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Comparative evaluation of live body weight, linear body measurement and carcass characteristics of West African dwarf and red sokoto goats in Abak municipality, Akwa Ibom State

Sam, I. M. and Ekpo, J, S.
Department of Animal Science, Faculty of Agriculture,
Akwa Ibom State University, Nigeria
Corresponding author: sidorenyin@yahoo.com; 08029004857

Abstract

Goats are kept primarily for meat in Nigeria, their body weight and body dimensions are important carcass trait of interest. Several approaches have been adopted to utilize body weight and linear body measurement in predicting carcass composition in goats. However this information on prediction of carcass composition from body weight and linear body measurements is limited for goats raised in the southern region of Nigeria. A study was conducted to determine the relationship between live body weight, linear body measurements and carcass characteristics of West African dwarf (WAD) goats and Red Sokoto (RS) goats. Live body weight (LBW), Heart girth (HG), Body depth (BD), Rump height (RH), Height at wither (HW) and Body length (BL) were the linear body measurements. Neck, hind limbs, head, slaughtered weight; empty carcass, fore limb and warm carcass were measured for carcass traits. Internal offals weighed were spleen, liver, lung, heart, kidney and empty gut. Twenty West African Dwarf goats (10 males and 10 females weighed 15.00 ± 0.10kg and 14.25 ± 0.50kg respectively) and twenty Red Sokoto (10 males and 10 females weighed 21.80 ± 0.67kg and 20.50 ± 0.12kg respectively)between the ages of 2-3 years were used for this study. Data obtained were analyzed using t-test, correlation analysis and multiple regressions. Results showed that the mean live body weight of WAD goats and RS goats were 14.63±0.46 and 21.13±0.36, respectively. Average linear body measurements of WAD and RS goats showed significant ($p<0.05$) differences in all the parameters except BL with RS goats having higher values . Average carcass traits of the two breeds of goats were significantly ($p<0.05$) different in hind limb, slaughtered weight and fore limb weight in favour of RS goats. Internal edible offal weight of both breeds differed significantly ($p<0.05$) in spleen, heart and kidney. There were significant positive correlations ($P<0.001$) between live body weight and linear body measurements in both breeds Strong and positive significant correlation ($P<0.05$) were also observed between linear body measurement and most of the carcass traits measured. The highest R^2 values in both breeds of goat were obtained when all the body measurements were included in the regression equations. It can be concluded that the correlation between linear body measurements can serve as selection criteria in improving carcass traits for better meat production. Moreso, carcass traits could be estimated more accurately by combination of two or more linear measurements.

Key words: *Goat, Breeds, Body weight, Linear measurements, Carcass traits*

Évaluation comparative du poids corporel vivant, de la mesure corporelle linéaire et des caractéristiques de la carcasse de West African dwarf et chèvre de red sokoto dans la municipalité d'abak, état d'akwa ibom

