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HERITABILITY ESTIMATES FOR BODY WEIGHT IN PUREAND CROSSBRED NIGERIAN GOATS

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ABSTRACT

Forty does and eight bucks of West African Dwarf (WAD) and Red Sokoto goats were mated to produce pure and reciprocal crossbreds (WADxRSG, RSGxWAD) kids whose records were used to estimate heritability of body weight at birth, weaning and yearling stages. Heritability was estimated using variance components due to sire, dam and combine sire-dam effect. Crossbred WADxRSG was not significantly different ($p>0.05$) in birth weight from the purebred WAD (1.81 vs. 1.75 kg). Significantly ($p<0.05$) positive effect of crossbreeding was observed in the yearling weights of crossbreds. Estimates of heritability for weaning weight obtained for the purebreds (WAD and RSG) and WADxSRG cross were generally high (over 60%). Dams' component heritability estimates were generally low (0.02 – 0.27) in RSGxWAD cross. Birth weight heritability estimates were low in pure WAD. Heritability estimates of yearling weight ranged from medium to high levels for all the methods of estimation except the dams' components of the crossbreds. The results obtained in this study suggests that heritability estimates of body at different stages of growth is largely influenced by breeding group but sire components heritability should be given higher preference for genetic improvement of yearling weight of WAD and SRG.

Key word: Heritability, West African Dwarf Goat, Red Sokoto Goat, crossbreeding.

INTRODUCTION

Knowledge of breed characteristics and estimation of genetic parameters for bioeconomic traits are major factors in the identification of genetic resources for goat breeding and improvement worldwide (Garcial-Peniche *et al.*, 2012). Heritability is the fractional unit of observed phenotypic variance which results from differences in heredity among the genes and gene combination of individual genotype. Prediction of response to selection and design of efficient breeding programmes for fast genetic progress therefore rely on information on heritability of production traits (Els, 1999; Kosum *et al.*, 2004).

Goats are the most numerous of all types of ruminant livestock in Nigeria. They are veritable resources for economic development and livelihood security (Yakubu *et. al.*, 2010), especially among the rural farm families. West African Dwarf goat is found largely in the coast and central Nigeria and it is trypanotolerant (Hamayun *et al.*, 2006). Red Sokoto Goat is the predominant and most widely distributed breed in the Northern savannah belts of Nigeria (Ngere *et al.*, 1984). It is also well known for its high quality skin (Akpa *et al.*, 1998). Both West African Dwarf and Red Sokoto Goats are raised primarily for meat and are known to be well adapted to the stressful tropical environment. Although some published reports exist on genetic properties

for morphometric and reproductive characteristics in both West African Dwarf and Red Sokoto Goat populations reared in Nigeria (Odubote 1994; Otuma, 2005; Akpa *et al.*, 2009; Ebegbulem *et al.*, 2011), there seem to be dearth of published information on heritability estimates of bodyweight of these two breeds of goat and their reciprocal crossbreds in an on-station research. Such comparative study is important as estimates obtained for different breeds in different locations may vary widely due to environmental influences.

The present study is aimed at estimating the heritability of birth, weaning and yearling weights in pure-bred (West African Dwarf, WAD and Red Sokoto Goat, RSG) and their reciprocal crossbred (WADxRSG and RSGxWAD).

MATERIALS AND METHODS

Experimental site: The study was conducted at the College of Agriculture, Zuru, Kebbi state, Nigeria. Zuru Local Government lies between latitude 11 – 35°N and 11 – 55°N and longitude 4° 45' to 5° 25'E. The weather is marked by a short raining season (May to October) and long dry season with a mean annual rainfall of 1025 mm (KARDA, 2007). The study was conducted in accordance with Institutional guidelines on the care and use of animals for scientific research, and in compliance with generally accepted rules of best practice worldwide.

Experimental Animal, Management and Breeding: A flock of forty 12-18 months old does and eight bucks of West African Dwarf (WAD) and Red Sokoto Goats (RSG) were maintained at the Animal Research Unit of the College of Agriculture, Zuru, Kebbi state. The animals were housed in pens and were allowed to graze on natural pasture land in addition to supplementation with crop residues in the morning. They were also supplied with concentrate diets and groundnut hay during the dry season. The animals were allotted to four breeding groups as indicated in Table 1. A mating ratio of 1:5 was used (each group contained 10 does which were serviced by 2 bucks). Estrumate® (a prostaglandin analogue) was used to synchronize oestrous in does to ensure that kids were born about the same time.

Table I: Number of sire, dam and progenies used for the evaluation of heritability

Breeding group	Number sire	Number of dam	Number of progenies
RSGxRSG	2	10	38
WADxWAD	2	10	59
WADxRSG	2	10	44
RSGxWAD	2	10	51
Total	8	40	192

WAD and RSG represent West African Dwarf and Red Sokoto Goat, respectively.

