GENETIC CORRELATION AND HERITABILITIES OF PERFORMANCE TRAITS AMONG THREE PIG GENOTYPES

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Abstract - Fifty four pigs (twenty five Duroc, twenty one Large white and eight crosses of Duroc and Large white (Hybrid)) were used to describe the performance traits of pigs. The aim of this study was to investigate the genetic correlation among the linear body measurements of three pig genotypes and the heritabilities of body weight at different ages. The pigs were averagely 30 kg of body weight and 70 days of age at the beginning of the study. Records for body weight (BW), body length (BL), trunk length(TRL), height at withers(HW), chest girth(CG), tail length(TL), shoulder to tail length(STL) were used for the analysis. The estimate of genetic parameters showed that heritabilities were low for individual weights at 21, 35 and 56 days of the experiment ranging from 0.087 to 0.132. The correlation of body weight and linear measurements in the study were positive. The chest girth (CG) and height at withers (HW) had the highest and strongest relationship (r=0.83, 0.82 respectively) with body weight among other linear measurements.

Index Terms— Genotype, quantitative traits, linear measurements, sex, selection, heritability, pleiotropic effects

INTRODUCTION

Improvement of pigs is important in order to increase their contribution to the much needed animal protein in this part of the world. The knowledge of genetic parameters is one of the pre-requisites for genetic improvement for economic traits [1]. The genetic correlation among the linear parameters and the study of heritability are important genetic parameters for optimizing and evaluating crossbreeding systems. These genetic parameters are especially needed in selection method to achieve genetic progress. The choice of a suitable genotype for the particular conditions of commercial breeding is a decisive step for pig breeders. Performance and suitability of various genotypes are verified by tests of populations [5]. Relationships between the body measurements are needful for the prediction of other performance traits in animal [2]. Heritability is the proportion of phenotypic variation in a population that is attributable to genetic variation among individuals. Heritability for back fat thickness, carcass length and feed conversion ratio in pig were 0.5, 0.55, 0.3 respectively [5]. Significant genotypic correlations between the body weight and the linear measurements and the heritability of the body weight at various stages of production are needful for breeding and selection purposes. Hence, this study was conducted to estimate the genetic correlation and the heritability for growth trait at various stages in the three pig genotypes namely; Duroc, Large White and their crosses (Hybrid).

MATERIALS AND METHODS

The study was carried out at the Piggery Unit of the Teaching and Research Farm, Federal University of Technology, Akure between December, 2009 and October, 2010. Further laboratory analyses were carried out at the Diagnostic Laboratory of the Department of Animal Production and Health, and the Research Laboratory of the Biochemistry Department, Federal University of Technology, Akure, Nigeria. A total of 54 pigs, averaging 30kg weight at the time of the trial were used to conduct the experiment. The animals were sourced from the Livestock Department of the Ministry of Agriculture and Natural Resources, Ondo, Ondo State, Nigeria. They were housed in well ventilated pens according to their group. Feed and clean water were supplied regularly. The quantitative characters such as body weight (BW), body length (BL), trunk length(TRL), height at withers(HW), chest girth(CG), tail length(TL), shoulder to tail length(STL) were taken on weekly basis as described by *Gizaw et al*. [3], Akanno and Ibe [1] and Kathiravan [6].

Statistical Analysis

Data generated from the trial were subjected to analyses of variance and genetic parameter estimates using the GLM procedure of SAS (v 9.2). The design of the experiment was the Nested or Hierarchical type by Henderson [4]. The simple Linear Correlation Procedure of SAS (version 9.2) was used to establish the strength of linear relationship and association between the different linear body measurements together with the body weight using the model;

Genetic correlation from sire component $r_G = \dfrac{\delta_{Sxy}}{\sqrt{(\delta^2{}_{Sxx} \, . \, \delta^2{}_{Syy})}}$

The Genetic correlation from dam component $r_G = \dfrac{\delta_{Dxy}}{\sqrt{(\delta^2{}_{Dxx} \, . \, \delta^2{}_{Dyy})}}$

