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VARIANCE COMPONENTS AND HERITABILITY OF SOME GROWTH PARAMETERS IN PUREBRED NIGERIAN INDIGENOUS CHICKENS

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ABSTRACT

The objectives of the study were to evaluate growth performance (body weight, BW; body weight gain, BWG; feed intake, FI; and feed:gain ratio, F:G) in a population of purebred Nigerian indigenous chicken (NIC) and to determine the variance components and additive genetic heritability of BW, BWG, and F:G in this population. Data were collected from a total of 500 purebred NIC (G_1 generation) produced from 5 sire groups (1 cock:10 hens) established from a foundation stock (G_0 generation) made up of mature hens and roosters (≥ 39 weeks of age) maintained in the Teaching and Research Farm of the Department of Animal Science, Enugu State University of Science and Technology, Enugu. On hatching, the chicks were identified according to sire group using wing bands. They were brooded and reared together on deep litter from hatch to 8 wk of age and thereafter separated into sire groups and then reared to sexual maturity (20 wk). Data on BW, BWG, FI and F:G were collected from hatch to 20 weeks of age and subjected to Analysis of Variance (ANOVA) using a sire model (paternal half-sib analysis). Sire component of variance was determined for BW, BWG, and F:G and used to calculate the additive genetic heritability for the traits. There were significant ($P<0.05$) sire effect on BW, BWG, and F:G across the age periods but not FI. Sire (σ_s^2) and additive genetic (σ_A^2) variances increased rapidly during the early phase of growth (0-12 wk) compared to later age periods. Additive genetic heritability (h_A^2) ranged from 0.28 ± 0.24-0.71 ± 0.47, 0.63 ± 0.53-0.77 ± 0.58 and 0.56 ± 0.50-0.79 ± 0.61 for BW, BWG, and F:G, respectively. It was concluded that BW, BWG and F:G varied significantly in NIC population and would respond to selection for genetic improvement.

Keywords: Nigerian indigenous chicken, variance components, additive genetic heritability, growth parameters, purebred.

INTRODUCTION

The Nigerian indigenous chicken (NIC) is known to adapt and produce valuable products (meat and egg) under variable environments and low external input. The productivity of local chickens is however constrained by adverse environmental factors such as unfavourable climatic conditions (Ali *et al.,* 2000; Islam and Nishibori, 2009), and poor genetic profile (Alexander, 2001; Mengasha *et al.,* 2008a; Ogbu, 2012). The NIC attains a body weight of less than 1 kg at sexual maturity (20-24 weeks of age) (Nwosu and Asuquo, 1985; Ebangi and Ibe, 1994). Such growth performance is unattractive to investors in poultry production hence the neglect of the NIC for poultry production when profit is the goal. The native poultry population contains genotypes that vary in productive potentials as well as those that exhibit major gene effects (Merat, 1990; Islam and Nishibori, 2009; Oke, 2011) which also influence productivity (Warnoto and Triadi, 2009; Fassill *et al.,* 2010). Improved local poultry production is necessary to achieve a poultry industry that is both economically viable and self sustaining. The performance of the NIC can be improved through directional selection and improved management and nutrition. Selecting and concentrating favourable indigenous poultry genes that confer productive adaptability (Nwachukwu *et al.,* 2006a, b) will greatly enhance productivity. To effectively utilize existing local poultry resources to improve poultry production, knowledge of the degree of genetic variation in productive traits in populations of NIC as well as the proportion of the total variability that is due to additive genetic effect is very necessary. Variance component estimation enables the breeder to understand the genetic mechanisms underlying performance in animal populations. It enables the prediction of breeding values of animals for traits of interest, aid the construction of selection indices used as unbiased predictors of merit, and in the optimization of breeding programmes. Estimates of sire component of variance reflect the additively determined portion of the total genetic variance while estimates of additive genetic heritability reflect the degree of inheritance uncompounded by genetic interaction, maternal effects and uncontrolled environmental effects (Becker, 1992). In addition, additive genetic heritability enables unbiased estimates of the breeding values of farm animals and so its estimation is central to the design and implementation of animal breeding plans and in making predictions of direct and correlated responses to selection.

