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Body Characteristics of West African Dwarf (WAD) Goats in Bassa Local Government Area of Kogi State

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ABSTRACT

This study was carried out in Bassa local government Area of Kogi State, Nigeria. The study aimed at evaluating the body characteristics of West African Dwarf (WAD) goats in study location. A total of one hundred and nine (109) matured WAD goats, comprising of twenty-seven (27) males and eighty-two (82) females, were randomly selected for the study. Animals were randomly selected across locations within the local government area. Sick and pregnant animals were not included in the study. Animals were selected based on the phenotypic appraisal only. Data were measured from various body parameters, these include; Live Body Weight (BW), Chest Girth (CG)**,** Height at Withers (HW)**,** Body Length (BL), Head Length (HL), Neck Length (NL), Ear Length (EL), Horn Length (HnL), Tail Length (TL) and Leg Length (LL). Data collected were subjected to statistical analysis. Results obtained showed that sex had a significant effect ($p < 0.05$) on all the body parameters considered. This trend confirms sexual dimorphism in WAD goats in the study location.

***Keywords*:** Characteristics, body parameters, West African Dwarf goat

1. INTRODUCTION

Nigeria human population is estimated at about 140.4 million (NPC, 2010), this population is continuously on the increase annually. This increase has led to more demand for animal and animal products to meet up with the minimum animal protein requirement per individual per day. The protein intake of an average Nigeria is estimated at 45.5g per head per day, this is lower compared with the Food and Agricultural Organization's recommended minimum intake of 70g per head per day, of which 50% (35g) should be of animal source (FAOSTAT, 2008). The inadequate supply of animal protein in Nigeria can be attributed to inadequate production potentials of the most common sources of meat which include poultry, goat, cattle, pig, sheep, rabbit etc. Thus, there is therefore, the need to increase the supply of animal protein through meat consumption and this could be accomplished through efficient use of promising indigenous animals such as goat. Gambo *et al.* (2004) reported that among the cheapest and mostly affordable protein source for this ever increasing population is mainly the poultry products and chevrons (goat meat).

Okpeku *et al.* (2011) also reported that rearing of small ruminants (sheep and goats) would have lasting effects in bringing about social change by improving the incomes and standard of living.

Goat (*Capra hircus*) is the earliest domestic animal and probably the first ruminant livestock, after the wolf was domesticated (Zeder and Hasse, 2000). They are one of the smallest domesticated ruminants which are managed for the production of milk, meat, wool and leather particularly in arid, semi-tropical or mountainous countries (Morand-Fehr, 2004). Goat is the most prolific ruminant among all domesticated ruminant under tropical and subtropical conditions. It is a resourceful and efficient ruminant producing meat, milk, skin and hair (Morand-Fehr, 2004).

Goats constitute the largest group of small ruminant livestock in Nigeria totalling about 53.8 million and also constituting 6.2 percent of the World's goat population (FAOSTAT, 2011). Surveys have shown that up to 85 percent of rural households, poor farmers and small-time business people of all age groups and sexes keep goat (FDLPCS, 2007). The ability of goats to tolerate harsh climates, the presence of trypanotolerance in some breeds (Salako, 2004), suitability to traditional systems on account of small size, short generation interval (Abdul-Aziz, 2010) and ability to thrive on poor quality diets provided by scarce grazing on marginal lands (Adedeji *et al*., 2011) all combine to make small ruminants strategic to increasing livestock productivity in rural agricultural systems (Adedeji *et al.*, 2011).

A recent livestock survey, however, puts the goat population in Nigeria at 34.5 million (RIM, 1992). Keeping of goats in any community is related to the value attached to their production.

The world population of goats was estimated at 746 million (FAOSTAT, 2008), with 96% of these being kept in developing countries. In Nigeria goat is the most numerous of all domesticated ruminants, and was estimated to be about 34.5million (Table 1).

Goats are reared primarily for meat production in Nigeria, as such body weight is a major trait of interest. It is an important criterion in meat producing animals.

Domestic goat classifications have been based on varying criteria but four commonly used classification methods are: classification based on origin, utility, body size and shape and length of ears. There exist about 570 breeds of goat all over the world out of which three breeds of goat are found in Nigeria (Aina, 2012). The Nigerian indigenous goats have been

phenotypically classified into three distinct breeds. Primarily three indigenous breeds, the Sahel, Red Sokoto and West African Dwarf goats, dominate the meat-producing goat industry in Nigeria, these breeds have been classified as separate breeds according to phenotypic traits, origin, function, body size, length or height (Adu and Ngere, 1979; Ngere *et al.*, 1984).

