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COMPARISON OF EARLY SEXUAL MATURITY CHARACTERISTICS BETWEEN *BOVAN NERA* AND *ISA BROWN* PARENT STOCK LAYER STRAINS AS INFLUENCED BY 10-WEEK BODY WEIGHT

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SUMMARY

The study was conducted to compare early sexual maturity characteristics between *Bovan Nera* and *Isa Brown* Parent stock chickens reared in a commercial breeding system in Ibadan, humid Tropical Nigeria. Records on Pullet weight at 10 weeks (PW10, g), Feed-intake at 10-weeks (FI10, g), Total feed intake from11 weeks to first egg (FI11FE, kg), weight gain from 11 weeks to first egg (WG11FE, g), Feed intake at first egg (FIFE, g), pullet-weight at first egg (PWFE, g) and pullet-age at first egg (PAFE, days) were culled from the parent stock breeding farm records of CHI Farms Ltd. Ibadan; covering 1999 to 2008. The effect of PW10on FI10, FI11FE, WG11FE, FIFE, PWFE and PAFE was investigated. A total of 20 flocks of each strain were compared. Data were analyzed using ANOVA, GLM, Tukey's T-test, correlation and regression procedures of SAS® (1999) in randomized complete block (RCBD) design. Findings revealed that three body weight classes at 10-weeks (<700, 801-900 and >900 g) caused significant differences between strains in WG11FE, PWFE and PAFE. The 701-800 g body weight group produced no significant (p>0.05) difference between the two strains. PWFE was positively related with PAFE in BN (R^2=0.11) and IB (R^2=0.71). Strain averages revealed significant (p<0.05) differences between strains in all characteristics, and this led to 6-day difference in PAFE between BN and IB strains. The prediction of PWFE was highly influenced ($p<0.0001$, $R^2 \geq 0.82$) by PW10 and WG11FE in both strains. All equations obtained were significant (P<0.0006-0.04), revealed minimal basal genotypic differences between strains, and gave varying R^2 values from 0.00-0.86. The equations elicited the underlining causes of variability between *Bovan Nera* and *Isa Brown* parent stock chicken. Study also revealed the importance of PW10 for breeding and management of chicken from the 11th week to first egg.

Key words: Age at first egg, body weight at 10 weeks, breeding, feed consumption, management, weight-gain at first egg.

INTRODUCTION

The time duration to sexual maturation in modern domestic chicken has been reduced drastically. Compared to the Red Jungle fowl, domestic layer hens attain maturity approximately 20% earlier (Wright *et al*, 2012) today. Growers begin to exhibit rapid growth and sexual development from the 10th week while the onset of lay and sexual maturity is signified by the first egg in a flock. Onset of lay varies greatly from flock to flock, and strain to strain in the tropics. Pullets have two stages of early sexual maturity (ESM) determined by a stage of fast growth rate and required body composition (Summers, 2008) rather than chronological age. The first stage is characterized by the appearance of comb development, skeletal structure development, between 9 and 14 weeks of age. The second stage is determined by the maturation of oviduct, attainment of the required body composition and laying of the first egg, thus beginning egg production (Summers, 2008; Grieve, 2010). This second stage of sexual development could be age related. At first egg, a pullet attains her mature body weight while weight gain beyond this point is small and influenced by type of feeding program employed (Leeson and Summers, 1978). Renden and Marple (1986) reported significant differences between body weight at 10 weeks and age at sexual maturity in dwarf Leghorn hens. ESM characteristics have demonstrated a high level of variability among in-coming pullets. Thus, researchers have reported varying values for ESM characteristics in the tropics:1369-1470g for PWFE (Sola-Ojo and Ayorinde 2009; El-labban *et al.,* 2011; Sola-Ojo, Ayorinde, Fayeye and Toye, 2012; Olawumi, 2014); 140-166 days for PAFE (Sola-Ojo and Ayorinde 2009; El-labban *et al.*, 2011; Sola-Ojo, Ayorinde, Fayeye and Toye, 2012; Agu *et. al.* 2012; Olawumi, 2014) and 30.1-38.5g for EWFE (Mian and Bhatti, 1990; El-labban*et al.* 2011; Agu *et al*., 2012) respectively for layer chickens in the hot humid environment. These traits areaffected by breed, strain and genetic diversity (Iraqi *et al.*, 2007; Oke, 2011; Agu, *et. al.* 2012; Olawumi, 2014); management and components of the environment. Researchers have recommended targeting 10% higher body weight in hot climates than the weight standards published by primary breeders, to enhance high weight of first egg, higher productivity, better persistency of production, and better resistance to heat stress and diseases. (Summers, 2008; Holik, 2015). This research compared ESM characteristics, studied relationships among them and predicted feed consumption, pullet weight and age at first egg of *Bovan Nera* (BN) and *Isa Brown* (IB) Parent stock layer chickens; to highlight differences between strains under same farm, management and environmental conditions. The hypothesis for study was: Ho: There were no significant differences in ESM traits between strains.

