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Effect of Egg Size on Reproductive Traits Keet Mortality and Growth Performance of the Pearl Guinea Fowl (*Numida meleagris*)

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Authors' contributions

This work was carried out in collaboration among all authors. Authors GT, AD, OK and DN designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors CGK and SYA performed the statistical analysis, managed the analyses of the study and managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study was conducted to investigate the influence of egg size on fertility, hatchability, keets mortalities and growth performance of indigenous Guinea fowl in Ghana. The study was carried out for a period of two (2) months. One hundred and thirty five day-old keets hatched from three different egg size groups: Small (23-39 g); medium (40-42 g) and large (43-49 g) were used in a completely randomize design. Data collected were subjected to analysis of variance with the aid of GenStat version 11.1 (2008). The results from the present study showed that fertility and hatchability were significantly (P= .05) higher in medium size eggs and lower in small size eggs. The cumulative mortality and percentage mortality rates during the experimental period were significantly (P= .05) higher in small size eggs and lower in medium size eggs. Number of survival and percentage survivability significantly (P= .05) increased with an increase in the size of the eggs. Egg size had significant (P= .05) effect on all growth parameters measured. Initial body

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weight, final body weight, body weight gain, daily weight gain, total feed intake and daily feed intake significantly (P= .05) increased with increasing egg size. Feed efficiency significantly increased (P= .05) with decreasing egg size. It was concluded that medium size eggs had higher fertility and hatchability. Number of survival and percentage survivability increased with increasing egg size. Initial body weight, final body weight, body weight gain, daily weight gain, total feed intake and daily feed intake increased with increasing egg size. Feed conversion ratio decreased with increasing egg size.

Keywords: Fertility; hatchability; survivability; body weight; feed intake.

1. INTRODUCTION

Guinea fowls are endemic to the continent of Africa and rank among the oldest of the gallinaceous birds. The bird belongs to the family of insect and seed-eating birds resembling partridges, but with featherless heads and spangled grey plumage than that of domestic chicken [1]. The fowl derived its name from Guinea, part of the west coast of Africa, it is sometimes called "pet speckled hen", or "original fowl" or *Guinea hen*) [2].

In Ghana, Guinea fowl is one of the most common poultry species found in the three northern regions. Guinea fowl plays an important role in the social life of many tribes in Ghana [1]. This is because the meat of Guinea fowl is highly accepted for food locally with no restriction or religious taboos [2,3]. The successful production of Guinea fowl in Ghana has great potential to improve the economy through the selling of the birds to lucrative markets such as restaurants and hotels [3].

The demand for Guinea fowl product such as meat and eggs in Ghana is increasing gradually among consumers. However, the productivity of indigenous Guinea fowl is very low to meet the demands of consumers due to high keet mortality, low keet survival rates and poor reproductive performance [1]. Numerous studies conducted in various countries have shown that among the other management practices, different egg size of which the keets are hatched from, have significant effect on survivability, growth and laying performance [4,5]. Guinea fowl eggs provide nutrition and protection to the developing keets, therefore the size of the egg is of immense importance for the hatchlings.

The major constraints to Guinea fowl production are egg size, keets mortalities, nutrition and seasonal variation [6]. Guinea fowls have different egg sizes which affect fertility, hatchability, survivability, growth and laying performance. For this reasons, fertility and hatchability in Guinea fowl are very low, whiles there is high keet mortality [5]. Egg size is considered as the major factor which influences the growth performances of local Guinea fowls. Guinea fowl eggs exhibit low hatchability than chicken eggs mainly because of their thicker egg shells and the size of the egg [4,6].

Egg size is considered as one of the major parameters which influence the growth performances of local Guinea fowls. However, these parameters have not been fully examined in Guinea fowl [6]. Guinea fowl eggs exhibit low hatchability than chicken eggs mainly because of their thicker egg shells and the size of the egg. Mortality is very high in Guinea fowl production during the brooding stage [1,5] as compared to the domestic chicken and this can be improved by egg selection [4,5].

Mortality is very high in Guinea fowl production during the brooding stage as compared to the domestic chicken and this can be improved by egg selection. In Ghana, there is no standard of characterization for Guinea fowl in terms of egg number, egg size, fertility, hatchability and early growth traits [1,5]. The physical characteristics of the egg play an important role in the processes of embryo development and successful hatching, reduce keet mortality and enhance the growth performance of the bird [7]. The productivity of local Guinea fowls in Ghana can be improved through good management practices, egg selection and nutrition.

The ultimate goal of this experiment was to investigate the effect of egg size on reproductive traits, keets mortalities and growth performance of the pearl guinea fowl in Ghana.

2. MATERIALS AND METHODS

2.1 Experimental Area

The experiment was carried out at the Poultry Section of the Animal farm of the Department of

Animal Science Education, University of Mampong-Ashanti lies in the transitional zone between the Guinea savanna zone of the north and the tropical rain forest of the south of Ghana along the Kumasi-Ejura road. Mampong lies on latitude 07°03' N and longitude 01°24'W on an altitude of 289.7 m above sea level. The rainfall pattern is bimodal, with the major rainfall season occurring from April to July with 1000 mm of rainfall while the minor season occurs from August to November with 350 mm of rainfall [8].

