RESEARCH ARTICLE

Age Related Morphological Studies on the Tongue of Non-Descript Sheep of Jammu Region with Special Emphasis on Lingual Papillae

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Abstract

The tongue of the non-descript sheep (n = 18) was a spatula shaped mobile organ consisting of apex, body, and root. The apex was notched at the centre. A longitudinal groove on the dorsal surface was present which was more apparent in the adult and senile groups. Caudo-dorsal portion of the body presented torus linguae, in front of which was a transverse fossa linguae. Dorsal surface of the tongue was covered by filiform, fungiform, conical, lenticular, and circumvallate papillae. Filiform papillae were pointed, thread-like, and directed caudally and were most abundant. Fungiform papillae were mushroom-shaped. Filiform and fungiform papillae were also present on the ventral surface of the tongue tip in 'V' configuration in all three age groups (below 1 year; 2-3 years,and 4 years and above). Lenticular papillae were found on the torus linguae. Largest lenticular papillae were placed along the midline of the prominence. Conical papillae were found lateral to lenticular papillae and orientated caudally. They were greater in the centre and smaller towards the caudal and lateral aspects. Circumvallate papillae were spherical and encircled by a deep moat which was surrounded by a slightly higher mucosal ring. They were arranged in two rows. Weight and volume of the tongue was significantly ($p<0.05$) greater in senile group followed by adult and least in the young sheep. In all the three age groups, length of the body was the longest part whereas root was the shortest. Width and thickness of the tongue was maximum at the level of torus linguae in all the age groups. Width of the tongue at apex, body and torus linguae showed significant difference ($p<0.05$) and thickness at apex and torus linguae showed significant difference ($p<0.05$). Total numbers of vallate papillae were the highest in senile group but the difference was non-significant among various age groups.

Key words: Gross anatomy, Lingual papillae, Sheep, Tongue, Torus linguae

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Introduction

The union territory of Jammu and Kashmir generally has an environment and socio-cultural system that encourages small ruminant farming. Sheep (*Ovis aries*) play a significant role in the agrarian economy, providing a source of income for many small farmers and landless labourers. The oral cavity is primarily associated with food prehension, selection, and mastication. The tongue is a movable organ that occupies most of the oral cavity and is composed of apical, corpus, and radix portions with a distinct mucous membrane in the digestive system (Dursun, 2008). In herbivores, the tongue functions as a prehensile organ for grasping food items (Meier *et al.,* 2016). It is capable of both strong and precise movements, as in prehension, lapping, grooming, and manipulation of food within the mouth on the one hand and speech articulation on the other, while in other animals, the tongue assists in the heat loss by panting, such as the dog (Dyce *et al*., 2010). Any alteration and damage of the tongue in farm animals, both in anatomy and function, has a substantial impact on the animals' performance (Dyce *et al*., 2010). Ruminant digestive system organs, particularly the tongue, vary in morphology according to nutrition and food type (Delibas *et al*., 2023). There is scant information on the specific structure of the tongue in small ruminants, particularly sheep which prompted to undertake this study to gain a better understanding of the anatomical features of the tongue of non-descript sheep of Jammu region.

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Materials and Methods

The present study was conducted in the Division of Veterinary Anatomy, Faculty of Veterinary Sciences & Animal

Husbandry, SKUAST-J, R.S. Pura, Jammu (India). Heads of freshly slaughtered sheep were collected from local slaughter houses in and around Jammu city and immediately brought to the laboratory. Sheep were divided into three age groups (young: below 1 year; adult: 2-3 years and senile: 4 years and above) as per the dentition. Six (6) samples from each age-group of non-descript sheep (total 18) were collected. Tongue was removed to study gross morphological features. For morphometric analysis, different measurements (in cm) were done on freshly collected tongue using scale, Vernier calliper and non-stretchable thread. The biometrical parameters recorded were: Weight (g) of the head; Weight (g) and volume (mL) of the tongue using a sensitive electronic balance; Relative weight (%) of tongue; Total length (cm) of the tongue; Length, Width and Thickness (cm) of apex, body, torus linguae and root; Distance (cm) of lingual fossa from apex and root; Number of vallate papillae on right and left sides; Total number of vallate papillae; Width of lingual groove; Length (cm) of median longitudinal groove; and Number of transverse ridges.

