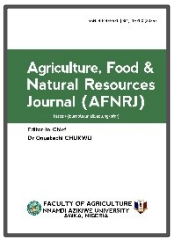
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Original Article

Variability in egg production hormones across four chicken genotypes raised in humid tropical region of Nigeria

OPEN ACCESS

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ABSTRACT

Egg production in chickens is influenced by hormonal regulation, which varies across genotypes and environmental conditions. This study examines the reproductive hormonal profiles of four distinct chicken genotypes reared in the humid regions of Nigeria. The genotypes included three indigenous types; Normal Feather, Frizzle Feather, and Naked Neck and an exotic breed, ISA Brown. A 4 × 2 factorial design laid out in a completely randomized design was adopted, involving 40 chickens, with ten individuals per genotype (5 hens and 5 cocks per genotype). The birds were reared under intensive management conditions, with controlled diets and standardized healthcare practices. Blood samples were collected at 34 weeks of age to analyze key reproductive hormones, including estradiol, progesterone, follicle-stimulating hormone (FSH), luteinizing hormone (LH), and prolactin, using enzyme-linked immunosorbent assay. Data were analyzed using two-way analysis of variance and hierarchical cluster analysis using average linkage. Significant means were separated using Duncan multiple range test at 95% confidence interval. The results demonstrated significant variations ($p<0.05$) in testosterone, progesterone, estrogen, and prolactin levels among the genotypes. Testosterone concentrations were highest in ISA Brown males, while progesterone and estrogen were significantly elevated in female birds, particularly in Naked Neck and Normal Feather genotypes. Prolactin levels varied widely, with higher concentrations observed in males of ISA Brown and Naked Neck genotypes. Despite the hormonal differences, LH and FSH levels did not show significant variations ($p>0.05$) across genotypes. The findings suggest that hormonal profiles play a crucial role in influencing egg production patterns, with specific genotypes exhibiting favorable reproductive traits.

KEYWORDS: *ISA Brown, Naked Neck, Variability, Prolactin levels*

INTRODUCTION

Egg production rate varies among chicken genotypes raised in the humid regions of Nigeria, representing a significant area of inquiry in order to address critical issues of food security and improvement in agricultural productivity. A primary goal of poultry production is to optimize egg yield, which serves as a crucial source of animal protein for human nutrition. However, the productivity of laying hens is subject to a range of genetic, environmental, and physiological influences. A significant factor affecting egg production is the hormonal regulation of the reproductive system, which varies among different chicken genotypes and under diverse environmental conditions (Du et al., 2020).

The humid climate of Nigeria presents distinct challenges for poultry production, including elevated temperatures that causes heat stress, high humidity, and the prevalence of diseases, all of

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which can adversely affect hormonal regulation and egg-laying efficiency (Ren *et al*., 2017). Indigenous chicken genotypes, such as Normal Feather, Frizzle Feather, and Naked Neck, have adapted over generations to thrive in these challenging conditions, exhibiting resilience and moderate productivity. Conversely, exotic breeds like ISA Brown, which have been commercially optimized for egg production in controlled environments, often encounter difficulties in achieving optimal performance in tropical settings. It is imperative to comprehend the interaction between these environmental factors and genetic variations in egg production hormones to optimize poultry management practices and improve egg yield (Ma *et al*. 2021; Shimmura *et al*., 2014).

Egg production in chickens is predominantly regulated by a complex interplay of hormones, including follicle-stimulating hormone (FSH), luteinizing hormone (LH), estrogen, and progesterone. These hormones are essential for the development of ovarian follicles, ovulation, and the subsequent formation of eggs. Variability in the levels of these hormones can be influenced by genetic factors, as different chicken genotypes display distinct hormonal profiles that impact their reproductive capabilities (Lumatauw & Mu'in, 2016). For example, research has demonstrated that polymorphisms in genes associated with hormone production can result in variations in egg-laying performance among different breeds (Igbatigbi, 2024).

The reproductive physiology of chickens is regulated by a complex interaction of hormones, each of which plays distinct and essential roles at various stages of egg production and brooding. Key hormones in this process include luteinizing hormone (LH), follicle-stimulating hormone (FSH), estrogen, progesterone, and prolactin, which can be ranked according to their direct influence on egg production and brooding behavior (Du et al., 2020). The hormones prolactin, follicle-stimulating hormone (FSH), luteinizing hormone (LH), estrogen, and progesterone are integral to the regulation of oogenesis in chickens. A comprehensive understanding of their functions and interactions is imperative for optimizing poultry management practices, particularly in response to diverse environmental conditions. Prolactin is a critical hormone that governs broodiness and reproductive behaviors in chickens, primarily facilitating the development of the brood patch and enhancing maternal instincts (Bhattacharya *et al*., 2011). Elevated levels of prolactin can suppress ovulation, resulting in reduced egg production, especially among broody hens. Consequently, the management of prolactin levels is essential for maximizing egg yield, particularly in indigenous breeds that naturally exhibit broodiness (Barman *et al*., 2022).

