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Estimation of Genetic Parameters of Biometric and Allometric Traits in Four Strains of the Nigerian Heavy Local Chicken Ecotype (NHLCE)

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Abstract

The study was conducted to determine some genetic parameters of biometric and allometric traits in the Nigerian heavy local chicken ecotype of Nigeria. This study was carried out at the Animal Science teaching and research, University of Nigeria, Nsukka. Data from 80 progenies produced by the artificial insemination of 4male heavy ecotype local chickens with 12 mature female chickens was used for this study. The data analyzed consisted of body weight records from 0-8 weeks, as well as conformation traits (body length, chest girth, shank length) at 1,4,6 and 8 weeks. The results show that there were no significant differences ($p>0.05$) on the body weight of progenies at weeks 1 and 4, body length of progenies at weeks 1,4 and 6, girth of progenies at weeks 1,4 and 8, shank length at weeks 1 and 4. However, there were significant difference ($p<0.05$) on body weight of progenies at weeks 6 and 8, body length at week 8, chest girth at week 6 and shank length at weeks 6 and 8. The heritability estimates for body weight, body length, chest girth and shank length ranged from low to high with an estimated value of -0.44 to 0.62 respectively. However, high heritability estimates were reported for body weight, body length and shank length (0.40, 0.40, 0.62 respectively). From this study, body weight, body length and shank length at 8 weeks could be used as selection indices for selection of parents of next generation. It's not advisable to carry out selection at young age, because heritability at early ages are being influenced by maternal and environmental effects.

Keywords: Additive; Genetic Progress; Heritability; Selection; Variance

Abbreviations: NHLCE: Nigerian Heavy Local Chicken Ecotype; NLC: Nigerian Local Chicken; BW: Body Weight; BL: Body Length; CG: Chest Girth; SL: Shank Length, NS: Not Significant.

Introduction

The population of chicken in Nigeria has been estimated at approximately 166 million [1]. The local chicken constitutes about 80% of this number [2]. The Nigerian local chicken is characterized by poor growth, small body size, small egg size and egg number which is not desirable in a competitive economy [3].

Despite these undesirable characteristics, the local chicken still plays important role in the rural economy of Nigeria by providing meat, egg and house hold income to the rural people. Studies have shown that the local chicken in Africa exhibit high genetic variability within their populations indicating their potential for genetic improvement through selective breeding [2,4]. Recent works revealed that the different ecotypes can be grouped into two major categories on the basis of body size and body weight as heavy ecotype and light ecotype [5]. The heavy ecotype (also referred to

as Fulani ecotype) is found in the dry Savannahs (Guinea and Sahel Savannah), montane regions and cattle Kraals of the North and weigh about 0.9-2.5 kg at maturity. The light ecotype are those chicken types from the Swamp, Rainforest and Derived Savannah agro-ecological zones whose mature body weight ranges between 0.68-1.5 kg.

Knowledge of genetic parameters is necessary for designing an appropriate breeding plan for genetic improvement of Nigerian local chicken (NLC) [6]. Relationships exists between body weight and linear body measurements. This is to organize the breeding programme so as to achieve an optimum combination of body weight and good conformation for efficient production and maximum economic returns. Body weight and body dimensions have been used as parameters for selection by local sellers and for research [7]. The aim of this work is to estimate the genetic parameters of biometric traits in four strains of the Nigerian heavy local chicken ecotype (NHLCE).

Material and Methods

Location and Duration of Study

The experiment was carried out at the Poultry Unit of the Department of Animal Science research farm, University of Nigeria, Nsukka. The study lasted for a period of 2 months.

Foundation Stock, Experimental Birds and Management

The foundation stocks were 16 mature Nigerian heavy ecotype local chickens, comprising of 4cocks and 12 hens. Mating of likes (associative mating) strains which are the black, barred, white and brown was adopted to generate progenies. The experimental birds consisted of 80 progenies produced from artificial insemination involving four different strains of the heavy ecotype local chicken (white, barred, black and golden).The experimental birds were grouped into 4 consisting of 20 chicks of the golden strain, 20 chicks of the white strain, 20 chicks of the barred strain and 20 chicks of the black strain and the brooding house was divided into 4 sections to house them, respectively from 0-8 weeks. Necessary vaccinations and medications were administered in addition to proper management practices.

Data Collection and Statistical Analysis

Data obtained from body weight, body length, shank length and chest girth was subjected to analysis of variance (ANOVA) in a paternal half sib method, all data generated was analyzed using SAS (2004) statistical procedure.

