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Full Length Research Paper

Biometrical study on postnatal changes of metapodial bones of Yankasa Ram

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This study gives the first biometric description of the Cannon bones (metacarpal and metatarsal bones) of Yankasa sheep, as well as the gross morphology of this indigenous sheep breed of Nigeria. The dearth of information on the biometry, applied anatomy of the limbs and general morphology on domestic animals and the indigenous sheep in particular was the motivation behind this study. Ten limbs (2[0-6months], 2[6months- 1year], 2[1-2years], 2[2-3years], 2[3years- above]) were collected from purposefully and randomly sampled Yankasa male sheep from a slaughter slab and processed for biometrical investigation. Several biometrical measurements were recorded from each of the limbs samples. From these, simple descriptive statistical analysis was obtained. The values obtained from these groups were increasing with ages. This study has described the biometric and the morphologic characteristics of the Yankasa sheep and concludes that a contribution for comparative model for other African local ovine breeds in general and Nigerian ovine breeds in particular has been made. Being the first study of its kind in Nigeria, it makes a significant contribution to a better understanding of the Yankasa sheep limbs. It is envisaged that the results obtained in this study will be useful as baseline research data in comparative sheep anatomy.

Keywords: Biometric, Cannon bones, Postnatal changes, Yankasa sheep

INTRODUCTION

Sheep (O*vis aries*) are guadrupedal, ruminant animals typically kept as livestock. They are members of the order *Artiodactyla*, the even-toed ungulates. Although the name “Sheep” applies to many species in the *genus ovis*, in everyday usage it almost always refers to *Ovis aries*. Domestic sheep differ from their wild relative, in several respects, having become uniquely ‘neotemic’ as a result of selective breeding by humans.

In Nigeria, sheep are found predominantly in northern part of the country Sheep and goat are seen as having secondary importance in relation to crops (Adu and Ngere, 1979). It is generally considered to be four breeds or races of sheep native to Nigeria, the Balami, Uda, Yankasa and West African Dwarf (WAD) (Adu and Ngere, 1979). The Yankasa breed has been the most extensively studied in Nigeria. The body colour is white with black patches around the eyes and usually black too. Rams have curved horns and a hairy white mane, and ewes are polled (Blench, 1999). Yankasa sheep have been recorded in all parts of Nigeria, through the population attenuate towards the northern border and the sea-cost (Blench, 1999). Yankasa sheep do not need daily watering in the wet season and watering once a day suffices in the day season (Aganga *et al*., 1988). Sheep contributes enormously to the protein requirements of most developing countries (Muhammad *et al*., 2008).

The main supporting structure of the vertebrate body is the skeleton of bony tissue (Rauf, 2014).

It consists of bones and cartilages.

The muscles, tendons and ligaments, are also attached to bones and cartilages. The skeleton provides rigidity for the body (Rauf, 2014). It forms a number of mechanical levers with attached tissues for the free muscular action as well as for the movement of a part or the whole body (Rauf, 2014).

The evaluation of sheep bones provides morphological information on the animals` shoulder height, body weight, sex, age, and other features, which can be used to define the animal population, and allows comparison with other historic or modern sheep populations (Alpak *et al*., 2009). Examination of sheep metapodial bones has both yielded data that cast light on the domestication of sheep and valuable information on their skeletal bones, which constitute a good source of fat in animals (Outram, 2002). It has been reported that metapodium is used on the separation of the sheep and goat bones belonging to the Neotithic period (Rowley-Conwy, 1998). Onar *et al.* (2008) and Pazvant *et al.* (2015) have researched sheep and goats metapodium.

It has been known for a long time that although certain elements of the limbs of sheep ossify, at least in part in the fetus, yet they appear inconstantly in the adult. Such structures are the clavicle, fibula, and the second and fifth metacarpal and metatarsal bones (Smith *et al*., 1960). However, in Nigeria there is paucity of information on the developmental changes in the limbs of indigenous breeds of sheep.