MATERIALS AND METHODS

Parent stock data on *Bovan Nera* (BN) and *Isa Brown* (IB) chickens were obtained from the record books of CHI Limited in Ibadan, Nigeria. Information required were culled from 24 flocks of each strain from1999–2008. Data collected were Pullet weight at 10 weeks (PW10, g), Feed-intake at 10-weeks (FI10, g), Total feed intake from 11 weeks to first egg (FI11FE, kg), weight gain from 11 weeks to first egg (WG11FE, g), Feed intake at first egg (FIFE, g), pullet-weight at first egg (PWFE, g) and pullet-age at first egg (PAFE, days). Experimental design employed was randomized complete block design (RCBD), using strain as fixed effect and pullet weight at 10 weeks as Treatment. Data were then subjected to ANOVA, Least squares means (LSM) analysis, Tukey's-test between strains ($p<0.05$), correlation and regression procedures of SAS (1999). The analysis compared ESM characteristics between strains within body weight groups. The total average population of hens in each strain at 10 weeks was 97,602 and 112,118 for BN and IB respectively at 10 weeks. Statistical Model employed was: $Y_{ijk} = \mu + G_i + T_j + \varepsilon_{ijk}$

Y_{ijk}= Response due to ith strain, jth weight group, kth flock.

μ = General and unknown mean.

G_i= Fixed genotypic effect due to ith strain (i=1, 2).

T_j= Random effect due to jth body weight group (j=1,4)

ε_{ijk}= Random error due to ith strain, jth body weight group and kth flock, NID $(0, \delta^2)$.

RESULTS AND DISCUSSION

Table 1 shows results of least-squares estimates for *Bovan Nera* and *Isa Brown* pullet-growers as influenced by the 10-Week Body weight. Three body weight groups at 10-weeks (<700, 801-900 and > 900 g) caused significant differences in WG11FE and PWFE between strains. Body weight group 3 (801-900g) in both strains gave figures of FIFE, PWFE and PAFE closest to strain means of BN and IB respectively. The pairs of values obtained in group 3 except WG11FE, were not significantly ($p>0.05$) different from strain means respectively. FIFE showed that strains could be fed with 78 and 70 g/day at First egg with adequate diets to meet their physiological requirements. Trend of results revealed that higher body weight at 10 weeks, resulted in lower chronological PAFE, that is, shorter days to First egg (885g–117 days and

