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**COMPARATIVE MORPHOLOGY AND HISTOLOGY OF BUFFALO  
AND GOAT TONGUE WITH HUMAN TONGUE**

**Fulse AC\*, Mishra P, Ksheersagar DD, Paikrao VM**

NKP Salve Institute of Medical Sciences of Medical Sciences & Research Centre, Nagpur, Maharashtra 440016, India.

**ABSTRACT**

The dorsal surface of tongue shows the lingual papillae. On the basis of their appearance four types of papillae can be distinguished – filiform, fungiform, circumvallate and foliate papillae. Filiform, lenticular and conical papillae possess a protective and mechanical function. The fungiform, foliate and vallate papillae are related to taste Perception. Taste buds on the mammalian tongue are confined to the epithelium of three types of gustatory papillae: the fungiform, circumvallate, and foliate. Aim to study the comparative gross morphology and histology of mammalian tongues with routine. Objectives to study the gross morphological characteristic features and histological pattern of tongue with special reference to the distribution of papillae. 10 cadaveric tongues of human, buffalo with 10 specimens and goat with 12 specimens each and tissue from anti 2/3, sulcus terminalis, lateral area, post. 1/3 pharyngeal, & at the root areas of the tongue are taken for histological studies. All the samples are fixed in Bouin's fluid. After paraffin-embedding, 5-7 micron thick are cut and mounted serially and stained with H and E stain. The following significant points are noted. In buffalo, the anterior part of the tongue is longer. Intermolar eminence is present in the tongue of buffalo and goat. The dorsum of human tongue is divided into an anterior (oral) part and a posterior (pharyngeal) part by a V-shaped sulcus terminalis. In buffalo and goat, the anterior part of the tongue is longer. Intermolar eminence is present in the tongue of buffalo and goat. The dorsum of human tongue is divided into an anterior (oral) part and a posterior (pharyngeal) part. The length of oral part is double than the pharyngeal part. The various papillae were noted in human and buffalo and goat. All of the circumvallate, foliate papillae and most of the fungiform papillae bear taste buds.

**Keywords:** Human Tongue, Papillae, Intermolar eminence, Sulcus terminalis, Bouin's fluid.

**INTRODUCTION**

The tongues of mammals share certain important characteristics, but there are also important differences. It varies in form and size and demonstrates morphological diversity that is greatly influenced by feeding habits [1]. The dorsal surface of the oral part shows four types of papilla: filiform, fungiform, circumvallate and foliate papillae. Filiform, lenticular and conical papillae possess a protective and mechanical function. The fungiform, foliate and vallate papillae are related to taste Perception. In man foliate papillae are rudimentary, but in many animals they are the site of localization of the main aggregation of taste

receptor [2, 3]. The taste buds are ellipsoid clusters of specialized epithelial cells embedded in the stratified squamous epithelium of fungiform, circumvallate and foliate papillae of tongue. Glands of the tongue can be divided into three main groups according to their structure and location [4].

**AIMS & OBJECTIVES**

**Aim:** This study is carried out with an aim to compare gross morphology and histology of mammalian tongues with routine stain.

**Objectives:** The objectives of study are to revise the gross morphological characteristic features of mammalian tongues and histological pattern of tongue with special reference to the distribution of papillae.

Corresponding Author

**Anant C. Fulse**

Email id: anantfulse@gmail.com

## **MATERIALS & METHOD**

Tongues of mammals were obtained from Nagpur Veterinary College while human cadaveric tongues were obtained from donated cadavers to Department of Anatomy, NKPSIMS, Nagpur.

All the specimens are collected within 2 to 6 hours after death of the animals. 10 cadaveric tongues of each human, buffalo and 12 specimens from goat were obtained. Tissue from ant. 2/3, sulcus terminalis, lateral area, post. 1/3 pharyngeal and at the root areas of the tongue are taken for histological studies. All the samples are fixed in Bouin's fluid. After paraffin-embedding, 5-7 micron thick sections are cut and mounted serially & stained with H & E stain.

## **OBSERVATIONS**

### **Human Tongue**

The human tongue observed macroscopically and microscopically for the morphological and histological study. The tongue shows various papillae and seromucous glands in pharyngeal and anterior region.

