GENETIC, PHENOTYPIC AND ENVIRONMENTAL CORRELATION ESTIMATES AMONG PHYSICAL BODY TRAITS OF THREE TURKEY GENOTYPES

By

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Abstract

An experiment was conducted to determine the relationship between body weight and linear body measurements such as breast girth (BRG), body length (BDL), thigh length (TL), keel length (KL) and shank length (SL) of three turkey genotypes namely local, cross and exotic breeds. Sixty one turkey birds comprising mixed sexes were used for the experiment. Genetic, phenotypic and environmental correlations among the traits were determined.The genetic correlation among the traits were fairly low while the phenotypic and environmental correlations were highly positive, this may be due to non- additive gene effect and strong influence of the environment.Genetic correlations between the growth traits were generally positive. This means that as the body weight was increasing, a corresponding increase was expressed in other body measurements.

Keywords: Genetic, phenotypic, environmental, traits.

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Introduction

Estimating genetic parameters for various livestock traits has been a main topic of animal breeding during the past half century (Sang 2003). The live body weight and linear body measurements contribute significantly to the lifetime performance of the animal (Chineke 2005). Reports on body weight and linear body measurements have been documented and was found useful in quantifying body size and shape (Ibe 1989 ; Ibe and Ezekwe 1994). The associations among live body measurements were established through the examination of correlations among them. Studies of interrelationship among body measurements also find application in selection and breeding. The magnitude of the correlation between live body measurements and raw meat yield was reported to be a valuable indicator for selecting high meat yielding strains of turkey (MacNeil 1969).

There are three components of correlations namely genetic, phenotypic and environmental correlation. The genetic and environmental correlations among traits are important when selecting for net merit involving several traits. According to Ndjon and Nwakalor (1998), the response of these traits to selection is the combined result of direct selection for each trait and indirect selection caused by the genetic correlation between the traits.

The phenotypic correlation (rP) measures the degree to which two traits covary among individuals in the population. If two traits covary, it means that variance in one is related to variance in the other. The phenotypic correlation is made up of two

components: the genetic and environmental correlations. The genetic correlation estimates the degree to which two traits are affected by the same genes (pleiotropy) or pairs of genes. The environmental correlation (rE) estimates the degree to which two traits respond to variation in the same environmental factors (Conner, 2002).

This study therefore was designed to determine the relationships between body weight and linear measurements such as breast girth (BRG), body length (BDL), thigh length (TL), shank length (SL) and keel length (KL).

Materials and methods

Location of the study: The experiment was carried out in the poultry unit of the Teaching and Research Farm of the Federal University of Technology, Akure, Nigeria. The location is situated on 350.52m above sea level at latitude 7^0 14'N and at longitude 5^0 14'E. The vegetation of the area is that of the rainforest characterized by hot and humid climate. The mean annual rainfall is about 1500mm and the rain period is bimodal with a short break in August with mean annual relative humidity of 75% and mean temperature of 20^{o}C.

Experimental bird: Sixty one turkey poults (day old) consisting of 15 local (8 females and 7 males), 25 cross (15 females and 10 males) and 21 exotic (10 females and 11 males) breeds was used for this experiment.
The birds were randomly assigned to experimental units according to breed.

Feeding and Watering: The turkey poults were fed *ad libitum* with the formulated feed and clean drinking water. The proximate composition of the formulated feed were 12.23% moisture content, 9.92% ash, 7.41% crude fibre, 9.43% fat, 32.10% crude protein, 87.77% dry matter and 41.14% nitrogen free extract.

Data Collection

Basic information of genetic groups and sex were kept on each turkey bird in addition to live weight and body measurements at the 7^{th}, 8^{th}, 9^{th}, 10^{th}, 11^{th}, 12^{th}, 13^{th}, 14^{th} and 15^{th} weeks of age. The body measurements studied were the body weight (BDW), breast girth (BRG), body length (BDL), keel length (KL), thigh length (TL) and shank length (SL). Measurements were taken with the aid of a measuring tape and ruler. The description of the measurements is as follows:

Breast girth (BRG): This was taken as the circumference around the deepest region of the breast.