2.2 Experimental Design and Treatments

Two hundred and ten (210) hatching eggs of different weight (small 23-39 g, medium 40-42 g, and large 43-49 g) from the Pearl breed of Guinea fowl were used for the experiment. Guinea fowl eggs were obtained from an on-going experiment at the Animal Science farm of the Department of Animal Science Education, University of Education, Winneba. Eggs were collected in the morning in containers which were cushioned to avoid breaking or shaking. Each egg was weighed using an electronic weighing scale and marked with a permanent marker. Eggs were grouped into small, medium and large sizes. The eggs were stored for two days prior to incubation in the egg storage room of the University at room temperature. Eggs were incubated at 37.5-37.8 C and 60% relative humidity for 28 days. Candling was done at 14 days after egg set to determine the percentage fertility. During egg transfer from setter to the hatcher (*i.e.*, 3 days prior to hatching) hatching egg trays were partitioned using wire mesh to allow placing of eggs into three treatment groups, *i.e.,* eggs from the same replicates were combined to make a treatment. A total of one hundred and thirty five (135) day-old keets hatched from different egg sizes (small: 45 birds, medium: 45 birds and large: 45 birds) were randomly selected for the experiment after grouping the eggs from which they were hatched into the various sizes. The different keets from different egg sizes constituted the treatment (small, medium and large size eggs). Each treatment had three replications of 15 keets.

2.3 Management and Feeding of Experimental Birds

The birds were reared under similar managerial conditions and the experiment lasted for 60 days. Feed and water were supplied to the birds *ad libitum*. Day-old keets were fed with a starter ration from day 1 up to 6 weeks of age. Grower diets were given from 6 weeks of age up to 8 Education, Winneba, Mampong-Ashanti, Ghana. weeks of age. The starter ration contained 22 % crude protein and 2,950 kcal ME/kg diet. The grower ration contained 17.5% crude protein and 2,800 kcal ME/kg diet (Table 1).

2.4 Reproductive Parameters Measured

2.4.1 Percentage fertility

A male was paired with four Guinea fowl hens across the different egg size treatment groups. Fertilized eggs were determined by candling at 14 days after incubation. Percentage fertility was calculated by expressing the total number of fertile eggs as a percentage of the total number of eggs set.

$$\text{Arithmetically, \% Fertility} = \frac{\text{Total number of fertile eggs}}{\text{Total number of eggs set}} \times 100$$

2.4.2 Percentage hatchability

Percentage hatchability was determined as the total number of eggs hatched as a percentage of total number of fertile eggs.

$$\text{Hatchability \%} = \frac{\text{Total number of Guinea keets hacthed}}{\text{Total number of fertile eggs}} \times 100$$

2.5 Keet Mortality

2.5.1 Percentage survivability

The total number of keets that died and birds that survived from different egg sizes was recorded throughout the experimental period.The percentage survivability was determined by expressing the total number of keets that survivead as a percentage of total number of keets hatched.

$$\text{Arithmetically \%, Survivability} = \frac{\text{Total number of keets that survived}}{\text{Total number of keets hacthed}} \times 100$$

2.5.2 Percentage mortality

The percentage mortality was determined by expressing the cumulative mortality as a percentage of total number of keets hatched.

$$\text{Arithmetically, \%Mortality} = \frac{\text{The cumulative mortality}}{\text{Total number of keets hacthed}} \times 100$$

2.6 Growth Parameters Measured

Feed intake was calculated as the difference between the initial feed offered to birds and the feed left-over. Body weight gain (g/bird) was

calculated by subtracting the initial weight from their final weights.

Feed conversion ratio (FCR) was computed as the feed intake divided by the total weight gain.

Arithmetically, FCR $= \frac{\text{Total feed intake (g)}}{\text{Total weight gain (g)}}$

2.7 Statistical Analysis

The data collected were analyzed using the one way analysis of variance (ANOVA) with the aid of GENSTAT Version 11.1 (2008) according to previously described [9,10] and the treatment means were separated by the least significant difference (LSD) to determine which of the treatments has significant difference or not at 5 % probability level.

Table 1. Percentage composition of the experimental diet

Ingredients	Starter diet (kg)	Grower diet (kg)
Maize	57.5	58.0
Wheat bran	11.0	21.0
Soya bean meal	8.50	5.00
Tuna fish meal	11.0	6.00
Russia fish meal	9.00	7.00
Oyster shells	1.50	1.50
Calcium	0.50	0.50
Vitamin premix	0.50	0.50
Salt	0.50	0.50
Crude protein (%)	22.0	17.5
Total	100	100

3. RESULTS AND DISCUSSION

3.1 Effect of Egg Size on Fertility and Hatchability

Results from the study Table 2 showed that the best (P= .05) fertility and hatchability were observed from medium size eggs, followed by large and small size eggs, respectively. The significant difference observed among fertility and hatchability in this experiment could be attributed to the size of the egg. Hussnain et al. [11] reported that medium size eggs have lower shell thickness which enhances hatchability whilst large and small size eggs have higher shell thickness. This finding is in support of the observation made by Kyere et al. [5] who reported 50.5% hatchability for medium size eggs from Guine fowl breeders. Similar results were reported by Abiola et al. [7] who observed 96.67% hatchability for medium size eggs from broiler breeders.

