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Genetic Parameter Estimates of Guinea Fowl (*Numida Meleagris*) in South-South Region of Nigeria

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Abstract

This study aimed at estimating heritability and repeatability of body weight and somebody parameters of Nigerian guinea fowls. Forty eight dams mated to specific sires in a nested experimental design produced offspring identified sire lines. Data collected at 4, 8 and 12 weeks of age respectively were subjected to analysis of variance. The body traits were: body circumference, thigh length, shank length and breast length. Results showed that heritability for BWT ranged from 0.40 ─ 0.81, while repeatability estimates were at a range 0.20 ─ 0.40 at 8 -12 weeks of age respectively. Body circumference was estimated to be 0.66 ─ 0.84 heritable and 0.33 ─ 0.42 repeatable. Heritability for body weight and linear body traits generally increased with age. It was concluded that mass selection can be employed from eight weeks of age for the improvement of the guinea fowl given the high estimates obtained in this study.

Keywords: Poultry; Species; Indigenous; Body Weight; Linear Body Parameters; Improvement

Introduction

The performance of farm animals can be evaluated using various indices, especially the growth and development traits. Linear body measurements are heritable and play a major role in the subsequent carcass yield of the animal [1]. Heritability for a given trait refers to the amount of superiority of the parents above their contemporaries, which is passed to the offspring [2]. The knowledge of the heritability estimates of traits of interest is very crucial to the establishment of appropriate breeding programmes for the improvement of the traits. Information regarding heritability estimates of traits enables the breeder to predict expected response to selection [3]. Ibe asserts that it is a measure of the similarity of successive records that are made by an individual [4]. The author added that repeatability is a measure of an individual's ability to repeat its ranking in a population and successive records. A body weight heritability estimate of 0.49 was reported by Sanjeev, et al. for guinea fowl at 16 weeks of age [5]. Earlier on, Ayorinde and Ayeni estimated the heritability of body weight in Nigeria indigenous guinea fowl at 0.35 and 0.40 at 0 and 16 weeks of age respectively [6].

There is a dearth of information on the heritability and repeatability estimates for body weight and linear body measurements of Nigeria indigenous guinea fowls in extant literature. This study sets to provide information in this regard which will serve as a basis for selection and improvement of this wonderful poultry species.

Materials and Methods

The study was carried out at the Teaching and Research Farm of Animal Science Department, University of Calabar, Nigeria. Forty eight (48) dams were mated to specific sires in a nested experimental design and offspring produced were identified along the side lines. A total of 717 guinea fowl keets were obtained in six hatches and used for the study. Data collected on body weight (BWT) and linear body measurements (LBMs) at 4, 8 and 12 weeks of age respectively were subjected to analysis of variance using SPSS procedure [7]. The variance components were determined from the expected mean square of the analysis of variance. The following LBMs were taken using flexible tailor's tape and recorded in centimeters:

- Thigh length (TL) — distance from the beginning of the fibula to the hock joint.
- Shank length (SL) — distance from the beginning of the hock joint to the last ring before the tarse metatarsus digit 3.
- Breast length (BL) — distance from the point of depression to the sharp edge.
- Body circumference (BC) — the circumference of the bird around the chest region.

Estimation of heritability:

Heritability was estimated on sire variance components (δ^2_s) and error (δ^2_w).

.Heritability was computed using the model below:

$$h^2 = \frac{4\delta^2_s}{\sqrt{\delta^2_s + \delta^2_w}}$$

Where

δ^2_s = sire component of variance

δ^2_w = error component of variance

h^2 = heritability (narrow sense)

The standard error of heritability was computed thus:

$$SE = \frac{2\sqrt{2(1-t)^2\,[1+(k-1)t]^2}}{K\,(k-1)(N-1)}$$

Where:

$$t = \frac{\delta s^2}{\sqrt{\delta s^2 + \delta w^2}}$$

K = number of measurements per mating group = (150)

N = number of mating groups = 8

Estimation of repeatability:

Repeatability (R) values were estimated from the variances using the method of Becker (1984). Repeatability was computed using the following model:

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

Where:

Y_{ij} = Record of the j^th sire on the i^th individual

μ = Population mean

A_i = Effect of the sire

e_{ij} = Random error

Repeatability was computed as follows:

$$R = \frac{\delta_s^{\,2}}{\sqrt{\delta_s^{\,2} + \delta_w^{\,2}}}$$

$$SE = \frac{\sqrt{2(1-R)^2\,[1+(k-1)R]^2}}{K\,(k-1)(N-1)}$$

Where R = repeatability estimate

Results

Table 1 shows the least square means of body weight and linear body measurements of the indigenous guinea fowls. There was steady increment with age in all the parameters measured. The results of the estimation of heritability and repeatability of BWT and LBMs of the birds are presented in Table 2 and Table 3 respectively. The heritability and repeatability estimates for BWT of guinea fowls were negative and low at the 4th week of age (-0.01 and -0.01 respectively). Values of 0.40 and 0.20 were recorded at the 8th week of age for heritability and repeatability respectively. Very high estimate of heritability for body weight (0.81) was obtained at the 12th week of age, while repeatability for the same trait was estimated to be 0.40 at this age.

