Trop. J. Anim. Sci. 4 (2): 85 - 96 (2001)
ISSN: 1119 - 4308

CROSSBREEDING OF LARGE WHITE AND NSUKKA LOCAL PIGS: GENOTYPE AND AGE ARE RELATED CHANGES IN HAEMATOLOGICAL PARAMETERS

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Target Audience: Researchers, breeders and geneticists.

ABSTRACT

Blood samples from 80 pigs of 4 genotypes - the Nsukka local (Lo), the exotic Large White (LW), the one-way F_1 (LW x Lo) and the F_2 crosses belonging to 5 age groups, were analysed, to determine the mean values of the haematological parameters in the genotypes and different age groups and to check if and how the values are altered by crossbreeding. The local pigs had significantly ($P<0.05$) higher haemoglobin (Hb, 11.64 g/100 ml), packed cell volume (PCV, 47.00%), red blood cells (RBC, 7.06 x 10^6/mm^3), white blood cells (WBC, 16.50 x 10^3/mm^3) and lymphocytes (61.45%) than the Large White (LW - 10.77 g/100ml, 41.55%, 6.26 x 10^6/mm^3, 10.65 x 10^3/mm^3 and 50.59%, respectively), with F1 and F2 crosses intermediate in values. The mean corpscular heamoglobin (MCH), the mean corpuscular heamoglobin concentration (MCHC), monocytes, neutrophils and corpuscular were highest in the LW (17.26 u2g, 25.92%, 6.60%, 39.05%, and 5.20%, respectively) and the lowest in the Lo (16.5 u2g, 24.59%, 4.8%, 30.90% and 2.45%, respectively), with F1 and F2 intermediate. The LW, Lo and F1 were similar in mean corpuscular volume (MCV). There were significant ($P<0.05$) increases in Hb, PCV, RBC, WBC, lymphocytes and eosinophils with age. However, significant genotype x age interactions were found for RBC, MCH, WBC, lymphocytes, monicytes and eosinophils which limit the iferences made on the main effects. Heterosis estimates based on the one-way F1 were zero, negative or low for most of the parameters. It was concluded that the blood parameters studied are heritable and that additive gene action was important in their inheritance, suggesting that they should respond to selective breeding.

Key words: Crossbreeding, genotype, age, blood parameters, pigs.

DESCRIPTION OF PROBLEM

Haematological examination is a useful procedure in the diagnosis of some livestock diseases in practical husbandry and reflects the pathophysiological responses of the animal to its environment (3,1). Normal physiological values of blood constituents of farm animals vary with different species, breed, age, sex and environmental factors such as heat stress, cold stress, excitement, nutritioal status and management technique of the animals (21). Amakiri *et al* (2) indicated that blood parameters in cattle are heritable and that the genes controlling their inheritance behave additively.

Although the exotic breeds of pigs imported into Nigeria produce better than the native pigs, they are highly susceptible to local diseases such as trypanosomiasis, and succumb to climatic stress. In order to get around this problem, crossbreeding of the exotic Large White pig and the Nsukka local pig was embarked upon, to produce animals which, while standing to the challenges of the humid tropical environment, will produce more abundantly than the local.

In this study the normal blood constituent values of the Large White pig, the Nsukka local and their crosses of different age groups were analysed and compared, to check if and how the mean values are altered by crossbreeding, and to determine the haematological qualities trnsferable in crossbreeding and whether such could be useful in selective breeding.

MATERIALS AND METHODS

Experimental animals and their management

Experimental animals comprised 80 pigs of 4 gentic groups, 20 each of the exotic Large White (LW), the Nsukka local (Lo), the F1 (LW x Lo) and the F2 crossbreeds. The F1 crossbreds were produced only by one-way mating of LW x Lo i.e. the mating of Large White boars to the local sows; the reciprocal mating Lo x LW was not practised in the herd. The pigs were further classified into 5 age groups: 3-4, 6-9, 24-28, 36-44 and 48-60, week-old covering the spectrum of animals available at the time of study. Thus, 4 animals were sampled from each genotype-age class, 2 from each of two different litters. The animls were certified healthy at the time of the experiment by the veterinarian.

The Nsukka local pig is an unimproved, unselected type, known to be resistant to local diseases, particularly trypanosomiasis. Its productivity is, however, low, being kept under extensive management system.

