



## EFFECT OF EGG SIZE ON REPRODUCTIVE AND PRODUCTION PERFORMANCE OF THE GUINEA FOWL: A REVIEW

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### ABSTRACT

This study aimed at reviewing relevant literature on the effect of egg size on the performance of indigenous Guinea fowl in Ghana. The egg of a laying Guinea hen is the tool for reproduction and also serves as a source of food for humans. Egg size has been widely studied because it can be highly variable. Hatchability, hatching time, embryonic mortalities, keets weight at hatch and chick's developmental performance at post hatch period are directly affected by hatching egg size. Guinea fowl breeding hens produce thicker shelled eggs in comparison to that of a chicken. An eggshell makes up 15 % of the total weight of the Guinea fowl egg which is 9 % of that of a chicken. The physical characteristics of the egg play an important role in the processes of embryo development and successful hatching. The size of the egg and internal quality of eggs are important for both table and hatching eggs. The nutrient content of Guinea fowl eggs and the weight of day-old keets depend on the size of the egg. Egg size has positive effect on the weight of keets and subsequent growth of Guinea fowl. The size of the egg positively influenced the overall performance of Guinea fowl. Hence, Guinea fowl producers and breeders must consider egg selection activities for higher productivity.

**KEYWORDS:** Guinea fowl; egg size; egg quality; fertility; hatchability; keet mortality.

### INTRODUCTION

Guinea fowl is a well-known bird in West Africa and European countries, but in the rest of the world especially in developing countries it is yet to be well-established on a commercial basis.<sup>[1]</sup> The Guinea fowl industry has been slowly developing and more recently, production units have been established in many parts of the world.<sup>[2]</sup> In developed countries like France, Germany and Italy, Guinea fowl production enhances their gross domestic product and provides high revenue from exports, whereas in less developed economies it provides a source of animal protein for consumption.<sup>[1]</sup> Guinea fowl products such as meat and eggs are highly acceptable in Ghana due to their limited cultural barriers on consumption.<sup>[3]</sup> This indicates that there is the need for farmers to improve upon Guinea fowl production.

The productivity of local Guinea fowls in Ghana can be improved through good management practices, egg selection and nutrition. Suitable Guinea fowl production systems such as housing, feeding etc. result in high productivity.<sup>[2]</sup> 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.<sup>[4]</sup> In Ghana, there are so many factors affecting the productivity of indigenous Guinea fowl production. One such factor is the size of the hatching egg. Guinea fowl eggs provide nutrition and protection to the developing keets; therefore, the size of the egg is of immense importance for the hatchlings. Egg size has been widely studied because it can be highly variable.<sup>[4]</sup> 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.<sup>[5]</sup>

The major constraints to Guinea fowl production are egg size, keets mortalities, nutrition and seasonal variation.<sup>[6]</sup> 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, while there is high keet mortality.<sup>[7]</sup> Despite the abundant potential and popularity of the bird; it has remained unimproved either as a meat or egg laying bird in Ghana. In Ghana, there is no standard of characterization for Guinea fowl in terms of egg number, egg size, fertility, hatchability and early growth traits.<sup>[2]</sup> 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.<sup>[6]</sup> 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.<sup>[2]</sup> as compared to the domestic chicken and this can be improved by egg selection.<sup>[4]</sup> Moreover, little research work has been carried out into various aspects of the bird to improve performance to achieve maximum productivity, most especially egg size.

The objective of the study was to review the effect of egg size on reproductive and production performance of the Guinea fowl (*Numida meleagris*).

## METHODOLOGY

A desk research was carried out using information from a previous experiment on effect of egg size on reproductive traits, keet mortality and growth performance of the pearl Guinea fowl (*Numida meleagris*) conducted at the Poultry Unit of the Department of Animal Science Education, University of Education, Winneba, Mampong-Ashanti campus from September, 2016 to December, 2017.