645g - 124 days in BN; and 916g – 105 days and 674g – 115 days in IB) within genotypes. Also, Pullets with >900g body weight at 10 weeks consumed less feed (BN:2.83; IB:1.9, kg) and gained less weight (BN:551.3; IB:233.2 g) to First egg in shorter days of 117 and 105 days respectively. For early first egg (117, 105 days) and higher profitability within strains, managers could target ≥ 900g body weight at 10-weeks for pullet-growers, and subsequently could offer about 3.0 and 2.0 kg feed-gift to BN and IB respectively from 11-weeks to first egg. The 701-800g body weight group at 10 weeks produced no meaningful (p>0.05) differences between strains. The average PWFE (1504.20 and 1351.40g) obtained in both strains were higher than 1369 and 1405g for black dominant strain, BDS and Fulani ecotype chicken, FEC (Sola-Ojo and Ayorinde, 2009). Results were also higher than 1499.60 and 1422.30g reported for commercial BN and IB pullets by Olawumi (2014). The average PAFE (121±8 and 115±9 days) in both strains were lower than 162.33±1.22 days reported for Nigerian south-eastern local chicken (Agu, *et al.,* 2012), 155 days for BDS and 169 days for FEC (Sola-Ojo and Ayorinde, 2009). Values obtained were also lower than 140 and 145 days reported for commercial BN and IB by Olawumi (2014). PWFE was positively related with PAFE in BN (R^2=0.11) and IB (R^2=0.71). This differed from that of Renden and Marple (1986) who reported a negative relationship between body weight and age at sexual maturity (first egg) in dwarf White Leghorn chicken. Differences between lowest and highest body-weight groups as influenced by 10-week body weight for BN and IB were 240.17 and 242.44 g, 9.01 and 9.85 g, 0.92 and 1.1 kg, 16.72 and 7.29 g, 346.27 and 451.34 g, 106.10 and 278.22 g, and; 9 and 13 days for PW10, FI10W, FI11FE, FIFE, WG11FE, PWFE and PAFE respectively. These differences indicated the importance of body weight at 10 weeks for breeding and management of chicken at first egg period.

Table 1: Comparative Least-squares estimates for *Bovan Nera* and *Isa Brown* pullet growers as influenced by the 10-Week Body weight

Pullet weight class @10-Weeks	Strain	FI10W (g) Mean±SD	FI11FE (kg) Mean±SD	FIFE (g) Mean±SD	WG11FE (g) Mean±SD	PWFE (g) Mean±SD	PAFE (days) Mean±D
< 700 g	BN	61.46±6.07[a]	3.62±0.82	85.31±14.97[a]	897.57±70.08[a]	1542.40±81.01[a]	124±11
	IB	50.05±6.68[b]	2.77±0.85	68.02±3.26[b]	567.04±92.03[b]	1241.50±91.26[b]	115±14
701-800 g	BN	57.51±2.17	2.70±0.27	68.59±2.50	770.38±152.19	1529.58±172.34	115±4
	IB	54.16±7.05	3.00±0.70	74.19±5.43	684.54±145.35	1428.89±125.28	118±8
801-900 g	BN	60.02±7.24	3.23±0.53	78.08±11.79[a]	667.87±97.24[a]	1492.65±100.80[a]	122±7
	IB	55.47±2.87	2.71±0.67	67.91±3.79[b]	542.63±136.55[b]	1381.17±117.74[b]	114±8
> 900 g	BN	52.45±10.01	2.83±2.41	72.96±6.68	551.30±38.49[a]	1436.30±22.58[a]	117±4
	IB	59.90±13.5	2.90±0.92	66.90±7.82	233.20±21.40[b]	1150.67±31.42[b]	105±6
RMSE		6.35	0.84	11.37	80.57	85.73	12
DIF	BN	9.01	0.92	16.72	346.27	346.27	9
	IB	9.85	1.10	7.29	451.34	278.22	13
Strain Average	BN	59.02±6.94[a]	3.41±1.05[a]	77.67±12.10[a]	727.81±148.13[a]	1504.20±104.56[a]	121±8
	IB	53.88±5.87[b]	2.79±0.71[b]	70.08±5.07[b]	582.93±158.90[b]	1351.40±137.62[b]	115±9

Notes: Paired values within same cell with different superscripts are significantly different from each other at 0.05% level. FI10W= Pullet feed-intake at 10-Weeks, FI11FE= Pullet feed-intake at 11-Weeks to First egg, FIFE=Pullet feed-intake at First egg, WG11FE=Pullet weight-gain at 11-weeks to First egg, PWFE=Pullet weight at First egg, PAFE=Pullet age at First egg. DIF= Difference between lowest and highest body weight classes. RMSE= Root mean square error.