Résumé

Les chèvres sont élevées principalement pour la viande au Nigéria, leur poids corporel et leurs dimensions corporelles sont d'importants traits de carcasse intéressants. Plusieurs approches ont été adoptées pour utiliser le poids corporel et la mesure linéaire du corps dans la prédiction de la composition de la carcasse chez les chèvres. Cependant, ces informations sur la prédiction de la composition de la carcasse à partir du poids corporel et des mesures corporelles linéaires sont limitées pour les chèvres élevées dans la région sud du Nigéria. Une étude a été menée pour déterminer la relation entre le poids vif, les mesures corporelles linéaires et les caractéristiques de la carcasse des chèvres West African Dwarf (WAD) et des chèvres Red Sokoto (RS). Le poids vif (LPV), la circonférence du cœur (CC), la profondeur du corps (PC), la hauteur de la croupe (HC), la hauteur au garrot (HG) et la longueur du corps (LC) étaient les mesures corporelles linéaires. Cou, membres postérieurs, tête, poids abattu ; la carcasse vide, le membre antérieur et la carcasse chaude ont été mesurés pour les caractéristiques de la carcasse. Les abats internes pesés étaient la rate, le foie, les poumons, le cœur, les reins et l'intestin vide. Vingt chèvres de West African Dwarf (10 mâles et 10 femelles pesaient respectivement 15,00 ± 0,10 kg et 14,25 ± 0,50 kg) et vingt Red Sokoto (10 mâles et 10 femelles pesaient respectivement 21,80 ± 0,67 kg et 20,50 ± 0,12 kg) âgés de 2 ans -3 ans ont été utilisés pour cette étude. Les données obtenues ont été analysées à l'aide d'un test t, d'une analyse de corrélation et de régressions multiples. Les résultats ont montré que le poids vif moyen des chèvres WAD et des chèvres RS était de 14,63 ± 0,46 et 21,13 ± 0,36, respectivement. Les mesures corporelles linéaires moyennes des chèvres WAD et RS ont montré des différences significatives ($p<0,05$) dans tous les paramètres sauf LC, les chèvres RS ayant des valeurs plus élevées . Les traits de carcasse moyens des deux races de chèvres étaient significativement ($p < 0,05$) différents pour les membres postérieurs, le poids à l'abattage et le poids des membres antérieurs en faveur des chèvres RS. Le poids interne des abats comestibles des deux races différait significativement ($p<0,05$) dans la rate, le cœur et les reins. Il y avait des corrélations positives significatives ($P<0,001$) entre le poids vif et les mesures corporelles linéaires dans les deux races. Une corrélation significative positive et forte ($P<0,05$) a également été observée entre la mesure corporelle linéaire et la plupart des traits de carcasse mesurés. Les valeurs R^2 les plus élevées dans les deux races de chèvres ont été obtenues lorsque toutes les mesures corporelles ont été incluses dans les équations de régression. On peut conclure que la corrélation entre les mesures corporelles linéaires peut servir de critère de sélection pour améliorer les caractéristiques de la carcasse pour une meilleure production de viande. De plus, les traits de carcasse pourraient être estimés avec plus de précision en combinant deux ou plusieurs mesures linéaires.

Mots-clés : Chèvre, Races, Poids corporel, Mesures linéaires, Caractéristiques de la carcasse

Introduction

The rapid increase in the population of Nigeria has led to more demand for animal and animal products to meet up with the minimum animal protein requirement per individual per day Ekpo *et al*., 2022. The human population in Nigeria is estimated at about 218.5. million (Worldometer, 2022, this population is continuously on the increase annually. Goats constitute the

largest group of small ruminant livestock in Nigeria totalling about 73.8 million and also constituting 6.2 percent of the World's goat population (Live GAPS,2022).

Goats are reared primarily for meat production in Nigeria; as such body weight is a major carcass trait of interest. It is an important criterion in meat producing animals. The Nigerian indigenous goats have been phenotypically classified into three distinct breeds. The Sahel, Red Sokoto and West African Dwarf goats, these three breeds dominate the goat meat-producing industry in Nigeria; these breeds have been classified as separate breeds according to phenotypic traits, origin, function, body size, length or height (Alphonsus et al., 2010). Goat meat is accepted by the people of all communities in Nigeria irrespective of tribe or religion. The West African Dwarf and Red Sokoto goats are known to have very high rate of fertility and fecundity, their meats are delicacies (Sam, 2012). Carcass weight of animal depends on the rate of gain, weight at slaughter and dressing percentage (Sam *et. al.,* 2016). There are several studies utilizing correlations to express the relationship between body measurements variables and /or growth performance with carcass traits. These number of approaches have been adopted for utilizing body weight and linear measurements such as heart girth, body length and height at wither in predicting carcass composition in goats (Singh *et. al.*, 1983; Sam *et. al.* 2012 and Sam *et. al.* 2016). Prediction of the carcass traits from body linear measurement of Red Sokoto (RS) and West African Dwarf (WAD) is yet to be carried out in the tropical rainforest zone, particularly, the southern region of Nigeria. There is paucity of information on the prediction of carcass parameters from linear body measurement in goats. Therefore, the objectives of this work were to evaluate the influence of breeds on live body weight, linear body measurement and carcass traits as well as to establish the phenotypic correlation between live body weight, linear body measurement and carcass traits of West African Dwarf and Red Sokoto.

Materials and Methods

Experimental Site

The study was carried out at the Goat Unit. Department of Animal Science, Akwa Ibom State University, Obio Akpa Campus. Obio Akpa campus is located between latitude 5 17^{o}N and 5 27^{o}N and between 27^{o}W and 58^{o}E with an annual rain fall ranging from 3500mm and 5000mm and average monthly temperature if 25^{o}C and relative humidity 60-90% (Wikipedia, 2016).

