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EVALUATION OF THE INFLUENCE OF BROILER BREEDER EGG WEIGHTS ON HATCHING AND POST-HATCH PERFORMANCES IN MARSHAL BREED

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ABSTRACT

This study was designed to evaluate the effects of different Marshal breed broiler on hatching egg weights on hatching characteristics and post-hatch performances; and also to compare the cost of production of hatchlings to table size. A total of 900 hatching eggs (HE) from 40 weeks old parent stock were sorted, graded and purposively grouped on weight basis into small (<50g), medium (50-65g) and large (>65g) sizes (3 groups). Each group was allotted 300 eggs and replicated thrice, with each replicate having 100 eggs in a complete randomised design before incubation for 21 days. Candling of incubated eggs was done on day 18 on group basis and numbers of fertile eggs noted. The chicks were individually weighed and counted to determine hatchability, hatchling weight and cost of production. Thereafter, hatched chicks were allotted into the respective groups and replicated to determine the post-hatch performance. Each replicate has 45 chicks, intensively raised and were fed *ad libitum* with broiler starter mash for the first 4 weeks of life and broiler finisher mash from 4-8 weeks. Data generated include feed intake, final weight, mortality; weight gain, feed conversion ratio and unit cost of production of chicken were calculated. The data were analyzed by GLM of SAS and Duncan's multiple-range test was used to separate significance of differences among treatment means at 5% significance level. The medium HE had the best fertility (93.00%), hatchability (95.67%) and cost of producing a chick (N 90.07) when compared with the small and large HEs. The large HE has the best results in terms of, final weight and weight gain, while medium HE has the best FCR, lowest mortality and least cost of production, which are significant at $p< 0.05$. It is therefore recommended poultry breeders and hatchery operators should consider the use of medium weight (50-65g) HEs in their operations, so as to cut down the production cost.

Keywords: Broilers, hatchability, hatchling weight, post-hatch, performance, production cost

INTRODUCTION

Malnutrition and under nutrition remain persistent in many developing countries, with close to one billion people undernourished across the world (FAO, 2012). Poultry products are the best source of quality protein, and are urgently needed by the poverty stricken malnourished populace in sub-Saharan Africa and South Asia to bridge the gap of protein deficiency (Smith and Wiesmann, 2007; Farrel, 2016).

Poultry production is fast gaining popularity in the developing countries as a result of its role in bridging the protein malnutrition. This is realisable due to the ability of broiler chicken to achieve the same body weight in a very short time when compared with their randomly bred predecessors (Havestein *et al*., 2003; King'ori, 2011).

The main goal of a commercial broiler integration unit is to produce high quality hatching eggs that will produce the greatest number of quality chicks for stocking. This is important for the success of the poultry production chain (King'ori, 2011; Butcher and Nilipour, 2017). Successful hatching is greatly influenced by the physical properties of the egg, especially egg weight (Narushin's and Romanov, 2002). Also, a highly significant positive correlation is believed to exist between egg weight and chick weight at hatching (Khurshid *et al*., 2003; Ramaphala and Mbargiorgu, 2013). The quality of the newly hatched chick and the percent hatchability are major factors in determining liveability, growth, health, chick output and performance in broiler production (Ulmer-Franco *et al*., 2010; Malik *et al*., 2015).

There are paucity of information on the effects of hatching egg weight on subsequent growth performance of hatchlings to table size and their cost of production in Marshal breed. This study is therefore designed to evaluate the effects of different broiler hatching egg (HE) weights on hatch and post-hatch performances; and also to compare the cost of production of hatchlings to table size in Marshal breed.

