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SEASONAL VARIATION IN EGG PRODUCTION AND MORTALITY OF MUSCOVY DUCKS (*CAIRINA MOSCHATA*)

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Abstract: Seasonal variation is one of the principal non-genetic factors influencing performance of poultry in tropical environment. This study was conducted to investigate influence of seasonal variation on egg production and incidence of mortality in intensively-reared non-descript Muscovy ducks in Nigeria. Egg production and incidence of mortality in sixty two (62) female Muscovy ducks was studied in a 12-month trial divided into two major seasons: wet (April – September) and dry (October – March) and four sub-seasons: early rainy season (April – June), late rainy season (July – September), early dry season (October – December) and late dry season (January – March). Student's t-test and Completely Randomized Design was used to analyse seasonal and sub-seasonal effect on performance, respectively. Season and sub-season significantly ($P < 0.05$) affected egg production; higher egg production was recorded in wet season compared with dry season (16.18% vs. 1.32%). Among sub-seasons, highest egg production was recorded in late rainy season (20.92%) while the least (0.00%) was obtained in late dry season. Conversely, there was no significant ($P > 0.05$) effect of season and sub-season on mortality. It is evident that seasonal variation had no effect on incidence of mortality but significantly affected egg production of Muscovy duck and the adverse effect is more pronounced in dry season most especially in late dry season.

Key words: Ducks, poultry, late dry season, non-genetic factors, tropical environ

Introduction

Poultry is now by far the largest livestock species world-wide (*FAO, 2000*), accounting for more than 30 % of all animal protein consumption (*Permin and Pedersen, 2000*). In Nigeria, poultry are the most numerous class of animal.

Members of this class include chicken, turkey, duck, guinea fowl and pigeon, however; preponderance of them is chicken (*Nwanta et al., 2006; Dafwang et al., 2010*). It is worthy of note that Nigerian poultry sector is dominated by local/indigenous breeds. These local avian species are bred under traditional breeding systems and constitute a fast means of bridging the protein deficiency gap in most developing countries (*Jibir and Usman, 2003*).

Muscovy duck is commonly referred to as local duck in Nigeria. It is an integral part of local poultry sector in Nigeria and are concentrated mostly in rural areas in the hands of small-holder farmers (*Oguntunji and Ayorinde, 2014*). They are estimated to be approximately 11million and were reported to be distributed all over the agro-ecological zones particularly in village settings (*FLDPCS, 1992*). Muscovy duck constitutes about 10% of local poultry sector in Nigeria (*Oluyemi and Ologhobo, 1997*) representing 74% of ducks reared in Nigeria (*Adesope and Nodu, 2002*).

This waterfowl is also one of the least exploited and underutilized locally adapted poultry species in Nigeria in spite of its innate potential for meat and egg production (*Oguntunji, 2013*) and adaptability to different climatic conditions. Dwindling population of Muscovy duck in the recent years attests further to its utter neglect.

Commercial egg production in Nigeria and other developing nations in warm and hot tropical environments is dominated by exotic strains that were developed and evaluated in temperate regions under optimal rearing conditions (*Oguntunji and Salako, 2012*). Over reliance on exotic commercial layers for internal egg production has not only led to the neglect and relegation of local poultry species to the background but has also served as a clog in the wheel of accelerated all-encompassing improvement of local poultry. Exploration of potentials of alternative poultry species such as Muscovy ducks for egg production is long overdue and will go a long way in boosting internal egg production and reducing foreign exchange on exotic chickens.

Seasonal variation is one of the major non-genetic factors affecting poultry production most especially in tropical environment. There are two major seasons in Nigeria, wet and dry seasons; each of these seasons is identified principally by change in ambient temperature, relative humidity and amount of rainfall (*Oguntunji et al., 2008*). Season has been identified as one of the most important factor adversely affecting poultry production in the tropics, not only in those reared extensively, but also in those intensively-reared without artificial regulation of microclimatic conditions (*Mahmoud et al., 1996; Ayo et al., 2007; Obidi et al., 2008*). The principal meteorological element commonly implicated with the adverse effect of seasonal variation on performance of poultry is ambient temperature, most especially in tropical and sub-tropical regions of the world**.**

Synthesis of literatures demonstrated that high environmental temperature commonly called heat stress adversely affected egg production performance of

commercial layers (*Oguntunji and Salako, 2012; Yakubu et al., 2007; Mashaly et al., 2004; Rozenboim et al., 2007; Shitu et al., 2014*), fertility (*McDaniel et al., 1995; 1996; Obidi et al., 2008*) and hatchability (*Lourens et al., 2005*) of breeders, immunoresponse of chickens (*Mashaly et al., 2004; Tirawattanawanich et al., 2011*) and increases incidence of mortality in chickens (*Mashaly et al., 2004; Yakubu et al., 2007; Oguntunji and Salako, 2012; Shittu et al., 2014*).

