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ARTICLE

Heterosis and Growth Statistics of Pure and Crossbred Sheep in Humid Tropics of Ibadan, Nigeria

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Summary

The twenty four ewes used in this study aged between 24-30 months old weighing 20-25kg.They were feed guinea corn offal (Dussa) at the rate of 1.0kg per ewe per day. The estrous cycles of the animals were synchronized-using prostaglandin ($PGf_2\alpha$). The result showed that the body weight of the lambs of Yankasa-Yankasa-Wad (YYW) (5.3±0.5kg) and Yankasa-Ouda-Wad (YOW) (5.3±0.6kg) were similar while these two values were significantly higher ($p<0.05$) than Yankasa-Yankasa (YY) with body weight of 2.3. ±0.1kg and 3.2±0.3kg respectively. The crown –rump length in YYW (53.1±2.2cm) and YOW (53.9±2.6cm) were higher than Wad-Wad WW (47.6±2.8cm) and YY (41.0±1.6cm).

The correlation coefficient for YYW indicated that except for mean body weight (WT) which was positively correlated at $p<0.01$ other body parameters showed positive correlation at each other ($p<0.05$). Purebred West African dwarf lambs had the lowest birth weight of 1.63kg closely followed by purebred Yankasa (2.0kg) these were inferior to the crossbred or backcrosses of YYW (2.73kg). The cross of Ouda and Yankasa (2.35kg) compete favorably with Yankasa X Ouda-West African dwarf cross with birth weight of 2.30kg, these are significantly less than YYW ($P<0.05$). The average birth weights of crossbred lambs 2.5kg, and pure bred is 1.81 indicating that the effect of heterosis is 0.70 or 38.57%. It can therefore be concluded that crossbreeding has an advantage over pure breeds in terms of birth weight which is a pre-requisite for growth rates and body size.

KEY WORDS: Birthweight, growth, crossbreeding, heterosis, ewe, Nigeria

INTRODUCTION

The West African dwarf (WAD) sheep is widely distributed throughout the humid West coast of Africa while the long-legged type breeds; Ouda, Yankasa and Balami, are "restricted" to the semi-arid and arid zones of West Africa (Davendra and McLeroy, 1982). However, due to continuous movement of animals, especially from the northern parts of Nigeria to the south, the long-legged breeds are now found in the coastal areas. The Yankasa exists in all parts of Nigeria, but thins out drastically towards the seacoast and towards the very northern border of the country (Wosu, 2002). These four main breeds of sheep in Nigeria (Adu and Ngere, 1979; Williamson and Payne, 1978) differ considerably in size, coat, colour, and other characteristics. All the indigenous sheep are hairy and can be broadly grouped into: large, long-legged types found in the northern parts of Nigeria and the dwarf type of the hot humid coast area. The sheep industry competes against beef, pork, poultry and fish for food dollars of consumers who have many choices of high-quality meats. To compete effectively, the industry needs to produce uniform, nutritious, lean lamb that satisfies the eating preferences of consumers and to improve reproductive efficiency and reduce labour requirements so that seedstock and commercial flocks are both practical and profitable under a range of production environments (Leymaster, 2002).

Sheep in Nigeria is used mainly for meat production. Therefore rapid growth rate is of considerable importance for efficiency. The functional relationship between size and conformational trait determines the extent to which phenotypic biometry is related to size and determines sizes during the various phases of an animal's life. It further aids the development of suitable criteria on the basis of body conformation (Misra, 1980; Hafez, 1993). Crossbreeding is a traditional practice that is widely used as a rapid and cost-effective method to improve efficiency of meat production by

mating ewes and rams of two or more pure breeds (Charray *et al*., 1992; Leymaster, 2002). Effective use of a crossbreeding system allows livestock farmer to take advantage of heterosis or hybrid vigor, complementarities and breed differences to feed animals with available feed resources and sell in predominant market (Chapman and ZoBell, 2004). Failure to adequately plan a crossbreeding programme can be potentially devastating. It could result in nothing more than a mongrel herd, which lacks both uniformity and the ability to produce under a given set of available resources (Leymaster, 2002; Chapman and ZoBell, 2004).

