SEASONAL EFFECT ON FERTILITY AND HATCHABILITY OF BREEDER EGGS FROM MARSHALL BROILER CHICKEN PARENT STOCKS KEPT UNDER HOT AND HUMID CONDITIONS

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ABSTRACT
This study was conducted to determine the effects of different seasons on fertility and hatchability of breeder eggs from Marshall Broiler parent stocks kept in the derived savanna zone of Southwestern Nigeria. Fertility and hatchability records of a commercial hatchery were extracted from 2015 to 2017. The records were partitioned into four groups: early rainy season (ERS), late rainy season (LRS), early dry season (EDS), and late dry season (LDS) based on the season of the year the records were kept. Records were subjected to Analysis of Variance (ANOVA) in a complete randomized design using the STATA®15.0 Statistical Software (2015). The Fisher's Least Significant Differences (LSD) option of the software was used to detect differences between the means at a probability level of 5%. The results showed significantly ($p<0.05$) the lowest fertility (63.46%) during the LDS with no significant ($p>0.05$) differences in the trait between ERS, LRS and EDS although it decreased slightly from 92.45 to 92.31 to 87.16% according to the seasons. There were no significant ($p>0.05$) differences in percentage hatchability of the eggs of Marshall broiler chicken across all the seasons of this study. Percentage hatchability for the seasons were: ERS (80.49%), LRS (88.16%), EDS (79.99%) and LDS (78.59%). The mean fertility and hatchability percentages were 83.42% and 81.29%, respectively. It was concluded that, fertility declined only during the LDS and season had no effect on hatchability of eggs from the Marshall broiler chickens in this study. When measures that mitigate negative effect of increased temperature on hatchability during hot periods of the year are put in place as was done on the farm in this case; all-round optimum day-old chick production should be expected without seasonal changes if eggs from the Marshall broiler chicken are used.

Keywords: *Fertility; hatchability; Marshall Broiler chicken; seasons*

INTRODUCTION
Broiler production under hot and humid conditions are faced with many constraints which have been stated by different authors (Kpomasse *et al*., 2021; Attia *et al.,* 2020; Oke *et al*., 2020; Ahaotu *et al*., 2019). This situation is more compounded by the use of various exotic breeds of broiler strains and breeds which are mostly from the temperate regions of the world. This has been a threat to successful broiler production in this part of the world. Sonaiya and Swan (2004) noted that, new hybrids of chickens are widely distributed and could be found in the nooks and crannies of every country in the tropics. Adapta-

bility of chicken parent stocks to their production environment is an important factor and one of the major determinants of success in chick production. The functionality and profitability of the day-old chick production sector is majorly influenced by fertility and hatchability of breeder eggs that are obtained from parent stocks raised by commercial, medium and small-scale producers (Peters *et al*., 2008). Fertility can be described as the percentage of incubated eggs that are fertile while hatchability is the percentage of fertile eggs that hatched. These two economic traits are interrelated quantitative heritable traits and are influenced by breed, variety and individuals in a breeding population (King'ori, 2011).

Kpomasse *et al.* (2021) listed the effects of harsh environmental conditions in terms of thermal stress as part of the challenges that affect the productivity of birds in hot and humid environments. Several authors have reported that both genetic and non-genetic factors affect fertility and hatchability of eggs. These include Kuda (2023); Wolc *et al.* (2009) and Zelleke *et al.* (2005) who indicated that fertility of a breeder egg is influenced by both the hen and the cock that produced it and that the trait changes at different periods of the laying cycle. Nwagu (1997) reported on fertility and hatchability in guinea fowl and indicated that, mating ratio, strain (breed differences) and age of breeders affect hatchability of their eggs. Wondmeneh *et al.* (2011) noted that pre-incubation handling, period of storage, fertility and incubation conditions such as temperature, humidity, ventilation, position of the egg, turning of the egg and candling affect hatchability in chickens**.** Egg production and hatchability of broiler hatching eggs are the parameters that are mostly influenced by a flock's non-genetic factors (Al-Bashan and Al-Harbi 2010). Seasonal changes have been reported to influence different traits including hatchability of chicken eggs (Awoyinka *et al.*, 2024; Ayo *et al.,* 2007). The results from this study will provide additional information on the effect of seasons on fertility and hatchability of breeder eggs of exotic meat-type layers outside their original temperate environments. In regards, the objective of this study is to investigate the effect of seasonal variations on fertility and hatchability of breeder eggs of the Marshall broiler chicken.