Literatures abound on effects of season on egg production performance and incidence of mortality in chickens; however, related studies on influence of seasonal variation on egg production and mortality of Muscovy duck in tropical environment is scarce. To the best knowledge of the authors, there is dearth of empirical studies on seasonal effect on egg production and mortality of local Muscovy ducks reared intensively or extensively. In view of the foregoing, the present study was conducted to investigate influence of seasonal variation on egg production and incidence of mortality in intensively-reared unselected Muscovy ducks in a Derived Savanna environment in Nigeria.

Materials and Methods

Study area

This study was conducted at the duck unit of the Teaching and Research farm of Bowen University, Iwo, Osun State, Nigeria. The study area is located in Derived Savanna Agro-Ecological Zone characterized with double maxima of annual rainfall.

Experimental animals

Sixty two (62) sexually matured pullets of local Muscovy ducks were purchased at Shasha poultry market, Ibadan, Oyo State, Nigeria. These experimental animals originated from the northwest region of the country. They were non-descript, unselected and were reared primarily on extensive system. Since the age of the birds could not be ascertained, efforts were made to buy only those that have not commenced laying. This was achieved through visual examination of caruncles and vents.

Management of the experimental animals

The birds were reared in deep litter and were also provided with fresh drinking water and wallowing trough for their water-related activities like preening, bathing, e.t.c. They were also fed *ad libitum* with commercial layer feed throughout the experimental period.

Data collection and analyses

Though the birds were sexually mature and were purchased in October 2011, they did not commence laying until April 2012 (six months after) when rain commenced. Therefore, data on egg production and mortality were taken between April 2012 and March 2013. Besides, data on meteorological elements {Ambient

temperature (AT) and Relative humidity (RH)} were collected from the meteorological station of Folawiyo Farms Limited, Ilora, Oyo State, Nigeria. The farm is a reputable commercial poultry farm and is about 45km to Iwo, and is also located in the same agro-ecological zone (Derived Savanna) with Iwo. Data collected on production performance and meteorological indices were categorized into two seasons: wet (April – September) and dry (October – March) and four sub-seasons: early rainy season ERS (April–June), late rainy season LRS (July–September), early dry season EDS (October–December) and late dry season LDS (January–March). Student's-t test at 5% probability level was used for testing significant differences between seasonal performance while data on sub-seasons were analysed with analysis of variance procedure:

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

Y_{ij}= individual observation;

μ= fixed overall mean;

S_i= effect of sub-season (ERS, LRS, EDS, LDS);

e_{ijk} = experimental error, assumed to be independently and identically normally distributed, with zero mean and constant variance, i.e. $_i$ $_i$nd (0, r^2).

Significant differences between sub-seasons were separated with Duncan Multiple Range Test at 5% probability level.

Besides, regression analysis model was used to investigate relationship existing between egg production of Muscovy ducks and meteorological indices (Ambient temperature and Relative humidity).

The regression model used was of the form:

$Y = a + b_1X_1 + b_2X_2 + e$

Where,

Y = Dependent variable (egg production)

a = Constant/intercept

b_1 = Regression coefficient of temperature

b_2 = Regression coefficient of relative humidity

X_1 = Ambient temperature

X_2 = Relative humidity

e = Error term

All statistical analyses were carried out with *SPSS* (*2001*).

Results and Discussion

Egg production

Average monthly and seasonal records of egg production, incidence of mortality, ambient temperature and relative humidity are presented in Table 1. There was significant ($P<0.05$) higher egg production in wet season compared with dry season (16.18% vs. 1.32%).

Analysis of sub-season effect (Figure 1) on egg production revealed significant ($P<0.05$) differences. Highest (31.17%) and least (0.00%) egg productions were recorded in LRS and LDS, respectively.

Mortality

Zero mortality was recorded throughout the experimental period and there was no significant ($P>0.05$) effect of season (Table 1) and sub-season (Figure 1) on incidence of mortality.