MATERIALS AND METHODS

Study locations

The setting of hatching eggs and hatching of chicks were carried out at a commercial hatchery located at Alexandra area of Apata (7° 24' 3''N, 3° 48' 6''E), Ibadan, South Western Nigeria, with an average relative humidity of 75–90% and mean monthly temperature range of 28-32 °C. The post-hatch performance was conducted at a commercial poultry farm at Asero, in Abeokuta (7°10' 17.40'' N, 3°25' 5.96'' E), South Western Nigeria. This zone has an average annual maximum and minimum temperature of 31.8±3.2°C and 18.0±3.7°C, respectively. The monthly average rainfall during the rainy season (May-October) is 148±68.4 mm 69.2-231.9 mm), while the monthly relative humidity is 71.1±9.7%.

Study design

A total of 900 hatchable eggs of different sizes/weights were sourced from a reputable breeding farm in Abeokuta. The HE were sorted, graded, marked and purposively grouped on weight basis into small (<50g), medium (50-65g) and large (>65g) sizes. All the eggs are from the same batch of parent stocks that are 40weeks old, which have been subjected to similar environmental and managemental conditions. Three hundred (300) HE were allotted to the 3 classes of eggs, and were replicated thrice, with each replicate having one hundred (100) HE in a completely randomised design (CRD) before incubation. After incubation, hatched chicks from the respective classes of eggs were allotted and replicated as previously described into a demarcated pen to determine the post-hatch performance.

Study procedures

Management of hatching eggs and hatching operations

The entire 300 HE were weighed individually with a sensitive weighing scale (Mettler-Toledo electronic balance), before they were sorted and classified according to the egg size/weight and kept in the cold room at a stable temperature of 18°C for 4 days prior to the day of incubation. The eggs were fumigated with formalin on potassium permanganate at the ratio of 2:1 for 15 minutes and then set into a Petersime® incubator with the broad ends facing upward and other incubation procedures complied with. The optimum incubation temperature was 99.7 °F with humidity of 83.5% while the hatching temperature was 98.5 °F with humidity of 85%. Candling of incubated eggs was conducted on the 18th day of incubation to identify HE with embryonic development and that are alive. The fertile eggs were transferred from the setting trays to hatching baskets of the hatcher, and remain here for the next three days for the chicks to hatch. Parameters monitored for hatching performance include the following viz., fertile eggs, number of chicks hatched and hatchling weight per replicate in each class of egg size/weight group.

Post-hatch operations

This is the second phase of this study. Thereafter, the hatched chicks were further allotted into the three groups and replicated thrice, with each replicate having 45 day old chicks. Chicks were intensively raised on deep litter system, they were fed *ad libitum* with a commercial broiler starter mash for the first 4 weeks of life and broiler finisher mash from 5-8 weeks, clean water was also given daily. They were used to determine the post-hatch performance of the commercial broilers hatched. This was done for the starter broilers and subsequently for the finishers. All necessary vaccinations and medications were administered as at when due.

Data collection and calculation

Data for all the parameters measured for hatching and post-hatch performances were recorded, this include number of HE set, fertile eggs, number of chicks hatched and hatchling weight per replicate in each class of egg size/weight group, the others are initial weight of chicks per replicate, final weight on weekly basis and over 4 weeks for starter phase and 5-8weeks for the finisher phase. The feed consumed on daily basis were recorded per replicate throughout the study period. The percentage fertility, hatchability, mortality and the feed conversion rate (FCR) were calculated using the formulae below. Also, the production cost per replicate was calculated with some assumptions taken into consideration.

Fertility (%) = Number of fertile eggs / Total number of eggs set ×100

Hatchability of all eggs (%) = Number of chicks hatched / Total number of eggs set × 100

Hatchability of fertile eggs (%) = Number of chicks hatched / Total number of fertile eggs set × 100

Mortality (%) = Number of birds that died/Total number of birds stocked x 100

Feed conversion rate (FCR) = feed intake/weight gain

Cost of production for chick = cost of setting HE x Nos of HE + cost of box/50 chicks

Cost of production per chick = Cost of production hatched chicks/Number of chicks hatched

Cost of production of 1kg chicken = Cost of production of chicken x 1kg/av. weight gain

Statistical analysis

The effect of egg weight on fertility, hatchability and hatchling weight of Marshal broiler chickens were analysed by using the general linear model procedures of the statistical analyses system (SAS, 2008). The statistical model used is:

$Yij = \mu + Ti + \Sigma ij$

Where:

Yij= the overall observation (fertility, hatchability, hatchling weight & post-hatch performance)

μ= Population means

Ti= Effect of different egg weights (small, medium, large)

Σij= Residual effect.

