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Effect of the season and the sex ratio on the laying performance and on the reproduction performance of indigenous guinea fowl (*Numida meleagris*) in South Togo

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1. ABSTRACT

The study was conducted to determine the impacts of seasonal and sex ratio variations on the production and reproductive performance of indigenous guinea fowl (*Numida meleagris*) in south Togo. A total of 177 birds were divided into 4 experimental groups (S_2, S_3, S_6 and S_{10}) of 3 replicates each. Cock and guinea hen were assigned in ratio 1:2, 1:3, 1:6 and 1:10 in group S_2, S_3, S_6 and S_{10} assigned respectively. Data was analysed by Graph Pad Prism 5.00.288 software. The results on the laying performance showed an early laying of the first egg (22.6 weeks of age) with an average live weight of 1314 ± 14.70 g. The best feed efficiency was recorded in the rainy season, as were the heaviest eggs. Eggs were obtained in all seasons of the year with an average laying rate of 45.58 ± 1.82%. The internal quality of the eggs was not affected by the season. Larger eggs were obtained during the rainy season with an average length of 48.91 ± 0.38 mm. The results on reproductive performance showed that 1:2 sex ratio allowed had the best fertility rates, 84.03 ± 1.16 % in the dry season and 79.62 ± 1.12% in the rainy season. The best hatching rates were obtained with 1:2, 1:3 and 1:6 sex ratio. In conclusion, guinea fowl reared under intensive system lay eggs all the year. The 1:3 is the efficient guinea cock to hen ratio for optimizing reproduction traits.

2. INTRODUCTION

The guinea fowl (*Numida meleagris*) are original from Africa (Nwagu and Alawa, 1995) and are present in the countrysides either in the wild, or still as a farmyard animal. Its wide distribution is partly due to the adaptation of this bird to varying ecological conditions. In Togo, guinea fowl and chicken are the two main components of poultry farming. With 1,681,701 heads (FAO, 2015), the guinea fowl ranks second in the classification of farmyard poultry species after chicken (*Gallus gallus*) and is reared mostly in the north of Togo (Savannah region). Hence, it is an important source of animal protein with higher nutritional value and an important for income generation for households in rural areas. In most sub-Sahara Africa countries and particularly in Togo, free range system is the popular rearing system of guinea fowl because of the lowest production cost of this system. It is picking system in which the management practices of poultry are not followed. The birds scavenge, find their feed and shelter themselves. They depend on harvest residues, weed seed, insects and worms, (Dahouda et *al.*, 2007). This rearing system is faced with too many constraints such as the high mortality of keets (64 % according to

Saina et *al.*, (2005), the lack of breeding flock which provide day-old keets, the difficulty in sex determination (Teye and Adam (2000), low production and reproduction performance of local strains (Duodu et *al.*, 2018). Furthermore, the lowest are fertility and hatchability of guinea fowl eggs. Ayorinde et *al.*, (1989) reported the fertility rate varies between 49 and 58 % in free range system. According to the hatching rate Karbo et *al.*, (2002) obtained 68 % which range in the rate of 66-69 % reported by Konlan et *al.,* (2011). However, these hatching rates are less than 72 % and 88 % reported respectively by Kone et *al.*, (2019) and Saina et *al.,* (2005). The sex ratio in these free range guinea fowl system varies often from 2 to 3 females for 1 male. Djiotsa et *al.,* (2016) surveys of traditional rearing system revealed a fertility rate of 95 % and a hatching rate of 90 % with a ratio of 1 male to 2 females. These variations in fertility and hatchability in the free-range guinea fowl rearing system are linked to the difficulties in sexing guinea fowl since they look exactly the same. However, another significant challenge is availability of fertilized guinea eggs at different seasons of the year due to seasonal breeding nature of guinea fowl, which is a limiting factor in large-scale production. Many studies have focused on improving the rearing conditions of guinea fowl and their impact on reproductive performance. Thus, different sex ratios have been proposed by researchers in order to increase fertility and hatchability in intensive rearing system. Gonzalez and Klein (1974) obtained 92 % fertile egg with of 1 male to 5 females ratio. In the same way Jacob and Pescatore, (2013) recommended 1 male 5 females ratio to optimize the fertility rate in intensive rearing. The work of Halbouche, et *al.*, (2010) reported a fertility of 85.8% and a hatchability of 77% in intensive rearing with 1 male to 6 females ratio. Okyere et *al.*, (2020) obtained with 1 male to 4 females ratio 66.61 % fertility rate of and 65.15 % hatchability. Sanfo et *al.*, (2012) in Burkina obtained a fertility rate of 82.7% and a hatching rate of 74.3% with 1 male to 2 females ratio. There is therefore great variability in the fertility and hatching rates of guinea fowl eggs. What ratio would then be the best that would optimize eggs laid fertility in intensive farming according to the seasons? The objective of this study, is to determine the male to female guinea ratio that increases fertility and hatchability rate of guinea fowl eggs throughout the year in intensive rearing system.

