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Comparative osteometric differences in humerus of bari Goat and Dumbi Sheep

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Morphological studies were conducted on the Humerus of 60 clinically healthy animals (30 Bari goat and 30 Dumbi sheep) of both sexes, slaughtered at Tandojam and Tando Allahyar abattoirs. For comparative study, animals were divided in three age groups viz., lambs/kids (6-9 months), yearlings (13-21 months) and adult (21-24 months). The estimated age was determined through dental formula, whereas, the body weight was obtained using spring balance. For collection and preparation of specimen standard procedures were adopted. The weight (Mean± SEM) of right and left humerus of three age groups of Bari goat and Dumbi sheep is found to be 26.66±0.23, 34.06±0.33, 46.44±0.44, 31.29±0.83, 47.20±1.27, 53.62±0.66, 26.54±0.34g, 34.87±0.40, 46.47±2.64, 31.32±0.83, 47.56±0.60 and 53.57±0.53 g, respectively. Statistical analysis revealed significant difference (p<0.05) between the kid/lamb and yearling groups but no significant difference between adult groups of both species. It is further revealed that the bones of sheep are generally heavier than goat. The mean ± SEM length of right and left humerus from three age groups of goat and sheep calculated as 11.51±0.92, 13.77±0.08, 16.61±0.11, 10.08±0.15, 12.93±0.13 and 14.63±0.12cm, respectively. The statistical analysis revealed a highly significant difference (P<0.01) between kid/lamb and yearling groups, but no statistical difference (p>0.05) in between and among the adult groups of both species. The Bari goat possess relatively longer humerus than those of the Dumbi sheep. Mean values for breadth of proximal end (Bpe), breadth of distal end (Bde) and circumference of right and left humerus from three age groups of Bari goat and Dumbi sheep showed statistical differences between the age groups but no statistical difference was noted among two species and sexes.

Key words: Osteometric, differences, humerus, Bari goat, Dumbi sheep.

INTRODUCTION

Livestock represents an important component of the agricultural sector in Pakistan (Mohammad, 2007). It

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accounts 55.1% of the agriculture value added and 11.5% to gross domestic production (GDP) during 2010-12. Livestock has witnessed a marginally higher growth of 4.0% against the growth of 3.97 percent last year (Anonymous, 2011-12).

The domestic goat (*Capra aegagrus hircus*) is a subspecies of wild goat of Southwest Asia and Eastern Europe (Hrist and Kris, 2008). Pakistan is rich in goat genetic resource and it is the third largest goat producing country in the World after China and India (Anonymous, 2010-11).

Pakistan has about 34 goat breeds (Isani and Baloch, 1996; Khan and Ashfaq 2012). The major objective of goat rising is meat, while milk obtained from goat is consumed by human being and hairs are used domestically for producing rugs by poor or needy families (Khan et al., 2008). Goat population of Pakistan is 63.1 million and breeds are generally categorized as meat, dairy and hairy types (Anonymous, 2011-12). Sindh Provence includes Bari, Chhapar, Kamori, Sindh Desi, Bujri, Jattan, Kacchan, Kurri, Kurri, Lohri, Lehri, Pateri, Tapri or Lappi, Tharki or Tharri in Sindh (Anonymous, 2003-04).

There are 30 breeds of sheep in Pakistan (Isani and Baloch, 1996). Sheep population of Pakistan is about 28.4 million heads (Anonymous, 2011-12). Sheep is an important source of food (meat and milk) as well as of other products of high economic value, such as wool and leather (Tariq et al., 2011). Most famous breeds of sheep include Dumbi, Kachhi and Kooka in Sindh province (Anonymous, 2003-04). The total milk production is around 46.4 million tons and out of this, sheep contribute 0.04 million tons (Anonymous, 2010-11). Wool yield per head is 1.4 kg per annum (Shah et al., 2001).