Body length (BDL): This was taken as the distance between the last cervical vertebrae before the thoracic vertebrae and the caudal vertebrae.

Keel length (KL): This was taken as the distance of the region of the sternum.

Thigh length (TL): This was taken as the distance between the patella (knee cap) and the posterior end of the tibia joining the tarso-metatarsus.

Shank length (SL) : This was taken as the length of the tarso-metatarsus from the anterior end joining the tibia bone to the first digit (hallux) of the digits (the foot).

Statistical analysis: Data taken on the body weight and linear measurements of the different turkey genetic groups was used to analyse for the genetic, phenotypic and environmental correlation estimates among the body weight and linear measurements using the mixed model least squares and maximum likelihood computer program of Harvey (1987).

Result

Genetic, Phenotypic and Environmental correlation estimates among the body measurements within the different turkey genotypes.

Correlations in the form of genetic, phenotypic and environmental among the measurements such as body weight (BDW), breast girth (BRG), body length (BDL), keel length (KL), thigh length (TL) and shank length (SL) within the local, cross and exotic turkey genotypes are presented in tables 1 to 3.

Correlation estimates among the body measurements for the local breed

The genetic correlations between BDW, BRG, BDL, KL, TL and SL ranged from a low value of 0.27rG (BDW/TL) to a moderate value of 0.48rG (BDW/KL) while that of phenotypic estimates ranged from a very high value of 0.83rP (BDW/BRG) to 0.93rP (BDW/KL) and for the environmental correlation, a high estimate range of 0.55rE (BDW/BRG) to 0.98rE (BDW/SL) was recorded while that of BDW/TL was overestimated. The correlation estimates between BRG, BDL, KL, TL and SL showed that the correlations (genetic, phenotypic and environmental) between BRG/BDL ranged from a low value of 0.29rG to a high value of 0.80rP, the correlations between BRG/KL ranged from 0.30rG to 0.81rP while that of BRG/TL ranged from a positively low value of 0.17rG to 0.8rP and BRG/SL ranged from 0.19rG to 0.77rP. The estimates between BDL, KL, TL and SL revealed a low genetic correlation of 0.34 for BDL/KL and a high value of 0.92 and 0.78 for phenotypic and environmental correlations respectively. A moderate genetic correlation of 0.34 and low values of 0.19 and 0.21 were recorded for BDL/KL, BDL/TL and BDL/SL respectively while a high phenotypic and environmental estimates were recorded for the three.

The estimates for KL/TL and KL/SL revealed low genetic correlation estimates of 0.20 and 0.22 respectively while the phenotypic and environmental correlations recorded high values. The genetic correlation estimates for TL/SL was as low as 0.12 while the phenotypic and environmental estimates were as high as 0.93 and 0.88 respectively. The general overview of these estimates revealed the importance of the environment on all the parameters.

Correlation estimates among body measurements for the cross breed

Table 2 shows correlations among the measured parameters for the cross bred. Generally, a low genetic correlation was recorded between all the parameters while a high phenotypic and environmental correlation was recorded.

The genetic correlation between BDW, BRG, BDL, KL, TL and SL ranged between 0.17(BDW/SL) and 0.23(BDW/KL). The phenotypic correlation ranged between 0.88 (BDW/BRG and BDW/BDL) to 0.92 (BDW/TL) while the phenotypic estimate ranged from 0.77 (BDW/BRG) to 0.85 (BDW/TL and BDW/SL). The estimate between BRG, BDL, KL, TL and SL showed a low range of genetic correlation estimate of 0.14 (BRG/SL) to 0.19 (BRG/KL) while the phenotypic correlation recorded a high value of between 0.84 (BRG/BDL) and 0.90 (BRG/TL) and the environmental correlation estimate ranged from 0.73 (BRG/BDL) to 0.82 (BRG/TL).