All crossbreeding systems are based on breed diversity and, therefore, heterosis influences performance. Some crossbreeding systems also form complementarities. Complementarity is the improved production efficiency that results from crossbreeding systems that let strengths of the sire breed offset weaknesses of the dam breed and strengths of the dam breed counter weaknesses of the sire breed. The sire and dam breeds therefore complement each other. Complementarities greatly improve efficiency of meat production by mating ewes of specialized dam breeds to ram of specialized sire breeds. The basis of complementarity is that ewes and rams do not equally influence the performance of offspring because lambs are produced, reared, and natured by ewes. Breed diversity is the resources that allow producers to benefit from complementarity (Gatenby, 1991; Hafez, 1993).

Heterosis is defined as the average performance of crossbred sheep relative to the average performance of the proved breeds that produced the cross. Effects of heterosis greatly impact productivity of crossbred sheep. Each breed represents a specific package of genetic effects resulting in characteristics that distinguish one breed from another. Sheep with two copies of the same form of a particular gene are said to be homozygous for that gene, whereas sheep with two different forms of the gene are heterozygous. During evolution and development, each breed becomes homozygous for some genes and heterozygous for others genes, creating a unique set of genetic information. For each breed, the average degree of heterozygosity considering all genes (sheep may have roughly 30,000 genes) is a reflection of the genetic history of that breed. When breeds are crossed, new combinations of gene form are created in crossbred sheep. Therefore, crossbred sheep have increased heterozygosity relative to breeds that produced the crossbred. The increase in heterozygosity is the basis for heterosis or hybrid vigor (Gatenby, 1991; Greiner and Kelvin, 2004).

MATERIALS AND METHODS

Experimental animals

The twenty four normocyclic ewes comprising of 6 YYW, YY; YOW and WW one male each from Ouda, Yankasa and WAD were carefully selected from the existing flock in the Small Ruminant Research Unit (SRRU) of the University of Ibadan, Nigeria and from a local market which is about 5km from University of Ibadan campus. These were maintained at the SRRU with mean temperature ranged from 24^{0}C in the rainy season to 33^{0}C in the dry season. The relative humidity ranged from 46.3% in the dry season to 81.0% in the rainy season.

Management of the experimental animals

Animals were housed at night between 1700h - 0800h in groups of two and the males (rams) kept separately in a roofed house with concrete floor and pens of size 4.70 x 3.14m. After parturition, nursing ewes and lambs were kept in the same nursing pen measuring 3.15 x 1.19m. The ewes were released in the morning at 0800h and allowed to graze (*Pennisetum puerperiem*) and giant star grass (*Cynodon plectostachum*). In the evening, hay was served and a basal diet of dry cassava peeling and guinea corn offal (*Dussa*). Fresh water was provided *ad libitum*. The floor litter consisting of wood shavings on concrete floor was changed fortnightly during the raining season and once a month during the dry season.

The animals were dewormed using levamisole (*Levadex*®) at 1.0ml/20kg body weight. Subsequent deworming was done using Albendazole 200mg (Albidol®). They were vaccinated against peste de petits ruminant (PPR) using *pests de petit* ruminant vaccine obtained from National Veterinary Research Institute (NVRI) Vom, Nigeria. These were done before breeding the animals.

Experiment

The animals were weighed before the experiment and then flushed for a period of three weeks on guinea corn offals (*Dussa*) – at the rate of 1.0kg per ewe per day. The ewes were synchronized using prostaglandin ($PGF_2\alpha$). The weight changes and behavioral patterns during estrus were observed. At breeding, the desired sire either to crossbreed or backcross was introduced into the pen of the females until mating occurs for at least twice. At parturition, the birth weight of the lambs was determined within twelve hours of parturition using calibrated hanging scale. The body parameters like withers height (WH), rump height (RH), crown-rump length (CRL), face length (FL), heart girth (HG) and the body length (BL) were also measured at twelve hour of parturition using a graduated flexible measuring tape for eight weeks. Heterosis for lamb birth weight and body weights were calculated.

