



E-ISSN: 2320-7078
P-ISSN: 2349-6800
 JEZS 2018; 6(1): 560-564
 © 2018 JEZS
 Received: 21-11-2017
 Accepted: 22-12-2017

TK Patbandha
 Polytechnic in Animal
 Husbandry, College of
 Veterinary Science & Animal
 Husbandry, JAU, Junagadh,
 Gujarat, India

BA Pata
 Department of Livestock
 Production and Management,
 College of Veterinary Science &
 Animal Husbandry, JAU,
 Junagadh, Gujarat, India

SP Trivedi
 Department of Animal
 Nutrition, College of Veterinary
 Science & Animal Husbandry,
 JAU, Junagadh, Gujarat, India

BC Gohil
 Department of Animal
 Nutrition, College of Veterinary
 Science & Animal Husbandry,
 JAU, Junagadh, Gujarat, India

PC Boradiya
 Department of Animal
 Nutrition, College of Veterinary
 Science & Animal Husbandry,
 JAU, Junagadh, Gujarat, India

A Sharma
 Department of Veterinary
 Anatomy, College of Veterinary
 Science & Animal Husbandry,
 JAU, Junagadh, Gujarat, India

KB Savalia
 Polytechnic in Animal
 Husbandry, College of
 Veterinary Science & Animal
 Husbandry, JAU, Junagadh,
 Gujarat, India

Correspondence

TK Patbandha
 Polytechnic in Animal
 Husbandry, College of
 Veterinary Science & Animal
 Husbandry, JAU, Junagadh,
 Gujarat, India

Evaluating phenotypic correlation between body weight and biometric traits of migratory goats

TK Patbandha, BA Pata, SP Trivedi, BC Gohil, PC Boradiya, A Sharma and KB Savalia

Abstract

Present study was conducted to evaluate the phenotypic correlation between live body weight and biometric traits of migratory goats at Junagadh Agricultural University, Junagadh. Live body weight and 25 biometric traits of body were measured from migratory female goats (n=80), twenty from each age group (5-20 days, 3-6 months, 1.0-1.5 and >2.0 years). Live body weight of the goats in 5-20 days, 3-6 months, 1.0-1.5 and >2.0 years of age was 5.54 ± 0.27 , 14.95 ± 0.69 , 31.80 ± 0.95 and 38.38 ± 1.05 kg, respectively. Among the biometric traits, height at hip (40.70 ± 0.85 cm) and height at wither (40.65 ± 0.62 cm) were higher as compared to other traits in kids (5-20 days). However, with an increase in age, barrel girth (60.43 ± 0.79 , 79.40 ± 0.90 and 84.45 ± 1.31 cm, respectively in 3-6 months, 1.0-1.5 and >2.0 years) remained highest among the all biometric traits studied. Phenotypic correlation with weight was positive and significant ($P \leq 0.05$) for majority of biometric traits, but differed among the age groups. Chest girth showed consistently higher positive association with weight ($r = 0.729, 0.866, 0.797$ and 0.802 , respectively in 3-6 months, 1.0-1.5 and >2.0 years, $P \leq 0.001$). Additionally, height at wither, body length, paunch and barrel girth had a positive and significant association with weight in all age groups ($P \leq 0.05$). Thus, it may be concluded that biometric traits like chest girth, height at wither, body length, paunch and barrel girth could be useful for genetic improvement of live body weight in migratory goats.