Table 2 shows the Multiple step-wise linear regression equations for predicting FI11FE, PAFE and PWFE in BN and IB. The equation predicting FI11FE revealed a strain constant of 3.41 kg for *Bovan Nera* from 11 weeks to First egg, while intake required by Isa Brown could depend on the targeted length of days set by the farmer from 11 weeks to First egg. Equations predicting PAFE reveal strain constants of 94 and 83 days for BN and IB strains respectively. These confirmed that BN possess longer PAFE than IB. The remaining difference between strains was contributed by FIFE in BN and combination of FI11FE and WG11FE in IB. The pairs of equations predicting FI11FE and PAFE were significant ($p<0.0001$, 0.01 and $p<0.04$, 0.0006) but posted very low R^2 (0.00, 0.23 and 0.40, 0.0006) for BN and IB respectively, indicating that equations were very weak and could not capture all variability for predicting FI11FE and PAFE. The R^2 of 0.00 implied that feed Intake to first egg could not be easily predicted using any of the measured parameters, while PAFE influenced feed intake in IB. The two equations are not reliable (R^2=0.00-0.40). FIFE was implicated in equation predicting PAFE in BN, while WG11FE and FI11FE were implicated in equation for IB. The equation for IB was better (R^2=0.54) in predictive ability than that of BN (R^2=0.23). Equations predicting PWFE revealed basal or genetic constants of 1.89 and 2.03 for BN and IB strains. For both strains, PW10 and WG11FE contributed to the variability for predicting PWFE. Thus, the difference between strains for PWFE was basal or genetic in origin, with BN having lower genotypic ability to first egg, but higher PWFE; while IB had higher genotypic ability to first egg, but lower PWFE between strains. The two equations showed the trait PWFE was influenced by PW10 and WG11FE in both strains. The high R^2 obtained (0.86 and 0.82) implied that the trait could be predicted to high level of accuracy in both strains respectively.

Table 2: Step-wise Regression Equations for Prediction of Feed Consumption, Age at First Egg and Hen weight at First egg in *Bovan Nera* and *Isa brown* Parent Stock Pullets Reared in Ibadan

Trait being Predicted	Strain of Bird	Model of Prediction $Y=\mu + \alpha X_i + \beta x_j + \varepsilon_{ij}$	Adj. R^2	Model Sig.	VIF	DW	Comments
Feed Intake at 11-weeks to First-egg (FI11FE, kg)	Bovan Nera	$Y=3.41 + 0.0X \pm 0.21$	0.00	0.0001	0.0	2.1	Intercept only
	Isa Brown	$Y= -3.25 + 0.053X \pm 1.50$	0.40	0.04	1.0		X=PAFE (days)
Pullet age at First Egg (PAFE, days)	Bovan Nera	$Y=94.22+0.34X \pm 9.71$	0.23	0.01	1.0	1.9	X=FIFE (g)
	Isa Brown	$Y=83.39+0.02X_1+6.63X_2\pm 8.93$	0.54	0.0006	1.3	2.5	X_1=WG11FE (g); X_2=FI11FE (kg)
Pullet weight at First egg (PWFE, g)	Bovan Nera	$Y= 1.89+1.0X_1+1.0X_2\pm\varepsilon$	0.86	0.0001	2.1	-	X_1=PW10(g); X_2=WG11FE (g)
	Isa Brown	$Y=2.03+1.0X_1+1.0X_2 \pm\varepsilon$	0.82	0.0001	1.3	-	X_1=PW10(g); X_2=WG11FE (g)

Notes: PW10=Pullet weight at 10-Weeks; PAFE=Pullet age at First egg; FI11= Feed Intake from 11-weeks to First egg; FIFE= Feed Intake at First egg; WG11FE= Pullet weight gain from 11-weeks to First egg.

CONCLUSION

Findings demonstrated significant differences in early maturity characteristics between *Bovan Nera* and *Isa Brown* strains within 801-900g class, based on 10-week body weight category. Regression equations showed that IB chicks had a better basal body weight potential to first egg, while BN recorded a higher pullet weight from 11 weeks to first egg. Regression results implied that from the 11th week, BN converted less feed to body weight better than IB.

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Statement of Animal Rights.
All applicable international, national, and/or institutional guidelines for the care and use of animals were followed. The manuscript does not contain clinical studies or patient data.

Conflict of Interest Statement: The author declares no conflict of interest.

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