Statistical Analysis

The general Linear Model procedure was used to compare various dependent variables. The simple analysis of variance ratio called F-ratio was employed. The't' tests was used to check the significant difference (Steel and Torrie, 1986).

RESULTS

The summary of the percentage mean values of weight and body parameters of lambs in different breeding groups is presented in Table I. The weight of YYW (5.3±0.56) and YOW (5.3±0.63) were the same while these two values were significantly higher ($p<0.05$) than YY (2.3±0.1kg) and WW (3.2±0.3g). The wither height (cm) followed the same pattern as above YYW and YOW were higher than YY and WW. The crown-rump length in YYW (53.1±2.7cm) and YOW (53.9± 2.6cm) were higher than WW (47.6±2.8cm) and YY (41.0±1.6cm) however this increase was not significant (P0<0.05). The other parameters presented in Table I indicates that YYW and YOW are higher than YY and WW. The correlation coefficient for the Yankasa x Yankasa-WAD (YYW) is presented in Table II. The mean body weight (WT) was positively correlated (P<0.01) to YYW, while other body parameters showed positive correlation with each other at P<0.05.

It was also observed that there is correlation coefficient for the Yankasa x Yankasa (YY) as presented in Table III. There was a positive correlation (P<0.01) between mean body weight (WT) and other body parameters. There was a strong correlation between mean rump height and mean body length.

Table I: Weight and Body Parameters of lamb in first eight week of life

Parameters	YYW (mean±SEM)	YY (mean±SEM)	YOW (mean±SEM)	WW (mean±SEM)
Weight (kg)	5.3 ± 0.5^a	2.3 ± 0.1^b	5.3 ± 0.6^a	3.2 ± 0.3^c
Wither height (cm)	41.2±2.8	36.8±0.6	41.6±2.2	39.4±1.6
Rump height	44.8±2.2	39.6±0.7	43.6±2.3	41.4±1.6
Crown -rump length	53.1 ± 2.7^a	41.0 ± 1.6^b	53.9 ± 2.6^a	47.6 ± 2.8^c
Face length	15.8±0.8	12.8±0.7	16.4±0.5	14.5±0.6
Heart girth	44.5±1.7	35.1±0.9	44.2±1.9	38.8±1.9
Body length	37.8±2.4	25.4±0.7	35.6±2.7	34.6±2.3

a, b, c: Numbers differently lettered along the rows differ significantly (P<0.05) Weights are in kg while others are in centimeters cm

Table II: Correlation table for Yankasa x Yankasa-Wad (YYW)

	WT	WH	RH	CRL	FL	HG	BL
WT	1.0						
WH	0.983	1.0					
RH	0.982	0.959	1.0				
CRL	0.988	0.962	0.998	1.0			
FL	0.995	0.977	0.994	0.997	1.0		
HG	0.995	0.973	0.994	0.995	0.996	1.0	
BL	0.991	0.966	0.996	0.998	0.998	0.996	1.0

TABLE III: Correlation table for Yankasa x Yankasa (YY)

	WT	WH	RH	CRL	FL	HG	BL
WT	1.0						
WH	0.677	1.0					
RH	0.776	0.961	1.0				
CRL	0.753	0.927	0.984	1.0			
FL	0.716	0.910	0.963	0.995	1.0		
HG	0.709	0.934	0.970	0.994	0.998	1.0	
BL	0.776	0.961	1.000	0.984	0.963	0.970	1.0

The correlation coefficient for Yankasa x Ouda-WAD (YOW) is presented in Table IV. There was high correlation between the mean body weight (WT), mean body length (BL) and other parameters (P<0.05). It was observed that there is a positive correlation (P<0.05) between the mean body weight and the mean of the body parameters measured as presented in Table V.

Pure bred WAD lamb had the lowest birth weight. The pure bred Yankasa (2.0kg) was also inferior to Yankasa x WAD crosses (2.73kg). The body size of WAD is an added advantage in this cross. The Ouda x Yankasa crosses (OY) birth weight compete favourably with Yankasa x Ouda-WAD crosses (YOW) birth weight (2.30kg). The birth weights of these two groups are less than Yankasa x Yankasa-WAD crosses (YYW) as presented in Figure 1.