Bari (Barbari) breed is predominantly utilized as meat and milk purpose especially in Sindh and Punjab. The population of Bari goat is 2.3 million heads. This breed of goat is found in Hyderabad, Dadu, Larkana Khairpur, Nawabshah and Jacobabad districts of Sindh. A compact body, pointed horns, head with a long narrow snout, small, straight and erect ears are prominent features of this breed. The body color of goat is usually white and brown or spotted. Body weight of adult male and female is 23 and 20 kg, respectively and the milk yield is 100 L / lactation of 110 days (Shah et al., 2001; Khan et al., 2008).

The skeletal system stands out as one of the body structures has been used for the characterization of different species of animals (Guintard and Lallemand, 2003). The natural morphological development of bones and joints is very important for the diagnosis of skeletal diseases in young animals (Makkaway et al., 1988). The development morphology of animals shows considerable variation with respect to breed, age, sex, nutritional situation and environmental factors among others (Outram and Conwy, 1998). Some researchers depended on limb bone length to estimate the late fetal and prenatal age (Schewers et al., 1980). The study of the appearance of limb ossification centers provide great aids in age estimation during prenatal life and assessment of fetal bone maturation and helps in the detection of some fetal abnormalities (Oishi et al., 1996). Morphologically examination of long bones provides rather significant insights into intra-species as well as interspecies differences.

MATERIALS AND METHODS

The findings of the present study will provide baseline data because osteological characteristics are often used to identify animal species rather in three different stages in a cheap and rapid manner. Further present study will also be helpful in performing orthopedic surgery in small ruminants.

Specimen collection

This experimental study was performed on the 60 clinically healthy animals (30 Bari goat 30 Dumbi sheep) of either sex slaughtered at Tandojam and Tando Allahyar abattoirs sindh Pakistan abattoirs during 2011-12. These animals were divided in three (10 animals in each group) groups according to the age. The estimated age was noted through dental formula (Vatta et al., 2006) and body weight was determined by using spring balance. Physical examination of all animals was conducted for any sign of deformity before the right and left pectoral or forelimbs were harvested.

Preparation of specimen for maceration

The soft tissues attached to the long bones of forelimbs such as muscles, fascia, tendons and ligaments were removed with scalpel and scissors. The long bones such as humerus, radius and ulna and metacarpal from forelimbs of both species were separated. The specimens were then arranged into two macerating buckets, one for goat and the other for sheep. Tap water was added to submerge the specimen. This process was allowed to stay bones for 3 days after which the water was changed. Further, 1 to 1.5 Mol of Potassium Hydroxide (KOH) was added to facilitate total removal of remaining soft tissues from bones. This process is known as maceration. The macerated bones were dried for 2 to 3 days after which they were boiled for 5 to 6 h with detergent until unless to remove bone marrow and fat. The bones were allowed to dry for the second time for 2 to 3 days on sunlight.

Measurement of the bones

Weight of the bones was obtained in grams by using a sensitive electronic balance. Length and other measurements of the long bones was measured by using a measuring tape as revealed by Salami et al. (2011). Diameter of the bone extremities and the mid shaft was measured in millimeters using Vernier calliper (Siddiqui et al., 2008). The result thus obtained was converted to centimeters.

The circumferences of the bones were taken using a thread. The weight, breadth of proximal end (Bpe), breadth of distal end (Bde), depth of olecranon (Do), depth of process anconaeus (Dpa), circumference (Cr), and length of all long bones were measured. All recorded weights, lengths and diameters were expressed as mean ± SEM (Standard Error of Mean) and further statistically analyzed by using Statistical Package for Social Sciences (SPSS) version 17.0. For paired samples t-test at 95 and 99% confidence interval