### Guinea Fowl Reproduction

#### Guinea fowl egg

The egg of a laying Guinea hen is the tool for reproduction and also serves as a source of food for humans.<sup>[8]</sup> As a highly complex reproductive cell, it is essentially a tiny center of life. The shape of Guinea fowl egg resembles a prolate spheroid with one end larger than the other and has cylindrical symmetry along the long axis. Guinea fowl eggs have a distinctive shape but it is pointed at one end and rounded at the other end.<sup>[3]</sup> The egg is surrounded by a thin, hard shell. Thin membranes exist inside the shell. The egg yolk is suspended in the egg white by one or two spiral bands of tissue called the chalazae. The larger end of the egg contains an air cell that forms when the contents of the egg cool down and contract after it is laid.<sup>[8]</sup>

Guinea fowl eggs are graded according to the size of the egg using a weighing scale. A very fresh egg has a small air cell and considered as high quality. As the size of the air cell increases the quality of the egg decreases. This provides a way of testing the age of an egg: as the air cell increases in size due to air being drawn through pores in the shell as water is lost, the egg becomes less dense and the larger end of the egg will rise to increasingly shallower depths when the egg is placed in a bowl of water. A very old egg will float in the water and should not be eaten. Guinea fowl eggs are categorized as small (23-39g); medium (40-42g) and large (43-49g).<sup>[3,4]</sup>

The albumen surrounds the yolk and protects this potential life (embryo). It is an elastic, shock-absorbing semi-solid with high water content. Together the yolk and albumen are prepared to sustain life (the life of a growing embryo) for three weeks, in the case of the chicken.<sup>[8]</sup> The entire mass is surrounded by two membranes and an external covering called shell which provides for an exchange of gases and a mechanical means of conserving food and water supply to the embryo.<sup>[3]</sup> The eggshell membrane is a clear film lining the eggshell, visible when one peels a boiled egg. Primarily, it composed of fibrous proteins such as collagen type I.<sup>[9]</sup> These membranes may be used commercially as a dietary supplement. The yolk in a newly laid egg is round and firm. As the yolk ages, it absorbs water from the albumen, which increases its size and causes it to stretch and weaken the vitelline membrane (the clear casing enclosing the yolk). The resulting effect is a flattened and enlarged yolk shape. Yolk color is dependent on the diet of the hen. If the diet contains yellow or orange plant pigments known as xanthophylls, then they are deposited in the yolk, coloring it. Lutein is the most abundant pigment in egg yolk.<sup>[10]</sup> A diet without such colorful foods may result in an almost colorless yolk. Yolk color is, for example, enhanced if the diet includes foods such as yellow corn, moringa leaf meal and marigold petals.

### Egg formation in Guinea fowl

The first step in the formation of the egg is ovulation of the yolk from the left oviduct. The yolk is captured by the infundibulum where the developing egg remains for about fifteen minutes and it is here that the formation of the perivitelline membrane and chalazae occurs. In breeder birds, fertilization occurs in this region of the oviduct.<sup>[11]</sup> Initial development of the embryo takes place in the blastoderm. The egg then moves into the magnum where it remains for about three hours while the albumen (proteins) is produced. The layer of proteins provides mechanical and bacteria protection for the yolk as well as creating a template for the later formation of the shell membranes and shell. The developing egg then enters the isthmus, which produces the fibre that make up the inner and outer shell membranes.<sup>[12]</sup> The egg then enters the shell gland where water and electrolytes enter the albumen for the formation of the mammillary cores, and it is here that the eggshell is formed. The organic matrix

of the eggshell consists of the shell membranes, the mammillary cores, the shell matrix and the cuticle. The inorganic portion of the eggshell consists of calcium carbonate. Finally, the egg is laid via vagina and cloaca. The complex nature of the process of formation of the internal components of the egg and the eggshell mean that the quality problems may arise at any of the several stages during the formation of the egg.<sup>[12]</sup>

### Guinea fowl egg production

The egg laying ability in Guinea fowl hens depend on breed and management.<sup>[12]</sup> Guinea fowl hen that is of good stock and is carefully managed may lay 100 or more eggs within a year.<sup>[4]</sup> Wild Guinea fowls hens commence egg laying at the age of 9 to 12 months, with each hen laying 12 to 20 eggs per breeding season. Breeder Guinea hens can be used for egg production for about 2 to 3 years; sometimes they are kept as long as 4 to 5 years in smallholder farms.<sup>[3]</sup> In such farms Guinea hens usually will lay about 30 eggs and then go broody. The local Guinea fowls can lay between 70-100 eggs within a year while the improved birds can lay 200 eggs per year. Guinea fowl hens which are about to commence laying make a peculiar monosyllabic sound like, “kienkienkien” which is similar to the sound produced after laying an egg.<sup>[3]</sup> Guinea fowl hens lay between 9:00 a.m. and 3:00 p.m. Guinea fowl eggs are very popular and common on the market from March to July.<sup>[13]</sup> Their thicker shells give them an obvious advantage for longer storage and handling with less breakage in comparisons to that of a regular chicken egg.<sup>[3]</sup>

