



## MORPHOMETRIC CHARACTERISTICS OF RED SOKOTO GOATS IN SOME SELECTED LOCAL GOVERNMENT AREAS OF BAUCHI STATE, NIGERIA

<sup>\*1</sup>Haruna, H. M., <sup>1</sup>Kalla, D. J. U., <sup>1</sup>Mai, H. M., and <sup>2</sup>Magaji, I. M.

<sup>1</sup>Department of Animal Production, Faculty of Agriculture and Agricultural Technology, Abubakar Tafawa Balewa University, Bauchi, Bauchi State.

<sup>2</sup>Department of Animal Science, Faculty of Agriculture, Federal University Gashua, Yobe State.

**Corresponding Author's E-mail:** hmharuna@atbu.edu.ng, **GSM:** 08034123856

### ABSTRACT

The study was conducted to determine the morphometric characteristics of Red Sokoto Goats (RSG) in Dambam, Gamawa and Misau Local Government Areas of Bauchi State. A total of six hundred (600) RSG were used for the study, out of which 121 were males and 479 were females. Body condition score (BCS) was assessed subjectively through principally massaging the loin region, abdominal fat and chest cavity and scored using the 5 points scale (where; 1 = very thin, 2 = thin, 3 = average, 4 = fat and 5 = Very fat/ obese) for both sexes. The effects of location and sex on morphometric characteristics were also determined. The qualitative traits recorded via visual observation included: coat colour, presence or absence of beard, wattle and supernumerary teat. Morphometric traits measured using tailor's tape and recorded in cm were: head length, ear length, horn length, chest girth, height at wither, body length, loin girth, rump length, rump height, rump width, tail length, udder length, udder circumference, teat length, scrotal circumference and scrotal length. The live body weight was measured using a digital weighing scale in kg. However, the study revealed that the RSG found in Gamawa had the highest values for all the significantly different parameters, while the least values were recorded on RSG in Misau ( $38.26 \pm 0.41$  vs  $24.16 \pm 0.41$ ). Sex is confirmed to have influence on live weight ( $P < 0.05$ ) where the male appeared to be heavier than the female animals. The effects of qualitative traits on morphometric characteristics were determined and found out that they have little to less impact on growth parameters.

**Keywords:** Beard, Body Condition Score, Morphometric characteristics, Goats.

### INTRODUCTION

Small ruminants are valuable genetic resources in the tropics and subtropics, where they play a great role in the sustenance of the livelihoods of less able families especially in the rural communities. In Nigeria, they represent about 63.70% of the total grazing domestic animals (Yakubu *et al.*, 2010). The goat is a household animal and its importance cannot be over emphasized. This livestock asset could be seen as "bank account" and it is also an important source of family savings that can be used in years of low crop production, reducing income insecurity and household vulnerability (Elisa *et al.*, 2015). Goats perform the task of supplying human population with meat, milk, skin, hair and other products. The World Health Organization (WHO) recommended protein requirement of an adult is 0.5- 1.0g per kg body weight per day (65g per day) (Juliette, 2017). Goat milk is a vital source of protein, fat, calcium, iron, phosphorous, magnesium, and vitamins, particularly vitamin A. Recent studies have shown that several of these vitamins from goat milk are more easily absorbed than cow milk (Peacock, 2008). The small fat globule of goat milk makes it more easily digestible than cow milk and therefore particularly suitable for children and the sick (Sachin *et al.*, 2017). However, goat milk is more easily digested than cow milk due to the absence of agglutinins (Maria *et al.*, 2017). The characterization of local genetic resources depends on the knowledge of the variation of morphological traits, which have played a very essential role in the classification of livestock based on size and shape (Yakubu *et al.*, 2010a). Size and conformation are important characteristics in meat animals especially ruminants. Traditionally, animals are usually assessed visually, which is a subjective method of judgment (Fajemilehin and Salako, 2008). Red Sokoto goats are one of the most important indigenous breed of goats in Nigeria. They are more adaptable to the climatic conditions of Northern Nigeria. These breed of goats are not adequately



characterized and an appropriate design of breeding procedure is impossible for breeds that have not been adequately characterized either phenotypically and/or genetically (Mwacharo *et al.*, 2002).