3.2 Effect of Egg Size on Keet Mortality

Results from the present study Table 3 showed that the cumulative mortality and percentage mortality rates during the experimental period were significantly (P= .05) higher in small size eggs and lower in large size eggs. Number of survival and percentage survivability significantly (P= .05) increased with an increase in the size of the eggs.

The variation in mortality, number of survival, percentage survivability and percentage mortality observed in this experiment could be as a result of the size of the egg. It has been established that birds hatched from large size eggs had higher body weight with strong immune system which protects them from a variety of pathogens or disease causing microorganisms and enhances rapid growth [5,6]. The variation observed could also be attributed to the yolk sac. During the first week of the post-hatching period, before the immune system is mature enough to produce its own blood lymphocytes, a chick's immunity depends on maternal antibodies received from the egg yolk. During incubation and after hatching, the yolk sac membrane transfers nutrients from the egg yolk to the developing embryo or newly hatched chick. The higher the size of the eggs the higher the yolk sac, therefore more nutrients are supplied to the chicks which enhance survivability and reduce mortality [12,13]. This result is in agreement with Petek et al. [14] who reported that the mortality of quail was significantly (P= .05) affected by hatching egg weight. The authors further reported that the survival rate of quails hatched from small eggs was found to be lower than those hatched from larger eggs.

3.3 Effect of Egg Size on Growth Performance

Initial body weight, final body weight, body weight gain, daily weight gain, total feed intake and daily feed intake significantly (P= .05) increased with increasing egg size (Table 3).

However, feed conversion ratio significantly (P= .05) decreased with increasing egg size. The variation in body weight, feed intake and feed conversion ratio observed in this experiment could be as a result of the size of the egg. This is because birds hatched from large size eggs have higher body weight at day-old which influences feed intake and enhances rapid growth of domestic fowls.

Table 2. Effect of egg size on reproductive performance

Reproductive parameters	Large	Medium	Small	SEM	*p*
Fertility (%)	57.1[b]	68.6[a]	48.6[c]	2.78	0.04
Hatchability (%)	67.0[b]	81.3[a]	58.8[c]	3.61	0.02

[abc] *Means bearing different superscripts in the same row are different at* (P=.05). *SEM= standard error of means, p = probability of mean effects*

Table 3. Effect of egg size on reproductive performance and keet mortality

Keet mortality	Large	Medium	Small	SEM	*p*
Total number of birds	45	45	45		
The cumulative mortality	6.00[c]	10.0[b]	16.0[a]	1.80	0.02
Number of survival	39.0[a]	35.0[b]	29.0[c]	2.16	0.02
Percentage survivability (%)	86.7[a]	77.8[b]	64.4[c]	2.66	0.03
Percentage mortality (%)	13.3[c]	22.2[b]	35.6[a]	3.89	0.01

[abc] *Means bearing different superscripts in the same row are different at (P=.05). SEM= standard error of means, p = probability of mean effects*

Table 4. Effect of egg size on growth parameters

Growth parameters	Large	Medium	Small	SEM	*p*
Initial body weight (g/bird)	28.6[a]	26.2[b]	24.1[c]	0.49	0.01
Final body weight (g/bird)	471[a]	446[b]	426[c]	6.70	0.01
Body weight gain (g/bird)	442[a]	420[b]	403[c]	6.73	0.01
Daily weight gain (g/bird)	7.38[a]	7.01[b]	6.71[c]	0.11	0.01
Total feed intake (g/bird)	1750[a]	1512[b]	1329[c]	12.0	0.01
Daily feed intake (g/bird)	29.2[a]	25.2[b]	22.2[c]	1.20	0.01
Feed conversion ratio	3.96[a]	3.60[b]	3.30[c]	0.07	0.01

[abc] *Means bearing different superscripts in the same row are different at (P=.05). SEM= standard error of means, p = probability of mean effects*

This result is in agreement with Song et al. [15] and Oke et al. [16] who reported that feed intake increased with increasing in the size of the egg of pheasant, quail and Guinea fowl. Birds' hatche from small size eggs had the lowest body weight and feed intake, and high feed conversion ratio. This could also be as a result of the small hatch weight as reported by Oke et al. [16] and Wilson [17] that egg size is known to have a positive effect on the growth on subsequent weight of domestic fowls. This result suggests that the guinea fowl egg weight determines the early growth of the keets it produces. According to Altinel et al. [18] the growth of chicks is directly linked with external and internal quality traits of eggs.

4. CONCLUSION

This study concludes that medium size eggs had higher fertility and hatchability. Cumulative mortality and percentage mortality increased with decreasing egg size. Number of survival and percentage survivability increased with an increase in the size of the eggs. Initial body weight, final body weight, body weight gain, daily weight gain, total feed intake and daily feed intake increased with increasing egg size. The feed efficiency increased with decreasing egg size.

ETHICAL APPROVAL

As per international standard written ethical permission has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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