All data obtained were subjected to one-way analysis of variance (ANOVA), and errors were calculated as Standard Errors of Means (SEM). Duncan multiple range test of the software was used to separate significance of differences among treatment means at 5% significance level ($p<0.05$).

RESULTS

Table 1 shows the hatching performance of broiler eggs of different weights/sizes (Fig. 1a). The fertility of the medium weight (50-65g) HE which was better than the small (<50g) and the large (>65g) weight HE at $p< 0.05$ (Fig. 2a). Also, the hatchability of the HE set and the fertile eggs followed the same pattern, with the medium weight HE (89, 95.67%) having the highest value when compared with the small (48, 69.23%) and large (45, 61.00%) HE at $p< 0.05$ (Fig. 2b).

The chick weight is directly proportionate to the HE weight during setting in the incubator. The large size HE has the highest chick hatch weight (60.67g), followed by chicks from the medium size HE (40g) and the chicks from small weight eggs is least (28g) at $p< 0.05$. Also, it was observed that the cost of producing a chick was highest for the large HE (N177.47), and least for the medium weight HE (N90.07) at $p< 0.05$ (Table 1).

Fig. 1a

Fig. 1b

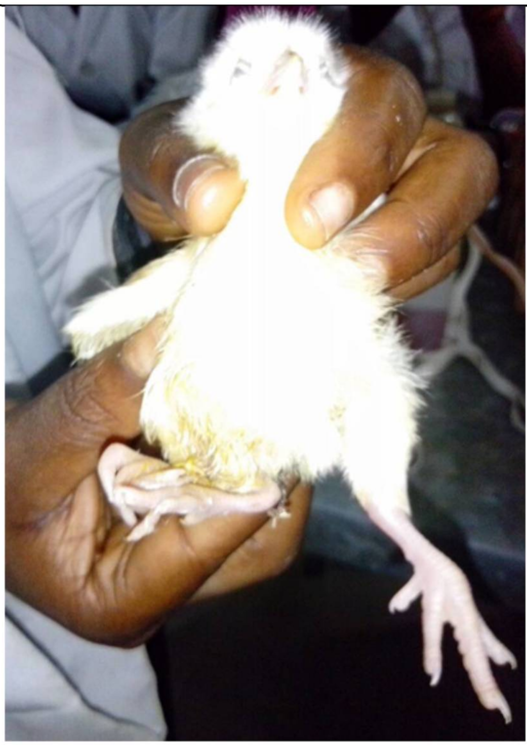

Fig. 1c

Fig.1a hatching eggs of different sizes/weights (small, medium and large)
Fig.1b small chick from small egg
Fig.1c an abnormal chick with four legs from large size (weight) hatching egg