Follicle-Stimulating Hormone (FSH), synthesized by the anterior pituitary gland, is vital for the growth and maturation of ovarian follicles. FSH stimulates granulosa cells in the ovaries to produce estrogen and is crucial for oocyte development (Liao *et al*., 2016). The presence of FSH is fundamental for initiating the follicular phase of the reproductive cycle, which directly influences egg production rates. Luteinizing Hormone (LH) operates in conjunction with FSH and is essential for triggering ovulation. An increase in LH levels induces the final maturation of ovarian follicles and the subsequent release of the egg (Jia *et al*., 2016). The interaction between FSH and LH is critical for the precise timing of ovulation, thereby ensuring efficient egg production. Additionally, LH stimulates the synthesis of progesterone, which prepares the reproductive tract for potential fertilization.

Estrogen, primarily produced by developing follicles, plays a significant role in regulating reproductive behaviors and the physiological changes associated with egg production. It promotes the growth of the oviduct and enhances the synthesis of egg yolk proteins in the liver (Boschiero *et al*., 2018). Furthermore, estrogen influences the expression of LH receptors in the ovaries, facilitating the ovulatory process. Progesterone, produced by the corpus luteum post-ovulation, is essential for maintaining the reproductive cycle. It prepares the uterine lining for potential implantation and supports early embryonic development (Nishita *et al*., 2011). In chickens, progesterone levels are closely associated with LH and FSH, and fluctuations in these hormones can significantly affect egg production and reproductive success.

While all these hormones are critical for egg production, their significance varies depending on the stage of the reproductive cycle. Prolactin and estrogen are essential for regulating reproductive behaviors and preparing the reproductive tract, whereas FSH and LH are crucial for follicle development and ovulation. Progesterone serves a supportive role in maintaining the reproductive environment following ovulation. A thorough understanding of the dynamics of these hormones can inform improved management strategies aimed at enhancing egg production in chickens, particularly in challenging environments such as the humid regions of Nigeria.

MATERIALS AND METHOD

Study Location

The research was carried out at Babcock University and the Federal University of Agriculture, Abeokuta, Nigeria. The birds were raised at the Teaching and Research Farm of the Federal University of Agriculture, Abeokuta, Nigeria while the hormonal assay was done at Babcock University Laboratory, Ilishan-Remo, Ogun State, Nigeria. These institutions are located in Nigeria's humid region, which is characterized by elevated temperatures, substantial rainfall, and high humidity levels. The experimental framework was established within a controlled poultry research facility specifically designed to replicate the natural environmental conditions of the region, thereby ensuring consistency in the data collection process.

Experimental Design

This study utilized four distinct chicken genotypes, which included the Indigenous Genotypes: Normal Feather (NF), Frizzle Feather (FF), Naked Neck (NN) and the Exotic Breed: ISA Brown (IB)

A completely randomized design (CRD) was utilized, wherein each genotype was represented by six chickens (n = 24). The birds were randomly assigned to their respective genotype groups.

Management of Experimental Birds

The birds were reared in battery cages. The birds were provided with a standard commercial poultry diet specifically formulated to fulfill their nutritional needs for growth. Clean drinking water was made available ad libitum. Standardized vaccination protocols and health management practices were implemented to reduce the risk of disease.

Sampling Procedures

Blood Collection Blood samples were obtained from the wing vein of 10 chickens (5 hens and 5 cocks) per genotype at 34 weeks of age. Each sample, approximately 3 mL in volume, was collected using sterile syringes and subsequently transferred into EDTA-coated tubes for hormone analysis, as well as into plain tubes for serum separation. The serum samples were preserved at -20°C until further analysis.

Hormonal Analysis

The hormones assessed in the samples collected include estradiol, progesterone, follicle-stimulating hormone (FSH), luteinizing hormone (LH), and prolactin. The quantification of hormone levels was conducted using enzyme-linked immunosorbent assay (ELISA) technique, with the assay executed in accordance with the manufacturer's instructions.

Microplate wells for each standard reference and samples were arranged in a rack and 25 µl of sample or reference standard pipetted into the assigned wells. All other protocols were carried out according to the manufacturer's instruction, till the addition of 50 µl of stop solution. The absorbance of each assay was then read using ELISA microplate plate reader. A calibration curve was plotted using the optical densities of the reference standards against their known concentrations. This was used to determine the concentrations of estradiol, progesterone, follicle-stimulating hormone (FSH), luteinizing hormone (LH), and prolactin respectively, present in each of the samples.

