



Morphological and Osteometric Analysis of the Skull in Abaza goats (*Capra aegagrus*)

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Abstract

This study presents osteological measurements and morphological descriptions of the Abaza goat skull. In total, 18 osteometric parameters of 10 Abaza goat skulls were measured. As a result, the mean skull length was determined as 20.82±1.4 cm, cranial length as 11.67±0.7 cm, facial length as 11.65±1.5 cm, skull index as 51.01±1.8 cm, cranial index as 50.5±7.5 cm, facial index as 71.0±8.1 cm and foramen magnum index as 106.7±13.7 cm respectively. In four skulls major intra-corneal protuberance was found on frontal bone, while in others (six skull) a deep fossa was observed. Prominent facial tuberosity was located dorsal to the 3rd-4th cheek tooth. Infraorbital foramen in four skulls was single one it her side which was dorsally located to the junction of the first and second upper premolar tooth, in the others had partition. Paracondylar process down wards one it her side and its not same level of the occipital condyle. As a result, morphological and osteometric data were obtained on the skull of Abaza goats. The data obtained were compared with other studies in the literature.

Anahtar Kelimeler: Abaza goat, morphology, osteometry

Abaza Keçilerinde (*Capra aegagrus*) Kafatasının Morfolojik ve Osteometrik Analizi

Öz

Bu çalışma da Abaza keçilerinde kafatası morfolojik ve osteolojik olarak değerlendirilmiştir. Toplamda, 10 tane Abaza keçisi kafatası üzerinden 18 adet osteometrik parametre ölçüldü. Sonuç olarak alınan osteometrik ölçülerden bazı parametrelerin ortalama uzunlukları sırasıyla şöyle bulundu; kafatası uzunluğu 20.82 ± 1.4 cm, cranial uzunluk 11.67 ± 0.7 cm, facial uzunluk 11.65 ± 1.5 cm, kafatası indeksi 51.01 ± 1.8 cm, cranial indeks 50.5 ± 7.5 cm, facial indeks 71.0 ± 8.1 cm ve foramen magnum indeks 106.7 ± 13.7 cm olarak belirlendi. Materyallerin dördünde frontal kemikte iki cornu arasında büyük bir çıkıntı bulunurken, diğer altısında derin bir fossa görüldü. Tuber faciale'nin PM3 (premolar 3) ve M1 (molar 1) dişin üst kısmında olduğu gözlemlendi. Birinci ve ikinci üst premolar dişin birleştiği yerin dorsalinde bulunan foramen infraorbitale, materyallerin dördünde tek bir delik iken diğer materyallerde ortasındaki bir septum ile ayrılmış iki delik şeklinde olduğu görüldü. Processus paracondylarisler'in condylus occipitalis seviyesine ulaşmadığı görüldü. Sonuç olarak, Abaza keçilerinde kafatası üzerine morfolojik ve osteometrik veriler elde edildi. Elde edilen veriler literatürdeki diğer çalışmalarla karşılaştırıldı.

Key Words: Abaza keçisi, morfoloji, osteometri

INTRODUCTION

Abaza goats raised in the province of Artvin usually have bronze, white, black or brown hair. Both their eye circles and around their black mouths, horns, legs are black. They have a thin body structure, therefore, it likens to gazelles. Their bucks are sword-shaped, while their horns are flat and broad shaped horns. Moreover, the females can be both horned or hornless (1).

Skulls made on macroanatomic, osteometric, morphological and morphometric studies not only reveal their contribution to the development of individual skulls of genetic and environmental components, but also reveal genetic and ecophenotypic intra-species variation, and in this context form the basis of clinical and surgical operations (2). Cephalometric anatomy is important for understanding the relationships between organs in the area. An important aspect of the cephalometric anatomy of any animal is the skull typology (3). There are many studies that have been carried

out on small ruminants including the West African dwarf goat (4), Kagani goat (5), Bardhoka autochthonous sheep (6), Awassi sheep (7) in this context. However, there are not studies conducted on the cephalometric and macroanatomic property of the skull bone of Abaza goats were not found in the literature review. This study was carried out to comprehensively reveal the macroanatomical, morphological and osteometric properties of the skull bones in Abaza goats.

