correlations

Groups egg weight	**Egg weight loss%**				r_1	r_2	r_3	r_4
	(0-7day)	**(8-14day)**	**(15-18day)**	**(0-18day)**				
< 44	3.93±1.03^{D}	3.85±1.48^{C}	3.57±1.07^{B}	11.94±1.46^{B}	0.15	0.38*	0.82***	0.14
44 - 48.99	4.94 ±0.18^{CD}	4.79±0.27^{ABC}	4.14±0.24^{AB}	13.27±0.32^{B}	-0.18	-0.03	-0.01	0.02
49 - 53.99	5.99 ±0.19^{BC}	3.92±0.14^{C}	4.08±0.16^{AB}	13.38±0.24^{B}	-0.19**	-0.04	0.13	0.09
54 - 58.99	6.01 ±0.26^{BC}	3.99±0.17^{C}	4.40±0.25^{AB}	13.74±0.34^{B}	-0.37***	0.06	0.25**	0.08
59 - 63.99	6.86 ±1.77^{BC}	4.19±2.52^{BC}	4.72±0.54^{AB}	15.04±0.45^{B}	0.003	-0.40*	0.34	-0.24*
≥ 64.00	8.20±2.62^{A}	5.64±0.75^{AB}	5.45±0.94^{A}	17.98±3.20^{A}	-0.28**	0.68***	0.59**	0.46*

A-D Means in the same column with noncommon superscripts differ significantly ($p<0.05$).
*: Significant at ($p< 0.05$); ** : Significant at ($p< 0.01$); *** : Significant at ($p< 0.001$).
r_1 : correlation between egg weight and egg weight loss% (0-7days).
r_2 : correlation between egg weight and egg weight loss% (8-14days).
r_3 : correlation between egg weight and egg weight loss% (15-18days).
r_4 : correlation between egg weight and egg weight loss% (0-18day).

Table (4): Effect of egg weight on hatched chick body weight (g), chick weight loss% and their correlations

Egg weight groups	Chick body weight at hatch (grams)	Chick body weight at pull -out (grams)	Chick body weight Loss (%) (grams)	r_1	r_2	r_3
< 44	34.00±1.34^{D}	31.38±1.49^{E}	7.93±0.79^{A}	0.52***	0.52***	-0.02
44 - 48.99	35.44±0.22^{D}	33.44±0.23^{D}	5.65±0.23^{AC}	0.49***	0.43***	0.02
49 - 53.99	39.05±0.15^{C}	36.27±0.15^{C}	7.08±0.26^{ABC}	0.69***	0.58***	0.03
54 - 58.99	42.44±0.18^{B}	39.26±0.23^{B}	7.52±0.27^{AB}	0.54***	0.42***	0.16
59 - 63.99	43.38±0.85^{B}	40.46±0.89^{B}	6.79±0.45^{ABC}	0.42***	0.42***	0.22
≥ 64.00	46.33±1.58^{A}	44.00±2.14^{A}	5.27±1.62^{C}	0.40***	0.52***	0.12

A-E Means in the same column with noncommon superscripts differ significantly ($p<0.05$).
***: Significant at ($p< 0.001$).
r_1 : correlation between egg weight and Chick body weight at hatch
r_2 : correlation between egg weight and Chick body weight at pull out
r_3 : correlation between egg weight and Chick weight loss percent

Table (5): Multiple regression value (R^2) and the contribution % of studied parameters on chick body weight at pull out, grams (Y)

Number of equation	**Studied traits**	**Formula of equations**	**Contribution for each item**	**Regression coefficient (R^2)**
1	$Ew_1 + Ew_{18}$	$Y = 3.906+0.211 Ew_1+0.491 Ew_{18}$	$Ew_1 = 5$ $Ew_{18}=95$	0.665
2	Ew_1 +Chick body weight at hatch	$Y = 1.466-0.023 Ew_1+$ 0.925 Chick body weight at hatch	$Ew_1=6$ Chick body weight at hatch=94	0.895
3	$Ew_1 + EW_{18} +$ Egg shape index	$Y=5.009+0.21 Ew_1+0.493 Ew_{18}-$ 0.15 Egg shape index	$Ew_1=5$ $EW_{18}=47$ Egg shape index=48	0.664
4	Ew_1 + Egg shape index+ Egg surface area	$Y=-6.863+0.368 Ew_1+$ 0.033Egg shape index + 0.003 Egg surface area	$Ew_1 =18$ Egg shape index=26 Egg surface area =56	0.633

EW_1: Egg weight before setting in the incubator
EW_{18} : Egg weight at 18th day of incubation

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Egg weight - Egg loss - Chick body weight - Regression.

الملخص العربي

تأثير وزن البيض على بعض صفات البيض ووزن الكتاكيت الفاقسة لسلالة دجاج الجميزة

نبيل جلبي بطرس؛ على محمد حسن الشيخ؛ وسام أديب فارس؛ على عبد الهادي
معهد بحوث الإنتاج الحيواني- مركز البحوث الزراعية- الجيزة- مصر

أجريت هذه التجربة لدراسة تأثير وزن البيض على صفات شكل البيض و حجم البيض ومساحة سطح البيضة وكذلك الفاقد في وزن البيض في ماكينة التفريخ وعلاقة ذلك بوزن الكتاكيت عند الفقس وعند الخروج من الماكينة. تم تقسيم عدد 852 بيضه تفريخ لدجاج سلالة الجميزة عند عمر 49 أسبوع إلى 6 مجاميع بفرق 5 جرام ما بين المجاميع 1 (< 44) ، 2 (44- 48،99) ، 3 (49 – 53،99) ، 4 (54 – 58،99) ، 5 (59 – 63،99) ، 6 (≥ 64).

وأظهرت النتائج أن بيض المجموعة التي تزن 64 جرام أو أكثر كانت أعلي معنوية في معدل شكل البيض مقارنة ببيض المجاميع الآخرى المدروسة. وأظهرت كذلك مجموعات البيض التي تزن 59 - 63،99 ، ≥ 64 زيادة معنوية في كل من حجم البيض ومساحة السطح. وأظهرت النتائج أن الارتباط معنوي سالب ما بين صفة وزن البيض وشكل البيض للمجاميع <(44) ، (59-63،99، ≥ 64) جرام. وكذلك تلاحظ أن هناك ارتباط عالي المعنوية ما بين وزن البيض ومساحة سطح البيض للمجاميع (44-48،99) ، (49-53،99) ، (54-58،99) ، (59-63،99) جرام.

وسجلت نسبة الفقد التراكمية في وزن البيض خلال فترة التحضين أعلى قيمه في البيض الذي يزن أكثر من 64 جم مقارنه بمجاميع وزن البيض الآخرى المستخدمة. وانخفضت معنوياً نسبة الفاقد في وزن الكتاكيت داخل المفقس مع زيادة وزن البيض.

وأظهرت النتائج ارتباط معنوي عالي بين كل من وزن البيض مع وزن الكتاكيت الفاقسة ووزن الكتاكيت عند الخروج في كل مجاميع البيض المستخدمة. وقد لوحظ أن زيادة وزن البيضه له تأثير عالي المعنوية على كل من وزن الكتاكيت عند الفقس وعند الخروج من المفقس. وأيضاً اتضح من معادلات الارتداد أهمية كل من وزن البيض وكذلك الفاقد في وزن البيض داخل ماكينة التفريخ على وزن الكتاكيت عند الفقس وعند الخروج. وقد خلصت الدراسة على أهمية فصل البيض داخل ماكينة التفريخ حسب الوزن وذلك للحصول على أحسن الأوزان للكتاكيت الفاقسة.