Table 1. Nigerian Livestock Population Estimate

S/N	Species	Number (million)
1	Chicken	82,400.00
2	Goats	34,500.00
3	*Other poultry	31,900.00
4	Sheep	22,100.00
5	Cattle	13,900.00
6	Pigs	3,500.00
7	Rabbits	1,700.00
8	Guinea pigs	0.50
9	Horses	0.20
10	Camels	0.09

*Pigeons, Ducks, Guinea fowls, and Turkeys
Source: (Bourn *et al*., 2007).

Sahel goat

The Sahel goat is found along the northern border of Nigeria, it is often known as 'Balami'. The coat is white or dappled, the ears are pendulous and the legs are notably longer than other breeds.

Red Sokoto goat

The red Sokoto, Kano Brown or Maradi, goat is probably the most widespread and well-known type in Nigeria. It is the usual village goat in the northern two-thirds of the country although it is less common with transhumant pastoralists. The red sokoto is still known for its suitability for fine leather.

West African Dwarf (WAD) goat

The WAD is usually black, although patched, pied, and occasionally all-white animals can be seen. The breed is well adapted to humid environment and very resistant to trypanosomiasis as WAD goat is believed to be trypanotolerant because it thrives in tsetsefly

areas. Indeed, like muturu cattle, they may once have been the main race of goat over most of Nigeria. Just as the Zebu has replaced the Muturu, so WAD goats have been driven to remote areas in the savannahs.

They are mostly found among households and small-scale farmers in varying numbers where they serve as a source of employment, food and income generation. The breed displays wide phenotypic variations in both quantitative and qualitative traits (Odubote, 1994). These traits can be used to characterize goats and improve their production. Characterization is necessary to realize the potential of native breeds of animals (Alderson, 1999). Improvement programmes are therefore necessary to increase and sustain the productivity of goats in the humid tropics in order to meet the demand of ever increasing human population for animal protein.

The WAD goats in the semi-arid zone resemble Red Sokoto goats in their body proportions. Bucks weight about 25kg and Does 22kg when matured. Their height is 30-50cm, they are able to feed on short grasses and browse on foliage not eaten by other ruminants and they are inquisitive in search of food. This breed is about 50cm in height and 20-30 Kg in weight, tending to be larger towards the savanna zone. It has characteristic of short legs and 'blocky' body, very hardy, good meat and prolific, frequently producing twins or triplets (Odubote, 1991). Growth rate and milk yield are very low, it is kept for meat production.

Goats in Nigeria are kept mainly for meat and hide (Williamson and Brinkmann 1997). The role of livestock in human development is enormous. Livestock production is an instrument of socio-economic change through enhancing the farmer's income and quality of life (Atinmo and Akinyele 1983).

Linear body measurements of animals have been used extensively to assess the growth of skeletal parts, it is also useful in describing changes in animals' conformation with age. An animal that will have to command high premium has to be one that has well established body composition, well-built head, meaty flanks and an appreciable weight (Ross, 1988).

Relationship between body weight and linear body measurement such as heart girth (circumference), body length and height at withers has been used (Singh and Tyagi 1970).

Growth and development is important for production of meat animals. Body weight and body measurements are important parameters to describe growth. In addition to weight measurement, body measurements can describe completely an individual or a population (Salako, 2006a). Phenotypic characteristics are important in breed identification and classification. The first step of the characterization of local genetic resources is to assess variation of morphological traits (Delgado *et al.*, 2001). Linear body measurements could be used as selection criteria for improvement of meat production in goat (Khan *et al.*, 2006) and for prediction of body weight in goat (Mohammed and Amin 1997).

Associations among live body measurements were established through the examination of correlation among them (Chineke, 2000). Studies of interrelationship among body measurements also find its application in selection and breeding. The magnitude of the correlation between live body measurements and raw meat yield was reported to be a valuable indicator for selecting high meat yielding strain of turkey (MacNeil, 1969) and in pig (Ogah *et al*., 2011). As in large animals, it will be desirable if farmers could determine from pre-slaughter measurements carcass traits when animals are suitable for slaughtering. Researches on predicting optimum finishing criteria for other livestock have been reported by (Dolezal *et al*., 1993) and (Minchin *et al*., 2009) for cattle.

