Effect of egg size and lines on hatching performance of chicks from broiler breeders under selection

Olutunmogun, A. K., Umar, A. U., Adejoh-Ubani, E. O., Nwagu, B. I., Adeyinka, I. A. and Muhammad, S. M.

National Animal Production Research Institute (NAPRI),
Ahmadu Bello University, Shika-Zaria, Kaduna State, Nigeria

Corresponding author: Olutunmogunkayode@yahoo.com

Abstract

The study was conducted with the objective of evaluating the effect of egg size (small, medium and large) and lines on egg and hatch weight, fertility, hatchability, embryonic mortality and infertile eggs of broiler breeders under selection. A total of 120 broiler chicks were hatched from three different egg sizes (40 chicks per egg size as indicated) from breeder parents at 40 weeks of age. The broiler breeders were mated in a ratio of 1:6. Data obtained were subjected to analysis of variance in a complete randomized design. The result showed that significant ($p < 0.05$) egg weight loss in incubator were recorded with the large egg size group having the minimum loss of 10.85%. The hatch weight was significant ($p < 0.05$) and increased from the small to the large (36.24, 36.73 and 40.22g) egg size group. Line had significant effect ($p < 0.05$) only on the medium egg size: egg weight (sire = 57.50g; dam = 55.00g) and hatch weights (sire = 39.71g; dam = 36.10g). The fertility (94.02, 93.01 and 78.01%), hatchability (87.42, 88.20 and 62.41%) and embryonic mortality (6.58, 9.80 and 15.6%) had significant ($p < 0.05$) differences with the small egg size group performing better excluding the average egg weight, which was then followed closely by medium egg size group. It can be concluded that for higher hatch weight target, the large egg size should be selected but for the purpose of better fertility and hatchability, the medium and small egg sizes should be selected.

Keywords: Egg size, egg weight loss, fertility, hatchability.

Introduction

Poultry production has been reported to be the main source of household nutrition and income in the developing countries with most of the species being exotic (Javid *et al.*, 2016). The production of poultry is practiced in Nigeria at all levels which ranges from subsistence to large scale commercial operations. Usually, the commercial operations rely on the exotic chicken breeds both for egg and meat type chickens. With this sort of operations at present, studies have nonetheless demonstrated conflicting evidence indicating that performance in broiler chickens in terms of hatchability and chick-hatch weight may be closely related to the weight of the eggs (Wilson, 1991; Uluocak

et al., 1995; Kalita, 1994; Abiola, 1999; Donald *et al.*, 2002; Rashid *et al.*, 2005; King'ori *et al.*, 2007). Thus, the egg weight and chick weight at hatching are positively related (Khurshid *et al.*, 2003). The time spent by broilers on the farm may be decreasing as selection for fast growth is required. The embryo has been found to still require 21 day incubation period, which translates into a greater percentage of the life of the broiler chicken being spent in the incubator. The size of the embryo before and at hatching can be altered by the weight of the egg and the incubation environment (Wilson, 1991). Furthermore, the performance potentiality of the chicken depends on egg quality. Egg quality is an important component for embryogenesis as

well as for a 1day-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. Deeming (1995), observed that day-old chick quality can be related to several factors, such as incubator quality, incubation environment and egg characteristics among many others. 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. Reports have shown that the broiler industry is running at commercial level and limited information exists on the effect of the hatching egg size, strains and breeder age on hatching performance. Egbeyale et al. (2011) observed the effect of breeder age to be largely associated with egg weight. King'ori (2011) suggested that chick weight, fertility and hatchability are interrelated heritable traits that vary among breeds, variety or individuals in a breed. Therefore, due to paucity of information on broiler parent stock under selection, it becomes very important to understand the effect of egg size and lines on hatching performance of chicks from broilers under selection as a sole objective of the study.