3. MATERIAL AND METHODS

3.1. **Study areas:** The study was carried out at the farm "AYODELE", with geographical coordinates 6 ° 22´15.65´´N and 0 ° 58´07.35´´ E, located in Badja in the prefecture of Ave, a village located at 47 km northwest of the city of Lome (Togo). It is humid tropical climate area. Average annual temperatures vary between 25 ° C and 32 ° C with an average humidity level of 75%. The study spanned two seasons: the rainy season from April to mid-July and the dry season from December to mid-March.

3.2. **Experimental birds and management:** The experimental guinea fowl came from 1286 eggs collected from farmers in the Savannah region of Togo. The guinea fowl eggs were hatched at the Regional Centre of Excellence on Avian Sciences of the University of Lome (CERSA/UL). The keet were reared under intensive management for 20 weeks where the birds were subjected to the same prophylactic program. The birds had free access to feed and water. Three types of ration were purchased from CERSA feed factory and distributed throughout experiment period (Table 1): starter diet (0 - 8 weeks), grower diet (9 - 20 weeks) and laying diet (after 20 weeks). At 20 weeks of age, the guinea fowl were sexed and 177 birds (138 females and 39 males) were randomly divided into three experimental groups and assigned to the male: female ratio: 1:2, 1:3, 1:6 and 1:10 of three replicates each. The birds were randomly allotted to the replicates as follow: 1:2 (6 cocks to 12 hens); 1:3 (4 cocks to 12 hens); 1:6 (2 cocks to 12 hens) and 1:10 (1 cock to 10 hens). The first egg was laid 22.6 weeks with guinea hen weighting average of

1314 ± 14.70 g. The reproduction trial started when birds reached 50 % hen day egg production and no mortality was recorded during the studies production period. The eggs collected from each group during the production period were stored at 16 - 18°C and 60 - 70 % relative humidity. After 7 days of storage, 130 eggs was incubated artificially for each group using an average temperature of 37.2 - 37.8 ° C and 60 – 70 % relative humidity. Eggs were candled on the nineth and twenty fourth day of the incubation period to determine infertile eggs and eggs with dead embryos. 30 eggs were selected weekly to measure internal and external quality traits.

Table 1: Diets composition and macronutrient levels according to age

Ingredients	Starter (%)	Grower (%)	Laying (%)
Maize	54	53	56
Wheat	3.5	17	11
Fish	5	5	7
Soybeans	20.5	15.5	14
Soybean meal	10	0	0
Shell	3	4.5	6
Broiler Concentrated	4	5	0
Dresh	0	0	4
Layer Concentrated	0	0	2
TOTAL	**100**	**100**	**100**
Proximate composition			
ME[1] (kcal/kg)	2918.93	2757.20	2803.30
Crude protein	22.00	18.04	17.02
Calcium	1.42	1.85	2.34
Phosphorus	0.64	0.73	0.67
Methionine	0.47	0.45	0.36
Lysine	1.18	0.93	0.88
Methionine + Cysteine	0.73	0.67	0.59

[1] metabolisable energy (ME)

