Variation in growth performance of pure and crossbred meat type chickens

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Abstract

Genetic variation from a combination of four breeds of chickens (Anak Titan, Alpha, Giriraja and Normal indigenous chickens) were examined for importance of sire, dam, season and sex on growth traits using a Mixed-model Least-Squares and Maximum Likelihood computer program. The results show that sire and dam genotypes significantly ($P < 0.05$) affected growth. Anak Titan cocks and hens performed best in body weight (BW) with values ranging from 38.45 ± 0.74 g and 40.21 ± 0.66 g at day old to 1135.9335.67g and 953.38 35.38g at week 12 respectively. Normal indigenous and Alpha improved indigenous performed better in linear body parameters. Genetic correlation coefficients among parameters for all the breeds were generally high. Positive estimates ranged from 0.15 for breast girth (BG) and keel length (KL) at week four to 0.99 for BG-KL at week twelve, while negative values ranged from -0.783 for body weight (BW) and wing length (WL) at week four to -0.99 for BW-BG at week twelve. Heritability estimates for body weight ranged from 0.14 at week one to 0.63 at week four. It can be concluded that appreciable variation exists for growth traits among the strains of chickens. Such variations can be utilized for improvement in the present environment.

Key words: Genetic variations, Heritability, Growth traits, Chickens

Introduction

The Nigerian indigenous chicken has been described as slow growing, poor feed converters and poor meat animals (Nwosu and Asuquo, 1985). This is as a result of long-term natural selection for fitness in a harsh tropical and disease prevalent environment. The preponderance of the birds which population was put at 72,400,856 (RIMS, 1992), makes them

a focal point for researchers and also the source of raw materials from which sustainable protein supply can be developed within the nation. Series of reports on the characterisation of the local chickens revealed that they could be classified based on the occurrence of some major genes such as dwarf gene (*Dw*), naked gene (*Na*) and Frizzling gene (*Fr*) (Ikeobi *et al.*, 1996, Adebambo *et al.*, 1999). Large variations were also reported

to exist among the birds in growth and egg laying performance (Peters, 2000). These findings led to an agreement that the indigenous birds have great potentials for a meaningful genetic improvement (Omeje and Nwosu, 1983, Nwosu *et al.*, 1985, Ikeobi *et al.*, 1996, Adebambo, *et al.*, 1996, Peters, 2000).

Improvement of the birds can either be by selection or cross-breeding. Crossbreeding of the indigenous stock with exotic commercial birds will take advantage of artificial selection for productivity in the exotic birds and natural selection for hardiness in the indigenous birds. A good combining ability resulting from a choice of the best performing lines will end up reducing cost of production. The end result will be the production of birds that will be well-improved in growth rate, efficiency of feed conversion and reproductive traits without sacrificing adaptation to the local environment.

The present study aims to study the phenotypic and genetic variations existing in the growth performance of pure and crossbred meat type chickens produced from four parental populations. – Giriraja; an Indian dual purpose breed (G), Anak Titan (A); a commercial broiler breed, Nigerian improved indigenous poultry chicken, alpha (B) and the local chicken breed (N).

Materials and methods

Description of the environment

The research was carried out at the Poultry Breeding Unit of the University farm, University of Agriculture, Alabata road, Abeokuta. Alabata

is on latitude 7°10'N and longitude 3°2'E in Odeda Local Government Area of Ogun State, Nigeria. The area has a prevailing tropical climate with a mean annual rainfall of about 1037mm. The mean monthly ambient temperature ranges from 28°C in December to 36°C in February with a yearly average of 34°C. Relative humidity ranges from 60% in January to 94% in August with a yearly average of about 82%. The vegetation represents an inter-phase between the tropical rainforest and the derived savannah.

The experimental birds

The experimental birds comprised of 488 chicks from a combination of four breeds of chicken: the Indian bred Giriraja (G), the Anak (A) a broiler breed, the Nigerian-improved indigenous chicken types, alpha (B) and the local chicken (N). Birds were set along sire lines. They were wing tagged at day one, brooded for four weeks in brooder cages and then transferred to battery cages. All other routine management procedures were supplied.

Data collection

The chicks were wing-tagged along sire lines and weighed using a sensitive balance. The skeletal dimensions were taken on weekly basis till the chicks reached 10 weeks of age. The birds were reared together, but differences in the parameters due to sex, age, season and other factors were noted. Parameters measured on weekly basis for 10 weeks are:

Body Weight (BW): This was measured with the use of a sensitive scale.

<i>Breast Girth (BG):</i>	This was taken as the circumference of the breast around the deepest region of the breast. A tape rule was used in taking the measurement.	which showed that interaction of season and sex were not significant were expunged from the analysis. The following model was used for weekly analysis of all growth traits.
<i>Body Length (BDL):</i>	A tape rule was used to measure this. It was measured as the distance between the base of the neck and the pygostyle.	Model: $Y_{ijk} = \mu + S_i + D_j + X_k + E_l + SD_{ij} + SX_{kl} + SE_{il} + DX_{jk} + DE_{jl} + e_{ijk}$
<i>Wing Length (WL):</i>	The distance between the tip of the phalanges and the coracoid-humerus joint. A tape rule was used in taking this measurement.	Where, Y_{ijk} = Observed value of dependent variable μ = Overall mean S_i = effect due to i^{th} sire (i = Anak titan, Giriraja, Local, Alpha) D_j = effect due to j^{th} dam (j = Anak titan, Giriraja, Local, Alpha) X_k = effect due to k^{th} sex (k = male, female) E_l = effect due to l^{th} season (l = 1, 2, 3) SD_{ij} = effect of the interaction of sire and dam genotype SX_{kl} = effect of interaction of sire genotype and sex SE_{il} = effect of interaction of sire genotype and season DX_{jk} = effect of interaction of dam genotype and sex DE_{jl} = effect of interaction of dam genotype and season e_{ijk} = random residual error normally distributed with zero mean variance σ^2_e
<i>Tibia length (TL):</i>	This was measured from the junction of tibia and femur to the junction of the tibia and metatarsus.	
<i>Shank length (SL):</i>	This was taken as the distance between the hock joint to the tarsometatarsus. It was measured on the right leg of each bird with the aid of a tape rule.	

