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The Effect of Mating Ratio on Guinea Fowl Reproductive Performance

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Abstract

This study was conducted to investigate the effect of mating ratio on Guinea fowl reproductive performance. A total of 420 Guinea fowls of the pearl variety were randomly selected from growers housed on the farm. The selected birds were sexed and assigned to three treatment groups according to a mating ratio of 1:4, 1:6 and 1:10 respectively, with a maximum of 120 female Guinea fowls in each group. Eggs were collected daily from the laying birds by treatment groups, graded and stored for a maximum of seven days at room temperature. The selected eggs were fumigated and incubated using an automated Petersime incubator. Percent fertility, hatchability and embryonic mortality were measured after 28 days of incubation. Mating ratios did not significantly affect reproductive performance. The mating ratio of one male Guinea fowl to four males was optimal for reproduction.

Keywords:

Embryonic mortality, Fertility, Guinea fowl, Hatchability.

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Introduction

Poultry production is an economic activity in developing countries. In 2009, the population of Guinea fowls in Ghana was estimated to be 2,574,996, representing approximately 7.1% of the total poultry population (FAO, 2014). Guinea fowls are resistant to common poultry diseases and thrive well under harsh nutritional and environmental conditions (Moreki and Seabo, 2012). Guinea fowl meat and eggs are an important source of animal protein and are in high demand due to their low-fat content and higher content of essential fatty acids (Moreko, 2009). In Ghana, Guinea fowls provide income especially for the rural population, and are used for the performance of some cultural and religious rites (Konlan et al., 2011).

The majority of Guinea fowls are reared in Northern Ghana under extensive or semi-intensive systems (Agbolosu et al., 2012). Unfortunately, this system of production cannot meet the increasing demand for Guinea fowl meat. This has led to the establishment of hatcheries to supply day-old keets for commercial production. The fertility and hatchability of eggs are primary determinants of the availability of day-old chicks for sale to the public (Peters et al., 2008).

Guinea fowl reproductive performance is low compared to other avian species such as the domestic fowl (Zeleke et al., 2020). The major parameters of Guinea fowl reproductive performance include egg fertility, hatchability and embryonic mortalities. These parameters have a direct effect on the availability of day-old keets for commercial production. Fertility refers to the percentage of incubated eggs that are fertile, while hatchability is the percentage of fertile eggs that hatch (Kingo'ri, 2011). Chicken and Guinea fowl eggs hatch after twenty-one and twenty-eight days of incubation respectively. During incubation, embryonic mortalities occur and are classified as early, intermediate or late mortalities, depending on the stage of development (Araújo et al., Mesquita, 2019).

Commercial Guinea fowl production is faced with challenges such as monogamous and seasonal reproductive behaviour, (Balma and Yeboah, 2016), high keet mortality (Avornyo et al., 2007; Moreki and Radikara, 2013), low fertility and hatchability rates (Balma and Yeboah, 2016; Kyere et al., 2017) and difficulty in sex determination in day-old guinea keets (Teye and Adam, 2000). Low fertility in Guinea fowl eggs is caused by inappropriate mating ratios (Apiiga, 2007; Premavalli et al., 2013), while faulty pre-incubation egg management and faulty incubation techniques are the major reasons for low hatchability (Moreki and Mothei, 2009).

To address the issues of low fertility, farmers and researchers have resorted to the use of different mating ratios. Some commercial farms use a mating ratio of one cock to ten cocks as recommended for commercial layer production (Molapo and Kompi, 2015), while others use ratios of 1:4 (Apiiga, 2007). Akate farms Limited has been using a mating ratio of 1:10 since 2011 and reproductive performance on this farm has been reported to be low (Atawalna et al.,2020). The purpose of this study was to investigate the effect of different mating ratios on Guinea fowl reproduction and determine the optimal mating ratio for commercial production.

Materials and methods

1. Study location

The study was conducted at the Guinea fowl section of Akate Farms located at Bosore in the Kwabre East District of the Ashanti Region of Ghana. The area is located in the semi-deciduous forest zone of Ghana between latitude $06^{0}45^{1}$N and longitude $01^{\circ}33^{1}$W (GSS,2012).