Materials and methods

Experimental site

The experiment was conducted at the Research Unit of the Poultry Research Programme of National Animal Production Research Institute, Shika-Zaria. Shika lies between latitude 11° 12' 42" N and longitude 7° 33' 14" E and altitude of 640m above sea level (Ovimaps, 2014). The temperature of Shika ranges between 14.5 – 39.5 °C with a humidity range of 21 - 72% occurring during the early dry and wet season respectively. Detailed description of Shika climate has been given elsewhere by

Kabir et al. (2006).

Experimental birds and management

One hundred and fifty hatching eggs of different egg size were obtained from two lines of broiler parent stock under selection (sire and dam lines). Seventy five hatching eggs were collected from each line. The parent stock from which fertile eggs were obtained was 40 weeks of age. The birds were in a mating ratio scheme of one male to six females (1:6). The egg sizes from each line were weighed using a Camry digital sensitive weighing scale to one decimal place.

The eggs were then classified into three groups of small (>41.0g – 51.0g), medium (52.0g – 61.0g) and large (62.0g – <71.0g). Each egg group had 50 eggs. After setting in the incubator, at the 18th day fertile eggs were sorted and weight loss was taken in percent of the initial egg weight.

After hatching in individual trays, 120 day-old chicks were obtained from a Buckeye incubator; 20 chicks from each of the egg size were collected with a sum total of 60 chicks per line. The hatched chicks were then weighted and wing tagged so as to maintain a pedigree record of the birds. The chicks were intensively managed on deep litter system, medication and vaccinations were administered as at when due and feed and water was provided ad libitum.

Data collection

Data were collected for egg weight for the three egg sizes, percent weight loss, fertility, hatchability, embryonic mortality and infertile eggs were estimated as follows:

% infertile =

$$\frac{\text{Total number of infertile eggs}}{\text{Total number of eggs set}} \times 100$$

% fertile = 100 – % infertile

$$\begin{aligned} \% \text{ hatchability} = & \\ \frac{\text{Total number of hatched egg} \times 100}{\text{Total number of fertile eggs}} \end{aligned}$$

The mathematical model is as expressed below:

$$Y_{ijk} = \mu + L_i + S_j + e_{ijk}$$

Where;

Y_{ijk} = measurement of trait on the i^{th} line of the j^{th} egg size of the k^{th} random error; μ =overall mean; L_i =effect of the i^{th} line (sire and dam), S_j = effect of the j^{th} egg size (small, medium and large) and e_{ijk} = random error assumed to be normally and independently distributed.

Statistical analysis

All the data obtained were subjected to analysis of variance in a complete randomized design using SAS (2002). Significant means were separated using Duncan Multiple Range Test (Duncan, 1955).

Results and Discussion

Table 1 shows the effect of egg size on weight and weight loss during incubation. Significant differences ($p < 0.05$) were recorded in egg size with values of small (46.46 ± 1.10), medium (55.90 ± 1.09) and large (64.14 ± 1.17), respectively. Egg weight loss (%) after 18 days in incubation had significant ($p < 0.05$) differences with minimum loss in the large egg (10.85 ± 0.09) size group while small (11.01 ± 0.12) and medium (11.05 ± 0.07) egg size were similar. The result obtained in this study on egg weights is comparable with those of Javid et al. (2016) where they obtained egg weights of 60.05g (small), 65.03g (medium) and 70.03 (large) in Hubbard Classic broiler breed. However, Abiola et al. (2008) reported values of 41.09 – 50.97g (small), 50.98 – 57.98g (medium) and 57.40 – 69.64g (large) in Anak broiler

which are similar with the findings of this present study. Although the values are comparable, the possible differences could be attributed to breed difference, age of the parent hen and degree of selection on the birds. The finding on egg weight loss had the small size eggs lost more weight than medium and large and is similar with those of Javid et al. (2016) where they obtained between 10.62 – 11.32% weight losses at 18th day for similar egg size in Hubbard Classic broiler breed with more loss recorded against the small size eggs. Also, Ulmer-Franco et al. (2010) reported that the percentage of egg weight loss decreased as egg size increased in Cobb 500 broiler breeder hen. Also, weight loss of between 10.85 to 11.05% obtained in the present study is in variance and do not support the results of Hristakieva et al. (2014) who obtained 15.91% for Ross 308 broiler and 14.74% for Cobb 500 broilers.