Experimental Animal and Management

A total of 40 animals consisting of 20 Red Sokoto goats (10 males and 10 females weighed 21.80 ± 0.67kg and 20.50 ± 0.12kg respectively) and 20 West African Dwarf goats (10 males and 10 females weighed 15.00 ± 0.10kg and 14.25 ± 0.50kg respectively) were used in this research. The animals were purchased from local livestock market in Abak. The animals that were used in the research were 2 -3 years of age determined by checking their dentition, thus only animal with 2 and 3 pairs of incisors were selected. The animals were kept for two weeks after procurement and fed with forages and water provided *ad libitum*.

Carcass Evaluation

A total of twenty goats (five males and fivefemales of WAD ; 5 males and 5 females of RS) were starved of feed for 12 hr prior to slaughtering. Slaughtering was carried out as described by Yami (2009). The animals were weighed, stunned and slaughtered by severing the head at its articulation with the atlas vertebra. The goats were processed according to the procedures of Okubanjo (1997). Thereafter, the carcasses were washed and

eviscerated. This involved making a sharp incision down the abdomen to enhance removal of gastro internal tracts with its content. The eviscerated weights were determined by subtracting the weights of the gut content from the pre-slaughter weight. The warm weights of the heart, liver, kidney and lungs were also taken using electronic weighing scale (AS3101) and calculated as percentages of live weight. Thereafter, carcasses were fabricated into primal cuts such as neck, forearm,hind leg, head and Ends using a sharp knife. Dressing percentage was calculated according to Ouhayoun and DalleZotte (1996) as the ratio of dressed warm carcass weight to Live weight and multiplied by 100 thus: Dressing % = (Dressed warm carcass weight/Live weight) x 100 . Finally, the legs and loin cuts were further dissected into muscles and bone with ligaments. These components were weighed and the weights pooled to obtain the meat: bone ratio.

Data Collection

Data on live body weight and linear body measurement were obtained according to procedure described by Sam *et al*., (2016) as follows: **Live body weight (LBW):** the body weight was taken for each goat using weighing scale in kilograms (kg).

Body depth (BD): this was measured with a measuring tape as the at the circumference of the region immediately after the hind leg towards the abdomen in centimeter.

Rump height (RH): this was recorded as the distance from the ground to the rump using a measuring tape in centimeter.

Height at wither (HW): this was measured as the distance from the ground level to the wither using a measuring tape in centimeter.

Heart girth (HG): this was measured as the circumference of the chest using a measuring tape in centimeter.

Body length (BL): this was measured as the distance from the occipital protuberance to the base of the tail using a measuring tape in centimeter.

Face length (FL): this was measured from the tip in-between the on down to the lower jaw region of the mouth using a tape in centimeter

Ear length (EL): this was measured from the back base of the ear to its tip with tape.

Tail length (TL): this was measured from the base of the tail to the tip of the tail using tape .

Carcass Parameters

The carcass parameters studied were the neck, shoulder, hind limb, tail, ribs, head and lumber region. They were separated and weighed individually using a weighing scale in kilograms. **Neck:** was prepared from a carcass by a cut through and between the 3rd and 4th cervical vertebrae which is the dorsal cutting line preparation for the Square Cut Shoulder. **Leg:** All the hind limb cuts were prepared from a Leg-Chump by following their natural seams and trimmed accordingly. **Warm carcass**: The warm carcass weight (WCW) was the weight of carcass in kilogrames after the head, skin, contents of thoracic and pelvic cavities and limbs distal to the carpal and tarsal joints were removed. **slaughtered weight**: This refers to the weight of animal after slaughtering. **Empty Gut:** This was obtained after the gut content was emptied and cleansed. **Empty liveweight:** This was obtained after subtraction of gut from slaughtered weight . The Ends was determined by adding six (6) abdominal ribs and belly while the **Loin** was referred to the lumbar region and a pair of ribs.The **Sets** is the combination of the breast and the neck. All the meat cuts were in line with the procedure of Adebowale and Ademosun (1981)

Statistical Analysis: Data collected in the experiment were subjected to an independent. T-test to compare treatment means between the two breeds. Correlation analysis was done to determine the

relationship between live body weight, linear body measurement and carcass traits. Simple and multiple regression were used to predict live body weight and carcass traits from linear body measurement. All analysis was done using SPSS 2000 version.