Feeding and watering were done twice daily at 0800 and 1500h. The feed was given as dry mash. Suckling piglets were given creep feed from 10 d of age till weaning at 42 d. During this period piglets had access to feed and water *ad libitum*. Weaners were given 0.5kg of feed/d, with an increase of 0.5 kg/d every 2 wk to a maximum of 2.5 kf/d. Lactating Large White sows received 3 kg and the local sows 2 kg of feed for maintenance, with an extra 0.25 and 0.16 kg, respectively, in respect of every piglet being nursed. Crude protein contents were 22-23%, 16-18% and 14-16%, for creep feed, weaners mash, and growers/finisher mash, respectively. Deworming was done regularly with piperazine anthelmintic drug to control worm infestastions. In addition, periodic administration of berenil was applied as prophylaic treatment to remove or reduce the effect of differential resistance of the various gentic groups to possible incidence of trypanosomiasis.

Collection and analysis of blood samples

About 5-10 ml of blood was drawn from the anterior vena cava of each animal by inserting the needle through the arch between the first and second ribs. The samples were collected in bijou specimen bottles containing a drop of 10% ethylene diamine tetra acetate (EDTA) anticoagulant, using a 10 ml sterile syringe and 3.8-7.6 cm hypodermic injection needles appropriate for the particular age group. Sampling was done in the mornings between 0900 and 100 h before the animals were fed.

The samples were analysed for red blood cell (RBC) and white blood cell (WBC) counts by the improved Neubauer method, for packed cell volume (PCV) or haematocrit by micro-haematrocrit at 3,000 rpm for 15 min, and haemoglobin (Hb) by cyanomethaemoglobin method (21, 6). Erythrocytic indices, namely mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were estimated as described by Schalm et al. (21). Differential leukocyte (lymphocytes, monocytes, neutrophils and eosinophils) counts were determined on blood smears stained with Giesma at a pH of 7.2.

The wet drop technique (13) was used in examination of blood samples for the presence of trypanosome parasites which was a possible source of bias due to the differential resistance of the various genotypes.

Estimates of heterosis

Estimates of F1and F2 heterosis in haematological characteristics were also made.Since only one-way crossing was practised,estimates of F1 heterosis in actual units relied on the mean of the one-way F1 crossbreeds.Thus, heterosis in each parameter was obtained as the mean of F1 minus the mean of midparent.Percent heterosis was then obtained relative to the midparent.

Statistical analysis

The model fitted was a cross-classified one.The data were statistical analysed by least squares analysis of variance using the General Linear Models procedure of SAS software package (20),for differences between genotypes and between age groups.Significance of variance due to genotype x age interaction was also tested. Multiple comparisons of means of genotypes and age groups were achieved by Duncan's(8) new multiple-range test programme contained in the software.

RESULTS AND DISCUSSION

Microscopic examination of wet blood films did not detect trypanosomes in pigs of different genotypes studied.This can be interpreted as indicating that the periodic prophylactic treatment using berenil was effective in

controlling trypanosomes. However, as Hall (12)pointed out, trypanosomes may be present in the animal without being readily obtained in blood films.This notwithstanding, it is safe to assume that results obtained in this study were unbiased by the differential resistance of the genotypes to trypanosomiasis.

Means and coefficients of variation for genotype-age subclasses

The genotype-age subclass means and coefficients of variation (CVs) for erythrocytic and leukocytic parameters are presented in Tables 1 and 2, respectively. Generally, Hb, PCV and RBC were higher in Lo and lowest in LW, with F1 and F2 intermidiate in values. Also, the general trend was similar to that observed for erythrocytic values. For monocytes, neutrophils and eosinophils, the LW appeared to have the highest values. There was no obvious age-related trend in leukocytic parameters in which values fluctuated with age.

Table 1. Means (coefficients of variation) of erythrocytic parameters for genotype-age subclasses