The heritability estimates for BC were high from 4-12 weeks of age in the guinea fowl. The values were 0.66, 0.71 and 0.84 at 4, 8 and 12 weeks of age respectively. The repeatability estimates were moderate, being 0.33, 0.36 and 0.42 at 4, 8 and 12 weeks of age respectively. The heritability and repeatability estimates for BL were very low at the 4th week of age. The values obtained were 0.02 and 0.01 respectively.

The heritability estimates for BL at the 8th and 12th weeks of age were moderate (0.53 and 0.58 respectively). The repeatability estimates were however, low (0.27 and 0.29) at the 8th and 12th weeks of age respectively. The estimates of heritability and repeatability for TL were very low (0.004 and 0.002 respectively) at the 4th week of age, but heritability for the trait was high (0.75), while repeatability for the same trait was moderately low (0.38) at the 8th week of age. At the 12th week of age, TL was estimated to be lowly heritable (0.26) and very lowly repeatable (0.13).

Very low heritability and repeatability estimates for SL were obtained at the 4th week of age (0.01 and 0.003 respectively). Values of 0.37 and 0.48 were obtained as heritability estimates for SL at the 8th and 12th weeks of age respectively. The repeatability estimates for SL at the same ages were 0.19 and 0.24 respectively.

Age (Weeks)	Parameter				
	BWT	BC	SL	TL	BL
4	172.67±	13.80±	3.64±	8.21±	7.07±
	2.86	0.82	0.31	0.07	0.08
8	463.19±	19.52±	5.03±	12.16±	10.99±
	8.06	0.15	0.03	0.08	0.09
12	783.63±	24.14±	6.30±	14.99±	13.85±
	10.51	0.13	0.04	0.08	0.1

Table 1: Least square means (±SE) of body weight and linear body measurements of guinea fowls.
SE= standard error, BWT= body weight, BC= body circumference, BL= breast length, TL =thigh length, SL = shank length.

Age (weeks)	Parameter				
	BWT(g)	BC(cm)	BL(cm)	TL(cm)	SL(cm)
4	-0.01±	0.66±	0.02±	0.004±	0.01±
	0.06	0.38	1.62	0.03	0.04
8	0.40±	0.71±	0.53±	0.75±	0.37±
	0.28	0.39	0.34	0.40	0.27
12	0.81±	0.84±	0.58±	0.26±	0.48±
	0.41	0.56	0.36	0.21	0.32

Table 2: Heritability estimates (±SE) of body weight and linear body parameters of guinea fowl.
SE= standard error, BWT= body weight, BC= body circumference, BL= breast length, TL =thigh length, SL = shank length.

Age (weeks)	Parameter				
	BWT(g)	BC	BL	TL	SL
4	-0.01±	0.33±	0.01±	0.002±	0.003±
	0.03	0.19	0.81	0.02	0.02
8	0.20±	0.36±	0.27±	0.38±	0.19±
	0.14	0.2	0.17	0.20	0.14
12	0.40±	0.42±	0.29±	0.13±	0.24±
	0.20	0.28	0.18	0.10	0.16

Table 3: Repeatability estimates (±SE) of body weight and linear body parameters of guinea fowl.
SE= standard error, BWT= body weight, BC= body circumference, BL= breast length, TL =thigh length, SL = shank length

Discussion

The heritability for BWT and LBMs in the present study generally increased with age. Similarly, Adeleke, et al. recorded a steadily increasing heritability in BWT, but not in LBMs, from 0-16 weeks of age, in Nigerian indigenous chickens [3]. On the contrary, Ojo, et al. reported a fluctuating trend in heritability estimates of BWT and LBMs from two to eight weeks of age in Hubbard broiler chickens [8]. Negative heritability estimate of BWT, at four weeks of age, was obtained in the present study. This was in disagreement with other authors at this age [3,9,10]. The heritability estimate for BWT at eight weeks of age, in the present study ($h^2 = 0.40$) was similar to the values reported, at the same age, by Sanda, et al. in Marshall broiler chickens ($h^2 = 0.46$), and Adeleke, et al. in Nigerian indigenous chickens ($h^2=0.39$) [3,11]. It was nevertheless higher than 0.26, 0.22 and 0.20 reported by Ohagenyi, et al. in Nigerian heavy ecotype chicken, Sanda, et al. in Ross broiler chicken and Adeyinka, et al. in naked neck broiler chickens respectively [9,10,11].

The high heritability estimate for BWT at 12 weeks of age obtained in the present study, is far higher than the values reported at the same age, by Adeleke, et al. in Nigerian indigenous chickens ($h^2 = 0.45$) and Ohagenyi, et al. in Nigerian heavy ecotype chickens (0.543) [3,10]. The differences between the study and the other reports could be due to differences in species, environmental effects, method of estimation as well as error due to small sample size. The high heritability estimates for BWT at 12 weeks of age, suggest that the application of mass selection at this age, will yield rapid genetic improvement in the guinea fowl. Progeny or pedigree selection may be appropriate methods to use if selection is to be made at four and eight weeks of age. The negative heritability for BWT at four weeks obtained in this study indicates that the observed variations in BWT at this age were mostly due to environmental effects, rather than genetic. The heritability estimates for BC was very high from 4 to 12 weeks of age. The values in the present study were higher than 0.28 and 0.16 reported by Sanda, et al. at 12 and 16 weeks of age respectively [11]. The high heritability estimates for BC imply that mass selection can be employed at any of these ages, for a fast genetic improvement of the trait in guinea fowl.