3.3. **Data collection :** The production parameters measured were feed intake (FI), feed conversion ratio (FCR), body weight at first egg, average body weight (BW), hen egg production (HEP). The external traits measured include, individual egg weight (EW), shell weight (SW), egg length (EL), egg width (Ewd) and shell thickness (ST). The internal egg quality traits measured were albumin weight (AW) and yolk weight (YW). The reproductive parameters studied were fertility rate, hatchability rate and embryonic death rate. The various parameters studied were calculated according to the formulas

$$FI = \frac{Feed\ provided - Feed\ refusals}{Number\ of\ guinea\ fowl}$$

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

$$HEP = \frac{Number\ of\ eggs\ laid}{Total\ number\ of\ hen} \times 100\ \%$$

$$\% \text{ Fertility} = \frac{Total\ number\ of\ fertile\ egg}{Total\ numbre\ of\ egg\ set} \times 100$$

$$\% \text{ Hatchability} = \frac{Total\ number\ of\ guinea\ keet\ hatched}{Total\ number\ of\ fertile\ egg} \times 100$$

$$\% \text{ Total embryonic mortality} = \frac{Total\ number\ of\ dead\ in\ shell}{Total\ number\ of\ fertile\ egg} \times 100$$

3.4. **Data analysis:** Data collected were subjected to statistical analysis using Graph Pad Prism 5.00.288 software. The model t-test was used to compare the averages data for feed intake, feed conversion ratio, body weight, egg characteristics and hen day egg production throughout experiment period. Two-way ANOVA test was used to analyse data from fertility rate, hatching rate and embryonic mortality rate. A probability value of 0.05 was retained as the degree of significance. The Tukey's test was used comparing the means when the general model were statistically different.

4. RESULTS AND DISCUSSION

4.1 Results

4.1.1 Effect of season on production traits: Table 2 presents the effects of season on the production traits. There was significant ($p<0.05$) effect of season on FI and FCR. Among the seasons the highest feed intake was observed in the rainy season (April – July). Hen egg production and body weight were not affected by the season. The average weight of guinea fowl obtained during the trial was 1480 ± 15.36 g and the average egg production was 45.58 ± 1.82 %.

Table 2: Effect of the season on the production performance of guinea fowl

Parameters	Season		Mean	p-value
	Dry	Rainy		
FI (g/day)	69,02 ± 1,64[b]	82,24 ± 3,12[a]	76,68 ± 2,35	0,0002***
FCR (g/g)	2,78 ± 0,19[b]	2,34 ± 0,16[a]	2,5 ± 0,13	0,0391*
BW (g)	1462 ± 20,88	1499 ± 22,48	1480 ± 15,36	0,0908 ns
HEP (%)	46.46 ± 1.29	44.70 ± 3.47	45.58 ± 1.82	0.6085 ns

a and b indicate that on the same row, the means that not have the same letters are significantly different at p <0.05. FI: feed intake; FCR: feed conversion ratio; BW: body weight.

4.1.2 Effect of the season on guinea egg characteristics: The results for quality traits of egg are presented in Table 3. Only egg weight and egg length were influenced significantly ($p<0.05$) by the season. The highest egg weight and egg length has been recorded at the rainy season. The others characteristics were similar across all the production seasons

Table 3: Effect of the season on the guinea egg quality

Parameters	Season		Mean	p-value
	Dry	Rainy		
EW (g)	40.27 ± 0.47[b]	42.13 ± 0.49[a]	40.99 ± 0.36	0.0031 **
AW (g)	19.31 ± 0.33	19.87 ± 0.37	19.80 ± 0.29	0.1246 ns
YW (g)	12.79 ± 0.15	13.17 ± 0.23	12.94 ± 0.13	0.3316 ns
SW (g)	7.44 ± 0.14	7.57 ± 0.21	7.48 ± 0.12	0.3710 ns
EL (mm)	47.87 ± 0.35	48.91 ± 0.38	48.26 ± 0.27	0.0489 *
Ewd (mm)	37.87 ± 0.16	38.28 ± 0.18	38.03 ± 0.12	0.0547 ns
ST (mm)	0.27 ± 0.01	0.26 ± 0.02	0.26 ± 0.01	0.3383 ns

a and b indicate that on the same row, the means that not have the same letters are significantly different at p <0.05. ALR: average laying rate; EW: egg weight; AW: albumin weight; YW: yolk weight; SW: shell weight; EL: egg length; Ewd: egg width; ST: shell thickness.