### Guinea fowl egg collection

Guinea fowl eggs should be collected early in the morning ideally between 8 am to 10 am, and 2pm to 4 pm respectively.<sup>[3]</sup> Eggs left in the nest for much longer than 42 hours tend to be poor hatchers. It's important that eggs collected for hatching are clean. However, hatching eggs ideally should not be washed, as this removes the protective egg bloom. The egg bloom protects the egg from both bacteria and moisture loss. If bacteria enter the egg, they can cause it to rot, and in the worst case, explode during incubation (thereby contaminating the remaining incubating eggs). Promote clean eggs by making sure nest boxes are clean (clean them out and add fresh litter prior to collecting hatching eggs), and by collecting the eggs twice daily.<sup>[3]</sup>

### Guinea fowl egg size

Egg size is an important trait that influences egg quality as well as grading.<sup>[14]</sup> There is a positive relationship between Guinea fowl egg size on pre hatching and post hatching performance of domestic Guinea fowls.<sup>[3,14]</sup> Guinea fowl eggs are categorized into small ( $\leq 39$ g), medium (40-42g) and large ( $\geq 43$  g).<sup>[4,16]</sup> A laying hens egg weight is affected by many factors such as breed, hereditary, strain, body size, age of hen, water consumption, feed, ambient temperature and disease.<sup>[3]</sup> Guinea fowl breeding hens produce thicker shelled eggs

in comparison to that of a regular chicken. An eggshell makes up 15 % of the total weight of the Guinea fowl egg which is 9% of that of a regular chicken egg.<sup>[4,14]</sup> Egg size represents one of the most important factors governing the profitability of a laying enterprise; even small increase in egg size can have significant effect on grading and hence increase economic returns.<sup>[16]</sup> Moreki and Mothei<sup>[16]</sup> stated that medium size hatching eggs are ideally preferable as compared to large and small size eggs. The size of the egg and internal quality of eggs are important for both table and hatching eggs. The nutrient content of Guinea fowl eggs and the weight of day-old keets depend on the size of the egg.<sup>[4,14]</sup>

### Guinea fowl egg storage

Egg storage is the time between oviposition (laying) and the start of the incubation process for hatching eggs. Optimal hatching results and chick quality can be achieved if eggs are stored properly. The quality of Guinea fowl keets depends on the quality of the egg. It is essential that care is taken in the storage and handling of the eggs.<sup>[17, 18]</sup> Eggs should be handled with care as any bumping may rupture the yolk membranes, in which case the egg will not hatch. Farmers and breeders need to make sure that Guinea fowl eggs are stored safely to keep them as healthy as possible until they are ready to hatch, so that most of the eggs will have the best possible chance of hatching. It must be emphasized that the eggs cannot be improved once laid, and will only deteriorate with poor storage and handling methods.<sup>[17,18]</sup>

The Ideal storage temperature is between 12°C and 15°C (50 – 69°F). High temperature will decrease the chances of the embryo developing. If storage temperature is below freezing the cell structure of the egg can break down and prevent the embryo from developing.<sup>[10]</sup> The best humidity level at which to store eggs is between 75 to 85% RH to avoid significant drying out of the egg before incubation. It is generally considered that Guinea fowl eggs should not be kept for more than 7 days prior to incubation. Beyond this time chances of hatchability decrease considerably. Beyond, 14 days after laying, vitamins decay and membranes breakdown and so the embryo can often suffer early mortality. Cracked, misshaped and heavily soiled eggs should be discarded. As the storage time increased, weight loss increased whereas Haugh unit and yolk index values decreased.<sup>[10]</sup>

### Incubation and hatching of Guinea fowl eggs

Nwagu<sup>[19]</sup> reported that there is little information on the hatching characteristics of Guinea fowl eggs. Guinea fowl eggs can be hatched through artificial means or natural means.<sup>[20]</sup> Fumigation between 12 hours and 4 days after setting the eggs affect the developing embryos. Guinea fowl eggs take 26 to 28 days to hatch.<sup>[3]</sup> According to Konlan and Avornyo<sup>[20]</sup> Guinea fowl eggs take 24-28 days to hatch. The normal incubation period for Guinea fowl eggs is 24 to 25 days for crossbreds and 26 to 28 days for local breeds.