Statistical and genetic analyses

Analyses of variance

Effects of sire genotype, dam genotype, sex, age, season and sex were carried out using the general linear models procedure of the Statistical Analysis System program (SAS, 1999). The same program was used to correct for effects of batch by covariant relationship. Preliminary analyses

Genetic parameter estimates.

Mixed-model Least-Squares and Maximum Likelihood computer programme (Harvey, 1990) which uses Henderson's method 3 (Henderson, 1953) was used to estimate the variance components due to sire (σ^2_s) and error (σ^2_e) by equating computed mean squares to their expectations and solving for the components.

Heritability, genetic, phenotypic and environmental correlation estimates and their standard errors were obtained using the paternal half-sib correlation method of the VarComp procedure of Harveys computer programme (Harvey 1990). Heterosis among pure and crossbreds was estimated as the difference between average parental means of pure breed and means of crossbred offspring.

Results

Sire effect

The table of analysis of variance shows that sire genotype had a very high significant ($P<0.001$) effect on body weight (BW) at week 4, 8 and 12 but not at week 1. The table of means of body weight (BW) for weeks 1, 4, 8 and 12 (Table 1) showed that Anak sire had superior mean body weights of 38.45/0.74g, 280.50/7.86g, 707.73/16.54g and 1135.93/35.67g at weeks 1, 4, 8 and 12 respectively. This was followed by Giriraja with values of 34.33/1.01g, 218.91/6.19g, 665.45/18.08g and 1061.35/41.94g at weeks 1, 4, 8 and 12 respectively. The Normal indigenous chicken had the least BW with values of 33.0/0.51g, 179.75/6.53g, 484.79/12.07g and 809.46/20.14g at weeks 1, 4, 8 and 12 respectively.

Analysis of variance of effect on linear measurements show that sire genotype had significant ($p<0.05$) effects on breast girth (BG) at weeks 4, 8 and 12 but not at week 1. On Keel length (KL) and thigh length (TL) sire genotype had significant ($P<0.01$) effect at week 1, 4 and 8 but not at week 12. Analysis of variance for wing length (WL) showed that sire genotype showed

significance only at week 1 and 12 and it was not significant ($P>0.05$) on shank length through out the experimental period.

The table of means of breast girth (BG) (Table 1) for weeks 1, 4, 8 and 12 showed that Alpha sire had the highest values of 6.6/0.22cm, 11.15/0.36cm and 16.74/0.51cm for weeks 1, 4 and 8 respectively while the Normal indigenous cocks had the highest mean value of breast girth at week 12 (19.62/0.48cm). The least values of means of breast girth for sires were recorded for Anak titan at weeks 1, 8 and 12 with values 6.10/0.13cm, 15.14/0.23cm and 19.51/0.33cm respectively, while Giriraja sire had the least value of 10.48/0.15cm at week 4. The table of means of keel length (KL) (Table 1) for weeks 4, 8 and 12 showed that Normal indigenous sire had the highest values of 5.64/0.27cm, 9.61/0.40cm and 11.73/0.50cm respectively while the Alpha cocks had the highest mean value of keel length at week 1 (2.27/0.11cm). The least values of means of keel length for sires were recorded for Anak titan at weeks 1, 4 and 12 with values 1.39/0.05cm, 4.12/0.11cm and 9.8/0.43cm respectively, while Giriraja sire had the least value of 7.05/0.16cm at week 8.

Means of wing length (WL) (Table 1) for weeks 1, 4, 8 and 12 showed that Normal indigenous sire had the highest values of 5.93/0.13cm, 17.23/3.83cm, 21.97/5.05cm and 20.95/0.49cm respectively while the least values of means of wing length for sires were recorded for Anak titan at weeks 1, 8 and 12 with values 4.01/0.13cm, 13.97/0.39cm and 17.54/0.49cm respectively, while Giriraja sire had the least value of 9.34/0.22cm at week 4.

Table 1 shows means of Thigh length (TL) as affected by sires showed that Normal indigenous cocks had the highest values at weeks 1 and 12 with values 4.58 0.24cm and 13.07 0.34cm respectively while at weeks 4 and 8, Alpha cocks had the highest values of 7.02 0.31cm and 10.65 0.37cm respectively. The least values at weeks 4, 8 and 12 were recorded for Anak titan cocks. The values were 5.31 0.12cm, 8.04 0.17cm and 11.68 0.25cm respectively, while at week 1 Giriraja cocks had the least mean thigh length with value 2.95 0.04cm.

The table of means of Shank length (SL) (Table 1) as affected by sires showed that Giriraja had the highest values at week 1 of 2.1 0.03cm, Normal indigenous cocks had the highest values at weeks 4 and 8 with values 4.58 0.24cm and 13.07 0.34cm respectively while, Alpha cocks had the highest values of 8.78 0.48cm at week 12.

