African Journal of Biotechnology Vol. 7 (14), pp. 2521-2526, 18 July, 2008
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2008 Academic Journals

Full Length Research Paper

Body measurement characteristics of the West African Dwarf (WAD) Goat in deciduous forest zone of Southwestern Nigeria

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Accepted 24 June, 2008

Two hundred and forty four (244) West African Dwarf (WAD) Goats comprising one hundred and sixty (160) females and eighty-four (84) males in five (5) age groups in years (0 - 1, 1 - 2, 2 - 3, 3 - 4 and 4 - 5) for female and two (2) age groups also in years (0 - 1 and 1 - 2) for males were investigated. The aim was to document the body characteristics of the WAD goats in the deciduous forest of Southwest Nigeria. Results showed that the body weights (BDW) for female and male goats averaged 5.97, 10.59, 14.59, 19.23, 20.06 males; 4.33 and 7.55 kg females respectively. The body linear measurements for male and female goats varied between 33.70 and 39.58 cm, 28.98 and 31.50 cm, 25.68 and 30.49 cm, 28.94 and 34.73 cm and 6.47 and 7.72 cm for male goats and 41.53 and 59.51 cm, 37.07 and 53.55 cm, 31.30 and 45.22 cm, 37.08 and 50.23 cm, 9.06 and 13.08 cm for female goats for heart girth (HTG), body length (BDL), height at wither (HTW), rump height (RPH) and sacral pelvic width (SPW), respectively. Age significantly (P < 0.05) influenced body weights and all the other linear body measurements in all age groups considered. In both age groups available for screening in male and female goats, that is 0 - 1 and 1 - 2 years, sex significantly (P < 0.05) influenced body weights and body linear measurements with the female consistently showing superiority. Regression analysis showed that body weights could be predicted accurately from heart girth, sacral pelvic width, body length, wither height and rump height.

Key words: WAD Goats, forest zone, body weight, linear measurements.

INTRODUCTION

Maijala, (1983) reported that genetic improvement is currently being centered on indigenous breeds because they have long been adapted to extreme harsh environmental conditions of nutrition, climate and disease and might be more productive in their own environment than the exotic breeds. They can also be valuable experimental animals in fundamental research and a potential store of unique genes, which may be useful especially when environmental concerns necessitate changes in production system (Salako and Ngere, 2002).

The indigenous small ruminant populations in Nigeria comprising sheep and goat are important genetic resources because of their adaptation characteristics such as hardiness to the stressful tropical environment and trypanotolerance (Salako, 2004). Goats are the largest group of ruminant livestock in Nigeria totaling about 345 million and are owned by the rural house holds, farmers, the small time business men and women, traders etc, with ownership spreading across all age groups and sexes (FDLPCS, 1991). The goat – an attractive, affectionate and very useful small ruminant has rendered an uncomplaining service to mankind for thousands of years. Goats primarily produce meat, skins and milk are likely to be important only in the long-term future.

Of the several breeds of goats in the world, the predo-

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minant breed in Ekiti state is the West African Dwarf goat. The majority of these are bred under the traditional management and their contribution to the total supply of meat in the region is enormous. Mason (1981) reported that many breeds of goat today are falling victim to upgrading schemes, especially the local breeds in many third world countries are being cross bred for improvement. The risk of losing many native breeds is therefore very evident and yet, even, the basic taxonomy of goat family is to date an issue being widely debated.

There is then a need to study variations among their populations via breed characters so as to facilitate their efficient utilization (Salako and Ngere, 2002). The ability of the producers and buyers to relate the live animals measurement to growth characteristics is essential for optimum production and value-based trading system. This ability will also adequately reward livestock farmers rather than the middlemen that tend to gain more profit in Livestock production business, especially in developing countries (Afolayan et al., 2006). A study of linear body measurements on most farms in the tropics is important because most farmers lack weighing scales and the education to understand their manipulations (Gerald, 1994). Linear body measurements can be used as a way of estimating weight and market value in terms of cost of the animals (Gerald, 1994).

Age of ruminant when the date of birth is not recorded is of practical importance to the breeder, the seller and the buyer and can be estimated approximately from the number of teeth that have erupted (Gerald, 1994). This study, therefore aims at studying the characteristics in body dimensions of West African Dwarf Goat (WADG), to test for possible effect of age and sex on their linear body dimensions and to establish the relationship between live weight and the body dimensions in West African dwarf goat as a step towards employing such dimensions in body weight estimation for selection and other purposes in the deciduous forest zone of southern Nigeria.