## Effect of Egg Size on Reproductive and Production Performance of the Guinea Fowl

### Effect of egg size on fertility and hatchability of Guinea fowl eggs

Fertility and hatchability are major constraints in Guinea fowl production. The different categories of Guinea fowl egg sizes have influence on fertility, hatchability and early growth traits.<sup>[21]</sup> Fertility refers to the percentage of incubated eggs that are capable of hatching while hatchability is the percentage of fertile eggs that hatch.<sup>[19]</sup> Research conducted by Dei *et al.*<sup>[22]</sup> on egg size showed that hatchability of fertile eggs increased as the egg size increased. Guinea fowl eggs exhibit low hatchability than chicken eggs mainly because of their thicker egg shells and sizes of the egg. According to Nwagu,<sup>[19]</sup> egg shell account for 15% of the total weight of Guinea fowl eggs as compared to chicken, egg shell accounts for 9% of the total weight of the egg. Nwagu<sup>[19]</sup> further reported that, the main factors that affect fertility and hatchability of Guinea fowl eggs are egg size, shell quality and variation in brooding temperature. Hussnain *et al.*<sup>[23]</sup> reported that fertility and hatchability is influenced by egg size, shell weight and shell thickness. Hussnain *et al.*<sup>[23]</sup> further reported that medium size eggs have lower shell thickness which enhances hatchability whilst large and small size eggs have higher shell thickness which affects the hatchability of broiler chicken.

### Effect of egg size on growth parameters

The quality of the newly hatched chick is a major factor to determine its livability, growth and health. Nahashon *et al.*<sup>[24]</sup> considered chick weight as an accurate predictor of final body weight. Most of the old breeder flocks lay heavier eggs and result in heavier chicks. Sklan *et al.*<sup>[25]</sup> also reported that heavier weight eggs produce heavier keets at hatch while medium and lighter weight eggs produce lighter weight keets. Egg size is known to have positive effect on the weight of keets and subsequent growth of Guinea fowl.<sup>[3,26]</sup> There are strong positive correlations among pre incubation egg weight, storage periods, keet weight and subsequent performance of different kinds of poultry.<sup>[19]</sup>

The shapes and sizes of Guinea fowl eggs differ among the various species of birds. The size of the egg and internal quality of eggs are important for both table and hatching eggs. The nutrient content of Guinea fowl eggs and the weight of day-old keets depend on the weight of the egg.<sup>[26]</sup> According to Kyere<sup>[3]</sup> birds produced from all categories of eggs had similar ( $P > 0.05$ ) growth rate and feed conversion ratio at all levels. However, egg size had significant effect ( $P < 0.05$ ) on feed intake and body weight. Daily feed intake and body weight increased with an increase in the size of the eggs that produced the birds. Kyere,<sup>[3]</sup> further explained birds hatched from large size eggs have higher body weight at day old which influence feed intake and enhances rapid growth of domestic fowls. This result is in agreement with Song *et al.*<sup>[27]</sup> who reported that feed intake increased with

increasing in the size of the egg of pheasant, quail and Guinea fowl.

### Effect of egg size on laying performance

Egg size is one of the most important traits in egg production. The size of the egg determines the price per crate for commercial poultry farmers. Okaeme *et al.*<sup>[28]</sup> reported that egg size influenced age at sexual maturity and egg size at first egg laying. Okaeme *et al.*<sup>[28]</sup> further reported that age at sexual maturity reduced with increasing egg size. They also observed that egg size had little influence on hen-day and hen house egg production. Research conducted by Nahashon *et al.*<sup>[24]</sup> in broiler chicken shows that egg size does not influence hen-day and hen house egg production. Saina *et al.*<sup>[29]</sup> reported that egg size influenced hen-day and hen-house egg production in broiler chicken. Saina *et al.*<sup>[29]</sup> further explained that large size eggs have higher protein levels which increase the total protein concentration in the blood of a newly hatch chick and this enhance early maturity and ensures that birds hatched from large size eggs will lay heavier eggs as compared to both medium and small. Hassan *et al.*<sup>[30]</sup> also reported that large size eggs influenced age at sexual maturity and egg size at first egg laying of domestic chicken. Kyere *et al.*<sup>[4]</sup> reported that egg size had significant ( $P < 0.05$ ) effect on age at sexual maturity and egg size at first egg laying. Age at sexual maturity reduced with increasing egg size. Egg size at first egg laying increased with increasing egg size.