The district experiences a major rainy season from March to July, a minor rainy season from August to November, and a dry season from December to February. The average annual rainfall is between 125 mm and 175 mm, with a relative humidity of 70-80 % (GSS,2012).

2. Management of Birds

A total of 420 Guinea fowls (360 females and 60 males) of the pearl variety were randomly selected from growers housed on the farm**.** Before the onset of lay, the Guinea fowls were sexed by the length and thickness of helmet and wattle (Arhin et al., 2018) and assigned to three treatment groups according to a mating ratio of 1:4, 1:6 and 1: 10 respectively, with a maximum of 120 female Guinea fowls in each treatment. They were housed in the same building but in different pens separated by a wall. They were allowed to acclimatize before the commencement of the study. The study lasted from May to June 2019. Grower Guinea fowls were a fed diet containing 17.1 % crude protein and 2650–2750Kcal/Kg ME from 15 weeks before the onset of lay. Matured breeding stock was fed daily with an average between 110-130g and provided with clean drinking water ad-libitum through an automated drinking system. The birds were given levamisole and vitalyte orally as prophylactic treatment and vaccinated intra-muscularly with the third Newcastle vaccine. They were provided with 3 hours of additional light daily.

3. Pre-incubation and Incubation Management of Eggs

Eggs were collected daily from the treatment groups, graded and stored for a maximum of seven days at room temperature. The eggs selected for incubation from each group were fumigated and sent to an automated Petersime incubator once weekly. Temperature and relative humidity were maintained at 37.5°C and 74-85% at setting and 36.5°C and 66-75% at hatching. Eggs were candled on the 24th day of incubation to remove infertile eggs. Only fertile eggs were transferred to the hatcher. Hatching was completed on the 28th day and the number of the hatched keets was recorded and classified either as viable or non-viable keets. Healthy, normal-sized keets were considered viable, while undersized, poorly feathered, lame, open-naveled and blind keets were regarded as non-viable. On the 29th day, unhatched eggs were broken to determine the number of dead embryos.

4. Parameters Measured

The parameters measured were defined as follows:

Fertility (%) =

$$\frac{\text{total number of fertile eggs}}{\text{total eggs set}} \text{ x } 100$$

Total Hatchability (%) =

$$\frac{\text{total number of keets hatched}}{\text{total eggs set}} \text{ x } 100$$

Fertile Hatchability (%) =

$$\frac{\text{total number of keets hatched}}{\text{total number of fertile eggs}} \text{ x } 100$$

Embryonic Mortality=

$$\frac{\text{total number of dead embryos}}{\text{total eggs set}} \text{ x } 100$$

Viable keets (%) =

$$\frac{\text{total number of viable keets hatched}}{\text{total number keet hatched}} \text{ x } 100$$

Non-viable keets (%) =

$$\frac{\text{total number of non}-\text{viable keets hatched}}{\text{total number of keets hatched}} \text{ x } 100$$

5. Data analysis

Fertility, hatchability, and embryonic mortalities were calculated by the number of eggs set for incubation per treatment group for each batch of keets hatched. The data obtained were analyzed using the statistical software Graph Pad Prism version 8.09. The means were compared using the analysis of variance (ANOVA) at $p<0.05$ and significant differences were separated by Tukey's multiple comparison test.

Results and Discussion

The reproductive performance of Guinea fowls under different mating ratios is presented in Table 1. The results are expressed as Mean± Standard deviation (SD) in percentages. The mating ratio did not significantly ($p>0.05$) affect reproductive performance. However, fertility, fertile hatchability and total hatchability rates were numerically higher in the group with 1:4, followed by the 1:6 group and lowest in the 1:10 group. These differences may be because Guinea fowls are monogamous in the wild and tend to retain this trait when confined. However, under confinement, male Guinea fowls' pair to a group of females for mating purposes. This pairing was probably higher with a smaller number of females. Consequently, in groups with a larger number of females, some females may not be mated with the male and therefore lay unfertile eggs. These findings are similar to that of Premavali et al., (2013), among Guinea fowls in Tamil Nadu, India. These authors concluded that the optimal mating ratio was 1:4 and 1:5 respectively, while 1:2 and 1:1, resulted in low productivity.