Genetic correlation from sire and dam $r_G = \dfrac{\delta_{Sxy} + \delta_{Dxy}}{\sqrt{(\delta^2{}_{Sxx} \, . \, \delta^2{}_{Syy})} \, . \, \sqrt{(\delta^2{}_{Dxx} \, . \, \delta^2{}_{Dyy})}}$

Where;

r_G, genetic correlation; δ_{xy}, variance due to traits x and y; δ_{xx}, variance due to xx traits; δ_{Wxy}, variance within breed due to trait x and y; δ_{Dxy}, variance due to dam for traits x and y; δ_{Wxx}, variance within breed for xx traits; δ_{Wyy}, variance within breed for yy traits; δ_{Dxx}, variance due to dam for xx traits; δ_{Dyy}, variance due to dam for yy traits; δ_{Sxy}, variance due to sire traits for x and y; δ_{Sxx}, variance due to sire for xx traits and δ_{Syy}, variance due to sire for yy traits.

Further analysis was performed using the mixed model least-squares and maximum likelihood computer program (SAS, 2008) which uses Henderson's Method 3 [4] to estimate the observable variance components due to sire (σ_s^2), dam (σ_d^2) and error (σ_e^2) by equating computed mean squares to their expectations and solving for the components. The estimates were used to compute heritability.

Heritability estimates were obtained as;

$$h^2_d = \frac{4\sigma d^2}{\sigma s^2 + \sigma d^2 + \sigma e^2}$$

RESULTS AND DISCUSSION

The genetic correlation of body weight and linear measurement at 35 days of the experiment is shown in Table 1. Generally, the correlation coefficient of body weight and all the linear measurements in the study were positive. The strongest relationships existed between the TR and SHT; HW and CG (r = 0.84 and 0.83) respectively while the weakest relationships existed between the TL and HW, TL and CG (r = 0.03 and 0.04) respectively. The chest girth and trunk length had the strongest relationship with the body weight (r = 0.63, 0.57) while the tail length had the weakest relationship with the body weight (r = 0.32).

BW = Body Weight, BL = Body Length, TRL = Trunk Length, HW = Height at Withers, CG = Chest Girth, TL = Tail Length, STL = Shoulder to Tail Length.

Table 2 shows the genetic correlation between the linear measurements and body weight at 56 days of the experiment. The coefficients of relationships were generally positive and high for all the linear measurements except for TL and TRL which had a negative correlation(r = -0.05).

The chest girth and height at wither had the highest and strongest relationship (r=0.83, 0.82) with the body weight among other linear measurements under studied while the weakest positive relationships were observed between the BL and TL, HW and TL with correlation coefficient of 0.05 and 0.03 respectively. The chest girth had the strongest relationship (r=0.83) with the body weight while the tail length had the weakest relationship (0.05) with the body weight. This implies that the chest girth can best predict the body weight of the pig while the tail length cannot be best used to predict the body weight. As the CG increased, there was a corresponding increase in the body weight of the animal. Similar associations among body measurements in goats ([8] and [9]), sheep [10] had been reported. The positive and high genetic correlations obtained between each linear measurement and body weight were consistent since the body weight is the overall body growth, which itself is the sum total of increase in size of different structural body components. It also indicates the pleiotropic action of genes responsible for these characters. Other implications of this also mean that genetic improvement could be made possible by direct selection for any of the measurements as the responses are correlated.

The heritability estimates from the dam component of variance for individual pig weight are given in Table 3. The heritability estimate was generally low for pig weight at 21, 35 and 56 days of the experiment, although the heritability estimates seemed to be increasing from day 21 to day 56 of the experiment with values of 0.087±0.01, 0.065±0.02 and 0.132±0.03 respectively.

The low heritability could be attributed to the environmental influence on the trait, additive gene action and the small sample size. Cecchinato *et al*. [2] observed this same trend of low heritability for both purebred and crossbred pigs but greater than the estimates reported by Knol *et al.* [7].

CONCLUSION

The body weights and the other measurements considered in this study increased with increase in age, implying a better performance in the long run and heavier market weights and sizes. The increase in heritability with age also suggest that selection can be done at the later stage of the production considered in the study. Furthermore, the positive relationships between body weights and other measurements at various ages indicated that increase in the growth rate of any of the components would correspondingly increase live weight gain. Obviously, improvement in the production characteristics of the pigs is feasible through breed manipulation.