Data Collection and Analysis: Birth, weaning and yearling weights records of 192 pedigreed, pure- and crossbred kids born between 2011 and 2012 were used to estimate heritability of birth, weaning and yearling weights for the various breeding group as indicated earlier. The data were subjected to Nested design Model of ANOVA to obtain variance components due to sire, dam and progenies as reported by McKenzie and Goldman (2005).

Estimates of heritability of birth, weaning and yearling weights for the four breeding groups were determined from sire, dam and combined sire-dam variance components using following formula (Becker, 1993):

Heritability from sire component: $h^2_s = 4\sigma^2_s / \sigma^2_p$

Heritability estimates for body weight

Heritability from dam component: $h^2_d = 4\sigma^2_d / \sigma^2_p$

Heritability from sire and dam components: $h^2_{s+d} = 2(\sigma^2_s + \sigma^2_d) / \sigma^2_p$

Where σ^2_s and σ^2_d were as sated above. σ^2_p = total phenotypic variance obtained from $\sigma^2_s + \sigma^2_d + \sigma^2_e$, and σ^2_e is the variance component due to random error.

The heritability of birth, weaning and yearling weights were obtained using the following mathematical model:

$y_{ijk} = \mu + \alpha_i + \beta_{ij} + e_{ijk,}$

where:

y_{ijk} = weight of the k^{th} kid produced by j^{th} doe that was mated by the i^{th} buck

μ = mean weight

α_i = fixed effect of the i^{th} buck

β_{ij} = fixed effect of the j^{th} dam mated by the i^{th} buck

e_{ijk} = uncontrollable environmental and genetic deviations attributed to individuals.

RESULTS

Least square means for birth, weaning and yearling weights in RSG, WAD and their reciprocal crossbred progenies is presented in Table 2. Purebred RSG had a significantly heavier ($p<0.05$) birth weight than purebred WAD and both crossbred (RSGxWAD or WADxRSG) goats. Furthermore, crossbred WADxRSG had a higher birth weight than the purebred WAD (1.81 versus 1.75 kg). However, RSGxWAD cross were significantly ($p<0.05$) lower in birth weight when compared to WAD kids. The coefficients of variation (CV) for birth weight ranged between 6.32% and 10.88% among the four genotypes. Purebred RSG had significantly higher ($p<0.05$) weaning weight value than the other breeding groups. Positive effect of crossbreeding was observed in the yearling weights of the goats. The highest yearling weight was obtained in RSGxWAD. Crossbred RSGxWAD and WADxRSG yearling goats were significantly heavier ($p<0.05$) than the purebred yearling WAD goat (As shown in Table 2).

Table 2: Least square mean for birth, weaning and yearling weights (kg) of pure and reciprocal crossbred goats

Traits	Breeding group	Mean±SEM	CV	Minimum	Maximum
Birth weight, Kg	RSGxRSG	2.02^{a} ±0.03	10.25	1.40	2.40
	WADxWAD	1.75^{b} ±0.02	6.32	1.50	1.90
	WADxRSG	1.81^{b} ±0.02	9.13	1.40	2.10
	RSGxWAD	1.64^{c} ±0.03	10.88	1.30	1.90
	(SEM ±)	0.02			
Weaning weight, Kg	RSGxRSG	8.87^{a} ±0.16	12.10	6.00	10.80
	WADxWAD	8.37^{b} ±0.14	11.68	5.90	10.20
	WADxRSG	7.41^{d} ±0.13	12.13	5.30	8.90
	RSGxWAD	7.89^{c} ±0.09	7.67	6.80	9.20
	(SEM ±)	0.08			
Yearling weight, Kg	RSGxRSG	15.18^{b} ±0.21	9.57	12.50	17.40
	WADxWAD	13.50^{c} ±0.19	9.58	11.00	16.00
	WADxRSG	14.87^{b} ±0.15	7.01	13.00	16.60
	RSGxWAD	15.73^{a} ±0.10	4.21	14.60	16.80
	(SEM ±)	0.10			

Means with different superscripts a, b, c and d are significantly different ($p< 0.05$). Standard Error of Mean = SEM; Coefficient of variation = CV; RSG, WAD = Red Sokoto Goat and West African Dwarf, respectively.

Heritability estimates of birth, weaning and yearling weights in West African Dwarf (WAD), Red Sokoto Goat (RSG) and their reciprocal crossbreds are presented in Table 3. Estimates of heritability for birth, weaning and yearling weights varied from 0.02 – 055, 0.25 – 0.84 and 0.34 – 0.94 respectively across the breeding groups for sire components. Dams' components heritability estimated at the range of 0.27 – 0.81, 0.20- 0.80 and 0.04 – 75 were respectively obtained for birth, weaning and yearling weights. Heritability estimates for weaning and yearling weights were generally higher than estimates obtained for birth weight in the four breeding groups. Heritability estimates for birth weight obtained from dam and combined sire-dam variance components were generally higher than estimates obtained from the sire variance component alone. Estimates of heritability for weaning and yearling weights ranged from medium to high irrespective of the method of estimation, except for RSGxWAD cross.