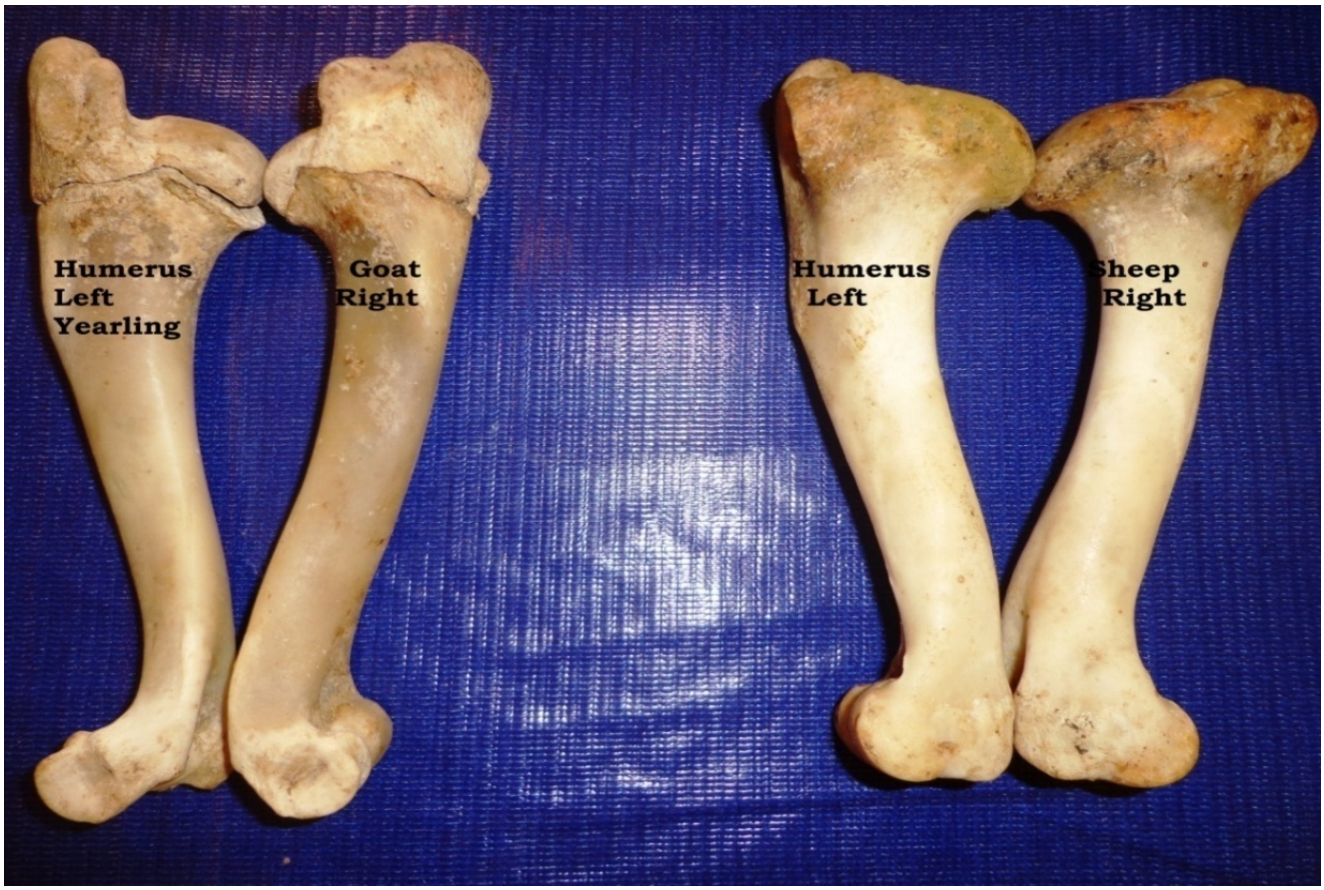

Plate 1. Left and right humerus of Bari goat and Dumbi sheep (Lateral view).

was used to determine the level of significance between the three age groups of two species.

RESULTS

Present study addresses morphological and osteometric data of long bones of pectoral limb from 30 Bari goat and 30 Dumbi sheep. The studied animals of both species were divided in three age groups namely lambs/ kids, yearling and adults. The weight, Breadth of proximal end (Bpe), breadth of distal end (Bde), depth of olecranon (Do), depth of process anconaeus (Dpa), circumference (Cr), and length of all long bones were measured. All recorded weights, lengths and diameters were expressed as mean ± SEM (Standard Error of Mean) and further statistically analyzed by using Statistical Package for Social Sciences (SPSS) version 17.0. For paired samples t-test at 95 and 99% confidence interval was used to determine the level of significance between the three age groups of two species.