Keywords: Live body weight, biometric traits, migratory goats

Introduction

Indian goats contribute appreciably to the national economy and play a significant role for nutritional security of rural livelihood by providing valuable source of animal protein like meat and milk [1]. Goat meat is accepted by all religions and has great demand in India due to leanness than the other red meat, that's why goat is considered as a national meat animal [2]. Further, the adaptability of goats to different ecological areas starting from arid desert to tropical rain forests, which reflects their ability to suit harsh environments [3]; hence goats are easily reared throughout the length and breadth of India but other meat animals lack such adaptability. Output of meat from goat depends on their live body weight at market age and thus live body weight is considered as a most important trait which is primarily influenced by the growth potential of the animals. Traits like growth and weight of adult hood are highly heritable in goats and could be improved through selective breeding or cross breeding [2]. However, selective breeding is common practice in India for improvement of goats' genetic potential for meat production. Goat production systems in India are migratory type and primarily rely on extensive grazing where recording of live body weight is impractical. Further, owing to scarcity of feed under the extensive grazing system the growth performance of goat is poor [4], so the measurement of live body weight may not represent their true growth potential. Therefore, biometric traits could be used as an alternative substitute for indirect improvement of growth potential and live body weight in migratory flocks. Previous studies also revealed significant and positive association between biometric traits of body and live body weight in goats under field condition as well as in organised farm in India [5-7], but the informations on such associations are scanty in goats reared under the migratory production system. Furthermore, above studies highlighted the association of few biometric traits particularly height at wither, body length, chest girth, neck length and paunch girth with body weight, ignoring several other biometric traits. Thus, the present study was designed with the aim to measure the absolute live body weight and body biometric traits of migratory goats and also to estimate their phenotypic correlation at different age groups.

2. Materials and Methods

The present study was conducted at College of Veterinary Science and Animal Husbandry, Junagadh Agricultural University, Junagadh (Gujarat) on migratory goats during February to May, 2017. The goat farmers followed a seasonal migration (November to June) and maintained their animals under extensive pasture grazing as well as grazing on crop residues and stubble left in the field. Farmers did not follow any deworming program for endoparasites or vaccination program for prevention of diseases but generally treat the animals during the disease condition only. Total of eighty female goats, 20 each from young (5-20 days), grower (3-6 months), yearling (1.0-1.5 years) and adult (>2.0 years) were included in this study. Age of the animals was determined based on the eruption of incisor teeth as well as the birth date or month shared by the farmers. Live body weight and 25 important body biometric traits were measured from each animal and detail definition of the biometric traits is presented in Table 1. Live body weight was measured using a hanging spring balance of 100 kg maximum weight limit. Biometric traits were measured using measuring tap and Vernier caliper. Animals were placed on a plane hard ground for measuring the biometric traits. The live body weight and biometric traits were measured during morning (between 7:00 AM to 10 AM) before letting the animals for grazing.

2.1 Statistical analysis

Live body weight and biometric traits of goats among different age groups were compared by one-way analysis of variance and the results are presented as mean and standard error. All pair wise mean differences between the groups were compared with the Duncan multiple range test as post hoc test and the difference was considered as significant when $P \leq 0.05$. Phenotypic correlation of live body weight with the biometric traits were analysed by Pearson correlation at different age groups. All the statistical analyses were carried out using SPSS software package (Version 16.0, USA).

3. Results and Discussion

3.1 Live body weight and biometric traits

Live body weight and biometric traits in the trunk region of migratory female goats are depicted in Table 2. Further, biometric traits of head, neck, tail and limb region are presented in Table 3. Live body weight and biometric traits differed significantly ($P \leq 0.05$) among different age groups. Mean value of the traits showed increasing trend with increase in age, but in some instances (shoulder width, chine length, rump length, head girth, tail length, fore cannon length and girth and thigh circumference) values remained similar between 1.0-1.5 years and >2.0 years of age. The results are similar to previous studies, which highlighted increasing trend of body weight and biometric traits of female goats native to Gujarat [8-10] and also other parts of India [5-7]. The migratory goats included in the present study were not true of any registered breed, but they resembled more or less to Kutchi and Gohilwadi goats. The live body weight of migratory goats is more or less comparable with the Kutchi and Gohilwadi goats which are native to the study area. The weight of Kutchi goat has been reported to be 3.31, 12.82-18.98 and 28.55 kg, respectively at birth, 3-6 and 12 months of age [8]; whereas, the weight of Gohilwadi goats during same age was 2.64, 10.6-16.6 and 21.07 kg, respectively [10] and similar results were observed in migratory goats. Body weight of the adult female Kutchi and Gohilwadi goats was observed to be 38.78-39.29 kg [8, 11] and 37.6 kg [10], respectively and comparable

values were observed in our study. In consonance with our results, Yadav *et al.* [12] reported body weight of female Kutchi goats 3.10, 9.46-15.86 and 21.13 kg, respectively at birth, 3-6 and 12 months age.

