



**Some Factors affecting Incubation Parameters of Guinea Fowl (*Numida meleagris*) Eggs**

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**Abstract**

The study was conducted at Dan Alkali Farm in Kura Local Government Area of Kano State between June 2016 and December 2017 to determine the effects of some factors on incubation parameters of guinea fowl eggs. A total of 97304 eggs from 160 Pearl and 400 Belgium strains, managed semi-intensively were used in determining the following parameters: fertility, hatchability and percentage dead in shell. Data generated were subjected to analysis of variance using the General Linear Model (GLM) procedure of SPSS, version 25 (2017). Significantly different means were compared using Least Significant Differences (LSD). The result showed that the Pearl strain had mean fertility, hatchability and percentage dead in shell of 55.97, 72.96 and 17.09 %, respectively. The corresponding values for Belgium type were 56.30, 72.26 and 16.73 %. Genotype had no effect on all the parameters observed. However, significantly ( $P < 0.001$ ) higher fertility and hatchability and lower dead in shell were recorded during the late rainy and early dry seasons. Strain x season interaction significantly ( $P < 0.05$ ) affected fertility and dead in shell. Thus, hatchability of guinea fowl eggs is higher in the late rainy and early dry seasons.

**Key words:** genotype, season, fertility, hatchability, guinea fowl

**Introduction**

The potential of the guinea fowl to increase egg production in Nigeria is a fact that deserves a better recognition. Under the free range system of management, guinea hens can lay up to 60 eggs per season, while intensively reared stock can lay up to 200 eggs per annum. According to Farrel (2017), average annual egg production of guinea fowl is between 55 and 100. The success of the guinea fowl enterprise is wholly hinged on egg productivity, as well as its fertility and hatchability. According to Ocheja *et al.* (2011), full scale domestication of the guinea fowl has not been attempted in Nigeria because seemingly, little attention has been given to its commercial production. Rearing of guinea fowl is not economical due to seasonal egg production and poor fertility associated with hatchability (Nwagu and

Alawa, 1995). The study by Dahouda *et al.* (2008) showed that local hens can be used to incubate guinea fowl eggs and are preferred to guinea fowl hens. Natural incubation which is common in smallholder guinea fowl production does not contribute many keets to the flocks; hence contributing to the underdevelopment of the guinea fowl enterprise across the continent. Fertility of guinea fowl eggs have been reported to range from 70 to 85% (Moreki, 2009; Agbolosu *et al.*, 2012), while hatchability ranges from 72 to 80 % had also been reported (Naandam and Issah, 2012; Ahaotu *et al.*, 2013; Farrel, 2017). Fertility and hatchability of guinea fowl eggs vary among breed, variety and individuals in a breed. Egg size, season of breeding, age and weight of guinea hen have been implicated to affect fertility, hatchability and embryonic mortality

(Ayorinde and Ayoni, 1986; Asuquo and Okon, 1993; Oke *et al.*, 2004). Although a number of studies have been carried out on nutrient requirement of guinea fowl (Agwunobi and Ek-penyong, 1990; Adeyemo *et al.*, 2006; Yildirim, 2012; Alli and Ayorinde, 2013), very few have concentrated on the reproductive aspect (Alsobayel, 1992; Almarshade, 2011). In recognition of the importance of guinea fowl production and its associated problems, a study of factors affecting fertility, hatchability as well dead in shell keets will help farmers to improve flock size there by increasing their income.

## Materials and Methods

### Location and climate

This study was conducted at Dan Alkali farm in Kura Local Government Area of Kano State. Kura is 27 Km away from Kano City and lies at longitude 11° 46' North and latitude 8° 25' East with a land area of 206 Km<sup>2</sup>. The Local Government is semi-arid with unpredictable rainfall distribution and duration. It has four seasons: early wet season (May-July), late wet season (August-October), early dry season (November-January) and late dry season (February-April). The mean annual rainfall ranges between 134.4 mm and 140 mm.

### Management of Experimental Animal

The animals used for this study were domesticated guinea fowls comprising of 400 Belgium (350 females and 50 males) and 200 Pearl (160 females and 40 males) breeds. They were managed intensively in deep litter and fed with vital feed layer ration (18 % CP and 2800 Kcal/ME/Kg).