MATERIALS AND METHODS

For this purpose, totally 10 adult skulls of Abaza goat skulls with no skeleton disorders were aquired from a local abattoir. The skulls were processed in the dissection room of Kafkas University in accordance with the boiling maceration techniques reportedly used for skeletal preparation (8). This study was approved by ethical committee KAÜ-HADYEK/2020-144. Following the approval, morphological

and osteometrical analyses of the skulls were carried out. In total, 18 parameters were recorded using a measuring scale, thread and digital calipers according to the methods described by Sarma (2006) (5) and the results were given as means ± SD (Table1). The measured parameters are described in the next section and represented in Figures1–3.

Table1. Various osteometrical measurements of Abaza goat skull.

Parameters	Mean ±SD
Skull parameters	mean±SD
SL	20.82±1.4
SW	10.7±1.5
SH	13.57±1.8
SI	51.0±1.8
Cranial parameters	
CL	11.67±0.7
MWNC	5.95±1.4
CI	50.5±7.5
Facial parameters	
FL	11.65±1.5
FW	08.35±1.3
FI	71.0±8.1
Foramen magnum parameters	
FMH	2.05±0.1
FMW	3.9±0.2
FMI	106.7±13.7
ICW	5.3±0.5
IPCW	7.2±0.8
OCHW	3.65±0.8
PCPL	3.32±0.7
OCT	1.65±1.3

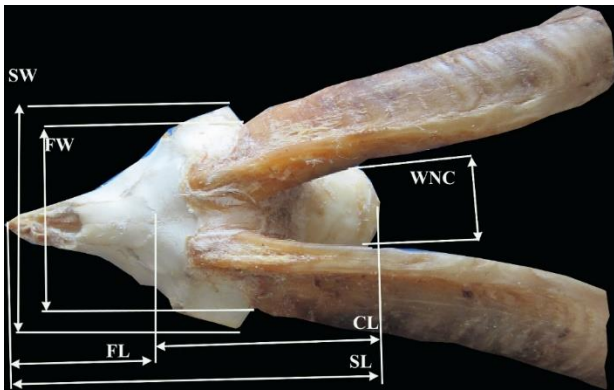


Figure 1. Dorsal view of an Abaza goat skull. Skull length (SL), facial length (FL), cranial length (CL), skull width (SW), facial width (FW), width of neurocranium (WNC).



Figure 2. Lateral view of an Abaza goat skull

Skull height, (SH), 1: Tuber faciale, 2: foramen infraorbitale, 3: meatus acusticus externus (external auditory meatus), 4: temporal fossa.

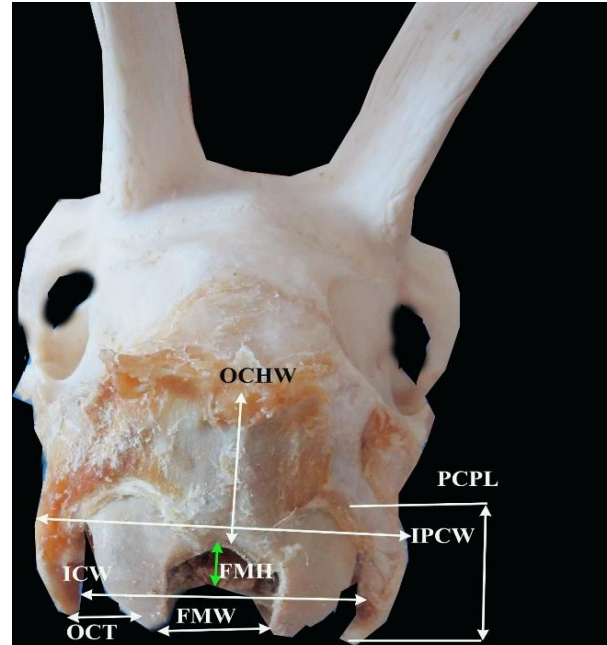


Figure 3. Caudal view of Abaza goat skull. Foramen magnum height (FMH), foramen magnum width (FMW), intercondylar width (ICW), interparacondylar width, (IPCW), occipital condyle thickness (OCT), paracondylar process length (PCPL)

RESULTS

Skulls were examined from the morphological and osteometric perspective. According to morphological analysis macroanatomical features of the anterior, lateral, nuchal and ventral surfaces of the skull were taken into account.