Lack of characterization and knowledge of the best production system for raising domestic resources is one of the difficulties in genetic resources conservation (Dossa *et al.,* 2007).

When little is known about a genetic resource, its identity as a genetic group, its production, reproduction and adaptive potentials, it is more difficult to find a market niche in the production system. Phenotypic characterization is therefore an important step in a conservation program, for breed identification and classification in ways that farming communities could be related (Mwacharo *et al.*, 2006).

Despite the ubiquity of this breed of goats in the study area, studies to evaluate the extent of the phenotypic characteristics variations had not been conducted. There is need for phenotypic characteristics of these goats, as this will serve as base line information for genetic improvement programme.

The objective of this study therefore, is to investigate the extent of variation in body characteristics of the West African dwarf goat in smallholder herd in Bassa Local Government Area of Kogi State.

2. MATERIALS AND METHOD

Description of study area.

The study was conducted in Bassa local government area of Kogi state, Nigeria. Bassa local government is located within the north central part of Nigeria. Bassa local government area is located between longitude 8° 47' E and latitude 10° 3' N (Worldatlas.com). The area falls within the sub-humid climate having annual rainfall range of 1250 – 2000 mm with annual temperature range of 32 – 50 °C (Daikwo *et al.*, 2011).

Experimental animal

A total of one hundred and nine (109) matured West African Dwarf (WAD) goats were randomly selected and used for this study. These comprise of eighty-two (82) females and twenty-seven (27) males. Animals were randomly selected from around the study area. Only healthy and non-pregnant animals were included in the study. All the animals were selected using phenotypic parameters. The animals were semi-intensively managed with little or no feed supplementation with kitchen waste or grain by-products.

Data collection and analysis

Data were collected from the individual animals. Ten (10) body traits were taken, including the body weights (kg) and linear body measurements (cm), from the animals. Simple weigh balance was used to measure the live body weights in kg while other body measurements were taken using simple tape rule. Pregnant animals were excluded from the samples. Animals were restraint and calmed before measurements were taken. Data were taken in the morning before animals were fed so as to avoid feed and water interference in the record. All measurements were taken according to the method described and adopted by Rotimi *et al*. (2015).

1. **Live Body Weight (LBW):** Live body weight of the animal was obtained by placing them on the weighing scale.

2. **Chest Girth (CG):** The chest girth was measured as the circumference of the body, slightly behind the shoulders and perpendicular to the body axis.
3. **Height at Withers (HW):** This was measured at the highest point on the dorsum of the animal to the platform at the level of the forelegs while the animal was standing.
4. **Body Length (BL):** Measured from the tip of the scapula close to the neck region to the pin bone of the tail region.
5. **Head Length (HL):** This was measured from the tip of the skull at the mouth region to the point where the cervical vertebrae connect to the skull.
6. **Neck Length (NL):** The entire region of the cervical vertebrae was measured as neck length.
7. **Ear Length (EL):** This was measured from the point where the ear is attached to its tip.
8. **Horn Length (HnL):** The point of attachment of the horns to the head up to its tips.
9. **Tail Length (TL):** This was measured as the distance between the beginning of the caudal vertebrae to its tip.
10. **Leg Length (LL):** The leg length was measured as the distance from the tips of the hoofs to the point where the tarsal joined to the tibia and fibula.

Data Analysis

Data collected were subjected to descriptive statistical analysis using SPSS, 2011 version 20.0 statistical software package.

3. RESULT AND DISCUSSION

Table 2. Total number of goats sampled per sex and at different location.

