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Radiological, Morphological and Morphometric Investigation of Mandible in Norduz Sheep

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Abstract

The mandibular nerve, which runs within the canalis mandibularis, is called nervus mentalis when it leaves the canal from the mental foramen. The innervation areas of these two different nerves are different. Therefore, in order to provide anesthetic blockade of the regions innervated by these two nerves, the region should be well known anatomically and topographically, and reference points should be determined well. Therefore, in this study, macroanatomical, morphometric, topographic and radiological methods were used to understand the anatomy of the mandible of Norduz sheep, which is one of the important gene sources in our country, where breeding is important. In this study, 10 female Norduz sheep mandibles were used. Mandibles were first examined with classical methods, macroanatomical, morphometric and topographic methods. Later, MR images were taken in the radiology unit. It was observed that the last molar teeth on the Margo alveolaris did not protrude from the alveolar cavity in any of the materials. It was observed that the premolar teeth consisted of 3 roots in forty percent of the material, and two roots in sixty percent. It was observed that the mental foramen was oval and round in shape and was located on the lateral surface of the mandible in different numbers. It was observed that the foramen mandible was elliptical. According to the statistical analysis, the length of the mandibula in the noble sheep was measured as 146.93±2.95 mm, on the right and 147.91±3.32 mm, on the left. The distance of the condylar process to the infradental space was analyzed as 165.15±2.62 mm, on the right and 162.43±2.97 mm, on the left. The height of the mandible was 87.87±0.75 mm, on the right and 88.00±0.81 mm, on the left. The length of the interalveolar region was measured as 35.69±0.61 mm, on the right side and 36.67±0.72 mm, on the left side. Statistically analyzed parameters did not show a significant value between the mandibles in terms of direction ($p>0.05$).

Key Words: Mammalian morphology, mandible, radiology

Norduz Koyunun da Mandibula'nın Radyolojik, Morfolojik ve Morfometrik Olarak İncelenmesi

Öz

Canalis mandibularis içerisinde seyreden nervus mandibularis, foramen mentale'den geçince nervus mentalis olarak isimlendirilir. Bu iki farklı sinirin innervasyon alanları farklıdır. Dolayısıyla bu iki sinirin innervasyonunu sağladığı bölgelerin anestezik blokajlarını sağlamak için bölgenin anatomik ve topografik olarak iyi bilinmesi ve referans noktalarının iyi belirlenmesi gerekmektedir. Bu nedenle, bu çalışma da yetiştiriciliği önem arzeden ülkemizdeki önemli gen kaynaklarından olan Norduz koyunu mandibulasının anatomisinin anlaşılması için makroanatomik, morfometrik, topografik ve radyolojik yöntemler kullanıldı. Çalışmada 10 adet dişi hayvana ait Norduz koyun mandibula'sı kullanıldı. Mandibulalar önce klasik yöntemlerle makroanatomik, morfometrik ve topografik yöntemlerle incelendi. Daha sonra radyoloji ünitesinde MR görüntüleri alındı. Margo alveolaris üzerinde bulunan son molar dişlerin materyallerin hiçbirinde alveolar çukurluktan dışarıya doğru çıkmadığı görüldü. Premolar dişlerin materyallerin yüzde kırkında üç kökten oluştuğu yüzde altmışında ise iki kökten oluştuğu görüldü. Foramen mentale'nin oval ve yuvarlak bir şekilde olduğu ve değişik sayılarda mandibula'nın lateral yüzünde yer edindiği görüldü. Foramen mandibula'nın eliptik bir şekilde olduğu gözlendi. Yapılan istatistiksel analize göre Norduz koyununda mandibula uzunluğu sağ tarafta 146.93±2.95, sol tarafta 147.91±3.32 mm, olarak ölçüldü. Processus condylaris'in infradental aralığa olan uzaklığı sağ tarafta 165.15±2.62, sol tarafta 162.43±2.97 mm, olarak analiz edildi. Mandibula'nın yüksekliği sağ tarafta 87.87±0.75 mm, sol tarafta 88.00±0.81 mm, olarak belirlendi. Margo interalveolaris'in uzunluğu sağ tarafta 35.69±0.61, sol tarafta 36.67±0.72 mm, olarak ölçüldü. İstatistiksel olarak analiz edilen parametreler mandibulalar arasında yön olarak anlamlı bir değer göstermedi ($p>0.05$).