Parameter1/Genotype	Age (wk)				
	3-4	6-9	24-28	36-44	48-60
Hb (g/100 ml)					
Large White (LW)	8.98 (0.07)	10.00 (0.07)	10.90 (0.02)	11.60 (0.01)	12.38 (0.03)
Local (Lo)	9.68 (0.06)	11.02 (0.04)	12.05 (0.05)	12.28 (0.05)	13.18 (0.03)
F_1 (LW x Lo)	9.23 (0.11)	10.35 (0.01)	11.05 (0.07)	12.13 (0.02)	12.50 (0.02)
F_2	9.83 (0.06)	10.00 (0.07)	11.95 (0.04)	11.40 (0.07)	12.58 (0.03)
PCV (%)					
Large White (LW)	27.50 (0.05)	39.50 (0.03)	41.00 (0.06)	44.50 (0.05)	45.25 (0.06)
Local (Lo)	42.75 (0.09)	43.25 (0.05)	48.00 (0.03)	50.50 (0.03)	50.50 (0.04)
F1 (LW x Lo)	39.50 (0.03)	41.50 (0.01)	44.25 (0.09)	46.00 (0.04)	49.50 (0.06)
F2	38.00 (0.06)	40.25 (0.04)	40.50 (0.05)	47.00 (0.02)	51.00 (0.05)
RBC (x 10^6/mm^3)					
Large White (LW)	5.65 (0.02)	5.83 (0.07)	6.11 (0.02)	6.41 (0.02)	7.28 (0.01)
Local (Lo)	6.11 (0.05)	6.33 (0.07)	6.80 (0.02)	7.39 (0.05)	8.65 (0.03)
F_1 (LW x Lo)	5.74 (0.01)	5.97 (0.02)	6.59 (0.05)	6.30 (0.02)	7.38 (0.02)
F_2	5.89 (0.02)	6.08 (0.03)	6.78 (0.02)	7.12 (0.03)	7.40 (0.02)
MCHC (%)					
Large White (LW)	23.98 (0.09)	25.35 (0.08)	26.83 (0.06)	26.13 (0.05)	27.43 (0.08)
Local (Lo)	22.83 (0.11)	24.55 (0.08)	25.13 (0.06)	24.30 (0.03)	26.13 (0.05)
F1 (LW x Lo)	23.37 (0.02)	24.95 (0.01)	25.08 (0.08)	26.38 (0.04)	25.33 (0.07)
F2	25.93 (0.09)	24.88 (0.11)	26.85 (0.01)	24.25 (0.06)	24.68 (0.04)
MCH (U2g)					
Large White (LW)	23.98 (0.08)	17.20 (0.12)	17.83 (0.02)	18.10 (0.03)	17.20 (0.04)
Local (Lo)	15.88 (0.07)	17.48 (0.04)	17.70 (0.04)	16.68 (0.09)	15.15 (0.00)
F1 (LW x Lo)	16.23 (0.03)	17.38 (0.02)	16.85 (0.11)	19.25 (0.01)	16.98 (0.02)
F2	16.70 (0.07)	16.45 (0.09)	17.63 (0.06)	16.03 (0.10)	16.50 (0.00)
MCV (u3)					
Large White (LW)	66.00 (0.03)	67.75 (0.04)	66.75 (0.07)	69.50 (0.02)	62.00 (0.05)
Local (Lo)	70.00 (0.11)	68.50 (0.10)	70.75 (0.05)	68.50 (0.07)	58.25 (0.04)
F1 (LW x Lo)	69.00 (0.04)	69.50 (0.03)	67.25 (0.14)	73.00 (0.03)	67.00 (0.06)
F2	64.50 (0.04)	66.25 (0.04)	65.75 (0.06)	66.25 (0.04)	66.75 (0.04)

*P<0.05; ** P<0.01; ***P<0.001.

Table 2. Means(coefficients of variation) of leukocytic parameters for genotype-age subclasses