Statistical Analysis

Data were expressed as mean ± S.E.M and analyzed using Statistical Package for the Social Sciences (SPSS) Version 20. The mean difference of the different groups was determined using two-way Analysis of Variance (ANOVA) for the effect of genotypes and sex, and their interactions. Means were separated by the use of Duncan New Multiple Range Test at 95% confidence interval. Data used for hierarchical cluster analysis were analyzed by descriptive statistics after which they were subjected to hierarchical cluster analysis using average linkage with SPSS (version 20) statistical package to produce dendrogram which indicates the relationship among the 4 genetic groups.

RESULTS AND DISCUSSION

The hormonal profiles observed in different genotypes of chickens (Table 1) reveal variations in key reproductive hormones, including testosterone, progesterone, estrogen, prolactin, luteinizing hormone (LH), and follicle-stimulating hormone (FSH). Testosterone levels were significantly higher ($p<0.05$) in males across all genotypes ($p < 0.05$), with IB M (2.33 ± 0.54 ng/mL) exhibiting the highest concentration, while IB F (0.51 ± 0.03 ng/mL) had the lowest. Testosterone (TESTO) concentrations were significantly higher in males compared to females across all genotypes ($p < 0.05$). The highest testosterone levels were observed in Isa Brown males (2.33 ± 0.54 mg/L), followed by Naked Necked males (2.00 ± 0.14 mg/L), Frizzled Feather males (1.91 ± 0.25 mg/L), and Normal Feathered males (1.83 ± 0.17 mg/L). In females, testosterone levels were considerably lower, with values ranging from 0.51 ± 0.03 mg/L in Isa Brown hens to 1.1 ± 0.21 mg/L in Frizzled Feather hens. Progesterone (Prog) levels varied significantly among the genotypes, with hens exhibiting higher concentrations than males. Naked Necked hens (30.2 ± 0.49 mg/L) had the highest progesterone levels, followed by Normal Feathered hens (30.1 ± 1.29 mg/L) and Isa Brown hens (29.44 ± 1.13 mg/L). Among males, Frizzled Feather cocks had the highest progesterone level (26.66 ± 0.95 mg/L), whereas Naked Necked males had the lowest (24.64 ± 0.89 mg/L). Estrogen (EST) levels were significantly higher in females than males, supporting its primary function in ovarian follicle development and calcium metabolism for eggshell formation. The highest estrogen level was observed in Normal Feathered hens (768.22 ± 21.25 mg/L), followed by Isa Brown hens (735.98 ± 40.36 mg/L). In contrast, the lowest estrogen concentration was recorded in Normal Feathered males (228.97 ± 90.45 mg/L). Prolactin concentrations were highly variable among genotypes, with Isa Brown males (77.65 ± 2.65 mg/L) and Naked Necked males (70.55 ± 3.65 mg/L) exhibiting the highest levels, while Frizzled Feather hens (12.8 ± 1.36 mg/L) and Normal Feathered hens (17.4 ± 3.57 mg/L) had the lowest. Luteinizing hormone (LH) and follicle-stimulating hormone (FSH) regulate ovarian follicle maturation and ovulation. While no significant differences were observed in LH levels among genotypes, the highest concentration was found in Naked Necked males (7.3 ± 4.2 mg/L). FSH levels were slightly higher in males, with Naked Necked males showing the highest value (18.9 ± 9.3 mg/L).

Table 1. Main Effects of Egg Production Hormones in Four Genotypes of Chickens

	FF M	FF F	IB M	IB F	NF M	NF F	NN M	NN F
Testosterone (ng/ml)	1.91 ± 0.25^{b}	1.1 ± 0.21^{a}	2.33 ± 0.54^{b}	0.51 ± 0.03^{a}	1.83 ± 0.17^{b}	0.71 ± 0.11^{a}	2 ± 0.14^{b}	0.52 ± 0.17^{a}
Progesterone (ng/ml)	26.66 ± 0.95^{ab}	30.91 ± 0.65^{d}	26.81 ± 0.71^{abc}	29.44 ± 1.13^{bcd}	24.82 ± 1.19^{a}	30.1 ± 1.29^{cd}	24.64 ± 0.89^{a}	30.2 ± 0.49^{cd}
Estradiol (pg/mL)	341.66 ± 27.2^{abc}	537.46 ± 60.68^{bcd}	321.39 ± 5.65^{ab}	735.98 ± 40.36^{de}	228.97 ± 90.45^{a}	768.2 2 ± 21.25^{e}	288.75 ± 3.53^{a}	560.8 ± 130.43^{cde}
Prolactin (ng/ml)	25.8 ± 17.16^{a}	12.8 ± 1.36^{a}	77.65 ± 2.65^{b}	27.1 ± 8.18^{a}	54.77 ± 18.3^{ab}	17.4 ± 3.57^{a}	70.55 ± 3.65^{b}	56.43 ± 19.96^{ab}
LH (mIU/L)	5.93 ± 3.39	3.27 ± 0.24	3.7 ± 1.1	4.6 ± 0.89	2.8 ± 0.35	4.1 ± 2.61	7.3 ± 4.2	3.7 ± 0.53
FSH (mIU/L)	15.2 ± 7.63	10.13 ± 1.89	12.3 ± 5.5	14.23 ± 2.33	9.17 ± 1.93	11.87 ± 6.9	18.9 ± 9.3	11.87 ± 1.85