Morphometry of long bones

The right and left humerus of Bari goat and Dumbi sheep were observed in study. Bones were collected randomly from both sexes.

Weight

The humerus is one of the long bones situated in proximal end of forelimb at an angle downward and backward; forms shoulder joint proximally with the scapula and elbow joint distally with the radius and ulna (Plate 1). The weight (Mean± SEM) of right humerus of three age groups of Bari goat and Dumbi sheep is shown in Figure 1, as 26.66±0.23, 34.06±0.33, 46.44±0.44, 31.29±0.83, 47.20±1.27, and 53.62±0.66 g, respectively. Statistical analysis revealed significant difference ($p<0.05$) between the kid/lamb and yearling groups but no significant difference between adult groups of both species. It is further revealed that the bones of sheep are statistically heavier than goat.

The differences calculated in the mean weight of left humerus (Figure 2) of three age groups of Bari goat and Dumbi sheep were, kids 26.54±0.34 g, yearling 34.87±0.40 g and adults 46.47±2.64 g and lambs 31.32±0.83 g, yearling 47.56±0.60 g and adult 53.57±0.53 g, respectively.

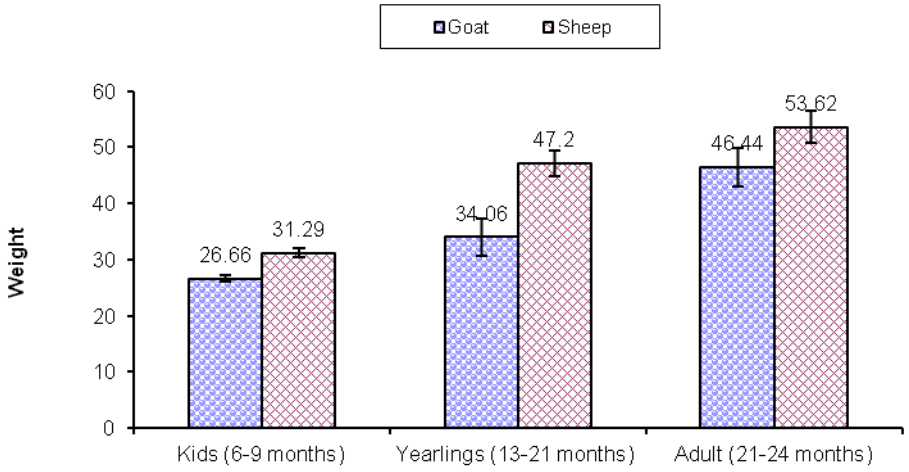

Figure 1. Mean ± SEM of absolute weight of right humerus (g) of different age groups in Bari goat and Dumbi sheep.

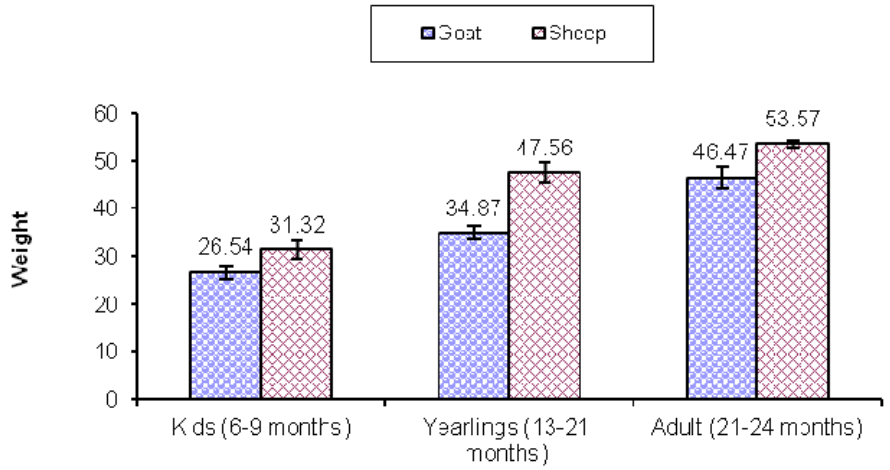

Figure 2. Mean ± SEM of absolute weight of left humerus (g) of different age groups in Dumbi sheep and Bari Goat.