The data of the tongue obtained was expressed as mean ± SEM and subjected to Statistical Analysis (Snedecor and Cochran, 1994). Values of $p \leq 0.05$ were considered significant between groups.

Results and Discussion

Gross Morphology

The tongues of all the non-descript sheep investigated rested on the floor of the oral cavity, supported mostly by intrinsic and extrinsic lingual muscles. The tongue was mostly whitish, but young and senile sheep showed coloration towards the apex (Fig. 1). Biradar *et al*. (2002) observed pigmentation in sheep tongue up to the lingual fossa. Hemram (2003) found the occurrence of black patches around the apex of goat tongues but not in sheep. The tongue of the non-descript sheep was divided into three parts: apex, body, and root (Fig. 1), as also previously reported by Delibas *et al*. (2023) in Norduz sheep. In the present study, the tongue in non-descript sheep of all the age groups was spatula shaped. Kadhim (2016) also reported spatula shaped tongue in goats. The apex was free and dorso-ventrally flattened, with dorsal and ventral surfaces. Similar observation was made by Hemram (2003) in sheep and goats. It was notched in the centre (Fig. 1) as reported by Deore *et al.* (2002) in goat. The dorsal surface of the apex had a shallow longitudinal groove, which was more apparent in the adult and senile groups (Fig. 1) and extended for a small distance from the centre of the notch towards body as per earlier reports of Murad *et al.* (2010) in mature rams. Biradar *et al.* (2002) recorded that the median groove extended up to one-third length of the sheep tongue.

The body of the tongue was attached to the floor of the mouth and was wider than the apex. Lateral surfaces were almost flat for the majority of the part. The caudo-dorsal portion of the body developed an elliptical protrusion, the torus linguae, in front of which was transverse fossa linguae (Fig. 1) as also reported earlier by Delibas *et al*. (2023) in Norduz sheep and Madkour *et al.* (2023) in Rahmani sheep. In the present study, the fossa linguae was prominent in adult and senile group as compared to shallow fossa in the young group (Fig. 1). The lingual prominence is a characteristic morphological character in mammals, especially those that eat fibrous vegetation such as grass, as noted in the present study and in rabbits (Nonaka *et al.,* 2008), Egyptian water buffalo (Emura and El Bakary, 2014), cattle (Ding *et al*., 2016) and most artiodactyls (Gozdziewska-Harłajczuk *et al*., 2015). The lingual prominence is important in the process of food mastication because it presses the food against the hard palate (El-Bakary and Abumandour, 2017). As per Hofmann (1989), all ruminant tongues are distinguished by the torus linguae. Its pushing interaction with the hard palate could be a functional correction for an incomplete dentition. Tongue of carnivores, omnivorous monkeys and pigs was devoid of lingual prominence (Kumar and Bate, 2004; Emura *et al*., 2006). Root was narrow and sloped caudo-ventrally with smooth dorsal surface.

The dorsal surface of the tongue, from the apex to the root, was covered by different types of papillae. However, the root part looked smooth and had fewer numbers of papillae. The free rostral region of the ventral side of the tongue was smooth.