Results and Discussion

Live body weight and Linear body measurements

The live body weight and linear body measurement in WAD and RS goats is shown in Table 1. The result indicated that there were significant ($p<0.05$) differences in all the parameters measured except body length. The mean live body weight of WAD goats was noted as (14.63 ± 0.46) while mean live body weight of RS goats recorded (21.13 ± 0.36). The linear body measurements of West African Dwarf goats were, 23.50 ± 1.50, 20.31 ± 1.26, 17.00 ± 1.46, 19.38 ± 0.46 and 25.50 ± 0.63 for HG, BL, HW, RH and BD respectively. While linear body measurements of Red Sokoto were 25.88 ± 0.23, 22.19 ± 0.77, 22.81 ± 0.25, 24.13 ± 0.61 and 28.69 ± 0.51 for HG, BL, HW, RH and BD, respectively. When comparing the values, RS goats had higher live body weight and linear body measurements than the WAD. This is expected, the RS goats have been reported to have higher live body weight than the WAD, Adu (1979). The linear body measurements in the present study were similar to those reported by Sam, 2012 for RS goats and Sam *et al.,* 2016 for WAD goats. The average live body weight of 21.13kg agrees with the range of 20-40 kg reported by Sam,2012 and Osuhor *et al*., (2002) for both males and females RS, and the average LBW of 14.63±0.46 agrees with the reports of Sam *et al*., 2016 who reported 21-23 kg in 2-3 years old WAD goats. The HG, BL, HW, RH and BD are all in agreement with earlier reports of Sam *et al.,* 2016 for WAD goats. Adeyinka and Mohammed (2006) reported lower mean body weight in RS goats, which is at variance with the present study. Variances between these studies may be as a result of the breed of goat, the season and the environmental condition of the area.

Table 1: Average live body weight and linear body measurement of WAD and RS goats

Parameters	WAD	RS	LOS
Live body weight(kg	14.63±0.46	21.13±0.36	**
Heart girth(cm)	23.50±1.50	25.88±0.23	**
Body length(cm)	20.31±1.26	22.19±0.77	NS
Height at wither(cm)	17.00±1.46	22.81±0.25	**
Rump height (cm)	19.38±0.46	24.13±0.61	**
Body depth(cm)	25.50±0.63	28.69±0.51	**

**= significant ($P<0.05$) difference, NS= non significantly ($P>0.01$) difference, LOS= level of significant, WAD = West African Dwarf, RS = Red Sokoto

Carcass characteristics

Average carcass weight in WAD and RS goats is presented in Table 2. Significant ($p<0.05$) differences were observed in hind limb weight, dead weight and fore limb weight, while neck weight, head weight, empty carcass weight and warm carcass weight showed no significant ($p>0.05$) difference. The average carcass weight recorded in WAD goats were (647.38 ±65.58, 1920.00 ± 20. 09, 1066.25 ± 60.09, 13.94 ± 0.05, 8687.50 ± 365.20, 1527.50 ± 30.06, 7362.50 ± 583.38 and 48.27 ± 2.36) for neck, hind limb, head, dead weight, empty carcass weight, fore limb, warm carcass weight and dressing percentage respectively, while average carcass weight recorded for RS were (681.25 ± 43.24, 1275.00 ± 36.60, 1081.25 ± 31.25, 17.63 ± 0.73, 9437.00 ± 470.16, 1850.00 ± 32.73,

8100.00 ± 279.03 and 37.63 ± 37.63) for neck, leg, hind limb, dead weight, empty carcass weight, fore limb, warm carcass weight and dressing percentage respectively. In comparison, the values for RS goats were higher in all parameters except for hind limb weight which was higher in WAD goats. The high value obtained in WAD goats over RS goats for hind limb weight may be attributed to variances in the amount of marble fat in different breeds Shija *et. al*. (2013). Shija *et. al.* (2013) reported 20.50kg warm carcass and 18.67kg empty carcass. Shija *et. al.* (2013) values were above the values obtained in this study, probably due to differences in breeds used. Dressing percentage is an indication of how much meat a carcass can yield. The result of this study showed that WAD goats can yield more meat than RS goat base on their LBW. This suggests that if properly managed better meat production could be achieved. The dressing percentage of 48.27% and 37.63% recorded for WAD and RS respectively is in line with range of dressing percentage for goats given to be between 35-55 % as reported by Steven *et al*, 2021.