MATERIALS AND METHODS

The study was carried out in Ekiti state, Nigeria. Ekiti state is located in the deciduous forest zone of southwestern Nigeria and it is characterized by hot and humid climate. The rain period is bimodal with a short break in August. Four local government areas within Ekiti state were randomly selected for the study. In all the local government areas, measurements were taken on a total of 244 goats comprising 160 female goats and 84 male goats classified as shown in Table 1 below.

The system of management in the local government areas was semi-intensive. The animals were fed supplemental feed in form of kitchen wastes, cassava peels, yam peels, coco yam peels, food remain, seed cakes, cereal offal etc in the morning before being released to scavenge for the bulk of their feed. During the day, the animals were allowed to roam about without any form of shelter provided except when the animals decided on their own to rest under shade, while at night the animals were housed.

Each of the animals selected for measurement was restrained and calmed before measurements were taken on them to ensure that they were not unnecessarily stressed. The following measurements were taken on each of the animals examined as described by Brown et al. (1983) and adopted by Orheruata and Olutogun (1984).

Body weight (BWT): This was taken using hanging scale. The animals were turned on their back in a Hessian bag and the weight taken as the difference between the final weight and the weight of the bag.

Body length (BDL): Body length was measured using a tape-rule, as the distance from the occipital protuberance to the base of the tail.

Height at withers (HTW): A flat platform was used upon which the animal was placed. The height at wither was measured as the distance from the surface of the platform to the withers using a measuring tape.

Heart girth (HTG): The Heart girth was measured by taking the measurement of the circumference of the chest with a tape rule.

Rump height (RPH): The rump height was measured as a distance from the surface of the platform to the rump using a measuring stick.

Sacral pelvic width (SPW): This was measured by a tape rule as the circumference of the region immediately after the hind leg towards the abdomen.

Each of the animals selected for measurement was sexed and aged according to Gerald (1994) using permanent teeth eruption. All measurements were taken in the morning before the animals were fed. Each dimension taken was recorded in centimeter while the weight was recorded in kilogram. The data collected on each animal were analysed using the General Linear Model Procedure (PROC GLM) of SAS (1999) to evaluate the significance of sources of variation affecting measurements of each animal. The interrelationship of body weights and linear body measurements were estimated by simple correlation and regression (Steel and Torrie, 1980). The fixed effects considered were sex and age. The model used is as follows:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + e_{ijk}$$

Where; Y_{ijk} = record of body weight and body linear measurements of each animal; μ =overall mean; α_i = the fixed effect of i^{th} sex of the animal (male and female); β_j = the fixed effect of j^{th} age of the animal; $(\alpha\beta)_{ij}$ = interaction of i^{th} sex and j^{th} age of the animal and e_{ijk} = random error associated with record of each animal.

RESULTS

The least square means and standard errors from the general linear model analysis of body weight (BWT) and linear measurements vis-à-vis heart girth (HTG), body length (BDL), height at wither (HTW), rump height (RPH) and sacral pelvic width (SPW) of goats at the various age groups were as presented in Table 2. The overall mean body weights at age groups 0 - 1, 1 - 2, 2 - 3, 3 - 4 and 4 - 5 years old respectively were 5.31, 9.62, 14.59, 19.23 and 20.06 kg and linear measurements of 38.36, 33.78, 29.02, 32.78 and 8.01 cm; 45.26, 38.45, 34.72, 40.28, and 9.53 cm; 53.99, 48.82, 40.83, 47.56 and 11.47 cm; 58.88, 52.57, 44.74, 49.77 and 12.91 cm; 59.51, 53.55,

Table 1. Total number of goats sampled per sex and at different age groups.

Age group (years)	Number of female	Number of male	Total
0 – 1	25	40	65
1 – 2	45	44	89
2 – 3	24	-	24
3 – 4	47	-	47
4 – 5	19	-	19
Total	160	84	244

Table 2. Least square means of body weight and body linear measurements of West African Dwarf Goat.