The estimation of genetic parameters especially additive genetic heritability is therefore essential for designing effective selection programmes for the improvement of the NIC and in determining the appropriate age at which to execute the selection programme to achieve optimal selection response. Estimates of additive genetic heritability for productive traits of the NIC have been documented by some workers

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(Nwosu and Asuquo, 1985; Adedeji *et al.,* 2004; Ndofor-Foleg *et al.,* 2006; Adeleke *et al.,* 2011) however; these estimates pertain to particular populations, time period, management and production environments. Genetic variances and heritability estimates are characteristics of the particular population that provided the data for their estimation as well as the time period, management and production milieu in which they were estimated. Literature values hence provide a broad idea of the range of values for the parameters in different environments and production systems but may not adequately substitute estimates made *in* situ and intended for use in selection schemes that pertain to a particular population. This is especially so where, like in Nigeria, lack of large data sets (consistently kept over years and generations) do not permit estimates that could suffice for most practical situations. The objectives of the present study were therefore to evaluate the growth performance, feed intake and feed:gain ratio of first (G_1) generation pure bred population of the Nigerian indigenous chicken (NIC) and to estimate the variance components and additive genetic heritability of body weight, body weight gain and feed:gain ratio at various ages in this population.

MATERIALS AND METHODS

Location of study: The study was carried out at the Poultry Unit of the Teaching and Research Farm of the Department of Animal Science, Enugu State University of Science and Technology, Enugu.

Experimental animals (base population): A total of 75 sexually mature (≥ 20 week of age) NIC (65 hens and 10 cocks) obtained from rural households and markets in Ebonyi and Enugu States and established for teaching and research formed the base population (foundation stock or G_0 generation) from which the experimental birds (G_1 generation) were produced. The birds were housed in groups of 5 - 10 according to sex in deep litter pens bedded with wood shavings. They were fed layers mash (125g/bird/day) and cool clean water provided *ad libitum* and received routine vaccinations against Newcastle and pox diseases as well as anthelmintic and antibiotic medications as and when due. They were also dusted with acaricide powder against ectoparasites at 8 and 16 wk of age, respectively. At the commencement of the present study, 5 cocks and 50 hens were selected from the pool based on sound physical appearance and laying performance in hens. The hens were randomly assigned to the cocks in a ratio of 1:10 (cock: hen) to form 5 sire breeding groups (S_1 to S_5).

Production of G_1 generation: After about 2 weeks (wk) of adaptation and stabilization of mating, fertile eggs were collected twice daily for 7 days from each sire group and hatched in a locally made incubator (~ 65-70% hatchability; Udeh *et al.,* 2003) according to sire group. These birds made up the G_1 purebred generation that was assessed in the present study. On hatching, the chicks were identified according to sire group using wing bands. They were brooded and reared together on deep litter from hatch to 8 wk of age and thereafter separated into sire groups and then reared to sexual maturity (20 wk). The birds were fed chick mash (18% CP, 2800 KcalME/kg) from 1 day (d) to 8 wk of age and growers mash (16% CP, 2670 KcalME/kg) from 9 wk to 20 wk of age. Water was provided at all times to the birds.

Data collection and analysis: Birds were weighed at hatch and at 4 weekly intervals to obtain their body weights. Daily weight gain was calculated as the difference between consecutive body weights divided by the number of days in the interval. The daily feed intake of each group of birds was determined as the difference between quantity given and quantity of left over during a 24 h period. The daily intake per bird (g/bird/day) was then calculated as this difference divided by the number of birds in the group. The daily feed intake per bird was subsequently divided by the daily weight gain to obtain the feed: gain ration. Data collected were submitted to Analysis of Variance (ANOVA) in Completely Randomized Design (CRD) to test for effects of sire using the following model by Becker (1992).