Anahtar Kelimeler: Memeli morfolojisi, mandibula, radyoloji

INTRODUCTION

Norduz sheep is one of the domestic sheep breeds that are bred in the Gürpınar district of Van (1). In terms of meat, milk and other characteristics of Norduz sheep raised in the Norduz region, higher quality yields are obtained compared to other sheep (2).

Gender discrimination in ruminants is particularly common in the skull (3). The results of many studies on different breeds and bones contribute to comparative anatomy, taxonomy, gender discrimination, veterinary practice, clinical-based studies to improve animal welfare (4-16). It is thought that the data presented to the literature with morphometric studies will contribute to the determination of race and sex of the animal bones found in the excavation areas (14,17).

Possible tooth fractures on the mandible, which provides support for the basic structures of the mouth, can directly affect the existing life of the animal. Pulp necrosis, abscesses and bacterial infections can be seen with tooth fractures, and with the progression of these conditions, clinically decreased appetite, weight loss, pain and discomfort symptoms can be seen (18,19). In severe cases that may occur due to such situations, a significant risk of death may occur with sudden changes (20).

Interventions in the case of mouth and jaw injuries require a deep anatomical and topographic knowledge. For this reason, this study was designed and the mandible was examined anatomically, morphometrically and radiologically in Norduz sheep, which is an important gene source in the region.

MATERIAL AND METHODS

In this study, 10 female Norduz sheep mandibles were used. The study was approved with permission from Kafkas University Animal Experiments Local Ethics Committee (KAÜ-HADYEK/2022-114). Study materials were obtained from local producers in Gürpınar district of Van province. Dissection procedures were performed on the supplied materials. After being separated from the skin and muscles on the mandibles, a controlled maceration process was performed. The materials were kept in hydrogen peroxide for the bleaching processes of the bones. Then drying was done. Mandibles were examined bilaterally morphologically and topographically (21) (Figure 1,2). The radiological evaluation of the mandibles was performed in the Radiology unit of the Department of Surgery, Faculty of Veterinary Medicine, Kafkas University. Radiographic images were taken in right-left latero/lateral (L/L) or ventro/dorsal (V/D)-dorso/ventral (D/V) position, with 35x43 cm cassette, at 50 kV and 3.2 mAs doses, and using the CR device (Figure 3). For the morphometric evaluation, 21 parameters were measured on the materials with the help of a Digital Caliper. The 6 parameters measured were the measurements taken to determine the topographic location of the foramen mandible and foramen mentale for clinical applications. Basic statistical analyzes and correlation values of all measured values were analyzed in SPSS (20.0 version) package program. After the materials were photographed, they were written according to Nomina Veterinaria Anatomica (22).

