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Morphogenesis of tongue in prenatal Surti goat (*Capra hircus*)

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Abstract
The study was undertaken to determine the development of tongue at different stages of prenatal life in Surti goat. A total 41 apparently normal Surti goat fetuses were procured and categorized broadly into three groups: group-I comprising of Surti goat fetuses with CR length up to 10cm, group-II of fetuses with CR length between 10.1 to 20cm and Group-III of fetuses with CR length above 20cm. Morphological observations of the tongue were recorded in respect to location, shape, external surface, size, colour of tongue and number of circumvallate papillae. Tongue situated on the floor of the mouth cavity proper with three parts: apex, body and root. Torus linguae appear in the form of minute prominence at 7.4cm CR length and well defined in group-III. In front of torus linguae, a crescent depression, fossa linguae was conspicuous from 26.7cm CR length. The mucous membrane of the dorsal surface bears different types of lingual papillae (Filiform, Conical, Lenticular, Fungiform and Circumvallate). Lateral borders in group-I were smooth and sharp, with progression of age in group-III they were scattered with filiform and fungiform papillae in apex and rostral part of body, whereas circumvallate papillae were present on the caudo-lateral aspect of the body.

Keywords: Morphogenesis, tongue, papillae, goat, prenatal, fetus, developmental

Introduction
Surti is the most popular breed in south Gujarat because of its prolificacy and adaptability to the arid and semi-arid climatic condition and contributes significantly to the rural economy of the region. The breed is most suited and performs well under complete confinement and stall-fed conditions. The surface anatomy and histology of tongue of adult sheep and goat, and its papillae is described (Getty, 1975; Nickel *et al.*, 1979; Stinson and Calhoun, 2006; Menaka and Chaurasia, 2016). [6, 15, 19, 13] Reports pertaining to morphogenesis of lingual papillae in various animals are available (Ahpin *et al.*, 1989; Tichy, 1992; Fujimoto *et al.*, 1993 and Iwasaki *et al.*, 1996). [1, 20, 5, 8] The available reports are concerned with adult structures of the tongue and papillae, much less have been reported about the prenatal development of the tongue and circumvallate papillae in the goat. Considering the paucity of the references available on anatomy of tongue in Surti goat and the enormous potential of tongue being an important organ of digestive system, there is a great need of prenatal study on tongue in Surti goat. The present study was carried out with objectives to study the morphological structures of tongue during prenatal development.

Materials and Methods
A total 41 apparently normal Surti goat fetuses were procured from the local abattoir and Department of Veterinary Anatomy, Vanbandhu College of Veterinary Science and Animal Husbandry, N.A.U., Navsari (presently under Kamdhenu University, Gujarat) for the present investigation. Each fetus was cleaned under running tap water for removal of tissue debris and blood clots.
The fetus was placed on its side keeping its neck and back in a straight line. The head was flexed at right angle to this line. The body measurement in respect to Crown-rump length (CR length) and Curved Crown-rump length (CVR length) recorded in cm using non-stretchable thread and scale as per the method adopted by Joubert (1956) [9]. The age of goat fetuses estimated on the basis of CR length as per the normograph perfected by Lyngset

(1971) [12]. The fetuses were grouped on the basis of Crown-rump length (CR length) *viz.*, group I comprising of Surti goat fetuses with CR length up to 10 cm, group II comprising of fetuses with CR length between 10.1 to 20 cm and Group III of fetuses with CR length above 20 cm.

The entire tongue was separated from the oral cavity by dissecting the frenum linguae from ventral surface and muscles from root of the tongue. The tongue of goat fetuses was fixed in 10% neutral buffer formalin immediately after recording morphological observations. The morphological observations of the tongue were recorded in respect to location, shape, external surface, size, colour of tongue and number of circumvallate papillae.

Results and Discussion

1. Location

In the present study, the tongue situated on the floor of the mouth cavity proper between two horizontal rami of the mandible which comprised of three parts viz., apex, body and root (Fig. 1 and 2). The results of present study are in agreement with Parmar *et al.* (1999) [16] in prenatal goat, Hemram and Ray (2009) [7] and Sarma *et al.* (2012) [18] and Menaka and Chaurasia (2016) [13] in postnatal goat, Murad *et al.* (2010) [14] and Kumar *et al.* (2008) [11] in postnatal sheep and Dhingra and Barnwal, (1979) [3] in postnatal buffalo.