Therefore this study is designed to have revealed slight variation in general morphology of the limbs (metacarpal, metatarsal and first phalanges) at different age of development, so that problems associated with these bones are minimized in each age categories.

MATERIALS AND METHODS

The study was conducted in Sokoto metropolis, the capital of Sokoto State of Nigeria (Sokoto, 2001). A cross sectional study design was used. Purposive sampling (Non-probability sampling) was used in this study (Patton, 1990).

The fresh limbs from slaughtered Yankasa sheep were selected based on the known breed characteristics, good health and lack of skeletal abnormalities (Olopade and Onwuka, 2005; Ahmadu, 2001). The sampling was stratified according to age; the age was estimated on the basis of the eruption of the permanent teeth as a guide (Vatta *et al*., 2006) and grouped (Table 1). Following slaughter, the forelimbs severed from carpo-metacarpal joint and hind limb from tarso-metatarsal joint and placed in clean bags according to age. The limbs (metacarpal and metatarsal) were later processed for morphometric analysis in the anatomy laboratory of the Faculty of Veterinary Medicine at Usmanu Danfodiyo University Sokoto, Sokoto State.

Table 1. Age group classification.

Groups	Age
Group 1	0-6months
Group 2	6months-1year
Group 3	1 year-2years
Group 4	2years-3years
Group 5	3years-Above

Maceration of the sheep limbs

The hot water maceration techniques as described by Simoens *et al*. (1994) were used in this study. The skin and most of the muscles were separated using knives and scalpel blades from the fresh limbs. The limbs were heated to over 80ºC for 1 h in solution of polycaboxylate and anionic surfactant (detergent). The muscles of boiled limbs were separated with the aid of forceps and scalpel in water following boiling. The boiled limbs were left to stand in the detergent water for 30 minutes after which the separation of remaining muscles and ligaments of the limbs was done. The limbs were then rinsed in clean water.

Biometrical measurements

Ten biometrical measurements were obtained on Yankasa sheep metacarpal and metatarsal bones by means of measuring tape and were weighed with a digital weighing balance (Citizens Scale1 PVT, Ltd, model MP-600, with a sensitivity of 0.01 g). The measurements were taken systematically according to the five categories of parameters as below at the same time retaining the numbering corresponding to the standard used. As precaution to minimize measurement error, only the trained researcher took all the measurement.

Metacarpal

(a) Weight of metacarpal (WM).
(b) Length of metacarpal (LM)
(c) Circumference of proximal metacarpal (CPM)
(d) Circumference of medial metacarpal (CMM)
(e) Circumference of distal metacarpal (CDM)

Metatarsal

(a) Weight of metatarsal (WM)
(b) Length of metatarsal (LM)
(c) Circumference of proximal metatarsal (CPM)
(d) Circumference of medial metatarsal (CDM)
(e) Circumference of distal metatarsal (CDM)

Data analysis

The data were analyzed statistically using Microsoft office Excel 2007. Numerical data were presented in forms of

Parameters	Group 1		Group 2		Group 3		Group 4		Group 5	
	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
WM	20.21±0.57^{a1}	20.92±0.57^{a1}	25.32±0.42^{b1}	25.51±0.21^{b1}	35.78±0.21^{c1}	36.03±0.28^{c2}	35.93±0.28^{d1}	36.21±0.14^{d2}	45.22±0.21^{e1}	45.31±0.14^{e2}
LM	14.30±0.42^{a1}	15.74±0.35^{a2}	16.53±0.28^{b1}	15.32±0.42^{b2}	16.33±0.35^{c1}	16.14±0.28^{c2}	17.23±0.28^{d1}	16.91±0.35^{d2}	18.33±0.28^{e1}	19.42±0.28^{e2}
CPM	6.72±0.00^{a1}	6.72±0.00^{a1}	7.33±0.35^{b1}	7.55±0.28^{b1}	8.13±0.14^{c1}	8.37±0.07^{c2}	8.24±0.28^{d1}	8.33±0.28^{d2}	9.31±0.28^{e1}	8.56±0.28^{e2}
CMM	4.64±0.42^{a1}	4.90±0.21^{a2}	4.83±0.35^{b1}	5.25±0.21^{b2}	5.45±0.28^{c1}	5.53±0.28^{c1}	5.82±0.42^{d1}	5.82±0.07^{d1}	6.22±0.21^{e1}	6.47±0.07^{e2}
CDM	6.82±0.21^{a1}	6.39±0.28^{a1}	6.43±0.28^{b1}	6.63±0.28^{b2}	6.84±0.07^{c1}	6.84±0.07^{c1}	7.24±0.21^{d1}	7.45±0.28^{d2}	8.40±0.28^{e1}	8.53±0.28^{e2}