Anterior Surface. In this study, it was seen to occur of the frontal, nasal and incisive bones on Abaza skull anterior surface. In some of the skulls a large intra-corneal protuberance was presented on the midline of the frontal bone, while in the others a deep fossa was determined (Figure 4).

Lateral Surface. In the Abaza goats, tuber faciale is dorsal to the 3rd-4th cheek tooth.

Basal Surface. There is a sharp middle protrusion on the os basisphenoidale in the skull of the Abaza goat. The basilar part of the os occipitale was surrounded by two pairs of muscular tubercles of similar sizes (Figure 5).

Nuchal Surface. In study on Abaza goat skull, external occipital bump of the outer lamina of the squamous occipital bone were found sharp and prominent. It was shown Figure 3.

Osteometric length findings measured on skulls are given in below. Skull length and skull width of Abaza goat were recorded as 20.82±1.4 and 10.7±1.5 cm, respectively. The FW and MNW of Abaza goat skull were found to be 08.35±1.3 and 5.95±1.4 cm, respectively. The skull index of the Abaza goat was determined as 51.0 ±1.8 cm.



Figure 4. Frontal and nasal bone



Figure 5. Ventral view of an Abaza goat skull
1: muscular tubercle, 2: sharp ridge on the basisphenoid, 3: tympanic bullae, 4: styloid process, 5: oval foramen, 6: transverse palatine suture, 7: median palatine suture.

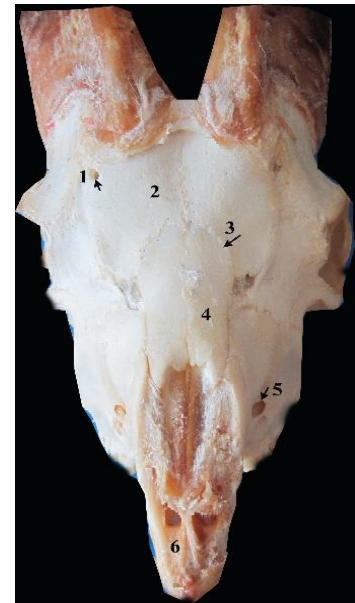


Figure 6. Frontal view of an Abaza goat skull
1: supraorbital foramen, 2: frontal bone, 3: frontonasal suture, 4: nasal bone, 5: infraorbital foramen, 6: incisive bone

DISCUSSION AND CONCLUSION

The skull index of the Abaza goat was determined as 51.0 ± 1.8 cm, while this value was found to be 47.77 ± 1.96 cm in Markhoz goats (9), 41,95 cm in Kagani goats (8) and 53.57 cm in Mehraban sheep (10). Mean skull length and skull width of Abaza goat were recorded as 20.82 ± 1.4 and 10.7 ± 1.5 cm, while skull length was found to be in female gazelle (*Gazella subgutturosa*) 164.40 ± 4.89 mm, in male gazelle (*Gazella subgutturosa*) 167.08 ± 2.28 mm (15) respectively. In addition, the facial length and cranial length of the Abaza goat skull were determined as 11.65 ± 1.5 and 11.67 ± 0.7 cm, respectively. In this study, cranial length was found to be higher than the facial part of the skull in Abaza goats, this finding similar to the Markhoz goat and unlike Mehraban sheep (10), Markhoz goats (9), Kagani goats (5).

The facial width and maximum neurocranium width of the Abaza goat skull were found to be 08.35 ± 1.3 cm and 5.95 ± 1.4 cm, respectively. Studies in the literature determined these values to be 18.28 and 4.30 cm in Kagani goats (5), 10.26 ± 0.21 cm and 5.99 ± 0.13 cm in Markhoz goats (9). According to the results of the present study, the Abaza goat was found to have a narrower facial and cranial portion compared to Markhoz goats (9). Furthermore, the value of the height of the Abaza goat skull was determined as 13.57 ± 1.8 cm, which was higher than that of Markhoz goats at 9.63 ± 0.47 cm.

In the present study, mean value of the FMI was found to be 106.07 ± 1.1 and the value of FMW was determined to be higher than the value of the FMH (Table 1). This index was reported to be 103.58 for camels (11), 102.5 for West African Dwarf goats (4), 89.32 ± 14.1 cm for Markhoz goats (9).