Dam effects

Dam genotype had significant ($P<0.001$) effect on BW throughout the experimental period. Dam genotype showed the same trend as sire genotype with Anak titan dam having the highest values of 40.21 0.66g, 285.73 8.69g, 594.89 17.72g and 953.38 35.38g at weeks 1, 4, 8 and 12 respectively (Table 1 to 4). Normal indigenous chicken had the least values of 30.38 0.8g, 179.75 6.53g, 484.79 12.07g and 809.46 20.14g at weeks 1, 4, 8 and 12 respectively.

Dam genotype showed significant ($P<0.05$) effect on breast girth (BG), keel length ($p<0.001$) and thigh length ($P<0.01$) through out the experimental period. Dam on the other hand was

significant on Wing length at weeks 1 and 12, while it was significant ($P<0.001$) at weeks 1 and 4 on shank length.

Giriraja dams had the highest values for breast girth (Table 2) of 10.20 0.15cm, 15.61 0.25cm and 19.62 0.38cm for weeks 4, 8 and 12 respectively, while Alpha had the highest at week 1 (6.83 0.37cm). The least means of breast girth were recorded for Anak titan at weeks 1, 4 and 8 with values 5.60 0.12cm, 10.20 0.15cm and 15.61 0.25cm respectively while Alpha had the least mean values of breast girth (19.49 0.28cm) at week 12.

Normal dams had the highest means of keel length (Table 2) throughout the experimental period with values of 1.95 0.06cm, 4.93 0.19cm, 8.61 0.3cm and 10.79 0.386cm for weeks 1, 4, 8 and 12 respectively. Alpha dams had the least values for weeks 8 and 12 (7.31 0.19cm and 9.71 0.29cm), Anak titan had least value at week 1 (1.57 0.11cm) and Giriraja had least values at week 4 (4.53 0.11cm).

Normal dams had the highest means of wing length (Table 2) for weeks 1, 4 and 8 with values of 5.23 0.12cm, 14.04 2.51cm and 18.73 3.36cm respectively, while Giriraja had the highest mean wing length at week 12. Anak titan dams had the least values for weeks 1 and 8 (4.66 0.25cm and 14.2 0.77cm), while Alpha dams had the least values at week 4 and 12 (9.31 0.21cm and 17.64 0.4cm).

Normal dams had the highest means of Thigh length (Table 2) for weeks 1, 4 and 8 with values of 3.88 0.17cm, 6.15 0.15cm and 9.63 0.23cm respectively while Giriraja hens had the highest

Table 1. Means of growth traits are affected by sire genotype at weeks 1, 4, 8 and 12

Age	Effects	N	Body weight	Breast girth	N	Keel length	Wing length	Thigh length	Shank length
1	Ausik	188	38.45 ± 0.74 ^a	6.10 ± 0.13 ^a	84	1.39 ± 0.045 ^a	4.01 ± 0.13 ^a	2.99 ± 0.05 ^a	2.0 ± 0.03 ^a
	Gerija	151	34.33 ± 1.01 ^b	6.51 ± 0.25 ^a	98	1.53 ± 0.06 ^b	4.55 ± 0.13 ^a	2.95 ± 0.04 ^a	2.09 ± 0.03 ^a
	Normal	99	29.93 ± 0.94 ^c	6.13 ± 0.18 ^a	99	2.25 ± 0.083 ^a	5.93 ± 0.13 ^a	4.58 ± 0.24 ^a	1.93 ± 0.06 ^b
4	Alpeu	50	33.02 ± 0.97 ^b	6.6 ± 0.22 ^a	50	2.27 ± 0.11 ^a	5.26 ± 0.22 ^a	3.97 ± 0.23 ^b	1.98 ± 0.05 ^b
	Ausik	161	280.5 ± 7.86 ^c	10.52 ± 0.16 ^b	75	4.12 ± 0.11 ^c	9.65 ± 0.28 ^b	5.31 ± 0.12 ^b	3.81 ± 0.07 ^a
	Gerija	142	218.91 ± 6.19 ^b	10.48 ± 0.15 ^b	93	4.16 ± 0.1 ^c	9.34 ± 0.22 ^b	5.42 ± 0.11 ^b	3.98 ± 0.09 ^a
8	Normal	89	177.05 ± 8.41 ^a	11.0 ± 0.22 ^a	89	5.64 ± 0.27 ^a	17.23 ± 3.83 ^a	6.81 ± 0.19 ^a	4.03 ± 0.1 ^a
	Alpeu	45	200.92 ± 13.78 ^b	11.15 ± 0.36 ^a	45	5.07 ± 0.19 ^b	10.13 ± 0.32 ^{ab}	7.02 ± 0.31 ^a	3.98 ± 0.12 ^a
	Ausik	135	707.73 ± 16.54 ^c	15.14 ± 0.23 ^a	66	7.14 ± 0.29 ^c	13.97 ± 0.39 ^d	6.09 ± 0.12 ^b	3.81 ± 0.07 ^a
12	Gerija	128	665.45 ± 18.08 ^b	16.16 ± 0.25 ^a	80	7.05 ± 0.16 ^b	14.35 ± 0.32 ^c	6.3 ± 0.16 ^a	3.98 ± 0.09 ^a
	Normal	76	473.14 ± 14.72 ^c	16.63 ± 0.3 ^a	76	9.61 ± 0.40 ^a	21.97 ± 5.05 ^a	6.51 ± 0.2 ^b	4.03 ± 0.1 ^a
	Alpeu	39	517.85 ± 25.06 ^b	16.74 ± 0.51 ^a	39	8.25 ± 0.28 ^a	15.45 ± 0.45 ^b	6.2 ± 0.24 ^{ab}	3.98 ± 0.12 ^a
	Ausik	73	1135.93 ± 35.67 ^a	19.51 ± 0.33 ^b	48	9.8 ± 0.43 ^b	17.54 ± 0.49 ^b	11.68 ± 0.25 ^b	8.19 ± 0.24 ^a
	Gerija	89	1061.35 ± 41.94 ^a	19.82 ± 0.24 ^{ab}	69	9.83 ± 0.26 ^b	18.78 ± 0.54 ^b	11.8 ± 0.27 ^b	8.62 ± 0.27 ^a
	Normal	89	800.84 ± 25.2 ^c	20.36 ± 0.31 ^a	50	11.73 ± 0.50 ^a	20.95 ± 0.49 ^a	13.07 ± 0.34 ^a	8.57 ± 0.29 ^a
	Alpeu	27	901.7 ± 47.11 ^b	19.62 ± 0.49 ^a	27	10.25 ± 0.32 ^b	17.73 ± 0.65 ^b	12.68 ± 0.38 ^a	8.78 ± 0.48 ^a