### **Macroscopic Observations**

The dorsum of the tongue is divided into an anterior (oral) part and a posterior (pharyngeal) part by a V-shaped sulcus terminalis behind the circumvallate papillae. The length of oral part is double than the pharyngeal part. Dorsum of the oral part is covered by different types of lingual papillae. These are filiform, fungiform, and circumvallate and foliate papillae. Filiform papillae occupy whole of the oral part. They are minute conical and they are arranged transversely. Fungiform papillae are scattered among the filiform papillae. These are more numerous around the tip and on the lateral cranial margin of the tongue. Circumvallate papillae are 8-10 in number, 4-5 on each side. They are arranged in a V-shaped pattern in front of the sulcus terminalis. Each is surrounded with a circular trench. Foliate papillae are two; each is in front of the palatoglossal fold on caudolateral part of tongue. Dorsum of the pharyngeal part show smooth nodular lingual tonsils. The ventral surface of the tongue is smooth and unapillated. Attached to it is a short fold of mucous membrane, the frenulum linguae.

### **Microscopic Observations**

In the anterior 2/3 and Post 1/3 of oral part of mucous membrane consists of epithelium (stratified squamous keratinized) and lamina propria. Lining epithelium is of stratified squamous keratinized. It shows the following layers from within outwards stratum basalis, stratum spinosum, stratum granulosum and stratum corneum. Lamina propria composed of finely interlacing dense connective tissue fibers. It is abundant and continuous with the similar tissue between the lingual muscle bundles. Numerous blood vessels and nerves are present in it. On the dorsum the lamina propria show elevated projection above the surface. It forms the core of

lingual papillae with the covering stratified squamous epithelium. These are filiform and fungiform papillae. Glands were present within the intermuscular connective tissue towards the ventral aspect present the several lobules of serous secreting acini. These are covered by connective tissue.

In the posterior 1/3 of oral part the Circumvallate papillae are large, surrounded by a circular trench. The top of it is broader and protrude beyond the lingual surface. The covering epithelium is stratified squamous non-keratinized. The bottom of trench shows opening of duct coming from deeply situated serous glands (Von-Ebner's). The Foliate papillae are the 7-10 leaf-like mucosal folds separated by grooves. In the pharyngeal part the lamina propria presents several lymphoid tissues in the sub epithelial region. Posteriorly the lymphoid nodules are numerous and larger. Area in between the lymphoid nodules is depressed one forming the crypt. At the bottom of the crypt there is an opening of the duct of mucous gland.

### **Buffalo Tongue**

Anterior oral part found to be four times longer than the posterior pharyngeal part. Filiform and fungiform papillae were observed anterior to torus linguae. (Fig. 1) Giant conical papillae on the torus linguae and simple conical papillae were on the sides of the giant conical papillae where as Circumvallate Papillae found on the posterior limit of the torus linguae, 13-20 on either sides (Fig.2). Buffalo tongue shows mucous acini in pharyngeal part (Fig. 3). Dorsum of the pharyngeal part is smooth and unapillated. Ventral surface is unapillated and shows frenulum linguae.

### **Macroscopic Observations**

The dorsum of the tongue is divisible into an anterior (oral) part and a posterior (pharyngeal) part by the presence of circumvallate papillae. Anterior part is approximately 4 times longer than the posterior part. The apex of the tongue is free and has a somewhat blunt rounded margin. The caudal part of the dorsum of the buffalo tongue presented elliptical dorsal prominence, the torus linguae, which are limited cranially by a transverse lingual depression. The dorsum of the tongue, except the root, is covered by different types of lingual papillae. They are sharp at the apex of the tongue, giving it a rasp like appearance. Filiform papillae are present anterior to the torus linguae up to the tip. Simple conical papillae are present on the sides of the giant conical papillae. Giant conical papillae are present on the torus linguae. These are flat leaf like papillae.

Fungiform papillae are scattered in the filiform papillae. The fungiform papillae are more numerous around the tip and on the lateral cranial edges of the tongue. Located on the torus linguae are large, broad and horny papillae. Some of these are large conical papillae.

Circumvallate papillae are present on the posterior limit of the torus linguae. On each latero-caudal part of the torus linguae there are 13-20 circumvallate papillae on the left side, while on the right side there are 14-22 of them, arranged in a V-shaped pattern with the apex of the V directed caudally (Fig. 1). Dorsum of the pharyngeal part is smooth and unapillated. Ventral surface is smooth and unapillated. From the ventral surface of the free part of tongue a fold of mucous membrane passed to the floor of the mouth – frenulum linguae.