### Pre-incubation and Incubation Managements of Eggs

During the period of laying, the hatching eggs were collected between 9.00 am and 4.00 pm daily. Soon after collection, the eggs (without any defects) were

fumigated with formaldehyde gas and later stored at physiological zero condition at 18±1°C with 70±5 % relative humidity. Prior to setting, the hatching eggs were allowed to attain room temperature (taken out of cold storage) for six hours. The eggs were incubated in automatic computer controlled high density incubator (5000 eggs capacity) and set with broad end up in the setter compartment. The temperature and relative humidity of this compartment were maintained at 37.5±0.3°C (99.5±0.5°F) and 60 %, respectively. Turning was automated at an hourly interval. The eggs were transferred to the hatcher on 24<sup>th</sup> day of incubation. In this compartment, respective temperature and relative humidity of 37.0±0.3°C (98.5±0.5°F) and 70 % were maintained till hatching. Eggs were candled on the 10<sup>th</sup> day of incubation to sort out infertile eggs and on 24<sup>th</sup> day to detect early embryonic mortality. On the 28<sup>th</sup> day, the hatchability and dead in shell keets were recorded immediately after hatching.

## Data Collection

### Incubation parameters

Total eggs fertile (number fertile) was determined by deducting infertile eggs from the total number of eggs set while fertility, total hatchability, fertile hatchability and percentage dead in shell were obtained using the following formulas:

$$\begin{aligned} \text{Fertility (\%)} \\ &= \frac{\text{Number fertile}}{\text{Total egg set}} \times 100 \end{aligned}$$

$$\begin{aligned} \text{Total hatchability (\%)} \\ &= \frac{\text{Number hatched}}{\text{Total egg set}} \times 100 \end{aligned}$$

$$\begin{aligned} \text{Fertile hatchability (\%)} \\ &= \frac{\text{Number hatched}}{\text{number fertile}} \times 100 \end{aligned}$$

$$\frac{\text{percentage dead in shell}}{\text{dead in shell}} = \frac{\text{Number fertile}}{\text{Number fertile}} \times 100$$

### Data Analysis

Data generated were analyzed using SPSS version 25 (2017). Prior to the analysis, the data were tested for normality using Kolmogorov-Smirnov test and found to be not normally distributed. They were therefore transformed using the arcsine transformation to normalize the distribution before analysis. Multivariate analysis of variance was employed to determine the effects of breed, season and year on incubation parameters (fertility, hatchability and dead in shell). The statistical model used was as follows:

$$Y_{ijk} = \mu + B_i + S_j + Y_k + (BS)_{ij} + e_{ijk}$$

Where:

$Y_{ijk}$  = incubation parameters

$\mu$  = Overall mean

$B_i$  = Effect of  $i^{\text{th}}$  breed ( $i = 1, 2$ )

$S_j$  = Effect of  $j^{\text{th}}$  season ( $j = 1, 2, 3$ )

$Y_k$  = Effect of  $k^{\text{th}}$  year ( $k = 1, 2$ )

$(BS)_{ij}$  = Interaction effect of  $i^{\text{th}}$  breed and  $j^{\text{th}}$  season

$e_{ijk}$  = Residual error

### Results

#### Effects Genotype, Season and Year on Fertility, Hatchability and Percentage Dead in Shell

Influences of breed, season and year on fertility, hatchability and percentage dead in shell are presented in Table 1. The result obtained in the present study revealed non-significant effect of breed on transformed fertility, hatchability and percentage dead in shell. However, Significant effect of season on these traits was observed. Late rainy ( $57.00 \pm 0.53$  and  $74.72 \pm 0.40$ ) and early dry ( $57.00 \pm 0.44$  and  $73.27 \pm 0.41$ ) seasons had significantly higher fertility and hatchability rates than early dry seasons. For percentage dead in shell, early rainy had higher value compared to late rainy and early dry seasons ( $19.09 \pm 0.66$  vs

$15.56 \pm 0.36$  and  $16.13 \pm 0.38$ ). The non-significant effect of year on these variables was however noticed.