abcde: means on the same rows with different superscripts are significantly different (P ≤ 0.05).
1,2: means on the same column with different superscripts are significantly different (P < 0.05).
Key:WM: Weight of metacarpal(g),LM: Length of metacarpal(cm), CPM: Circumference of proximal metacarpal(cm), CMM: Circumference of medial metacarpal(cm), CDM: Circumference of distal metacarpal(cm), Group 1= 0-6months, Group 2=6months-1year, Group 3=1 year-2years, Group 4=2years-3years, Group 5=3years-Above.

Table 3. Mean ±SD values of the metatarsal bone of clinical importance.

Parameters	Group 1		Group 2		Group 3		Group 4		Group 5	
	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
WM	18.91±0.28^{a1}	19.12±0.07^{a2}	27.13±0.28^{b1}	27.22±0.21^{b1}	37.32±0.35^{c1}	37.51±0.14^{c1}	42.17±0.28^{d1}	42.20±0.07^{d2}	50.22±0.07^{e1}	50.34±0.21^{e2}
LM	14.52±0.28^{a1}	14.33±0.28^{a1}	14.33±0.28^{b1}	14.52±0.28^{b2}	14.63±0.28^{c1}	14.74±0.21^{c1}	15.52±0.28^{d1}	15.62±0.07^{d2}	17.74±0.28^{e1}	17.64±0.28^{e2}
CPM	6.63±0.21^{a1}	6.44±0.21^{a2}	6.50±0.00^{b1}	6.50±0.00^{b1}	6.82±0.28^{c1}	7.04±0.28^{c2}	7.52±0.28^{d1}	7.41±0.35^{d2}	7.73±0.00^{e1}	7.73±0.07^{e1}
CMM	5.09±0.28^{a1}	4.91±0.28^{a2}	4.82±0.28^{b1}	4.62±0.28^{b2}	5.04±0.28^{c1}	4.84±0.28^{c2}	5.05±0.35^{d1}	4.93±0.28^{d2}	6.33±0.07^{e1}	6.45±0.07^{e2}
CDM	6.43±0.28^{a1}	5.91±0.28^{a2}	6.50±0.28^{b1}	6.13±0.07^{b2}	7.24±0.21^{c1}	6.83±0.14^{c2}	7.25±0.28^{d1}	7.37±0.28^{d1}	7.62±0.07^{e1}	7.58±0.07^{e2}

abcde: means on the same rows with different superscripts are significantly different (P ≤ 0.05).
1,2: means on the same column with different superscripts are significantly different (P < 0.05).
Key: WM: Weight of metatarsal(g) ,LM: Length of metatarsal(cm), CPM: Circumference of proximal metatarsal(cm), CMM: Circumference of medial metatarsal(cm), CDM : Circumference of distal metatarsal(cm),
Group 1= 0-6 months, Group 2=6 months-1year, Group 3=1 year-2years, Group 4=2 years-3years, Group 5=3years-Above.

tables as means and ± standard deviation. Two tailed t-test to compare the different groups and a significance level of (*P ≤ 0.05)* was used for all the comparisons.