Values with different superscripts are significantly different ($P < 0.05$)

Table 2: Means of Growth traits as influenced by three genotypes at weeks 1, 4, 8 and 12

Age	Effects	N	Body weight	Beak length	N	Keel length	Wing length	Thigh length	Shank length
1	Awak	155	40.21 ± 0.66 ^a	5.60 ± 0.12 ^b	28	1.57 ± 0.11 ^a	4.66 ± 0.25 ^b	3.24 ± 0.17 ^b	2.14 ± 0.1 ^a
	Girija	83	35.28 ± 1.86 ^b	6.57 ± 0.18 ^a	83	1.6 ± 0.07 ^a	4.68 ± 0.17 ^b	3.20 ± 0.08 ^a	2.14 ± 0.04 ^a
	Normal	147	30.38 ± 0.8 ^c	6.46 ± 0.14 ^a	147	1.95 ± 0.036 ^a	5.23 ± 0.12 ^a	3.87 ± 0.17 ^a	1.87 ± 0.04 ^b
	Alpha	103	33.0 ± 0.51 ^b	6.83 ± 0.37 ^a	75	1.91 ± 0.12 ^a	4.71 ± 0.18 ^b	3.63 ± 0.19 ^a	2.07 ± 0.03 ^a
4	Awak	133	285.73 ± 8.69 ^a	10.20 ± 0.15 ^a	27	4.61 ± 0.20 ^a	9.93 ± 0.53 ^a	5.69 ± 0.22 ^b	4.15 ± 0.14 ^a
	Girija	68	265.18 ± 9.92 ^b	11.68 ± 0.23 ^a	66	4.53 ± 0.11 ^a	10.92 ± 0.27 ^a	6.0 ± 0.15 ^a	4.39 ± 0.11 ^a
	Normal	137	179.75 ± 6.53 ^c	10.78 ± 0.18 ^b	137	4.93 ± 0.2 ^a	14.04 ± 2.51 ^a	6.15 ± 0.15 ^a	3.81 ± 0.07 ^a
	Alpha	72	205.90 ± 7.43 ^b	10.46 ± 0.18 ^a	72	4.54 ± 0.16 ^a	9.31 ± 0.21 ^a	6 ± 0.22 ^a	3.85 ± 0.09 ^b
8	Awak	113	791.45 ± 19.19 ^a	15.61 ± 0.25 ^a	24	7.88 ± 0.54 ^b	14.2 ± 0.77 ^a	6.65 ± 0.28 ^a	4.15 ± 0.14 ^a
	Girija	59	636.53 ± 18.28 ^b	16.82 ± 0.3 ^a	57	7.60 ± 0.30 ^b	15.98 ± 0.32 ^a	6.43 ± 0.16 ^a	4.29 ± 0.11 ^a
	Normal	115	484.79 ± 12.07 ^c	16.0 ± 0.27 ^a	115	8.61 ± 0.30 ^a	18.73 ± 3.36 ^a	6.22 ± 0.15 ^a	3.81 ± 0.07 ^a
	Alpha	91	594.89 ± 17.72 ^b	15.75 ± 0.25 ^a	65	7.31 ± 0.19 ^a	14.41 ± 0.3 ^b	6.16 ± 0.17 ^a	3.85 ± 0.09 ^a
12	Awak	59	1311.85 ± 54.47 ^a	19.62 ± 0.38 ^a	24	9.86 ± 0.34 ^a	18.62 ± 1.37 ^a	11.33 ± 0.33 ^a	8.73 ± 0.36 ^a
	Girija	48	1027.5 ± 33.18 ^b	20.92 ± 0.29 ^a	46	10.67 ± 0.46 ^a	19.65 ± 0.53 ^a	12.53 ± 0.31 ^a	8.56 ± 0.28 ^a
	Normal	75	809.46 ± 20.14 ^c	19.51 ± 0.29 ^b	75	10.79 ± 0.38 ^a	19.31 ± 0.43 ^a	12.41 ± 0.25 ^a	8.33 ± 0.23 ^a
	Alpha	57	953.38 ± 35.38 ^b	19.49 ± 0.28 ^b	49	9.71 ± 0.3 ^a	17.64 ± 0.40 ^b	12.07 ± 0.37 ^a	8.7 ± 0.36 ^a