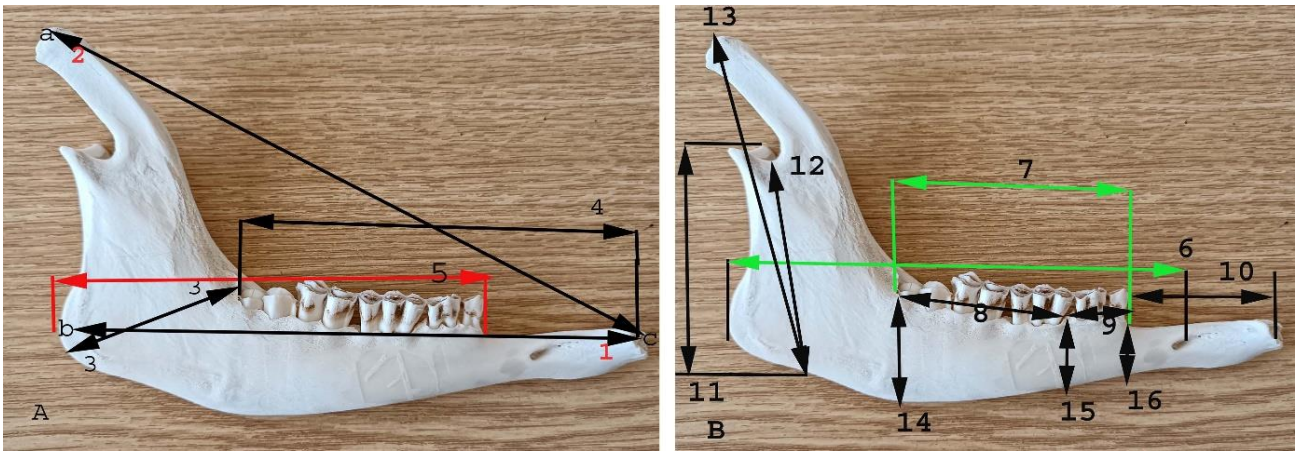

Figure 1A/B: Measured points on the mandible**, a:** the caudal endpoint of processus coronideus**, b:** The caudal endpoint of processus angularis, **c:** The rostro-superior point of the alveoli between incisive teeth, **1:** Lenght between gonion caudale and infradentale, **2:** Length between infradentale and aboral edge of condylar process, **3:** Length between gonion caudale and aboral alveolar edge of 3rd molar tooth, **4:** Length between infradentale and aboral alveolar edge of 3rd molar tooth, **5:** Length between gonion caudale and rostral alveolar edge of 2nd premolar tooth, **6:** length between gonion caudale and aboral edge of mental foramen, **7:** length between first premolar tooth and last molar tooth, **8:** length between first and last molar teeth**, 9:** length between first and last premolar teeth**, 10:** length of diestema**, 11:** length between gonion ventrale and condylion**, 12:** length between gonion ventrale and the deepest point of incisura mandibulae**, 13:** length between gonion ventrale and coronion**, 14:** height of mandible level of alveolar edge of 3rd molar tooth**, 15:** height of mandible level of rostral alveolar edge of 2nd premolar tooth, **16:** height of mandible level of rostral alveolar edge of 1st molar tooth

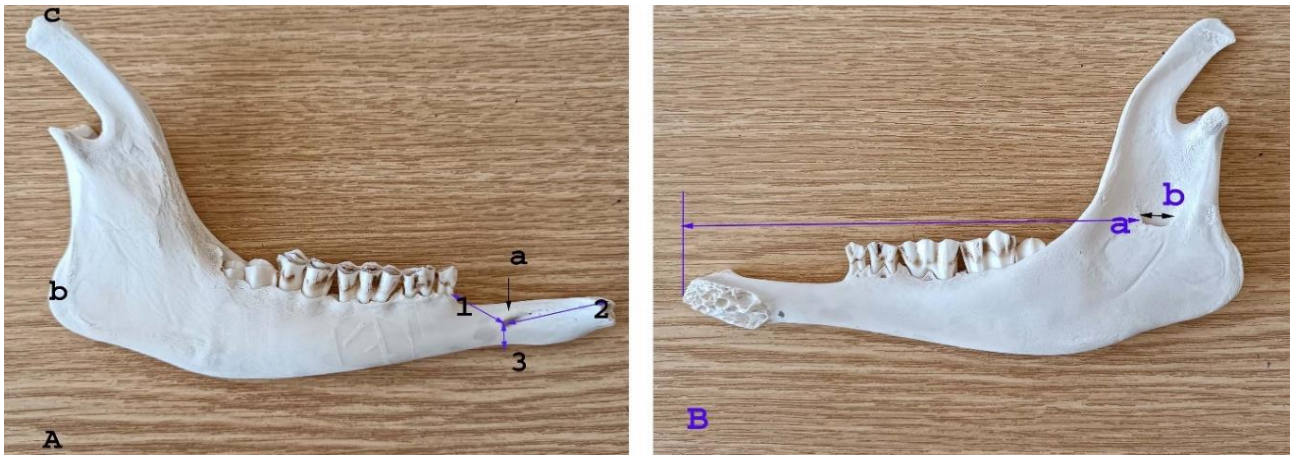

Figure 2A/B: Measurement points taken for the topography of the foramen mandible and foramen mentale, a: foramen mentale, **b:** the caudal endpoint of processus angularis**, c:** the caudal endpoint of processus coronideus, **1:** Distance between first premolar tooth and mental foramen**, 2:** Distance between lateral incisor tooth and mental foramen **3:** Distance between the base of the mandible and mental foramen, **Figure 2B: a:** Distance between foramen mandible and infradental, **b:** The length of mandible foramen