RESULTS

The parameters obtained from the metacarpal and metatarsal appeared in (Tables 2 and 3).The metacarpal bones of both left and right limbs were measured and all the parameters measured showed a significant difference (*P ≤ 0.05*) from group 1 to 5. In the difference between the left and right metacarpal parameters there were slight differences in between groups. The weight of the bones of group 1 to group 5 in both left and right metapodial bones showed a geometrical increase with significant difference (*P ≤ 0.05*) between right and left legs in groups 3, 4 and 5, with a low mean value of 20.21±0.57 and 20.92±0.57 in left and right metacarpal bone in group 1 to as high as 45.22±0.21 and 45.31±0.14 left and right metacarpal bone in group 5. The result of the study showed significant difference (*P ≤ 0.05*) in length (LM) between left and right metacarpal bones in the entire group. The circumference of the proximal metacarpal (CPM) showed significant difference (*P ≤ 0.05*) between left and right limbs only in groups 3, 4, and 5. The circumference of medial metacarpal bone (CMM) showed a significant difference (*P ≤ 0.05*) between left and right in groups 1, 2 and 5 only. The circumference of distal metacarpal (CDM) showed significant difference (*P ≤ 0.05*) between left and right metacarpals in group 3 only (Plates 1 and 2).

The weight of the metatarsal bone (WM) showed a geometrical increase from group 1 to 5 with a statistical significant difference (*P ≤ 0.05*) between left and right metatarsals in groups 1, 4 and 5 only. On the other hand all other parameters (LM, CPM, CMM, and CDM) measured in this study showed an arithmetical increase with age advance in age from group 1 to 5. The length of metatarsal bone (LM) showed a

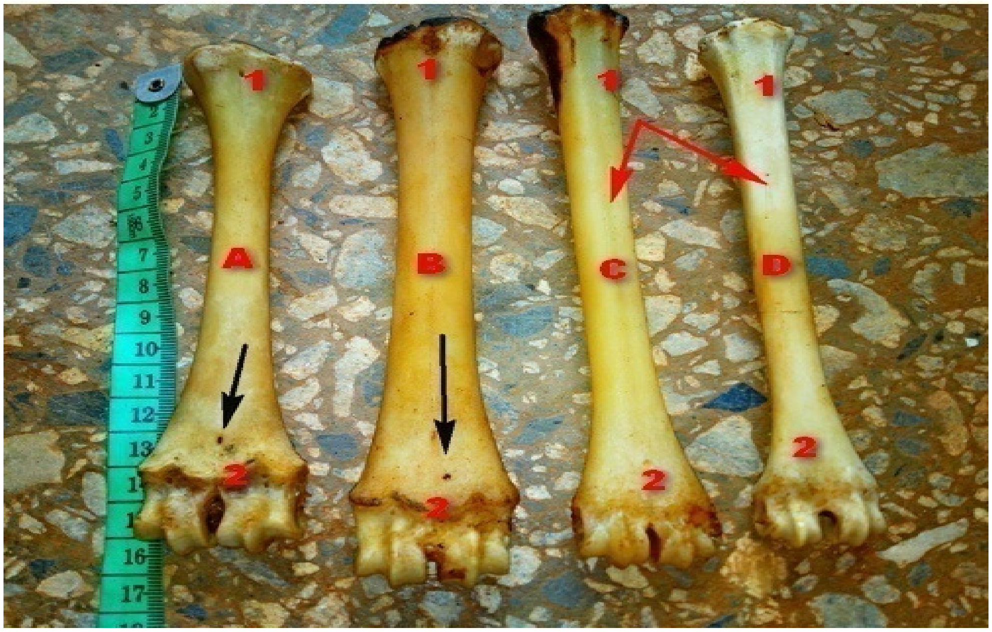

Plate 1. Metacarpal and Metatarsal showing: A&B. Metatarsal; C&D. Metacarpal; Black arrow: Distal metatarsal canal; Red arrow: Dorsal longitudinal groove; 1.proximal metacarpal; 2. Distal metacarpal.