Statistically significant difference (P<0.05) was observed in between kid/lamb and yearling groups. However, no statistical difference was calculated between adults groups of both species.

Breadth of proximal end (Bpe)

Mean values for breadth of proximal end (Bpe) of right humerus of kid, yearling and adult are 2.55±0.06, 3.48±0.05 and 3.74±0.10 cm, respectively and that of sheep are 2.74±0.12, 3.38±0.06 and 3.88±0.05 cm, respectively. The statistical analysis proved that there is no significant difference in between yearling and adult groups of two species. However, a significant difference (P<0.05) is noted among kid/lamb group (Table 1).

Whereas, the Bpe measurements (Mean±SEM) of left humerus of goat and sheep are measured as 2.51±0.09, 3.40±0.06, 3.71±0.06 and 2.78±0.12, 3.73±0.09 and 3.86±0.06 cm, respectively (Table 1). Statistically no significant difference is found in between the adult group, but significant difference (P<0.05) revealed among kid/lamb and yearling age groups of two species.

Breadth of distal end (Bde)

The breadth (mean ± SEM) of distal end of right humerus in three age groups of both species were found to be 2.39±0.07, 2.70±0.04, 2.82±0.06 cm and 2.52±0.11, 2.83±0.08 and 2.89±0.12 cm, respectively. Statistical observation shows that there was no significant

Table 1. Osteometric values (Mean ± SEM) of right and left humerus of Bari goat and Dumbi Sheep.

Variable	Right Humerus		Left Humerus	
	Bari Goat	Dumbi sheep	Bari Goat	Dumbi Sheep
Weight (g)				
Kid	26.66±0.23[a]	31.29±0.83[b]	26.54±0.34[a]	31.32±0.83[b]
Yearling	34.06±0.33[a]	47.20±1.27[b]	34.87±0.40[a]	41.56±0.60[b]
Adult	46.44±0.44[a]	53.62±0.66[b]	46.47±2.64[a]	53.57±0.53[b]
Bpe				
Kid	2.55±0.06[a]	2.74±0.12[b]	2.51±0.09[a]	2.78±0.12[b]
Yearling	3.48±0.05[a]	3.38±0.06[a]	3.40±0.06[a]	3.37±0.09[a]
Adult	3.74±0.10[a]	3.88±0.05[a]	3.71±0.06[a]	3.86±0.06[a]
Bde				
Kid	2.39±0.07[a]	2.52±0.11[b]	2.35±0.05[a]	2.52±0.11[b]
Yearling	2.70±0.04[a]	2.83±0.08[a]	2.70±0.06[a]	2.81±0.10[a]
Adult	2.82±0.06[a]	2.89±0.12[a]	2.84±0.04[a]	2.92±0.08[a]
Circumference				
Kid	3.63±0.09[a]	3.76±0.07[a]	3.65±0.13[a]	3.75±0.15[a]
Yearling	4.58±0.03[a]	4.88±0.03[a]	4.61±0.12[a]	4.88±0.04[a]
Adult	5.36±0.10[a]	6.22±0.14[b]	5.37±0.16[a]	6.26±0.10[b]

Means with different superscripts in the same row differ (P < 0.05); Bpe=Breadth of proximal extremity; Bde= Breadth of distal extremity.

difference in between yearling and adult age groups, but a highly significant difference (P<0.01) is calculated among kid/lamb and adult groups (Table 1).

Whereas, the values for left humerus of kid, yearling and adult is found to be 2.55±0.05, 2.70±0.06 and 2.84±0.04cm respectively and in sheep 2.52±0.11, 2.81±0.10 and 2.92±0.08 cm, respectively. Statistical analysis showed no significant difference present in between kid/lamb and adult groups, but a highly significant difference (P<0.01) is found among yearling groups of two species as indicated in the Table 1.