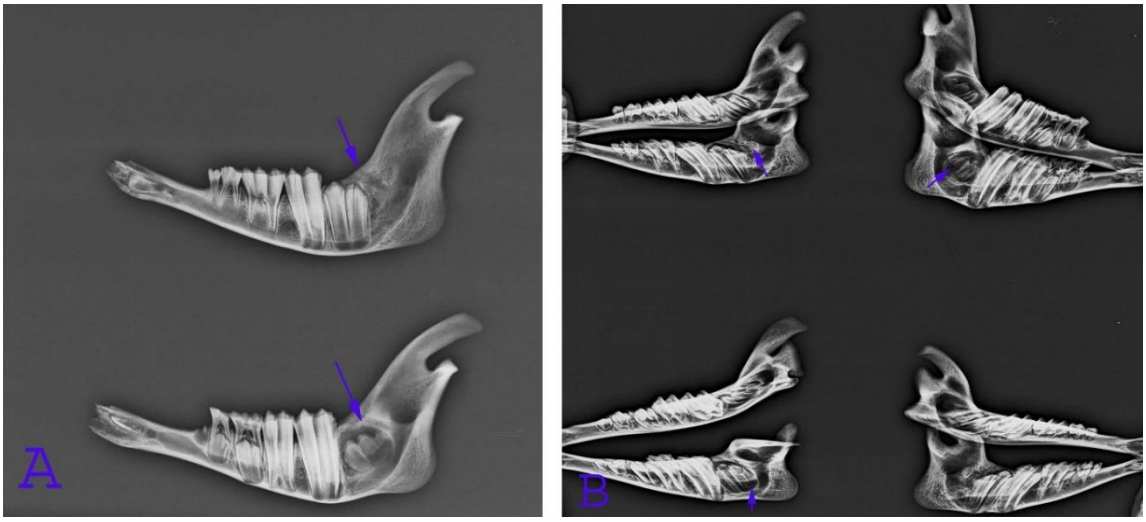

Figure 3A/B. x-ray image of the mandible, arrow: view of molar tooth in alveolar curvature

RESULTS

Macroanatomical Results

It was seen that the mandible, which carries the teeth on the lower jaw, consists of three parts. Foramen mentale was seen just below the edentulous area in the corpus section where incisor, molar and premolar teeth were located. In the transition from corpus to ramus, muscle adhesion lines and pits were seen on the mandible. It was also observed that the angulus part had a sharp edge. It was observed that the incisor teeth had a very sensitive structure and easily protruded from the alveoli. It was observed that the cartilaginous connection between both mandible halves easily disappeared and the mandibles were separated. It was observed that the last molar teeth on Margo alveolaris did not protrude from the alveolar cavity in any of the materials. It was observed that the premolar teeth consisted of 3 roots in forty percent of the materials, and two roots in 60 percent. It was observed that the foramen mentale was elliptical or rounded as previously stated in the literature and was located on the lateral edge of the mandible in different numbers. It was observed that the foramen mandible was elliptical.

Morphometric Results

21 descriptive lengths were measured to identify descriptive regions over the mandibles. The measurements were subjected to statistical analysis. According to the statistical analysis, the distance between the infradental space and the caudal edge of the mandible, which is stated in the literature as the length of the mandible, was measured as 146.93±2.95 mm, on the right side and 147.91±3.32 mm, on the left side in Norduz sheep. The distance of the protuberance called condylar process in the ramus mandible to the infradental space was analyzed as 165.15±2.62 mm on the right side and 162.43±2.97 mm on the left side. The height of the mandible was 87.87±0.75 mm, on the right and 88.00±0.81 mm, on the left. The distance from the caudal edge of the mandible to the second premolar tooth was analyzed as 100.88±2.10 mm, on the right side and 101.35±2.89 mm, on the left side. The length of the margo interalveolaris was measured as 35.69±0.61 mm, on the right side and 36.67±0.72 mm, on the left side. The distance of the first premolar tooth to the foramen mentale was analyzed as 17.01±0.47 mm, on the right and 17.37±0.56 mm, on the left.

