

FERTILITY AND HATCHABILITY PERFORMANCE OF FERAL AND DOMESTICATED HELMETED GUINEAFOWL EGGS: A COMPREHENSIVE REVIEW

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Abstract

Despite helmeted guineafowl (HG) laying a large quantity of eggs during its breeding season, few were hatched, while the majority were wasted in feral areas. Fertility and hatchability of HG eggs in feral and domestication ecological habitats have been issues of great influence affected by variation of factors (environmental, nutritional, and genetic conditions), and future availability of the HG for a growing population would ensure a sustainable alternative from non-cholesterol game birds. It is incumbent to review available reports from different literature. Thus, it is crucial to compare the fertility and hatchability of both related and different emergences. This will enhance the level of breakthrough either in feral and domesticated HG and pave the way forward to ensure improvements in the production of HG for food protein sustainability in perpetuity.

Keywords: Helmeted Guinea fowl, fertility, hatchability, feral, domestication

INTRODUCTION

Helmeted guineafowl (HG) is a well-known bird in West Africa and European countries. Still, in the rest of the world, especially in developing countries, it is not enough to be well established on a commercial basis (Embury, 2001). The guineafowl industry has been slowly developing, and more recently, production units have been established in many parts of the world (Annor *et al.*, 2012; Houndonougbo *et al.*, 2017; Shoyombo *et al.*, 2021), while guineafowl production in Nigeria is still in its vestigial stage, even though these birds originated from Africa (More Ki and

Radikara, 2013). There are ready markets for guineafowl in Africa (Nahashon *et al.*, 2006).

However, these birds are still raised with minimal input by subsistence farmers, with low productivity (Oke *et al.*, 2015). The rearing of guineafowl has a greater potential to bridge the demand-supply gap in animal protein intake. This indigenous species makes significant contributions to animal protein availability in Nigeria through cheap meat and eggs, which serve as a buffer to the shortage of other poultry products. In developed countries like France, Germany, and Italy, Guinea fowl production enhances their gross domestic

products and provides high revenue from exports, whereas in less developed economies, it provides a source of animal protein for consumption (Abdul-Rahman and Adu, 2017; Houndonoubo *et al.*, 2017).

refers to the percentage of incubated eggs that are fertile, while hatchability is the percentage of fertile eggs that hatch. It is therefore important to understand different factors that influence fertility and hatchability of eggs. For the hatchability traits, breed has little effect on the hatchability of poultry eggs, although light breeds have been reported to have higher fertility and hatchability. The diet of breeder poultry should be adequate in both quality and quantity to meet the recommended levels set out in the feed standards for the category. The most influential egg parameters that influence hatchability are: weight, shell thickness and porosity, shape index (described as maximum breadth to length ratio), and the consistency of the contents. The most important problems in the production of guinea fowls in Nigeria include low hatchability, high mortality up to 8 weeks of age, lack of reliable advice on veterinary complications, and a shortage of a source of hatching eggs and young stock (King'or, 2011; Oke *et al.*, 2012; Yusuf *et al.*, 2020). This study aimed to conduct a comparative assessment of the fertility rates and hatchability performance of feral and domesticated helmeted guinea fowl eggs under both artificial and natural incubation methods, and it also examined their performance under varying technological applications and management practices. Therefore, it is crucial to review available literature reports on the fertility and hatchability performance of feral and domesticated HG.

COMPREHENSIVE REVIEW

Heat stress vs external and internal qualities of eggs

Heat stress reduces the external and internal egg qualities. Heat stress affects all phases of semen production in breeder cocks. Hatchability for small eggs is lower compared to that of medium and large eggs. There are many factors contributing to the failure of a fertile egg to hatch, which include lethal genes, insufficient nutrients in the egg, and exposure to conditions that do not meet the needs of the developing embryo. Breeder factors that affect hatchability include strain, health, nutrition, and age of the flock, egg size, weight, and quality, egg storage duration, and conditions (King'or, 2011). Eggs stored with the small end up have higher hatchability as compared to the large end up. Incubation of fertile eggs can be done naturally by a broody hen or in an incubator. The broody hen provides the fertile eggs with optimum environmental conditions (temperature, egg turning, and humidity) to stimulate embryonic development until hatching (Araújo *et al.*, 2019). The incubator is a simulated artificial design that mimics the broody hen's role of providing fertile eggs with optimum environmental conditions (temperature, egg turning, and humidity) to stimulate embryonic development until hatching.