Age Group (yrs)	No	BWT (cm)	HTG (cm)	BDL (cm)	HTW (cm)	RPH (cm)	SPW (cm)
0-1	65	5.31±0.24^{d} (30.86)	38.36±1.18^{d} (19.85)	33.78±1.18^{d} (22.69)	29.02±1.07^{d} (20.81)	32.78±1.22^{d} (18.06)	8.01±0.32^{b} (25.91)
1-2	89	9.62±0.24^{c} (20.16)	45.26±0.91^{c} (16.42)	38.45±1.03^{c} (21.71)	34.72±0.81^{c} (18.88)	40.28±0.92^{c} (18.53)	9.53±0.24^{b} (20.82)
2-3	24	14.59±0.24^{b} (8.19)	53.99±0.40^{b} (3.67)	48.82±0.17^{b} (1.86)	40.83±0.17^{b} (1.98)	47.56±0.27^{b} (2.89)	11.47±0.06^{a} (2.42)
3-4	47	19.23±0.13^{a} (4.54)	58.88±0.37^{a} (4.51)	52.57±0.54^{a} (8.16)	44.74±0.64^{a} (11.70)	49.77±0.67^{a} (10.76)	12.91±0.16^{a} (9.46)
4-5	19	20.06±0.07^{a} (1.53)	59.51±0.21^{a} (1.53)	53.55±0.17^{a} (1.49)	45.22±0.37^{a} (3.81)	50.23±0.44^{a} (4.10)	13.08±0.12^{a} (4.07)

BWT = Body weight, HTG = Heart girth, BDL = Body length, HTW = Height at wither, RPH = Rump Height, SPW = Sacral pelvic width and N = number of animals screened.
abcd within columns, means lacking a common superscript differ ($P < 0.05$).
Figures in parentheses represent the coefficients of variation.

Table 3. Least square means of body weight and body linear measurements of West African Dwarf goat.

Age Group (yrs)	Sex	N	BWT (cm)	HTG (cm)	BDL (cm)	HTW (cm)	RPH (cm)	SPW (cm)
0 - 1	F	25	5.97±0.32^{a} (26.65)	41.53±1.35^{a} (16.28)	37.07±1.34^{a} (18.08)	31.30±1.30^{a} (20.81)	37.08±1.34^{a} (18.06)	9.06±0.35^{a} (19.57)
0 - 1	M	40	4.33±0.22^{b} (21.10)	33.70±1.56^{b} (19.06)	28.98±1.58^{b} (22.42)	25.68±1.54^{b} (24.69)	28.94±1.74^{b} (24.73)	6.47±0.35^{b} (22.27)
1 - 2	F	45	10.59±0.22^{a} (13.63)	50.25±0.14^{a} (1.90)	44.03±0.21^{a} (3.25)	34.72 ±0.25^{a}(4.27)	45.21±0.27^{a} (3.95)	10.84±0.07^{a} (4.31)
1 - 2	M	44	7.55±0.22^{b} (13.42)	39.58±0.29^{b} b3.87)	31.50±0.32^{b} (5.51)	30.49±0.30^{b} (5.47)	34.73±0.35^{b} (5.39)	7.72±0.08^{b} (5.76)

BWT = body weight, HTG = heart girth, BDL = body length, HTW = wither height, RPH = rump height, SPW = sacral pelvic width, F = female, M = male.
ab within columns, means lacking a common superscript differ ($P < 0.05$).
Figures in parentheses represent the coefficients of variation.

45.22, 50.23 and 13.08 cm for HTG, BDL, HTW, RPH and SPW, respectively. Age was found to significantly influence ($P < 0.005$) body weight and linear body measurements up till age group 2 - 3 years in all the traits studied but do not differ significantly ($P > 0.05$) at age groups 3 - 4 years and 4 - 5 years .

Table 3 compares the least square means and standard errors from the general linear model analysis of body weight and body linear measurements vis-à-vis HTG, BDL, HTW, RPH SPW between female and male goats at age groups 0 - 1 and 1 - 2 years. The overall mean body weights at age group 0 - 1 were 5.97 kg for female and 4.33 kg for male while at age group 1 - 2, 10.59 and 7.55 kg were recorded for female and male goats, respectively. The linear measurements were 41.53, 37.07, 31.30, 37.08 and 9.06 cm for female and

Table 4. Coefficients of correlation between bodyweight (kg) and linear body measurements (cm).

Age group (yrs)	Sex	HTG	BDL	HTW	RPH	SPW
0 - 1	F	0.80445**	0.98366**	0.95317**	0.98448**	0.66815*
0 - 1	M	0.83283**	0.85572**	0.8720**	0.84302**	0.84740**
1 - 2	F	0.74909**	0.45731	0.31455	0.27346	0.31013
1 - 2	M	0.93429**	0.90516**	0.75587**	0.89891**	0.02871
2 - 3	F	0.47028	0.80481**	0.73094**	0.23714	0.65880*
3 - 4	F	0.66850**	0.58799**	0.82421**	0.79914**	0.42744
4 - 5	F	0.41267	0.45822	0.80125**	0.76812**	0.31954

BWT = body weight, HTG = heart girth, BDL = body length, HTW = wither height, RPH = rump height, SPW = sacral pelvic width, F = female, M = male
** (P < 0.001) * (P < 0.005).