In goats, most commonly measured biometric traits are height at wither, body length and chest girth; the value of these traits observed at different age groups of migratory goats are more or less comparable with Gohilwadi and Kutchi goats [10, 13-14] as well as Zalawadi goat of Gujarat [9], but higher than the medium sized Surti goats of South Gujarat [15]. Alex *et al.* [5] reported higher values of paunch girth, followed by chest girth, height at wither and body length in Malabari goats under field condition, the results are contradictory in our study. In our study, taking above 4 traits (paunch girth, chest girth, height at wither and body length) paunch girth was observed highest, followed by height at wither, chest girth and body length at 3-6 months, 1.0-1.5 and >2.0 years of age, but in 5-20 days kids the mean value of height at wither was higher. Moreover, among all biometric traits studied, mean value of height at wither and hip bone were observed to be higher compared to other traits in new born kids (5-20 days age). After that, with the increase in age the barrel girth remained highest among the traits studied in migratory goats. Variation of results in different studies might be attributed to the genetic makeup [13] of the breeds studied as well as rearing practices particularly feeding practices [16].

In the present study, head length of migratory goats was 11.38, 15.35, 20.78 and 21.98 cm, respectively in 5-20 days, 3-6 months, 1.0-1.5 years and >2.0 years of age, which are comparable to female Gohilwadi goats [10]. Further, head length of adult Gohilwadi goats varies between 16 and 22 cm [10] and in our study the value (21.98 cm) was within the range. Neck length of the female migratory goats of different age groups observed in the present study is similar to Rohilkhand local goats of Uttar Pradesh [6], but higher than adult female Black Bengal goats of West Bengal (21.45 cm) [17]. Neck circumference of the adult migratory goat was 42.08 cm, which is contradictory to observation of Bhattacharya *et al.* [18], who observed in adult female Black Bengal goats as 30.06 cm. The migratory goats are comparatively larger in size than the Black Bengal goats, may be the reason of higher neck length and girth.

3.2 Phenotypic correlation

Phenotypic correlation of live body weight with biometric traits at trunk region is presented in Table 4. Further, phenotypic correlation between live body weight and biometric traits at head, neck, tail and limb region of migratory female goats are presented in Table 5. The association was observed to be positive and significant ($P \leq 0.05$) in majority of traits but differed among the age groups, which is in consonance with others [5-7]. Among the traits, chest girth showed consistently significant ($P \leq 0.001$) and higher positive association with weight in all age groups ($r = 0.729$ to 0.866). Additionally, height at wither ($r = 0.516$ to 0.911), body length ($r = 0.609$ to 0.933), paunch girth ($r = 0.597$ to 0.775) and barrel girth ($r = 0.505$ to 0.873) had also a positive and significant association with body weight in all age groups (Table 4). The results are more or less comparable to other Indian goat breeds [5, 6]. In a similar line, Alex *et al.* [5] observed positive correlation of body weight with chest girth, paunch girth, body length and height at wither at <1 month ($r = 0.558, 0.531, 0.563$ and 0.503), 3 months ($r = 0.823, 0.719, 0.655$ and 0.634), 6 months ($r = 0.800, 0.658, 0.710$ and 0.683), 9 months ($r = 0.794, 0.600, 0.597$ and 0.539) and 12