The lambs mean birthweight for the crosses and pure bred is as presented in Table VI.

Table IV: Correlation table for Yankasa x Ouda-Wad (YOW)

	WT	WH	RH	CRL	FL	HG	BL
WT	1.0						
WH	0.956	1.0					
RH	0.960	0.999	1.0				
CRL	0.984	0.981	0.981	1.0			
FL	0.990	0.975	0.978	0.983	1.0		
HG	0.993	0.967	0.968	0.991	0.993	1.0	
BL	0.986	0.976	0.977	0.993	0.988	0.994	1.0

Table V: Correlation table for WAD x WAD (WW)

	WT	WH	RH	CRL	FL	HG	BL
WT	1.0						
WH	0.998	1.0					
RH	0.998	0.998	1.0				
CRL	0.995	0.992	0.995	1.0			
FL	0.999	0.998	0.998	0.995	1.0		
HG	0.997	0.995	0.998	0.999	0.997	1.0	
BL	0.980	0.975	0.984	0.991	0.982	0.989	1.0

Key to tables II – V; WT – Weight, WH – Wither height, RH – Rump height, CRL – Crown-rump length, FL – Face lengths, HG – Heart girth, BL – Body length

Table VI: Lamb live birth weight and body weights

(a) Birth weight of the crosses	
Crosses	**Mean birth weight**
Purebred Yankasa lamb (YY)	2.00±0.60kg
Purebred WAD	1.63±0.82kg
Yankassa × Yankasa -WAD (YYW)	2.73±0.92kg
Ouda × Yankasa (OY)	2.35±0.67kg
Yankasa × Ouda-WAD (YOW)	2.30±0.38kg

(b) Lamb Heterosis for Birth weight (kg)

	Purebred	**Lambs**	**Crossbred lambs**	
Item	Y	W	YYW	YOW
Weight	2.0	1.63	2.73	2.30
Average	1.815		2.515	
Heterosis	0.70 (2.515–1.815)			
	$\frac{0.70}{1.815} \times 100 = 38.57\%$			

Weight and Heterosis for the weight of the lambs

	Purebred	**Lambs**	**Crossbred lambs**	
Item	Y	W	YYW	YOW
Weight	2.3	3.2	5.3	5.3
Average	2.75		5.3	
Heterosis	2.55 (5.3–2.75)			
	$\frac{2.55}{2.75} \times 100 = 92.72\%$			

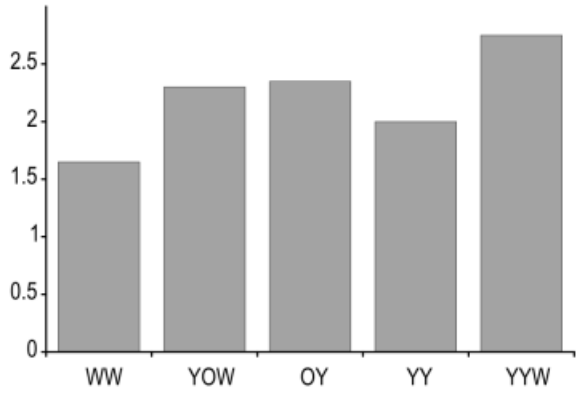

Figure 1: Bar chart showing the birth weight of lambs of some Nigerian breeds of sheep and some of their crosses.

WW – West African dwarf lambs (pure breed)
YY – Yankasa lambs (pure breed)
YOW – Yankasa x Ouda-WAD lambs
OY – Ouda x Yankasa lambs
YYW – Yankasa x Yankasa-WAD lambs (y-axis in kg)

DISCUSSIONS

The weight and body parameters of lambs in different breeding groups within the eight weeks in this study showed that average body weight of Yankasa crossed with Yankasa-West African dwarf (YYW) showed superior average body weight ($P<0.05$) than average body weights of Yankasa crossed with Yankasa (2.3±0.1kg) and West African dwarf crossed with West African dwarf (3.2±0.3kg). However, the average body

weight within this period for Yankasa crossed with Ouda-WAD (5.3±0.6kg) was similar to the average weight for Yankasa crossed with Yankasa-WAD. This may not be unconnected with height and size of Yankasa and Ouda in the combination. These may be the effect of back crossing and 3-way crossing. These are similar to reports of Salako (1999b) and Blood and Studdert (2000).