MATERIALS AND METHODS

Study location

Fertility and hatchability records from a reputable commercial hatchery from 2015 to 2017 were used for this study. The farm is located between Ede Junction and Ara within the Egbedore Local Government area of the Osun State in Nigeria. The study area is within the derived savannah agro-ecological zone in South-western Nigeria. The geographical coordinates of the farm are: latitude 7° 51' 0" North of the equator and longitude 4° 23' 0" East of the Greenwich Meridian. The location has two separate seasonal periods namely, rainy (April to October) and dry (November to March) seasons. The two major seasons were partitioned into four sub-seasons namely: early rainy season/ ERS (April to June), late rainy season/ LRS (July to September), early dry season/ EDS (October to December) and late dry season/ LDS (January to March) as described by Oguntunji and Salako (2012).

Data collection

Records kept on the RTO Farm during the study periods were used. The records included the number of eggs collected from the pens (hen-house), percentage lay, percentage fertility, number of eggs that hatched and percentage hatchability. The meteorological data, minimum and maximum temperature (^{0}C) and relative humidity (%), were collected from the Nigerian Meteorological Agency (NIMET), Osogbo, Nigeria.

Fertility were determined as percentage of incubated eggs that were fertile while hatchability was calculated by dividing the number of chicks hatched with the number of fertile eggs and multiplied by 100 as stated by Oluyemi and Roberts (2000):

$$\text{Percentage fertility} = \frac{\text{number of eggs fertile}}{\text{total number of eggs set}} \times 100$$

$$\text{Percentage hatchability of fertile eggs} = \frac{\text{number of chicks}}{\text{number of fertile eggs}} \times 100$$

Table 1: Average weather parameters across the four seasons of the years (2015 to 2017)

Season	Maximum Temperature (°C)	Minimum Temperature (°C)	Relative Humidity (%)
ERS	32.22±1.62[b]	22.60±0.53	82.92±2.75[b]
LRS	28.24±0.69[c]	21.96±0.60	90.38±2.13[a]
EDS	31.56±2.03[b]	21.23±1.74	80.00±12.15[b]
LDS	34.78±0.84[a]	22.07±1.79	71.00±8.22[c]
Overall	31.79±2.54	21.89±1.43	80.87±10.11

Means along the same column with different superscripts are significantly (p<0.05) different. Overall maximum temperature ranged between 27.0° and 35.9°C. while, minimum temperature ranged between 15.1 and 23.8°C. Relative humidity ranged between 45 and 95%. ERS- early rainy season, LRS- late rainy season, EDS-early dry season, LDS-late dry season, degree Celsius (°C) and % percentage.
Source: *Nigerian Meteorological Agency (NIMET), Osogbo, Nigeria. (2020).*

Management of experimental birds

The birds were housed in battery cages that were placed in concrete floor pens roofed with asbestos roofing sheets. Trees were planted round the pens to provide shade. Other measures which were put in place to mitigate adverse effects of heat stress on the farm include the use of fogger (sprinkler irrigation system), cooling fans, and chillers to decrease the surrounding temperature and that of the drinking water. Water was served *ad-libitum*, standard broiler breeder feed was served twice daily, and daily egg collection was done in every six hours. The birds were artificially inseminated and eggs were only handled according to the standard protocols used by the farm for storage and transportation of the breeder eggs.