#### Effect of Genotype x Season on Fertility and hatchability

Interaction effect of genotype x season on fertility is presented in Table 2. There was significant ( $P < 0.05$ ) interaction effect. Within each strain (Pearl and Belgium), fertility varied with season and was observed to increase from early rainy to early dry and late rainy seasons. The values of late rainy ( $56.61 \pm 0.66$  and  $57.38 \pm 0.66$  %) and early dry seasons ( $56.19 \pm 0.68$  and  $58.32 \pm 0.68$  %) in both strains were at par while in early dry, Pearl strain recorded significantly ( $P < 0.05$ ) higher fertility than the Belgium type. Table 3, shows the effect of genotype x season interaction on percentage dead in shell. Significant ( $p < 0.05$ ) interaction effect was also observed. In both strains, percentage dead in shell was higher in early rainy season, with the least been observed in late rainy. The values obtained in late rainy season for both genotype were at par while in early rainy and dry, significant difference was observed between the two strains.

### Discussion

#### Fertility

The mean value of  $55.97 \pm 0.34$  % observed in the present study is similar to those (50 and 59 %) reported by Ayorinde *et al.* (1989) and Mwale *et al.* (2008), respectively. However, higher value of  $62.89 \pm 0.91$  was recorded by Premavalli (2013) in White and Pearl strains of guinea fowl and this could be as a result of accurate feed formula (guinea fowl breeder mesh) fed to the experimental animals. Guinea cocks have smaller testicular weight (1-9 g) than chicken cocks (14-16 g) (Belshaw, 1985; Nwagu and Alawa, 1995). This may place guinea fowl at a disadvantage because sperm production is associated with size of the testis in poultry (Ayorinde *et al.*, 1989).

The fact that genotype had no effect on fertility as observed in the current study confirms the findings of Obike *et al.* (2011) who observed same among black and Pearl strains of guinea fowl. Working on four genotypes of chicken (Rhode Island Red, Barred Plymouth, White leghorn and White rock), Islam *et al.* (2002) detected non-significant effect of genotype on fertility. This is similar to the earlier report of Ali *et al.* (1993) who observed non-significant effect of genotype on fertility among Rhode Island Red, Fayoumi chickens and their crosses. Furthermore, Sapp *et al.* (2004) attributed the non-significant influence of genotype on fertility to poor heritability estimate of this trait (0.06). On the contrary, Singh *et al.* (2011) detected significant effect of strain on fertility and observed that Lavender and Pearl varieties produced nearly 10-12 percent more fertile eggs than white types. Similarly, Ayorinde and Okaeme (1984) reported marked variations in percentage fertile and embryonic mortality in local stocks of ash, black, Pearl and white as well as among exotic (Golden Sovereign) strains and concluded that Pearl were more fertile with a lower incidence of dead in shell than the other varieties.

The fact that fertility in guinea fowl varied widely with respect to seasonal variation is well documented (Ayorinde *et al.*, 1989; Nwagu and Alawa, 1995). The significantly lower fertility observed in the early rainy season could be as a result of poor semen characteristics of the guinea cocks during this period. The earlier reports of Awotwi (1987) proved that semen attributes varied with season and correlated this fact to drastic decrease in the testicular parenchyma (supporting tissues) of the cocks. Abdul-Rahman *et al.* (2016) also recorded significantly higher testicular morphometry (weight and linear measurements) in breeding compared to non-breeding seasons and attributed the differences to several

unpredictable environmental factors. Further reports of Nwagu and Alawa (1995) indicated that low relative humidity and rainfall and high temperature results in a reduction of semen production. This is also associated with low spermatozoa concentration, a high percentage of sperm abnormality and a high dead to live spermatozoa ratio. Premavalli *et al.* (2009) observed considerable effect of season on hatching performance of guinea fowl and recorded higher percentage in south west monsoon (56.60) than summer (50.80), north west monsoon (47.60) and winter (34.10). More recently, Dharmani *et al.* (2018) detected significant increase in percentage fertile eggs during the monsoon and post-monsoon periods as compared to winter and summer.

Similarly, Kulkarni and Zhang (2015) detected a significant variation in the reproductive performance (fertility, hatchability and dead in shell) of white leghorn inbred lines over a period of eight years (2005-2012). The authors reported higher percentage fertile eggs, hatched and dead in shell of  $95.0 \pm 0.90$ ,  $54.90 \pm 2.10$  and  $43.6 \pm 1.80$  in 2010, 2005 and 2011, respectively.

