Nigerian J. Anim, Sci. 2024, 26 (3): 20-29

Phenotypic Correlation Between Growth Traits and Blood Haematology and Serum Biochemistry in F_1 Pig Genotypes and Crossbreds

[1]Nwakpu, O. F and *[1]Nosike, R. J.,

[1]Department of Animal Breeding and Physiology, College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.
Corresponding author: nosikereginald@gmail.com., *+2348105957396*

Target Audience: *Animal breeders/scientists, pig farmers and breeders*

Abstract

A total of 18 mature pigs comprising 6 Large White (LW), 6 Duroc (DR) and 6 mixed breeds(LWxDR) were used to generate 60 F_1 piglets and used to correlate between growth traits and blood parameters. Growth traits measured were ***Body weight*** *(BWT),* ***Punch girth*** *(PG), Heart girth(HG), Ear length(EL), Height at withers, Pin bone to pin-bone(PB) and Body length (BL). Biologic markers measured were Packed Cell Volume (PCV), Haemoglobin (Hb), Red Blood Cell (RBC), White Blood Cell (WBC), Blood glucose(GLU), Total blood protein (PROT) and creatinine (CRT). Results showed that there were significant ($p<0.05$) positive correlations between BWT and Hb, PROT and CRT and also between BL and Hb in LW genotype. There were significant ($p<0.05$) positive correlations between BWT and GLU, RBC, PROT, between punch girth (PG), Height at withers (HW) and WBC, between EL and GLU, and also between BL and PROT and CRT in DR genotype. There were high significant ($p<0.01$) positive correlations between EL and PCV, WBC and PROT. The correlations were moderate. HW was correlated significantly ($p<0.05$) with PCV and PROT in LWXDR genotype.* Haematological and Serum Biochemical indices studied *showed that HB, WBC, CRT, PROT, GLU and PCV can effectively be incorporated in Marker assisted selection scheme for selection of LW, DR pigs and LWxDR in Nigeria. It was concluded that for rapid improvement of these traits, Large White x Duroc could be used to enhance growth of pigs in the study area.*

Keywords: Phenotypic correlations; growth traits; blood haematology; serum biochemistry, pig genotypes; crossbreds

Description of problem

Improvement of animals based on breeding work is a set of activities aiming to obtain individuals with fixed and desired traits. Improvement trends differ between breeders and often change depending on consumer's preferences. Pigs have been used widely in biomedical research owing to their physiologic and anatomic similarities to humans (models for studying diseases such

as gastrointestinal, renal, and cardiovascular diseases in humans (12). Pigs are seen as popular and valuable animal models for studying diseases such as gastrointestinal, renal, and cardiovascular diseases in humans (2, 25), and they serve as organ donors in xenotransplantation (5).

Crossbreeding is a successful management practice for improving litter productivity in swine. This mating system, by exploiting heterosis, is known to improve prolificacy, piglet viability and post-weaning gain. Results of several crossbreeding studies in the humid tropics (1) have indicated varying levels of heterosis for sow productivity traits.

As the demand for animal protein in Nigeria increase the need to improve animal protein production becomes necessary. The choice of the right type of animals to be raised in the area where it is best adapted which result in higher productivity and performance (7).

More particularly, it is estimated that 22% of known livestock breeds have become extinct in the last 100 years and another 27% are at varying degrees of risk (21).

Globally, this realization has led to efforts to study genetic diversity in livestock species in order to provide a foundation for conserving these potentially useful germplasms.

Phenotypic characteristics of Pig Breeds as well as their adaptive characteristics are important in identifying breeds attributes for immediate use by farming communities.

The advent of molecular techniques has led to an increase in studies that focus on the genetic characterization of domestic breeds using genetic markers as a tool used in evaluating genetic variation, markers can provide useful information at different levels and purpose such as structure of animal populations, levels of gene flow, phylogeneic relationship, patterns of historical bio geography, and percentage. In addition, genetic assessment is also of interest for the design of genetic improvement programmes including appropriate choice of breeds for cross breeding (20).

However, (10) has stated that quantitative genetic methods are useful in bringing about improvement in this economic characters and knowledge of genetic parameter enables the breeders to decide on the best method of selection to achieve rapid genetic progress.