$$X_{ij} = \mu + S_i + e_{ij}$$

where, X_{ij} is an observation, μ is the overall mean, S_i is fixed effect of the sire and e_{ij} is the error term or residual. Variance components were estimated using the paternal half-sib method (Cardellina and Siewerdt, 1992; Becker, 1992; Sharma *et al.,* 2013) as:

$$\sigma_s^2 = ¼\ C_oHS$$

where σ_s^2 is sire component of variance and C_oHS stands for covariance of half-sibs. The additive genetic variance (σ_A^2) was then obtained by noting that:

$$4\ \sigma_s^2 = C_oHS = \sigma_A^2$$

The additive genetic heritability (h^2_A) was then calculated using the expression:

$$h^2_A = 4\sigma_s^2/\ \sigma_s^2 + \sigma_w^2$$ (Cardellina and Siewerdt, 1992; Sharma *et al.,* 2013)

Where, σ_w^2 is error variance. The σ_w^2 was estimated by the mean square error (MSE) from paternal half-sib analysis of variance. The standard error for h^2_A was calculated using the relationship:

$$S.E.\ (h^2_A) = {}^4\sqrt{2(1 - t)^2[1+(k-1)t]^2/k(k - 1)(s - 1)}$$
(Koots and Gibson, 1996)

where, t is the intraclass correlation, k is average number of progeny per sire and s is number of sires. The intraclass correlation, t and average number of progeny per sire, k is given, respectively by:

$$t = \sigma_s^2/\ \sigma_s^2 + \sigma_w^2 \text{ and}$$
$$k = 1/s\text{-}1[n. - (\textstyle\sum n_i^2/n.)]$$ (Becker, 1992)

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where, s, σ_s^2, and σ_w^2 are as defined above, n_i is number of progeny for the i^{th} sire and n. is total number of progenies.

RESULTS AND DISCUSSIONS

The growth performance of the experimental birds (sexes combined) is presented in Table-1 according to sire groups. The Table reveals significant ($P < 0.05$) sire effect on growth performance across the age periods. At hatch, birds belonging to sire groups 1, 2, and 4 were heaviest compared to those of groups 3, and 5. The same trend was observed from wk 12 to 20 whereas in wks 4 and 8 the sire groups were most similar in their growth performance. The significant differences in hatch weight were probably due to differences in egg size which could be related to differential age and size of dams and/or laying potentials. Thus the superiority in hatch weight was not sustained between 4 and 8 wk of age probably because the positive maternal influence through egg size and egg quality waned during this period. The re-enactment of superior body weight from 12 to 20 wks by progenies of sires 1, 2, and 4 indicates significant influence of sire genetic potentials for growth from grower phase to maturity. It also indicates the presence of significant variation in growth potentials within the local chicken population which could be exploited for genetic improvement of the NIC (Ogbu and Omeje, 2011; Ogbu, 2012). Ogbu and Omeje (2011) showed that the Nigerian local chicken population could be segregated into body weight lines differing significantly in growth potentials.

Table-1. Effect of sire group on body weight (g) of Nigerian indigenous chicken at various age periods.

Age (wk)	**S_1**	**S_2**	**S_3**	**S_4**	**S_5**
0	27.06 ± 0.41^a	26.98 ± 0.43^a	25.56 ± 0.33^b	27.12 ± 0.32^a	25.68 ± 0.29^b
4	168.22 ± 3.36^{ab}	170.31 ± 3.86^a	160.36 ± 3.18^{ab}	177.33 ± 3.29^a	160.37 ± 3.17^b
8	331.67 ± 9.68^a	335.79 ± 10.89^a	311.42 ± 8.75^{ab}	332.95 ± 9.01^a	291.98 ± 6.65^b
12	671.42 ± 19.66^a	640.82 ± 18.66^a	591.79 ± 15.94^b	660.00 ± 18.92^a	564.60 ± 13.64^b
16	750.15 ± 25.65^a	794.33 ± 22.58^a	666.62 ± 18.34^b	759.86 ± 21.65^a	647.15 ± 17.37^b
20	937.88 ± 31.34^a	940.00 ± 26.08^a	831.50 ± 20.76^b	950.98 ± 22.05^a	821.95 ± 18.54^b
a, b: means in the same row having different superscripts are significantly different ($P < 0.05$).					