## MATERIALS AND METHODS

### Study Location

The study was carried out in Dambam, Gamawa and Misau Local Government Areas of Bauchi State. Bauchi State occupies a total land area of 49,119 km<sup>2</sup> (18,965 sq mi) representing about 5.3% of Nigeria's total land mass and it is located between latitudes 9° 3' N and 12° 3' N of the equator and longitudes 8° 50' and 11° E of the Green Which Meridian. Dambam, Gamawa and Misau are located between 11° 40' 48" N and 10° 42' 32" E, 12° 08' N and 10° 32' E, 11° 19' 6" N and 10° 28' 4" E, respectively. The State is bordered by seven States; Kano and Jigawa to the North, Taraba and Plateau to the South, Gombe and Yobe to the East and Kaduna to the West. Bauchi State has two distinctive vegetation zones, namely, the Sudan and the Sahel Savannah. Sudan savannah vegetation covers the Southern part of the State. Sahel type of the savannah, which is also known as the semi-desert vegetation, becomes manifest from the middle of the State as one moves from the State's South to its North. This type of vegetation comprises isolated stands of thorny shrubs. On the other hand, the Southwestern of the State is mountainous as a result of the continuation of the Jos Plateau, while the Northern part is generally sandy. The vegetation types are conditioned by the climatic factors, which in turn affects the amount of rainfall received in the area. For instance, the rainfall in Bauchi State ranges between 1,300 millimeters per annum in the South and only 700 millimeters per annum in the extreme North (<https://www.bauchistate.gov.ng/history>, 2019).

### Method of Data Collection

Live weight in kg was measured along with sixteen (16) linear body measurements (LBM) in cm on each animal. The LBM were: head length (HDL), ear length (EL), horn length (HL), chest girth (CG), height at wither (HW), body length (BL), loin girth (LG), rump length (RL), rump height (RH), rump width (RW), tail length (TL), udder length (UL), udder circumference (UC), teat length (TTL), scrotal circumference (SC) and scrotal length (SL) all in cm. The height measurements (cm) were done using a graduated measuring stick. The length, circumference and the width measurements (cm) were done using a tape rule (Tailor's tape). While the weight (kg) was measured using a weighing scale.

### Data Analysis

Body condition score, live weight (kg), linear body measurements (cm) and qualitative parameters of each of the animals were coded into spreadsheets. Data collected were subjected to descriptive statistics and were analyzed using Statistical Package for Social Sciences (SPSS version 22, 2013) using the General Linear Model (GLM) procedure. The effects of class variables were expressed as overall mean  $\pm$  SE. Significantly different means were separated using Duncan Multiple Range Test (DMRT).

## RESULTS AND DISCUSSION

### Effect of Location on Body Condition Score, Live Weight and Morphometric Traits

Table 1 showed the mean effect of location on body condition score, live weight and morphometric traits of Red Sokoto goats. Live weight (kg) was significantly ( $P < 0.001$ ) higher in Gamawa than in Dambam and Misau ( $38.26 \pm 0.41$ ,  $31.27 \pm 0.41$  and  $24.16 \pm 0.41$ ) respectively. There was no significant ( $P > 0.001$ ) difference in the body condition score among the locations. The result of this study was slightly higher than the report of Adamu *et al.* (2020) on Red Sokoto and Sahel goats. There were significant ( $P < 0.001$ ) effect of location in Head length, Ear length, Horn length, Chest girth, Height at wither, Body length, Loin girth, Rump length, Rump height, Rump width, Tail length, Udder length, Teat length, Scrotal circumference and Scrotal length. The RSG found in Gamawa local government had the highest values for all the significantly affected traits, while the least values were recorded in Misau local government. This agrees with the work of Ijomanta, (2012) who reported that zone (Katsina, Daura and Malumfashi) had effect on body weight and morphometric characteristics of Red Sokoto goats in Katsina State of Nigeria. This observed variation is attributed to

varied feed availability and management practices in the study areas. Similar assertion was also made by Mekuriawa *et al.* (2013) and Tesfay *et al.* (2017).