2. Shape

In group I, tongue of goat fetuses was elongated in the antero-posterior direction. With further progression of age in group III, the tongue became thicker and more elongated (Fig. 3). Similar results reported by Dar *et al.* (2014) [2] and Kumar *et al.* (2015) [10] in goat fetuses and Verma *et al.* (2010) [21] in buffalo fetuses.

3. Size

The size of the tongue increased significantly with the advancement of age from group I to III (Fig. 3). The observation of present study is in agreement with Parmar *et al.* (1999) [16] and Dar *et al.* (2014) [2] in goat fetuses and Verma *et al.* (2010) [21] in buffalo fetuses.

4. Apex

The apex was thin and spatula shaped with dorsal and ventral surfaces facing the palate and the floor of the mouth cavity, respectively forming free rostral part of the tongue (Fig. 4). With the progression of age apex became thicker with rounded borders in group II and group III. A notch in the centre of anterior border of the apex was observed (Fig. 5). This observation is in agreement with reports of Dar *et al.* (2014) [2] in goat fetuses.

Impressions of palatine ridges were faint in group I and became prominent at 19.3 cm CR length (84 day) and gradually became lighter in group III (Fig. 5 and 6). Similar observations made by Verma *et al.* (2010) [21] in buffalo fetuses. However, Kumar *et al.* (2015) [10] found very faint impressions of palatine ridges in first group which gradually became evident from 49 days onward in goat fetuses.

5. Body

The body was the largest and the longest part of the tongue constituted the bulk of the organ. The body was narrow towards the root and gradually increased in width and thickness with advancement of age, on reaching towards apex it became narrower. It was relatively triangular in shape with three free surfaces (Fig. 7). The dorsal surface was rounded and the lateral borders were flattened. The ventral face was related to the lingual muscles. The torus linguae appear in the form of minute prominence from 7.4 cm CR length (51 day) and became well defined in group III (Fig. 8). In front of torus linguae, a transverse crescent depression, fossa linguae was become conspicuous from 26.7 cm CR length (103 day) (Fig. 7). These observations are in accordance with Parmar *et al.* (1999) [16] in goat fetuses.

6. Root

The root was the most posterior part of the tongue, attached to the hyoid bone and mandible by muscle hyoglossus and genioglossus, with the soft palate by anterior pillars, with the pharynx by muscles and with the epiglottis by glossoepiglottic fold. Only dorsal surface was free and slopes caudo-ventrally toward the base of the epiglottis (Fig. 2) which is in agreement with the descriptions of Dyce *et al.* (2009) [4] and Reece, (2009) [17]. In group I, root had smooth dorsal surface and slops caudo-ventrally. The dorsal surface of root was rostrally broad and caudally narrow. In group II and III, the root increased in thickness as well as in width with progression of fetal age. These observations are in accordance with Kumar *et al.* (2015) [10] in goat fetuses.

7. Surfaces and Borders

The tongue had two surfaces: dorsal, ventral and two lateral borders.

7.1 Dorsal surface

The dorsal surface or dorsum linguae was free throught and in contact with the palate except at the glosso-epiglottic space. No median sulcus noticed on dorsal surface of body of tongue which extended towards apex and disappeared just before the beginning of apex. Similar observation made by Kumar *et al.* (2015) [10] in goat fetuses. The mucous membrane of the dorsal surface bears different types of lingual papillae from apex to root of the tongue (Fig. 9). The fungiform and circumvallate papillae developed earlier at 6.6 cm CR length (48 days) whereas, filiform, conical and lenticular appeared later on at 22 cm CR length (92 days) in group III. The development of papillae was better in the posterior part than the anterior part of the tongue in all stages. The findings of present work are in line with Kumar *et al.* (2015) [10] in goat fetuses and Verma *et al.* (2010) [21] in buffalo fetuses.

In group I, the dorsal surface of the tongue was smooth and flat with small mucosal eruptions at the level of future circumvallate papillae at caudo-lateral aspect of the body of the tongue. The “V” shaped mucosal elevation in the form of single strip on either side at caudo-lateral aspect of body in circumvallate region was firstly observed at 7.6 cm CR length (52 day). In group II, at 11.10 cm CR length (62 day) miniature of circumvallate papillae became visible (Fig. 4). In group III, round, convex at its free surface and surrounded by a deep moat encircled with slightly elevated mucosal ring, distinct circumvallate papillae observed in two rows in “V” shape at caudo-lateral aspect of the body (vallate region) (Fig. 9). In group III, the mucous membrane was thick, tough with prominent lingual papillae. These observations are in agreement with Kumar *et al.* (2015) [10] in goat fetuses.