The tongue was studded with five different types of lingual papillae: filiform, fungiform, conical, lenticular, and circumvallate papillae, which varied in distribution across the tongue. Murad *et al*. (2010) in adult rams, Goodarzi and Shah (2014) in goats, Ding *et al*. (2016) in cattle, El-Bakary and Abumandour (2017) in buffalo, and Thanvi *et al*. (2020) in camels all had reported these five forms of papillae. Filiform papillae were the most abundant. They were pointed, thread-like, and directed caudally (Fig. 3). Similar observations were made by Parvez and Rahaman (2005) in cows, Khan *et al*. (2006) in goats, and Murad *et al.* (2010) in adult rams. Musk deer had soft filiform papillae, giving the tongue a smoother appearance (Khan *et al*., 2006). They were densely packed on the apex. They were also found on the body of the tongue, albeit in smaller numbers than at the apex. The filiform papillae provided the mucosa a velvety appearance (Fig. 3). The fungiform papillae were less numerous but larger than the filiform papillae. They were mushroom-shaped and increased in size antero-posteriorly (Fig. 3), as previously also observed by Murad *et al.* (2010) in adult rams. These papillae were somewhat elevated from the dorsal surface. Similar findings were also reported by Mahabady *et al.* (2010) in Iranian buffaloes. Again, Parvez and Rahaman (2005) described club-shaped fungiform papillae in cows. They were irregularly scattered over the lateral margin of the tongue, extending beyond the lingual fossa. Fungiform papillae were spherical in cattle but elliptical in European bison (Plewa *et*

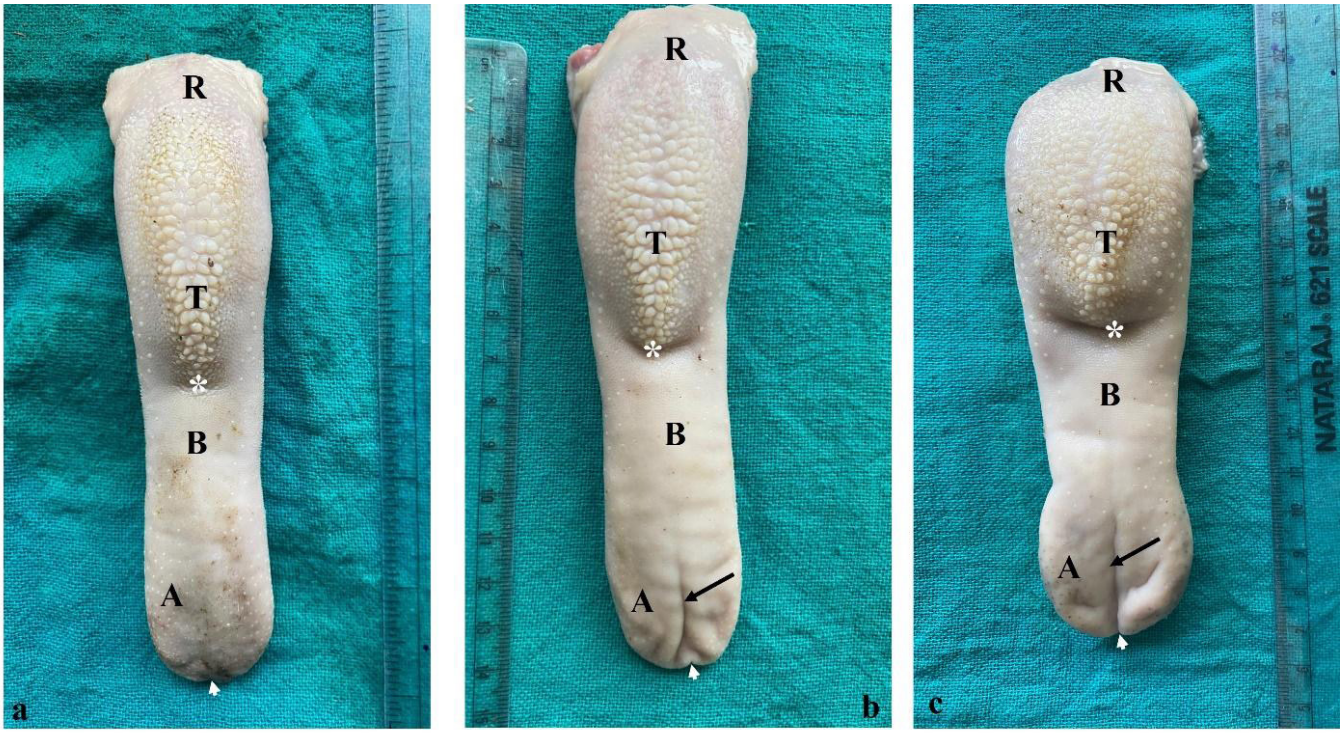

Fig. 1: Gross morphology of dorsal surface of tongue of young (a), adult (b) and senile (c) non-descript sheep of Jammu region showing apex (A), body (B), torus linguae (T), root (R) and fossa linguae (*). Apex is notched (white arrow head). Median longitudinal groove (arrow) is prominent in adult and senile age group.