Overall values for BW reported in the present study for the various age periods closely agree with some of the values reported by other studies for indigenous chickens of Nigeria (Asuquo and Nwosu, 1987; Adedokun and Sonaiya, 2001; Ogbu and Omeje, 2011). For instance, average values calculated from the report of Momoh *et al.* (2010) for BW of heavy and light local chicken ecotypes at hatch, 4, 8, 12, 16, and 20 wks of age were 27.2, 148.0, 324.5, 640.0, 773.5 and 903.5g, respectively which substantially agree with our reported values of 26.48 ± 0.17, 167.44 ± 1.56, 320.06 ± 4.16, 624.83 ± 8.28, 779.64 ± 10.20 and 895.91 ± 11.40g for the same age periods, respectively. These values were intermediate compared to values for light and heavy ecotypes reported by Momoh *et al.* (2010). Ebonyi state is known to have large populations of the light local chickens but shares borders with Cross River state known to have large populations of the heavy strain. Inter regional marketing between states enable the distribution, spread and interbreeding of these strains thereby producing populations with tremendous variation in growth potentials.

Feed intake did not differ among sire groups except at the 16^{th} wk of age at which progenies of sire 5 surpassed other groups in feed intake (except sire 2) (80.94 ± 1.79 vs 78.36 ± 0.78g/bird/day, respectively, $P > 0.05$) (Table-2).

Table-2. Effect of sire group on daily feed intake (g) of Nigerian indigenous chickens at various age periods.

Age (wk)	**S_1**	**S_2**	**S_3**	**S_4**	**S_5**
4	18.72 ± 0.50	19.42 ± 0.55	19.15 ± 0.54	18.00 ± 0.52	17.84 ± 0.46
8	39.52 ± 0.85	40.50 ± 1.03	41.87 ± 0.90	42.22 ± 1.02	42.79 ± 1.12
12	69.59 ± 1.52	66.50 ± 1.29	67.82 ± 1.14	65.80 ± 1.77	70.87 ± 1.45
16	77.56 ± 0.76^b	78.36 ± 0.78^{ab}	77.31 ± 0.69^b	76.00 ± 0.94^b	80.94 ± 1.79^a
20	88.47 ± 1.80	88.94 ± 2.55	91.25 ± 1.39	91.04 ± 2.45	84.78 ± 1.80
a, b: different superscripts in the row are significantly different ($P < 0.05$).					

The similarity in feed intake among sire groups shows poor genetic variation for feed intake in the population used for the study and indicates that feed intake has poor genetic component (Ogbu and Omeje, 2011) and that it is most possibly strongly influenced by environmental factors (ambient temperature, type of diet,

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management practices) as well as differential growth rate). The predominantly non-significant differences in FI across sire groups is supported by previous studies involving indigenous chickens in Africa (Hassen *et al.,* 2006; Momoh and Nwosu, 2009; Reta, 2009). Progenies of sires 1 and 4 were higher (P < 0.05) in body weight gain (BWG) followed by those of sire 2 while progenies of sires 3 and 5 had the least (P < 0.05) BWG (Table-3).

Table-3. Effect of sire group on body weight gain (g) of Nigerian indigenous chickens at various age periods.

Age (wk)	**S_1**	**S_2**	**S_3**	**S_4**	**S_5**
0-4	6.85 ± 0.43^{ab}	6.21 ± 0.30^{bc}	5.58 ± 0.37^{c}	7.43 ± 0.41^{a}	5.65 ± 0.30^{c}
5-8	8.82 ± 0.35^{a}	8.28 ± 0.46^{ab}	7.00 ± 0.43^{b}	9.11 ± 0.49^{a}	7.46 ± 0.49^{b}
9-12	10.12 ± 0.54^{ab}	10.23 ± 0.45^{ab}	8.80 ± 0.50^{b}	11.19 ± 0.49^{a}	8.70 ± 0.39^{b}
13-16	5.79 ± 0.28^{ab}	6.23 ± 0.26^{a}	5.07 ± 0.37^{b}	6.51 ± 0.38^{a}	4.99 ± 0.41^{b}
17-20	7.93 ± 0.29^{ab}	7.03 ± 0.41^{c}	6.53 ± 0.64^{c}	8.73 ± 0.32^{a}	6.74 ± 0.33^{bc}
a, b, c: different superscripts in the row are significantly different (P < 0.05).					