Columns with different superscripts are significantly different ($P < 0.05$)

mean Thigh length at week 12 (12.53 $\pm$ 0.31cm). The least mean of Thigh length for weeks 4, 8 and 12 was recorded among Anak titan hens with values of 5.69 $\pm$ 0.22cm, 8.51 $\pm$ 0.27cm and 11.33 $\pm$ 0.33cm respectively, while Giriraja hen recorded the least values at week 1 with mean Thigh length of 3.20 $\pm$ 0.08cm

Table 1 to 4 showed that Anak titan dams had the highest means of Shank length at weeks 1, 8 and 12 with values 2.14 $\pm$ 0.1cm, 6.65 $\pm$ 0.27cm and 8.73 $\pm$ 0.36cm respectively while Giriraja hen had the highest mean value of 4.29 $\pm$ 0.11cm at week 4. The least values at weeks 1, 4 and 12 were recorded among Normal indigenous hens with values 1.87 $\pm$ 0.04cm, 3.81 $\pm$ 0.07cm and 8.33 $\pm$ 0.23cm respectively, while at week 8 Alpha had the least mean value for shank length of 6.16 $\pm$ 0.17cm

Sex effects

Sex had significant effect on body weight only at weeks 4 and 8. The cocks had the highest mean values for body weight throughout the experiment with values of 35.56 $\pm$ 0.72g, 242.16 $\pm$ 5.91g, 648.79 $\pm$ 14.21g and 1048.60 $\pm$ 30.02g for weeks 1, 4, 8 and 12 respectively, while the hens had values of 34.17 $\pm$ 0.68g, 219.06 $\pm$ 7.03g, 602.82 $\pm$ 15.43g and 975.50 $\pm$ 31.83g for weeks 1, 4, 8 and 12 respectively (Table 3).

Sex showed no significant effect on breast girth and keel length throughout the experimental period. On wing length (WL) and thigh length

Sex showed significant effect only at week 2 and 4 respectively, while it was only significant on shank length at week 12.

The cocks had the highest mean values for breast girth (Table 3) throughout the experiment except at week 8. The values recorded were 6.41 $\pm$ 0.18cm, 10.72 $\pm$ 0.14cm and 19.9 $\pm$ 0.23cm for weeks 1, 4 and 12 respectively. The hens had the lower breast girth values of 6.15 $\pm$ 0.09cm, 10.62 $\pm$ 0.14cm, 15.8 $\pm$ 0.18cm and 19.73 $\pm$ 0.23 for weeks 1, 4, 8 and 12 respectively.

The hens had the highest mean values for keel length (Table 3) throughout the experiment with values 1.89 $\pm$ 0.06cm, 4.79 $\pm$ 0.18cm, 8.1 $\pm$ 0.25cm and 10.4 $\pm$ 0.29cm for weeks 1, 4, 8 and 12 respectively, while the cocks had the least values of 1.76 $\pm$ 0.06cm, 4.66 $\pm$ 0.10cm, 7.91 $\pm$ 0.23cm and 10.35 $\pm$ 0.29cm for weeks 1, 4, 8 and 12 respectively. The hens had the highest mean values for wing length (Table 3) at weeks 1, 2 and 8 with values 5.18 $\pm$ 0.12cm, 13.72 $\pm$ 2.39cm and 18.34 $\pm$ 3.06cm respectively, while the cocks performed better at week 12 with mean wing length of 19.04 $\pm$ 0.44cm. The hens had the highest mean values for thigh length (Table 3) at weeks 1, and 8 with values 3.63 $\pm$ 0.14cm and 9.38 $\pm$ 0.19cm respectively, while the cocks had higher values at weeks 4 and 12 with values 6.12 $\pm$ 0.14cm and 12.31 $\pm$ 0.23cm respectively.

The cocks had the highest mean values for shank length (Table 3) throughout the experiment with values 2.04 $\pm$ 0.03cm, 3.97 $\pm$ 0.06cm, 6.36 $\pm$ 0.11cm and 8.81 $\pm$ 0.22cm for weeks 1, 4, 8 and 12 respectively, while the hens had the least values 1.97 $\pm$ 0.04cm, 3.94 $\pm$ 0.07cm, 6.23 $\pm$ 0.14cm and 8.26 $\pm$ 0.2cm respectively.