The genetic correlation between the BDL, KL, TL and SL ranged from 0.12 (BDL/SL) to 0.17 (BDL/KL), that of phenotype ranged from 0.85 (BDL/SL) and 0.89 (BDL/TL) while that of environment ranged from 0.76 (BDL/SL) and 0.81 (BDL/TL). The correlations between KL, TL and SL recorded a range of 0.16 (KL/SL) to 0.19 (KL/TL) for genetic, 0.89 (KL/SL) to 0.91 (KL/TL) for phenotypic and 0.81 (KL/SL) to 0.83 (KL/TL) for the environmental. The estimate between TL and SL revealed a low genetic estimate of 0.15, a high phenotypic estimate of 0.94 and similarly a high environmental estimate of 0.90.

Correlation estimates among body measurements for the exotic breed

Generally, the correlation estimates for the exotic breed showed a low value for the genetic estimates while the phenotypic and environmental estimates were high.

The estimates of genetic correlations between BDW, BRG, BDL, KL, TL and SL ranged from 0.03 (BDW/BDL) to 0.06 (BDW/BRG and BDW/KL). The phenotypic correlation ranged from 0.89 (BDW/BRG) to 0.94 (BDW/KL) while the environmental correlation estimate ranged from 0.85 (BDW/BRG) and 0.92 (BDW/KL).The estimate between breast girth and other linear measurements showed that the genetic estimate ranged from 0.04 (BRG/BDL) to 0.09 (BRG/KL), that of phenotypes were ranged 0.84 (BRG/BDL) and 0.86 for the others while that of environment ranged from 0.79 (BRG/KL) and 0.82 (BRG/TL and BRG/SL). The correlation estimate values between the body length and other linear traits revealed a genetic estimate range of 0.02 (BDL/TL and BDL/SL) to 0.04 (BDL/KL) while the phenotypes revealed a range of 0.86 (BDL/SL) and 0.88 (BDL/KL and BDL/TL) and an environmental estimate range of 0.83 (BDL/SL) and 0.86 (BDL/KL and BDL/TL). The estimate of genetic correlations between keel length and other linear traits ranged from 0.05 (KL/SL) and 0.06 (KL/TL), that of phenotype ranged from a high value of 0.87 (KL/SL) to 0.90 (KL/TL) and the environmental correlation estimates of 0.83 for KL/SL and 0.87 for KL/TL. The genetic estimate for TL/SL was 0.03, phenotype of 0.93 and environmental correlation estimate of 0.91.

Table 1: Estimate of genetic (G), phenotypic (P) and environmental (E) correlations among body measurements for the local breed

		BDW	BRG	BDL	KL	TL	SL
BDW	G		0.42	0.47	0.48	0.27	0.31
	P		0.83	0.90	0.93	0.92	0.89
	E		0.55	0.73	0.86	1.12	0.98
BRG	G			0.29	0.30	0.17	0.19
	P			0.80	0.81	0.80	0.77
	E			0.53	0.56	0.65	0.57
BDL	G				0.34	0.19	0.21
	P				0.92	0.89	0.83
	E				0.78	0.84	0.69
KL	G					0.20	0.22
	P					0.93	0.90
	E					0.92	0.84
TL	G						0.12
	P						0.93
	E						0.88
SL	G						
	P						
	E						

N.B: BDW: body weight, BRG: breast girth, BDL: body length, KL: keel length, TL: thigh length, SL: shank length, G: genetic correlation, P: phenotypic correlation, E: environmental correlation.

