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Effect of seasons on performance and egg quality traits of commercial laying birds raised in tropical monsoon climate in southern Nigeria

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ABSTRACT

Climate change has been a major challenge facing poultry production within the tropical monsoon climate of southern Nigeria. An experiment was set up for a period of one year to examine the effects of seasonal fluctuations on the productivity as well as the quality of egg traits of commercial-laying birds between the rainy and hot-dry seasons. There were 600 laying-pullets of 20-week-old used in a completely randomized design (CRD). Initial live weight, final live weight, weight gain, feed intake, hen-day production, mortality rate, egg weight, egg cracks, feed efficiency/g egg, and internal and external features were among the performance indicators that were recorded. The season of rain (April–October) and the hot-dry season (October–March) were used to group the records. In the rainy season, there were significant ($p<0.05$) effects on final live weight, weight gain, feed intake, hen-day- production, and egg cracks. There was also a significant ($p<0.05$) difference in mortality rate, with the dry-hot season showing the highest rates. There was a significant difference ($p<0.05$) in the internal and external egg quality parameters such as yolk weight, albumen weight, yolk colour, and haugh unit, with the rainy season being superior to the dry-hot season. The findings showed that in a tropical monsoon in southern Nigeria, the laying hen performed better in the rainy season than in the dry-hot season in all variables studied. Houses should be properly built, and trees made available for the appropriate shading of laying houses.

Keywords: Egg production; egg quality; climate change; monsoon climate

INTRODUCTION

Since livestock is one of the most important animal resources used as a weapon against poverty and malnutrition, particularly in rural areas of most developing countries, the production of poultry is an important agricultural activity for almost all rural communities in Africa. It also provides a reliable source of petty cash and scarce animal protein in the form of meat and eggs (Dunya *et al*., 2015). As a result, there is growing interest in using chickens as a means of poverty alleviation in villages throughout the world, (Ade *et al*., 2024). However, the expansion and advancement of chickens is a complex process that is heavily influenced by both genetic and non-genetic variables (Pourtorabi *et al.*, 2017). Nigeria's poultry industry is expanding quickly because it provides a substantial portion of the nation's

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population's animal protein needs. While most farmers raise pullets to produce eggs, broilers are raised for meat production. Considering its economic relevance to the egg production sector, egg qualities like egg weight, shell thickness, and shell index are of great significance (Savegnago *et al.*, 2011)

The rising demand for livestock products is primarily driven by urbanization and growth in income and population. Increased temperatures, shifts in precipitation patterns, an upsurge in the periodicity of extreme events, and growing carbon dioxide concentrations are all consequences of climate change that are exerting growing pressure on the production of livestock (Cheng *et al.*,2022). Apart from the inherent fluctuation of the climate seen the UNFCCC (2014) while on comparable periods defined climate change as a change in climate that is attributed, either directly or indirectly, to human activity that modifies the atmosphere's structure globally (Falloon and Betts 2010, Fatoki *et al.*, 2020). Variability in climate is the term used to describe variations in the average condition of the weather as well as other statistics (such as standard deviations, the frequency of extremes, etc.) over all temporal and spatial scales that go beyond individual weather occurrences. Climate change can affect livestock production directly through increased heat stress and indirectly through effects on the quantity and quality of forage and crop-based feeds, as well as land and water availability. It has been observed that such changes have an impact on livestock performance across many tropical regions (FAO, 2021).

There are many research gaps in this area, even though many studies have been conducted on it. Most of this research centered primarily on ruminants, with minimal exposure compared to poultry.

This study investigates the results of seasonal variations on the performance and egg quality of laying pullets in a monsoon climate in southern Nigeria.

MATERIALS AND METHODS

Study Site

The experiment was conducted at the Dennis Osadebay University Poultry Unit of the Teaching and Research Farm in Anwai, Asaba, Delta State, Nigeria. The farm is situated on latitude 60º 12´ N and longitude 60º 45´ E. With approximately 1800 and 3000 mm of rainfall annually, and highest daytime temperature ranges between 27.5 to 34.9 °C (Efe, 2006).