BWG averaged 6.85 ± 0.43, and 7.43 ± 0.41g for sire groups 1 and 4, respectively compared to 5.58 ± 0.37 and 5.65 ± 0.30g for sire groups 3 and 5, respectively. For F:G, marked differences were observed across the age periods among the sire groups (Table-4).

Table-4. Effect of sire group on F:G of Nigerian indigenous chickens at various age periods.

Age (wk)	**S_1**	**S_2**	**S_3**	**S_4**	**S_5**
0-4	2.90 ± 0.21^{a}	3.27 ± 0.24^{ab}	3.71 ± 0.30^{b}	2.54 ± 0.21^{a}	3.26 ± 0.16^{ab}
5-8	4.61 ± 0.26^{a}	5.12 ± 0.35^{ab}	6.38 ± 0.43^{c}	4.80 ± 0.30^{a}	6.12 ± 0.46^{bc}
9-12	7.24 ± 0.53^{ab}	6.66 ± 0.30^{a}	8.07 ± 0.42^{b}	6.10 ± 0.46^{a}	8.36 ± 0.39^{b}
13-16	13.84 ± 0.74^{ab}	12.90 ± 0.59^{a}	16.90 ± 1.51^{bc}	12.14 ± 0.77^{a}	17.70 ± 1.41^{c}
17-20	11.38 ± 0.58^{a}	13.10 ± 0.73^{ab}	16.10 ± 1.66^{b}	10.59 ± 0.50^{a}	13.04 ± 0.78^{ab}
a, b, c: different superscripts in the row are significantly different (P < 0.05).					

Birds of sires 1 and 4 were most efficient in feed utilization at wk 4; those of 1, 4 and 2 at wk 8, 12 and 16 and progenies of sires 4, 1, 2 and 5 at wk 20. Thus among the sire groups progenies of sires 1, 2 and 4 were consistent in having lower (better) F:G compare to other groups and this corresponds to their higher rate of growth (higher BW and BWG). The results indicate that BW, BWG, and F:G are positively correlated and that selection for one could improve the other traits. Values reported for FI, BWG and F:G for local chickens in Nigeria and elsewhere are varied reflecting the wide variation in type of birds, management practices, age of birds evaluated, physiological status and experimental procedure. Whereas the values reported in the present study for FI, BWG and F:G were in good accord with those of Mupeta *et al.* (2002), Kingori *et al.* (2004), and Sarkita and Noor (2005), they were at variance with those of Haitook *et al.* (2003) for indigenous chickens of Thialand and Hassen *et al.* (2006) for the Fayoumi in Egypt. Hassen *et al.* (2006) reported FI of 24.0 - 34.2g between 0-4 wks of age, and 36.6 - 47.3g for 5-8 wks of age. The corresponding range for BWG and F:G were 3.3 - 4.2g and 6.1 - 9.6, respectively for 0-4 wk, and 8.8 - 11.5g and 36.4 - 47.3, respectively for 5-8 wks of age. These values were all higher than the values reported in the present study. In Nigeria Momoh *et al.* (2010) reported a range of 4.24 - 4.54 and 4.04 - 4.45g for BWG and F:G at 0-4 wks in heavy and light local chicken ecotypes and their reciprocal crosses which were different from the range of 5.58 ± 0.37 - 6.85 ± 0.43g (mean; 6.27 ± 0.18g) and 2.54 ± 0.21 - 3.71 ± 0.30 (mean: 3.18 ± 0.11) reported in the present study. Values for other age periods were also different (6.15 - 6.69g and 3.24 - 4.28 vs 7.00 ± 0.43 - 8.82 ± 0.35g and 4.61 ± 0.26 - 6.36 ± 0.43 for wk 4-8, 12.5 - 13.2g and 4.47 - 5.38 vs 8.70 ± 0.39 - 11.19 ± 0.49g and 6.10 ± 0.46 - 8.36 ± 0.39 for 8-12 wk etc). These results reflect the tremendous variation in performance attributes of Nigerian indigenous chickens and these variations constitute raw materials for genetic improvement. The observed significant variation among sire groups in BWG and F:G reflect strong genetic influence on these traits and shows that the performances of the local chicken population in these traits would respond readily to directional selection.