Table 2: Carcass characteristics of WAD and RS goats

Parameters(g)	WAD	RS	LOS
Sets (kg)	1.65±65.58	1.68±43.24	NS
Hind limb (kg)	1.92±20.09	1.27±36.60	**
Head (kg)	1.06±60.90	1.08±31.25	NS
slaughtered weight (kg)	13.94±0.50	17.63±0.73	**
Empty live weight/ carcass (kg)	8.68±36.20	9.44±47.16	NS
Fore limbs (kg)	1.53±30.06	1.85±32.73	**
loin(kg)	1.50±35.06	2.20 ±30.06	NS
Ends(kg)	1.02±0.66	1.36±0.73	NS
Dressed warm carcass (kg)	7.36±58.38	8.10±27.03	NS
Dressing percentage(%)	50.30±2.36	38.33±37.63	**
Pre slaughter weight (kg)	14.63±0.46	21.13±0.36	**
Muscle(kg)	3.26±0.53	2.31±0.43	**
bone(kg)	1.69±0.13	2.99±0. 17	**
Muscle/bone ratio	1.93±0.68	0.77±0.81	**

**significant (P<0.01) difference, NS= non significantly (P>0.01) difference, LOS= level of significant, WAD = West African Dwarf, RS = Red Sokoto

The Values for internal edible offal of WAD and RS goats are shown in Table 3. The result showed that there were significant (P<0.05) differences in spleen, heart and kidney while liver, lung and empty guts had no significant (p>0.05) differences. The mean internal offals weight of WAD were (18.88 ± 1.16, 249.50 ± 50.00, 163.75 ± 4.34, 65.13 ± 3.26, 39.63 ± 2.60 and 518.00 ± 45.21) for spleen, liver, lung, heart, kidney, and empty gut respectively while mean internal offal weight of RS were (29.50 ± 2.64, 306.88 ± 22.48, 210.13 ± 15.24, 92.88 ± 2.76, 53.88 ± 3.65 and 624.88 ± 25.68) for spleen, liver, lung, heart, kidney, and empty gut respectively. Comparing the two breeds, RS goats had higher values than WAD goats in all the parameters. Abd-Alla (2014) reported 25.0, 384.0, 274.5, 90.5 and 60.0g for spleen, liver, lungs, heart and kidney, respectively for RS goats. However the value for internal edible part in this study for RS goats were similar to values reported by Abd-Alla (2014) except kidney weight, which was lower in this study. The empty guts value for WAD goats was below while that of Red Sokoto goats was within the range of 624 - 801g obtained by Alexandre *et. al.* (2008). In recent times consumer preference for edible internal offal has increase, primarily due to affordability, nutritional value and taste.

Table 3: Internal edible offal weight of WAD and RS goats

Parameters	WAD	RS	LOS
Empty gut (g)	518.00±45.21	624.88±25.68	NS
Spleen (%)	0.23±1.16	29.50±2.64	**
Liver (%)	2.87±50.00	306.88±22.48	NS
Lungs (%)	1.88±4.34	2100.13±15.24	NS
Heart (%)	0.75±3.26	9.88±2.76	**
Kidney (%)	0.45±2.60	53.88±3.65	**

**= significant (p< 0.01) difference, NS= non significantly (P>0.01) difference, LOS= level of significant,WAD =West African Dwarf, RS=Red Sokoto. (%)=percentage of empty carcass

Phenotypic correlation between live body weight, linear body measurement and carcass traits of WAD (below diagonal) and RS goats (above diagonal)