a, b: Means along the same row with different superscript are significantly different (P<0.05). Group mean and standard error of samples (x±sem) shown, Luteinizing Hormone - LH, Follicle Stimulating Hormone - FSH, Frizzled Feather Cocks – FFM, Frizzled Feather Hens – FFF, Isa Brown Cocks – IBM, Isa Brown Hens – IBF, Normal Feathered Cocks –NFM, Normal Feathered Hens – NFF, Naked Necked Cocks – NNM, Naked Necked Hens-NNF

The hormonal profiles from four genotypes of chickens were analyzed for testosterone, progesterone, estradiol, prolactin, luteinizing hormone (LH), and follicle-stimulating hormone (FSH). The results are summarized in Table 2. Table 2 presents the concentrations of key reproductive hormones, including testosterone (TESTO), progesterone (PROG), estrogen (EST), prolactin, luteinizing hormone (LH), and follicle-stimulating hormone (FSH) in serum from four chicken genotypes. The interaction effects were significant ($p < 0.05$) for testosterone, progesterone, estrogen, and prolactin, indicating that genotype influences the expression of these hormones in eggs. However, LH and FSH showed no significant interaction effects ($p > 0.05$).

Table 2. Fixed Effects and Interaction Effect of Egg Production Hormones in Four Genotypes of Chickens

	Males	Females	FF	IB	NF	NN	Interaction
Testosterone (ng/ml)	1.99 ± 0.12	0.69 ± 0.09	1.51 ± 0.23	1.12 ± 0.41	1.27 ± 0.27	1.26 ± 0.34	0.000
Progesterone (ng/ml)	25.64 ± 0.53	30.11 ± 0.46	28.79 ± 1.08	28.56 ± 0.92	27.46 ± 1.42	27.42 ± 1.32	0.001
Estradiol (pg/mL)	292.81 ± 26.06	657.18 ± 42.3	439.56 ± 52.93^{a}	597.78 ± 91.07^{b}	498.59 ± 127.54 ^{ab}	450.58 ± 84.29^{ab}	0.000
Prolactin (ng/ml)	53.81 ± 9.35	28.33 ± 6.57	19.3 ± 8.23^{a}	43.95 ± 11.87^{ab}	36.08 ± 11.8^{ab}	62.08 ± 11.52^{b}	0.023
LH (mIU/L)	4.82 ± 1.24	3.97 ± 0.6	4.6 ± 1.63	4.3 ± 0.66	3.45 ± 1.21	5.14 ± 1.62	0.811
FSH (mIU/L)	13.55 ± 2.85	12.19 ± 1.65	12.67 ± 3.69	13.58 ± 2.09	10.52 ± 3.26	14.68 ± 3.56	0.913

a, b: Means along the same row with different superscript are significantly different (P<0.05). Group mean and standard error of samples (x±sem) shown, Luteinizing Hormone - LH, Follicle Stimulating Hormone - FSH, Frizzled Feather – FF, Isa Brown – IB, Normal Feathered –NF Naked Necked – NN

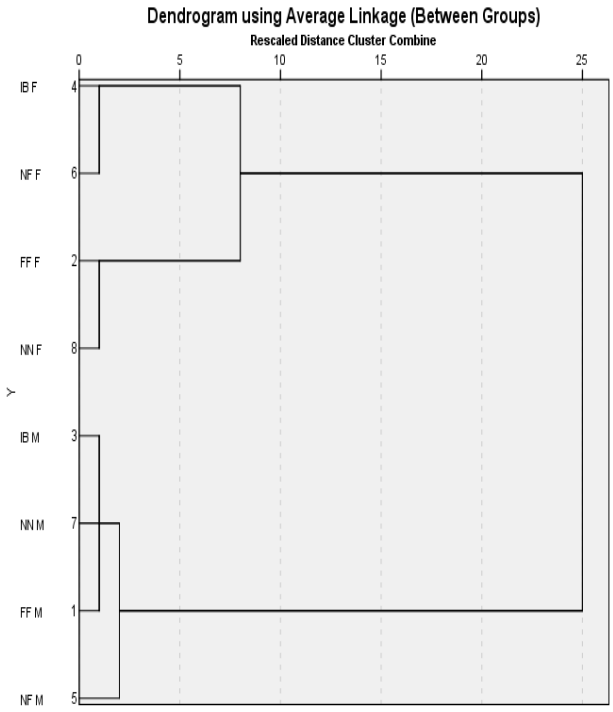


Figure 1. Dendrogram for Egg Production Hormones obtained from average linkage (between groups)