Data analyses

Data on fertility, hatchability and climate variables were subjected to Analysis of Variance (ANOVA) in a complete randomized design using the STATA®15.0 Statistical Software (2015). The Fisher's Least Significant Differences (LSD) option of the software was used to detect differences between the means at a probability level of 5%. The statistical model used in the study was:

$$Y_{ij} = \mu + S_i + e_{ij}$$

Where; Y_{ij} is the individual observation;
μ = fixed overall mean;
S_i = effect of seasons (1, …, 4);
e_{ij} = experimental error observed to be independently, identically and normally distributed with zero mean and constant variance.

RESULTS AND DISCUSSION

Weather parameters

The results in Table 1 indicated that, there was significant (p<0.05) difference in terms of maximum temperatures during ERS and LRS, ERS and LDS, EDS and LRS, LDS and LRS, LDS and EDS. But there was no significant (p>0.05) difference between EDS and ERS. The minimum temperature did not show any significant (p>0.05) differences in values across the sub-seasons. Table 1 further revealed no significant (p>0.05) difference in relative humidity between EDS and ERS but there were significant differences (p<0.05) in LRS and ERS, LDS and ERS, EDS and LRS and LDS and LRS and LDS and EDS. Table 1 further showed the overall minimum and maximum temperatures across the four seasons ranged between 21.89±1.43°C and 31.79±2.54°C while the relative humidity was 80.87±10.11%.

Table 1 showed the weather parameters indicating the maximum temperature and their corresponding minimum temperatures across the four sub-seasons of the year. The relative humidity across the four sub-seasons were also shown in Table 1. The LDS showed the highest maximum temperature (34.78^{0}C) which is significantly highest compared to other seasons with values of 32.22°C, 28.24°C and 31.56°C ERS, LRS and EDS respectively. The relative humidity was the lowest during LDS indicating an inverse relationship between temperature and relative humidity.

Fertility

Significantly ($p<0.05$), the least percentage fertility was recorded during the LDS, which might be as a result of sudden changes that may have occurred in the weather conditions before the measures that were used to mitigate against increases in ambient temperature were put in place. Fertility was highest during the ERS (92.45±1.28%) although the variation was not significantly ($p<0.05$) different from the values recorded for LRS (92.31±3.12%) and EDS (87.16±9.12%). The values for percentage hatchability showed that there was no significant difference ($p>0.05$) across all the seasons. The overall mean percentage fertility and hatchability reported in this study were 83.42±22.67% and 81.29±15.61% respectively. These values are lower than the values reported by Tahir *et al.* (2016) who reported 95.09±1.66 and 89.75 ±1.84 percent for fertility and hatchability respectively in some broiler breeders in Pakistan. Kabir and Mohammad (2012) reported a comparable value of fertility (84.02%) but a lower value of percent hatchability (73.65%) for eggs obtained from the Shika Brown commercial egg-type chicken in Nigeria against the mean percentage fertility (83.42%) and hatchability (81.29%) reported in this study. Bolatito *et al.* (2017) noted that, in some egg-type Nigerian Shika Brown chicken genotypes (SS-98, SG-98 and SB-98) fertility ranged between 91.2 to 96.5% with an overall mean of 93.7%. These values vary from those reported in the current study (83.42%). However, Oluyemi and Roberts (2000) noted that fertility, hatchability, frequency of mating and quality of semen are reduced during high temperatures.