Table 3: Means of Growth traits as affected by sex at weeks 1, 4, 8 and 12

Age	Effects	N	Body weight	Breast girth	N	Keel length	Wing length	Thigh length	Shank length
1	Male	253	35.56 $\pm$ 0.72 ^a	6.41 $\pm$ 0.18 ^a	174	1.76 $\pm$ 0.06 ^b	4.71 $\pm$ 0.11 ^b	3.58 $\pm$ 0.12 ^a	2.04 $\pm$ 0.03 ^a
	Female	235	34.17 $\pm$ 0.68 ^a	6.15 $\pm$ 0.09 ^a	157	1.89 $\pm$ 0.06 ^a	5.18 $\pm$ 0.12 ^a	3.63 $\pm$ 0.14 ^a	1.97 $\pm$ 0.04 ^a
4	Male	230	242.16 $\pm$ 5.91 ^a	10.72 $\pm$ 0.14 ^a	158	4.66 $\pm$ 0.10 ^a	10.17 $\pm$ 0.2 ^a	6.12 $\pm$ 0.14 ^a	3.97 $\pm$ 0.06 ^a
	Female	207	219.06 $\pm$ 7.03 ^b	10.62 $\pm$ 0.14 ^a	144	4.79 $\pm$ 0.18 ^a	13.72 $\pm$ 2.39 ^a	5.95 $\pm$ 0.12 ^a	3.94 $\pm$ 0.07 ^a
8	Male	196	648.79 $\pm$ 14.21 ^a	15.92 $\pm$ 0.20 ^a	135	7.91 $\pm$ 0.22 ^b	15.05 $\pm$ 0.26 ^b	6.36 $\pm$ 0.11 ^a	3.97 $\pm$ 0.06 ^a
	Female	182	602.82 $\pm$ 15.43 ^a	15.98 $\pm$ 0.18 ^a	126	8.1 $\pm$ 0.25 ^a	18.34 $\pm$ 3.06 ^a	6.22 $\pm$ 0.14 ^a	3.94 $\pm$ 0.07 ^a
12	Male	118	1048.60 $\pm$ 30.02 ^a	19.9 $\pm$ 0.23 ^a	93	10.35 $\pm$ 0.29 ^a	19.04 $\pm$ 0.44 ^a	12.31 $\pm$ 0.23 ^a	8.81 $\pm$ 0.22 ^a
	Female	121	975.50 $\pm$ 31.83 ^b	19.73 $\pm$ 0.23 ^a	101	10.4 $\pm$ 0.29 ^a	18.74 $\pm$ 0.38 ^a	12.14 $\pm$ 0.22 ^a	8.26 $\pm$ 0.2 ^a

Columns with different superscripts are significantly different (P<0.05)

Effect of season

Age and season had significant ($P<0.001$) effect on body weight through out the experimental period. The late dry season showed highest mean weight at age 1 and 4 (35.64 1.37g, 252.15 8.56g), while late wet showed highest mean weight at ages 8 and 12 (751.0 60.0g and 1155.5 148.5g), while late wet season had the least values of 28.89 1.95g and 751 60g for weeks 1 and 8 respectively and early wet season had the least values of 194.90 5.75g and 910.11 25.60g at weeks 4 and 12 (Tables 4).

Season and age had significant ($P<0.001$) effect on breast girth, keel length and thigh length through out the experimental period. They were significant on wing length (WL) at only weeks 1 and 12, while only significant on shank length at week 4.

The late dry season had the highest means of breast girth (Table 4) with values 7.67 0.13cm, 11.70 0.18cm, 16.35 0.23cm and 19.95 0.26cm for weeks 1, 4, 8 and 12 respectively, while the least season was late wet with values 4.59 0.07cm, 9.25 0.25cm, 15 0.5cm and 17.75 0.75cm for weeks 1, 4, 8 and 12 respectively.

Birds grew more in terms of keel length (Table 4) during the late wet season with values 5.75 0.75cm, 9 1cm and 13.8 0.8cm at weeks 4, 8 and 12 respectively, while at week 1 birds grew more in terms of keel length during the early wet season. The least growth was experienced at late dry season with values 1.31 0.04cm, 4.07 0.08cm, 6.55 0.11cm and 8.76 0.13cm at weeks 1, 4, 8 and 12 respectively.

Birds grew more in terms of wing length (Table 4) during the early wet season with values 5.51 0.1cm, 13.14 1.73cm and 18.14 2.26cm weeks 1, 4, and 8 respectively, while at week 12 birds grew more in terms of wing length during the late wet season. The least growth was experienced at late dry season with values 3.85 0.09cm, 9.34 0.19cm, 13.73 0.28cm and 16.91 0.49cm at weeks 1, 4, 8 and 12 respectively.

Table 4 shows that birds' thigh grew more during the late wet season with values 4.62 0.1cm, 8.5 0.5cm, 13.4 0.9cm and 17.5 0.5cm for weeks 1, 4, 8 and 12 respectively, while they grew less at late dry season with values 3.07 0.04cm, 5.18 0.1cm, 8.04 0.15cm and 11.06 0.19cm for weeks 1, 4, 8 and 12 respectively.

Birds' Shank (Table 4) grew more during the late wet season with values 2.28 0.06cm, 4.25 0.75cm, 6.75 0.75cm and 8.9 1.1cm for weeks 1, 4, 8 and 12 respectively, while they grew less at late dry season with values 3.89 0.08cm, 6.07 0.11cm and 8.07 0.13cm for weeks 4, 8 and 12 respectively, while at week 1, birds shank grew less at the early wet season with a mean shank length of 1.92 0.03cm.

Genetic correlation

The pooled weekly genetic correlation coefficients ' r_G ' among live bodyweight and other linear body measurements in Tables 5 to 8 showed that the values ranged from low to high. Correlation values between BW and other traits were generally negative with the exception of BW-BG, BW-SL at weeks one and four with values 0.91, 0.93 and 0.72, 0.65 respectively