Regression analysis

Regression analysis of meteorological indices (AT and RH) on egg production revealed significant ($P < 0.05$) relationship. Besides, R^2 representing coefficient of determination was 0.854 while the generated regression equation using standardize coefficients of the two climatic factors was:

$Y = 83.06 – 0.70X_1 + 0.248X_2 + e$

Related researches on seasonal influence on egg production of non-descript intensively-reared Muscovy ducks are very scarce to validate result obtained in this present study.

Table 1. Seasonal variation in performance of Muscovy ducks and prevailing meteorological indices

Season	Month	Egg production (%)	Mortality (%)	Ambient temperature (^oC)	Relative humidity (%)
Wet					
	April	4.34	0.00	34.70	50.10
	May	10.25	0.00	30.60	58.30
	June	19.73	0.00	28.20	74.30
	July	29.84	0.00	28.40	72.04
	August	18.99	0.00	29.70	68.74
	September	13.92	0.00	31.30	63.84
	Mean (±SD)	**16.18 ±8.80[a]**	**0.00 ±0.00**	**30.48 ±2.39[a]**	**64.55 ±9.13[a]**
Dry					
	October	5.15	0.00	33.50	56.60
	November	1.77	0.00	33.50	56.80
	December	1.01	0.00	34.20	41.60
	January	0.00	0.00	33.41	30.03
	February	0.00	0.00	36.51	29.90
	March	0.00	0.00	35.10	31.30
	Mean (±SD)	**1.32 ±2.01[b]**	**0.00 ±0.00**	**34.37 ±1.23[b]**	**41.02 ±12.87[b]**

[ab]Means along the same column with different superscripts are significantly ($P < 0.05$) different

The egg production of the studied population is higher than values reported for two ecotypes of local Muscovy ducks reared intensively in north-central Nigeria (*Ogah et al., 2011*). The low egg production of Muscovy ducks reported by *Ogah et al.* (*2011*) compared with the result of the present study could probably be attributed to differences in prevailing climatic conditions and management systems.

Significant higher egg production in wet season in compared to dry season agrees with the earlier reports on seasonal effect on egg production of commercial egg layers (*Guobadia, 1997; Yakubu et al., 2007; Oguntunji et al., 2008*). These investigators attributed poor egg production in dry season to the adverse effects of high ambient temperatures. The observed seasonal variation in egg production of the studied population is consistent with the report of *Sauveur and DeCarville* (*1995*) that Muscovy ducks are seasonal breeder and express seasonal character in egg laying which in most cases is dependent on the season and genetics.

This submission agrees with the report of *Ola* (*2000*) that Muscovy ducks have limited breeding capacity during the dry season. This submission was buttressed further that though Muscovy ducks attained sexual maturity at 27 weeks of age in dry season; oviposition was delayed for about 20 weeks later when ducks reached 47 weeks of age at the onset of the wet season (*Ola, 2000*). It is noteworthy that the trend in egg production of Muscovy ducks in the present study aligns with the report of *Ola* (*2000*). The population understudy were purchased in October 2011 but failed to lay eggs until April 2012 following year (6 months after) when rain started. In addition, the author observed similar trend in the first set of 100 adult female Muscovy ducks bought in November 2009 and were reared in the same farm but egg production did not commence until April 2010 (5 months after) when rain started (*Personal observation, data not published*).

Highest egg production in LRS (July – September) compared with ERS (April – June) is in agreement with the report of Ogah et al. (*2011*) on egg production performance of two ecotypes of Muscovy ducks reared in north-central Nigeria. Besides, the trend of egg production performance in the studied production whereby highest egg production was recorded in LRS, followed by ERS, EDS but least in LDS is consistent with previous reports on seasonal effect on egg production of commercial egg layers in Derived Savanna agro-ecological zone (*Oguntunji, et al., 2008; Oguntunji and Salako, 2012*) in Nigeria.

Though heat stress impairs the physiological mechanisms connected with egg production in poultry; however, neither the remote nor the immediate reasons for the negligible and cessation of egg production in EDS and LDS, respectively is clearly understood in spite of the fact that they are all-year-round breeder under extensive management system in Nigeria.

It could be inferred from Figure 1 that meteorological indices under investigation influenced egg production of Muscovy ducks. Highest egg production was recorded in LRS having the least ambient temperature and highest relative

humidity. Conversely, least egg production (0.00%) was recorded in LDS, the sub-season with highest ambient temperature and lowest relative humidity. Increased relative humidity and decreased environmental temperature was accompanied with 45.32% increase in egg production between ERS and LRS. Conversely, significant increase in temperature and decreased relative humidity resulted in 87.38% drop in egg production between LRS and EDS.