Table 1: Effect of Mating Ratios on Guinea Fowl Reproductive Performance (%).

Mating ratio	Eggs Set	Fert	FHat	That	EM	VK	NVK
1:4	3247 ± 536	84 ±3.4	66 ± 3.3	55 ± 3.7	34 ± 3.3	98 ± 0.72	2.0 ± 0.72
1:6	2858 ± 198	78± 3.9	59 ±28	47 ±24	41± 28	96 ±2.5	3.6
1:10	5800 ±1311	75± 5.1	51 ±35	39 ± 28	49 ± 35	96 ± 2.0	3.6± 2.0
PValue	0.014	0.112	0.222	0.685	0.806	0.442	0.239

Fert-fertility, FHat- fertile hatchability, That- total hatchability, EM- embryonic mortality, VK-viable keets, NVK-non-viable keets

The findings are also similar to reports by Oluwaseun et al., (2020), that mating ratios had no significant effect on the fertility and hatchability of eggs of Nigerian native chickens. According to Chotesangasa, (2001), the mean fertility rates of 35-44 weeks old native Thai hens in mating ratios of 1:7, 1:10, 1:13 and1:16 were 88.21, 91.20, 88.20 and 79.82% respectively. These values were not significantly different. On the contrary, percent fertility in the Chukar partridge (*Alectoris chukar*) was greater with sex ratios of one male: one or two females than with one male to three to five females (Hassan et al., 2019). The authors attributed greater percent fertility with the one male to one or two female sex ratios to increased frequency of copulations with female(s) as compared to the latter females. The fertility of avian eggs generally improved when proper mating ratios were maintained and the cocks were frequently tested for semen quality (McGary et al., 2003).

Fertility rates in this study were similar to the 67.1-81.5 % reported for pearl Guinea fowls in India (Premavali et al., 2013) and 80% for Guinea fowls under intensive management in Pakistan (Khairasan et al., 2016). They were however higher than 55.64 % for Guinea fowls in Umudike, Nigeria (Odukwe and Onunkwo, 2016) and 56.9% for Guinea fowls in the humid areas of Ghana (Adu-Aboagye et al., 2020). On

the contrary, the fertility rate was lower than 94.5 % reported for French broiler Guinea fowls in Katsina state Nigeria (Dzungwe et al., 2018). The differences in fertility rates may be due to the different management systems and existing climatic conditions. Guinea fowls intensively reared had better feeding, housing and other husbandry practices and hatching of eggs was better handled using more efficient incubators.

This study reported that percent fertile hatchability and total hatchability decreased from 66 ± 3.3 and 55 ± 3.7 to the lowest values of 51±35 and 39 ± 28 respectively, as the mating ratio changed from 1:4 to 1:10. These findings agree with the trend of hatchability of Guinea fowls under different mating ratios in India (Premavalli et al., 2013). However, the percent hatchability rates were lower in the current study compared to the former. The percent hatchability rate was lower than 82.2% in Southern Ghana (Adu-Aboagye et al., 2020). These variations in hatchability may be due to differences in pre-incubation egg management and the functioning of incubators.

The percent total embryonic mortality (34 ±3.3 to 49 ± 35) was similar to previous reports of embryonic mortalities in Ethiopian Guinea fowls (Zeleke et al., 2020). The latter authors remarked that embryonic mortalities were higher in Guinea fowls compared to native chicken genotypes such as Tilili, Horro and Potchefstroom koekoek. The embryonic mortality rate (%) in this study was higher than 16.4-25.3 % for Guinea fowls in Mampong Ashanti (Kyere et al., 2017) and 20.8% in Katsina State, Nigeria (Dzungwe et al., 2018).

The percent viable keets at hatch ranged from 96 ± 2.0 to 98 ± 0.72 and were very high. This was an indication of the profitability of the commercial production of day-old Guinea keets.

Conclusion

The mating ratio did not significantly affect Guinea fowl reproduction. The optimum mating ratio was one male Guinea fowl to 4 females. Measures should be taken to reduce embryonic mortality by constantly monitoring pre-incubation egg management and the technical operation of the incubator systems.

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Conflict of interest statement

The authors declare that there is no conflict of interest.

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