### **Hatchability**

The mean hatchability ( $73.16 \pm 0.29$  %) observed in the current observation is similar to 72.9 % reported by Dahouda *et al.* (2008). Singh *et al.* (2011) also reported mean hatchability values of 75.25, 74.19 and 72.55 % for Lavender, Pearl and White strains of guinea fowl, respectively. However, Nwagu *et al.* (1997) and Premavalli (2013) recorded lower means of 32.97 and  $45.68 \pm 0.91$  % in local varieties and could be attributed to the age (24-26 weeks) at which the birds are laying. It is a well-known fact that guinea fowl reproductive performance (fertility and hatchability) increases at 28-31 weeks up to 36-39 weeks and gradually decline thereafter

between 60 to 63 weeks of age (Ayorinde *et al.*, 1989). The non-significant effect of genotype on guinea fowl eggs hatchability observed in the current study could be attributed to genotype by environment interaction (when two genotype perform differently in different environment). Though the Belgium breed are genetically improved in terms of growth and reproduction, but their adaptability to tropical environment is poor. Contrary to this finding, Naazie *et al.* (2007) and Sanfo (2009) detected significant effect of strain on hatchability. In their separate studies, the authors recorded higher pipped and hatched eggs in Pearl strain than lavender and white varieties. They attributed this to reproductive adaptability of this strain which might be the reason why pearl varieties dominate the Sub-Saharan Africa compared to others. Similarly, Almarshade (2011) reported a significantly higher percent of eggs hatched in pearl compared to ash, black and Lavender varieties and associated this result to varied egg size across the strains. The author also observed that pearl strain produced mostly medium sized egg which had higher hatchability than small and larger ones.

The significantly higher hatchability in rainy and early dry seasons observed in the present study is in conformity with the findings of Naandam and Issah (2012) in local stocks of guinea fowl managed intensively. Alsobayel and Albadry (2002) similarly reported significantly higher hatchability in late rainy than early rainy and dry seasons among pearl, lavender, black and white strains of guinea fowl and attributed this to varied egg weight across these seasons. They observed that small eggs were mostly produced in early rainy and dry seasons and this accounted for the poor hatchability. The result of the present finding showed that fertility and hatchability of guinea fowl were higher

during the late rainy and early dry seasons compared to early rainy while for dead in shell embryo, the reverse is the case. This observation could be as a result of fresh succulent grasses provided to the experimental birds in early dry season (November-January). During this period, grasses were grown artificially (through irrigation process). The eggs produced in this period were comparable to those of the late rainy season in terms of size. This might be the reason why hatchability of the birds was high in these seasons. Since fertility and hatchability were higher in these periods, definitely the percentage dead in shell embryo will decreased as observed in the present study.

The non-significant influence of year (period) on hatchability observed in the present study contradicts the report of Premavalli *et al.* (2009). In their study, hatchability values of 50.90, 63.60, 66.00 and 66.80 % for P<sub>1</sub> (1997-1999), P<sub>2</sub> (2000-2002), P<sub>3</sub> (2003-2005) and P<sub>4</sub> (2006-2008), respectively were obtained.

### Percentage Dead in Shell

The overall mean percentage dead in shell keets ( $16.92 \pm 0.28$ ) recorded in the current study is lower than  $21.74 \pm 2.4$  % reported by Premavalli (2013). However, Premavalli *et al.* (2013) found that the mean per cent total embryonic mortality for Nandanam Guinea fowl-1 bred with 1:4 mating ratio was 9.09 %. The authors related this low incidence partly to selective improvement of this strain on both productive and reproductive traits. Insignificant effect of genotype on percentage dead in shell observed in this study agrees with the work of Bobbo *et al.* (2013). The authors linked most early, mid and late embryonic mortality to poor management practice. Kalita *et al.* (2013) attributed this incidence (high dead in shell embryos) to poor temperature, inadequate turning during incubation processes and improper hygiene. Similarly, Ernst *et al.* (1999) also

indicated these factors in addition to poor handling of fertile eggs. Earlier reports of Deeming (1995) indicated high embryonic mortality in ostriches and related this incidence to microbial contamination of the egg prior and during incubation process. In addition, the authors observed that inadequate pre-incubation management practice could lead to early embryonic development which cause dead germs resulting in decreased hatchability. However, Bernacki *et al.* (2012) detected the effect of genotype on percentage dead embryo among local stocks of guinea fowl. In their study, significantly higher dead in shell embryo was recorded for the white strain of guinea fowl compared to grey. They further reported that this trait is negatively correlated to hatchability.