Table 3: Heritability for birth, weaning and yearling weights in pure and reciprocal crossbred goats

	Breeding group	Sire ($h^2_{(S)}$)	Dam ($h^2_{(D)}$)	Sire and Dam ($h^2_{(S+D)}$)
Birth weight	RSGxRSG	0.41	0.81	0.61
	WADxWAD	0.19	0.27	0.23
	WADxRSG	0.02	0.57	0.29
	RSGxWAD	0.55	0.27	0.41
Weaning weight	RSGxRSG	0.65	0.75	0.70
	WADxWAD	0.62	0.80	0.71
	WADxRSG	0.84	0.61	0.72
	RSGxWAD	0.25	0.20	0.23
Yearling weight	RSGxRSG	0.75	0.31	0.39
	WADxWAD	0.34	0.75	0.55
	WADxRSG	0.94	0.29	0.62
	RSGxWAD	0.71	0.04	0.38

RSG WAD = Red Sokoto Goat and West African Dwarf, respectively. $h^2_{(S)}$), $h^2_{(D)}$ and $h^2_{(S+D)}$ represent heritability from sire, dam and combined sir-dam variance components, respectively.

Heritability for yearling weights obtained from sire components were higher than values obtained from both dam and combined sire-dam components (except for WADxWAD kids). Estimate of heritability for birth, weaning and yearling weights obtained for purebred RSG were medium to high (0.39 to 0.81) except for yearling weight calculated from dam variance component (0.31). Estimates of heritability for weaning weights obtained for purebred WAD and crossbred WADxRSG were generally high (over 60%). The estimate of heritability for weaning weight obtained was generally low. Heritability estimates for yearling weight ranged from medium to high (55 to 94%) in the four genotypes except for purebred WAD (0.34 obtained from sire component) and crossbred WADxRSG (0.29 obtained from dam component). However, the estimate of heritability for yearling weight obtained for RSGxWAD was generally low.

DISCUSSION

The mean birth, weaning and yearling weights obtained in this study for RSG, WAD and their reciprocal crossbred progenies were lower compared with Boer goat in South Africa (Els, 1999). However, the mean weight obtained for Red Sokoto Goat at birth and weaning were comparable to 1.8 and 7.2 kg (respectively) obtained for Red Sokoto Goat that were raised under smallholder production system at Saunawa and Amarzakawa villages in Kano state of Nigeria (Akpa *et al*., 2009). An earlier estimation of kid birth weight in Nigerian Maradi goat by Akpa *et al*. (1998) gave a similar result. The low body weights of both Red Sokoto Goat and West African Dwarf and their crossbred progenies may be due to the fact that they have not

been previously selected for meat production like the Boer goat of South Africa. The present study further suggests that crossbreeding may help to improve the yearling weights of West African dwarf goat, thereby boosting its potential for meat production. The low birth weight of RSGxWAD crossbred kids may be due to an unfavourable maternal effect of doe traits on kids' bodyweight. An evaluation of different crossbreeding programmes by Otuma (2005) showed that all the crossbred goats had lower mean birth weights except for $RSGxF_1$ backcross.

Estimates of heritability in the present study varied among bodyweight measurements as well as the method of estimation employed. Similar results were obtained by (Odubote. 1994) in his work on West African dwarf goat. The variation between breed in heritability of birth, weaning and yearling weights are consistent with earlier reports (Garcial-Peniche *et al.*, 2012, Els, 1999, Akpa *et al*., 2009). Heritability of birth weights in this study were generally close to values of 0.30 to 0.36 obtained for improved and Adelaide Boer goat of South African (Els, 1999, van Nieker *et al.*, 1996). The combined sire-dam heritability of birth weight obtained for Red Sokoto Goat in this study was in agreement with the value reported by Akpa *et al*. (2009) for Red Sokoto Goat that were reared under the smallholders' traditional system. Studies conducted in South West Nigeria by Odubote (1994) and Ebezoje and Ngere (1995) showed heritability estimates of 0.32-0.38 for litter size at birth in West African Dwarf goat and their crosses. The higher estimates of heritability for weaning weight obtained in this study (compared with the estimates for birth weight) agreed with the earlier report of Els (1999) on the South African Boer goat. The observed lower heritability of birth weight suggests significant effects of maternal and environmental influence on kid's birth weight.