Hierarchical agglomerative clustering among four chicken strains

Note:
Frizzled Feather Cocks – FFM, Frizzled Feather Hens – FFF, Isa Brown Cocks – IBM, The hormonal profiles from four genotypes of chickens were analyzed for testosterone, progesterone, estradiol, prolactin, luteinizing hormone (LH), and follicle-stimulating hormone (FSH). The results are summarized in Table 2. Table 2 presents the concentrations of key reproductive hormones, including testosterone (TESTO), progesterone (PROG), estrogen (EST), prolactin, luteinizing hormone (LH), and follicle-stimulating hormone (FSH) in serum from four chicken genotypes. The interaction effects were significant ($p < 0.05$) for testosterone, progesterone, estrogen, and prolactin, indicating that genotype influences the expression of these hormones in eggs. However, LH and FSH showed no significant interaction effects ($p > 0.05$). Isa Brown Hens – IBF, Normal Feathered Cocks –NFM, Normal Feathered Hens – NFF, Naked Necked Cocks – NNM, Naked Necked Hens-NNF

Figure 1 presents a dendrogram generated through hierarchical agglomerative clustering, using average linkage to group chicken genotypes based on similarities in egg hormone concentrations.

The clustering pattern revealed two primary groups:

Group 1: Isa Brown Hens (IBF), Normal Feathered Hens (NFF), and Frizzled Feather Hens (FFF) clustered together, suggesting similar hormone profiles, particularly high estrogen and progesterone concentrations.

Group 2: Frizzled Feather Males (FFM), Naked Neck Males (NNM), and Normal Feathered Males (NFM) formed a distinct cluster, characterized by higher testosterone levels and lower prolactin concentrations.

Discussion

The role of reproductive hormones in egg production is critical in poultry science. Testosterone (TESTO), progesterone (Prog), estrogen (EST), prolactin, luteinizing hormone (LH), and follicle-stimulating hormone (FSH) collectively regulate reproductive functions in birds. This study examines the hormonal profiles of four chicken genotypes: Frizzled Feather (FF), Isa Brown (IB), Normal Feathered (NF), and Naked Necked (NN), comparing both males (M) and females (F). These findings align with previous studies showing that males typically exhibit higher testosterone levels, which are associated with increased aggression and secondary sexual characteristics (Etches, 1996). Lower testosterone levels in females are necessary for optimal egg production, as excessive androgens can inhibit follicular development (Hocking, 2009). This aligns with findings by Etches (1996), who reported that testosterone plays a vital role in spermatogenesis, secondary sexual characteristics, and aggression in male chickens.

Progesterone is crucial for ovulation, as it stimulates the release of luteinizing hormone (LH), triggering ovulation in hens (Johnson, 2014). The higher progesterone levels in hens suggest efficient ovarian activity, correlating with increased egg production (Onagbesan *et al*., 2006). Progesterone, a critical hormone for egg production, showed significantly higher concentrations in female chickens compared to their male counterparts, this is consistent with the findings of Williams (2012), who noted that progesterone is essential for follicular development and ovulation in poultry.

High estrogen levels are indicative of superior reproductive performance, as noted by Hrabia *et al*. (2019), who linked elevated estrogen to improved egg-laying rates in commercial laying hens. Estrogen levels varied significantly, with the highest concentration recorded in NF F (768.22 ± 21.25 pg/mL). This aligns with previous studies demonstrating the role of estrogen in yolk formation and calcium metabolism for eggshell synthesis (Hocking, 2009). The marked difference between males and females highlights estrogen's primary function in egg production.

Prolactin is known to inhibit egg production by inducing broodiness in hens (Sharp *et al*., 2007). Lower prolactin levels in hens suggest reduced broodiness and enhanced laying performance, a phenomenon well-documented in commercial layer breeds (Scanes, 2016). Elevated LH and FSH levels have

been linked to enhanced reproductive capacity in poultry (Etches, 1996). The observed trends suggest that certain genotypes, such as Naked Necked, may have superior reproductive hormone profiles, potentially leading to better fertility rates (Hocking, 2009). LH and FSH, both key gonadotropins regulating reproductive function, showed no significant variations between the genotypes. The observed values are consistent with the findings of Wilson & Sharp (2013), who reported that LH and FSH levels fluctuate based on photoperiod and reproductive status in birds.