Parameter1/Genotype	Age (wk)				
	3-4	6-9	24-28	36-44	48-60
WBC (x 103/mm3)					
Large White (LW)	10.49 (0.08)	9.94 (0.05)	9.70 (0.08)	11.52 (0.07)	11.62 (0.02)
Local (Lo)	16.41 (0.15)	17.45 (0.04)	15.25 (0.02)	18.31 (0.02)	15.06 (0.03)
F1 (LW x Lo)	14.15 (0.00)	12.65 (0.00)	11.31 (0.02)	11.94 (0.02)	12.29 (0.01)
F2	12.96 (0.10)	12.98 (0.14)	12.41 (0.02)	13.38 (0.14)	10.12 (0.01)
LYMPH(%)					
Large White(LW)	52.75 (0.03)	50.25 (0.02)	49.50 (0.03)	51.50 (0.01)	50.75 (0.02)
Local(Lo)	60.75 (0.02)	61.50 (0.03)	62.50 (0.02)	61.75 (0.02)	60.75 (0.02)
F1(LWxLo)	55.50 (0.01)	55.00 (0.01)	54.75 (0.01)	54.75 (0.02)	52.00 (0.04)
F2	57.75 (0.02)	56.50 (0.05)	58.50 (0.02)	55.00 (0.03)	58.25 (0.03)
MONOCY(%)					
Large White (LW)	6.50 (0.09)	7.25 (0.13)	6.75 (0.14)	6.00 (0.14)	7.25 (0.07)
Local(Lo)	4.75 (0.20)	4.50 (0.13)	4.75 (0.20)	4.75 (0.11)	5.25 (0.10)
F1(LWxLo)	5.75 (0.09)	5.75 (0.09)	6.50 (0.09)	6.00 (0.14)	6.50 (0.09)
F2	6.25 (0.08)	6.75 (0.07)	6.25 (0.08)	5.50 (0.18)	4.50 (0.13)
NEUTRO(%)					
Large White(LW) (0.02)	35.75 (0.08)	36.25 (0.03)	38.25 (0.04)	36.00 (0.02)	36.50
Local(Lo)	31.75 (0.05)	31.25 (0.03)	30.25 (0.06)	30.00 (0.03)	31.25 (0.04)
F1(LWxLo)	33.50 (0.04)	33.25 (0.02)	33.00 (0.02)	31.25 (0.04)	
F2	33.25 (0.03)	34.25 (0.09)	31.50 (0.04)	34.75 (0.03)	32.00 (0.03)
EOSINO (%)					
Large White (LW)	5.00 (0.28)	5.50 (0.18)	5.500 (0.16)	5.25 (0.10)	5.25 (0.10)
Local (Lo)	2.50 (0.23)	2.00 (0.40)	2.50 (0.23)	2.75 (0.35)	2.50 (0.23)
F1 (LW x Lo)	3.50 (0.17)	4.50 (0.13)	5.50 (0.11)	5.25 (0.10)	4.25 (0.12)
F2	2.75 (0.18)	2.50 (0.23)	2.50 (0.23)	3.50 (0.17)	4.50 (0.13)

The coefficients of variation ranged from 0% to 14% for erythrocytic parameters and from 0% to 40% for leukocytes but most of the CVs were within the range of 0% to 20% expected of biological traits. From all indications, the leukocytic parameters were more variable than the erythrocytic parameters.

Analysis of variance

Analyses of variance of haematological characteristics (Table3) showed significant effect of genotype on Hb, PCV,RBC ($P<0.001$) and MCH ($P<0.005$). There were no differences in MCHC attributable to genotype. Significant age effect was indicated for Hb, PCV, RBC MCH ($P<0.001$), MCHC and MCV ($P<0.01$). Whereas influence of genotype was highly significant ($P<0.001$) on all the leukocytic parameters studied, age effect was felt only

on WBC (P<0.001) and eosinophils (P<0.05). The absence of gnotype x age interaction in Hb, PCV, MCHC, MCV and neutrophils implies that the relative difference between the geno type groups in these trait remained the same irrespevtive of the age group to which pigs belonged. Significance of the interaction terms, on the other hand, reduces the inference that can be made about the main effects on RBC, MCH, WBC, lymphocytes, monocytes and eosinophils.

Table 3. Mean squares for haematological characteristics

Source of variation		Mean squares					
	Df	Hb	PCV	RBC	MCHC	MCH	MCV
Genotype (G)	3	2.630***	99.946***	2.487***	6.232	3.126*	44.413
Age (A)	4	26.034***	240.519***	8.285***	9.892**	5.860***	78.769**
Interaction (G x A)	12	0.393	4.935	0.279***	4028	2.700*	24.985
Error	60	0.252	5.313	0.060	2.861	1.155	17.904
		WBC	LYMPH	MONOCY	NEUTRO	EOSINO	
Genotype (G)	3	122.809***	394.700***	11.513***	237.817***	31.283***	
Age (A)	4	8.600***	3.938	0.519	31.394	1.419*	
Interaction (G x A)	12	4.547***	6.804***	1.669**	31.244	1.710***	
Error	60	0.907	1.842	0.571	28.633	0.492	

