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Effect of Egg Size on Hatchability and Subsequent Growth Performance of Fayoumi Chicken

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Abstract

The study was conducted to determine effect of egg-weight on hatchability and subsequent growth performance of Fayoumi breeds. A total of 576 eggs were purposively selected and arranged into three groups of small, medium and large sizes each with 192 eggs. Each egg group was randomly sub-divided into three replicates of 64 eggs in a CRD. Eggs were incubated for 21 days and chicks hatched on the same day were counted and individually weighed. Chicks were intensively raised on deep litter system for eight weeks on same diet, but kept separately according to their initial treatment of eggs. Data was analyzed by GLM of SAS and separated for means by Duncan's multiple-range test. The study result revealed that egg size had effect on hatchability and strongly influenced all parameters measured during the brooding periods. It has significant effect on day-old weight, body weight, final weight gain, final feed conversion and mortality. Chicken producers may opt for medium-sized eggs principally for the purpose of better hatchability and feed conversion ratio whereas large sized eggs for better hatchling weight, weight gain and survivability. It is also recommended that future work may also address the effect of egg size on the same parameters at grower or pullet stage performance and specific diseases which cause paramount chick mortality should be identified.

Keywords: chicks, egg size, fayoumi, performance

1. Introduction

Egg weight and chick weight at hatching is positively related (Khurshid et al., 2003). Many agree that it is preferable to have eggs of average weight to achieve good hatchability as far as chicken, turkey, ducks and ostriches are concerned (Brah et al., 1999; Gonzales et al., 1999). The size of the embryo before and at hatching can be altered by the weight of the egg and the incubation environment (Wilson, 1991). There are many factors which influence hatchability of eggs and these include storage time, fertility, temperature, relative humidity, ventilation, position of the egg, turning of the egg and candling. Similarly feed variation also affects hatchability (Mussaddeq et al., 2002). Other factors that affect hatchability of a breeding hen include genetic constitution of the embryo, disease, egg size, age and shell quality (King'ori, 2011). Egg weight, fertility, hatchability and late dead in germs varied greatly between feed regimes (Lariviere et al., 2009). Similarly the fertility of an egg is affected by factors directly related to the laying hen such her ability to mate successfully, store sperm, ovulate and finally produce a suitable environment for the formation and development of embryo (Brillard, 2003). Fertility also depends on the ability of cock to mate successfully, quantity and quality of semen deposited (Brillard, 2003). Wondmeneh et al. (2011) showed that breed had a significant effect on the hatchability parameters and also on weight of the day-old chicks. Islam et al. (2002) concluded that breed have little effect on the hatchability of fertile eggs and fertility and hatchability on total eggs is significantly higher in White leg horns compared to White Rock, Rhode Island Red, and Barred Plymouth rock and also the White Leghorn had more positive correlation on hatchability parameters than the other breeds.

The performance potentiality of the chicken depends, in part, on egg quality. Egg quality is an important parameter for embryogenesis as well as for one day old chick quality and growth.In hatchery management, the judgment of the quality of a day-old chick is usually based on qualitative aspects, such as abnormalities and contamination. Thus, day-old chick quality when removed from the hatcher seems to be anall-or-nonequestion.Improved quality of day-old chicks as starting material ensures greater survivability and better growth potential during the first days or first week of life (Christensen, 2001). According to Deeming

(1995), day old chick quality can be related to several factors, such asincubatorquality, incubation environment and egg characteristics. Alabi et al. (2012) reported the effect of egg weight on hatchability and subsequent performance of white leghorn chicks from one to seven weeks of age found that the weight of white leghorn eggs influenced all parameters measured except the mortality rate percentage. The growth response of males to egg weight is greater than that of females (Joubert et al., 1981). The report of Tufft and Jesen (1991) revealed that the effect of the egg weight on body weight at market age is independent of the age of the breeders from which the eggs originated. The effect of breeder age seems to be largely associated with egg weight.

Although the effect of egg size on hatchability was extensively studied for chickens, there was limited information on the effect of egg size on subsequent growth performance of Fayoumi chicks under eastern Ethiopian condition. Therefore, the objective of this study was to determine the effect of egg size on hatchability, hatchling weight and growth performance of Fayoumi during the first eight weeks of post-hatchability.

2. Materials and Methods

2.1 Description of the Study Area

The study was conducted at Haramaya University poultry farm, located at 505 km east of Addis Ababa and situated at an altitude of 1980 meter above sea level, 9°26′N latitude and 42°3′E longitude. The area has an average annual rainfall of 741.6 mm. The mean annual minimum and maximum temperatures are 8.25 °C and 23.4 °C, respectively.