Location	Number of females	Number of males	Total
A	27	9	36
B	28	9	37
C	27	9	36
Total observation	82	27	109
Percentage (%)	**75.23**	**24.77**	**100**

A = Bassa, B = Gbokolo and C = Mozum Districts

Table 2 showed the sex distribution of the animals sampled in the study area. Percentage distribution for female animal was higher than that of males (75.23% and 24.77% respectively). This might be as a result of preference of female animal in the herd for production and multiplication. Majority of the farmers prefer to keep the females for breeding while the males were majorly sold out or slaughter for festival of for personal consumption. This corresponds with the report of Rotimi *et al*. (2015) who also reported that female goats have higher percentage than male goats in Makurdi local government area of Benue state

Table 3 shows the descriptive statistics of body weight and morphometric traits of WAD goats in the study area. Results showed that average body weight was significantly ($P < 0.05$) affected by sex. Body weight was higher in female WAD goats than males compared to their male counterparts in the three locations (18.93±5.50 and 18.49±2.60, 17.82±4.30 and 15.67±6.00 and 18.42±5.70 and 14.39±4.70 respectively). However, there are no significant difference observed among locations.

Table 3. Least square means of body weight (Kg) of male and female West African Dwarf Goats in the study locations.

Location	Sex	Body Weight (±SD)
A	**F**	18.93 ± 5.50^{a}
	M	18.49 ± 2.60^{b}
B	**F**	17.82 ± 4.30^{a}
	M	15.67 ± 6.00^{b}
C	**F**	18.42 ± 5.70^{a}
	M	14.39 ± 4.70^{b}

A = Bassa District, B = Gbokolo District, C = Mozum District.
Means with the same superscript are not significantly different ($P<0.05$).

Table 4 shows the mean values of other parameters considered in the study. Sex had significant ($P<0.05$) effect on all the parameters. However, location had no significant effect on the parameters. Sexual dimorphism in farm animals can be phenotypically expressed as differences in skeletal size and body mass. Report obtained in this present study revealed that sex had effects on the body mass of WAD goats in the study area, with higher values recorded in females. This report is contrary to the reports of (Isaac, 2005; Vargas, *et al.*, 2007 and Rotimi *et al*., 2015) who reported higher values for males over females' mammalian and goats. This trend, though common, may not be exclusive pattern. However, Bacchi, *et al*., (2010) reported no sexual dimorphism in the body parameters measured in *Lama guanicoeguanicoe* in Argentina. Yakubu, (2009) in his report stated that the morphological traits of male and female kids were similar.

The influence of sex on the body weight and morphometric parameters in this present study may be due to hormonal action which leads to differential growth rates. However, the

trend observed in this study can be partially explained by different methodologies used in measurements.

Table 4. Least square means of some body measurements (cm) of male and female West African Dwarf (WAD) Goats in the study locations.

Loc.	Sex	WH	CG	BL	HL	NL	EL	HnL	TL	LL
A	F	41.39±9.50^{a}	60.89±7.0^{a}	52.00±11.30^{a}	13.63±3.00^{a}	14.56±3.10^{a}	9.26±2.20^{a}	7.19± 2.80^{a}	8.40± 1.91^{a}	12.77±2.80^{a}
	M	37.66±3.30^{b}	57.44±3.30^{b}	50.89± 1.90^{b}	11.66±1.30^{b}	12.54±1.30^{b}	9.56±0.93^{b}	6.11±1.97^{b}	6.67± 1.10^{b}	11.56±1.30^{b}
B	F	41.96±4.60^{a}	59.21±5.16^{a}	51.86±5.60^{a}	14.00±1.00^{a}	15.18±1.10^{a}	8.85±1.70^{a}	7.72±2.90^{a}	8.40±1.50^{a}	12.55±1.30^{a}
	M	39.11±4.20^{b}	56.00±3.90^{b}	46.56± 3.92^{b}	11.67±1.30^{b}	12.33±1.30^{b}	8.89±0.90^{b}	5.67±1.60^{b}	6.66±1.20^{b}	11.88±1.60^{b}
C	F	40.86±10.00^{a}	60.46±12.60^{a}	50.25±11.10^{a}	14.95±3.20^{a}	14.95±3.21^{a}	8.71±2.10^{a}	7.09±2.90^{a}	7.78±1.80^{a}	13.29±2.90^{a}
	M	36.88±2.60^{b}	54.00±3.80^{b}	48.22±3.50^{b}	11.00±1.00^{b}	10.57±1.80^{b}	8.28±1.00^{b}	4.94±1.93^{b}	5.61±1.70^{b}	9.94±1.00^{b}

A = Bassa District, B = Gbokolo District, C = Mozum District.
BWT = Body Weight, WH = Wither Height, CG = Chest Girth, BL= Body Length, HL = Head Length, NL = Neck Length, EL = Ear Length, HnL = Horn Length, TL = Tail Length and LL = Leg Length. Means with the same superscript are not significantly different ($P<0.05$)

4. CONCLUSION

Results obtained in this study revealed that sex had significant effect (P>0.05) on the body parameters considered with females having higher values. However, location had no significant effect (P>0.05). Therefore, the information obtained in the present study would be useful for phenotypic characterization of West African Dwarf (WAD) goats in the study area and could assist farmers and breeders when conducting management, selection and preservation programs.