Javid et al. (2016) suggested that owing to the increased surface-to-volume ratio in small eggs (inferred from egg size); it was not surprising to observe that the small eggs lost the highest percentage of moisture. Large eggs had a greater proportion of albumen (and thus greater moisture content) than small eggs. Similarly, the average weight loss of 10.97% regardless of the egg size class in the study is lower than the value of 12.94% reported by Soliman et al. (1994) for quail eggs but higher than 7.75% reported by Javid et al. (2016) in Hubbard Classic broiler. It is also lower than the values of 24.76% reported by Saylam (1999) and 20.90% reported by Saylam and Sarica (1999) in quail eggs, and higher than the values of 1.25% reported by Khan et al. (2013) in Fayoumi eggs which consequently affect the chick weight at hatching. The differences in weight losses among different studies during incubation can be due to the difference in species. Egg

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weight loss that occurs during incubation of eggs is about utterly due to water diffusion through the shell (Tona et al. 2001). 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) under which the eggs were set (Gonzalez et al. 1999). Similarly, Deeming (1995) determined that 10–12% weight loss is necessary during incubation in order to get a good incubation result in stored and non-stored eggs.

Table 1: Effect of egg size on egg weight and weight loss during incubation

Egg size	Egg weight at time of incubation (g)	Egg weight loss (%) at 18day in incubation
Small	46.46±1.10 ^c	11.05±0.07 ^b
Medium	55.90±1.09 ^b	11.01±0.12 ^b
Large	64.14±1.17 ^a	10.85±0.09 ^a
P-value	0.032	0.04

^{abc}= Means in the same column with different superscripts are statistically different (P<0.05)

Table 2 shows the LSM effect of egg size on hatch weight with significant differences (p<0.05) obtained between the egg sizes. The result revealed that hatch weight was amplified as the egg size increased as this correlates the earlier reports of Javid *et al.* (2016) in Hubbard classic broiler that increase egg size increases the hatch weight and chick length however, the chick weight obtained by the authors were (40.29 – 47.82g) much heavier than the 36.24 to 40.22g obtained in this study. Also, Olutunmogun *et al.* (2016), obtained similar hatch weight of between 37.52 to 37.73g in two lines of broiler parent under selection though the authors did not group the hatching eggs into egg size group.

These differences in chick weight could be tailored to degree of select, environment factors (quality of feed, weather) and age/potential of parent breeder. Adeyinka *et al.* (2001) observed that the setting size of hatching eggs on the chicks' performance at day old and at subsequent ages is affected by egg size with the larger egg size having a higher chick quality over other egg sizes in two strains of Rhode Island Red. Chick or hatch weight as reported by Decuyper *et al.* (2002) is the most widely used indicator for day-old chick quality assessment. It is known that a positive correlation exists between egg size and chick weight in broiler chickens (Abiola *et al.* 2008).

Table 2: Least square means effect of egg size on hatch weight

Egg size	Hatch weight (g)
Small	36.24±0.91 ^b
Medium	36.73±0.80 ^b
Large	40.22±0.61 ^a
P-value	0.001

^{ab}= Means in the same column with different superscripts are statistically different (P<0.05)

The effect of line on egg weight and hatch weight is as shown in Table 3. The result revealed that line had significant (p<0.05) effect on the medium egg weight and hatch weight with the sire line being the better of the both. Line effects on egg weight has been reported by several authors suggesting

that each of these genetic organisms differ and pose to exhibit its own inherent abilities either as a breed (Abanikannda *et al.*, 2011), strain (Abudabos, 2010) and genotype (El-Safty, 2012). The results of line on hatch weight confirms the report of Egbeyale *et al.* (2011) were the authors reported

between 33.95g, 36.70g and 41.94g hatch weights for similar egg size and also obtained 38.26 g and 37.13g for Dominant Black and Yaffa Brown strains.

