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Estimation of Genetic Parameters for Body Weight and Some Colour Traits in the Seventh-generation Index Selected Nigeria Heavy Local Chicken Ecotype

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ABSTRACT

Background: This study was conducted to estimate the genetic parameters of body weight and some colour traits in seventh generation (G7) index selected Nigerian Heavy Local Chicken Ecotype (NHLCE) progenies at point of lay to 12 weeks.

Methods: 5 sires and 12 hens were used to generate the progenies used for the experiment. Traits measured included weekly body weight, egg colour, beak colour and feather colour. Data collected were subjected to one way analysis of variance in a Paternal half sib analysis using Animal model of SAS (2003). Four weeks body weight measurements, egg colour, beak colour and feather colour for 5 sires ranged from 1.29±0.05 1.54±0.07; 2.55±0.02 to 4.00±0.02; 2.45±0.02 to 4.83±0.02 and 1.73±0.02 to 4.58±0.04 respectively.

Result: The new Duncan's multiple range test shows that sire families are similar (p>0.05) in the body weight and beak colour, but significantly differed (p>0.05) in the egg colour and feather colour. The heritability estimates of mature body weight for week 3 was medium, while estimates of heritability for weekly mature body weight for weeks 1, 2 and 4, egg colour, beak colour and feather colour of NHLCE were low heritability. Low h^2 of traits suggest that progeny and pedigree selection could be employed for improvement of the egg colour, beak colour and feather colour of NHLCE. The study showed positive genetic correlations between beak colour and egg colour, negative genetic correlations between beak and feather colour. This means that no decision can be taken in isolation as the selection of one trait will have consequences on other traits.

Key words: Chickens, Colour, Correlations, Growth, Heritability, Index selected.

INTRODUCTION

The Central Bank of Nigeria, CBN (2019) report substantiated that standard of living as well as average animal protein intake has continued to fall while analyzing the economic sub-sectors owing to the downward trend of the gross domestic product (GDP). These figures are grossly inadequate and unable to meet the recommended 75g per caput daily animal protein intake or its equivalent 25.357 kg per person per annum intake hence the need for prompt improvement of our indigenous livestock species.

The indigenous chicken constitutes about 80% of the total chicken population in Nigeria (Dana *et al.* 2011) where they are mostly kept by the rural farmers. They are very hardy and possess the capacity to withstand harsh and stressful environmental conditions (Mpenda *et al.,* 2019). They are good scavengers with the innate ability to hatch and brood their eggs and also possess appreciated immunity for endemic diseases (Ajayi, 2010). Studies have shown that the local chicken has very extensive genetic variability hence making them a valuable resource for genetic improvement programme (Dana *et al.,* 2011). The effectiveness of breeding programmes depends on the accuracy of genetic and phenotypic parameter estimates, which include heritability and repeatability (Burrow, 2001). Hence, knowledge of genetic parameters is required for designing an appropriate breeding plan for genetic improvement of the Nigerian local chicken species (Khan and Ashok, 2002).

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The Nigerian indigenous chickens are slow-growing birds exposed to natural selection forces, which have embedded in them great genetic resources and some fitness traits like the ability to withstand harsh weather conditions, appreciated immunity from endemic diseases and hardiness (Haunshi *et al.,* 2019). The indigenous chicken has been classified based on location (Fulani and Yoruba Ecotyoes), Feather structure (Normal and frizzled feathered (Adembambo 2005) and body size (heavy ecotype and light ecotype) by (Momoh *et al.,* 2010). The Nigerian Heavy Local Chicken Ecotype (NHLCE) has its root in Obudu, a montane region of south eastern Nigeria and the Guinea Savana agro-ecological zone of Northern Nigeria. The growth traits of the NHLCE and the light ecotype were evaluated by Momoh *et al.* (2010) and Ndofor-Foleng *et al.* (2015), respectively. The mature body weight of the heavy ecotype chickens, according to Momoh *et al.* (2010) range from 0.9-2.5 kg and it is significantly ($p<0.05$) higher than the light ecotype chickens.