Mean square sire (MS_S) was significant (P<0.01, 0.001) for BW, BWG and F:G across the age periods (Table-5).

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Table-5. Components of variance for BW, BWG, and F:G in population of Nigerian indigenous chicken (NIC) at various age periods.

		Variance estimates				
Age (wk)	**Parameter**	**MS$_S$**	σ_s^2	σ_A^2	σ_w^2	σ_p^2
0	BW	31.152***	0.494	1.976	6.456	6.950
	BWG	NA	NA	NA	NA	NA
	F:G	NA	NA	NA	NA	NA
4	BW	2276.956***	42.107	168.428	484.725	526.832
	BWG	8.876***	0.467	1.868	1.992	2.459
	F:G	2.845**	0.136	0.544	0.842	0.978
8	BW	13752.369***	272.438	1089.752	3148.236	3420.674
	BWG	11.999**	0.614	2.456	2.949	3.563
	F:G	9.925***	0.528	2.112	2.151	2.679
12	BW	81611.747***	1834.874	7339.496	11617.536	13452.410
	BWG	15.646***	0.826	3.304	3.479	4.305
	F:G	12.594***	0.668	2.672	2.746	3.414
16	BW	146698.083***	3533.157	14132.628	16429.624	19962.781
	BWG	6.508**	0.331	1.324	1.759	2.090
	F:G	86.975***	4.726	18.904	16.889	23.857
20	BW	147372.455***	3663.902	14655.608	19795.376	23459.278
	BWG	11.172**	0.624	2.496	2.707	3.331
	F:G	64.410***	3.650	14.60	14.895	18.545

MS$_S$: Mean square sire, σ_s^2: variance due to sire, σ_A^2: additive genetic variance, σ_w^2: residual variance, σ_p^2: phenotypic variance, **, ***: significant at P<0.01 and 0.001, respectively, NA: not applicable.

This indicates significant sire variance for the traits and shows that selection of sires for improvement in the traits would yield rapid genetic progress. The result also means that there is significant additive genetic variation in the traits to allow for genetic improvement through selection. The Sire (σ_s^2) and additive genetic (σ_A^2) variances for BW, BWG and F:G. increased progressively and rapidly from hatch to 12 wk of age but became slow as the birds attained sexual maturity from 16 to 20 wks of age. This observation is in agreement with the reports of (REF) that the local chicken exhibits a biphasic growth pattern namely an auto-accelerating phase of growth (0-12 wk of age) and an auto-decelerating phase of growth (> 12 wk of age). For instance σ_s^2 was 0.494 for hatch weight but 42.107 for BW at wk 4 (> 98% increase), 272.438 for BW at 8 wk (85% increase), 1834.874, 3533.157, and 3663.902 for BW at 12, 16 and 20 wk, respectively or increases of 85, 48 and 3.6%, respectively from one age period to the next. Similar increases in error (σ_w^2) and phenotypic variances (σ_p^2) with age were also observed. The rapid increases in sire and additive genetic variances from the very low value of 0.494 at hatch to 3663.902 by wk 20 for σ_s^2 and 1.976 at hatch to 14655.608 (≈100% increase) at 20 wk for σ_A^2 could arise from individual bird differences in the number of genes (quantitative trait loci) that affect growth performance, the interaction among these genes, and between the genotypes and the environment all of which contribute to the variance of quantitative traits like BW, BWG and F:G (Deep and Lamont, 2002). It has been reported that different stages of growth in chickens are controlled by different sets of genes (Carlborg *et al.,* 2003; Kerje *et al.,* 2003; Carlborg *et al.,* 2006) and genetic effects (Carlborg *et al.,* 2003; Carlborg and Haley, 2004). Individual differences in the distribution and frequency of growth genes and the age at which each gene comes to expression would be expected. The increases in residual (error) and phenotypic variances follow from increases in σ_s^2 and changes in environmental variance with age of the birds. Gowe and Fairfull (1985) had reported that environmental variance experiences relatively large increases with age compensating for reductions in additive genetic variation. From the observations, it does appear that mean and variances for growth are positively correlated in chickens (Ogbu and Omeje, 2011). The increases in variances with age and BW values were not observed with regards to BWG and F:G probably because these traits do not show linear increases with age as does BW values. Values of variance components for different measures of growth and feed efficiency in Nigerian indigenous chickens are scarce in literature. Furthermore, the few estimates available vary widely being influenced by genotype and a myriad of environmental factors that do not permit meaningful comparisons across distinct production populations and environments. This notwithstanding, the reported increases in the variances with age are supported by the reports of Ogbu (2012a) who reported increasing within and between line variances with age in two generations of the Nigerian indigenous chickens.