33.70, 28.98, 25.68, 28.94 and 6.47 cm for male goats and the same record for age group 1 - 2 were 50.25, 44.03, 34.72, 45.21 and 10.84 cm for female and 39.58, 31.50, 30.49, 34.73 and 7.72 cm for male for HTG, BDL, HTW, RPH and SPW respectively. Sex significantly influenced (P < 0.005) body weight and linear body measurements for all the traits studied.

Table 4 presented the coefficients of correlation between body weight and the linear body measurements vis-à-vis HTG, BDL, HTW, RPH and SPW. Correlations between all pairs of measurements were high, positive and highly significant (P < 0.001, P < 0.005) except female goats at age groups 1 - 2 (BDW : BDL, BDW : HTW, BDW: RPH and BDW : SPW), 2 - 3 (BDW : HTG and BDW : RPH), 3 - 4 (BDW : SPW) and 4 - 5 (BDW : HTG, BDW : BDL, and BDW : SPW) that were not significant (P > 0.005).

Table 5 presented the coefficients of correlation between the linear body measurements vis-à-vis HTG, BDL, HTW, RPH and SPW. The correlations between all pairs of measurements were high, positive and highly significant (P < 0.001, P < 0.005) for all the age groups except HTG : BDL, HTG: RPH, HTG : SPW, BDL : RPH, HTW : RPH, HTW : SPW, RPH : SPW at age group 2 - 3; HTG, SPW, BDL : SPW, HTW : SPW, RPH : SPW at age group 3 - 4 and HTG :RPH, HTG : SPW, BDL : RPH, BDL : SPW, HTW : SPW and RPH : SPW.

Table 6 presented the summary of simple linear regression analysis and generating models for predicting overall growth from linear body measurements. The analysis showed that body weights can be predicted from heart girth (R^2 = 0.78), body length (R^2= 0.58), height at wither (R^2 = 0.46), rump height (R^2 = 0.41) and sacral pelvic width (R^2 = 0.66). The coefficients of determination R = r^2 between body weight and the other body linear measurements ranged between 0.78 and 0.41.

DISCUSSION

Table 1 indicated that more female animals than males were available for screening. While female animals from all age groups were available for screening, male animals from only two age groups were available for screening. This was because farmers will want to keep female goats in preference to male to minimize cost of feeding and to increase production efficiency. Most of the male animals are therefore preferably castrated and fattened for sale as meat and source of income to the owners in time of financial need at about the age of not more than two years. The net effect of this act is availability of very few male animals at age above 2 years.

Table 2 showed that age strongly influenced (P < 0.01) body weight and body linear traits in West African Dwarf (WAD) goat, as there were consistent increases in all the traits studied as the animals aged. This scenario is however not surprising since the size and shape of the animal is expected to increase as the animal is growing with age. There was wide variability as the age of the animals increased most particularly in the body weight. This was in consonance with the report of Orheruata and Olutogun, (1984) in cattle.

The variability as the animals' aged sharply reduced between age groups 3 - 4 years and 4 - 5 years in all the traits examined as shown in the table most probably because the matured body weight of the animal was almost fully attained. This finding was in agreement with the work of Jeffery and Berg (1972) who reported that at maturity, linear body measurements are essentially a constant**,** thereby reflecting heritable size of the skeleton. The body conditions of the animals investigated could be said to be good and the skeletal development normal by the consistent increases noticed in wither height and the heart girth of the animals as they aged. This is consistent with the report of Jeffery and Berg, 1972 that the height at wither at any given time reflects the animal's skeletal size and the heart girth reflects body conditions.

Table 3 showed the effect of sex on body weight and body linear measurements. The tables revealed that sex is an important source of variation for body weight and body linear measurements at the two age groups of male animals available for measurement. In this study does (females) were heavier than bucks (males) at these ages and the linear measurements were superior because fe-

Table 5. Coefficients of correlation between the variables.