Table 4 shows the relationship between live Body weight, linear body measurement and carcass traits in West African dwarf and Red Sokoto goats. Live body weight had positive and significant ($p < 0.05$) correlation with all the parameters measured in both WAD and RS goats. The highest coefficient of correlation was observed between LBW and BL ($r = 0.90$) followed by relationship between LBW and leg ($r = 0.77$), LBW and RH (0.68) in West African Dwarf goat. In WAD, negative correlations were observed between HG and BL ($r = -0.38$), BL and HW ($r = -0.74$), BL and RH ($r = -0.19$). Negative correlations were also observed between dead weight and HW ($r = -0.34$), DW and RH (-0.25). In Red Sokoto, ranges of low positive to negative estimates were observed between the parameters measured. Live body weight was positively and significantly ($p < 0.05$) correlated with all the parameter measured except DW which had no correlation at all with LBW ($r = 0.00$). But negative correlations were observed between HW and other parameter measured except its relationship with leg ($r = 0.02$), DW ($r = 0.33$) and hand 0.02. Significant ($p < 0.01$) correlations were found between live body weight and empty carcass in both breeds, WAD and RS ($r = 0.80$ and $r = 0.40$ respectively). This indicate that Warm Carcass is strongly correlated with live weight, this result is in agreement with reports of Raham, 2007, The results suggest that improvement in LBW will lead to corresponding increase in warm carcass weight. Most of the linear body measurements in the population of goats studied were positively correlated with carcass traits. Therefore, selection to improve any of these traits may lead to the improvement in carcass traits of the goats. The inter-relationship between the linear body measurements HG, BL, HW and BD which were mostly positive suggest that these variables measure the conformation of the goats. Positive relationship between linear body measurements had earlier been reported (Khan, 2006, Zujovic *et al*., 2011, Sam, 2012, Sam *et al*., 2016).

Prediction of live body weight from linear body measurement in WAD and RS goats.

Regression equations for estimating live body weight from linear body measurements for WAD and RS goats are shown in Table 5. The result indicates that in WAD goat, the equations with BD and RH alone had the highest coefficient of determination R^2 (0.46 and 0.47, respectively). This indicates that 46% and 47% of the variance in LBW was explained by the model respectively. The R^2 values increased as the no of variables increased. When RS goats were considered, the highest R^2 value was obtained when HW was used. It was also observed that the R^2 value increased to 0.91 (91%) when the all variable were included in the equation. This result agrees with Sam *et al*. (2016) who

reported that R^2 may be confidently applied to investigate the fitting state of simple and multiple regression models to actual data for estimation of body weight in livestock. These findings are in contrary with that of Sam *et al*. (2016) who reported that HG as the best predictor of weight. Bhattacharya *et al*. (1984) and Islam *et al*., (1991) also reported that body length and heart girth as good reliable predictors to assess live body weight in Bengal goats.

Table 4: Correlation between live body weight, linear body measurements and carcass traits in WAD and RS goats

	LBW	HG	BL	HW	RH	BD	Neck	Legs	Head	DW	EC	Hands
LBW	1	0.51	0.38	0.03	0.43	0.52	0.56	0.33	0.30	0.00	0.40	0.37
HG	0.58*	1	0.37	-0.21	0.40	0.33	0.57	0.05	0.20	0.28	-0.14	0.30
BL	0.90**	-0.38	1	-0.51	0.94**	-0.47	0.40	0.10	0.07	-0.28	0.20	0.27
HW	0.25	0.46	-0.74	1	-0.33	-0.10	-0.25	0.02	-0.12	0.33	-0.03	0.02
RH	0.68*	0.73**	-0.19	0.50*	1	-0.44	0.31	-0.02	0.06	-0.06	0.23	0.33
BD	0.27	0.34	0.14	0.24	0.09	1	-0.18	0.10	0.36	0.50	-0.59	0.14
Necks	0.61**	0.26	-0.02	0.01	0.42	-0.37	1	0.69*	0.82**	0.22	0.38	0.77**
Hind leg	0.71**	0.61*	0.26	-0.02	0.01	0.42	0.37	1	0.68*	0.05	0.09	0.48
Heads	0.77**	0.76**	-0.31	0.41	0.68*	-0.44	0.72**	0.49	1	0.62*	-0.00	0.89**
DW	0.13	0.12	0.22	-0.34	-0.25	0.43	-0.40	0.52*	-0.15	1	-0.10	0.69
EC	0.80**	0.75**	0.03	0.31	0.68*	0.44	0.14	0.77**	0.66**	0.37	1	-0.03
Fore limbs	0.38	-0.04	0.42*	-0.59	0.10	0.34	0.74	0.20	0.26	0.00	0.05	1

* = (P < 0.05) ** = (P > 0.001)

Table 5: Regression equation for estimating live body weight from linear body measurement in WAD and RS goats