A constant incubation temperature of 37.8 °C is the thermal homeostasis in the chick embryo and gives the best embryo development and hatchability. Mortality is seen if the temperature drops below 35.6 °C or rises above 39.4 °C for several hours. Egg turning during incubation is critical for successful hatching and influences hatchability. No turning of eggs during incubation results in low hatchability and delays hatch by a few days (King'or *et al.*, 2010; King'or, 2011). Moreso, low fertility, poor hatchability, and occurrence of dead in-shell embryos were affected by nutrition, especially the manganese

level of the diet, season, sex ratio, period after insemination, age, variety, and method of insemination (Ayorinde *et al.*, 1989; Ayorinde, 1987a, 1987b, 1989a, and 1989b) in HG. Although a mating ratio of one male to four or five females gave satisfactory results, a much higher fertility was obtained when there were only two females to a male.

Helmeted Guineafowl and egg production

The major constraints to helmeted guinea fowl production are egg size, keets mortalities, nutrition, and seasonal variation (Moreki and Seabo, 2012). Guinea fowls have different egg sizes, which affect fertility, hatchability, survivability, growth, and laying performance. For these reasons, fertility and hatchability in guinea fowl are very low, while there is high keet mortality (Tebesi *et al.*, 2012; Twumasi *et al.*, 2020; Alli *et al.*, 2016a and Alli *et al.*, 2016b). Heritability estimates for fertility and hatchability in chickens range from 0.06 to 0.13 (Sapp *et al.*, 2004). This indicates that the non-genetic factors have a stronger influence on these traits. Fertility and hatchability are interrelated heritable traits that vary among breeds and individuals in a breed or variety (Akilarasan *et al.*, 2017). Several other factors including egg age (Tarongoy *et al.*, 1990), storage condition (Brah and Sandhu, 1989), age of flock (Rogue and Soares, 1994; Buhr, 1995), system of husbandry and rearing technology (Weis, 1991), mating system (Gebhardt-Henrich and Mark, 1991), incubation relative humidity and eggs turning angle (Permsak, 1996) have been shown to influence the hatchability of poultry eggs. At each level, it is important to understand the factors that influence egg fertility and hatchability.

Physical and chemical conditions of the egg

Under normal circumstances, a fertile egg contains all the nutrients necessary for the development of the embryo to hatching. However, there are certain physical and chemical conditions of the egg that may lower or cause no hatchability at all. These may be due to the hen or environmental factors. Eggs usually become fertile about four days after the cock has been introduced to the hens. The physical characteristics of the egg play an important role in the processes of embryo development and successful hatching (Narushin and Romanov, 2002; Lengthang *et al.*, 2023). The most influential egg parameters are weight, shell thickness and porosity, shape index (described as maximum breadth to length ratio), and the consistency of the contents. The average values of the physical characteristics mostly meet the requirements for the embryo's development. For those eggs, whose parameters do not fall into the average range, the incubation process is more successful if the shell is thicker than average, the eggs are more pointed rather than round, and the contents are firm. The results reported for investigations into incubating eggs, whose weights are not within the average values, are contradictory.

Both thick shells and firm interiors, which are accepted as being higher than average, lead to an increase in egg weight, which probably results in the more successful hatching of embryos from heavier eggs. Hatchability for small eggs is lower compared to that of medium and large eggs (Asuquo and Okon, 1993). Egg size affects hatchability (Neshiem and Card, 1972; Williamson and Payne, 1978; Mandlekar, 1981). Eggs within 45-56g hatch better than lighter eggs. Mandlekar (1981) reported hatchability of large (51-56g) and medium eggs (45-50g) of 88.2 and 84.8%, respectively. These were higher than the

hatchability of small eggs (37.5-44g) reported by Asuquo and Okon (1993). Best hatchability (97%) was reported for medium-sized eggs (50g) of Anak broiler eggs (Abiola *et al.*, 2008). Large eggs (60g) had the lowest hatchability (83%). As egg size increases, yolk size increases more than the quantity of albumen (North and Bell, 1990; Kyere *et al.*, 2021).

Fertility and Hatchability in Semi-Intensive, Intensive, Extensive Management and Free-Ranging HG

Fertility of eggs from free-ranging guineafowls varied from 10% to 45% (Ayorinde, 1987). However, eggs collected from the wild had fertility values in the range of 5% to 20% (Ayorinde and Ayeni, 1986). The poor fertility and hatchability could be attributed to the time lag between egg-laying, collection, and incubation, poor handling or holding conditions, poor nutrition, and failure of the males to mate with some females. Also, Yusuf *et al.*, 2020 studies found that fertility of eggs collected from Kainji Lake and Old Oyo National Parks had 33.4% and 66.6% for eggs stored at room temperature (RT), 56% and 44% eggs stored in refrigerator (RF) and 39.5% and 60.5% eggs not stored (NS) before incubation while hatchability of 7.7% and 7.4% were recorded respectively. Also, Yusuf *et al.* (2024) said that the guinea fowl smallholder farmers in Kano reached 22% and 24% hatchability rates.