Least squares means for erythrocytes

Least squares means for erythrocytic characteristics are presented in Table 4. Overall least squares means were 11.15 ± 0.06 g/100 ml for Hb, 44.34 ± 0.26% for PVC, 6.59 ± 0.03 x 10^6/mm^3 for RBC, 16.92 ± 0.12 u^2g for MCH, 25.21 ± 0.91% for MCHC and 67.29 ± 0.47 u^3 for MCV. The mean percent Hb agrees well with the values of 9.2-13.9% reported by Miller et al. (15), 10.7-12.6% reported by Stamatovic et al. (22) and 11.1-15.6% given by Copland (7), count (x 10^6) and PCV (%) are within the ranges reported by some earlier workers (4, 23, 11, 5, 7) but are higher than values from the work of Miller et al. (15), Ramirez et al. (18) and Rao and Rao (19). The values of erythrocytic indices are within the normal ranges reported in the literature for pigs (23, 21).

Least squares means by genotypes for Hb (%), PCV (%) and RBC counts (x 10^6), Table 4, were significantly (P<0.05) higher in Lo than LW, with the intermediate genotypes (F1 and F2) having middle values and F2 showing higher RBC than F1. The LW, F1 and F2 were similar in MCH (u2g) and MCHC (%), values of which were lowest in the Lo. For MCV (u3), the F1 had essentially the highest value which did not differ significantly from the values for the LW and the Lo. The general picture that emerged is that among the genotypes, the Lo had higher erythrocytic values than the LW,

Table 4. Least squares means (+ SE) for erythrocytic characteristics

	Hb (g/100ml)		PVC (%)	RBC (x 10^6/mm^3)	MCHC (%)	MCH (u^2g)	MCV (u^3)
Variable	N	Mean + SE	Mean + SE	Mean + SE	Mean + SE	Mean + SE	Mean + SE
Overall	80	11.15 ± 0.06	44.34 ± 0.26	6.59 ± 0.03	25.21 ± 0.19	16.92 ± 0.12	67.29 ± 0.47
Genotype							
Large White (LW)	20	10.77 ± 0.11c	41.55 ± 0.52c	6.26 ± 0.05c	25.92 ± 0.38a	17.26 ± 0.24ab	66.30 ± 0.95ab
Local (Lo)	20	11.64 ± 0.11a	47.00 ± 0.52a	7.06 ± 0.05a	24.59 ± 0.38b	16.58 ± 0.24b	67.10 ± 0.95ab
F1 (LW x Lo)	20	11.05 ± 0.11bc	44.15 ± 0.52b	6.39 ± 0.05c	25.02 ± 0.38ab	17.34 ± 0.24a	69.45 ± 0.95a
F2	20	11.14 ± 0.11b	44.65 ± 0.52b	6.65 ± 0.05b	25.32 ± 0.38ab	16.66 ± 0.24ab	66.30 ± 0.95b
Age (wk)							
3-4	16	9.43 ± 0.13e	39.44 ± 0.58e	5.85 ± 0.06e	24.03 ± 0.42b	16.19 ± 0.27c	67.69 ± 1.06a
6-9	16	10.34 ± 0.13d	41.75 ± 0.58d	6.05 ± 0.06d	24.93 ± 0.42ab	17.13 ± 0.27ab	67.69 ± 1.06a
24-28	16	11.49 ± 0.13c	44.44 ± 0.58c	6.57 ± 0.06c	25.94 ± 0.42a	17.50 ± 0.27a	68.25 ± 1.06a
36-44	16	11.85 ± 0.13b	47.00 ± 0.58b	6.81 ± 0.06b	25.26 ± 0.42ab	17.51 ± 0.27a	69.31 ± 1.06a
48-60	16	12.66 ± 0.13a	49.06 ± 0.58a	7.68 ± 0.06a	25.89 ± 0.42a	16.46 ± 0.27bc	63.50 ± 1.06b

a,b,c,d,e Means in the same column within the same variable with different superscripts are significantly different (P<0.05).

with the crossbreds intermediate. In addition, the Lo was inferior to the LW in MCH and MCHC. The higher erythrocyte values estimated for the Lo pigs in comparison with LW mat be an inherent breed factor or it may have arisen from some envirnmental factors such as heat stress, excitement and management practised, as elaborated by Schalm et al. (21). The major function of red blood cells is to transport haemoglobin, which in turn carries oxygen from lungs to the tissues. In addition, red blood cells contain a large quantity of carbonic anhydrase which catalyses the reaction between carbon dioxide and water, transporting large quantities of carbon dioxide from the tissues to the lungs. Besides, the haemoglobin in the cells is an excellent acid-base buffer, thus the red blood cells are to a large extent possible for all the buffering power of whole blood. It would appear that the Lo pigs are endowed with higher red blood cells counts so as to be able to perform in the difficult tropical environment. The intermediate ranking of the F1 and F2 genotypes suggest that the erythrocytes are genetically transferable and both additive and non-additive gene actions are important for their inheritance. Amakiri et al. (2) working with cattle concluded that blood parameters were heritable and attributed the inheritance of the genes to addictive action.