Breed	Regression equation	R^2	SEE
WAD	Y=2.95+0.49 (HG)	0.33	1.13
	Y=15.19+(-0.39) (BL)	0.11	1.38
	Y=10.17+0.25(HW)	0.07	1.33
	Y=2.37+0.62(RH)	0.46	1.02
	Y=17.58+(-0.12)(BD)	0.47	1.13
	Y=10.82+0.62HG+(-0.43)BD	0.49	1.28
	Y=7.36+0.67+(-0.39)BD+0.06BL	0.52	1.51
	Y=2.71+0.40HG+(-0.21)BD=0.64BL+0.33RH	0.01	1.38
	Y=-3.33+(-0.92)BD+1.16HG+0.65RH+1.09HW+0.37BL	0.64	1.86
RS	Y=-21.94=1.56HG	0.27	2.31
	Y=12.11+0.17BL	0.03	2.87
	Y=-3.12+1.04HW	0.65	1.72
	Y=-13.24+1.45RH	0.60	1.84
	Y=-5.55+0.81BD	0.40	2.26
	Y=-16.50+0.24HG+1.31RH	0.60	2.01
	Y=-21.37+0.64HG+0.39RH+0.75HW	0.78	1.62
	Y=-29.21+0.86HG+(-0.005)RH+0.99HW+0.31BL	0.90	1.30
	Y=-30.62+1.16HG+(-0.32)RH+1.27HW+0.04BL+(-2.65)BD	0.91	1.50

R^2=coefficient of determination, SEE=standard error of estimation

Prediction of warm carcass from linear body measurement in WAD and RS goats

The regression equations for estimating warm carcass weight from linear body measurements for both WAD and RS goats are shown in Table 6. From the results, warm carcass weight could be predicted accurately from HG for WAD goats. For RS goats, none of the parameters showed high coefficient of determination except when all were included in the equation. But in WAD, when HG was included in the equation, R^2 value of 0.62 was obtained. The R^2 values increased as the no of variables increased, therefore as more variable were included the R^2 values also increased. When all the five variables were included in the equation, the R^2 and SEE values were 0.77 and 3050.36 respectively for WAD goats.

Table 6: Regression equation for estimating warm carcass from linear body measurement in WAD and RS goats

Breed type	Regression equation	R^2	SEE
WAD	Y=-14229.16+917.70HG	0.620	1186.95
	Y=9838.79+(-129.75)BL	0.067	1862.76
	Y=-2503.57+575.00HW	0.213	1710.36
	Y=-11218.00+958.75RH	0.565	1271.93
	Y=-3041.07+412.50BD	0.073	1856.50
	Y=-15993.75+596.97HG+481.25RH	0.688	1205.09
	Y=-16232.50+587.50HG+462.50RH+50.00HW	0.689	1388.94
	Y=3467.15+873.46HG+140.53RH+682.75HW+301 .10BL	0.772	1455.80
	Y=-33086.68+(-154.53) BD+1018.29HG+ (- 36.35)RH+838.54HW+344.31BL	0.774	3050.36
RS	Y=5100.00+105.00HG	0.029	840.13
	Y=9467.30+(-69.23)BL	0.071	821.40
	Y=7985.08+6.40HW	0.000	852.32
	Y=7431.93+33.61RH	0.040	850.80
	Y=8427.66+(-12.51)BD	0.001	851.95
	Y=4800.00+197.72HG+(-72.72)RH	0.037	916.36
	Y=4752.00+201.71HG+(-81.78)RH+7.38HW	0.037	1024.41
	Y=6694.12+148.29HG+17.91RH+(-62.75)HW+(-79.14)BL	0.115	1133.89
	Y=7363.09+4.97HG+169.78RH+(-186.050HW+(-137.97)BL+128.217BD	0.143	1366.92

R^2=coefficient of determination, SEE=standard error of estimation

Prediction of hind limb weight from linear body measurement in WAD and RS goats.

The regression equations for estimating hind limb weight from linear body measurements for WAD and RS goats are presented in Table 7. The result shows that hind limb could be predicted accurately from HG and RH for WAD and RS goats respectively. The R^2 values obtained were 0.82 and 0.47, respectively. The R^2 values increased as the no of variables increased. As more variable were included the R^2 values also increased, when all the five parameters were included in the equation, the R^2 and SEE values were 0.93 and 30.18 respectively for WAD goats. The corresponding values for R^2 goats were 0.77 and 92.1

Table 7: Regression equation for estimating of Hind limb weight from linear body measurement in WAD and RS goats.