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References

[1] Abdul-Aziz, M. (2010). Present status of the world goat populations and their productivity. *Lohman Inf.* 45: 42-52.

[2] Adedeji, T. A., Ozoje, M. O., Peters, S. O., Sanusi, A. O., Ojedapo, L. O. and Ige, A. O. (2011). Coat pigmentation and Wattle genes effect on some haematological characteristics of heat stressed and extensively reared West African Dwarf goats. *World J. Life Sci. Med. Res.* 3: 48-55.

[3] Adu, I. F. and Ngere, L. O. (1979). The Indigenous Sheep of Nigeria. *World Review of Animal Production* 15(3): 51-62.

[4] Aina, A. B. J. (2012). GOAT (*Capra hircus*): A misunderstood animal. Inaugural Lecture Series No. 35. Federal University of Agriculture, Abeokuta, Nigeria. 96 pp.

[5] Alderson, G. L. H. (1999). The development of a system of Linear Measurements to provide an assessment of type and function of beef cattle. *Animal Genetic Resources Information* 25: 45-56.

[6] Atinmo, O. and Akinyele, O. (1983). Nutrition and food policy of Nigeria. Published by national institute for policy and strategic studies Kurum, Jos.

[7] Bacchi, C. S., Lanari, M. R., von Thungen, J. (2010). Non-genetic factors affecting morphometric and fleece traits in guanaco (*Lama guanicoeguanicoe*). *Small Rumin. Res.* 88: 54-61.

[8] Bourn, D., Wint, W., Blench, R and Woolley, E. Nigerian livestock resources survey. http://www.fao.org/livestock/agap/frg/FEEDback/War/t1300b/t1300b0g.htm

[9] Chineke, CA. (2000). Characterization of physical body traits of domestic rabbits in humid tropics. *Proceedings of the 25th annual conf. of Nigeria society for animal production,* Umudike, 19-23 March, pp. 237-239.

[10] Daikwo, I. S., Okpe, A. A. and Ocheja, J. O. (2011). Phenotypic Characterization of Local Chickens in Dekina. *International Journal of Poultry Science* 10 (6): 444-447.

[11] Delgado, J. V., C. Barba, M. E. Camacho, F. T. P. S. Sereno, A. Martinez and J. L. Vega-Pla (2001). Livestock characterization in Spain. Anim. *Genet. Resour. Info.* 29: 7-18.

[12] Dolezal, H. G , Tatum, J. D. and Williams, Jr F. C. (1993). Effect of feeder cattle frame size, muscle thickness and age class on days fed weight and carcass composition. *J. of Anim. Sc.* 71: 2975-2985.

[13] Dossa, L., Wollny, C., Gauly, M. (2007). Spatial variation in goat populations from Benin as revealed by multivariate analysis of morphological traits. *Small Ruminant Research,* 73: 150-159.

[14] FAOSTAT (2010). Food Balance Sheets. Food and Agriculture Organization of the United Nations, Rome, Italy.

[15] FAOSTAT. (2008). Number of animals: cattle and buffalo and sheep and goat; *Statistics division.* FAO statistical yearbook.

[16] FAOSTAT. (2011). Food and Agricultural Organization of the United Nations (available at http://faostat.fao.org/default.aspx; accessed 19 July 2011).

[17] FDLPCS. (2007). Federal Department of Livestock and Pest Control Services. FLDPCS Nigerian. Livestock Resources. National Synthesis, 440 pp.

[18] Gambo, M., Igwebuike, J. U. and Kwari, I. D. (2005). Performance of growing rabbit and feed graded levels of goat rumen content, *Global Journal of Pure and Applied Sciences* Vol. 11(1): 39-43

[19] Isaac, J. L. (2005). Potential causes and life-history consequences of sexual size dimorphism in mammals. *Mammal Review,* 35: 101-115

[20] Khan, H., F. Muhammed, R. Ahmed, G. Rahimullah and M. Zubair (2006). Relationship of body weight with linear body measurements in goats. *J. Agric. Biol. Sci.* 1 (3): 51-54.