REFERENCES

[1] Akanno E.C, Ibe S.N (2006). Prediction of body weight of the domestic rabbits at different stages of growth using linear body measurements. Nig. J. Anim. Prod. 33(1): 3-8.

[2] Cecchinato A., de los Campos G., Gianola D., Gallo L. and Carnier P. (2009) The relevance of purebred information for predicting genetic merit of survival at birth of crossbred piglets *J ANIM SCI* 2010, 88:481-490.doi: 10.2527/jas.2008-1744

[3] Gizaw S, Komen H, Hanotte O, Van Arendonk JAM (2008). Indigenous sheep resources of Ethiopia: types, production systems and farmers preferences. Animal Genetic Resources Information 43: 25-39.

[4] Henderson C. R. (1963) Estimation of variance and covariance components. *Biometrics* 9: 226-252.

[5] Joe Cassady, (2002) Genetic Parameters and Their Use in Swine Breeding, Purdue University Cooperative Extension Service, West Lafayette, IN 47907 http://www.ces.purdue.edu/extmedia

[6] Kathiravan P, Sadana DK, Mishra BP, Kataria R S, Kaur P, Kumar A,. Jayaprakash NS (2008). Survey and Characterization of South Kanara buffaloes in India. Anim. Genet. Resour. Inf. 43: 67-77.

[7] Knol, P. W., A. A. Sosnicki, R. E. Klont, and A. Lacoste. 2002. Simultaneous improvement of meat quality and growth-and-carcass traits in pigs. Comm. No. 11-07 in Proc. 7th World Cong. Genet. Appl. Livest. Prod., Montpellier, France.

[8] Odubote, I.K and Akinokun, J.O (1991) Evaluation of the reproductive and body weight performances of the New Zealand White rabbits. *Nigerian Journal of Animal Production*. 18: 61-65.

[9] Ozoje, M.O and Mgbere, O.O. (2002) Coat pigmentation effects in West African Dwarf goats: live weights and body dimensions. Nig. J. Anim. Prod. 29(1) : 5-10

[10] Salako, A.E and Ngere, L.O. (2002) Application of multifactorial discriminant analysis in the morphometric structural differentiation of West African Dwarf (WAD) and Yankasa sheep in South West Nigeria. Nig. J. Anim. Prod. 29(2): 163-167

[11] SAS/STAT (2008) SAS user's guide: Statistics released version 9.2 Statistical Analysis System Institute. Inc; Cary, NC Sborník CSAZ, 133.

Table 1: Genetic correlation of body weight and linear measurements at 35 days

	BW	TRL	TL	SHT	HW	CG	BL
BW	-	0.57***	0.13	0.52***	0.49***	0.63***	0.51***
TRL			0.11	0.84***	0.23	0.35**	0.48***
TL				0.63***	0.03	0.04	0.32**
SHT					0.19	0.29**	0.54**
HW						0.83***	0.35**
CG							0.69***
BL							-

* = Significant (P<0.05) ***= Highly Significant (0.01)

Key;

BW = Body Weight, BL = Body Length, TRL = Trunk Length, HW = Height at Withers, CG = Chest Girth, TL = Tail Length, STL = Shoulder to Tail Length

Table 2 Correlation of body weight and linear measurements at 56 days

	BW	TRL	TL	SHT	HW	CG	BL
BW	-	0.62**	0.05	0.51**	0.75***	0.83***	0.61***
TRL			-0.05	0.73***	0.30**	0.38**	0.33**
TL				0.64***	0.03	0.06	0.26**
SHT					0.25	0.33**	0.44***
HW						0.82***	0.44***
CG							0.77***
BL							- -

* = Significant (P<0.05) ***= Highly Significant (0.01)

Key

Table 3 Heritability estimate for pig weight

	h^2
Individual pig at 21days	0.087±0.01
Individual pig at 35days	0.065±0.02
Individual pig at 56days	0.132±0.03