Table 1. Statistical analysis of values taken from reference points determined on the mandible

Parameters	Right (mean±st. error)	Left (mean±st. error)
1	146.93±2.95	147.91±3.32
2	165.15±2.62	162.43±2.97
3	45.14±0.85	44.63±0.71
4	100.88±2.10	101.35±2.89
5	102.36±2.12	102.07±2.30
6	117.54±2.34	121.49±4.30
7	55.72±1.83	55.55±2.81
8	38.08±1.80	36.11±1.47
9	15.00±0.45	16.32±1.68
10	35.69±0.61	36.67±0.72
11	61.98±1.25	60.86±1.44
12	58.02±1.00	58.98±0.83
13	87.87±0.75	88.00±0.81
14	32.12±0.44	32.13±0.42
15	19.64±0.52	19.40±0.42
16	13.81±0.46	13.65±0.49
b (Figure 2/B)	8.02±0.60	8.53±0.45
a (Figure 2/A)	127.40±2.49	127.01±2.60
1 (Figure 1/B)	17.01±0.47	17.37±0.56
2 (Figure 1/B)	21.47±0.59	20.67±0.74
3 (Figure 1/B)	7.25±0.39	7.69±0.50

DISCUSSION AND CONCLUSION

In this study, which was carried out to understand the mammalian morphology, the mandibles of female individuals in Norduz sheep were examined and revealed using many different methods. A total of 21 parameters were measured to determine gender and species-specific findings on the mandible.

Avdic et al. (2013) revealed the differences between deer and sheep mandibles in their studies. Similarly, related

researchers conducted various studies and found statistically significant values in the mandible of Morkaraman and Tuj sheep (24), bardhoka sheep (25), and Hemşin sheep (7). In a study conducted on the mandible of Sharri sheep (14), the length of the mandible was reported as 185.91±13.33 mm. These values were reported as 15.76±2.25 mm, in Mehraban sheep (26) and 14.08 ± 0.01 cm, in Iranian domestic sheep (27). In our study, the mandible length was measured as 146.93±2.95 mm, on the right side and 147.91±3.32 mm, on the left side in Norduz sheep. When we evaluated the length of the mandible, in other studies available in the literature, the length was reported for Hemşin sheep (7), as 167.8 mm, for Morkaraman sheep (24) 152.4 mm, for Tuj sheep (24) 147.8 mm, for Mehraban sheep (26) 157.6 mm, for Barbados sheep (6) 181.6 mm, for Yankasa sheep (28) 198.0 ±0.28 mm, for Hasmer sheep (29), 186.30±9.30 mm, and in a study on Sarajevo sheep (23), 176.0 mm, respectively. When we make a comparison in terms of mandible length, it is noticed that female Norduz sheep have a very short jaw structure among the sheep we have accessed in the literature.

In order to understand the morpho-physiology of the ruminant, many studies on the lower jawbone attract attention. Mandible height as well as mandible length is part of the understanding of this morpho-physiology. Mandible bone height was reported as 94.2 mm, on average, in Hemşin sheep (7). These values were analyzed in Morkaraman sheep (24), and Tuj sheep (24), which are intensively bred in Eastern Anatolia, and reported as (87.0 mm) and (85.4 mm) on average. Apart from our country, there are also sheep breeds studied in other countries. For example, in the Mehraban sheep studied in Iran (26), the height of the mandible was reported as (95.7) mm. Similarly, it was published as 107.9 mm in Barbados sheep (6), 129.0± 0.57 mm in Yankasa sheep (28), and 108.68±2.36 mm in Hasmer sheep (29). In the study conducted on sheep (23) in Sarajevo, which has been researched in the literature in recent years and is very popular, it has been declared as 99.6 mm. This value was determined as 87.87±0.75 mm on the right side and 88.00±0.81 mm on the left side in female Norduz sheep.

Margointeralveolaris, which we call the edentulous area in the lower jaw in ruminants; In a study on Sharri sheep (14), diastema length was reported as 45.81±3.73 mm, and 45.98±3.87 mm, respectively. Among Morkaraman and Tuj sheep (24) reared in the margo inter aveolaris Eastern Anatolia region, which we call the edentulous region, this value was reported for (37.16±1.88 mm) in morkaraman sheep and (36.44±2.5 mm.) in Tuj sheep, respectively. This parameter was reported as (3.98±0.48 cm) in Mehraban sheep (26). In Norduz sheep, the length of margo interalveolaris (Diastema) was analyzed as 35.69±0.61 mm, on the right side and 36.67±0.72 mm, on the left side. When we make a comparison in terms of diastema length, it is seen that this parameter is close to morkaraman sheep but smaller than other sheep breeds in female Norduz sheep.