**Table 1** Effect of Location on Body Condition Score, Live Weight and Morphometric Traits

Parameters	Overall mean $\pm$ S.E	Location			
		Dambam	Gamawa	Misau	LOS
BCS	3.45 $\pm$ 0.09	3.45 $\pm$ 0.10	3.45 $\pm$ 0.10	3.45 $\pm$ 0.10	NS
LW	31.23 $\pm$ 0.37	31.27 $\pm$ 0.41 <sup>b</sup>	38.26 $\pm$ 0.41 <sup>a</sup>	24.16 $\pm$ 0.41 <sup>c</sup>	***
HDL	19.02 $\pm$ 0.22	18.95 $\pm$ 0.25 <sup>b</sup>	21.75 $\pm$ 0.25 <sup>a</sup>	16.37 $\pm$ 0.25 <sup>c</sup>	***
EL	16.82 $\pm$ 0.31	16.97 $\pm$ 0.35 <sup>b</sup>	18.97 $\pm$ 0.35 <sup>a</sup>	14.52 $\pm$ 0.35 <sup>c</sup>	***
HL	15.15 $\pm$ 0.40	16.22 $\pm$ 0.45 <sup>b</sup>	17.94 $\pm$ 0.45 <sup>a</sup>	11.27 $\pm$ 0.45 <sup>c</sup>	***
CG	70.98 $\pm$ 1.26	70.55 $\pm$ 1.42 <sup>b</sup>	78.65 $\pm$ 1.42 <sup>a</sup>	63.73 $\pm$ 1.42 <sup>c</sup>	***
HW	64.46 $\pm$ 0.53	64.23 $\pm$ 0.60 <sup>b</sup>	78.65 $\pm$ 0.60 <sup>a</sup>	59.84 $\pm$ 0.60 <sup>c</sup>	***
BL	65.70 $\pm$ 0.67	65.05 $\pm$ 0.76 <sup>b</sup>	76.05 $\pm$ 0.76 <sup>a</sup>	55.99 $\pm$ 0.76 <sup>c</sup>	***
LG	71.16 $\pm$ 1.21	77.40 $\pm$ 1.37 <sup>b</sup>	89.40 $\pm$ 1.37 <sup>a</sup>	46.70 $\pm$ 1.37 <sup>c</sup>	***
RL	15.46 $\pm$ 0.45	15.75 $\pm$ 0.51 <sup>b</sup>	18.26 $\pm$ 0.51 <sup>a</sup>	12.37 $\pm$ 0.51 <sup>c</sup>	***
RH	46.33 $\pm$ 1.07	60.99 $\pm$ 1.21 <sup>b</sup>	65.41 $\pm$ 1.21 <sup>a</sup>	59.60 $\pm$ 1.21 <sup>c</sup>	***
RW	14.45 $\pm$ 0.44	14.76 $\pm$ 0.49 <sup>b</sup>	17.48 $\pm$ 0.49 <sup>a</sup>	11.11 $\pm$ 0.49 <sup>c</sup>	***
TL	14.98 $\pm$ 0.41	14.88 $\pm$ 0.46 <sup>b</sup>	16.41 $\pm$ 0.46 <sup>a</sup>	13.64 $\pm$ 0.46 <sup>c</sup>	***
UL	14.88 $\pm$ 0.28	14.51 $\pm$ 0.36 <sup>b</sup>	16.75 $\pm$ 0.36 <sup>a</sup>	13.40 $\pm$ 0.36 <sup>c</sup>	***
UC	33.82 $\pm$ 0.57	33.34 $\pm$ 0.74	34.34 $\pm$ 0.74	33.79 $\pm$ 0.74	NS
TTL	3.81 $\pm$ 0.10	3.73 $\pm$ 0.12 <sup>b</sup>	4.37 $\pm$ 0.12 <sup>a</sup>	3.34 $\pm$ 0.12 <sup>c</sup>	***
SC	17.59 $\pm$ 0.17	17.88 $\pm$ 0.27 <sup>a</sup>	18.46 $\pm$ 0.27 <sup>a</sup>	16.44 $\pm$ 0.27 <sup>b</sup>	***
SL	13.83 $\pm$ 0.17	13.85 $\pm$ 0.27 <sup>b</sup>	15.01 $\pm$ 0.27 <sup>a</sup>	12.62 $\pm$ 0.27 <sup>c</sup>	***

BCS: Body condition score, LW: Live weight, HDL: Head length, EL: Ear length, HL: Horn length, CG: Chest girth, HW: Height at wither, BL: Body length, LG: Loin girth, RL: Rump length, RH: Rump height, RW: Rump width, TL: Tail length, UL: Udder length, UC: Udder circumference, TTL: Teat length, SC: Scrotal circumference, SL: Scrotal length.