Breed	Regression equation	R^2	SEE
WAD	Y=283.33+28.33HG	0.825	21.60
	Y=1040.62+(-4.72)BL	0.124	48.35
	Y=847.97+5.83HW	0.034	50.86
	Y=566.25+19.75RH	0.334	42.15
	Y=697.14+10.00BD	0.060	50.08
	Y=306.25+(-6.25)RH+32.50HG	0.841	23.04
	Y=360.77+(-2.44)RH+34.40HG+(-10.14)HW	0.907	20.30
	Y=489.91+(-8.34)RH+39.08HG+(-7.21)HW+(-6.98)BD	0.917	23.46
	Y=607.69+0.92BD+29.39HG+3.27RH+(-20.24)HW+(-4.62)BL	0.932	30.18
RS	Y=75.00+50.00HG	0.287	96.74
	Y=1062.30+10.76BL	0.101	106.03
	Y=980.53+16.41HW	0.112	105.34
	Y=306.30+48.73RH	0.471	81.30
	Y=609.43+25.41BD	0.275	95.17
	Y=270.00+2.72HG+47.27RH	0.472	89.03
	Y=96.48+5.07HG+44.37RH+8.85BL	0.539	93.00
	Y=20.23+(-1.58)HG+42.21RH+5.50BL+13.26BD	0.594	100.72
	Y=385.18+(-51.48)HG+106.44RH(-14.22)BL+48.12BD+(-54.04)HW	0.774	92.18

R^2=coefficient of determination, SEE=standard error of estimation

Prediction of fore limb weight from linear body measurements in WAD and RS goats

Data for regression equations for estimating weight of fore limb from linear body measurements in WAD and RS goats is present in Table 8. The equation with HW had the highest coefficient of determination (R^2 = 0.350), indicating that 35% of variance in the weight of fore limb was explained by the model in WAD goats. But in RS goat, the equation with HG had the highest coefficient of determination R^2 = 0.422, meaning that 42% of the variance in the weight of hand was explained by the model.

Table 8: Regression equation for estimating fore limb weight from linear body measurements in WAD and RS goats

Breed	Regression equation	R^2	SEE
WAD	Y=812.08+(-1.97)HG	0.001	100.31
	Y=510.50+12.89BL	0.244	87.26
	Y=1417.38+(-38.33)HW	0.350	80.91
	Y=616.25+7.75RH	0.014	99.68
	Y=1734.46+(-36.75)BD	0.238	87.58
	Y=738.75+(-15.31)HG+20.00RH	0.043	109.75
	Y=1042.94+(-4.70)HG+41.22RH+(-56.59)HW	0.52	82.78
	Y=1489.74+(-12.12)HG+49.58RH+(-73.02)HW+(-7.82)BL	0.613	98.77
	Y=1466.51+(-20.97)HG+60.38RH+(-82.53)HW+(-10.45)BL+9.44BD	0.615	139.23
RS	Y=-425.00+56.25HG	0.422	76.03
	Y=1145.28+(-11.15)BL	0.135	93.01
	Y=788.53+7.60HW	0.030	98.48
	Y=290.33+31.93RH	0.253	86.44
	Y=1099.07+(-6.64)BD	0.024	98.81
	Y=-410.00+52.61HG+3.63RH	0.423	83.18
	Y=-370.97+49.37HG+11.00RH+(-6.00)HW	0.434	92.18
	Y=7.80+38.95HG+30.45RH+(-17.73)HW+(-15.43)BL	0.650	83.71
	Y=-37.76+48.71HG+20.10RH+(-8.65)HW+(-11.42)BL+(-8.59)BD	0.659	101.16

R^2=coefficient of determination, SEE=standard error of estimation

Conclusion and Recommendation

Red Sokoto goats had higher values for live body weight, linear body measurement and carcass traits except for dressing percentage which was higher in West African Dwarf goat. This suggests that improvement can be made in this breed for better meat production.

The moderate to high relationship between live body weight and linear body measurement with carcass traits suggests that these traits can be used as indirect selection criteria for carcass characteristics in goats.

The coefficient of determination R^2 values were higher when all variables were included in the equation, suggesting that for better accuracy more than two variables should be included in the model or equation for predicting.

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