Experimental Design

The experimental design used was the paternal half sib analysis

Model: $Yijk = \mu + \alpha i + eijk$,

Where:

μ= overall mean

αi= random effect of the sire

eijk= the uncontrolled environment and genetic deviation attributed to individual progeny

Results and Discussions

The photos of the progenies of the four genetic groups of the Nigerian heavy local chicken ecotypes are shown in Figure 1 below.

Figure 1: Picture Showing the Progenies of the Four Strains of the Nhlce at 4 and 8 Weeks of Age.

Parameters	Week	White Strain	Barred Strain	Black Strain	Golden/Brown Strain
BW(KG)	1	0.038±0.002$^{N.S}$	0.036±0.002$^{N.S}$	0.036±0.022$^{N.S}$	0.036 ±0.002$^{N.S}$
	4	0.1960±0.009$^{N.S}$	0.960±0.002$^{N.S}$	0.200±0.009$^{N.S}$	0.188±0.008$^{N.S}$
	6	0.312±0.0143^{b}	0.360±0.0157^{ab}	0.370±0.0179^{a}	0.346± 0.016^{ab}
	8	0.564± 0.226^{ab}	0.516± 0.256^{b}	0.524±0.0173^{ab}	0.584 ±0.010^{a}
BL(CM)	1	6.410±0.177$^{N.S}$	6.450±0.116$^{N.S}$	6.270±0.209$^{N.S}$	6.410 ±0.094$^{N.S}$
	4	11.160 ±0.82$^{N.S}$	10.910±0.167$^{N.S}$	10.920±0.19$^{N.S}$	11.140±0.139$^{N.S}$
	6	14.220±0.222^{a}	14.350±0.263^{a}	14.330±0.265^{a}	14.200 ±0.251^{a}
	8	15.600±0.385^{b}	15.600±0.385^{b}	16.500±0.433^{ab}	17.020 ±1.255^{a}
CG(CM)	1	6.390±0.198$^{N.S}$	5.910±0.200$^{N.S}$	6.170±0.752$^{N.S}$	5.970±0.586$^{N.S}$
	4	10.290±0.065$^{N.S}$	10.150±0.005$^{N.S}$	10.260±0.177$^{N.S}$	10.180±0.916$^{N.S}$
	8	16.010±0.545$^{N.S}$	16.280±0.396$^{N.S}$	16.200±0.667$^{N.S}$	16.200±0.667$^{N.S}$
SL(CM)	1	2.230±0.085$^{N.S}$	2.310±0.202$^{N.S}$	2.300±0.051$^{N.S}$	2.290±0.096$^{N.S}$
	4	4.980±0.129$^{N.S}$	5.000±0.210$^{N.S}$	5.000±0.066$^{N.S}$	4.940±0.106$^{N.S}$
	8	6.880±0.196^{ab}	6.500±0.290^{b}	6.500±0.290^{b}	7.360±0.160^{a}

Table 1: Descriptive Statistics for Biometric and Allometric Traits of Four Genetic Group of Nigerian Heavy Local Chicken Ecotype.

Means having different subscripts in the same row are significantly different (P<0.05).

The Table 1 above shows the means and standard error for biometric traits of 4 genetic groups of the Nigerian heavy local chicken ecotype for four weeks. The mean result of the study on body weight of white, barred, black and golden strain for week 1,4,6,8 ranges from R0.036±0.002 to 0.038±0.002, 0.188 ±0.008 to 0.200±0.009, 0.312±0.014 to 0.370±0.017,0.516±0.256 to 0.584±0.010, respectively. There was no significant difference (P>0.05) in body weight of progenies of the four genetic group at week 1, they were statistically similar. However, at 6 weeks of age, there was significant differences (P<0.05) in the body weight of the progenies of the genetic group. The body weight of the white, barred and black strain was statistically similar and significantly higher (P<0.05) than bodyweight of progenies of white strain. At 8 weeks, there was significant difference (P<0.05), body weight values for progenies of golden, black and white strain was statistically similar and significantly higher than bodyweight value of progenies of barred strain.

The mean body length of the progenies of 4 genetic groups of the heavy ecotype local chicken for 4 weeks ranges from 6.410±0.094 to 6.450±0.116, 10.910±0.167 to 11.160±0.482, 14.200± 0.251 to 14.830±0.265, 15.600±0.385 to 17.020±1.255 respectively. There was no significant differences (P>0.05) in body length of progenies of the four genetic group at weeks 1,4 and 6, they were statistically similar. But at 8 weeks of age, there were significant differences (P<0.05) in the body length as body length values of progenies of barred, black and golden strain are statistically similar and significantly higher (P<0.05) than body length values of progenies of white strain. The mean and standard error for the chest girth of 4 genetic groups of heavy ecotype local chicken varies from 5.910±0.200 to 6.390 ±0.198,10.150±0.05 to 10.290±0.065, 16.010±0.545 to 16.280±0.396 respectively There was no significant difference (P>0.05) for the chest girth values observed at weeks 1 and 4, and week 8 of age. The mean outcome of the research on shank length for white strain, black strain, barred strain, golden strain were 2.230±0.085 to 2.310 ±0.200 for week one, 4.980±0.129 to 5.000±0.210,for week 4, 6.500±0.290 to 7.360±0.160 for week 8 respectively. No significant differences (P>0.05) were observed at week 1 and week 4. However, at week 8, the mean value of the shank length of progenies of golden strain, white strain were statistically similar and significantly higher (P<0.05) than the shank length values of the progenies of black and barred strain.