Table 4 also gives the least squares means by age for erythrocytic characteristics. The figures show that Hb, PCV and RBC significantly ($P<0.05$) increased with age, but with some flunctuations. The increase of erythrocyte values with age is as would be expected in growing animals in which active haemopoiesis is still ongoing. It has been expected that RBC count tends to increase with age up to maturity when it averages in the Hb and erythrocyte count. However, haemopoiesis is regulated bu a feedback mechanism, being inhibited by a rise in the circulating red cells is always available to provide sufficient tissue oxygenation but at the same time the cells are not so concentrasted that they impede blood flow. From the RBC values reported in the current study, it seems that the pigs were yet to attain full maturity 48-60 weeks of age.

Least squares means for leukocytes

Overall least squares mean for WBC count (x $10^3/mm^3$) was 13.0 ± 0.11 (Table 5). For differential leokocytes, the least squares means were 56.0 + 0.15% for lymphocytes, 5.84 + 0.08% for monocytes, 34.23 + 0.60% for neutrophils and 3.83 + 0.08% for eosinophils. The WBC count falls within the range of 6.1-15.1 x 103/mm3 reported by Copland (7) for pure Native pigs and Native x British crossbred pigs in Papua New Guinea. It falls short of the range of 17.6-18.0 x 103/mm3 obtained by Vaiman et al. (23). The differential leukocytes (%) are within the normal range reported for

pigs (21, 7, 16). The pigs had significantly (P<0.05) the highest WBC counts and lymphocytes and the LW the lowest. The F1 and F2 had intermediate counts in these parameters. On the other hand, the LW had singnificantly (P<0.05) the highest monocytes, neutrophils and eosinophils while the Lo had the lowest and the F1 and F2 intermediate values. The indicaton was that the Lo pig were more resistant to blood infection and pathogenic invasion of the body than the LW and the crosses wth it. The lower WBC count and percent lymphocytes and higher monocytes, neutrophils and estimated for the LW suggests greater susceptibilit of the bread to infections. The F1 and F2 pigs would have a resistance value intermediate the values of the two breeds.

Table 5. Least squares means (+SE) for luekocytic characteristics

		WBC (x 10^3/mm^3)	Lymph (%)	Monocy. (%)	Neutro. (%)	Eosino. (%)
Variable	N	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Overall	80	13.00 + 0.11	56.00 + 0.15	5.84 + 0.08	34.23 + 0.60	3.83 + 0.08
Genotype						
Large White (LW)	20	10.65 + 0.21^c	50.59 + 0.30^d	6.60 + 0.17^a	39.05 + 1.20^a	5.20 + 0.16^a
Local (Lo)	20	16.50 + 0.21^a	61.45 + 0.30^a	4.80 + 0.17^c	30.90 + 1.20^c	2.45 + 0.16^d
F1 (LW x Lo)	20	12.47 + 0.21^b	54.40 + 0.30^c	6.10 ± 0.17^b	33.80 ± 1.20^b	4.50 ± 0.16^b
F2	20	12.37 ± 0.21^b	57.20 ± 0.30^b	5.85 ± 0.17^b	33.15 ± 1.20^b	3.15 ± 0.16^c
Age (wk)						
3-4	16	13.50 ± 0.24^a	56.69 ± 0.34^a	5.81 ± 0.19	36.69 ± 1.34	3.44 ± 0.18^c
6-9	16	13.25 ± 0.24^a	55.81 ± 0.34^{ab}	6.06 ± 0.19	33.75 ± 1.34	3.63 ± 0.18^{bc}
24-28	16	12.17 ± 0.23^b	56.31 ± 0.34^{ab}	5.88 ± 0.19	33.25 ± 1.34	3.88 ±
0:18^{abc}						
36-44	16	13.79 ± 0.23^a	55.75 ± 0.34^{ab}	5.56 ± 0.19	33.50 ± 1.34	4.19 ± 0.18^a
48-60	16	12.28 ± 0.23^b	55.44 ± 0.34^b	5.88 ± 0.19	33.94 ± 1.34	4.00 ± 0.18^{ab}

^{a,b,c,d} Means in the same column within the same variable with different superscripts are significantly different (P<0.05).