According to (9), growth is measured by increase in body weight. While (13) noted that weight is an important selection objective. Body weight is the pivot on which animal production thrives. Pricing of animals is based on live weight. When animals are priced and bought by visual appraisal as in our traditional practice, invariably, the middlemen gain and farmers lose. This can be addressed by weighing and selling the animal on price per kg live-weight basis.

Linear measurements are divided into two groups, which include skeletal and tissue measurements. Skeletal measurements include all the height and length measurements while tissue measurements include heart girth, chest depth, punch girth, and width of hips (4). Pigs grow in a pattern that suits their requirement for survival. After nervous tissue development, the skeleton grows to enhance movement and balance (15).

Animal protein consumption for normal physical and mental development is low in Nigeria, (8). FAO estimate in 2012 indicate that significant progress has been made in reducing under nourishment in the world during the last 20 years. During the period 2010-2012, a total of 870 million people did not have access to sufficient Dietary energy and where chronically under nourished, 132

million fewer than in 1990. The results imply that the target of having proportion of people who suffers from hunger by 2015 (relatively to the proportion suffering from hunger in 1990).

The marker-assisted selection (MAS) technique is an important application of genetic engineering to animal breeding (17). Rapid progress could be made in genetic engineering of domestic animals and improvement of economic characters by efforts geared towards identifying various blood markers. To improve effectively on physical body characteristics and physiological parameters of pigs, there is need to understand the production potentials of these pig breeds. The measurements of the amount of various biochemical constituents of blood have been used in the evaluation of the physiological status of animals (22). This gives genomic information required for effective use of MAS for genetic improvement (16). Thus the objective of the study was to determine the phenotypic correlations between growth traits and Blood haematology and Serum Biochemical indices in F_1 pig genotype and crossbred.

Materials and Methods

Experimental Site

This experiment was carried out at the Chimereogoeze and Sons Nigeria Limited, Okpu Umuobo, Aba, Osisioma LGA, Abia State, as approved by the supervisory board. This area is situated within the tropical rainforest zone of West Africa which is characterized by long duration of rainfall (April - October) and short period of dry season (November-March). Average rainfall is 2169.8mm in 148 – 155 rain days. Average ambient temperature is 26^{o}C with a range 22^{o}C and 30^{o}C. Its relative humidity ranges from 50 to 90%.

Generation of Based Population

A total of 18 mature pigs weighing average of 40-50kg, comprising 6 Large white (LW) (1male: 5 females), 6 Duroc (DR) (1male: 5 females) and (1male LW: 5 females DR) at mating ratio of 1:5 were used to generate 60 F_1 piglets for the study. The parent pigs were sourced from a reputable farm in Aba, Abia State. They were managed intensively.

Management of Pigs on Experimental Station

Pigs were intensively managed and penned in groups according to genotype.

Feeding was given twice daily using conventional and non-conventional feed ingredients mixtures including, Palm kernel cake (PKC), maize, fish meal, corn chaff, wheat bran, grower concentrate, kitchen wastes, salt and vitamin premix.

Experimental Procedure

Boars were introduced to mature gilts on heat at the ratio of 1 male: 5 females. Standard management practices were followed throughout mating, gestation (114 days) and weaning periods. As the projected parturition date approached, sows were taken to farrowing pens that had been cleaned and disinfected. As from two weeks of age, piglets were fed a commercial creep feed *ad libitum* until weaning at day 42.

Mating Scheme for the production of pig genotypes is given in Table 3.1.

Table 1: Distribution of Parent pigs per genetic group

Mating	Genetic group
Large white x Large white	Large white piglets (20)
Duroc x Duroc	Duroc piglets (20)
Large white x Duroc	Large white x Duroc piglets (20)

Experimental F_1 Pigs and their Management

A total of 60 weaner Pigs between 8 - 10 weeks of age and comprising Large white, Duroc and Large White x Duroc crosses with twenty (20) pigs per genotype were replicated four times with five pigs per replicate. They were managed intensively. Iron injection was administered to pigs after collection of blood samples to enable the animals regain themselves.

Data Collection

Growth Traits measured include:

Body weight, Punch girth, Heart girth, Ear length, Height at withers, Pin bone to pin-bone, and Body length

Punch girth (cm): Circumference of the body was measured immediately after the abdomen just before the hind legs

Heart Girth (HG) (cm): The body circumference immediately posterior of the front legs or the body circumference on the fore ribs

Ear length (EL) (cm): The distance of the ear using measuring tape.