7.2 Ventral surface

The ventral surface of tongue attached to floor of mouth with a fragile fold of mucous membrane, frenum linguae in group I and in later stage, this fold became thickened which was more prominent in group III (Fig. 2). These findings are in accordance with Parmar *et al.* (1999) [16] and Kumar *et al.* (2015) [10] in goat fetuses. The ventral surface was smooth in group I but studded with a number of filiform and fungiform papillae on its lateral surfaces in group II and III which is in agreement with Parmar *et al.* (1999) [16] in goat fetuses.

7.3 Lateral borders

Two lateral borders of the tongue in group I were smooth and sharp, with progression of age in group II, borders became thicker, broad and rounded. In group III, the lateral borders were studded with filiform and fungiform papillae in apex and rostral part of body whereas circumvallate papillae were present on the caudo-lateral aspect of the body (Fig. 10). These observations are in accordance with Kumar *et al.* (2015) [10] in goat fetuses and Verma *et al.* (2010) [21] in buffalo fetuses.

8. Colour

Colour of the tongue in the goat fetuses was pink with no pigmentation in all three groups. This observation was in accordance with Sarma *et al.* (2012) [18] in adult Bakerwali goat while Hemram and Ray (2009) [7] in adult Black Bengal goat reported black spot or pigmentation present on the dorsal surface. Verma *et al.* (2010) [21] reported the white coloured tongue in group I (fetuses up to 20 cm CVR) and II (fetuses between 20.1-40 cm CVR), and light black pigmentation on both dorsal and ventral surface in group III (fetuses above 40 cm CVR) in buffalo fetuses.

9. Number of circumvallate papillae

Circumvallate papillae were not observed in group I. Number of circumvallate papillae in right and left side at caudo-lateral part of the body were 9.57±1.12 and 8.57±0.84 in group II; and 16.33±0.84 and 15±0.90 in group III, respectively (Table 1). Total number of circumvallate papillae in goat fetuses of group II and III were 18.14±1.99 and 31.33±1.69, respectively. Circumvallate papillae increased in number with advancement of age (Table 1). However, Parmar *et al.* (1999) [16] reported 3 to 15 in group 2 (CR length 10 to 20 cm) and 11 to 15 circumvallate papillae in group 3 (CR length above 20 cm) in goat fetuses. Menaka and Chaurasia (2016) [13] reported the number of circumvallate papillae as 14.2±0.56 in right side and 14.8±0.44 in left side in adult Surti goat.

Table 1: Distribution and Number of Circumvallate papillae in tongue of goat fetuses.

Part of tongue			Group-I	Group-II	Group-III
Body	Caudo-lateral part	Left side	-	9.57±1.12	16.33±0.84
		Right side	-	8.57±0.84	15±0.90
		Total	-	18.14±1.99	31.33±1.69

Fig 1: Photograph of tongue at 29 cm CR length (110 days) of goat fetus showing the location of tongue at floor of the mouth cavity between two horizontal rami of the mandible (Dotted line).

Fig 2: Photograph of the tongue at 29.4 cm CR length (112 days) of goat fetus showing parts of tongue: A-apex, B-body, R-root, and ventral surface with frenulum linguae (Arrow).

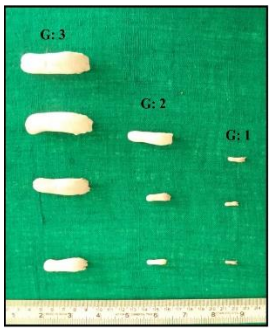

Fig 3: Photograph of tongues of goat fetuses showing increase in size with age from group I to III.

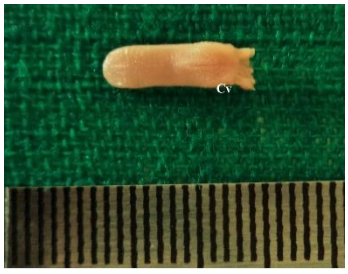

Fig 4: Photograph of the tongue of a goat fetus at 6.8 cm CR length (50 days) showing thin and spatula shaped apex (Rectangle) and Cv-circumvallate papillae

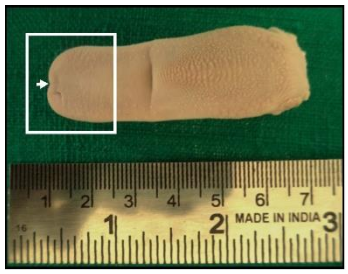

Fig 5: Photograph of tongue of a goat fetus at 32 cm CR length (120 days) showing apex (Rectangle) with thicker and rounded borders, and a notch (Arrow) in the center of anterior border.