Length

From the present study, it is observed that the mean ± SEM length of right humerus from three age groups of goat are 11.51±0.92, 13.77±0.08, 16.61±0.11 cm, respectively, whereas, that of sheep are 10.08±0.15, 12.93±0.13 and 14.63±0.12cm, respectively. The statistical analysis revealed a significant difference (P<0.05) between kid/lamb group and highly significant difference (P<0.01) between yearling, but no statistical difference in adults group of both species. The Bari goat possess relatively longer humerus than those of the Dumbi sheep (Figure 3).

The values regarding mean ± SEM length of left humerus of both goat and sheep are to be 11.51±0.23, 13.76±0.04 and 16.06±0.17 cm, and 10.75±0.15, 12.98±0.14 and 14.20±0.20 cm, respectively. Statistical analysis revealed significant difference (P<0.05) in kid/lamb and yearling groups whereas no statistical difference was found in adult groups of Bari goat and Dumbi sheep as depicted in the Figure 4.

Circumference

The data regarding circumference at mid shaft of right humerus is presented in Table 1. The mean ±SEM values for three groups in Bari goat found to be 3.56±0.09, 4.58±0.03 and 5.36±0.10 cm, respectively. Whereas, in sheep it is calculated to be 3.76±0.07, 4.88±0.03 and 6.22±0.14 cm, respectively. The statistical analysis revealed no significant difference (P>0.05) in between the kid/lamb and yearling groups. However, a significant difference was observed among the adult groups of goat and sheep.

The values (mean ±SEM) for circumference at mid shaft of left humerus is calculated to be 3.65±0.13, 4.61±0.12 and 55.37±0.16 cm, and 3.75±0.15, 4.88±0.04 and 6.26±0.10 cm in three age groups of studied goat and sheep. Statistical analysis revealed same trend of results as for right humerus among both species.

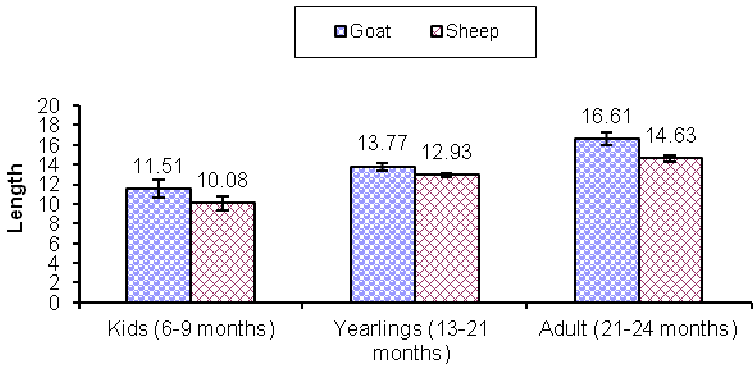

Figure 3. Mean ± SEM of length (cm) of right humerus of different age groups of Bari goat and Dumbi sheep.

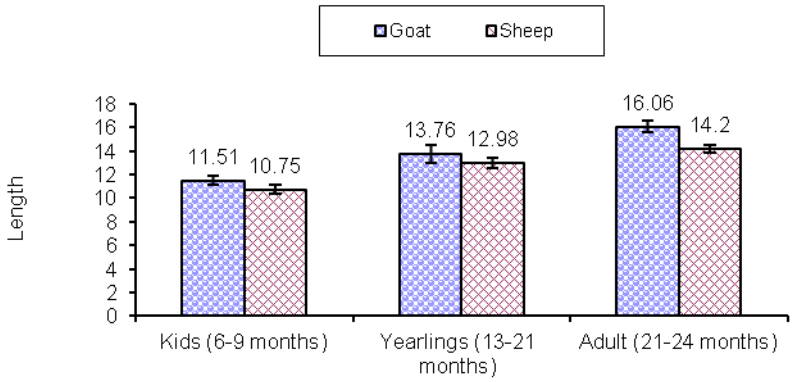

Figure 4. Mean ± SEM of length (cm) of left humerus of different age groups of Bari goat and Dumbi sheep.