### Effect of egg size on egg characteristics

Poultry industry is flourishing in many parts of the world and the quality of the egg is considered as the backbone for successful pheasant farming.<sup>[24]</sup> Saina *et al.*<sup>[29]</sup> stated that the growth of chicks is directly linked with external and internal egg quality traits. The characteristics of the egg depend on the internal and external egg quality.<sup>[24]</sup> Egg quality is a general term which refers to different standard use to define both internal and external quality.<sup>[4]</sup> Wilson<sup>[15]</sup> suggested that if eggs are separated by their weight and size in hatchery, and the hatched chicks reared separately, there is a great variation in growth between small size egg, medium size egg and large size eggs. The main components of an egg include: the yolk (30-33%), albumen (60%) and the shell (9-12%).<sup>[26]</sup>

Egg size affects the proportions of the components of the hatching egg and the reduction in the proportion of yolk affect the developing embryos in eggs with small yolks.<sup>[30]</sup> Longer storage and poor shell quality affect internal and external egg characteristics.<sup>[7]</sup> This is because shell quality play significant role in gas exchange and moisture loss during incubation. Song *et al.*<sup>[27]</sup> reported that larger size eggs have higher albumen and yolk weight which help in the development of the embryo while medium and light weight eggs have small albumen and yolk weight which affect the growth and development of the embryo and subsequent growth

performances of the newly hatched keet. Sklan *et al.*<sup>[25]</sup> reported that the yolk content increases as the egg size increases and further explained that egg weight and chick weight are correlated.

Sklan *et al.*<sup>[25]</sup> further reported that large size eggs have sufficient nutrients, large surface area and pores which increased the yolk weight and height, albumen weight and height. The compositions of the components for fresh eggs are 10% shell, 32% yolk and 58% albumen. Egg yolk from a newly laid egg is round and firm.<sup>[29]</sup> As the egg gets older, the yolk absorbs a lot of water from the egg white and increasing its size. As soon as the egg is laid, its internal quality starts to decrease: the longer the storage time, the more the internal quality deteriorates.<sup>[24]</sup> Egg shell quality has been one of the major concerns to commercial egg producers.<sup>[29]</sup> Small size eggs have higher surface to volume ratio which reduces shell weight, shell thickness, yolk weight and height.<sup>[24]</sup>

According to Kyere.<sup>[3]</sup> egg size had no significant effect on Haugh unit, egg diameter, yolk weight, yolk colour, albumen height and albumen weight. However, the author reported that egg size had significant effect on yolk height, shell weight and shell thickness. Large size egg had the highest yolk height, followed by both medium and small size eggs. This means that yolk height increased with increasing egg size. Kyere<sup>[3]</sup> attributed the significant differences observed on yolk height, shell weight and shell thickness to the size of the eggs. The author further explained that large size eggs have sufficient nutrients, large surface area and pores which increased the height of the yolk.

## CONCLUSIONS

This study concludes that egg selection is an important activity in Guinea fowl breeding and reproduction. Egg size had significant influence on fertility, hatchability and post hatching performance in Guinea fowls. Medium size eggs are very good for hatching as it increased fertility and hatchability as compared with both small and large eggs. Egg size had significant influence on feed intake and body weight. Daily feed intake and body weight increased with an increase in the size of the eggs that produced the birds. Age at sexual maturity reduced with increasing egg size. Egg size at first egg laying increased with increasing egg size. This study also concludes that shell weight, shell thickness and yolk weight increased with increasing egg size. This study recommends to farmer and breeders that medium and large sized eggs are more suitable for setting in the incubator in order to obtain good hatchability and higher growth performance.

## Disclosure of conflict of interest

Authors have declared that, no conflict of interests exist.

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