The last two decades have witnessed more steady and serious researches for the genetic improvement of the Nigerian indigenous chicken, known as Nigeria Heavy Local Chicken Ecotype (NHLCE). The NHLCE has been evaluated for its genetic parameters of growth and egg traits (Ohagenyi, 2009; Agu *et al.,* 2015). The NHLCE was lightly bred under controlled breeding and selection to 3rd generation Ogbu *et al.* (2012), further bred to the 6th generation by Agbo (2018) to 8th generation. Aguji (2019) did a comparative study of the 8th index selected NHLCE, broiler and nondescript Nigerian unimproved chicken, which revealed that the meat yield of the NHLCE was 1.6 times more than the nondescript chicken, lower than broiler. Implying therefore more generations of selection and mating system to further improve its growth and reproductive traits of the 7th generation of NHLCE. In order to advance genetic progress and fix such character, genetic variation and genetic parameters are a sine qua non (Khan and Ashok, 2002).

MATERIALS AND METHODS

Location of the study

This study was carried out in the local bird section of the poultry unit of the Department of Animal Science Teaching and Research farm University of Nigeria, Nsukka. The Nsukka town is located on latitude 05°22′ North and longitude 07°24′ East with annual rainfall ranging from 986-2098mm (Asadu, 2002). This study lasted for 12 weeks.

Experimental birds and management

The population used for this study is the seventh index selected population of the NLHCE. A total of 55 NHLEC (5 males and 50 females) was used as parent stock to generate five sire families to produce 500 progenies. Each male mated to 10 hens generated 100 progenies. The female progenies of the 5 sire families generated from the mating of NHLEC were used for this study. The birds were housed in a battery cage system and they were fed commercial layer diet daily. Clean drinking water was provided.

Data collection

Data was collected on the following parameters; daily feed intake of the birds, egg number, egg colour, beak colour, feather colour, body weight.

Experimental design and statistical analysis

The data generated was subjected to analysis of variance (ANOVA) in a paternal half sib analysis. All data generated was analyzed using SAS (2003) to derive variance and covariance components as well as correlations of all traits under study. Heritability was estimated from the expression below:

$$\text{Heritability} = \frac{\text{4x sire variance components}}{\text{Total variance}}$$

The experimental model was

$$Yij = \mu + \alpha_i + e_{ijk}$$

Where,

Yij = The record of average body weight, egg weight of individual progeny of the ith sire.

μ = Overall mean.

α_i = The random effect of ith sire.

e_{ijk} = The uncontrolled environmental and genetic deviations attributable to individual progeny (chick) within each sire group.

RESULTS AND DISCUSSION

Descriptive statistics for body weight of female progenies and colour traits of 5 genetic groups of Nigerian heavy local chicken ecotype

Table 1 shows the means and standard error for body weight and some colour traits of 5 genetic group of Nigerian heavy local chicken ecotype. The mean result of the study on body weight of sire families 1, 2, 3, 4, 5, for four weeks ranged from 1.37±0.07-1.43±0.09, 1.47±0.07-1.54±0.07, 1.40±0.06-1.50±0.06, 1.34±0.07-1.43±0.08, 1.29±0.05-1.44±0.05 respectively. Four weeks body weight measurements for sire 1, 2, 3, 4, 5 progenies ranged from 1.29±0.05 to 1.54±0.07. The mean egg colour of sire families 1, 2, 3, 4 and 5 were 2.55±0.02, 3.08±0.02, 4.00±0.02, 3.67±0.02 and 3.11±0.03 respectively. The egg Colour measures for the five genetic groups ranged from 2.55±0.02 to 4.00±0.02. The analysis of Variance showed that there were significant differences ($p<0.05$) in egg colour of 5 genetic groups. The mean beak colour of sire families of 1,2,3,4 and 5 were 2.45±0.02, 4.83±0.02, 3.00±0.02, 2.75±0.02 and 3.11±0.03 respectively. The mean values on beak colour of sire families 1,2,3,4 and 5 ranged from 2.45±0.02 to 4.83±0.02. The result of the study on sire families 1,2,3,4 and 5 for feather colour were 1.73±0.02, 2.08±0.02, 3.64±0.05, 4.58±0.04 and 3.89±0.05 respectively. The feather colour of the sire families were grouped into nine. The means for feather color of five genetic group ranged from 1.73±0.02 to 4.58±0.04. The result further revealed that the light brown egg color and white feather were significantly higher than other colours among the entire sire families. This again consolidates the predictive accuracy of the ongoing selection program carried out by researchers at the station.