Height at withers (HW) (cm): Vertical distance from the highest point of the shoulder (withers) to the ground surface at the level of the fore legs

Pin bone to pin-bone (PB) (cm): distance between the iliac crest on either side of the waist.

Body length (BL) (cm): were measured on individual pig with the aid of tailor's tape (cm).

Body Weight (BW) (kg): Each pig was weighed just after the linear body measurements with a hanging 50 kg scale with sensitivity of 50g.

The animals were made of both male and female. The animals were restricted by the handlers using basket on the head. All parameters were measured in the morning before feeding.

Blood sample collection

Blood samples were collected from the experimental animals using the method of (24), by puncturing the jugular vein of the experimental animals early in the morning before feeding. 2mls of blood was collected from the jugular vein of each of the experimental animals using sterile disposable syringe which was emptied into sterile bottle containing Ethylene Diamine Tetra Acetic Acid, (EDTA), to serve as anti-coagulant and this would be used to determine the haematological component. Another 5 ml of blood was collected and deposited in an anti-coagulant free sterile bottle and allow to clot which was used for biochemical studies. It was done immediately after the skin had been damped with alcohol to disinfect the area and expose the vein.

Blood haematology and Serum

Biochemical indices measured:
They were: Packed Cell Volume, Haemoglobin, Red Blood Cell, White Blood Cell, Blood glucose, Total blood protein and creatinine.

Determination of blood parameters:
Packed cell volume (PCV): Packed cell volume (PCV) were determined by the micro haematocrit method by (6).
Haemoglobin (Hb): Haemoglobin (Hb) were determined using the cyanomethaemoglobin method as described by (11).
White blood cell (WBC) and White blood cell (RBC): WBC and RBC were determined using a microscope with improved Nuebacuer haemacytometer as described by (11).
Total Blood Protein (PROT): The Total Blood Protein (PROT) was done by method described by (14).
Blood Glucose (BGC): The Blood Glucose (BGC) determination was done by the process describe by (3). **The standard flame photometry was used to determine the creatinine**

Statistical Analysis
Data obtained was statistically analyzed using SPSS version 16 software.
Phenotypic **correlations between growth traits and blood parameters were determined using Pearson's product moment correlation coefficient**:

$$Y_p = \frac{CoV(P_X P_Y)}{\sqrt{V_X}\ \sqrt{V_Y}} \quad \ldots\ldots(1)$$

]Where,
Y_p = Phenotypic correlation
CoV (Px Py)- Phenotypic covariance between traits X and Y
Vx- Phenotypic variance of X
Vy- Phenotypic variance of Y

Results and Discussion
Correlation between growth traits and blood parameters in Large White x Large White genotype.
There were significant ($p<0.05$) positive

Table 1: Correlations between growth traits and blood parameters in Large White genotype

Traits Markers	BWT	PG	EL	HW	PB	BL
PCV	0.43	0.42	-0.59	-0.41	0.26	-0.42
Hb	0.66*	-0.05	-0.44	-0.79	-0.09	0.91**
GLU	0.21	-0.27	-0.61	-0.34	0.42	-0.57
RBC	0.43	0.52	0.42	0.31	0.47	0.39
WBC	0.02	-0.49	-0.99**	-0.88*	0.52	0.11
PROT	0.87*	0.68*	-0.40	-0.49	-0.21	0.06
CRT	0.85*	0.97**	-0.19	0.05	-0.70	0.00

*Correlation is significant ($p<0.05$)
* *Correlation is significant ($p<0.01$)

aBWT = Body weight, PG=, Punch Girth EL=Ear length, HW= Height at Withers PB= Pin bone, BL= Body length, PCV = Packed Cell Volume, WBC = White Blood Cell, Hb=Haemoglobin Concentration, RBC = Red Blood Cell, BPT = Blood Protein, BGC = Blood Glucose, CRT = Creatinine

correlations between Body weight (BWT) and Haemoglobin (Hb), Blood Protein (PROT) and Creatinine (CRT) and also between body length (BL) and Hb (r=0.91**) in Large White genotype.