Studies in the literature have been reported that FMH and FMW for WAD goats as 1.72 and 1.67 cm (4), for Kagani goats as 3.08 and 3.12 cm, and for Markhoz goats as 2.02 ± 0.19 and 1.79 ± 0.16 , respectively (5,9). Thus, it can be said that the FMH and FMW of the Abaza goat was less than that of the Kagani goats and more than the West African dwarf goats and Markhoz goats.

The occipital condyles width was determined as 5.3 ± 0.5 cm for the Abaza goats, while it were reported to be 4.6 ± 0.32 cm for Markhoz goats (9), 4.09 cm for West African Dwarf goats (4) and 4,0 cm for Red Sokoto goats (3). Moreover, the width between the lateral borders of the processus paracondylaris and the length of processus paracondylaris were 7.2 ± 0.8 cm and 3.32 ± 0.7 cm, respectively, for the Abaza goats and 4.4 cm and 4.2 cm for Red Sokoto goats (3) and 6.44 ± 0.23 cm and 2.09 ± 0.16 cm respectively for Markhoz goats (9).

The frontonasal suture was found to be "V" shaped just like Kagani goats and Markhoz goats (5,9) (Figure 6). In addition, the frontonasal suture of some of the Abaza goats was determined to be "U" shaped. In some materials, the outer surfaces of the nasal bones were convex and ended with a sharp rostral tip. In the others the rostral process blunt ended (Figure 4).

Tuber faciale located dorsal to the 3rd-4th cheek tooth in the study on Abaza goats skull. It is stated that it is located 3rd cheek tooth Markhoz goat (9), ox (12), and Mithun (*Bos frontalis*) (13). However, it is stated in the literature that in Kagani goats it was located at the junction of the 4th and 5th cheek teeth (5), in Assam goats it was located dorsally to the 4th cheek tooth (14). Foramen infraorbitale in some of the skulls were single, with the side inserted dorsally into the combination of first and second upper premolars, this

finding was found to be the same as the one given for Markhoz goat. While there is a deep fossa with 1-2 foramina in the cranial part of this foramina, it has been reported that there are four foramina in Mehraban sheep (10) and Kagani goat (5). Studies in the literature reported that the temporal crest of Kagani goats (5) began as a sharp little tubercle caudo-lateral to meatus acusticus externus and ended into a blunt tuber clein. In addition, the temporal fossa in Markhoz goats (5) and Mehraban sheep (10) was reported to be deep and extensive. In the present study, the orbits were determined to be round and complete and located on a front lateral oblique plane. There was a deep notch on the rostro-dorsal margins of the orbits. A deep fossa for the lacrimal sac was seen on the orbital surface of the lacrimal bone. Foramen ovale was detected in the caudal part of the pterygoid bone.

In this study there is a sharp middle protrusion on the os basisphenoidale in the skull of the Abaza goat and the basilar part of the os occipitale was surrounded by two pairs of muscular tubercles of similar sizes. Its similar to Markhoz goat but It was reported that the rostral pair was larger in Mehraban sheep (10) while the caudal pair was larger in Kagani goat (5). It has been reported that the tympanic bullae on the temporal bone is caudo-laterally pressed and small in Kagani goats (5). It has been reported that the tympanic bullae is caudo-medially pressed and well developed in Mehraban sheep (10). The study conducted on Markhoz goats (9), reported that tympanic bullae was bilaterally compressed and developed well. Tympanic bullae also developed well in our study on Abaza goats.

It was observed that the rostral part of the os maxillare had become narrow, and palatine part appeared as "V". In addition, the transverse palatine suture, which was lying over the greater palatine foramina, was also found to be "V" shaped and serrated. The minor palatine foramina were found to be absent. The median palatine suture was slightly serrated in the maxillary rostral section (Figure 5).

External occipital bump of the outer lamina of the squamous occipital bone was both prominent and sharp in the study on Abaza goat skull, while it has been reported to be broad and blunt in Mehraban sheep (10) and sharp and pointed in Kagani goats (5). Paracondylar proces extends downward and they are not at the same level with occipital condyles. The temporal line was continuous of the temporal crest and ran over the parietal bone. Its similar to Markhoz goat (9).

To conclude, the morphologic and osteometric data obtained from Abaza goat were found to be comparable to other small ruminants. The study provided basic information regarding the skull osteometry of Abaza goats that could be used to compare with other breeds of goats and descriptions of the adaptational physiology of the species of Abaza goats.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest with respect to the publication of this manuscript.

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