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GENOTYPE AND GENERATION EFFECTS ON THE GROWTH PERFORMANCE TRAITS OF THREE BREEDS OF PIGS

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Abstract

This study was conducted to determine the effects of genotype and generation on the growth performance traits of three breeds of pigs. A total of 18 weaner gilts and 6 weaner boars of genotypes derived from the Duroc, the Landrace and the Large White genotypes of the domestic pig (Sus scrofa domesticus) respectively were used for foundation stock bred to raise the F_1 stock which comprised 72 pigs of 24 pigs of both male and female were also used for the study. The animals comprised 6 weaner gilts per genotype which were randomly selected and placed in two replicate pens of 3 gilts and a boar per genotype were used for this study. Feed and water were given ad-libitum throughout the experimental period. The parent generation was heavier than their F_1 generation in all the weeks of experimentation in mean body weight. The Duroc parent was the heaviest at the beginning of the trial and still the heaviest at 36 weeks of age which indicates a constant increase in body weight, followed closely by the Large White and lastly the Landrace breeding group. The progeny generation was significantly higher than their parents in heart girth and also in all the weeks across breeds, progeny generation had broader body girths compared to their parents. From the findings, it is concluded that both breed and generation had effects on the growth traits studied and as a result of insinuated inbreeding coefficient effect on the body weight, a cross breeding, programme is suggested using the Large White to cross the Duroc or the Landrace breeds.

Keywords: *Genotype, Generation, Growth, Performance and Breeds*

Introduction

Growth is simply defined as an increase in size. It consists of increases in animal's cell in sizes (hypertrophy) and numbers (hyperplasia) and also in extra cellular fluid. During the early embryonic development of pigs, growth is primarily of hyperplasia. After birth, growth of most tissues is largely, in some cases totally due to hypertrophy (Johnson, Chewning *et al.*,2002). Animal growth has been defined by Moran (1977) as the sum of the growth of component parts of the carcass that is, meat, bone and skin. These parts not only differ in their rate of growth as age advances, they are also dependent upon levels of nutrition (Chambers *et al.*, 1981). Growth is therefore, a complex physiological process that exists from conception until maturity in animals. It is a dynamic process and nutrients are partitioned among developing tissues according to their metabolic rates (Ogbu, 2010). Due to the different priorities of the nervous, reproductive, skeletal, muscular and adipose tissues, the level of nutrition influences meat composition (Orheruata *et al.*,2009). Growth performance is an important factor in animal production and it determines the rate of progress made most especially in pig production. Information on both pigs and chemical characteristics of carcass of several European breeds of pigs and indigenous pigs are available in literature (Sofoluke and Detters, 1973; Madubuike, 1984; Sikka, 2006 and 2007). Growth performance is an important component in pig industry to determine the maximum profit in a short period of time. Knowledge of growth performance of pigs is essential for designing breeding programmes for commercial production of pigs.

Numerous studies have been conducted by various workers to see the effect of genetic and non-genetic factors on pre weaning body weights but only few of them have seen the effect of inbreeding on these traits. Inbred lines have lesser pre weaning growth rate as compared to out-bred pigs (lvanchuk, 1989; Gaur, 1997).

The weight of animals fluctuates as a result of management system, pregnancy, gut fill and lactation (Johnson *et al.,* 2002). Physical body characteristics measurements are less affected by the above factors and allow for growth comparison of different parts at any stage of growth. Measurement of various body conformations are of value in judging quantitative characteristics of meat and are also helpful in developing suitable selection criteria. Moreover, because of relative ease in measuring linear dimensions they can be used as indirect way to estimate weight. Knowledge of animal weight is also essential for determining the dosage level of some drugs and the amount of feed to be given to the animals. Animal weight is highly prone to within individual variation due to the amount of feed and water in the gut. Increasing genetic potential for meat production of pig breeds requires selection for an increased size and live weight. Adeoye *et al.* (2012) reported a non- significant effect of genotype on the weekly body weights of F_1 progenies produced by the Large White and the Duroc which they attributed to non-significant difference in their nursing ability.

Despite the contributions of the pig to the economic growth and its ability to alleviate the animal protein and calorie deficit and the absence of discrimination against its production and consumption, little attention has been paid to its growth performance traits especially here in the tropics. There is therefore need for genetic improvement in these growth traits. The study was therefore conducted to determine the effects of genotype and generation on the growth performance traits of the Large White, the Duroc and the Landrace breeds of pigs.