Age (yrs)	Variables	HTG	BDL	HTW	RPH	SPW
0 - 1						
	HTG		0.91878**	0.94384**	0.90003**	0.85975**
	BDL			0.98049**	0.97947**	0.84766**
	HTW				0.96039**	0.82900**
	RPH					0.83358**
1 - 2						
	HTG		0.99396**	0.98246**	0.98119**	0.97430**
	BDL			0.99402**	0.98899**	0.98322**
	HTW				0.98285**	0.97754**
	RPH					0.98744**
2 - 3						
	HTG		0.62811	0.65347*	0.63269	0.45584
	BDL			0.83466**	0.41816	0.75582**
	HTW				0.37983	0.62260
	RPH					0.26732
3 - 4						
	HTG		0.80270**	0.55708**	0.55523**	0.25160
	BDL			0.52189*	0.50465*	0.35753
	HTW				0.73254**	0.43993
	RPH					0.47462
4 - 5						
	HTG		0.80064**	0.66196*	0.52997	0.54143
	BDL			0.62332*	0.50378	0.68026
	HTW				0.89966**	0.53262
	RPH					0.34086

BWT = Body weight, HTG = Heart girth, BDL = Body length, HTW = Height at wither, RPH = Rump Height, SPW = Sacral pelvic width and F = Female, M = Male.
** ($P < 0.001$) * ($P < 0.005$).

Table 6. Simple regression models for predicting overall growth from linear body measurements in West African Dwarf Goat.

Dependent (Y)	Independent (X)	Regression equation	S.E	R^2 values
BDW	heart girth (HT)	-13.60 + 0.53X	0.02	0.78
BDW	body length (L)	-9.25 + 0.53X	0.03	0.57
BDW	wither height (HW)	-7.6 + 0.57X	0.04	0.46
BDW	rump height (RH)	-7.6 + 0.49X	0.04	0.41
BDW	sacral pelvic width (P)	-8.19 + 2.01X	0.10	0.66

BDW = Body weight, HT = Heart girth, L = Body length, HW = Height at wither, RH = Rump height and P = Sacral pelvic width.

male goats grow faster than the bucks at early stage. This sex influenced differences in body weight and linear measurements might be partly due to hormonal effect, that is, non release of androgen (which is known to have growth and weight - stimulating effects) in male animals until the testes are well developed (Frandson and Elmer, 1981). It is therefore safe to say that in the experiment, sex significantly influenced body weights and body conformation in West African Dwarf goats. This report is in consonance with the works of Ifut et al. (1991), Akpa et al. (1998) and Devendra and Burns, (1983) that both sex and strains significantly influenced body weight and linear traits. Olutogun et al. (1983) reported a non-significance effect of sex on body weight and linear measurements except heart girth because the animals measured were brought for sale and were probably therefore made to appear robust by feeding them grasses and water *ad-libitum* before bringing them to market for sale to attract good prices and because male animals usually have larger gut fill than the females**,** they then tend to assume

false weight.

Correlations between body weight and body linear measurements were high, positive and highly significant ($P < 0.001$, $P < 0.005$) except in few cases in female goats at age groups 1 - 2, 2 - 3, 3 - 4 and 4 – 5 years. This implies that body weight and all linear measurements covary positively. These findings are consistent with the reports of Orheruata and Olutogun, (1984) and Salako and Ngere, (2002).

The correlations between all pairs of linear body measurements were high, positive and highly significant ($P < 0.001$, $P < 0.005$) in all the age groups except in few cases at age groups 2 - 3, 3 - 4 and 4 - 5 years that were not significant ($P > 0.005$). The high correlation between height at wither and heart girth on one hand and body length on the other hand confirm the report of Buvanendran et al (1982) who reported that frame size and absolute height were complementary and that the total size of the animal is a function of length, height and circumference measurements. Low correlation is a confirmation of non- suitability of the parameters as a measure of the other parameter in the breed under study (Raymond et al., 1982).

Based on linear regression model, live weight changes with linear body measurements and were strongly predictable with R^2 values ranging from 0.41 - 0.78 though the significance of the differences between the regression models was not tested. The R^2 values showed that 41 to 78% of every one-kilogram change in body weight is caused by the variables while other factors not considered are responsible for between 22 and 59%. Unambiguously therefore, heart girth, sacral pelvic width, body length, height at wither and rump height in the arranged order of suitability could be used to predict the weight of the animal accurately. Simple regression models that can be used when measurement is to be based on body weight alone are shown below:

Body weight = 0.53 heart girth – 13.60
Body weight = 0.53 body length – 9.25
Body weight = 0.57 height at wither – 7.63
Body weight = 0.49 rump height – 7.6
Body weight =2.01 sacral pelvic width – 8.19.

Conclusion

Body weight and linear measurements are important traits in meat animal. The analyses of data on body measurements provide quantitative measure of body size and shape that are desirable, as they will enable genetic parameters for these traits to be estimated and also permit inclusion in breeding programmes. Both sex and age had significant influences on body measurements at different ages and this finding should be considered in improvement programme to increase meat yield from goat.

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