months ($r = 0.694, 0.638, 0.494$ and 0.379), respectively in female Malabari goat. In Rohilkhand goats, Fahim *et al.* [6] observed positive and significant association of weight with chest girth ($r = 0.579$ to 0.850), body length ($r = 0.319$ to 0.803) and height at wither ($r = 0.439$ to 0.682) from birth to adult hood which are supported by our results. In Osmanabadi goats, correlation value of $0.25-0.61, 0.33-0.63, 0.25-0.48$ from birth to adult hood for height at wither, chest girth and body length with body weight was reported by Mule *et al.* [7], but the values were comparatively higher in migratory goats. Most of the previous association studies as discussed above primarily focused on height at wither, chest girth, body length and paunch girth, but cited correlation of other biometric traits with body weight in Indian goats [6] as well as goats from other countries [19-22]. We observed positive association of head length and width with weight but it was significant between 3 and 18 months of age. In a similar line, Berhe [19] observed positive association of head width and length with

weight in Maefur goat of Ethiopia. In our study, positive and significant association of neck length with live body weight ($r = 0.880$) was observed during the age of 3 to 6 months, which is higher than Rohilkhand local goats of same age ($r = 0.457$) [6]. Neck girth of the migratory goat was positively and significantly correlated with weight up to 1.5 years, but later the association was non-significant, which is inconsonance with the female Afar goats of Ethiopia [20] and contrary to Red Sokoto goats of Nigeria [21]. The chest depth and width was positively correlated with weight in migratory goats which are more or less comparable with other goat breeds of Nigeria [21] and Ethiopia [19, 22]. Further, several authors reported positive association of rump length and height with weight in different goat breeds [19-20, 22] and similar results were also observed in this study. In consonance to our results, correlation of weight with tail length [21] and cannon circumference [19] has also been observed positive in Red Sokoto goats of Nigeria and Maefur goat of Ethiopia, respectively.

Table 1: Body biometric traits of goat and their definition

Biometric traits	Definition
Height at wither	Vertical distance from ground to the highest point of wither
Chest depth	Distance from top to lowest part of body behind front legs
Sternum height	Difference between height at wither and chest depth
Chest girth	Circumference of the chest just behind the point of elbow
Shoulder width	Horizontal distance between point of two shoulders
Body length	Length from point of shoulder to point of pin bone
Chine length	Distance from posterior edge of scapula to last rib.
Loin length	Distance from last rib to hip bone.
Rump length	Distance from hip bone to pin bone.
Height at hip	Distance from ground to hip bone.
Paunch girth	Circumference of the abdomen just before the hind limbs.
Paunch depth	Distance from top to lowest part of body before hind legs.
Barrel girth	Circumference of body at the largest section of the body.
Barrel depth	Distance from top to the point at largest section of the body ventrally
Head length	Distance from the poll to the extreme end of mouth.
Head girth	Girth at the widest part of head
Face length	Base of eye (inner canthus) to the extreme end of mouth.
Neck length	Length from neck attachment with head to attachment with body
Neck girth	Circumference at base of neck.
Tail length	Length from the base of the tail to the tip of the tail.
Fore Cannon length	Length from the knee to the fetlock.
Fore Cannon girth	Circumference around the middle of the fore cannon.
Hind Cannon length	Length from the hock to the fetlock.
Hind Cannon girth	Circumference around the middle of the hind cannon.
Thigh circumference	Circumference around middle of thigh

Table 2: Body weight (kg) and biometric traits (cm) in trunk region of migratory goats