The significant effect of season observed on percentage dead in shell is inconformity with the findings of Premavalli *et al.* (2009). The author recorded higher value in winter than north west monsoon, summer and south west monsoon. Working on Assam chickens native to India, Islam *et al.* (2012) reported significant variation in dead in shell keets during the spring and summer periods. The authors recorded

higher percentage in the former than the latter and attributed this to increase in early embryonic mortality prior to incubation.

### **Genotype x Season Interaction on Fertility and Percentage Dead in Shell**

The genotype x season on fertility in this study was significant and generally, the values for both strains declined from late rainy to early dry and early rainy period. This corroborate the work of Premavalli (2013) who also reported that fertility in guinea fowl varied with seasonal variation. Fertility in this study was better in Belgium breed at early dry period, this contradicts the reports of Ayorinde and Okaeme (1984). In their study among local stocks of guinea fowl (ash, Pear, white and black) and exotic golden sovereign variety, higher fertility was recorded in the rainy season and the result of Pearl was superior than other strains in this period (rainy season). The percentage dead in shell in both strains in this study was high in early rainy and dry seasons. This has similarly been observed by Ayorinde and Ayeni (1986), who found that variation in percentage dead in shell with season differed significantly with genotype.

### **Conclusions**

1. The differences in fertility, hatchability and dead in shell between Belgium strain and Pearl strain were significant.
2. Higher fertility and hatchability were recorded during late rainy and early dry seasons.
3. Incidence of dead in shell was high during the early rainy period.
4. Effect of season x breed interaction on fertility and percentage dead in shell was evident.

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**Table 1: Effects of genotype, season and year on fertility, hatchability and percentage dead in shell**

Factors	N	Fertility	Fertile Hatchability	Total hatchability	Dead in shell
<b>Overall mean</b>	116	55.97±0.34	73.16±0.29	54.49±0.33	16.92±0.28
<b>±S.E</b>					
<b>Breed</b>		NS	NS	NS	NS
Pearl	58	55.97±0.34	72.96±0.34	52.38±0.51	17.09±0.40
Belgium	58	56.30±0.73	74.26±0.43	51.60±0.69	16.73±0.40
<b>Season</b>		***	***	***	***
Early rainy	16	49.95±0.99 <sup>b</sup>	71.05±0.69 <sup>b</sup>	48.22±0.89 <sup>c</sup>	19.09±0.66 <sup>a</sup>
Late rainy	52	57.00±0.53 <sup>a</sup>	74.72±0.40 <sup>a</sup>	63.09±0.67 <sup>a</sup>	15.56±0.36 <sup>b</sup>
Early dry	48	57.00±0.44 <sup>a</sup>	73.27±0.41 <sup>a</sup>	52.16±0.51 <sup>b</sup>	16.13±0.38 <sup>b</sup>
<b>Year</b>		NS	NS	NS	NS
2016	58	56.08±0.58	73.78±0.42	54.44±0.43	16.97±0.39
2017	58	56.19±0.56	73.44±0.39	54.54±0.43	16.84±0.38

N = Number of setting, S.E = Standard error, \*\*\* = P<0.00 and NS = Non-significant

**Table 2: Interaction effect of genotype x season on fertility**

Season	Pearl	Belgium
Early rainy	52.21±1.18 <sup>ba</sup>	46.69±1.19 <sup>bβ</sup>
Late rainy	56.61±0.66 <sup>aa</sup>	57.38±0.66 <sup>aa</sup>
Early dry	56.19±0.68 <sup>aa</sup>	58.32±0.68 <sup>aa</sup>

<sup>a b</sup> Means with different superscripts along columns differ significantly (P<0.05)

<sup>aβ</sup> Means with different superscripts along rows differ significantly (P<0.05)

**Table 3: Interaction effect of genotype x season on percentage dead in shell**

Season	Pearl	Belgium
Early rainy	10.18±0.87 <sup>aβ</sup>	11.80±0.87 <sup>aα</sup>
Late rainy	7.27±0.49 <sup>ca</sup>	6.94±0.49 <sup>ba</sup>
Early dry	9.34±0.51 <sup>ba</sup>	7.18±0.52 <sup>bβ</sup>

<sup>a b c</sup> Means with different superscripts along columns differ significantly (P<0.05)

<sup>aβ</sup> Means with different superscripts along rows differ significantly (P<0.05)