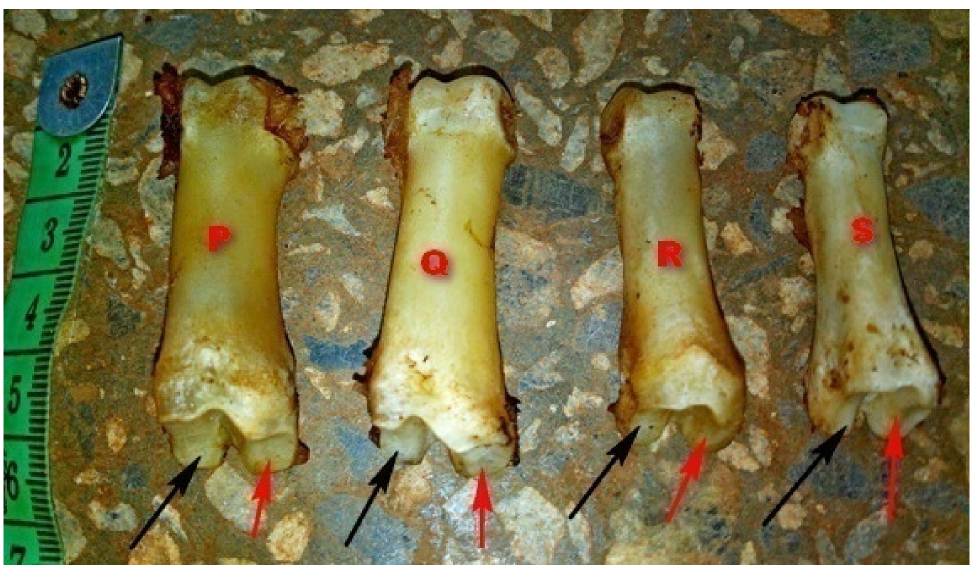

Plate 2. showing PQR&S: First phalanx; Black arrow: medial aspect; Red arrow: lateral aspect.

significant difference ($P \leq 0.05$) between left and right in groups 2, 4 and 5 but not in 1 and 3. The circumference of proximal metatarsal (CPM) showed a significant increase ($P \leq 0.05$) in groups 1, 3 and 4 only. The circumference of the medial metatarsals (CMM) showed a significant difference ($P \leq 0.05$) in size between left and right throughout the various groups while circumference of the distal metatarsal showed significant increase in size ($P \leq 0.05$) in all the groups except in group 4.

DISCUSSION

This study has documented the age related changes in the biometry of the metacarpal and metatarsal bones of Yankasa male sheep. Due to lack of information in the areas mentioned above on Yankasa sheep, the results obtained in this study as shown in the result section forms the baseline data for the Yankasa male sheep metacarpal, metatarsal and first phalange. It is envisaged that this baseline data will be useful for future studies in the *Ovinae* subfamily and other species of domestic animals in Nigeria. The implications and applicability of the results are discussed here under.

Richardson *et al*. (1976) established that bone growth in weight and length depends primarily on the amount of calcium salt deposited during ossification. The deposition of calcium in turn depends on the quantity of the mineral in animal feed, and utilization of minerals for bone calcification (Sivachelvan *et al*., 1996). It is therefore, pertinent to point out that the nutritional status of animals used in this research from which the bone specimens were collected were unknown. The values observed in the study showed significant difference in relation to the ages and the values were increasing with advancement in ages. The results of this study however, showed that increased development of metapodial bones of Yankasa sheep increased with age. Several factors have been reported to influence the growth and development of bone tissue. Vaughan, (1980) classified these factors into two main groups: Endogenous (genetic and hormonal) and Exogenous (environmental and dietary) factors. These two broad factors also interact with each other to affect bone development and growth (Lawrence and Fowler, 1997). Of these factors, the endogenous factor is of more relevance to this study since as stated earlier, the nutritional status of the animals used was not considered.

Authors' declaration

We declared that this study is an original research by our research team and we agree to publish it in the journal.

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