Relationship between egg production and weather elements as depicted in Figure I suggest further that climatic factors (low AT and high RH) in LRS is more conducive and favourable to the optimum physiological activities connected with the egg production in Muscovy ducks. Putting into consideration the highest and lowest egg production recorded in seasons with lowest and highest ATs, respectively, It is suggestive that this waterfowl could probably perform better at lower AT while higher AT is detrimental to their egg production ability.

Furthermore, the highest ambient temperature and lowest relative humidity in LDS resulted in cessation of egg production in the studied population. Poor egg production recorded in sub-seasons (EDS and LDS) with higher environmental temperatures is consisted with the recent reports on influence of environmental temperature on egg production by *Nickolova* (*2004*) on Muscovy ducks and *Ma et al.* (*2014*) on egg-laying Fujian ducks in China.

Studies had revealed adverse relationship between high ambient temperatures, plasma reproductive hormonal levels and potency of reproductive hormones regulating egg production mechanisms in female poultry (*Oguntunji and Alabi, 2010*). *Ayo et al* (*2011*) corroborated this that stress due to adverse effect of HAT disturbs the pulsative gonadotrophin-releasing hormone generator frequency, which in turn compromised reproduction functions of the axis, due to heat-induced impairement in the secretion of follicle stimulating and luteinizing hormones in laying birds (*Ayo et al., 2011*). In similar vein, *Oguntunji and Alabi* (*2010*) attributed low egg production of heat-stressed female poultry to the fact that attempts by egg-type poultry to offset the physiological stress induced by high environmental temperature is accompanied by alteration and disruption of hormonal equilibrium of laying hens thereby resulting in inefficient and impairment of the entire mechanism involved hence; poor egg production of heat-stressed hens.

Regression analysis of climatic factors on egg production

The coefficient of determination (R^2) generated from the regression analysis is very high (0.854). This implies that synergistic effects of AT and RH were responsible for 85.40% of the observed variations in egg production of the studied population while the remaining 14.60% could be adduced to other extraneous factors such as feed intake, age of the ducks, management system among others which are not considered in the present study. Putting into consideration high R^2 of the two meteorological elements, it is instructive that they

are important environmental factors affecting egg production of Muscovy ducks in the study area.

In addition, comparison of degree of contribution cum relative importance of the two independent variables (AT and RH) to egg production through the absolute values of their beta coefficients indicated higher contribution of AT (0.700) compared to RH (0.248). It could be inferred further from their beta coefficients that AT exerts greater influence on physiological mechanisms connected with egg production of Muscovy ducks than RH.

Further investigation into the nature (direct or inverse) of relationship between climatic factors under consideration and egg production of the studied population using standardized coefficients revealed that inverse and direct relationship exists between AT and Muscovy duck egg production, and RH and Muscovy duck egg production, respectively. The trend observed in the nature (direct and inverse) of the relationships between meteorological indices and egg production corroborates Figure 1 in the present study; whereby egg production declines and increases as AT and RH increases, respectively. The reported direction of relationship indicates that AT impacted negatively on egg production and vice versa for RH.