Experimental Birds and Management

A total of six hundred (600) 20-week-old pullet birds, "Isa-brown," were assigned to the two seasons as treatments comprising three hundred birds each in three replicates with 25 birds. Data were collected and used to ascertain the impact of seasonal variation on the performance and quality of eggs produced by the experimental laying birds. The season of rainy, which runs from (April to October), and the hot-dry season, which runs from (October to March). A conventional tropical open-sided chicken house with battery cages was utilized for managing the birds. A commercial layer feed that was thoroughly pelletized and contained 16% crude protein, 2550 kcal/kg of metabolizable energy, 4.00% fat, 4.60% crude fiber, 3.70% calcium, and 0.41% available phosphorus was fed to the experimental birds *Ad libitum.* Supplies of clean water were also provided. Akpodiete (2008) recommended management procedures for laying birds in tropical regions were followed.

Data Collection and Analysis

Body weight and weight gains, the birds were weighed at the start and finish of the trial. At the close of each week, feed consumption was calculated by deducting the amount of left-over feed from the pre-weighed feed given and dividing what was left by the total number of birds per replicate. To ascertain the Hen Day % and egg weight during the study period, egg production records were collected, noting the number of eggs laid per replicate.

$$Feed\ efficiency\ (FCR) = \frac{Feed\ Consumed\ (g)}{Egg\ Mass\ Produced\ (g)}$$

$$Egg\ Shape\ Index\ (ESI) = \frac{Egg\ width\ (mm)}{Egg\ length\ (mm)} \times 100$$

At the end of the experiment, internal egg traits were examined on a replicate basis. Eggshell weight and thickness were measured, yolk weight, length, and breadth were also taken. The Haugh unit was computed using the formula Hu = 100log (H+ 7.57 – 1.7W 0.37), where H is the albumen height (mm), and W is the egg weight (g). The shell surface area (SSA) was calculated as EW0.667 × 4.67. Using the Roche Color Fan, the average score was recorded weekly by two observers present.

Table 1: Experimental diets for laying pullets

Ingredients (%)	Level of inclusion
Maize	53.30
Soyabean meal	18.00
Wheat offal	14.50
Bone meal	3.00
Limestone	7.50
Fishmeal	3
Methionine	0.25
Salt	0.20
Premix	0.25
TOTAL	100
Calculated composition	
Energy (Kcal/kgME)	2673
Crude protein (%)	17.34
Calcium (%)	3.90
Phosphorus (%)	0.87
Methionine (%)	0.55
Lysine (%)	0.90
Fibre (%)	3.50

*Vit. A, 10000i.u; Vi.D) $_{2000i.u}$; Vit.E, 5i. u; Vit.K, 2mg; Vit. B_2,4.2mg; Vit.B_{12}, .01mg; nicotinic acid, 20mg; folic acid, 0.05mg; choline,3mg; Mg,56mg; Fe,20mg; Cu,1.0mg; Zn,5.0mg; Co,1.25mg; Iodine,0.8mg.

According to Steel and Torrie's (1980) recommendations, data collected were subjected to independent sample t-test at a 5% level of significance and was used to compare all parameters measured in the rainy and hot-dry seasons, in a completely randomized design (CRD), as described by Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Table 2 presents the impact of seasonal variation on the performance of laying pullets, the results showed that initial live weight, egg weight, and feed efficiency, which were not significantly (P>0.05) influenced by either season, the final live weight, weight gains, feed intake, hen day production, mortality, and egg cracks of laying pullets within the different seasons (rainy and dry-hot) were significantly (P<0.05) affected among treatment means.

Table 2: Impact of seasonal variation on performance of laying pullets

Parameter	Rainy Season	Dry Season
Initial Live weight/bird(g)	160.03 ± 0.07	160.03 ± 0.07
Final Live weight/bird (g)	171.01 ± 0.12^{a}	167.03 ± 0.10^{b}
Weight gain/bird(g)	8.98 ± 0.13^{a}	6.98 ± 0.03^{b}
Feed Intake/bird/week(g)	86.23 ± 0.16^{a}	82.52 ± 0.06^{b}
Hen-day egg Production (%)	93.17 ± 3.30^{a}	76.52 ± 2.30^{b}
Mortality (%)	0.50 ± 0.07^{b}	1.15 ± 0.13^{a}
Egg weight (g)	60.02 ± 0.50	60.06 ± 0.50
Egg cracks (%)	0.15 ± 0.22^{b}	4.02 ± 0.29^{a}
Feed efficiency/g egg	0.93 ± 0.12	1.08 ± 0.12

^{abc}, means within a row with different superscripts are statistically (P < 0.05) different.