### **Microscopic Observations**

#### **Part A (Anti. $\frac{2}{3}$ of oral part)**

**I) Mucous membrane:** It consists of epithelium and lamina propria.

**a) Epithelium:** It is stratified squamous heavily keratinized. It shows following layers from within outwards: i) Stratum basalis, ii) Stratum spinosum, iii) Stratum granulosum and iv) Stratum corneum.

i) Stratum basalis is composed of deeply placed single layered cells based upon the basement membrane. Each cell is of low columnar type with oval nucleus placed at the middle of the cell.

ii) Stratum spinosum is situated next to the basal cell layer and varies from 6 to 8 cell layers. These are the polygonal in shape with oval nucleus in the centre. The adjacent cells are connected to each other by a few intercellular bridges that cross the narrow intercellular spaces. The cell margins are very clear.

iii) Stratum granulosum is situated next to the stratum spinosum and varies from 4 to 5 cell layers. These are polygonal, flattened cells with oval to flattened nucleus respectively. Cytoplasm shows various granules.

iv) Stratum corneum is of many layers of flattened cells with degenerating nuclei. The more superficial cells become much more flattened and loose their nuclei so as to form a layer of thick cornification.

**b) Lamina Propria:** The lamina propria was formed of fine interlacing connective tissue fibres with fibroblasts and blood vessels. It is closely bound down to the underlying striated muscle fibres, disposed chiefly in longitudinal, transverse and vertical directions.

i) On the basis of their microscopic structure and location, four types of filiform papillae are noted in the buffalo. The type found on the lateral margin and at the tip of the tongue is highly cornified. Their epithelium tapered into curved spine-like processes, the papilla filiformis (Fig. 2A). Their connective tissue core is scarce. Large sized giant conical papillae are the second type. They are mostly confined to the caudal part of torus linguae. The prominent dermal core with secondary dermal papillae is the identifying feature. Another type is the typical blunt curved variety of filiform papillae with moderately developed secondary dermal papillae (Fig. 2B). Their connective core penetrated the general epithelial surface. These papillae are

distributed on the entire dorsal surface of the tongue. The last type is restricted to the cranial part of the torus linguae. They have a hump-like appearance with the pointed end directed caudally. They carried a moderately developed connective core and their epithelium is capped by a highly cornified layer. The connective tissue core of each of the filiform papillae is poorly innervated with a few strands of both thin and thick nerve fibres.

ii) Fungiform papillae are flat-topped mushroom-shaped structures which are sparsely scattered between the densely crowded filiform papillae. The summit is as broad as the base. The surface epithelium is of moderately cornified stratified squamous type and is indented by several secondary papillae. The papillary core is made up of coarse areolar connective tissue and contained a number of thick and thin nerve fibres. A few of the richly innervated secondary papillae are furnished with few taste buds of irregular shape. No glands are associated with these papillae (Fig. 3).

**I) Muscle mass:** It consists of skeletal muscle fibers, grouped into bundles. These are arranged in superior longitudinal, transverse, vertical and inferior longitudinal bundles. Some bundles are placed obliquely. The intermuscular tissue is continuous with the lamina propria and contains numerous blood vessels, nerve bundles and fibro fatty tissue (Fig. 4).

**II) Glands:** Simple branched tubulo-acinar serous glands (Von Ebners' glands) are present in the lamina propria of circumvallate papillae. At places, the glands extended even into the tunica muscularis. Their ducts opened into the trenches of these papillae.