[21] MacNeil, J. H. (1969). Yield characteristics and relationship to body measurement of commercial status of turkeys. *Poult. Sc.* 48: 1598-1603

[22] Minchin, W., Buckley, F., Kenny, D. A., Keane, M. G., Shalloo, L. and O'Donovan, M. (2009). Prediction of cull cow carcass characteristics from live weight and body condition score measurement preslaughter. *Irish J. of Agric. Food Research.* 18: 75-86

[23] Mohammed, I. D. and J. D. Amin (1997). Estimating body weight from morphometric measurements of Sahel (Borno White) goats. *Small Rumin. Res.* 24: 1-5.

[24] Morand-Fehr, P. (2004). Proposals for improving the research efficiency in goats. *Small Ruminant Res.* 51: 145-153.

[25] Mwacharo, J.M.; Okeyo, A.M.; Kamande, G.K. (2006). The small East African shorthorn zebu cows in Kenya. In: Linear body measurements. *Tropical Animal Health and Production,* v. 38, p. 65-74.

[26] Odubote, I. K. (1994). Influence of qualitative traits on performance of West Africa dwarf goats. *Nig. J. Anim. Prod*. 21: 25-28.

[27] Ogah, D. M., Yusuf, N. D. and Ari, M. M. (2011). Path coefficient model for assessment of weight using linear traits at birth and at weaning in Nigeria indigenous pig. *In* Proc. of 34th conf. of Tanzania Soc. of Anim. Prod.

[28] Okpeku, M., Yakubu, A., Peters, S., Ozoje, M., Ikeobi, C., Adebambo, O and Imumorin, I. (2011). Application of Multivariate Principal Component Analysis to Morphological Characterization of Indigenous Goats in Southern Nigeria. *Acta argiculturae Slovenica*, 98 (2): 101-109.

[29] RIM. (1992). Nigerian Livestock Research, Vol. III, National Synthesis. Report by Resource Inventory and Management Limited (RIM) to Federal Department of Livestock and Pest Control Services, Abuja, Nigeria.

[30] Ross, J. C. (1988). The estimation of live weight of Nigerian cattle from linear body measurement. *Epiz. Dis. Afr.* 6: 253-356.

[31] Rotimi, E. A., Egahi, J. O. and Adeoye, A. A. (2015). Effects of Sex and location on Body Weight and Morphometric traits in West African Dwarf (WAD) Goats in Ushongo Local Government Area of Benue State, Nigeria. *FUDMA J. Agric & Agric. Tech.* 1(1): 56-60

[32] Salako, A. E. (2004). Maturity rate of some morphometric traits in the West African Dwarf sheep of Nigeria. *Trop. J. Anim. Sci.*, 7 (1): 51-55.

[33] Salako, A. E. (2006). Application of morphological indices in the assessment of type and Function in sheep. *Int. J. Morph.* 24: 8-13.

[34] Singh, B. B. and Tyagi, J. C. (1970). Magnitude of effect of factors affecting birth weight of Hariana calves. *Indian vet. J.* 97: 851-854.

[35] SPSS. (2011). Statistical Package for the Social Sciences. User's Guide: Statistics, Version 20.0, Institute, Inc., Cary, NC, USA.

[36] Vargas, S., Larbi A., Sanchez, M. (2007). Analysis of size and conformation of native Creole goat breeds and crossbreds used in smallholder agrosilvo-pastoral systems in Puebla, Mexico. *Tro. Anim. Health Prod.* 39: 279-286

[37] Williamson, P. N. and Brinkmann, W. E. (1997). The effect of plane of nutrition on the growth and development of East African goats. Effect of plane of nutrition live weight gain and the external measurement of Kids. *K. Agric. Sci.* 50(2) 198-200.

[38] Yakubu, A. (2009). Fixing collinearity instability in the estimation of body weight from morphobio-metrical traits of West African Dwarf goats, *Trakia J. Sci*. 7: 61-66.

[39] Zeder, M. A. and Hasse, B. (2000). The initial domestication of goats (*Capra hircus*) in the Zagros Mountains 10,000 years ago. *Sci.*, 287: 2254-2257.

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