Though moisture and high temperatures affected the rate and extent of bird growth (Riddell *et al.*, 2019), the season of rainy outperformed the dry-hot season in production, as demonstrated by the mean final live weight recorded during the season and the hot-dry season. The rainy season has superior performance in terms of final live weight.

Weight gain is possible because of high feed consumption as well as optimal nutrient utilization (Pawar *et al.*, 2016, Nawab *et al*., 2018). Similar research was done by Ayo *et al.*, (2022) who found that heat stress during the hot-dry season had a detrimental effect on laying hens' feed intake. According to Wasti *et al.*, (2020), the management of caloric intake has been suggested to be the driving force behind the decrease in feed intake, which is one of the mechanisms that regulate appetite.

Due to their inability to meet their thermal requirement, hens have proven to lay more eggs during the rainy season than during the dry-hot season (Goel, 2021; Yakubu *et al.,* 2007; Lin *et al.,* 2006). To deal with stress and preserve healthy visceral functions, hens in hot environments must attempt to keep the temperature of their body within a normal range to grow and lay (Abbas, 2021).

It was noted that there was a high death rate during the hot-dry season. This could be because of the harmful effects of high temperatures. This is consistent with Sinkalu's (2015) observation but contradicted the report of Mmereole and Omeje (2005), who concluded that the rainy season had greater fatality rates than the dry season.

The present investigation on egg cracks supports the concept that temperatures above 26 °C, particularly during the dry-hot season of the year, depress egg quality (Habte *et al.*, 2017). The prevalence of egg cracks was higher during the dry-hot season when temperatures were more likely to reach extreme levels.

Table 3 shows the results of the attributes of egg quality. Except for yolk index, eggshell, eggshell thickness, egg surface area, and egg shape index, which were not significantly (p>0.05) impacted by the seasonal variations, all internal and external egg traits were significantly (P< 0.05) influenced as well by the seasonal changes.

Table 3: Impact of seasonal variation on egg quality of laying pullets

Parameter	Rainy Season	Dry Season
Egg weight(g)	60.02 ± 0.50	60.06 ± 0.50
Yolk weight(g)	18.19 ± 0.40^{a}	15.30 ± 0.10^{b}
Yolk index	0.30 ± 0.07	0.30 ± 0.07
Yolk colour	5.54 ± 0.32^{a}	5.30 ± 0.22^{b}
Albumen weight(g)	34.17 ± 0.31^{a}	31.27 ± 0.58^{b}
Albumen height(mm)	6.40 ± 0.24^{a}	5.10 ± 0.22^{b}
Egg shell weight(g)	5.80 ± 0.10	5.80 ± 0.10
Eggshell thickness(mm)	0.43 ± 0.25	0.43 ± 0.25
shell surface area (SSA)	70.16 ± 0.60	70.16 ± 0.60
Egg shape index	0.72 ± 0.07	0.72 ± 0.07
Haugh unit	76.24 ± 0.77^{a}	72.45 ± 0.43^{b}

^{abc} means within a row with different superscripts are statistically (P < 0.05) different.

These results agree with the results of (Durum and Kamanli, 2015; Aswathi *et al.*, 2019) that variation in climate has effects on egg yolk and yolk color. The yolk weight, yolk index, and yolk color were better in the rainy season than in the dry-hot season. These could be associated with the high temperature in the dry-hot season during the experimental period.

Albumen height is a critical component used in estimating the Haugh Unit, which is a measure used in the egg industry to determine the quality and freshness of eggs based on the thickness of the egg white and the weight of the egg, this was observed more during the rainy season, (Durum and Kamanli, 2015; Nematinia and Mehdizadeh, 2018), similarly reported the increase in albumen weight in their study on the effects of cold and heat stress on egg quality traits of a newly developed native hybrid layer.

The haugh unit was improved during the rainy season compared to the dry-hot season. These findings correspond with those of previous studies (Ahvar *et al.*, 1982; Deaton 1983, Gill and Gangwar, 1984; Durum and Kamanli, 2015), which determined that the Haugh unit decreases when laying birds suffer under heat stress conditions.

CONCLUSION

In conclusion, the study underscores the vulnerability of poultry production to seasonal climate changes in tropical monsoon climates and underscores the need for adaptive strategies to sustainably enhance poultry farming under such conditions.

The building and maintenance of poultry houses for Isa-Brown layers should be carefully planned with the planting of trees to mitigate the seasonal fluctuations' effects on the geographical region, especially in southern Nigerian regions with tropical monsoon climates, to reduce such losses.

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