The values for additive genetic heritability (h_A^2) for BW, BWG and F:G (Table-6) show that h_A^2 was 0.28 ± 0.24 - 0.71 ± 0.47 for BW from hatch to 20 wk of age. The corresponding range for BWG and F:G was 0.63 ± 0.53 - 0.77 ± 0.58 and 0.56 ± 0.50 - 0.79 ± 0.61, respectively. Thus h^2_A was moderate to high for BW and generally high for BWG and F:G.

Table-6. Estimates of additive genetic heritability (h_A^2) for growth parameters of Nigerian indigenous chickens (NIC) at various age periods.

	Parameter		
Age (wk)	**BW**	**BWG**	**F:G**
0	0.28 ± 0.23	NE	NE
4	0.32 ± 0.24	0.76 ± 0.34	0.56 ± 0.30
8	0.32 ± 0.24	0.69 ± 0.32	0.79 ± 0.34
12	0.55 ± 0.30	0.77 ± 0.30	0.78 ± 0.35
16	0.71 ± 0.33	0.63 ± 0.33	0.79 ± 0.35
20	0.62 ± 0.32	0.75 ± 0.32	0.79 ± 0.35

BW: Body weight (g), BWG: body weight gain (g), F:G: feed:gain ratio, NE: not estimable.

These results are in agreement with reports of Adedeji *et al.* (2004), and Ndofor-Foleng *et al.* (2006). Adedeji *et al.* (2004) reported that heritability for growth traits in sire strains to 8 week of age were generally high while Ndofor-Foleng *et al.* (2006) reported average heritability values of 0.40 and 0.37 for heavy and light local chicken ecotypes of Nigeria, respectively. Ogbu (2012b) also reported range of estimates of additive genetic heritability in males of the Nigerian indigenous chicken as 0.24 to 0.59 from 12 to 20 wk of age and 0.13 to 0.25 for 39 wk of age over three generations. The low to moderate values for 39 wk was attributed to reduction in additive genetic variation for growth at this age period. On the other hand, Adeleke *et al.* (2011) reported a range of 0.05 at day-old to 0.45 at wks 12 and 16 for pure and crossbred Nigerian indigenous chickens. Heritability estimates are influenced by environmental factors. They vary widely among populations and changes over time hence it is regularly estimated as and when required even for the same population. The moderate to high values reported for BW and generally high values reported for BWG and F:G in the present study indicate that these traits are highly heritable and will respond favourably to directional selection for genetic improvement.

CONCLUSIONS

There were high sire and additive genetic variances in BW, BWG, and F: G that would support directional selection for genetic improvement in these traits in the NIC. Furthermore, BW, BWG, and F: G are moderately to highly heritable and could be combined in selection schemes for improved growth performance in the NIC.

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