Table 4: Means of Growth traits as affected by season at week 1, 4, 8, and 12

Age	Effects	N	Body weight	Thrust girth	N	Keel length	Wing length	Thigh length	Shank length
1	Late dry	112	35.64 ± 1.17 ^a	7.67 ± 0.13 ^a	112	1.31 ± 0.04 ^a	3.85 ± 0.09 ^a	3.07 ± 0.04 ^a	2.14 ± 0.03 ^a
	Early wet	210	31.54 ± 0.50 ^a	6.17 ± 0.11 ^a	210	2.11 ± 0.05 ^a	3.51 ± 0.1 ^a	3.84 ± 0.14 ^a	1.92 ± 0.03 ^a
	Late wet	9	28.89 ± 1.95 ^a	4.59 ± 0.07 ^a	9	1.46 ± 0.12 ^a	4.493 ± 0.06 ^a	4.62 ± 0.1 ^a	2.28 ± 0.06 ^a
4	Late dry	101	252.15 ± 8.56 ^a	11.79 ± 0.18 ^a	101	4.07 ± 0.08 ^a	9.34 ± 0.19 ^a	5.18 ± 0.1 ^a	3.89 ± 0.08 ^a
	Early wet	210	194.90 ± 5.74 ^a	10.62 ± 0.15 ^a	199	5.04 ± 0.14 ^a	13.14 ± 1.73 ^a	6.45 ± 0.12 ^b	3.99 ± 0.06 ^a
	Late wet	9	218.3 ± 5.5 ^a	9.25 ± 0.25 ^a	9	5.75 ± 0.75 ^a	11.25 ± 1.25 ^a	8.5 ± 0.5 ^a	4.25 ± 0.75 ^a
8	Late dry	88	590.59 ± 14.52 ^a	16.35 ± 0.22 ^a	88	6.55 ± 0.11 ^a	13.73 ± 0.28 ^a	6.07 ± 0.11 ^a	3.89 ± 0.08 ^a
	Early wet	182	534.78 ± 12.40 ^a	16.1 ± 0.22 ^a	171	8.74 ± 0.23 ^a	18.14 ± 2.26 ^a	6.4 ± 0.12 ^b	3.99 ± 0.06 ^a
	Late wet	8	751 ± 60 ^a	15 ± 0.5 ^a	8	9 ± 1 ^a	15.85 ± 0.15 ^b	6.75 ± 0.75 ^a	4.25 ± 0.75 ^a
12	Late dry	68	940.38 ± 24.17 ^a	19.95 ± 0.26 ^a	68	8.76 ± 0.13 ^b	16.91 ± 0.49 ^a	11.06 ± 0.19 ^b	8.07 ± 0.13 ^b
	Early wet	131	910.12 ± 25.04 ^a	19.81 ± 0.22 ^a	124	11.2 ± 0.28 ^b	19.94 ± 0.33 ^b	12.77 ± 0.2 ^b	8.77 ± 0.22 ^b
	Late wet	6	1156.5 ± 148.5 ^a	17.74 ± 0.75 ^b	6	13.8 ± 0.8 ^a	20.5 ± 0.5 ^a	17.5 ± 0.5 ^a	8.9 ± 1.1 ^a

Columns with different superscripts are significantly different (p < 0.05)

Table 5: Heritability, genetic and phenotypic correlation estimates for growth traits at week 1

	BW	BG	KL	WL	TL	SL
BW	0.14	0.21	-0.08	-0.19	-0.18	0.11
BG	0.91	0.24	0.01	0.05	0.05	0.26
KL	-0.92	-0.90	0.99	0.66	0.52	-0.02
WL	-0.93	-0.91	0.96	0.94	0.51	0.02
TL	-0.91	-0.91	0.97	0.98	0.97	-0.04
SL	0.93	0.76	-0.96	-0.88	-0.91	0.08

Heritability, genetic and phenotypic estimates in the diagonal, below the diagonal and above the diagonal respectively

(Tables 6 and 7). Correlation values of BG-KL, BG-WL and BG-TL at week four was least with values 0.15, 0.19 and 0.26 respectively. All other values were high ranging from 0.57 for KL-SL at week 4 to 0.99 for BG-KL at week twelve for the positive values. Values range from -0.78 for BW-WL at week four to -0.99 for BW-BG at week twelve for the negative values.

Phenotypic correlation

Tables 5 to 8 showed that phenotypic correlation values were generally low. Values range from low to high. The least value was -0.26 for BG-SL, while the highest was 0.66 for KL-WL.

Heritability

Estimates of heritability from sire component of variance for body weight for weeks one, four, eight and twelve are shown in Tables 5 to 8. The heritability values for body weight were generally

high and decreased with age with the exception of week 1 which had a low value of 0.14. Other values are 0.63, 0.59 and 0.44 for weeks four, eight and twelve respectively. Other traits show high heritability estimates with the exception of BG which had values ranging from 0.02 (week 4) to 0.24 (week 1) and SL which also had values ranging from 0.01 (week 4) to 0.08 (week 1). Heritability estimates for other traits also decreased with age.

Discussion

The importance of indigenous chicken has been reported by many scientists, especially in terms of fitness and adaptability to their environment. On the other hand report of poor production parameters has also been published.

Programs have been suggested to improve the indigenous chicken by introgression of

Table 6: Heritability, genetic and phenotypic correlation estimate for growth traits at week 4

	BW	BG	KL	WL	TL	SL
BW	0.63	0.22	0.03	0.06	-0.22	0.35
BG	0.72	0.02	0.36	0.45	0.33	0.12
KL	-0.9	0.15	0.72	0.64	0.52	0.43
WL	-0.78	0.19	0.95	0.99	0.45	0.31
TL	-0.83	0.26	0.98	0.8	0.94	0.06
SL	0.65	0.88	0.57	0.69	0.94	0.05

Heritability, genetic and phenotypic estimates in the diagonal, below the diagonal and above the diagonal respectively

Table 7: Heritability, genetic and phenotypic correlation estimate for growth traits at week 8

	BW	BG	KL	WL	TL	SL
BW	0.59	0.07	0.01	0.03	-0.03	0.37
BG	-0.92	0.14	0.10	0.54	0.46	-0.07
KL	-0.92	0.97	0.79	0.56	0.24	0.31
WL	-0.97	0.92	0.92	0.83	0.5	0.2
TL	-0.91	0.84	0.84	0.87	0.92	0.11
SL	-0.91	0.96	0.96	0.91	0.97	0.01