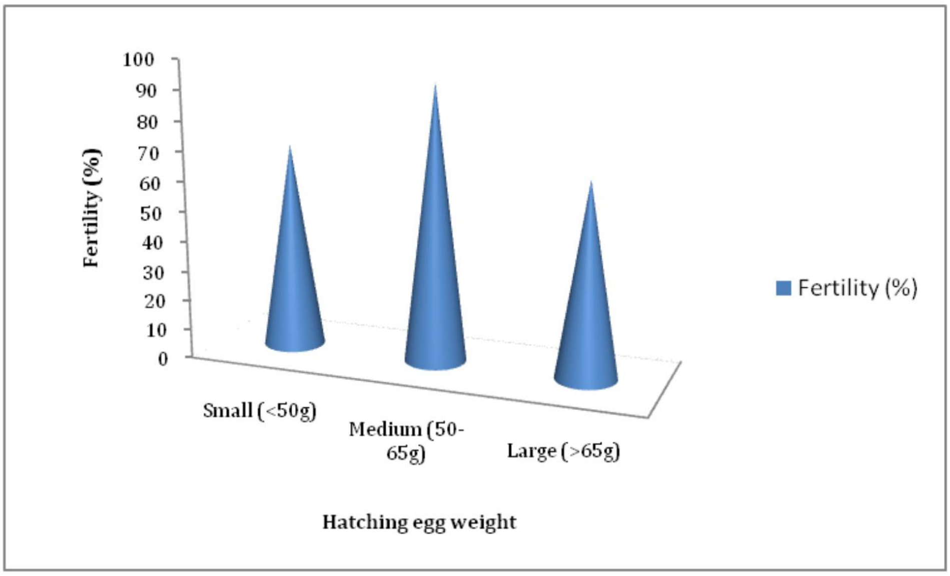

Fig. 2a fertility of broiler hatching eggs of varying weights

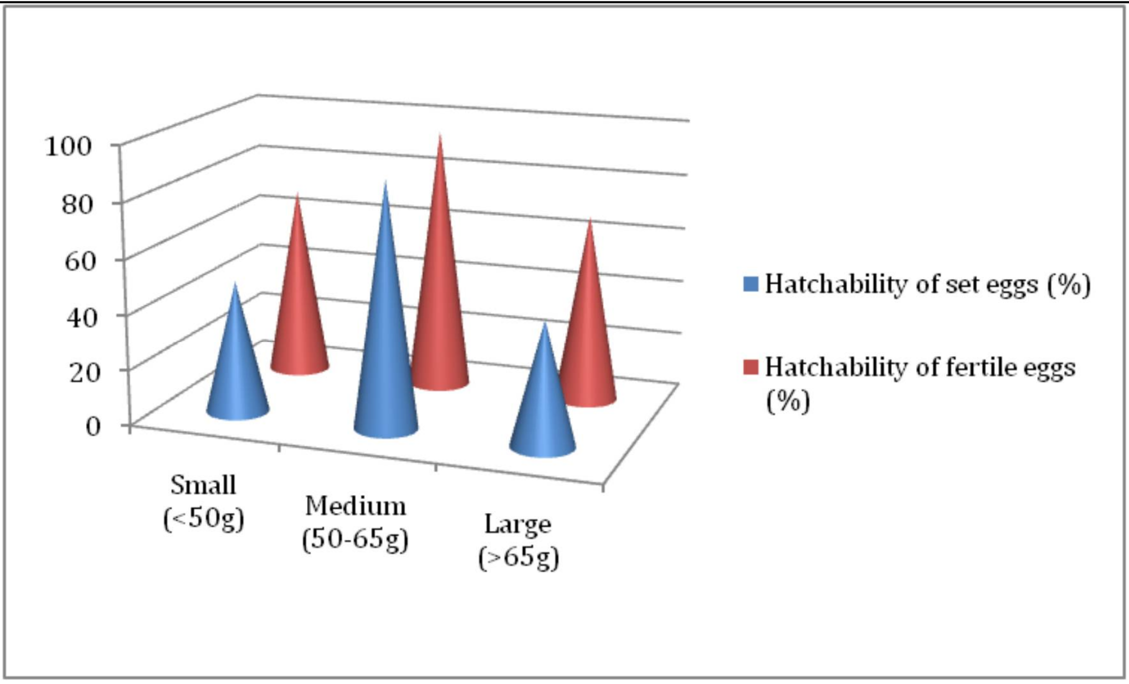

Fig. 2b hatchability of broiler hatching eggs of varying weights

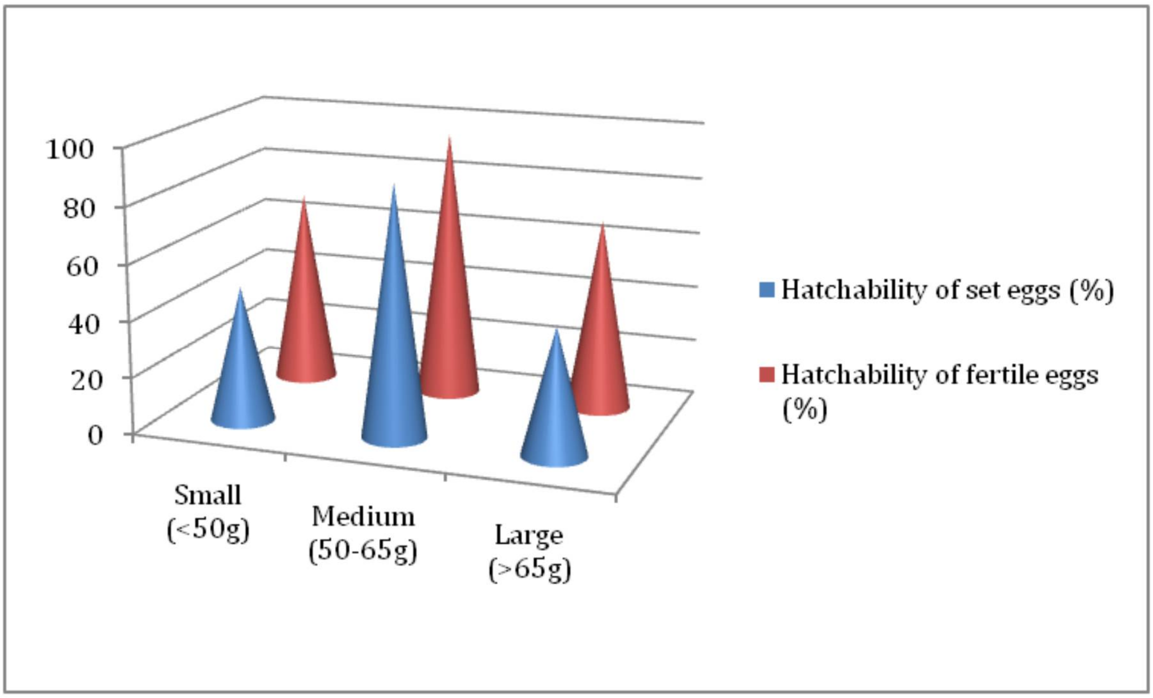

Fig. 2b hatchability of broiler hatching eggs of varying weights

Table 1 Hatching performance of broiler hatching eggs of different weight

HE Type	Nos of HE set	Fertility of HE (%)	Nos of chicks hatched	Hatchability from eggs set (%)	Hatchability from fertile eggs (%)	Chick hatch weight (g)	Cost of prod a chick (N)
Small (<50g)	300	69.33^{b}	144.00^{b}	48.00^{b}	69.23^{b}	27.50^{c}	166.70^{b}
Medium (50-65g)	300	93.00^{a}	267.00^{a}	89.00^{a}	95.67^{a}	40.00^{b}	90.07^{c}
Large (>65g)	300	65.67^{b}	135.00^{b}	45.00^{b}	68.53^{b}	60.67^{a}	177.47^{a}
±SEM	0.00	4.32	7.14	7.14	4.48	4.84	13.76

^{a,bc} Values in the same column with different superscripts are significantly different ($p \leq 0.05$)

*Assumptions: Production cost was determined by considering only costs of HE and setting costs, other factors were assumed to be common to all treatments

Table 2. Performance characteristics of starter broilers hatched from hatching eggs of different weights

Parameters	Chicks from Small eggs (50g)	Chicks from Medium eggs (50-65g	Chicks from Large eggs (>65g)	±SEM
Av. initial weight (g)	27.50[c]	40.00[b]	60.67[a]	4.84
Av. final weight (g)	660.00[c]	970.00[b]	1056.67[a]	60.53
Av. Weight gain (g)	632.00[c]	930.00[b]	996.00[a]	56.26
Av. Tot. feed intake (g)	1900.00[c]	2150.00[b]	2313.33[a]	60.72
Feed Conversion Ratio	3.00[a]	2.31[b]	2.32[b]	0.11
Mortality (%)	20.67[a]	2.00[c]	6.00[b]	2.87
*Unit cost of production (N)	510.87[a]	351.43[c]	396.43[b]	23.87