Sr. No.	Parameters	Age groups			
		5-20 days	3-6 months	12-18 months	>2.0 years
1	Body weight (kg)	5.54 ^a ±0.27	14.95 ^b ±0.69	31.80 ^c ±0.95	38.38 ^d ±1.05
2	Height at wither (cm)	40.65 ^a ±0.62	57.28 ^b ±1.28	75.55 ^c ±1.03	80.60 ^d ±0.62
3	Chest depth (cm)	14.40 ^a ±0.41	20.55 ^b ±0.40	28.65 ^c ±0.45	31.50 ^d ±0.46
4	Sternum height (cm)	26.25 ^a ±0.58	36.73 ^b ±0.99	46.90 ^c ±0.72	49.10 ^d ±0.50
5	Chest girth (cm)	39.15 ^a ±0.59	53.78 ^b ±0.71	72.38 ^c ±0.77	76.15 ^d ±0.80
6	Shoulder width (cm)	9.30 ^a ±0.26	13.43 ^b ±0.69	17.95 ^c ±0.25	18.75 ^d ±0.40
7	Body length (cm)	36.03 ^a ±0.76	52.93 ^b ±1.41	70.28 ^c ±0.45	75.35 ^d ±0.99
8	Chine length (cm)	13.88 ^a ±0.39	19.30 ^b ±0.56	23.95 ^c ±0.45	24.85 ^d ±0.67
9	Loin length (cm)	11.13 ^a ±0.44	18.73 ^b ±0.52	21.90 ^c ±0.29	24.78 ^d ±0.48
10	Rump length (cm)	9.60 ^a ±0.27	15.70 ^b ±0.43	19.80 ^c ±0.26	20.70 ^d ±0.43
11	Height at hip (cm)	40.70 ^a ±0.85	59.25 ^b ±1.23	77.55 ^c ±0.63	80.30 ^d ±0.58
12	Paunch girth (cm)	37.30 ^a ±0.84	57.48 ^b ±0.88	76.18 ^c ±0.74	80.75 ^d ±0.90
13	Paunch depth (cm)	15.28 ^a ±0.29	22.88 ^b ±0.88	28.28 ^c ±0.41	31.58 ^d ±0.55
14	Barrel girth (cm)	39.18 ^a ±0.79	60.43 ^b ±0.79	79.40 ^c ±0.90	84.45 ^d ±1.31
15	Barrel depth (cm)	14.78 ^a ±0.37	22.68 ^b ±0.33	28.20 ^c ±0.31	31.23 ^d ±0.46

Means with different superscripts (a, b, c, d) differ statistically ($P < 0.05$) within a row, N=80 with 20 animals in each age group

Table 3: Biometric traits (cm) in head, neck, tail and limb region of migratory goats

Sr. No.	Parameters	Age groups			
		5-20 days	3-6 months	12-18 months	>2.0 years
1	Head length (cm)	11.38 ^a ±0.34	15.35 ^b ±0.49	20.78 ^c ±0.36	21.98 ^d ±0.41
2	Head girth (cm)	26.57 ^a ±0.47	33.83 ^b ±0.99	43.10 ^c ±0.32	44.72 ^c ±0.52
3	Face length (cm)	6.33 ^a ±0.22	9.55 ^b ±0.27	13.10 ^c ±0.17	13.78 ^d ±0.18
4	Neck length (cm)	12.55 ^a ±0.36	19.00 ^b ±0.70	24.10 ^c ±0.44	28.15 ^d ±0.81
5	Neck girth (cm)	23.25 ^a ±0.54	29.85 ^b ±0.71	39.80 ^c ±0.56	42.08 ^d ±0.82
6	Tail length (cm)	10.95 ^a ±0.38	14.95 ^b ±0.49	16.95 ^c ±0.32	17.50 ^c ±0.42
7	Fore Cannon length (cm)	10.95 ^a ±0.18	13.28 ^b ±0.32	16.83 ^c ±0.18	17.18 ^c ±0.22
8	Fore Cannon girth (cm)	6.59 ^a ±0.12	7.45 ^b ±0.11	8.57 ^c ±0.13	8.85 ^c ±0.10
9	Hind Cannon length (cm)	13.38 ^a ±0.31	16.33 ^b ±0.61	21.28 ^c ±0.21	22.63 ^d ±0.23
10	Hind Cannon girth (cm)	6.70 ^a ±0.11	7.59 ^b ±0.13	8.78 ^c ±0.13	9.30 ^d ±0.11
11	Thigh circumference (cm)	18.08 ^a ±0.44	22.75 ^b ±0.67	30.28 ^c ±0.40	31.68 ^c ±0.62

Means with different superscripts (a, b, c, d) differ statistically (P≤0.05) within a row; N=80 with 20 animals in each age group