Comparative differences in humerus

Like other ruminants, the humerus of goat and sheep also possesses one shaft and two extremities (proximal and distal). The shaft is twisted cylindrical and presents four surfaces and makes "S" shape in goat and highly curved "S" shape in sheep. Head is small and rounded; fossa in front of head is deep and prominent in goat, whereas, the head is large with shallow fossa in case of sheep. Tricepetal line is more prominent in sheep but less so in goat. Deltoid tuberosity is less prominent and smooth in goat but more prominent and rough in sheep. The distal epiphysis is thin in Bari goat but thick in Dumbi Sheep (Plate 2)

The radial and olecranon fossae of the humerus of Bari goat are shallow, but deep in Dumbi sheep. At lateral aspect pit of lateral condyle is deep but the cavity of lateral condoyle is broad and shallow (Plate 3). The epicondyloid crest of humerus is quite prominent in goat, but inconsistent in sheep (Plate 3).

DISCUSSION

The values of absolute weight, breadth of proximal end, breadth of distal end, circumference and length of right and left humerus of both goat and sheep have been presented in the Figures 1 to 3 and Table 1. While comparing humerus at different variables revealed that the bones of Dumbi sheep are heavier, broader but shorter than those of Bari goat. Okpe and Adamu (2002) indicated that the bones of the Yankassa sheep were heavier and longer, with greater diameter than those of the Red Sokoto goat of the same age. Although the differences he found were not statistically significant ($p>0.05$). The humerus of adult Black Bengal goat was found to be 12.06 ± 0.27 cm in length. The diameter of shaft at the level of nutrient foramen was 4.24 ± 0.05 cm. The breadth of humerus was 1.66 ± 0.06 cm. The deltoid tuberosity was less prominent and there was shallow radial and olecranon fossa (Siddiqui et al., 2008). Whereas, Hassan et al. (2007) measured the length (16.12 ±0.41), breadth of the proximal end (4.41 ±0.17), breadth of the distal end (3.49 ±0.21) and breadth of diaphysis (1.77 ±0.09) of humerus in adult female Morkaraman sheep, a local Turkish breed. Findings of present study are in agreement with Okpe and Adamu (2002) but partial agreement with those of *Siddiqui* et al.