Punch Girth was correlated significantly ($p<0.05$) with PROT and highly ($p<0.01$) with CRT (r=0.97**).

The correlation between Ear length (EL) and WBC (r= -0.99**) was highly significant ($p<0.01$) and negative. The negative correlation implies that for any increase in WBC will lead to decrease in Ear length.

All other correlations were not significant ($p>0.05$). As in this case of Large White pigs, positive correlations indicate that an increase in value of one growth trait is associated with an increase in value of each blood parameters and vice-versa.

The non-significant correlations between blood parameters and all quantitative traits, implies that there will be no gain in the respective quantitative traits if the respective blood parameters are incorporated in MAS. Weak correlations between PCV, GLU and WBC and the quantitative traits in Large white pigs in this study were also reported by (18) for domestic rabbits.

However, this result has shown that improvement in animals differs among genetic groups. Since more positive significant correlations occurred between quantitative traits and markers in Large white genotype, consist of both genetic and environmental components, correlations between growth traits and blood markers in Large white pigs arose from correlations between genetic and environmental effects affecting quantitative traits and markers (10). Large white genotypes should therefore be involved in the improvement during marker assisted selection (MAS) programmes using Haemoglobin, Protein and Creatinine.

Correlation between growth traits and

Table 2: Correlations between growth traits and blood markers in Duroc genotype

Traits / Markers	BWT	PG	EL	HW	PB	BL
PCV	0.15	-0.57	0.00	-0.88*	-0.78	-0.58
Hb	0.20	-0.25	-0.49	-0.21	-0.50	0.30
GLU	0.97**	-0.81	0.93**	-0.45	-0.58	0.25
RBC	0.87*	0.53	0.46	0.48	0.49	0.38
WBC	-0.52	0.91*	0.55	0.99**	-0.94	-0.41
PROT	0.82*	-0.63	0.33	-0.16	-0.57	0.74*
CRT	-0.50	-0.08	0.00	0.44	0.10	0.99**

*Correlation is significant ($p<0.05$)

**Correlation is significant ($p<0.01$)

aBWT = Body weight, PG=, Punch Girth EL=Ear length, HW= Height at Withers PB= Pin bone, BL= Body length, PCV = Packed Cell Volume,WBC = White Blood Cell, Hb = Haemoglobin Concentration, RBC = Red Blood Cell, BPT = Blood Protein, BGC=Blood Glucose, CRT = Creatinine

blood parameters in Duroc x Duroc genotype

There were significant ($p<0.05$) positive correlations between Body weight (BWT) and Glucose (GLU) (r=0.97**), Red blood cell (RBC), Blood Protein (PROT), between punch girth (PG), Height at withers (HW) and WBC(r=0.99**), between EL and GLU (r=0.93**), and also between body length (BL) and PROT and CRT(r=0.99**) in Duroc genotype**.** This correlation between BWT and Blood glucose is in agreement with the report by (19) on Nigerian local turkey black phenotype.

The correlation between HW and PCV was significant ($p<0.05$) and negative.

All other correlations were not significant ($p>0.05$). As in this case of Duroc genotype, positive correlations indicate that an increase in value of one growth trait is associated with an increase in value of each blood marker and vice-versa. The significant ones indicate that the affected markers could be used in selection studies instead of the corresponding growth traits if the latter are more difficult to measure and if environmental influence is negligible.

Correlations in Duroc x Large White genotype

Table 3 : Correlations between growth traits and blood parameters in Duroc xDuroc genotype

Traits Markers	BWT	PG	EL	HW	PB	BL
PCV	0.41	-0.17	0.95**	0.97*	-0.90	0.20
Hb	-0.07	0.55	-0.24	-0.64	0.09	0.67*
GLU	0.52	0.17	0.48	0.17	-0.72	0.69*
RBC	0.43	033	0.48	0.41	0.50	0.45
WBC	0.09	-0.50	0.93**	-0.65	0.70*	-0.74
PROT	0.03	0.18	0.97**	0.89*	-0.74	0.40
CRT	0.22	-0.67	-0.23	-0.47	0.58*	-0.56

*Correlation is significant ($p<0.05$) ** Correlation is significant ($p<0.01$)

aBWT = Body weight, PG=, Punch Girth EL=Ear length, HW= Height at Withers PB= Pin bone, BL= Body length, PCV = Packed Cell Volume, WBC = White Blood Cell, Hb =Haemoglobin Concentration, RBC = Red Blood Cell, BPT = Blood Protein, BGC=Blood Glucose, CRT = Creatinine

There were high significant ($p<0.01$) positive correlations between Ear lenght (EL) and PCV (r=0.95**), WBC(r=0.93**), PROT. (r=0.97**) Height at withers was correlated significantly ($p<0.05$) with PCV and PROT in LW x DR genotype.