Materials and Methods

The study was conducted at the Pig Breeding and Genetic Research (PBGR) unit of the Department of Animal Science of Delta State University, Asaba Campus. Asaba campus is located at Latitude 06^o 14^{1}N and Longitude 06^o 49^{1}E. It lies in the tropical rainforest zone, characterized by seven months of rainy season between April and October, punctuated by a short break in August with annual rainfall of 1500mm – 1849mm. A total of 18 weaner gilts and 6 weaner boars of genotypes derived from the Duroc, the Landrace and the Large White breeds of the domestic pig (*Sus scrofa domesticus)* was used for foundation stock bred to raise the F_1 stock for this study. This comprised 6 weaner gilts per genotype which were randomly selected and placed in two replicate pens of 3 gilts and a boar per pen and used for this study also 72 off-springs of the F_1 generation which comprised 32 males and 40 females were used. This comprised 24pigs from each genotype. Feed and water were given *ad-libitum* and all the necessary prophylactic medications were given throughout the experimental period which lasted from when the parent was 22 weeks till the F_1 generation was 36 weeks of age. The animals were housed in a concrete floor, well ventilated and fly-proof pig house and all the following measurements: body weight, Body length; Body girth and heart girth were taken using standard methods.

All data collected were subjected to analysis of Variance (ANOVA) in a nested (or hierarchal) design using a computer data processing package (SAS, 2010) and in accordance with the guidelines by Steel *et al.* (1997) in which one sire was mated to several dams with each producing several off-springs, with genotype and generation as the main sources of variation. The new Duncan's multiple range test (SAS, 2010) was used to compare significantly different multiple means. The following linear model (Becker, 1992) was used to assess the effects of genotype and generation of the pigs on the parameters monitored:

$Y_{ijklm} = \mu + X_i + A_j + S_k + D_{kl} + E_{ijklm}$,

Where,

$Y_{ijklm,}$ is the observation on the mth progeny of the lth dam or gilt mated to kth sire or boar belonging to jth generation in the ith genotype;

μ = the overall population mean common to all observations;

X_i = Fixed effect of genotype;

A_j = Fixed effect of generation;

S_k = Random effect of sire;

D_{kl} = Random effect of dam with sire;

Eijklm = random error associated with the experimental determinations.

Results and Discussion

Table 1 presents the result of the effects of genotype and generation on the mean body weight of three breeds of pigs from week 22 to 36. The result indicates very high significant (P<0.001) differences among genotypes and between generations in all the experimental weeks. The parent generation was heavier than their F_1 generation in all the weeks of experimentation. The Duroc parent was heaviest at the beginning of the trial and still the heaviest at 36 weeks of age which indicates a constant increase in body weight, followed closely by the Large White and lastly the Landrace breeding group. In the F_1 generation, the Landrace had the heaviest progeny at 22weeks followed by the Duroc and then the Large White. At week 36 the trend changed and the Duroc recorded the heaviest weight, followed by the Landrace and lastly the Large White. The differences in body weight between generations and among breed is indicative that they all had effect on body weight. The parent generation being significantly heavier than their F_1may be as a result of insinuated inbreeding coefficient effect affecting the trait in question. The superiority of the parent generation over their off-springs in live body weight suggests some loss of fitness arising from the in-flock mating among the parents aimed at creating more stable gene frequencies required for dependable out-breeding of the pigs across line. This will target higher heterotic performance of the expected out-bred progeny genotypes. Significant genotype difference registered in this study is in contradiction with the report of Walugembe *et al.* (2014) who reported non-significant breed effect on the body weight of Ugandan village pigs (the Large White, the Landrace and some crosses) which they attributed to the fact that the genetic potential from the improved breed animal is not that high and that the feeding regime do not allow the improved to express their potential. The finding of this study contradicts the report of Adeoye *et al.* (2012) who reported a non-significant effect of genotype on the weekly body weights of the F_1 progenies produced by the Large White and the Duroc which they attributed to non-significant difference in their nursing ability. The difference in the findings may be attributed to differences in environment, feeding and other management practices since the pigs were not raised in the same environment.

Table 1: Effect of genotype and generation on the mean body weight in kg of the three breeds of pigs

Age Wk	LW Parent	LW Progeny(F_1)	DUR Parent	DUR Progeny(F_1)	LR Parent	LR Progeny (F_1)
22	19.87±0.04[a]	11.18±0.42[b]	20.00 ±0.02[a]	11.88±0.38	18.12± 0.10[b]	13.45±0.86
24	21.37 ±0.12[a]	11.71±0.42[b]	21.1± 0.14[a]	12.99±0.47	19.12 ± 0.28[b]	15.03±1.01
26	23. 12±0.60[a]	12.42±0.43[b]	23.5± 0.45[a]	14.32±0.54	20.37± 0.96[b]	15.12±1.00
28	25.12±0.65[a]	13.09±0.41[b]	22.50± .64[b]	15.54±0.65	21.37±0.80[b]	16.06±0.99
30	26.12±0.06[a]	13.76±0.42[b]	27.12±0.68[a]	16.51±-0.66	22.62±1.01[b]	16.75±0.96
32	27.12± 0.01[a]	14.42±0.42[b]	28.37± 0.22[a]	17.37±0.69	23.46±0.86[b]	17.30±0.40
34	29.25± 0.05[a]	14.98±0.41[b]	30.00 ±0.55[a]	18.90±0.72	23.93± 0.21[b]	18.02±0.96
36	30.37± 0.12[b]	16.03±0.41	32.25 ±0.07[a]	20.14± 0.62[a]	24.18± 0.15[c]	18.86± 0.97[a]