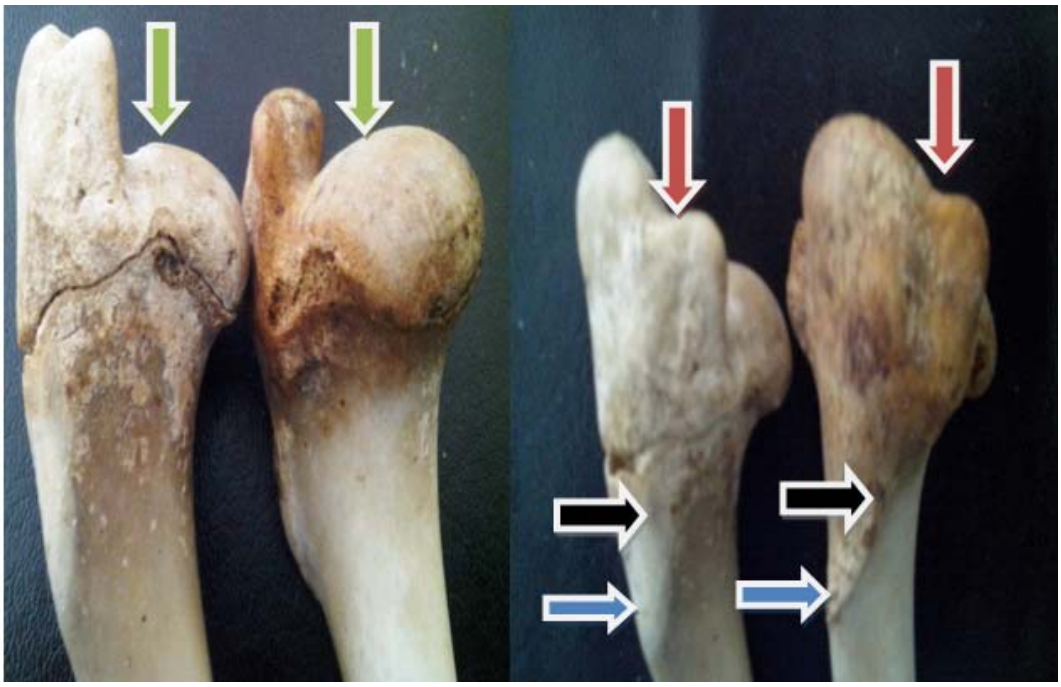

Plate 2. Comparative differences in head (Green arrows), inter tubercle groove (brown arrows), neck (B), deltoid tuberosity (Blue arrows) and tricepital line (Black arrows).

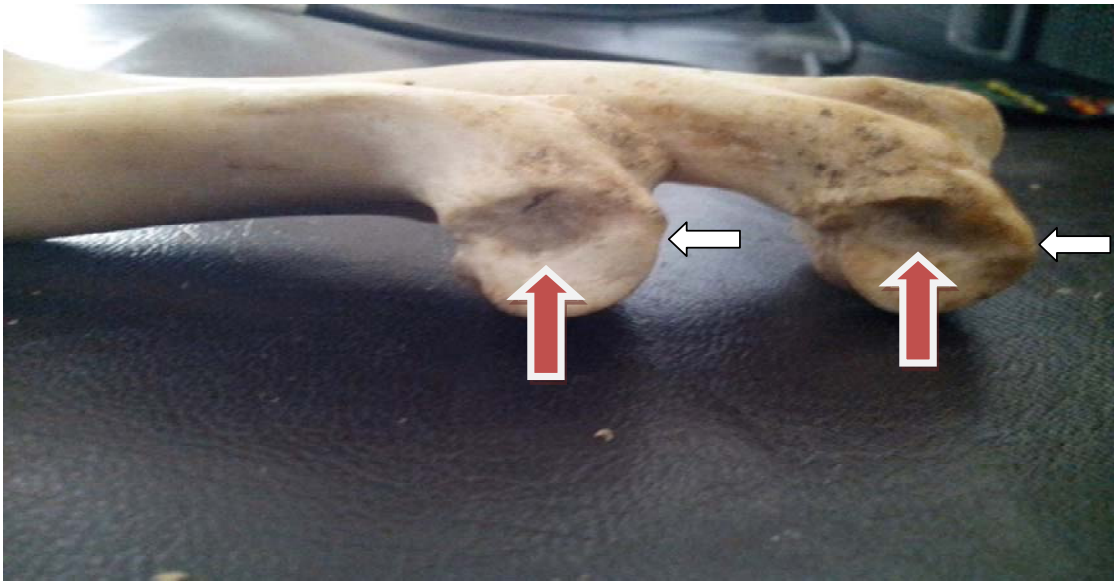

Plate 3. Shows the comparative differences in lateral aspect pit of lateral condyle (Brown arrows) and epicondyloid crest (White arrows).

(2008) and Hassan et al. (2007). The variation could be attributed to breed difference.

CONCLUSIONS AND SUGGESTIONS

On the basis of these findings and osteometric differences in humerus of both goat and sheep it is quite apparent to explanation that: The humerus of Dumbi sheep observed to be massive in terms of weight, circumference and breadth of proximal and distal ends than that of Bari goat, when compared among three different age periods. Comparative analysis revealed major differences in the morphology of humerus bones

that could be used as a breakthrough in identification of a particular species.

The sturdy suggests:

1. Further studies are suggested to study other age groups like lambs below 06 months and old age group (Above 36-months) in Dumbi sheep and Bari goat.
2. These studies are also suggested in large breeds like Kamori, Beetal etc.
3. Comparative study of the long bones of hind limb so that a clear depiction of gross anatomical and morphometric studies of these bones can be observed.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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