4.1.3 Effect of season and sex ratio on reproductive traits: Reproductive traits were significantly (p<0.05) influenced by season and different sex ratio (table 4). Reducing hen ratio to cock improved fertility of guinea eggs during all seasons. The highest fertile eggs are obtained in the dry season with 1:2 ratio. However, in the rainy season the lowest fertile egg are obtained with 1:10. The best hatching rates were obtained with the ratio: 1:2, 1:3 and 1:6 during the seasons. The highest hatching rate was recorded during the raining season. The highest embryo mortality was recorded in 1:10 ratio.

Table 4: Effect of sex ratio on reproductive parameters during the two seasons

Season	Parameters (%)	Treatments				p-value
		S_2	S_3	S_6	S_{10}	
Dry : December - March	**F**	84,03 ± 1,16[a]	69,11 ± 2,08[b]	57,55 ± 0,82[c]	40,14 ± 1,54[d]	p<0,0001 ***
	H	56,57 ± 0,83[a]	52,20 ± 0,65[b]	52,21 ± 0,66[b]	47,36 ± 1,54[c]	p<0,0001 ***
	TEM	43,43 ± 1,53[c]	47,80 ± 1,13[b]	47,79 ± 1,91[b]	52,64 ± 1,27[a]	p<0,0001 ***
Rainy : April - July	**F**	79,62 ± 1,12[a]	73,20 ± 1,50[b]	70,51 ± 1,60[b]	51,39 ± 1,29[c]	p<0,0001 ***
	H	60,47 ± 1,77[a]	58,36 ± 1,19[a]	61,55 ± 1,97[a]	53,48 ± 0,95[b]	p<0,0001 ***
	TEM	39,53 ± 0,68[b]	41,64 ± 1,09[b]	38,45 ± 0,40[b]	46,52 ± 1,31[a]	p<0,0001 ***

a, b, c and d indicate that on the same row the lots that do not have the same letters are significantly different at p <0.05. F: fertility rate; H: hatching rate; TEM: Total embryonic mortality rate.

4.1. DISCUSSION

4.2.1 Effect of season on production traits: Feed intake (FI) was significantly affected by the season in this study. The highest FI recorded in the rainy season is linked to cold which increased feed consumption by the guinea fowl. Increasing feed intake in birds helps them to increase body temperature and thus fight against the cold (Alves et *al.*, 2012). The feed intake in this study is similar to the report of Okyere et *al.*, (2020). However, the range of value for feed intake is lower compared to 106.48 g reported by this author. According to Quiniou et *al.*, (2000), there is negative correlation between temperature and feed intake, as temperature increases feed intake decrease. The results indicate that the lowest

feed conversion ratio (FCR) was recorded in the rainy season where feed intake is high and this FCR is negatively correlated with body weight. However, there is no significant different in body weight of the birds for both season. This outcome is supported by the efficiency in the use of feed intake. This result is in range of the report that hot periods exert detrimental effect on feed efficiency (Mashaly et *al.*, 2004). This result contradicts the report of Okyere et *al.*, (2020) who found positive correlation between feed intake and FCR in rainy season. The hen egg production was not influenced by the season. The first egg is laid in dry season. We can note that in this study, the intensive rearing system of the guinea allowed hen laid egg during all the season of the trial with average laying rate of 45.58 ± 1.82 %. This result indicate that the affirmation according to guinea fowl are essentially seasonal breeders (Aire et *al.*, (1979) is accepted if and only if the birds were reared in free range system management. Under this management system, the birds were left alone, no investments in the flock, no feed supplement… but in the rainy season, the birds find abundant insects, harvest residues, vegetables to supplement its regimen. This result confirm that of Sanfo et *al.*, (2012) but the mean egg production obtained is lower (42.39 %) compared to that of this study.