For each row of results, between generations differing superscript letters indicate mean values with significant differences ($P<0.01$) LW= Large white; DUR= Duroc; LR= Landrace

Effects of breed and generation on the mean body length as presented in Table 2 indicated a significant generation and breed differences in body length in weeks 22 to 36. The Large white and the Landrace progenies had longer bodies compared to their parents while the Duroc parent had longer body length compared to their progeny. The Duroc parent had the longest body length at weeks 22 and 36 followed by their progeny and lastly the Landrace parent. The body length and other linear body parts increased alongside the body weight in both the parents and their progeny generations. This trend of increase in body length as the body weight increased had been reported by many authors in literature in other breeds of animals although there is paucity of information on this in pig. Olutogun *et al.* (2003) reported a positive correlation between body weight and linear body parts in West African dwarf goats crossed with Red Sokoto goats (RSG). This finding is in harmony with earlier view of Sulabo *et al.* (2006) and Brown and Butts (1973). It also agrees with the view of Tegbe and Olurunju (1988) and Oke *et al.*(2006) that changes in linear body measurements are indications of tissue growth and tend to increase as the animal grows.

Table 2: Effects of breed and generation on mean body length in cm of parent and progeny generations

Age Wk	LW Parent	LW Progeny(F_1)	DUR Parent	DUR Progeny (F_1)	LR Parent	LR Progeny (F_1)
22	47.00± 0.11^b	58.48±0.69^a	66.37±0.02^a	61.32±0.94^b	47.98±0.10^b	61.83 ±2.41^a
24	49.00± 0.33^b	60.44± 0.63^a	68.15± 0.32^a	63.05± 0.99^b	48.75±0.28^b	63.39 ± 2.31^a
26	50.75±0.60^b	61.85±0.64^a	69.87±0.48^a	65.21± 1.00^b	49.87±0.62^b	64.47± 2.23^a
28	52.25± 0.56^b	64.52±0.63^a	71.62±0.24^a	67.58±1.05^b	50.37±0.10^b	65.75±2.11^a
30	53.37±0.06^b	66. 37±0.66^a	73.37±0.43^a	69.53±0.88^b	51.31±0.01^b	66.78±2.14^a
32	55.12± 0.25^b	68.26±0.66^a	74.75±0.22^a	71.32±1.03^b	55.12±0.13^b	67.78±2.10^a
34	57.12±0.22^b	70.81±0.68^a	76.68±0 .55^a	73.00±1.00^b	55.67±0.21^b	69. 22±2.09^a
36	63.00±0.12^b	73. 26±0.64^a	76.95±0.07^a	74. 94±0.99^b	56.62±0.15^c	72.22±1.91^a

For each row of results, between generations differing superscript letters indicate mean values with significant differences (P<0.01) LW= Large white; DUR= Duroc; LR= Landrace

Effects of breed and generation on mean heart girth in cm of parent and progeny generations as presented in Table 3, indicated significant (P<0.05) generation differences in all the weeks of experimentation. The progeny generation was significantly higher than their parent in heart girth. At 22 week the Landrace had higher heart girth while in week 36 the Duroc the highest mean value. Across the breed, non- significant differences were recorded. Florence *et al.* **(**2011) used body length and heart girth to determine the weight of pigs in rural Western Kenya. In their study, pig weight increased with increasing length and girth. The authors attributed the increase in body length as a result of the skeletal growth, while increases in girth are due to muscle development plus accumulation of adipose tissue. Linear measurements such as length and height are related to bone growth and are closely related to body weight of growing animals (Essien and Adesope, 2003; Murillo and Valdez, 2004). Groesbeck *et al.* (2010) used girth measurements to predict pig weight in the United States. Carcass yield of pigs can be increased by genetic improvement of its live weight which requires proper measurement. In a study carr ied out by Machebe and Ezekwe (2010) the linear measurements, body length (BL), heart girth (HG), flank to flank (FF) and height at withers (HW) were highly correlated with body weight. Otuma (2007) reported a significant breed effect on the linear body measurements in crossbred Nigerian goats.