Heritability Estimates for Biometric Traits in 4 Strains of the Nigerian Heavy Local Chicken Ecotype (NHLCE).

Body weight: Table 2 below shows the heritability estimates for biometric traits in 4 strains of the Nigerian Heavy Local Chicken Ecotype (NHLCE).

The heritability of body weight ranged from low to high. Low (0.00) at week 1 and high (0.4) at 8 week. The result revealed that heritability estimates for body weight at week 1, 4, 6 and 8 were 0.00, 0.2, 0.36 and 0.4 respectively. It shows that body weight of heavy ecotypes were low at week 1, moderate at

week 4 and 6, and high at 8 weeks, indicating that selection of body weight of heavy ecotypes should be done at 8 weeks of age, and it reveals that mass selection at 8 weeks could lead improve their genetic performances.

Traits	Vs	Vt	Heritability
Bw(kg)			
Week 1	0	0	0
Week 4	0	0.02	0.2
Week 6	0.01	0.06	0.36
Week 8	0.01	0.09	0.4

Table 2: Heritability estimates for biometric traits of 4 strains of the Nigerian heavy local chicken ecotype.

Heritability Estimates for Allometric Traits in 4 Strains

The heritability estimates for allometric traits in 4 strains of the Nigerian Heavy Local Chicken Ecotype (NHLCE) are presented in the (Tables 3-5) below.

TRAITS	Vs	Vt	Heritability
BL(CM)			
Week 1	0.027	0.381	0.29
Week 4	0.061	0.857	0.28
Week 6	0.323	0.607	0.15
Week 8	0.184	1.791	0.4

Table 3: The heritability estimates for body length in 4 strains of the Nigerian heavy local chicken ecotype (NHLCE).

The result of the study revealed that the heritability for body length at week 1,4,6,8 of ages were 0.29 (moderate), 0.28(moderate), 0.15(Low) and 0.40(high) respectively. The heritability estimates of body length observed in this study ranged from 0.15(low) at week 6 and 0.40 (high) at 8 weeks of age and moderate(0.29,0.28) at week 1 and 4. The result shows that selection for body weight at 8 weeks could improve genetic performance of the heavy ecotype local chicken.

Traits	Vs	Vt	Heritability
CG(CM)			
Week 1	0.005	0.431	0.04
Week 4	0.007	1.09	0.25
Week 8	0.323	3.042	0.42

Table 4: The heritability estimates for chest girth in 4 strains of the Nigerian heavy local chicken ecotype (NHLCE)

Chest Girth: The result in Table 4 revealed that the heritability estimates for chest girth of heavy ecotype local chicken at 1, 4, 8 weeks were 0.04, 0.25 and 0.42. The heritability estimates of chest girth ranged low (0.04) to high (0.42) indicating that family/pedigree selection could be used at week 1, while mass selection could be used at week 8 for improved performance of the chicken population.

TRAITS	Vs	Vt	Heritability
SL(CM)			
Week 1	0.03	0.572	0.23
Week 4	0.09	0.838	0.44
Week 8	0.08	0.69	0.62

Table 5: The heritability estimates for shank length in 4 strains of the Nigerian heavy local chicken ecotype (NHLCE).

Shank Length: The heritability estimates of the study shows that the shank length of heavy ecotype local chicken at week 1, 4, 8 was 0.23, 0.44 and 0.62 respectively. Heritability estimates for shank length was moderate (0.23) at week 1, but high (0.44 and 0.62) at weeks 4 and 8. This study indicates that mass selection can be used to improve shank length of heavy ecotypes at the ages of 1, 4 and 8 weeks. The result obtained from 0 to 8 weeks in this study for biometric traits: body weight, body length, chest girth and shank length amongst four strains or genetic groups of the heavy ecotype local chicken namely white strain, black strain, barred strain and golden strain shows an increasing trend supporting that age is a major determinant of growth and physiological development. This report formally agrees with Momoh OM, et al. [5] that the body weight of the heavy ecotype local chicken ranges from 0.9kg to 2.5 kg.