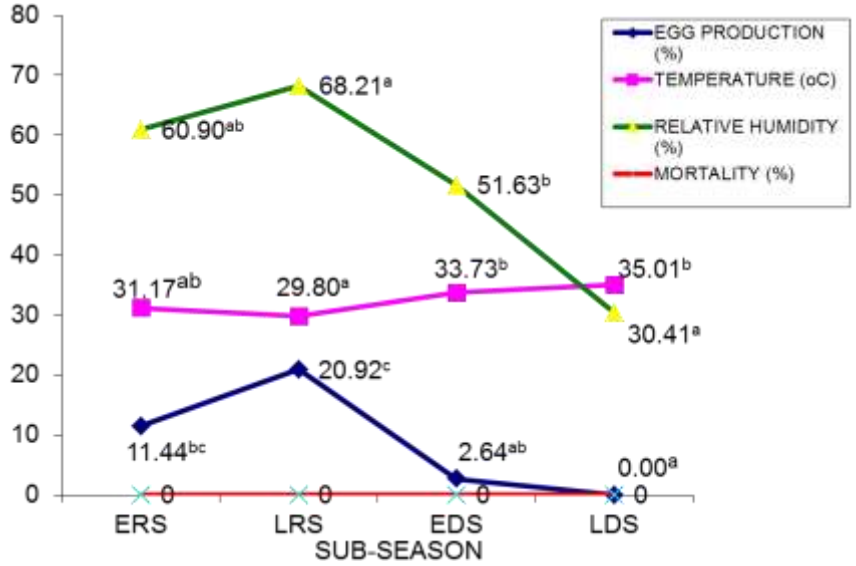

Figure 1. Sub-season effect on performance of non-descript Muscovy ducks

Mortality

Dearth of related studies on seasonal influence on incidence of mortality of non-descript Muscovy ducks and other local poultry species reared intensively did not permit head-to-head comparison with the result of the present study.

Zero mortality throughout the trial period (12 months) contradicts reports of *Ogah et al* (*2011*) who reported 20% and 24.14% mortality in Guinea Savanna and Rain Forest ecotypes of local Muscovy ducks, respectively, in a six-month trial in north-central Nigeria. The observed differences in viability of Muscovy ducks in the two studies might be attributed to different management practices adopted and prevailing environmental factors.

The reported zero mortality and absence of seasonal influence on mortality of local Muscovy duck in the present study also contradicts reports of related studies on commercial egg layers whereby significant differences were observed in the incidence of mortality between seasons (*Oguntunji et al., 2008; Oguntunji and Salako, 2012; Yakubu et al., 2007; Shitu et al., 2014*). The remote and immediate underlying factors responsible for zero mortality throughout the 12-month trial period are not clearly understood. A possible reason for the absence of mortality throughout the study period could be attributed to the improved immunity enhanced by routine medication.

Absence of seasonal and sub-seasonal influence on mortality in spite of significant differences in ambient temperature, relative humidity and egg production suggests that physiological mechanisms responsible for egg production and livability/survival ability of Muscovy duck are different. It implies further higher sensitivity of physiological activities connected with egg production to adverse meteorological elements than livability trait in Muscovy duck.

Conclusion

It is evident that seasonal variation affects egg production of Muscovy ducks conversely; season had no influence on incidence of mortality.

It could be inferred further that AT is an important climatic factor adversely affecting egg production of Muscovy ducks in the study area. Adoption of improved management systems to mitigate adverse effects of heat stress most especially in dry season months would enhance optimal performance of laying ducks and all-year-round production of eggs of Muscovy ducks reared intensively.

Further investigation of seasonal influence on reproductive hormones of this waterfowl is recommended to give insight to relationship between the studied meteorological indices and reproductive hormones connected with egg production.

Sezonsko variranje u proizvodnja jaja i smrtnost mošusne patke (*Cairina moschata*)

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Rezime

Sezonsko variranje je jedan od glavnih ne-genetskih faktora koji utiče na performanse živine u tropskom okruženju. Ova studija je sprovedena kako bi se ispitao uticaj sezonskih varijacija na proizvodnju jaja i učestalost smrtnosti mošusnih pataka u intenzivnom odgoju u Nigeriji. Ispitivana je proizvodnja jaja i učestalost smrtnosti u šezdeset dve (62) mošusne patke u periodu od 12 meseci koliko je trajao ogled - podeljen u dve glavne sezone: sa padavinama (april - septembar) i sušni period (oktobar - mart) i četiri pod-godišnja doba: rano kišna sezona (april - jun), kasno kišna sezona (jul - septembar), rano sušna sezona (oktobar - decembar) i kasno sušna sezona (januar - mart). Student t-testa i potpuno slučajan dizajn su korišćeni za analizu uticaja sezone i pod-godišnjih doba na performanse, respektivno. Sezona i pod-godišnja doba su značajno ($P<0,05$) uticali na proizvodnja jaja; veća proizvodnja jaja je zabeležena u vlažnoj sezoni u poređenju sa sušnom sezonom (16,18% prema 1,32%). Među pod-godišnjim dobima, najviša proizvodnja jaja je zabeležena krajem kišne sezone (20,92%), dok je najmanja (0,00%) bila zabeležena krajem suve sezone. Obrnuto, nije bilo značajnih ($P> 0,05$) uticaja sezone i pod-godišnjih doba na mortalitet. Evidentno je da sezonsko variranje nije imalo efekta na učestalost smrtnosti, ali značajno je uticala na proizvodnju jaja mošusne patke i da je neželjeno dejstvo izraženije u suvoj sezoni najviše u kasno sušnom periodu.

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