Tables 4: Correlation of body weight with biometric traits in trunk region of migratory goats

Sr. No.	Parameters	Age groups			
		5-20 days	3-6 months	12-18 months	>2.0 years
1	Height at wither	0.633**	0.911***	0.753***	0.516*
2	Chest depth	0.164	0.801***	0.703***	0.556**
3	Sternum height	0.560**	0.852***	0.634**	0.122
4	Chest girth	0.729***	0.866***	0.797***	0.802***
5	Shoulder width	0.514*	0.859***	0.382	0.237
6	Body length	0.609**	0.933***	0.780***	0.645**
7	Chine length	0.606**	0.801***	0.394	0.113
8	Loin length	0.507*	0.751***	0.534**	0.267
9	Rump length	0.487*	0.818***	0.164	0.525*
10	Height at hip	0.559***	0.926***	0.741***	0.240
11	Paunch girth	0.597**	0.738***	0.713***	0.775***
12	Paunch depth	0.191	0.247	0.316	0.532*
13	Barrel girth	0.506*	0.604**	0.505*	0.873***
14	Barrel depth	-0.026	0.576**	0.380	0.628**

* indicates P≤0.05; ** indicates P≤0.01 and *** indicates P≤0.001; N=80 with 20 animals in each age group

Tables 5: Correlation of body weight with biometric traits in head, neck, tail and limb region of migratory goats

Sr. No.	Parameters	Age groups			
		5-20 days	3-6 months	12-18 months	>2.0 years
1	Head length	0.088	0.654***	0.454*	0.345
2	Head girth	0.307	0.748***	0.431*	0.307
3	Face length	0.547**	0.372	0.804***	0.506*
4	Neck length	0.080	0.880***	-0.316	-0.024
5	Neck girth	0.762***	0.848***	0.533**	0.176
6	Tail length	0.746***	0.665***	0.248	0.110
7	Fore Cannon length	0.533**	0.792***	0.393	-0.336
8	Fore Cannon girth	0.302	0.504*	0.527*	0.495*
9	Hind Cannon length	-0.081	0.730***	0.147	-0.058
10	Hind Cannon girth	0.301	0.302	0.432*	0.305
11	Thigh circumference	0.501*	0.766***	0.015	0.113

* indicates P≤0.05; ** indicates P≤0.01 and *** indicates P≤0.001; N=80 with 20 animals in each age group

4. Conclusion

Live body weight and biometric traits of migratory goats increased gradually from birth to adult hood. Chest girth showed consistently higher positive and significant association with live body weight followed by height at wither, body length, paunch girth and barrel girth. The above results indicated that biometric traits such as chest girth, height at wither, body length, paunch girth and barrel girth could be useful for genetic improvement of migratory goats.

5. Acknowledgement

Authors are highly thankful to Principal, Polytechnic in Animal Husbandry for his valuable suggestions while

preparing this manuscript. The migratory farmers and supporting staffs of Polytechnic in Animal Husbandry are also acknowledged for their co-operation and assistance during the data collection.

6. References

1. Bhakat M, Patbandha TK, Mohanty TK, Singh A, Mondal S. Commercial goat farming in India. Enabling extension functionaries to address field level problems in animal husbandry. All India Animal Husbandry Officers' Workshop. 2015; 115-122.
2. Dhanda JS, Taylor DG, Murray PJ, Pegg RB, Shand PJ. Goat meat production: present status and future