Discussion

The average body weights of the brown and white strains of the NHLCE were higher than the average weight (560g) of four Egyptian dual-purpose chickens (Matrouh, Mandarah, Inshas, and Silver Montazah) [8]. Considerable direct additive genetic effects were found at week 4 and 8 for body length, chest girth and shank length. This seems to have contributed to high heritability estimate recorded in the study.

The heritability estimate of body weight at week 1 is in agreement with the report of Aslam, et al. [9] who reported 0.00 at day old to 6 days. It is lower than the value given by Frank, et al. who reported 0.02 and Ohagenyi IJ, et al. [10] who reported 0.2 in NHLCE. The heritability estimates at week four reported in this study was within the same range (0.21 and 0.25) reported by Ajayi FO [7], Ohagenyi IJ, et al. [10] and Ogbu CC, et al. [11] in NHLCE. It corresponds to El-Attrouny MM, et al. [8] and Ndofor-Foleng, et al. who reported 0.41 and

0.40 for Egyptian chicken and heavy ecotypes of Nigerian local chicken, respectively at week 8. However, it was higher than the values (0.26 and 0.35) given by Ogbu CC, et al. [11] and Ohagenyi IJ, et al. et al. [10] among the NHLCE and lower than the values (0.60) and (0.54) reported by Agu C, et al. [12] for heavy ecotypes and Osei-Amposah, et al. for the local chicken of Ghana at the age of 8 weeks. These differences in heritability estimates for body weight could be due to differences in strains of chicken used and environment; and equally establishes the fact that heritability is affected by population.

The heritability estimates for body length of NHLCE at weeks 4 and 8 were higher than the values (0.06 and 0.27) reported by Ohagenyi IJ, et al. [10]. The estimated heritability for body length (0.21) reported at week 4 of this study was lower than the value (0.28) reported by Udeh FU, et al. [13] however the value (0.46) reported at week 8 was slightly higher than the value (0.40) reported by the same authors.

On the body girth, heritability estimate was low (0.04) at day old, but higher than the value 0.08 reported by Udeh FU, et al [13] and agreed with the value (0.44) reported by same authors. The trend of this study is equally in tandem with the trend reported by Udeh FU, et al. [13], which revealed increasing heritability estimates with increasing age. These variations in the results could attribute to the statistical model, genetic groups, and the number of chickens used in the study [14].

The estimated value for shank length reported in this study at weeks 4 and 8 were higher than the values (0.23 and 0.18) reported by Ohagenyi IJ, et al [10], 0.02 and 0.51 Udeh FU, et al. [13] for NHLCE. The value obtained at 4 weeks was also higher than the value (0.03) reported by Udeh FU, et al. [15], but lower than the value (0.92) obtained by Adeleke MA, et al. [16]. The shank length and chest girth reported in this study at week 4 and week 6 are in contrast with the values reported by Ige AO [17] and Agbo CC, et al. [11], who reported a heritability estimate of 0.73 for shank length and 0.89 for chest girth in Fulani ecotypes. It is higher than the values (0.49 and 0.42) given by El-Attrouny MM, et al. [8] and Osei- Amposah, et al. for shank length at week 8 for Egyptian and Ghana local chicken, respectively. The existing Variances found in the estimated values could be due to environment (differences in techniques used, differences in strains of chicken used and management).

Generally, the heritability estimates for body weight fall within range of previously reported heritability estimates. This study also reveals that fitness traits such as BWT and SHL tend to have higher heritability estimates compared to traits that are not connected to reproductive efficiency of animals. The low heritability at younger ages indicates that body weight and other traits at these ages are to a very large extent a function of environmental factors. The implication of this is that the selection of traits of interest at younger ages may not result in any appreciable improvement; this explains why day old body weights were not heritable. The high heritability estimates for body weight, chest girth and shank length, as well as moderate to high heritability estimates for body length and chest girth implies that additive genetic variance made a greater contribution to the total phenotypic variance observed in the body weight, body length, chest girth and shank length compared to environmental and gene combination variance. It's an indication that variability due to additive gene action is probably higher than non-additive component, implying that a larger proportion of superiority of parents will be retained in the offspring and genetic progress can be made through mass selection. Selection should be carried out at ages where heritability estimates were high so as to ensure genetic improvement [18-25].

Conclusion

This study shows that the heavy ecotypes vary significantly in their biometric and allometric traits. The heritability estimates reported for traits studied (body weight, body length, chest girth and shank length) were low at 1 week old; low and moderate at 4 and 6 weeks of age, but high at the age of 8 weeks . High heritability estimate at week 8 is an indication that variability due to additive gene action is probably higher than non-additive component and implies that a larger proportion of superiority of parents will be retained in the offspring and genetic progress can be made through mass selection at week 8.

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