Fig. 2: Dorsal surface of tongue of young (A) and senile (B) sheep showing pigmentation towards apex, distribution of filiform and fungiform papillae (encircled). Filiform papillae are numerous giving velvety appearance to the tongue.

al., 2022). Filiform and fungiform papillae were also found on the lateral margin of the ventral surface of the tongue tip in all three age groups. The papillae were organised in a 'V' configuration (Fig. 2). Murad *et al*. (2010) also found filiform and fungiform papillae on the ventral side of the tip of the tongue in adult ram. According to El-Bakary and Abumandour (2017), the five types of lingual papillae in Egyptian water buffaloes play a significant role in the detection and selection of various nutrients present in Egyptian fields.

Lenticular papillae were irregularly distributed over the torus linguae in all the three age groups (Fig. 1, 4). The size of the lenticular papillae varied, with the largest ones being placed along the midline of the prominence and the smallest at the edges (Fig. 4). Adult ram lenticular papillae were lens-shaped (Murad *et al*., 2010). Conical papillae were found on the torus linguae, lateral to lenticular papillae and orientated caudally. They were larger towards the centre and smaller towards the caudal and lateral aspects (Fig. 4), as also previously reported by Thanvi *et al*. (2020) in camel. The tips of these papillae were pointed. The existence of a lingual prominence with filiform, conical, and lenticular papillae enables herbivores to grind food by crushing it between the tongue and the upper palate (Shao *et al*., 2010).

The circumvallate papillae were spherical and encircled by a deep moat which was surrounded by a slightly higher mucosal ring. They were arranged in two rows (Fig. 4) as reported by Deore *et al*. (2002) in goats and Korake *et al*. (2002) in buffalo. However, in camels, circumvallate papillae were arranged in a single row (Thanvi *et al*., 2020). Murad *et al*. (2010) observed round to oval-shaped circumvallate papillae in adult rams. The distribution of the different types of papillae on the surfaces of the tongue plays a vital role in taxonomic ranking (Pastor *et al.,* 2011).

Biometry

The biometrical parameters of the tongue of young, adult and senile non-descript sheep have been depicted in Table 1. The weight of the tongue was significantly ($p<0.05$) greater in senile (100.23 ± 1.16 gm) followed by adult (88.15 ± 2.43 gm) and least in the young (69.35 ± 2.64 gm) age group. Similar pattern was observed for volume of the tongue. Mahmud *et al*. (2021) recorded the weight of tongue as 72.83± 8.15 gm in adult Uad ram. Total length of the tongue did not show any significant ($p>0.05$) difference. However, length of apex and root showed significant ($p<0.05$) difference. Length of apex was longer in senile and shorter in young sheep. Root was the longest in adult (2.29 ± 0.11 cm) followed by young and shortest in senile sheep (1.55 ± 0.16 cm). Reports of earlier studies revealed the length of tongue to vary from 15.54 ± 1.56 cm to 19.77 ± 0.334 cm in adult sheep and goats (Murad *et al*., 2010; Kadhim, 2016; Mahmud *et al.,* 2021; Delibas *et al.,* 2023) and 47.00 ± 1.2 cm in adult buffalo (El-Bakary and Adumandour, 2017). In all the three age groups of sheep under study, length of the body was the longest part whereas root was the shortest as earlier reported by Murad *et al.* (2010) in adult ram. However, in adult Uda ram, apex was the longest and root was the shortest (Mahmud *et al*., 2021).