[abc]values in the same row with different superscripts are significantly different ($p \leq 0.05$)

***Assumptions**:

i. Only costs for chick, weight gain and total feed intake were considered, other factors were assumed to be common to all treatments
ii. Mortality was considered to be half of what is stated because the death occurred at different stages of growth

Table 2, shows the performance characteristics of starter broilers hatched from hatching eggs of different weights. The starter broiler from the large HE had the highest value for the average weight gain (996g) over the first 4 weeks (starter phase) when compared with birds from medium HE (930g) and those from small eggs (632g) at p< 0.05. The average total feed intake is observed to be proportionate to the egg weight; with the birds from the large HE having consumed the greatest amount of feed when compared with the other categories of starter broilers. The best FCR (2.31) was observed in starter broilers hatched from medium weight HE, while the worst was in bird from the small HE (3.00) at p< 0.05. The mortality of 20.67% was the highest recorded for the starter broilers hatched from the small eggs over the 4 weeks period, and the birds from the medium weight HE with the least value (2%). Furthermore, the unit cost of production of starter broiler over the 4 weeks period was highest for the small HE (N511), when compared with birds produced from the large HE (N376) and medium HE (N351) at p< 0.05. The average weight gain over a period of four weeks (finisher phase) for the chicken produced from large HE (1248.33g) was the highest, followed by the medium (1271.67g). The chicken produced from the medium HE was weightier than the chicken from the small HE (1086.67g) at $p < 0.05$ (Table 3). The average total feed consumed is proportionate to the HE weight; with the chicken from the large HE consuming the highest quantity of feed (2750g), followed by the chicken from the medium HE (2600g), while the chicken from the small HE consumed the least feed (2450g), at $p < 0.05$. Furthermore, the FCR is the same for the chickens produced from the small (2.20) and large (2.25) HE, but either of them had value greater than for chicken produced from the medium (2.00) HE at $p<0.05$ (Table 3). The mortality recorded was highest for birds reared from the small HE (10.33%), followed by those reared from the large HE (3.00%) and medium HE (2.00%) at $p < 0.05$. Finally, the unit cost of producing a kilogram of chicken meat, its more expensive for chicken from small HE (N916.23), followed by chicken from large eggs (N748.30), and least for bird from medium HE (N711.57) at $p<0.05$.

DISCUSSION

The smooth running and successful operations recorded in any poultry production outfit and hatchery operations which could lead to high economic efficiency of the chain process can be attributed to good chick quality, good practical biosecurity and the running operational cost of production (Yassin *et al*., 2009; Carvalho *et al*., 2015).

It has been well established that irrespective of egg size or weight, during incubation certain percentage of the weight is lost as water (Iqbal *et al*., 2016), hence the difference in egg weight and chick weight. This study however further corroborates this assertion. Deeming (1995) indicated that eggs which lose less than 10% or over 20% of their initial mass were less likely to hatch.

This study further revealed that the hatchability of HE is a function of the size/weight of HE that is set for hatching in the incubator. This further supports the assertions of Narushin's and Romanov (2002) and Alabi *et al*. (2012). The small HE are known to produce small size chicks and runts, usually rejected by the customers because these are known to be associated with high mortality and poor liveability during rearing (Christensen, 2001). While on the other hand oversize or large HEs are usually known to produce chicks with congenital deformities, malformed and co-joined chicks (Clauer, 2002). This therefore had effect on the hatchability of the large size HE. However, the medium HE has the best hatchability, which is in line with the findings from previous studies (Gonzales *et al.,* 1999; Ramaphala and Mbagiorgu, 2013; Othman *et al*., 2014; Ewonetu, 2017), in which they recommended eggs of average weight to attain good hatchability. Shatokhina (1975) concluded that the hatchability of small HE and large HE are usually lower than for eggs of average weight (50-65 g).