In most cases, the value of body parameters like wither height, rump length and crown-rump length are similar in YYW and YOW but lower (P<0.05) in YY and WW. The differences may not be unconnected with long-legged nature of the Yankasa and Ouda while the main contribution of the WAD will be more of the body mass. The face length in YYW (15.8±0.8cm) was lower than 16.4± 0.5cm of YOW however; both were longer than 14.5±0.6cm of WW and 12.08±0.7cm of YY. The breed differences and hybrid vigor is coming out clearly. The cross breeds had their face lengths higher than pure breeds. (Leymaster, 2002).

The heart girth and body length follow the pattern as the face length. The values for heart girth are 44.5±1.7cm; 44.2±1.9; 38.8±1.9 and 35.1±0.9cm for YYW, YOW, WW and YY respectively. The crossed Yankasa with Yankasa-WAD present a superior value when compared to other crosses and this has influenced the complementarity and bringing out the best of crossbreeding. These parameters will help in improving and monitoring growth rate in breeds especially during crossbreeding programme (Salako, 1999a). There was a high correlation (P<0.05) between the body weight (WT), wither height (WH), and other body parameters, like the rump height (RH), crown-rump length (CRL), face length (FL), heart girth (HG) and body length (BL) in Yankasa crossed with Yankasa-WAD (YYW). It means that as the body increased these other parameters increased. This is synonymous with reports of Salako (1999b) and Greiner and Kelvin (2004).

It was discovered that the mean body weight (BW) of Yankasa crossed with Yankasa was significantly higher (P<.05) compared to mean body weight of other crosses. There was a strong correlation between mean rump height and mean body length (P<.05). These confirm some reports that for certain traits, body weight may increase as the other body parameters increase either in length or in weight (Charray *et al.*, 1992; Anon, 2004). Birth weight of the lambs which is a prerequisite for rapid growth was higher (P<0.05) in Yankasa crossed with Yankasa-WAD (2.73kg) than Ouda x Yankasa (2.35kg), Yankasa x Ouda-WAD (2.30kg) and WAD x WAD which is 1.63kg. The purebred WAD lambs had the lowest birth weight (1.63kg) and purebred Yankasa (2.0kg) was also inferior to Yankasa x WAD (2.73). Ouda x Yankasa and Yankasa x Ouda--WAD birth weights were 2.35kg and 2.30kg respectively and these were lower than Yankasa x Yankasa–WAD (2.73kg) and higher than purebred WAD (1.63kg) and purebred Yankasa (2.00kg). These are advantages of crossbreeding of an animal with heavy body weight and another with light body weight but with long legs. These are similar to reports of Pagot (1993) and Greiner and Kelvin (2004).

The average body weight of crossbred lambs was 2.50kg, indicating that the effect of heterosis is 0.70 or 38.57%. The birth weight of crossbred lamb is greater than the average birth weight of purebred ewes due to increased heterozygosity of crossbred ewes. This is also observed for the weight of the ewes. This is similar to the reports that crossbred sheep have increased heterozygosity relative to breeds that produced the crossbreed. The increase in heterozygosity is the basis for heterosis or hybrid vigor (Charray *et al.*, 1992; Leymaster, 2002).

CONCLUSION

It can be concluded that breeds of sheep in Nigeria differ in different environments and in performance for traits that influence efficiency of production and product quality. Efficiency of meat production is maximized in crossbreeding systems by use of specialized sire breeds to complement characteristics of crossbred ewes. Complementarity and heterosis are clearly observed in this study. It is recommended that crossbreeding is an advantage over pure breeds in terms of birth weights, growth rates and body size.

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