Table 3: Least square means effect of line on egg weight and hatch weight

Traits	Line/egg weight (g)		P-value
	Sire	Dam	
Egg size			
Small	47.37±1.13 ^{ns}	48.00±1.32 ^{ns}	0.199
Medium	57.50±0.44 ^a	55.00±0.52 ^b	0.034
Large	64.05±0.59 ^{ns}	64.25±0.61 ^{ns}	0.860
Egg size	Line/hatch weight (g)		P-value
	Sire	Dam	
Small	38.43±0.61 ^{ns}	37.52±0.80 ^{ns}	0.711
Medium	39.71±0.33 ^a	36.10±0.29 ^b	0.051
Large	41.21±0.19 ^{ns}	41.27±0.28 ^{ns}	0.420

^{ab}= Means in the same row with different superscripts are statistically different (P<0.05), ns = not significant

The effect of egg size on the average egg weight, fertility, hatchability, embryonic mortality and infertile egg are as show in table 4. At this stage of production, all the parameters had significant (p<0.05) difference with the small egg size being superior in all the traits apart from average egg weight followed by the medium and lager egg sizes respectively. Fertility and hatchability are two major parameters that influence day-old chicks Javid *et al.* (2016). However, there is a scarcity of information on the effect of egg size on hatchability in broiler breeders of any breed. This result confirms the earlier report of Javid *et al.* (2016) for the small and medium egg size. Also, this result is in consonance with earlier observations of Kirk *et al.* (1980) that found that fertility of broiler breeders declined by 11% and hatchability declined 9% in eggs weighing more than 70 g. In general, several authors agrees 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). Actually, hatchability of the incubated eggs increased as egg weight increased to large egg-size group. Wilson (1991) suggested that egg size group of 60–69 g were best suited for incubation. Similar the results obtained in the current study suggest that best fertility and hatchability traits were obtained in small and medium egg size groups having 46.46–64.14g g egg weight. Reviews from literature shows that hatchability reduction of eggs from older broiler breeders is a result of many contributing factors, including larger egg size (Leeson and Summers 2000), increased early and late embryo mortality (Elibol and Braket 2003), poorer shell quality due to bigger surface area (Bennett 1992), albumen quality deterioration (Tona *et al.* 2004) and increased the yolk cholesterol content (Dikmen and Sahan 2007).

Table 4: Effect of egg size on fertility and hatchability performance

Parameters	Egg size			P-value
	Small	Medium	Large	
Egg numbers	50	50	50	-
Av. egg weight (g)	46.46±1.10 ^c	55.90±1.09 ^b	64.14±1.17 ^a	0.04
Egg Fertility (%)	94.02±0.70 ^a	93.01±0.41 ^a	78.01±0.39 ^b	0.001
Hatchability (%)	87.42±1.08 ^a	88.20±0.33 ^a	62.41±0.75 ^b	0.001
Embryonic mortality (%)	6.58±0.39 ^a	9.80±0.11 ^b	15.6±0.20 ^c	0.003
Infertile eggs (%)	6.01±0.70 ^a	7.00±0.41 ^b	22.00±0.39 ^c	0.001

^{abc}= Means in the same row with different superscripts are statistically different (P<0.05), Av. = Average

Conclusion

In conclusion, minimum egg weight loss occurred in the large egg size group. To attain better fertility and hatchability traits in broiler breeder flock, medium egg size (52–61g) should be selected for incubation although the small egg size (greater than 46.46g) can also be considered. For larger chick at hatch, the large egg size can be used. Embryonic mortality (6.58 to 9.80%) and infertile eggs (6.01 to 7.00%) were low for the small and medium egg size when compared to the 15.6 and 22.00% recorded for the large egg size.

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