The increasing trend from weeks 31 to 34 obtained in this study for body weight as the birds advances in age suggests that age is a major determinant of growth and physiological development. This report disagrees with the value (0.98) reported earlier by Ohagenyi (2009). Atteh (1990) also reported that the light ecotype ranges from 0.68 to 1.5 kg and the heavy ecotype ranges from 0.9 to 2.5 kg.

Table 1: Descriptive statistics for body weight of female progenies and colour traits of 5 genetic groups of Nigerian heavy local chicken ecotype.

Parameter	SIRE 1	SIRE 2	SIRE 3	SIRE 4	SIRE 5
B.W (kg)					
Week 31	1.37±0.07[a]	1.47±0.07[a]	1.40±0.06[a]	1.34±0.07[a]	1.29±0.05[a]
Week 32	1.39±0.08[a]	1.48±0.06[a]	1.48±0.06[a]	1.36±0.08[a]	1.37±0.05[a]
Week 33	1.46±0.08[a]	1.57±0.07[a]	1.50±0.06[a]	1.43±0.07[a]	1.41±0.05[a]
Week 34	1.43±0.09[a]	1.54±0.07[a]	1.50±0.06[a]	1.43±0.08[a]	1.44±0.05[a]
E.C	2.55±0.02[c]	3.08±0.02[bc]	4.00±0.02[a]	3.67±0.02[ab]	3.11±0.03[bc]
B.C	2.45±0.02[a]	4.83±0.02[a]	3.00±0.02[a]	2.75±0.02[a]	3.11±0.03
F.C	1.73±0.02[b]	2.08±0.02[b]	3.64±0.05[a]	4.58±0.04[a]	3.89±0.05[a]

Legends: BW-Body weight; E.C-Egg volour; B.C-Beak volour; F.C-Feather colour.

Duncan's multiple range test of the means of body weight and colour traits of progenies of 5 genetic groups of Nigerian heavy local chicken ecotype

The new Duncan's multiple range test shows that there were no significant differences (p>0.05) in the body weight and beak colour of 5 sire families studied and also revealed that there were significant differences (p>0.05) in the egg colour and feather colour of the 5 sire families experimented. Progenies of sires 3, 4 and 5 also have similar egg colour, but the sire families of 1 was significantly different from 3, 4 and 5. Sire families 3, 4 and 5 are similar in feather colour. Sire families 1 and 2 are similar in feather colour. However, progenies of sires 3, 4 and 5 varied significantly (p <0.05) from progenies of sire 1 and 2.

The egg colour value contradicts the value (1.68) reported by Ohagenyi (2009). The disparity in egg colour could be attributed to selection pressure, which gradually changes the frequency of genes generation after generation. It also serves as strong evidence that the genetic improvement plans or breeding decision employed by breeders for seven generation is efficient. More so, feed and age can also affect the colour of the egg. Odabasi *et al.* (2007) reported that hens laid eggs with lighter coloured shell as the flock aged. It can also be as a result of different genes and their expression as stated by (Nys *et al.,* 2004). A decrease in pigmentation was associated with a decrease in the amount of redness in the egg shell. A study by Samiullah *et al.* (2015) reported that the brown coloration of the shell was an important shell quality parameter. Consumers prefer more and more dark shelled eggs of brown colour which results to changes in consumption rate. White shelled eggs are less expensive compared to dark shelled eggs which variably affect the economic stand of the dark shelled egg positively.