4.2.2 Effect of season on egg characteristics: The result shown that the heaviest eggs were laid at the rainy season. This higher value of egg weight in rainy season is attributed to the highest feed intake of the guinea fowl during that season. This egg weight is similar to that recorded by Okyere et *al.*, (2020) in the major rainy season period (April to July) in Ghana. The longest egg is obtained during the rainy season. This egg performance is linked to the egg weight. The non-significant effect of season on the others egg characteristics as albumin weight, yolk weight, shell weight, shell thickness and egg width is due to the fact that the way season influence body weight of birds differ from how body weight influences egg weight (Zagbede et *al.*, (2019). The non-significant effect was reported by Okyere et *al.*, (2020) according to yolk weight and shell weight but contradicted the same author for albumin weight and shell thickness which were significant. However, albumin weight (17.04 g) and shell thickness (0.05 mm) reported by Okyere et *al.*, (2020) during rainy season were lower when compared to our result in the same season.

4.2.3 Effect of season and sex ratio variation on reproductive traits: The results had shown that season and sex ratio had influenced reproductive traits. Increase fertile eggs resulting in one cock to hen ratio reduced. Fertility rate of 1 cock to 2 hens ratio was significantly ($p<0.05$) higher during seasons. Similar result was obtained by Okyere et *al.*, (2020). However, the fertility rate of this author were obtained with 1:4 ratio and were lower (77.58 % dry season and 63.33 % rainy season) compared to those of our study. Furthermore, the fertility rates of rainy season were higher compared to dry season fertility rates for all sex ratio combined. These results are in agreement with those of Islam et al (2008) who obtained a positive correlation between environment factors (season, temperature, humidity and photoperiod) and fertility. In other hand, the lower fertility rates recorded in dry season were linked to lower semen production of guinea cocks. According to Abdul-Rahman et *al.*, (2015), in breeding season (wet season) guinea cock testicular weight increase resulting in increasing of testicular sperm production per mg of testis, testicular sperm production per testis and relative volume of seminiferous tubules. The significant difference ($p<0.05$) recorded between sex ratio is resulted in numeric fertile eggs obtained with male: female ratio 1:2, 1:3 and 1:6 compared to 1:10 ratio. This results supported those of Alsobayel and Albadry (2012) who studies effects of age and 1:6, 1:10 and 1:14 male: female ratio on fertility and hatchability in Leghorn and Baladi breeds. The hatchability rate in the rainy season was significantly higher than dry season. The higher hatchability is linked to the fact that wet season promote the viability of the eggs. In hot atmosphere, eggs water loss is very significant

and this affects the vitality of the embryo and therefore the hatchability and the chicks quality. These results are in line with those of Belitz et *al.*, (2009). The present hatchability rate is lower than 68.94 % hatching rate of Okyere et *al.*, (2020) by ratio of 1 cock to 4 females and that (77 %) of Halbouche et *al.*, (2010). The hatchability falls in the range reported by Naandam and Issah (2012) in local stocks of guinea fowl managed intensively. The dead in shell embryo of the 1:10 ratio is the highest significantly ($p<0.05$) compared to the other ratio. This result in the lowest rate of hatching of 1:10 egg in these periods, so the total embryo mortality percentage will increased as observed in the present study. This result conforms to that of Yakubu et *al.*, (2019) in their work on the factors affecting incubation parameters of guinea fowl eggs.

5 CONCLUSION

From the results reported in the present study, the indigenous guinea hen are capable to lay fertile egg throughout the different season of the year when given adequate feed with improving rearing conditions. The production traits, fertility and hatchability were affected by breeding season. From season and sex ratio results we suggest that in dry season less than 3 hen ratio for 1 cock whether adopted for reproduction and more than 3 hen for 1 cock ratio for wet season in purpose to improve local guinea fowl reproduction traits. Also more studies are needed to be done to determine suitable development environment of indigenous guinea fowl.

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