In all the three age groups, width and thickness of the tongue was maximum at the level of torus linguae which was similar to the findings of Mahmud *et al*. (2021). Width at apex, body and torus linguae showed significant difference

Fig. 3: Gross morphology of ventral surface of tongue of young (a), adult (b) and senile (c) non-descript sheep of Jammu region showing arrangement of filiform and fungiform papillae along the lateral margin of tip of the tongue in 'V' arrangement.

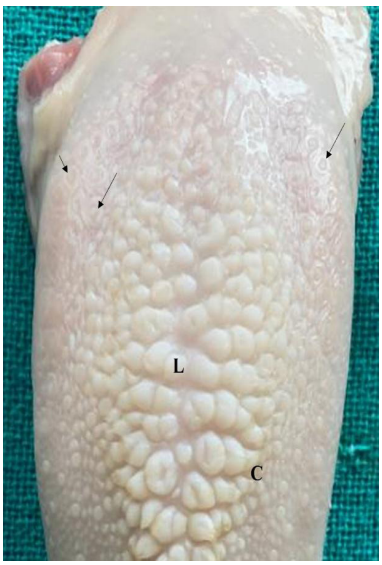

Fig. 4: Dorsal surface of tongue of adult sheep showing distribution of lenticular (L) and conical (C) papillae over the torus linguae. Conical papillae are directed caudally Circumvallate papillae (arrow) are arranged in two rows on either side.

($p<0.05$). Thickness at apex and torus linguae showed significant difference ($p<0.05$) among all the age groups. Distance between lingual fossa and tip of the tongue was maximum in senile (9.63 ± 0.38 cm) followed by adult and least in young (8.18 ± 0.36 cm) age group. It was more than the data (6.99 ± 4 cm) recorded by Madkour *et al*. (2023) in Rahmani sheep. Total number of vallate papillae were the highest in senile but the difference was non-significant ($p>0.05$). In cow, the number of vallate papillae ranged from 25-38 (Parvez and Rahaman, 2005). Length of median longitudinal groove did not show significant difference ($p>0.05$) among various age groups. It was longest in senile (4.01 ± 0.16 cm) followed by adult and shortest in young sheep (2.88 ± 0.92 cm). In adult ram, the length of median longitudinal groove was 3.75 ± 0.26 cm (Murad *et al.,* 2010).

Table 1: Showing age related biometrical parameters of tongue of non-descript sheep of Jammu region