The significance of the leukocytes in clinical diagnosis of disease and their special characteristics in various disease states have been amply discussed(9).An increase in the total numbers of lymphocytes in blood is found in association with resistance to parasitic infection, due to the ability of the lymphocytes to prduce antibiotics (10). Monocytes and neutrophils are phagocytic in character and increase in number is when there are subacute and acute blood infections. An increase in the number of eosinophils also results from an incidence of chronic parasitic infections (7,10).These may explain the higher monocytes and granulocytes in the LWand crosses which are more susceptible to infections, particularly the blood parasite trypanosomes, than the Lo.

Changes in leukocytic characteristics with age though signficant for

WBC,lymphocytes and eosinophils,did not present any definite trend.

Heterosis estimates

Estimates of heterosis in haematological characteristics (Table 6) were low and mostly negative,essentially zero for the major blood parameters-Hb,RBC,PCV and WBC.In the F1,positive but low estimates of heterosis were found for some of the erythrocytic indices(MCH,MCV) and percent differential leukocytes (monocytes,eosinophils),with the highest estimate of 17% for eosinophils.The pattern was similar in F2 crosses. It can be inferred from these results that in both F1and F2 crosses, heterosis estimates were essentially zero for erythrocytic values, erythrocytic indices, lymphocytes and eosinophils, -9% for WBC, 5% for monocytes, and -4% for neutrophils. Absence of heterosis in most of the parameters indicates that additive gene action is important in their inheritance. However, non additive gene expression is not ruled out for some of the traits, in which case dominance appears to be the most likely type of gene action. Amakiri et al. (2) working with cattle concluded that the genes controlling inheritance of blood parameters behaved additively. However, it must be pointed out that heterosis estimates in this study are likely to be biased either way, judging that only one-way F1 crosses were available for estimation. No estimates were found in the literature for comparison with the present results.

Table 6. Estimates of heterosis in haematological charactreistics

Blood characteristics	Mean of parental breeds	Mean of F1	F1 heterosis Difference[a]	% [c]	Mean of F2	F2 heterosis Difference[b]	% [c]
Hb (g/100ml)	11.21	11.05	-0.16	-1	11.14	-0.17	-1
PCV (%)	44.28	44.15	-0.13	0	44.65	0.37	1
RBC (x 106/mm3)	6.66	6.39	-0.27	-4	6.65	-0.01	0
MCHC (%)	25.26	25.02	-0.24	-1	25.32	0.06	0
MCH (U2g)	16.92	17.34	0.42	2	16.66	-0.26	-2
MCV (u3)	66.70	69.45	2.75	4	66.30	-0.40	-1
WBC (x 103/mm3)	13.58	12.47	-1.11	-8	12.37	-1.21	-9
Lymphocytes (%)	56.20	54.40	-1.70	-3	57.20	1.00	2
Monocytes (%)	5.70	6.10	0.40	7	5.85	0.15	3
Neutrophils (%)	34.98	33.80	-1.18	-3	33.15	-1.83	-5
Eosinophils (%)	3.83	4.50	0.67	17	3.15	-0.68	-18

[a] Mean of F1 minus mean of parental breeds.
[b] Mean of F2 minus mean of parental bredds.
[c] Difference as a percentage of midparent as denominator.

CONCLUSIONS AND APPLICATIONS

The findings from this study suggest that the blood parameters are heritable and that additive gene action is important in their inheritance, indicating that they should respond to selective breeding. There was also an indication that non additive expression of genes was involved. It will be of interest to evaluate the productive performance of these genotypes to determine if the high reproductive performance generally acclaimed for the exotic Large White pigs and the disease resistance properties of the Nsukka local pigs can be suitably combined in crosses to achieve optimal productivity in a commercial herd.

ACKNOWLEDGEMENTS

The author is grateful to Dr. S. N. Oboegbulam of the Department of Veterinary Pathology for help rendered in bleeding the animals, and to Mr. N. U. Ibezim of the Department of Animal Science for assistance in the collection and analysis of the blood samples.

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