S.E = Standard error, NS= No significant differences, LOS= Level of significant.

\*\*\*= (P < 0.001). a, b, c= Numbers with diff. superscript within the same row are statistical different.

### Effect of Sex on Body Condition Score, Live Weight and Morphometric Traits

Influence of sex on live weight and linear body measurements are shown in Table 2. The fact that sex had effect on live weight as reported in the present study agrees with the finding of Inthujaa *et al.* (2018) who reported that male Batticaloa goats native to Sri Lanka were 19 % (5.8 kg) heavier than females. The reports of Gelana and Belete (2016) in indigenous goats of South East Ethiopia depicted that bucks were superior to does in terms of live weight and linear body traits. Fajemilehin and Salako (2008) and Bedada *et al.* (2019) revealed that morphometric characteristics are sexually dimorphic and could be due to effect of androgenic hormones. Similarly, earlier report showed that Red Sokoto bucks had significantly higher live weight and chest girth than Red Sokoto does, while the latter had longer body length and higher height at wither than the former (Ojedapo *et al.*, 2007). The work of Alemu (2015) among central highland goats of Abergelle showed that male kids were heavier at birth than females (2.34  $\pm$  0.03 kg vs 2.25  $\pm$  0.03 kg) and that this effect decreases as the animal ages. The author associated this early life differences (weight at birth) between the two sexes to hormonal variation which could probably be androgen. Working on Ethiopian native sheep, Aklilu *et al.* (2013) reported higher value for live weight in males than females and observed that most linear body traits are sexually dimorphic. The work of Tesfay *et al.* (2017) in some selected districts of Ethiopia (Tanqua-Abergelle, Kola-Tembien and Adwa) depicted the considerable effect of sex on body measurements and was attributed to differential effects of androgens and estrogens in males and females, respectively. Androgenic hormones promote larger muscle and longer bone development in males (Thiruvankaden, 2005; Semakula *et al.*, 2010; Taye *et al.*, 2011). Sownade and Sobola (2008) linked the differences observed between the two sexes to genes located on sex chromosomes. The authors suggested that the higher growth rate and larger body size observed in males could be as a result of Y-chromosomes which initiate the production of sex hormone in bucks and other male

livestock species. On the contrary, some investigators (Jimcy *et al.*, 2011; Okpeku *et al.*, 2011) reported that matured female does had higher values for both live weight and biometric traits than bucks. This is in conformity with the findings of Rotimi *et al.* (2016) who showed that matured does had higher body mass than bucks in Red Sokoto goats. This could be as a result of small sample size of bucks or negative selection where bigger males were castrated and fattened for economic purposes (Ijomanta, 2012). Similar assertion was also made by Osuhor *et al.* (2002).

**Table 2:** Average Body Condition Score, Live Weight and Morphometric Traits (Linear body measurements) According to Sex.

Parameters	Overall mean $\pm$ S.E	Sex		LOS
		Male	Female	
BCS	3.45 $\pm$ 0.09	3.77 $\pm$ 0.15	3.12 $\pm$ 0.06	***
LW	31.23 $\pm$ 0.37	31.96 $\pm$ 0.63	30.50 $\pm$ 0.24	*
HDL	19.02 $\pm$ 0.22	19.33 $\pm$ 0.39	18.71 $\pm$ 0.15	NS
EL	16.82 $\pm$ 0.31	17.51 $\pm$ 0.54	16.14 $\pm$ 0.21	**
HL	15.15 $\pm$ 0.40	15.89 $\pm$ 0.68	14.40 $\pm$ 0.26	*
CG	70.98 $\pm$ 1.26	73.02 $\pm$ 2.16	68.93 $\pm$ 0.83	NS
HW	64.46 $\pm$ 0.53	66.32 $\pm$ 0.91	62.61 $\pm$ 0.35	***
BL	65.70 $\pm$ 0.67	66.86 $\pm$ 1.16	64.54 $\pm$ 0.45	*
LG	71.16 $\pm$ 1.21	73.24 $\pm$ 2.08	69.08 $\pm$ 0.80	*
RL	15.46 $\pm$ 0.45	16.01 $\pm$ 0.78	14.91 $\pm$ 0.30	NS
RH	46.33 $\pm$ 1.07	47.99 $\pm$ 1.84	44.67 $\pm$ 0.71	NS
RW	14.45 $\pm$ 0.44	14.86 $\pm$ 0.75	14.04 $\pm$ 0.29	NS
TL	14.98 $\pm$ 0.41	15.84 $\pm$ 0.70	14.12 $\pm$ 0.27	*

BCS: Body condition score, LW: Live weight, HDL: Head length, EL: Ear length, HL: Horn length, CG: Chest girth, HW: Height at wither, BL: Body length, LG: Loin girth, RL: Rump length, RH: Rump height, RW: Rump width, TL: Tail length.