There were significant ($p<0.05$) positive correlations between PB and each of WBC and CRT. The correlation between Body length (BL) and Hb and GLU were significant ($p<0.05$) and positive.

All other correlations were not significant ($p>0.05$). In this study, Large White x Duroc pigs crosses, yielded positive correlations which indicate that an increase in PCV, WBC and PROT will lead to increase in ear length, also to increase in PVC and PROT will lead to increase in Height at withers.

Moreso, increase in WBC and CRT leads to increased PB which indicates growth.

Improvement was also observed in body length as Hb and Glucose increases.

Blood parameters for the improvement of growth parameters using the various indices studied are presented in Table 4. The selected parameters are those which had significant positive correlation with body weight for the different pig genotypes.

Table 4 : Blood parameters for improvement of growth traits of pigs

Genotype	Marker Bank
Large White	HB, CRT, PROT
Duroc	WBC, GLU, CRT, PROT
Large White x Duroc	PCV, WBC, HB, GLU

Blood haematology and Serum Biochemistry studied showed that HB, WBC, CRT, PROT and GLU can effectively be incorporated in MAS for selection of Large White, Duroc pigs and their crosses in Nigeria. The relationships, on which the choice of markers were based, were phenotypic and therefore could lead to genetic improvement of the specified growth traits.

Conclusion and Applications

1. The study has showed that phenotypic correlation between the growth traits and some blood markers were positive and significant.
2. Meaningful indirect selection can be achieved by improving the growth traits using the blood parameters; due to significant correlation established between the two.
3. Blood parameters showed that HB, WBC, CRT, PROT., GLU and PCV can be effectively incorporated in MAS for selection of Large White, Duroc pigs and their crosses in Nigeria. These could be used in MAS for all the pig genotypes studied.
4. Rapid improvement of these traits in Large White x Duroc could be used to enhance growth of pigs in the study area. The present findings could assist in the design of long-term genetic improvement programmes for pig production in Nigeria using the Blood parameters.
5. Recommended that the Large White and crosses with Duroc genotypes should be selected by breeders to achieve improved production of pigs, using the quantitative traits BW, BL, PG, HW, PB and the blood parameters HB, WBC, CRT, PROT., GLU and PCV.

REFERENCES

1. Adebambo, O. A. (1986). Selective breeding of the Nigerian Indigenous pigs for the rural producer. *Proc. 3rd World Cong. On Genetics Applied to Livestock Prod.* Nebraska USA X: 70-74.
2. Aloi, M., Tromba, L. and Nardo, G. D. (2012). Premature subclinical atherosclerosis in pediatric

inflammatory bowel disease. *Journal of Pediatrics* 2012;161:589–594.