Table 3: Effects of breed and age on mean heart girth in cm of parent and progeny generations

Age	LW Parent	LW Progeny (F_1)	DUR Parent	DUR Progeny (F_1)	LR Parent	LR Progeny (F_1)
22	42.75± 0.47[b]	52.18± 0.69[a]	51.75 ± 0.7[b]	54.70±0.73[a]	49.00 ± 0.72[b]	55.53±1.31[a]
24	45.62 ± 0.39[b]	54.07± 0.66[a]	53.50± 0.77[b]	57.18± 0.90[a]	50.37± 0.48[b]	56.88±1.32[a]
26	47.50± 0.37[b]	56.64± 0.74[a]	55.75± 0.24[b]	60.82± 1.06[a]	51.75± 0.76[b]	57.65±1.35[a]
28	49.75± 0.31[b]	57.71±0.61[a]	57.75± 0.27[b]	64.00±0.99[a]	53.37±0.81[b]	58.82± 1.29[a]
30	51.25± 0.25[b]	59.71±0.81[a]	60.00±0.26[b]	66.14± 0.91[a]	55.25±0.87[b]	58.82±1.25[a]
32	53.25± 0.26[b]	61.71±0.82[a]	61.50± 0.23[b]	67.27±0.86[a]	57.00± 0.86[b]	59.65±1.11[a]
34	55.37±0.28[b]	64.14±0.79[a]	63.37± 0.21[b]	68.27±0.79[a]	58.50±0.85[b]	60.76± 1.07[a]
36	57.12± 0.26[b]	65.86±0.74[a]	66.75± 0.28[b]	69.77±0.74[a]	60.00± 0.90[b]	62.24±0.99[a]

For each row of results, between generations differing superscript letters indicate mean values with significant differences (P<0.01) LW= Large white; DUR= Duroc; LR= Landrace

Effects of breed and generation on mean body girth in cm of parent and progeny generations as reported in Table 4 show a significant (P<0.05) breed and generation effects on the mean body girth in almost all the weeks of experimentation with exception of few weeks where non-significant differences were recorded. In all the weeks across breeds, progeny generation had broader body girths compared to their parents. William and Ogara (2011**)** used body length and body girth to determine the weight of pigs in rural Western Kenya, and established that pig weight increased with increasing length and girth of the animal. The authors attributed the increase in body length to skeletal growth, and argued that increases in body girth were due to muscle development plus accumulation of adipose tissue. In earlier findings by Essien and Adesope (2003) and Murillo and Valdez (2004) linear body measurements such as length and height are related to bone growth and are closely related to body weight of growing animals.

Conclusion

From the findings, it is concluded that both breed and generation had effects on the growth traits of pigs and as a result of insinuated inbreeding coefficient effect on the body weight, cross breeding programme is suggested using the Large White to cross the Duroc or the Landrace breeds.

Table 4: Effects of breed and generation on mean body girth in cm of parent and progeny generations

Age	LW Parent	LW Progeny (F_1)	DUR Parent	DUR Progeny (F_1)	LR Parent	LR Progeny (F_1)
22	55.87±0.04^{b}	58.61±0.13^{a}	56.00 ± 0.02^{b}	60.90±0.22^{a}	64.87± 0.10^{a}	57.94±0.16^{b}
24	58.25±0.12^{b}	60.73± 0.21^{a}	56.50± 0.14^{b}	63.81± 0.18^{a}	65.62 ± 0.28^{a}	59.94± 0.30^{b}
26	60.25±0.60^{a}	62.19± 0.22^{a}	59.50± 0.45^{b}	67.18±0.19 ^{a}	66.56± 0.96^{a}	60.77±0.31^{b}
28	62.75±0.65^{b}	63.80± 0.19^{a}	61.25±0.64^{b}	69.60±0.19^{a}	67.50±0.80^{a}	61.83±0.28^{b}
30	65.37±0.06^{a}	66.11±0.22^{a}	62.93±0.68^{b}	70.09±0.18^{a}	68.37±1.01^{a}	62.94±0.25^{b}
32	67.50± 0.01^{a}	68.00±0.21^{a}	64.75±0.22^{b}	71.68±0.16^{a}	69.12± 0.86^{a}	64.05±0.24^{b}
34	69.62± 0.05^{a}	70.07±0.21^{a}	66.50±0.55^{b}	72.90±0.12^{a}	69.87± 0.21^{a}	65.16±0.21^{b}
36	71.87±0.12^{a}	72.61±0.21^{a}	69.12± 0.07^{b}	75.45±0.16^{a}	72.25± 0.15^{a}	66.61±0.23^{b}

For each row of results, between generations differing superscript letters indicate mean values with significant differences (P<0.01) LW= Large white; DUR= Duroc; LR= Landrace

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