The heritability of weaning weights for West African Dwarf, Red Sokoto Goat and West African Dwarf x Red Sokoto Goat cross bred in this study were similar to the estimate (0.78) obtained by Akpa *et al*. (2009) for weaning body weights in Red Sokoto Goat. The heritability estimates obtained in the present study suggests that a good prospect exist for genetic improvement of body weight in both WAD and RSG goats. However, the reliability of heritability estimates obtained in this study is limited by the small data set.

CONCLUSION

The precision of heritability value from small population sample size (as in this study) could be enhanced by using prediction models that combines available small population records with genotypic data. Variation in the magnitude of heritability estimate due to various components across the breeding groups in this study suggests that heritability estimates of body at different stages of growth is largely influenced by breeding group but sire components heritability should be given higher preference for genetic improvement of yearling weight of WAD and SRG.

REFERENCES

Akpa, G. N., Abubakar, M. Y., Nwagu, B. I. and Alphonsus, C. (2009). Genetic and relationship estimations of body weight and morphometric traits in the Red Sokoto Goat. *Animal Production Research Advances* 5(4): 232-237.

Akpa, G. N., Duru, S. and Amos, T.T. (1998). Influence of strain and sex on estimation within age group body weight of Nigerian Maradi goats from their linear body measurements. *Tropical Agriculture (Trinidad)* 75: 462-467.

Becker, W.A. (1993). Manual of Quantitative Genetics, 5th Ed., Academic Enterprises Valllman, Washington, USA.

Ebegbulem, V.N., Ibe, S.N., Ozung, P.O. and Ubua, J.A. (2011). Morphometric trait characteristics of West African Dwarf goats in Abia State, South East Nigeria. *Cont. Journal of Agricultural Sciences* 5 (2): 1 – 6.

Ebezoje, M.O. and Ngere, L.O. (1995). Genetic analysis of pre-weaning growth in West African dwarf goats and their halfbreds. *International Journal of Animal Science* 10: 247 – 251.

Els, J.F. (1999). Heritability estimates for growth traits in the improved Boer goat. http://www.nbri.org.na/old/agricola_files/Agricola1998_99_No10_09_Els.PDF. Accessed 17 August, 2013.

Garcial-Peniche, T.B., Montaldo, H.H., Valencia-Posadas, M., Wiggans, G. R., Hubbard, S. M., Torres-Vasquez, J. A. and Shepard, L. (2012). Breed Differences Over Time and Heritability Estimates for Production and Reproduction Traits of Dairy Goats in the United States. *Journal of Dairy Science* Vol. 95 (5): 2707 – 2717.

Hamayun, K., Fida, M., Riaz A., Gul N. Rahimullah and Muhammad, Z. (2006). Relationship of Body Weight with Linear Body Measurements in Goats. *Journal of Agricultural and Biological Science*. Volume1, no. 3.
http://www.arpnjournals.com/jabs/research_papers/jabs_0906_28.pdf.
Accessed 20 August, 2013.

KARDA (2007). Kebbi State Agricultural and Rural Development Authority. Metrological Report of Kebbi State Agricultural and Rural Development Authority Zone III Zuru.

Kosum, N., Taskin, T., Abas, Y. and Kaymakci, M. (2004). Heritability Estimates of Birth and Weaning Weights in Saanem, Bornova and Saanem x Killis Goat. *Pakistan Journal of Biological Science* 7(11): 1963-1966.

McKenzie, J. and Goldman, R. (2005). Student Guide to MINITAB Release 14 Statistical software (Book +CD), Minitab Inc, USA.

Ngere, L.O., Adu, I.F. and Okubanjo, I.O. (1984). The indigenous goats of Nigeria. FAO/UNEP Animal Genetic Resources Information, Food and Agricultural Organisation of the United Nations, Rome, Italy.

Odubote, I.K. (1994). Genetic Analysis of reproductive performance of West African Dwarf goats in the humid tropics. In: Small Ruminant Research and Development in Africa. *Proceedings of the Third Biennial Conference of African Small Research Network,* Kampala, Uganda, 5-9 Dec. 1994. Pp 33-36.

Otuma, M.O. (2005). Evaluation of different crossbreeding programmes, season and sex on birth weight and linear traits in Nigerian goats. *Journal of Agriculture, Food, Environment and Extension* 4 (2): 34-37.

van Nieker, M.M., Schoeman, S.J., Botha, M.E. and Case, N. (1996). Heritability estimates for pre-weaning growth traits in the Adelaide Boer goat flock. South Afr Tydskr Veek 26(1): 6-10

Yakubu, A., Salako, A.E., Imumorin, I.G., Ige, A.O. and Akinyemi, M.O. (2010). Discriminant analysis of morphometric differentiation in the West African Dwarf and red Sokoto goats. *South African Journal of Animal Science* 20 (4): 2