2.2 Egg Collection and Selection

A total of five hundred and seventy six (576) hatching eggs were collected from 49 weeks of age Fayoumi layers reared at Haramaya university poultry farm. The eggs were selected based on shape, free of shell cracks and stored in cold room for seven (7) days. The eggs were individually weighed, marked and purposively grouped into small (33-40 g), medium (41-48g) and large (49-56 g) each with a total of one hundred and ninety two (192) eggs which were also randomly sub-divided into three (3) replicates each with sixty four (64) eggs in a CRD.

2.3 Egg Incubation and Its Managements

Eggs were individually placed into a tray with the broad ends pointing upwards and incubated at 37.5 °C and 70% relative humidity for eighteen (18) days during which the tray was placed at an angle of 45° and other incubation procedures followed. On 18^{th} day of incubation, eggs were transferred at once into same hatchery unit. A temperature of 36.0 °C and relative humidity of 80% were provided for the last three days. Chicks hatched on same day (21) were counted, weighed on a sensitive balance and the percentage hatchability was calculated using formulas described by Sahin et al. (2009).

2.4 Management of Birds

In the second part of study, all normal chicks hatched from each treatment group were used for subsequent growth trial. Pens, watering and feeding troughs were thoroughly cleaned, disinfected and sprayed before placing the experimental chicks in pen. Chicks hatched from the same egg groups were grouped in to same group based on their intial treatment, to evaluate their growth performance. Chicks were intensively raised on deep litter system for eight (8) weeks. The litter materials used was wood shavings. On first day of hatching, chicks were provided water with vitamin premix (15 gm vitamin premix in 10 litter water). On second day of hatching, birds were vaccinated against new castle disease and medications were provided using broad spectrum antibiotics. Each pen installed with two infra red that was on 24 hrs. Hatched chicks were reared on same diet, but kept separately according to the initial treatment of the eggs. Feed and water were given to the birds *ad libitum*. The experimental diet was composed of ground corn (44%), soybean meal (7.5%); peanut meal (20%), wheat short (25%), salt (0.2%), limestone (2.3%) and vitamin premix (1%).

2.5 Body Weight Measurements

Live weight of chicks were taken at hatching and recorded as initial weight then the average live weight per bird was measured every fourteen (14) days by weighing the chicks in each pen and total weight was divided by the total number of birds in each pen. These live weights were used to calculate growth rate. The overall average body weight for each treatment was then computed by taking average values for the replication.

2.6 Feed Intake and Feed Conversion Ratio (FCR)

A weighed amount of feed was offered once daily at 08:00 am every day and refusal was collected the next morning and weighed after removing external contaminants by visual inspection and hand picking. The feed offer and refusal were recorded for each replicate and multiplied by the respective dry matter (DM) content. The amount of DM consumed was determined as the difference between the DM offered and refused. Feed conversion ratio (FCR) is measured by dividing feed consumed into live weight gain within two consecutive weeks.

2.7 Mortality

Mortality was recorded daily during the study and expressed as percent for two consecutive weeks.

2.8 Statistical Analysis

Effect of egg weight on hatchability, hatchling weight and subsequent growth performance of chicks were analyzed by general linear model (GLM) procedure of the statistical analysis system (SAS, 2008). The statistical model used was: Yijk = μ + Ti + ∑ijk, Where, Yijk is the overall observation (hatchability, weight gain, mortality), Ti is effect of different egg size (small, medium and large), ∑ijk is residual effects.

3. Results and Discussion

Egg weight had strong effect on hatchability of Fayoumi strains (Table 1). This study discovered better hatchability for medium sized eggs as compared to other groups, which was in line to the findings reported by Alabi et al. (2012) who reported that the intermediate size eggs of chickens have higher hatchability. Similarly, Hassan et al. (2005) reported that medium sized eggs yield at least 75% hatchability compared with 50 to 70 of small and large egg weights. Unlikely, De Witt and Schwabach (2004) observed that large eggs recorded to have higher hatchability in New Hampshire and Red Rhode Island chicken breeds. Another study showed that large sized eggs of indigenous Venda chickens had higher hatchability than medium and small sized eggs (Mbajiorgu, 2011). There was a negative correlation between egg weight and hatchability in crossbred chickens and heavier eggs resulted in lower hatchability than medium (Farooq, 2001). Wondmeneh et al. (2011) indicated that breed had a significant effect on the hatchability parameters. The average hatchability of eggs recorded in this study (71.87 to 84.03%) showed a value similar to those reported for same breed (75.00 to 88.3%) (Rashid et al., 2011; Miazi et al., 2012). In this study, the reason for differences in hatchability percent was the effect of egg weight.

Table 1. Effect of egg size on hatchability of Fayoumi chicken breeds

Egg groups	Total Eggs (n)	Egg weight range (g)	Egg weight (g)	Hatchability (%)
Small	192	33-40	38.45 ± 1.64^{c}	71.87 ± 2.70^{c}
Medium	192	41-48	43.99 ± 1.84^{b}	84.03 ± 4.27^{a}
Large	192	49-56	50.17 ± 1.86^{a}	79.69 ± 1.56^{b}
SL	-	-	***	*

Note. [abc], Means with the same letter are not significantly different.