The hormonal variations observed in this study are consistent with earlier findings. For instance, Onagbesan *et al*. (2006) reported that higher estrogen and progesterone levels in commercial layers correlated with superior egg production. Additionally, Johnson (2014) emphasized the inhibitory role of testosterone in females, aligning with the low TESTO levels observed in hens in this study.

The hormonal variations across genotypes suggest genetic influence on reproductive performance. The higher estrogen and progesterone levels in Isa Brown and Normal Feathered hens indicate their suitability for commercial egg production. Lower prolactin levels in Frizzled Feather hens suggest reduced broodiness, making them ideal for continuous egg production. The findings highlight significant differences in the hormonal profiles of male and female chickens across different genotypes, reinforcing the importance of these hormones in egg production and reproductive performance. This study demonstrates significant hormonal variations across different chicken genotypes, with implications for egg production efficiency. The findings reinforce the importance of hormonal balance in optimizing reproductive performance in poultry breeding programs.

Testosterone levels varied significantly among the genotypes. The significant interaction suggests genotype-dependent variation. Previous studies have reported that testosterone levels influence embryonic development, particularly in sexually dimorphic traits (Goymann & Wingfield, 2014). The higher levels in cocks may support faster growth rates than the hens (Cox & John-Alder, 2005).

Progesterone concentrations were significantly higher in hens than in cocks. This aligns with findings by Scanes (2015), which indicate that progesterone levels in hens correlate with egg production and reproductive success. Progesterone hormone promotes the pre-ovulation release of luteinizing hormone (LH) that impacts egg production (Zaghari et al., 2009). The observed differences among genotypes suggest that maternal effects could be influencing egg hormone composition. Estradiol showed the highest mean concentration in hens. High estradiol levels in eggs have been associated with enhanced feminization of offspring and improved reproductive traits (Williams, 2012). These findings are consistent with previous reports that estrogenic effects in avian species influence sex differentiation and reproductive success (Von Engelhardt *et al*., 2009).

Prolactin plays a crucial role in maternal behavior and incubation (Angelier & Chastel, 2009). High prolactin levels in Naked Neck hens may indicate stronger maternal instincts, possibly leading to improved chick survival rates. No significant differences were observed in LH and FSH levels across the genotypes. These findings suggest that these reproductive hormones may be under strong regulatory control, irrespective of genetic differences. Previous research (Casarini *et al.*, 2018; La Marca *et al.*, 2023) suggests that LH and FSH levels in avians are relatively stable and primarily function in ovarian follicle development rather than early embryonic differentiation.

The observed variations in egg-production related hormone concentrations among different chicken genotypes highlight the role of maternal effects in shaping offspring development. Higher testosterone levels in cocks are consistent with studies showing that androgen exposure can enhance competitive traits in male chicks (Kent *et al*., 2009. Similarly, elevated estradiol levels in hens may contribute to enhanced reproductive potential (Hanlon *et al*., 2022).

The significant prolactin variation across genotypes suggests potential differences in incubation behavior and maternal investment, with Naked Neck hens exhibiting higher prolactin levels. This aligns with research indicating that prolactin influences incubation persistence and chick rearing in poultry (Bedecarrats *et al*., 1997).

Overall, these results underscore the diversity in the hormonal profiles essential for egg production in different genotypes of chickens, with potential implications for breeding programs aimed at optimizing reproductive success and offspring fitness. The results of this cluster analysis are consistent with prior research by Du *et al*. (2020) and Tajudeen *et al*. (2025), which demonstrated that hormone profiles are strongly influenced by genetic background and sex differentiation. The significant hormonal variations across genotypes indicate that genetic selection can influence reproductive traits in chickens. The high estrogen and progesterone levels in Isa Brown and Frizzled Feather Hens suggest superior reproductive potential, which can be leveraged in breeding programs to enhance egg production. Additionally, the elevated prolactin levels in Naked Neck Hens suggest a potential for broodiness, which may affect egg-laying frequency. These findings provide insights into the endocrine basis of reproductive efficiency in chickens, which is crucial for optimizing breeding strategies.

CONCLUSION AND RECOMMENDATIONS

This study highlights the significant influence of genetic factors on the hormonal profiles on egg production of four chicken genotypes reared in Nigeria's humid environment. The observed variations in testosterone, progesterone, estrogen, and prolactin levels across genotypes underscore their role in reproductive efficiency and egg-laying potential. Notably, ISA Brown demonstrated hormonal traits favorable for enhanced egg production, while the Naked Neck and Normal Feather

genotypes exhibited elevated estrogen levels, suggesting their suitability for breeding programs aimed at optimizing productivity. The relatively stable levels of LH and FSH across genotypes indicate that while these hormones are crucial for follicular development and ovulation, other genetic and environmental factors may exert a more dominant influence on reproductive outcomes. These findings provide showed genotype-specific reproductive traits, which can inform selective breeding and management strategies to improve poultry production efficiency. Overall, this study underscores the importance of hormonal profiling in poultry breeding and management. Understanding the endocrine mechanisms governing egg production can help optimize genetic selection and environmental adaptations for sustainable poultry farming.