The post-hatch performance was also determined to know the performance of chicks derived from the different HE, and to determine the cost of producing a kilogram of chicken meat. The performance potentials of every chicken is hinged on the hatching egg quality; which is an important parameter for the development of the embryo as well as for the day old chick quality and subsequently the growth performance (Ewonetu, 2017). This study shows that the chicks hatched from large HE had highest average weight and weight gain when compared with the chicks hatched from medium and small HEs during the starter phase. But this is not the case at the finisher phase, in which there is no significant difference between the average weight gain of the chicks from the large and medium HEs. This further confirms the importance of large and medium HEs for incubation based on the recommendations of Abiola *et al*. (2008) that medium HE should be used for incubation. Also, this was approved also by Ramaphala and Mbajiorgu (2013) because of the availability of yolk to the chick after hatching which will support their subsequent performance.

Egbeyale *et al*. (2011), reported that HE weight had significant effect on the averages of initial weight, total weight and weight gain. Other studies further stated that chick weight at hatch is directly related to egg weight, corresponding to 62 to 76% of egg weight (Wilson, 1991; Traldi *et al*., 2011). It has been established that hatchling weight is highly dependent on the egg weight (Narushin's and Romanov, 2002; Alabi *et al*., 2012). This is highly relevant to the selection process of HE from the breeder farms before getting to the grading room at the hatchery. This consideration is important that eggs and incubation spaces are not wasted, but are judiciously utilised. Also, this could mean that chicks hatching from small HEs, because of small yolks, may be at a disadvantage when reared under the same conditions as chicks produced from medium to large HEs with larger yolks (Ulmer-Franco *et al*., 2010).

The chicks hatched from large HE consumed more feed than chicks hatched from other groups of HEs. There is a positive correlation between the weight/size of the growing broilers and the feed intake so as to maintain the systemic functionality and corresponding demand for energy and protein (Mwale *et al*., 2008). Thus it is expected that the larger chicken will have higher feed intake, which is in line with the submissions of Abiola *et al.* (2008) and Nsoso *et al*., (2008). The chicks produced from the small HEs had the poorest value for the feed conversion ratio (FCR) at the starter phase, while the chicks from the medium and large HEs are the same. But as they progressed to the finisher phase the (FCR) was better for chicks hatched from the medium HE, possibly because of the uniformity of the flock. Similar findings were recorded by De Witt and Schwalbach (2004) that FCR was better in chicks hatched from medium HEs than in those hatched from larger eggs, irrespective of the breed.

The chicks produced from the medium HEs has a better overall liveability of the chicken , while there was no difference for the liveability between chicken for small and large HEs. The poor liveability or high mortality recorded during the brooding and growing period could be attributed to the small size of the birds with small amount of yolk and poor feathering (Ramaphala and Mbagiorgu, 2013). But this is contrary to the findings of Singh et al. (2003) who reported that the egg size had no effect on mortality pattern in chicken.

The cost of production of in this study shows that at hatch and post hatch performances that the chicks and chicken produced from medium weight HEs are cheaper than those hatched from other categories of HEs. The factors that may contribute to this include the low hatchability recorded for the small and large HE, which could be the factor responsible for the high cost of production of chicks when compared with hatchability from medium HE in this study. Other factors include the low mortality recorded during the rearing period whose cost was also taken into consideration along with the feed intake to produce a unit kilogram of chicken meat. Mortality in broilers means a loss in income to broiler farms as well as to the hatcheries (Yassin *et al*., 2009).

CONCLUSION

The results of this study revealed that medium HEs presented best fertility, hatchability, FCR, weight gain, liveability and low cost of production, while the large HE was better off in terms of hatchling weight and final weight. It is therefore recommended that poultry breeders and hatchery operators should consider the use of medium weight (50-65g) HEs in their operations, so as to cut down the production cost.

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