Egg size of Fayoumi breed influenced all parameters measured from day old to eight weeks of age (Table 2). Similarly, Alabi et al. (2012) reported the effect of egg weight on hatchability and subsequent performance of white leghorn chicks from one to seven weeks of age found that the weight of white leghorn eggs influenced all parameters measured except the mortality rate percentage. The egg size had significant effect on the means of initial weight at hatch and during the brooding age (0-8 weeks) of chicks. In this finding, higher hatchling weight (26.12 to 32.78 g) was recorded for the same breed than findings (23.55 g) of Rashid et al. (2011). Solomon (2004) reported higher mean hatching weight (42 g) for the White leghorn in Jimma College of agriculture of Ethiopia. This study result revealed that small chicks were hatched from small eggs while large chicks hatched from large eggs. This is in agreement with the reports of Garip and Dere (2011) for Japenese quail, Çaðlayan et al. (2009) for rock partridges, Raju et al. (1997) for chicken and Saatc et al. (2005) for geese. They indicated in their study as the hatchling weight has function of egg weight regardless of strain difference. Similarly, Caglayan and Inlal (2006) observed that chick weight increased with the increasing egg weight. Egg weight and chick weight at hatching are positively related as reported by Khurshid et al. (2003). Ramaphala and Mbajiorgu (2013) also indicated that large-sized eggs produced chicks with higher chick hatch-weight than medium and small sized eggs. However, contrary to the present findings, Asuquo and Okon (1993) reported that egg size within the intermediate weight hatched heavier chicks than small or large eggs. Furthermore, it is also known that heavier eggs contain more nutrients than small or medium sized eggs (Williams, 1994) and hence as a result, chicks from heavier eggs tend to have more yolk attachment at hatching (Hassan et al., 2005; Woanski et al., 2006). Wondmeneh et al. (2011) also reported as breed had a significant effect on weight of the day-old chicks. The current results suggest selection of hatching eggs of proper size to produce quality chicks of better hatchling weight and livability.

Table 2. Effect of egg size on subsequent growth performance of unsexed (sex unidentified) Fayoumi chicks (mean ± SE)

Parameters	Age, weeks	N	Chicks hatched from			SL
			Small size	Medium size	Large size	
Day-old weight, g/bird	-	SML0	26.12±0.31^c	29.30±0.56^b	32.78±0.81^a	***
Body weight, g	2	SML2	47.16±0.19 ^{c}	60.38±0.54^b	61.35±0.87^a	***
	4	SML4	69.90±0.79^c	101.20±0.14^b	108.20±0.62^a	***
	6	SML6	113.00±0.15^c	141.90±0.42^b	167.70±0.54^a	***
	8	SML8	159.00±0.32^c	168.90±0.11^b	217.90±0.47^a	***
Body weight gain, g/bird	0-2	SML0-2	21.04±1.12^c	31.08±0.97^a	28.60±0.47^b	***
	2-4	SML2-4	22.07±0.44^c	41.33±0.83^b	46.83±0.11^a	***
	4-6	SML4-6	43.09±0.11^c	66.01±0.87^a	59.53±1.31^b	***
	6-8	SML6-8	46.00±0.81^b	26.99±0.22^c	50. 19±1.02^a	***
Aggregate weight gain, g/bird	0-8	-	132.20±0.22^c	165.10±0.33^b	185.20±0.01^a	***
Average feed intake, g/bird/day	0-2	SML0-2	9.07±1.21^c	12.47±0.89^a	11.28±0.47^b	***
	2-4	SML2-4	16.70±0.88^c	22.20±2.11^b	24.00±0.71^a	***
	4-6	SML4-6	19.14±2.09^b	19.07±1.52^c	30.50±1.67^a	***
	6-8	SML6-8	10.30±0.77^c	14.08±0.53^b	33.19±0.42^a	***
Aggregate feed intake, g/bird	0-8	-	55.21±0.19^c	67.82±0.21^b	98.97±0.33^a	***
Feed conversion, g/bird	0-2	SML0-2	0.43±0.52^a	0.40±0.54^b	0.39±0.51^c	***
	2-4	SML2-4	0.73±0.11^a	0.54±0.52^b	0.51±0.47^c	***
	4-6	SML4-6	0.44±0.91^a	0.29±0.29^b	0.10±0.48^c	***
	6-8	SML6-8	0.22±1.23^c	0.52±0.57^b	0.66±0.81^a	***
Aggregate feed conversion, g/bird	0-8	-	0.42±0.22^b	0.41±0.61^c	0.53±0.23^a	***
Mortality, %	0-2	SML0-2	26.19±0.86^b	10.71±0.54^c	29.82±0.63^a	***
	2-4	SML2-4	22.58±0.78a	9.33±0.69^b	5.00±0.81^c	***
	4-6	SML4-6	25.00±0.67^a	17.65±0.39^b	7.89±0.77^c	***
	6-8	SML6-8	44.44±0.55^b	54.05±0.32^a	12.90±0.88^c	***
Aggregate mortality, %	0-8	-	76.19±3.81^a	57.14±5.33^b	45.61±8.09^c	***