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Authors contributions

SOO and AOA: Management of experimental animals, data collection, data management and data analysis. ARA and AOA: Conceptualization, design of the experiments, Visualization, manuscript review and final approval of manuscript.

Ethical Statement

Not Applicable.

REFRENCES

Angelier, F. & Chastel, O. (2009). Stress, prolactin and parental investment in birds: A review. *General and Comparative Endocrinology*, 163(1-2), 142-148.

Barman, D., Sarkar, S., Parvez, M., Hasan, M., Aziz, F., Islam, R., Ahmed, S., Haque, MH. & Rashid, M. (2022). Anti-prolactin agent with gonadotropin-releasing hormone synergistically improves egg production in indigenous chicken via regulating broody behavior. *European Journal of Agriculture and Food Sciences*, 4(1), 92-97. https://doi.org/10.24018/ejfood.2022.4.1.456

Bedecarrats, G., Guemene, D., & Richard-Yris, MA. (1997). Effects of environmental and social factors on incubation behavior, endocrinological parameters, and production traits in turkey hens (*Meleagris gallopavo*). *Poultry Science*, 76(9), 1307-1314. https://doi.org/10.1093/ps/76.9.1307

Bhattacharya, T., Chatterjee, R., Sharma, R., Niranjan, M., Rajkumar, U., & Reddy, B. (2011). Identification of haplotypes in promoter of prolactin gene and their effect on egg production and quality traits in layer chicken. *Animal Biotechnology*, 22(2), 71-86. https://doi.org/10.1080/10495398.2011.555680

Boschiero, C., Moreira, GCM., Gheyas, AA., Godoy, TF., Gasparin, G., Mariani, PDSC., Paduan, M., Cesar, ASM., Ledur, MC. & Countinho, LL. (2018). Genome-wide characterization of genetic variants and putative regions under selection in meat and egg-type chicken lines. *BMC Genomics*, 19(83). https://doi.org/10.1186/s12864-018-4444-0

Casarini, L., Santi, D., Simoni, M. & Potì, F. (2018). Spare'luteinizing hormone receptors: facts and fiction. *Trends in Endocrinology and Metabolism*, 29(4), 208-217. https://doi.org/10.1016/j.tem.2018.01.007

Cox, RM. & John-Alder, HB. (2005). Testosterone has opposite effects on male growth in lizards (*Sceloporus spp.*) with opposite patterns of sexual size dimorphism. *Journal of Experimental Biology*, 208(24), 4679-4687. https://doi.org/10.1242/jeb.01948

Du, Y., Liu, L., He, Y., Dou, T., Jia, J. & Ge, C. (2020). Endocrine and genetic factors affecting egg laying performance in chickens: a review. *British Poultry Science*, 61(5), 538–549. https://doi.org/10.1080/00071668.2020.1758299

Etches, RJ. (1996). Reproduction in Poultry. CAB International.

Goymann, W. & Wingfield, JC. (2014). Male-to-female testosterone ratios, dimorphism, and life history—what does it really tell us?. *Behavioral Ecology*, 25(4), 685-699. https://doi.org/10.1093/beheco/aru019

Hanlon, C., Ziezold, CJ. & Bédécarrats, GY. (2022). The diverse roles of 17β-estradiol in non-gonadal tissues and its consequential impact on reproduction in laying and broiler breeder hens. *Frontiers in Physiology*, 13, 942790. https://doi.org/10.3389/fphys.2022.942790

Hocking, PM. (2009). Biology of egg production. Poultry Science, 88(9), 1815-1819.

Hrabia, A., Paczoska-Eliasiewicz, H. & Rząsa, J. (2019). Ovarian function and hormonal regulation in laying hens. *Animal Reproduction Science*, 207, 75-84.

Igbatigbi, L. (2024). Diversity of the ghrelin gene in Nigeria's Fulani and Yoruba ecotype chickens. *Journal of Experimental Agriculture International*, 46(5), 419-427. https://doi.org/10.9734/jeai/2024/v46i52393

Jia, Y., Yang, M., Zhu, K., Wang, L., Song, Y., Wang, J., Qin, W., Xu, Z., Chen, Y. & Liu, G. (2016). Melatonin implantation improved the egg-laying rate and quality in hens past their peak egg-laying age. *Scientific Reports*, 6:39799. https://doi.org/10.1038/srep39799.