Parameters	Age group		
	Young	Adult	Senile
Total length (cm)	16.43^{a} ±0.45 (15.00-17.50)	17.40^{a} ±0.55 (15.20-18.50)	17.80^{a} ±0.66 (15.70-19.50)
Length of the apex (cm)	3.66^{a} ±0.09 (3.40-4.00)	4.91^{b} ±0.18 (4.00-5.20)	5.10^{b} ±0.18 (4.50-5.70)
Length of the body (cm)	9.78^{a} ±1.24 (5.90-12.50)	10.00^{a} ±0.52 (8.70-11.40)	11.45^{a} ±0.62 (9.30-13.00)
Length of torus linguae (cm)	7.20^{a} ±0.21 (6.70-7.90)	7.58^{a} ±0.36 (6.40-8.30)	7.95^{a} ±0.04 (7.80-8.10)
Length of the root (cm)	1.91^{b} ±0.10 (1.50-2.20)	2.29^{b} ±0.11 (1.90-2.60)	1.55^{a} ±0.16 (1.00-2.00)
Width at the tip (cm)	2.65^{a} ±0.08 (2.40-3.00)	3.14^{b} ±0.11 (2.70-3.40)	2.75^{a} ±0.07 (2.50-3.00)
Width at the body (cm)	2.96^{a}±0.15 (2.50-3.50)	3.45^{b} ±0.09 (3.10-3.80)	3.53^{b} ±0.13 (3.20-4.00)
Width at the torus linguae (cm)	4.06^{a} ±0.04 (3.90-4.20)	4.11^{a} ±0.09 (3.80-4.40)	4.48^{b} ±0.06 (4.20-4.60)
Width at the root (cm)	3.70^{a} ±0.09 (3.40-4.00)	3.71^{a} ±0.10 (3.50-4.00)	3.71^{a} ±0.06 (3.50-3.90)
Thickness at the tip (cm)	0.86^{a} ±0.03 (0.78-0.98)	0.65^{a} ±0.06 (0.45-0.89)	0.80^{a} ±0.05 (0.66-0.98)
Thickness at the body (cm)	1.59^{a} ±0.12 (1.23-1.99)	1.39^{a} ±0.06 (1.23-1.67)	1.70^{a} ±0.10 (1.34-1.99)
Thickness at the torus linguae (cm)	2.00^{a} ±0.23 (1.34-2.70)	2.37^{b} ±0.10 (2.12-2.78)	3.14^{c} ±0.21 (2.67-3.88)
Thickness at the root (cm)	1.37^{a} ±0.15 (0.89-1.80)	1.22^{a} ±0.11 (0.89-1.56)	1.29^{a} ±0.11 (0.89-1.67)
Distance of fossa linguae from the tip (cm)	8.18^{a} ±0.36 (7.10-9.20)	8.81^{a} ±0.41 (7.20-10.00)	9.63^{a} ±0.38 (8.40-10.50)
Distance of fossa linguae from the root (cm)	8.35^{a} ±0.12 (7.90-8.60)	8.65^{a} ±0.19 (8.00-9.10)	8.18^{a} ±0.40 (7.40-9.50)
Weight of the tongue (gm)	69.35^{a} ±2.64 (64.70-78.00)	88.15^{b} ±2.43 (77.40-94.80)	100.23^{c} ±1.16 (97.00-104.20)
Relative weight (%)	3.33^{ab} ±0.07 (3.14-3.55)	3.79^{b} ±0.15 (3.26-4.23)	3.13^{a} ±0.21 (2.76-3.83)
Volume (mL)	68.66^{a} ±2.20 (64.00-76.00)	87.16^{b} ±2.82 (75.00-95.00)	97.33^{c} ±1.05 (95.00-101.00)
Shape index (%)	17.94^{a} ±0.60 (16.60-20.00)	20.00^{a} ±0.67 (18.47-23.02)	19.77^{a} ±0.65 (17.43-21.42)
No. of vallate papillae on right side	15.66^{a} ±1.05 (12.00-18.00)	18.16^{a} ±0.79 (15.00-20.00)	19.83^{a} ±2.02 (15.00-27.00)
No. of vallate papillae on left side	19.66^{a} ±1.85 (16.00-26.00)	18.16^{a} ±1.27 (15.00-24.00)	18.66^{a} ±2.29 (12.00-25.00)
Total No. of vallate papillae	35.33^{a} ±2.72 (28.00-44.00)	36.33^{a} ±1.80 (31.00-44.00)	38.50^{a} ±4.25 (28.00-52.00)
Total weight of head (kg)	2.08^{a} ±0.08 (1.82-2.40)	2.34^{a} ±0.11 (2.11-2.81)	3.26^{b} ±0.17 (2.70-3.60)
Width of lingual groove (cm)	2.11^{a} ±0.04 (2.00-2.30)	2.03^{a} ±0.24 (1.40-3.00)	1.70^{a} ±0.12 (1.30-2.10)
Median longitudinal groove length (cm)	2.88^{a} ±0.92 (0.00-4.90)	3.78^{a} ±0.80 (0.00-5.30)	4.01^{a} ±0.16 (3.50-4.50)
No. of transverse ridges	16.00^{b} ±0.25 (15.00-17.00)	14.66^{a} ±0.42 (13.00-16.00)	15.00^{a} ±0.25 (14.00-16.00)

Mean values with different superscript (a, b, c) within the row differ significantly ($p<0.05$)

Conclusion

The present research extends the depth of the knowledge regarding anatomy of tongue in non-descript sheep which prefers grazing. The detailed anatomical study further adds to the literature. When compared with available literature on goat which prefers browsing, gross anatomical differences existed which can be correlated to their digestive physiology.

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