- possibilities. *Asian-Australasian Journal of Animal Sciences*. 2003; 16(12):1842-1852.
3. Alexandre G, Mandonnet N. Goat meat production in harsh environments. *Small Ruminant Research*. 2005; 60:53-66.
 4. Kumar S, Rao CAR, Kareemulla K, Venkateswarlu, B. Role of goats in livelihood security of rural poor in the less favoured environments. *Indian Journal of Agricultural Economics*. 2010; 65:760-781.
 5. Alex R, Raghavan KC, Mercey KA. Prediction of body weight of Malabari goats from body measurements under field conditions. *Journal of Veterinary and Animal Science*. 2010; 41:21-27.
 6. Fahim A, Patel BHM, Rijasnaz VV. Relationship of body weight with linear body measurements in Rohilkhand local goats. *Indian Journal of Animal Research*. 2013; 47(6):521-526.
 7. Mule MR, Barbind RP, Korake RL. Relationship of body weight with linear body measurement in Osmanabadi goats. *Indian Journal of Animal Research*. 2014; 48(2):155-158.
 8. Arun K, Sushil K, Mishra AK, Singh VK. Characteristics of Kutchi goats of Gujarat. *Indian Journal of Small Ruminants*. 2006; 12(2):162-168.
 9. Singh MK, Rai B, Singh SK, Singh NP. Morphological and physical attributes of Zalawadi Goats. *Indian Journal of Animal Sciences*. 2007; 77(12):1334-1337.
 10. Singh MK, Rai B, Kumar A, Sisodiya HS, Singh NP. Production performance of Gohilwadi goats under range conditions. *Indian Journal of Animal Sciences*. 2009; 79(6):587-593.
 11. Thiruvenkadan AK. Country reports 2013/14 of the Asian-Australasian dairy goat network. Institute of Tropical Agriculture, University Putra Malaysia. 2014; 19-32.
 12. Yadav JS, Kumar S, Bhasin V, Singh L, Yadav MC, Khan BU. Genetic analysis of factors affecting body weight at different ages in closed flock of Kutchi goats. *Indian Journal of Animal Sciences*. 2013; 83(5):554-556.
 13. Acharya RM. Sheep and goat breeds of India. FAO Animal production and Health paper 30, Food and Agriculture Organisation of the United Nation, Rome, Italy, 1982.
 14. Verma NK, Dangi PS, Aggarwal RAK, Dixit SP, Chander R, Ahlawat SPS. Features and performance Gohilwadi goats under field conditions. *Compendium of National symposium on role of Animal genetic resources in rural livelihood security, Ranchi (Jharkhand), 2007, 250.*
 15. Deshpande SB, Sabapara GP, Malik PK, Sadana DK, Singh PK, Singh G *et al.* Morpho-metric characteristics of Surti goats and socio-economic status of Surti goat keepers. *Indian Journal of Animal Sciences*. 2010; 80(6):575-577.
 16. Moniruzzaman M, Hashem MA, Akhter S, Hossa MM. Effect of different feeding systems on carcass and non-carcass parameters of Black Bengal goat. *Asian-Australasian Journal of Animal Sciences*. 2002; 15(1):61-65.
 17. Haldar A, Pal P, Datta M, Paul R, Pal SK, Majumdar D *et al.* Prolificacy and its relationship with age, body weight, parity, previous litter size and body linear type traits in meat-type goats. *Asian-Australasian Journal of Animal Sciences*. 2014; 27(5):628-634.
 18. Bhattacharya B, Ghosh TK, Duttagupta R, Maitra DN. Estimation of body weight in Black Bengal goats from body measurements. *Indian Veterinary Journal*. 1984; 61(5):406-408.
 19. Berhe WG. Relationship and prediction of body weight from morphometric traits in Maefur goat population in Tigray, northern Ethiopia. *Journal of Biometrics and Biostatistics*. 2017; 8(5):370.
 20. Tekle T. Predicting live weight using body measurements in Afar goats in north eastern Ethiopia. *Momona Ethiopian Journal of Science*. 2014; 6(2): 18-32.
 21. Yakubu A, Mohammed GL. Application of path analysis methodology in assessing the relationship between body weight and biometric traits of Red Sokoto goats in northern Nigeria. *Biotechnology in Animal Husbandry*. 2012; 28(1):107-117.
 22. Tsegaye D, Belay B, Haile A. Linear body measurements as predictor of body weight in Hararghe highland goats under farmers' environment: Ethiopia. *Global Veterinaria*. 2013; 11(5):649-656.