Johnson, AL. (2014). The avian ovary and follicle development. *Animal Reproduction Science*, 149(3), 77-86.

Jones, R. & Williams, M. (2019). Role of progesterone in avian reproduction. *Poultry Science Journal*, 98(4), 1123-1135.

Kent, JP., Murphy, KJ., Bannon, FJ., Hynes, NM. & Hayden, TJ. (2009). Testosterone: from initiating change to modulating social organisation in domestic fowl (*Gallus gallus domesticus*). *Naturwissenschaften*, 96, 763-770. https://doi.org/10.1007/s00114-009-0526-9

La Marca, A., Longo, M., Sighinolfi, G., Grisendi, V., Imbrogno, MG. & Giulini, S. (2023). New insights into the role of LH in early ovarian follicular growth: a possible tool to optimize follicular recruitment. *Reproductive BioMedicine Online*, 47(6), 103369. https://doi.org/10.1016/j.rbmo.2023.103369

Liao, R., Zhang, X., Chen, Q., Wang, Z., Wang, Q., Yang, C. & Pan, Y. (2016). Genome-wide association study reveals novel variants for growth and egg traits in Dongxiang blue-shelled and White Leghorn chickens. *Animal Genetics*, 47(5), 588-596. https://doi.org/10.1111/age.12456

Lumatauw, S. & Mu'in, M. (2016). A 24-bp indel (insertion-deletion) polymorphism in promoter prolactin gene. *Animal Production*, 18(1), 1. https://doi.org/10.20884/1.anprod.2016.18.1.526

Ma, Z., Jiang, K., Wang, D., Wang, Z., Gu, Z., Li, G., Jiag, R., Tian, Y., Kang, X., Li, H. & Liu, X. (2021). Comparative analysis of hypothalamus transcriptome between laying hens with different egg-laying rates. *Poultry Science*, 100(7), 101110. https://doi.org/10.1016/j.psj.2021.101110

Nishita, T., Tomita, Y., Imanari, T., Ichihara, N., Orito, K. & Arishima, K. (2011). Biochemical and developmental characterization of carbonic anhydrase ii from chicken erythrocytes. *Acta Veterinaria Scandinavica*, 53(1). https://doi.org/10.1186/1751-0147-53-16

Onagbesan, OM., Bruggeman, V. & Decuypere, E. (2006). Involvement of reproductive hormones in egg production. *World's Poultry Science Journal*, 62(3), 406-428.

Ren, J., Xu, N., Zheng, H., Tian, W., Li, H., Li, Z., Wang, Y., Tian, Y., Kang, X. & Liu, X. (2017). Expression of thyroid hormone responsive spot 14 gene is regulated by estrogen in chicken (*Gallus gallus*). *Scientific Reports*, 7(1), 10243. https://doi.org/10.1038/s41598-017-08452-6

Scanes, CG. (2015). Sturkie's Avian Physiology, 6th Edition. SpringerVerlag, New York, pp. 503-504. https://www.elsevier.com/books/sturkies-avianphysiology/scanes/978-0-12-407160-5

Scanes, CG. (2016). Poultry Physiology. *Poultry Science Journal*, 92(1), 2-12.

Sharp, PJ., Macnamee, MC., Talbot, RT., Sterling, RJ. & Hall, TR. (2007). Evidence for a role of prolactin in the regulation of broodiness in poultry. *General and Comparative Endocrinology*, 168(3), 181-187.

Shimmura, T., Maruyama, Y., Fujino, S., Kamimura, E., Uetake, K. & Tanaka, T. (2014). Persistent effect of broody hens on behaviour of chickens. *Animal Science Journal*, 86(2), 214-220. https://doi.org/10.1111/asj.12253

Tajudeen, H., Hosseindoust, A., Mun, JY., Ha, SH., Park, SR., Silvestre, PN., Kim, MJ. & Kim, JS. (2025). Regulation of serum reproductive hormones, gap junction proteins, and cytokine profiles in laying hens fed varying levels of expanded black soldier fly meal. *Poultry Science*, 104(5), 105045. https://doi.org/10.1016/j.psj.2025.105045

Williams, JB. (2012). Regulation of ovulation and egg production in poultry. *Poultry Science*, 91(6), 1341-1350.

Wilson, SC. & Sharp, PJ. (2013). Regulation of LH secretion in domestic fowl. *Journal of Endocrinology*, 217(2), 169-178.

Zaghari, M., Taherkhani, R. & Honarbakhsh, S. (2009). Effects of progesterone injection on performance, plasma hormones and ovarian morphology of *ad libitum* and restricted fed broiler breeder hens. *African Journal of Biotechnology*, 8(22), 6481-6489. https://www.doi.org/10.5897/AJB09.1381