S.E = Standard error, NS= No significant differences, LOS= Level of significant.

\* = (P < 0.05), \*\* = (P < 0.01), \*\*\* = (P < 0.001).

## CONCLUSION AND RECOMMENDATION

It can be concluded that the Red Sokoto goats (RSG) found in Gamawa L.G.A. had the highest values for all the significantly different parameters, while the least values were recorded on RSG in Misau L.G.A. (38.26 $\pm$ 0.41 vs 24.16 $\pm$ 0.41). Sex is confirmed to have influence on live weight (P < 0.05) where the male appeared to be heavier than the female animals. The effects of some qualitative traits on morphometric characteristics were determined and found out that they have little to less impact on growth parameters. Further study should be conducted on morphological and morphometric characteristics with a larger population of goats, as this could possibly help in selection, thereby, improving the productivity of goats.

## REFERENCES

- Alemu, A. (2015). On-Farm Phenotypic Characterization and Performance Evaluation of Abergelle and Central High Land Goat Breeds as an Input for Designing Community Based Breeding Program. M. Sc. Thesis, University of Haramaya.
- Aklilu, E., Kebede, K., Dessie, T. and Banerjee, A. K. (2013). Phenotypic Characterization of Indigenous Sheep in Ethiopia. *International Journal of Interdisciplinary and Multidisciplinary studies*, 1(1): 24-32.
- Adamu, H., Ma'aruf, B. S., Shuaibu, A., Umar, H. A. and Maigado, A. I. (2020). Morphometric characteristics of Red Sokoto and Sahel goats in Maigatari Local Government Area of Jigawa State: *Nigerian Journal of Animal Production*, 47(4):15 – 23.
- Bedada, Z. E., Gilo, B. N. and Debala, G. T. (2019). Morphometric and Physical Characterization of Borana Indigenous Goats in Southern Oromia, Ethiopia. *Universal Journal of Agricultural Research*, 7(1): 25 - 31.