Note. S, M, and L-Number of chicks hatched from small, medium and large egg sizes. S(0)-42, M(0)-84, L(0)-57,S(0-2)-31, M(0-2)-75, L(0-2)-40, S(2-4)-24, M(2-4)-68, L(2-4)-38, S(4-6)-18, M(4-6)-57,L(4 6)-35, S(6-8)-10, M(6-8)-37, L(6-8)-31.

Chicks hatched from large sized eggs had higher live weight than chicks hatched from medium and small sized eggs all over the brooding periods (Table 2). This result confirmed the significance of large eggs for incubation in analogous to Abiola et al. (2008) who reported big size-egg for incubation. Also, this was approved by Ramaphala and Mbajiorgu (2013) as the yolk attachment is utilized by the chick after hatching and the potential performance of day-old chicks may depend on the quality and quantity of this yolk. As cited by Jiang and Yang (2007), many researchers have shown that day-old chick weight is an important factor affecting brooder performance and similar conclusion was also obtained by Hartmann et al. (2003) in a White Leghorn breeds. However, some studies have found that the advantage of chick weight at hatch diminishes rapidly after hatching (Gupta & Johar, 1975; Pinchasov, 1991; quoted by Jiang & Yang, 2007). The increase in body weight represents growth and development of farm animals (Nsoso et al., 2008). This finding illustrated the difference in aggregate body weight in the brooding age that might be due to differences in egg weights.

Chicks hatched from medium sized eggs had better body weight gain during the first two weeks and from four to six weeks whereas chicks hatched from large sized eggs had higher weight gain from two to four, six to eight and at the end of experimental weeks (Table 2). As reported by Egbeyale et al. (2011), egg size had significant effect on the means of initial weight, total weight and daily weight gain. Chicks hatched from large sized eggs were consumed more feed than chicks hatched from other groups of eggs except the first two weeks (Table 2). It is common knowledge, the higher the size of an animal the higher the intake in order to maintain the body processes and productivity, thus it is expected that the larger chicken will require higher feed intakes. These results are similar to the findings of Abiola et al. (2008) who observed that daily feed intake of chickens increased with increase in the weight of chicks. Increase in feed intake as birds grew is due to the increasing demand for protein and energy needed for growth (Mwale et al., 2008). The increase in feed intake as birds grew is consistent with Nsoso et al. (2008).

The first six weeks the feed conversion ratio was better in chicks hatched from large sized eggs whereas the aggregate feed conversion ratio (FCR) in the brooding phase was better for chicks hatched from medium sized eggs (Table 2). Similarly, De Witt and Schwalbach (2004) found that feed conversion ratio was better in chicks hatched from medium New Hampshire and Rhode Island Red eggs than in those hatched from larger eggs. The same to this study, Mwale et al. (2008) noted that decreasing FCR with age could be due to increasing feed quantities needed for growth. Solomon (2004) reported higher feed conversion efficiency (5.8%) for the white leghorn breed raised for 60 days under intensive management conditions in Jimma College of agriculture of Ethiopia and this might be due to difference in breeds.

Egg weight affected survivality of Fayoumi chicks during the brooding period (Table 2). These results were contrary to the findings of Singh et al. (2003) who reported that the egg size had no effect on mortality pattern in chicken. Contrarily, Alabi et al. (2012) reported as the weight of white leghorn eggs influenced all parameters measured from one to seven weeks of age except the mortality rate percentage. The mortality rates obtained from this study were higher than 26.3%, the result obtained by Badamasi et al. (2014) for Arbor acre strain. This may be due to difference in breeds' used in study or management system applied. Solomon (2004) reported 8.1% mortality for white leghorn breed raised for 60 days under intensive management conditions in Jimma College of agriculture of Ethiopia. During the brooding periods chicks exhibited recurrent symptoms of wing droppings, one or both eyes closed and leg weakness but the specific disease type which cause paramount mortality was not identified.

4. Conclusion

Chicken producers may opt for medium-sized eggs principally for the purpose of better hatchability and feed conversion ratio whereas large sized eggs for better hatchling weight, weight gain and survivability. This study was conducted only on Fayoumi chicken breeds during rooding stage, therefore, future work may also address effect of egg size on the same parameters at grower or pullet and layer stages including other breeds and also specific disease which cause paramount chick mortality should be identified.

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