3. Barker, F. J. and Silverton, R. E. (1976). *Introduction to medical laboratory technology*, 5th Edition. Butterworth and Co. Publishers Ltd, London. Pp.540-621.
4. Blackmore, D. W., McGulliard, L. D. and Lush, J. L. (1995). Genetic relationship between body weight measurements at three ages in Holstein. *Journal of Dairy Science*, 41:1045
5. Cooper, D. K., Gollackner, B. and Sachs, D. H. (2002). *Annu. Rev. Med.*; 53:133–147.
6. Dacie, J. V. and Lewis, S. M. (1999). *Practical haematology* (7th Ed) ELBS with Churchill Livingstone, England.
7. Ekwe, O. O. and Nweze, B. O. (2012). Effect of stall-fed management on growth performance of pure and crossbred Muturu Cattle. *World Journal Engineering, Pure and Applied Science*., 2: 9.
8. FAO, (2012). *FAO publications on animal production*. FAO Animal Production and Health. Avail. *http://www.fao.org/Ag/AGAInfo/resources/en/pubs_aprod.html*
9. *Holness,* D. H. (*1991)*. Grain legumes (lupins, lablab beans, cowpeas and navy beans) as supplements for sheep and goats. *Recent Advantages Animal Nutrition* 62-71
10. Ibe, S. N. (1998). *An Introduction to Genetics and Animal Breeding*. Longman Nig. Plc. Lagos. Pp 92-93.
11. Jain, C. N. (1986). *Shalms Veterinary haematology* 4th ed. Lea and Feabriger, Philadephia.
12. Ji, M. H., Yang, J. J. and Wu. J. (2012). Experimental sepsis in pigs — Effects of vasopressin on renal, hepatic, and intestinal dysfunction. *Ups Journal of Medical Science*, 2012;117:257–263.
13. Kosum, N., Taaskin, T., Akbas, Y. and Kaymakei, M. (2004). Heritability estimation of birth and weaning weight in Saanen, Bornova and Saanen x Kilis goats. *Pakistan Journal of Biological Science.* 7 (11): 1963 -1966.
14. **Lawrence, M. S. (1986).** *Amino acids and proteins*. *In: Textbook of Clinical Chemistry.* Tiezt, N. W. *(editor).* W. B. Saunders Company, US. Pp. 519-618.
15. Lawrence, T. L. and Fowler, V. R. (1997). Growth of Farm Animals. CAB International, Wallingford, 330. Cited by Atta, M. and El Khidr, O.A. (2004) Use of Heart Girth, Wither Height and Scapulo-Ischial Length or the Prediction of Live Weight of Nilotic Sheep. *Small Ruminant Research*, 55, 233-237.
16. Lynch, M. and Walsh, B. (1998). *Genetic and analysis of quantitative traits*. Sunderland, Massachusetts, Sinauer Publications. P. 980.
17. Montaldo, H. H. (2006). Genetic engineering applications in animal breeding. Pontificia Universided Católica de Valparaiso-Chile. *Electronic Journal of Biotechnology*. http://www.ejbiotechnology.info/content/vol9/issue2/full/4/index.html.
18. Nosike, R. J., Nwachukwu, E. N., Ibe, S. N., Obike, O. M. and Okoro, V. M. O. (2013). Relationship between biologic markers and quantitative traits in the domestic rabbit. *Proc. 40th Confr., Nig. Soc. Anim. Prod.* Rivers State University of Science and Technology, Port Harcourt, Nigeria, Pp. 62-65.
19. Nosike, R. J., Onunkwo, D. N., Ezike, J.

C., Amaduruonye, W., Obasi, E. N., Obike, O.M. Nwakpu, O. F., Ibe, S. N. and Oke, U. K. (2018). Correlations between blood markers and growth parameters in establishing marker bank for black colour Nigeria local turkey. *Nigerian Journal Animal Science,* 20 (2): 16-25.

20. Nwacharo, J. M., Okeyo, A. M., Kamande, G. K. and Rege, J. E. O. (2006). The small East African shorthorn zebu cows in Kenya. 1: Linear body measurements. *Tropical Animal Health and Production*, 38:65-76.
21. Rege, J. E. O. (ed). (1999). Economic valuation of animal genetic resources. *Proceedings of an FAO/ILRI workshop,* Rome, Italy, 15-17 March 1999.
22. Solomon, I. P., Monsi, A. and Umoh, B. I. (2005). Effect of Zinc on blood biochemical constitutents and haematological characteristics of rabbits in the humid tropics. *Journ. of Sustainable Tropical Agricultural Research* **15**: 101-106.
23. SPSS (Statistical Package for Social Sciences). SPSS Inc. (16.0), 444 Michigan Avenue, Chicago.
24. Uko, O. J. Ataja, A. M. and Tanko, H. B. (2000). Weight gain, haematology and blood chemistry of rabbits fed cereal Offals. Sokoto *Journal of Veterinary Science 2(2),* 18-26.
25. Yang, Y., Hayden, M. R., Sowers, S., Bagree, S.V. and Sowers, J. R. (2010). Retinal redox stress and remodeling in cardiometabolic syndrome and diabetes. *Oxidative Medicine and cellular Longevity*, 2010; 3: 392–403.