Meanwhile, fertility was slightly higher in semi-intensively raised stocks and varied from 28% to 51% (Ayorinde, 1999). On the deep litter with a mating ratio of one male to four or five females, the fertility of 34% to 74% was obtained (Ayorinde *et al.*, 1989; Ayorinde, 2004). Losses in guineafowl production from incubation to hatching could be attributed to

improper handling of guineafowl eggs before hatching, prolonged storage resulting in poor hatchability, and low brooding temperatures resulting in high keet mortalities (Dzungwe *et al.*, 2018; Ahiagbe *et al.*, 2021). Farmers believe that 51-100 eggs (59.2%, 62.5%) hatched from incubation, and sometimes 101-150 eggs hatched (28.6%, 27.1%) from a natural incubation system using mother hens (Yusuf *et al.*, 2021).

Moreso, fertility also improved significantly when hens were inseminated with either whole or diluted semen (Ayorinde and Ayeni, 1987a and 1987b). Inseminating each hen with either 0.05 or 0.10ml of diluted semen once or twice weekly resulted in higher fertility than 50% to 53% in a naturally mated flock (Ayorinde *et al.*, 1989). Fertility percentages of 58.8 and 65.2 were obtained when hens were inseminated with 0.05ml of the extended semen once or twice weekly, respectively. Inseminating hens with 0.10ml of diluted semen resulted in fertility of 71.1% and 75.4% for once or twice weekly inseminations, respectively (Ayorinde, 1999). Ayorinde (1987a, 1987b, 1989a and 1989b) reported that the method of insemination, natural or artificial, significantly influenced percent egg fertility.

In addition to these, Fani *et al.* (2004) reported that hatchability and fertility of guinea fowl are 75-80%, and the incubation period of guinea fowl egg is varying within 26-28 days. The average weight of a keet at one-day-old is 24.62 g (Fani *et al.*, 2004). The fertility of guinea fowl eggs observed in Khairunnesa *et al.*, 2016 study was almost 80%, which is close to the reports of Fani *et al.* (2004). Natural mating or artificial insemination may affect fertility. Ayorinde *et al.* (1989) investigated laying characteristics and reproductive

performance of four indigenous helmeted guineafowl varieties (*Numidia meleagris*) in Nigeria and found that the egg fertility ranges between 49 to 58% in naturally mated stock. In other reports by Galor (1983) and Ayorinde *et al.* (1989) however stated that the fertility of guinea eggs under artificial insemination was found much higher than that of natural mating while the breeder stock of guineafowl subjected to natural copulation however the egg fertility resulted 80%, which was almost comparable to the egg fertility observed by Surai and Wishart (1996) in artificially inseminated birds.

In the report of Khairunnesa *et al.*, 2016, artificial incubation was practiced for hatching of guinea eggs, while hatching eggs were collected from two sources, either from scavenging birds kept by rural farmers at different regions of the country or from the own parent breeder stocks kept at a poultry farm. Hatchability of the eggs collected from scavenging birds and own breeder stocks was found 68% and 60%, respectively. Published reports suggest a wide variation in the hatchability of guinea eggs. The actual reason for such wide variation in hatchability remains different, and it was assumed that the thickness of egg shell, improper storage of eggs, improper turning in incubators, etc., might be factors that usually affect the hatchability.

Not only these, but also fertility and hatchability are major constraints of the French broiler guinea fowl production and appear to be directly related to egg fertility rate. Fertility in naturally mated stock ranges from 49%-58% while using artificial insemination ranged from 70%-80% (Galor, 1983) higher than the value (80%) reported by Khairunnesa *et al.*, 2016 who investigated fertility in naturally mated guineafowl and also

higher than the values reported by Ayorinde *et al.*, 1989 who investigated lay characteristics and reproductive performance of four indigenous guineafowls in Nigeria. Surai and Wishart (1996) also reported lower values that the breeding stock from which the eggs were collected had guinea cocks and hens kept together in the ratio 1:1. Khairunnesa *et al.* (2016) for scavenging and housed guineafowls (Okyere *et al.*, 2020). Galor (1983) reported hatchability rates of 70%-75% under artificial incubation, while 74.2% hatchability was reported in the grey variety of guinea fowl by Bernarki *et al.*, 2012 was as a result of the short egg storage time, care full handling of eggs, and accurate incubator conditions maintained during the hatching period as well as the high fertility of the French broiler guineafowl.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

From the foregoing, it has been clearly shown that variations in fertility and hatchability of HG eggs from the feral and domesticated points of view. There was improvement and greater performance in fertility and hatchability in domesticated HG compared to feral ones, also from artificial incubation to natural incubation, and from artificially induced HG to naturally mated HG. Therefore, egg selection is an important activity in guineafowl breeding and reproduction, while egg size has a significant influence on fertility, hatchability, and post-hatching performance as well.

Recommendations

It is recommended that eggs from natural ecozones should be in continuous collection for sustainable improvement in domestication and facilitation of rigorous and stable food protein in terms of eggs and flesh flavour of the HG.

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