The height of the mandible corresponding to the last molar tooth level was analyzed as 32.12±0.44 mm, on the right side and 32.13±0.42 mm, on the left side in female Norduz sheep. This value was analyzed as 31.50±0.82 mm, on the right side and 31.26±1.16 mm, on the left side of male Norduz sheep (13). In studies on other sheep breeds, this value is; It was reported as 37.47±3.25 mm, in Hasmer sheep (29), 37.93 mm, in Hemşin sheep (7), and 38.88 mm, in Morkaraman (24) sheep. Studies on goats also reported this parameter as 36.75 mm, in females and 35.61 mm, in males for Abaza goats (9).

Parameter (6), which we determined to measure the distance between the caudal posterior part of the mandible and the foramen mentale, and numbered six (6), was analyzed as 117.54±2.34 mm in the right mandible and 121.49±4.34 mm in the left mandible in female Norduz sheep. This value, which was measured in other studies and analyzed after the measurement in order to understand the neural blockade of the foramen mentale and the morphology of the mandible, was declared as 137.4 mm in Mehraban sheep (26). This reference point, which was reported as 152.3 mm in Barbados sheep (6), was reported as 165.0 in Yankasa sheep (28). Our country is a close neighbor and cultivated in Iran; It is reported in the literature as 112.9 mm in Iranian domestic sheep (27). Similarly, this value has been reported as 149.40±11.02 mm in Hasmer sheep (29), which has captured a current study area that has been brought to the literature in recent years.

It is known that there are a few distinct differences between the skulls of sheep and goats, which are classified as small ruminants. In addition to the sheep mandible, goat skull and mandible are among the most studied subjects in recent years. Similarly, in some studies on goats, which we reached as a result of literature review, the same parameter was given. Although this parameter is reported as 128.87 mm, in females and 118.84 mm, in males, for example in Abaza goats (9), in Gurcu goats (30), 125.30 ± 8.49 mm, in females and 151.31 ± 0.5 mm, in females. In the study, in which males were preferred as gender and named as Blackbuck, this parameter (31) was reported as 43 ± 0.08 cm. Again, these goats (32), which are called black bengal goats in the literature, have been reported as 11.69±0.40 cm. It was analyzed as 9.26±0.49 cm, in goats shortened as GVD (33). Finally, in Barbados sheep, 15.23 ± 1.46 cm (34); It has been reported as 11.8 ± 0.89 cm (32) in the Black Bengal goat.

Parameter 21, which we numbered to measure the distance between the ventral edge of the mandible and the foramen mentale, was examined in female individuals of Norduz sheep. As a result of this examination, it is observed that this analysis is 7.25±0.39 mm, on the right side and 7.69±0.50 mm, on the left side. This value was reported as 0.67±0.22 cm, on the right side and 0.70±0.24 cm, on the left side in the study previously studied (13) on male individuals of the same sheep breed and brought to the literature. Similarly, in studies conducted on other sheep breeds, this value was reported as 0.70±0.18 cm for Barbados black belly (34), and 0.69±0.13 cm for Hemşin sheep (7). These values have also been reported in studies on goats, which we frequently compare in small ruminant studies and which have started to appear widely in the literature. For example, this value was reported as 2.35±0.26 cm in the Gwembe Valley dwarf goat (33), and as 0.77±0.04 cm in the Black bengal goat (32).

In order to easily block the nervus mentalis, another parameter that we examined topographically, measured over the mental foramen, is the parameter we determined as the distance between the first premolar tooth and the mental foramen. This parameter was analyzed as an average of 17.01±0.47 mm on the right side and 17.37±0.56 mm on the left side in female Norduz sheep. Similarly, in a study on male Norduz sheep (13), this parameter was reported in the literature as 1.68±0.79 cm on the right side and 1.73±1.09 cm on the left side. Although there are studies on other sheep species, this parameter was declared as 2.25±0.38 cm in Barbados black belly (34), sheep and 1.98±0.21 cm in Hemshin sheep (7). Again, this parameter can be studied in goats and it was reported as 1.46±0.09 cm in Black bengal goat (32).

As a result, the Norduz sheep mandible, which is an important gene source in our country, which we have examined with radiological, macro-anatomical and morphometric methods, will be an important study in terms of understanding the mammalian morphology by subjecting it to morphological analysis in our future studies.

CONFLICT OF INTERESTS

The author declares no conflicts of interest with respect to the research, authorship, and/or publication of this paper.

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