Table 2: Estimate of genetic (G), phenotypic (P) and environmental (E) correlations among body measurements for the cross breed

		BDW	BRG	BDL	KL	TL	SL
BDW	G		0.21	0.18	0.23	0.21	0.17
	P		0.88	0.88	0.91	0.92	0.90
	E		0.77	0.79	0.82	0.85	0.85
BRG	G			0.15	0.19	0.17	0.14
	P			0.84	0.87	0.90	0.87
	E			0.73	0.75	0.82	0.79
BDL	G				0.17	0.15	0.12
	P				0.88	0.89	0.85
	E				0.79	0.81	0.76
KL	G					0.19	0.16
	P					0.91	0.89
	E					0.83	0.81
TL	G						0.15
	P						0.94
	E						0.90
SL	G						
	P						
	E						

N.B: BDW: body weight, BRG: breast girth, BDL: body length, KL: keel length, TL: thigh length, SL: shank length, G: genetic correlation, P: phenotypic correlation, E: environmental correlation.

Table 3: Estimate of genetic (G), phenotypic (P) and environmental (E) correlations among body measurements for the exotic breed

		BDW	BRG	BDL	KL	TL	SL
BDW	G		0.06	0.03	0.06	0.04	0.04
	P		0.89	0.90	0.94	0.93	0.92
	E		0.85	0.88	0.92	0.91	0.90
BRG	G			0.04	0.09	0.06	0.05
	P			0.84	0.86	0.86	0.86
	E			0.81	0.79	0.82	0.82
BDL	G				0.04	0.02	0.02
	P				0.88	0.88	0.86
	E				0.86	0.86	0.83
KL	G					0.06	0.05
	P					0.90	0.87
	E					0.87	0.83
TL	G						0.03
	P						0.93
	E						0.91
SL	G						
	P						
	E						

N.B: BDW: body weight, BRG: breast girth, BDL: body length, KL: keel length, TL: thigh length, SL: shank length, G: genetic correlation, P: phenotypic correlation, E: environmental correlation.

Discussion

The genetic correlation estimates among the body measurements within the local and cross breeds revealed a range of 0.12 to 0.48, some were positively weak and some moderate, the exotic breed recorded a very low range of 0.02 to 0.09. This results disagreed with the report of Adeyinka *et al.* (2006) in a population of naked neck broiler chicken where high genetic correlation value range of 0.74 to 0.95 were recorded and Kabir *et al.* (2006) who reported a high genetic correlation between body weight and shank length in a male and female broiler line at 30 and 40 weeks of age. Chhabra *et al.* (1972) reported a highly positive genetic correlation (0.86) for live body weight and shank length at 20 weeks of age, but partially in agreement with the report of Sani *et al.* (1991), who reported a correlation estimate as low as 0.09 between body measurements at different weeks.

The phenotypic and environmental correlations were positively high which indicates that they could be simultaneously improved, the results corroborated with the findings of Adeogun and Adeoye (2004) who recorded a positively high phenotypic correlation estimates in Japanese quails and Jull and Glazener (1946), Reddy *et al.* (1993), Malik *et al.* (1997) and Adeyinka *et al.* (2006) who also recorded high phenotypic correlation estimates among body measurements of broiler chicken.

The higher values of correlation estimates (genetic, phenotypic and environmental) recorded by the local breed can be attributed to adaptability of the breed to favourable environmental condition of the study area. Since correlation estimates indicates the relationship between two or more traits, farmers can select based on the degree of correlation estimates, the higher the correlation estimate between two traits, it means

selecting for one of the traits will strongly affect the expression of the other trait. The cross breed group recorded a significantly higher correlation estimate values than the exotic breed, this indicates the benefit of heterosis, improvement of a breed will simultaneously improve breeds with lower production efficiency if cross breeding is practiced.

Conclusion

The moderately low to very low range of genetic correlations between the body measurements within each breed and highly positive phenotypic and environmental correlation estimates indicate the importance of environmental factors and non additive genes in the body measurements of the three turkey genotypes.

Higher correlation estimates (phenotypic and environmental) obtained in this study between body weight and other linear body parameters implies that selection for body weight will bring about selection for the other body parameters in the three turkey breeds studied.

The local breed gave the best performance in terms of correlation estimates over the exotic breed, crosses between the local and exotic breed shows an improvement in the genetic correlation estimates between the different traits measured.

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