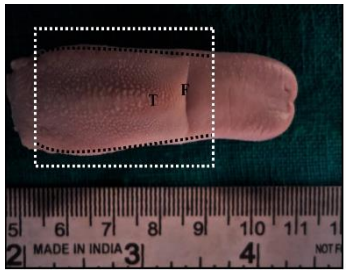

Fig 7: Photograph of dorsal surface of tongue of a goat fetus at 32 cm CR length (120 days) showing relatively triangular body (dotted rectangle), two lateral borders (dotted lines), T-torus linguae, and F-fossa linguae.

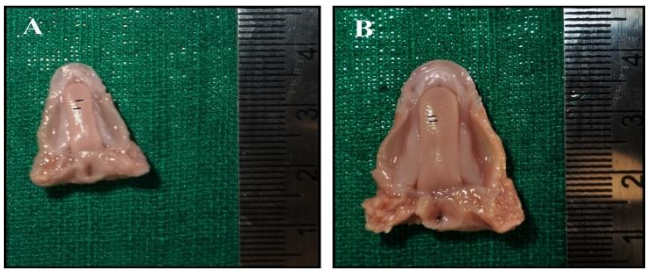

Fig 6: Photographs of tongues of goat fetuses at 8.6 cm (56 days) (A) and 12.20 cm (64 days) (B) CR length showing impressions of palatine ridges (line).

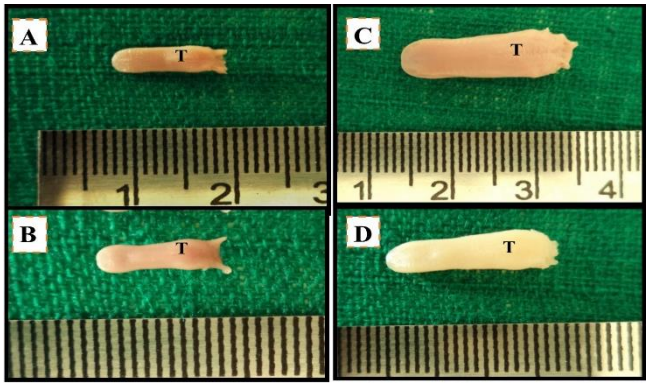

Fig 8: Photographs of tongues of goat fetuses in Group I (A and B) and Group II (C and D) showing development of torus linguae (T).
A: 6.8 cm CR length (50 days); B: 8.4 cm CR length (55 days);
C: 11.10 cm CR length (62 days); D: 19 cm CR length (84 days).

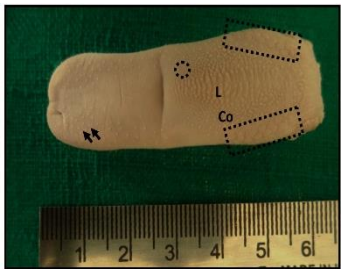

Fig 9: Photograph of dorsal surface of tongue of goat fetus at 32 cm CR length (120 days) showing circumvallate papillae in a "V" shape in two rows (rectangle) arrangement, Arrow-fungiform papillae, Co-conical papillae, L-lenticular papillae and Circle-filiform papillae.

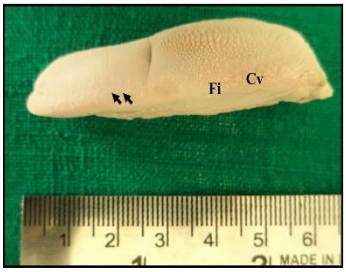

Fig 10: Photograph of tongue of goat fetus at 32 cm CR length (120 days) showing broad and rounded lateral border of tongue, Cv-circumvallate papillae, Arrow-fungiform papillae and Fi-filiform papillae.

Conclusions

The present study revealed the progressive morphological development of the tongue in goat fetuses. Structurally divided into apex, body and root, the tongue showed progressive elongation, thickening, and differentiation with advancing gestational age. Lingual papillae appeared sequentially, with fungiform and circumvallate papillae developing earlier, followed by filiform, conical, and lenticular types. The number of circumvallate papillae increased notably in later stages. The tongue remained uniformly pink, with no pigmentation observed. These findings provide detailed insight into prenatal tongue development in goats, contributing to the understanding of comparative and developmental anatomy in domestic ruminants.

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