Heritability, genetic and phenotypic estimates in the diagonal, below the diagonal and above the diagonal respectively

Table 8: *Heritability, genetic and phenotypic correlation estimate for growth traits at week 12*

	BW	BG	KL	WL	TL	SL
BW	0.44	0.06	0.09	0.02	0.24	0.41
BG	-0.99	0.04	0.08	0.37	0.29	-0.26
KL	-0.91	0.99	0.36	0.48	0.36	0.31
WL	-0.92	0.97	0.98	0.5	0.33	0.02
TL	-0.91	0.95	0.98	0.83	0.31	0.34
SL	0.6	0.74	0.69	0.98	0.66	0.02

Heritability, genetic and phenotypic estimates in the diagonal, below the diagonal and above the diagonal respectively

genes from high producing exotic stocks thereby having a base of parents that retain fitness and adaptability genes and at the same time are economically productive (Akinokun, 1990). Four hundred and eighty eight (488) chicks resulting from crossing of four breeds of chickens (Anak Titan, Giriraja, Normal indigenous, Alpha (improved Normal indigenous for higher production)) were used to show the importance of sire, dam, season, batch and sex on body weight and linear body measurements.

Sire effect on growth

The sire contributes 50 percent of offspring gene and in chicken breeding, the sire to dam ratio ranges from 1:10 to 1:15. This means that a good cock with high breeding value can cause a fast genetic speed especially if at the level of great grand parent stock in a breeding company. As a

result of this, it is very important to get the true breeding value of every sire before going into breed improvement work.

The results of the present study show that sire had significant effects on growth traits. The exotic breeds performed better for body weight (Table 1 to 4), while the normal indigenous and Alpha improved indigenous performed better in the linear body parameters (Table 1 to 4). The indigenous birds are generally endowed for traits that will aid in fitness in the environment, like wide wing span for flight from predators, long shank lengths for speed. These are all adaptive traits for specific environment, while the exotics have been selected for improved body weight and shorter appendages. This was observed by Deeb and Lamont (2002) who reported that Shank length measurement in poultry though characterized by high heritability, when long

relative to their weight are considered unfit and a source of leg problems in heavy-bodied chickens. Therefore meat-type birds have been successfully selected for proportionally shorter shanks for many generations. This is also the case for other linear body parameters.

Dam effects on growth

Dam contributions to offspring performance have been emphasized most especially in terms of maternal environment. Analyses of traits show that dam effects were important on body weight and linear body parameters with results following the same trends as sires. The exotic chickens perform more in the body weight due to long term artificial selection; while indigenous perform more in the linear body parameters due to long term natural selection for fitness. Giriraja dams performed well at both body weight and linear body parameters showing its dual purpose abilities for fitness and productivity.

The low performance of the Alpha and normal indigenous chicken is expected since according to Ibe (1993), our indigenous chickens have gone through more of natural selection for adaptive genes to increase fitness in the tropical climate rather than artificial selection for productivity as in the exotics.

The Alpha improved indigenous strains performed better in the body weight and breast girth traits than the native strain most likely as a result of heterotic effects, since it is an improvement over the normal using an exotic breed. Among other growth traits Alpha and

Normal indigenous shared superiority over other exotic breeds.

Effect of season on growth

Season had effect ($P < 0.001$) on the growth pattern of most of the body parameters. This result is expected because the rates of growth of the different genotypes are not expected to be the same under varying environmental conditions. This is as a result of changes in environmental conditions: temperature, humidity, which had been reported by Perez (1989) to affect meat production viz a viz growth in poultry chicken.

Sex effects on growth

The weekly results of sex effects revealed that sex generally had effects at older ages (week 12) for most parameters. This is in line with the result of Ikeobi *et al.* (1996) who reported onset of sexual dimorphism being evident from week six to eight. Males generally had higher values than females in body weight, breast girth and shank length which is consistent with the results of Garcia *et al.* (1993) and Ikeobi *et al.* (1996). They all reported sexual dimorphisms in favor of males in the performance of strains of birds studied.

Genetic and phenotypic correlation

The genetic correlation coefficients of body weight and live body measurements were generally negative, significant ($P < 0.05$) and ranged from medium to high. This is in agreement with the results of Peters (2000) and Ebangi and Ibe (1994) who got medium to high genetic

correlation while working with the Nigerian indigenous chicken. This result suggests that direct selection for improvement in body weight would bring about a corresponding reduction in linear body measurements as a result of the correlated response at the different ages.

Heritability

The weekly Heritability estimates of body weight and other linear body traits as recorded in Table 5 to 8 revealed that Heritability (h^2) from sire component of variance are quite high. The Heritability estimates of this nature suggest that appreciable genetic progress can be made in these traits in the strains of chickens used and hence fast response to selection is expected. This result is in line with the result of Ebangi and Ibe (1994) that got a sixth week body weight heritability of 0.41.

Conclusion

The results of the present study showed that sire and dam genotypes significantly affected growth. The exotic breeds (Anak Titan and Giriraja) performed better for body weight, while the normal indigenous and Alpha improved indigenous performed better in the linear body parameters. A cross involving the exotics and indigenous will therefore be a good base population for improvement for meat production. Genetic correlations among parameters for all the breeds were generally high. This means selection for improved body weight will improve most other linear measurements. Heritability estimate for body weight from sire components of variance

was high showing selection a better method of improvement for body weight, while cross breeding will be better in improving for linear body measurements.

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