Low heritability estimates were obtained at four weeks of age for BL, TL and SL. This observation was in agreement with the reports of Ojo, et al. and Ohagenyi, et al. [8,10]. Adeleke, et al. equally reported low heritability estimates of BL and TL (0.1 and 0.12 respectively) at the fourth week of age, but a high heritability estimate (0.92) for SL at this age [3]. The moderate to high heritability estimates obtained from 8 to 12 weeks of age in BL, TL, and SL suggest that the observable variations in these traits were attributable more too additive genetic effects, than environmental. These traits can therefore be improved by the mass selection method at these ages. Indirect selection methods, like index method, can be used for improvement when selection is made at the 4th week of age, on the bases of these linear traits.

Repeatability estimates for BWT and LBMs at four weeks of age were generally low, except for BC. This observation negates the report of Obike, et al. who recorded repeatability estimate (R) range of 0.62 – 0.87 in medium body weight line of Japanese quails, at the same age [12]. Ojedapo reported R estimate range of 0.282 – 0.813 for BWT and LBMs in Marshall broiler chickens at four weeks of age, whereas, Sanda, et al. obtained low to moderate R estimates (0.04 – 0.66) of BWT and LBMs in Ross strain of broiler chickens [11,13]. At 8 and 12 weeks of age, R estimates for BWT and LBMs were low and moderate respectively. The negative R estimate for BWT at four weeks of age obtained in this study was a reflection of high environmental input to the total variance component of the birds at this age. The negative R estimate disagreed with the reports of previous researchers in other species of poultry (0.59, 0.032 and 0.51 by Ojo et al., Ojedapo and Obike, et al. respectively) [8,12,13]. Ojedapo reported a repeatability estimate for BWT at 8 weeks of age, which is similar to the present study [13]. Moderate R estimate (0.55) for BWT was reported by Ojo, et al. in Hubbard broiler chickens at the same age, while very high values (0.90, 0.86, and 0.81) were reported by Kabir, et al. and Sanda, et al. in broiler chickens [8,11,14].

Moderate (0.33 to 0.42) R estimates for BC were obtained in the present study. These values fall within the range (0.20 to 0.62) reported by Sanda, et al. in three strains of broiler chickens [11]. Ojo, et al. reported high and moderate R estimates (0.80 and 0.48) for BC at four and eight weeks of age respectively in Hubbard broiler chickens [8]. A range of 0.90 to 0.99 was reported in four strains of broiler chickens between two to eight weeks of age, by Sola-Ojo and Ayorinde [1].

BL had R estimate range of 0.01 to 0.29 in the present study. These values were very much lower than the range of 0.63 to 0.85 reported by Obike, et al. in Japanese quails and 0.71 to 0.94 reported by Sola-Ojo and Ayorinde in four broiler strains. Ojedapo reported R estimate for BL range of 0.282 to 0.695 in Marshall broiler chickens [1,12,13].

TL exhibited low R estimates at 4 and 12 weeks of age (R = 0.002 and 0.13 respectively). A fairly moderate value (R = 0.38) was obtained at the eight week of age. This value corresponded with the report (R = 0.38) of Sanda, et al. in Marshall broiler chickens at the 10th week of age [11]. Ojedapo obtained R estimates for TL of 0.386 and 0.666 at four and eight weeks of age respectively, in Marshall broiler chickens [13].

Low R estimates (0.003 to 0.24) were obtained for SL in the present study. These values were lower than the range (0.136 – 0.382) reported by Ojedapo, (0.71 – 0.92) reported by Obike, et al. and (0.36 – 0.64) reported by Sanda, et al. [11-13]. It is imperative to note that the highest repeatability estimates for BWT and LBMs obtained in this study were at the 12th week of age (except in TL), while the lowest R values were obtained at the fourth week of age. This trend of increasing repeatability estimates in BWT and LBMs with age, corroborates the report of Kabir, et al. [14]. The low to moderate repeatability estimates obtained in this study, suggest that larger number of records are required to estimate the potential of guinea fowls and to realize a high expected response from selection. This is in agreement with the assertion of Falconer that in order to realize a high expected response from selection fewer number of records are required for traits with high repeatability estimates, while larger number of records are required for traits with low repeatability estimates [15].

Repeatability estimate still remains a useful tool for predicting the performance of individuals, especially when they are still young, as well as a guide to selection. This is in view of the fact that it allows for the assessment of the individuals' performance ahead of time.

Conclusion

Based on the findings of this research it can be concluded that mass selection may be employed from eight weeks of age for the improvement of the guinea fowl given the high heritability and repeatability estimates obtained. The heritability and repeatability estimates obtained in the present study can serve as base line information in the selection and improvement of the guinea fowl.

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