There were no differences observed from the values of the beak colours of the 5 sire progenies studied. This disagreed with the result reported earlier by Ohagenyi (2009). This can be attributed to the fact that the selection pressure by breeders for seven generations. This possibly has increased the uniformity of genes that control pigmentation of the beak among the 5 sire families studied. This corroborates the fact that selection brings about increased gene frequency of desired genes as well as genetic progress (Asok and Khan, 2002).

The observed differences in the feather colour can be attributed to the fact that different genes control the pigmentation of feather. The similarity of body weight value reported for sire groups in this study could be attributed to the outcome of seven generations of selection, which serves as a breeder's tool for achieving uniformity of traits among individuals in a population. The beak colours are similar, because genetic variations get eroded easily, when they are controlled by few genes by continuous selection.

Heritability estimate for body weight and colour traits of 5 genetic groups

Table 2 shows the heritability estimates for the body weight and some colour traits of 5 genetic groups. The heritability values for the four weeks body weights were 0.02, 0.08, 0.38 and 0.19 respectively. The heritability estimates of body weight for 34[th] weeks were low except for 33[rd] week which is medium. More so, estimates of heritability for egg colour, beak colour and feather colour obtained from this analysis were low (0.10, 0.00 and 0.17) respectively.

The heritability estimate obtained in this study at the 31[st] week is comparable with the values (0.03±0.02 and 0.04±0.016) reported at 20 weeks of age by Naik *et al.* (2019) and Pragnya *et al.* (2021), respectively. More so, the heritability estimates for body weight at the 33rd week differed from the value (0.30±0.2) reported by Momoh *et al.* (2010) at 20th week. Prince *et al.* (2020) reported (0.19 ± 0.04) at 40[th] week, which conforms to the value reported in this study for body weight at 34[th] week.

Moderate h^2 of the body weigh suggest that mass selection could bring about genetic improvement of the

Table 2: Heritability estimate for body weight and colour traits of 5 genetic groups.

Traits	V_S	V_T	Heritability
Body weight (B.W.)			
Week 31	0.002	0.492	0.02
Week 32	0.001	0.052	0.08
Week 33	0.005	0.055	0.38
Week 34	0.0028	0.058	0.19
Egg colour (E.C.)	0.054	2.272	0.10
Beak colour (B.C.)	0.002	2.300	0.00
Feather colour (F.C.)	0.282	0.523	0.17

Table 3: Genetic correlation of various traits of Nigerian heavy local chicken ecotype.

Traits	Genetic correlation
E.C*B.C	.053
E.C*F.C	-.041
B.C*E.C	.053
B.C*F.C	-.241**

**Significant at P<0.05.

NHLCE. Low heritability implies that additive genetic variance (VA) has little contribution to the observed variability in a trait. Corollary, non-additive variance could be implicated. Hence, the population will show very little response to selection.

Zero heritability indicates that additive variance may have no contribution compared to phenotypic variance among traits (Steinsaltz, 2020). Thus, (VA = 0) does not imply that the character lacks a genetic basis; it means that the observed trait variation within the population being considered is entirely environmental. Hence traits may be improved by upholding good management practices.

Genetic correlation of various traits of nigerian heavy local chicken ecotype

The Table 3 shows the genetic correlation of some of the colour traits measured in Nigerian heavy local chicken ecotype. There was positive correlation between egg colour and beak colour whereas a negative and significant correlation was found between feather colour and egg colour as well as beak colour.

This result indicated that selection for egg colour could bring about genetic improvement of beak colour.

CONCLUSION

The heritability estimates of mature body weight for week 3 were medium. The result showed positive genetic correlation of beak colour with egg colour, as well as negative correlation between beak colour and feather colour respectively. This means that no decision can be taken in isolation. Selection of one trait will thus have consequences on other traits as well.

The heritability estimates of matured body weight of NHLCE at week 33 was medium, but low for 31, 32, 34 weeks body weights and colour traits (egg colour, beak colour and feather colour). Moderate and low heritability estimates for body weight reveals that genetic improvement of the NHLCE could be achieved by mass selection using records of 33rd week body weight or progeny/pedigree selection using records of the 31, 32 or the 34th week. However, progeny and pedigree selection could be employed for improvement of the egg colour and feather colour of NHLCE.

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