- Elisa, M. V. B., Mário, T., Vanda, N., Maria, L. S. C. and Pedro, D. S. H. (2015). The Livestock Roles in the Wellbeing of Rural Communities of Timor-Leste. *Revista de Economia e Sociologia Rural*, **53**(1): 1-6.
- Fajemilehin, O. K. S. and Salako, A.E. (2008). Body Measurement Characteristic of the West African Dwarf (WAD) Goat in Deciduous Forest Zone of South Western Nigeria. *African Journal of Biotechnology*, **7**(14): 2521-2526
- Gelana, J. and Belete, A. (2016). Characterization of Indigenous Goats types using Morphological Characters and Body Measurements in Sinana District, Bale Zone, South East Ethiopia. *Global Journal of Science Frontier Res.* **16**(7): 20-26. (<https://www.bauchistate.gov.ng/history>, 2019).
- Ijomanta, O. E. (2012). Genetic Profile of Morphological Traits and their Association with Production Capacity of the Red Sokoto Goat in Katsina State of Nigeria. M.Sc. Thesis, Ahmadu Bello University Zaria, Nigeria.
- Inthujaa, S., Pagthinathan, M. and Pragashan, P. (2018). Phenotypic Characterization of Indigenous Goat Population in Batticaloa District, Sri Lanka. *Scholars Journal of Agriculture and Veterinary Sciences*. DOI: 10.21276/sjavs.2018.5.12.8s
- Juliette, S. (2017). How much protein in Eggs, Chickens, Tuner, Beef, Dairy and Nuts. Food and drink.
- Jimcy, J., Raghavan, K. C. and Sujatha, K. S. (2011). Diversity of Local Goats in Kerala, India, Based on Morphobiometric Traits. *Livestock Research for Rural Development*, **23**(5): 234-242.
- Maria, J. R. L., Edite, T. L., Jorge, O., Luís, P., Teixeira, L., António, M. C. M. and José, M. C. (2017). Nutritional and Health Profile of Goat Products: Focus on Health Benefits of Goat Milk. *Open access peer-reviewed chapter*, Pp 1-26.
- Mekuriawa, S., Mekuriawa, Z., Tayeb, M., Mekuriawa, G., Amanea, A., T. Bimrewa, T. and Haile, A. (2013). Growth Performance and Linear Body Measurements of Washera, Farta and their Crosses under Farmers' Management System in Western Highland of Amhara Region. *Scientific Journal of Veterinary Advances*, **2**(9): 132-143.
- Mwacharo, J. M., Otieno, C. J., Okeyo, A. M. and Aman, R. A. (2002). Characterization of Indigenous fat-tailed and fat-rumped hair sheep in Kenya. Diversity in blood proteins: *Tropical Animal Health and Production*, **34**: 515-524.
- Ojedapo, L. O., Adedeji, T. A., Olayeni, T. B., Adedeji, O. S., Abdullahi, A. R. and Ojebiyi, O. O. (2007). Influence of Age and Sex on Body Weight and Some Body Linear Measurements of Extensively Reared WAD Goats in Derived Savannah Zone of Nigeria. *Journal of Animal and Veterinary Advances*, **6**(1): 114 – 117.
- Okpeku, M., Yakubu, A., Peters, S. O., Ozoje, M. O., Ikeobi, C. O. N., Adebambo, O. A. and Imumorin, I. G. (2011). Application of Multivariate Principal Component Analysis to Morphological Characterization of Indigenous Goats in Southern Nigeria. *Acta Agriculturae Slovenica*, **98**(2): 101-109.
- Osuhor C.U., Alawa J.P. and Akpa, G.N. (2002). Research note: Manure Production by Goat Grazing Native Pasture in Nigeria. *Tropical Grasslands*, **36**: 123 – 125.
- Peacock, C. (2008). Dairy Goat Development in East Africa. A Replicate Model for Small Holder, *Small Ruminant Research*. **77**(2-3): 225-238.
- Rotimi, E. A., Egahi, J. O., Adelani, A. A., Yahaya, M.A. and Zhimada, J. (2016). Characteristics of West African Dwarf (WAD) Goats in Bassa Local Government Area of Kogi State. *Proc. 21st Ann. Con. Animal Science Association of Nigeria*. 18– 22.
- Sachin, S., Lad, K. D., Aparnathi, B. M. and Suresh, V. (2017). Goat Milk in Human Nutrition and Health – A Review: *International Journal of Current Microbiology and Applied Sciences*, **6**(5): 1781-1792.
- Semakula, J., Mutetikka, D., Kuginza, R.D. and Mpairwe, D. (2010). Variability in Body Morphometric Measurements and their Application in Predicting Live Body Weight of Mubende and Small East African Goat Breeds in Uganda. *Middle East Journal of Scientific Research* **5**(2); 98 – 105.



- Sownade, O. S. and Sobola, O. S. (2008). Body Measurements of West African Dwarf Sheep as Parameters for Estimation of Live Weight. *Tropical Animal Health and Production*, **40**: 433-439.
- Taye, M., Bimerow, T., Yitayew, A., Mekuriaw, S. and Mekuriaw, G. (2011). Estimation of Live Body Weight from Linear Body Measurements for Farta sheep. *Online Journal of Animal and Feed Research*, **2**(1): 98-103.
- Tesfay, H. H., Banrejee, A. K and Mummed, Y. Y. (2017). Live Body Weight and Linear Measurements of Indigenous Sheep Population in their Production System for Developing Suitable Selection Criteria in Central Zone of Tigray, Northern Ethiopia. *African Journal of Agricultural Research*, **12**(13): 1087-1095.
- Thiruvankaden, A. K. (2005). Determination of Best Fitted Regression Model for Estimation of Body Weight in Kanni Adu kids under Farmers' Management System. *Livestock Research for Rural Development*, **17**(7): 1-11.
- 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*. **40**: 381-387.
- Yakubu, A., Raji, A.O. and Omeje, J.N. (2010a). Genetic and Phenotypic Differentiation of Qualitative Traits in Nigerian Indigenous Goats and Sheep Populations. *Journal of Agriculture and Biological Science*, **5**: 58-66.