The LSD test of significance in Table 2 shows that the mean percentage fertility observed did not show any significant ($p>0.05$) difference among the ERS, LRS and EDS. However, fertility was significantly lowest during the late dry season of this study. This indicates that, fertility of hatching eggs of the Marshall broiler chicken can change at different seasons and extreme temperatures could negatively affect the ability of the birds to lay fertilized eggs. This indicates that, seasons have significantly affected fertility in Marshall breeder stocks during the extremes of temperature. This report is in agreement with that of Awoyinka *et al.* (2024) who concluded that, environmental conditions affect fertility and hatchability in Abor-Acre plus broiler breeder eggs. It is also in line with the report of Aminami *et al.* (2022) who also reported that season had significant effect on fertility. This is because higher temperatures in the dry seasons lead to heat stress which negatively affects metabolic and enzymatic processes that affects digestion and thus reduce appetite and feed intake (Oluyemi and Roberts 2000). These authors also reported that, feed intake of layers decreases by 1.7% per 1°C rise on the average. The effect of heat stress in poultry production especially in broilers is a challenge because of its adverse effect on production. Thus, adequate measures to ameliorate environmental conditions on poultry farms must be put in place particularly during the dry sub-seasons of the year. Such measures may include application of artificial means of temperature suppressants such as air cooling fans, foggers, sprinkler systems in pens, ice in water tanks and the use of chillers may help to improve performance in terms of fertility of broiler parent stocks during the hot seasons of the tropics and other hot parts of the world (Oluyemi and Roberts 2000). Although fertility was significantly lower in LDS, this might be as result of increased temperature during this season as shown in Table 1. This result indicates that, breeding farms should consist of adequate facilities that will mitigate against adverse effects of LDS on the ability of breeders to fertilize their eggs as a result of prolonged exposure to high temperature.

Table 2: Average egg set, percentage fertility and hatchability of Marshall parent stocks across four seasons (2015 to 2017)

Season	N	Total egg set	Percentage fertility± SD	Percentage hatchability± SD
ERS	12	111378±15439	92.45 ±1.84[a]	80.49±12.16
LRS	8	119240±9538	92.31±3.12[a]	88.16±3.77
EDS	16	108922±14114	87.16±9.12[a]	79.99±19.48
LDS	12	104736±7258	63.46±3.36[b]	78.59±18.79
Mean		110209±12949	83.42±22.67	81.29±15.16

Means along the same column with different superscripts are significantly (p<0.05) different. N = number of hatchings per each sub-season. ERS (early rainy season), LRS (late rainy season), EDS (early dry season), LDS (late dry season).

Hatchability

Table 2 revealed that, there was no significant (p>0.05) difference in hatchability across the sub -seasons in this study. This observation can be attributed to standardized and proper pre-incubation handling of the eggs across the seasons. The eggs were subjected to the same handling and environmental conditions. The insignificant variation of the current hatchability results is in agreement with Babiker and Musharaf (2008) who reported non-significant effect of different seasons on percentage hatchability of fertile eggs in a Bovans egg-type parent stock in Sudan and concluded that hatching operations can be carried out during the different seasons of the year without any negative effect. Also, the results in this study is at variance with the reports of Awoyinka *et al.* (2024) who noted a higher hatchability in ERS and LRS. The differences in these reports might be as a result of differences in breeds, management practices on the farms and other non-genetic factors.

It was observed from this study that a high temperature was observed in the LDS, and a corresponding low humidity and that resulted in low fertility of eggs in that sub-season. These findings were corroborated by the report of Kim *et al*. (2024) who stated that high temperature conditions result to low humidity, thereby causing low production and fertility of eggs. In comparison, LRS reported a low temperature regime which resulted to high humidity and high fertility of eggs as similarly reported by Awoyinka *et al.* (2024). Conversely, Kim *et al.* (2022), Borzouie *et al.* (2020) and Barrett *et al.* (2019) reported that heat stress can reduce the body weight, egg production and fertility in laying hens. When comparing the ERS and EDS, the observed moderate temperature resulted to moderate humidity and a high fertility of eggs while the LRS recorded a low temperature with a corresponding highest value of relative humidity and moderately high egg fertility. However, Awoyinka *et al.* (2024) reported the highest percentage fertility during ERS which is similar to what was obtained in this study.

CONCLUSION

It was concluded that, seasons can have significant effect on fertility in Marshall breeder stocks particularly during the seasons of extreme of temperatures. The results of this work show that hatchability of the Marshall broiler chicken breeder eggs will not be affected by seasonal changes; especially when measures that mitigate the effect of increased temperature in hot and humid environments are put in place. This study therefore suggests the use of Marshall chicken parent stocks for optimum day-old production in broiler chicken, under hot and humid conditions.

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