**III) Nerves:** Nerve fibres are closely associated with the acini and ducts of these lingual glands.

**IV) Vessels:** Several small blood vessels are present in the lamina propria as well as in the intermuscular septa.

#### **Part B (Post $\frac{1}{3}$ of oral part)**

**I) Mucous membrane :** Same as part 'A'.

**a) Epithelium :** Same as part 'A'.

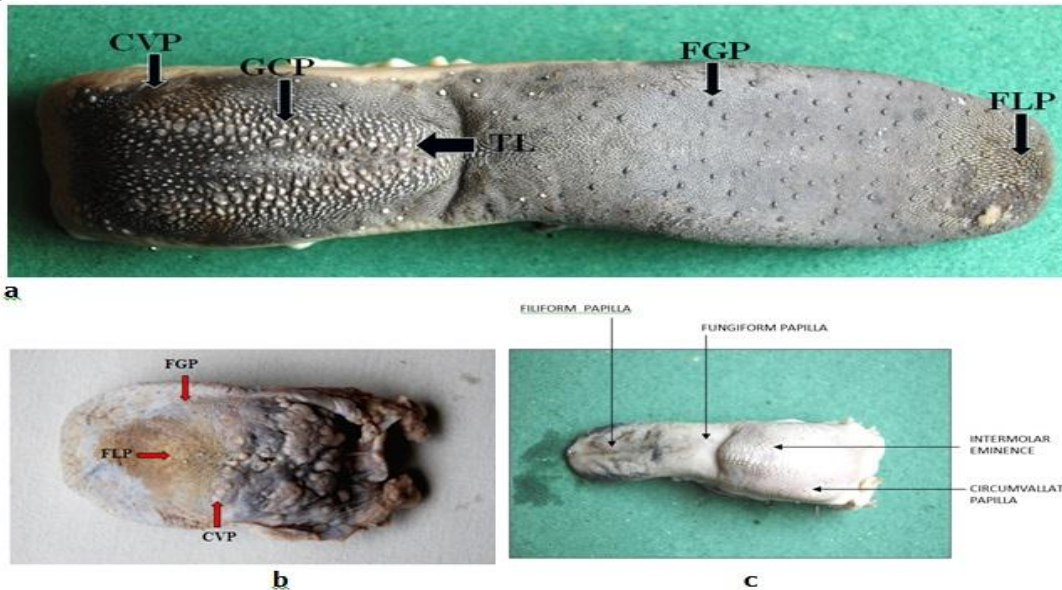
**b) Lamina propria :** Papillary projections are giant conical, simple conical and circumvallate papillae.

i) Giant conical papillae are large, broadened papillae with flattened top. The dermal core carries several low secondary papillae. The covering epithelium is highly keratinized showing processes with a short blunt conical extremity directed upwards (Fig. 5).

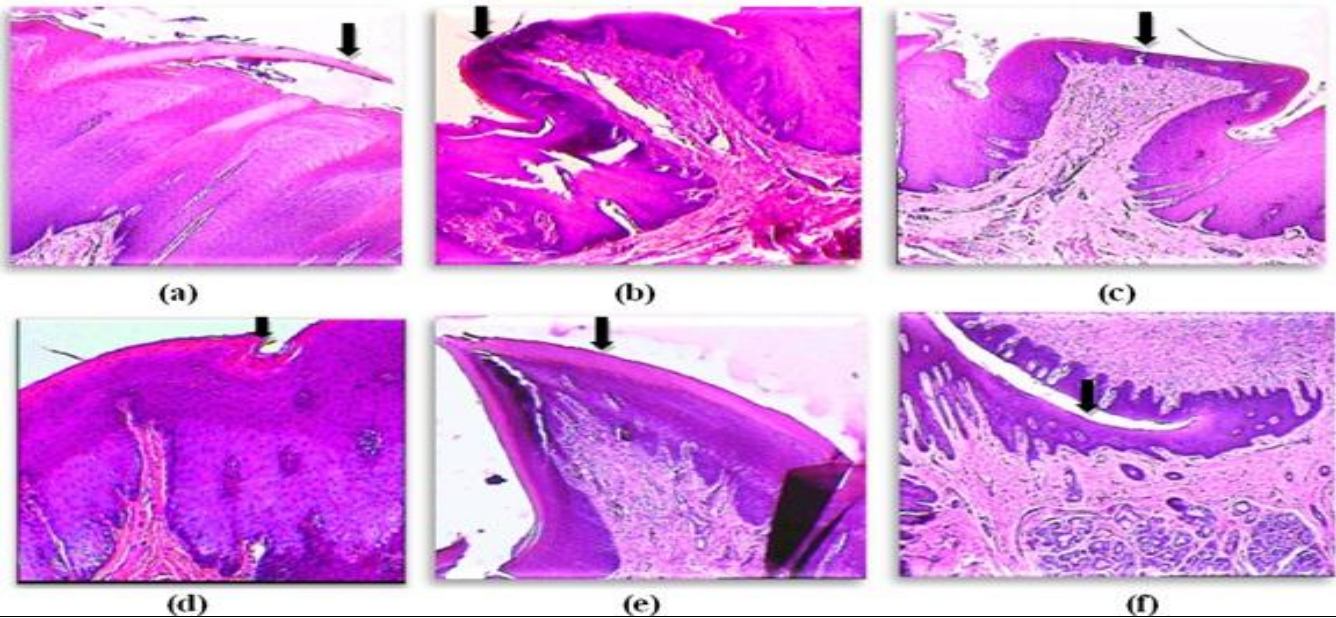
ii) Simple conical papillae are the cone shaped papillae covered with highly keratinized epithelium drawn into a tough conical process (Fig. 6).

iii) The circumvallate papillae are large flattened circumscribed structures, which are surrounded by deep circular trenches or moats (Fig. 7A). The papillae are entirely covered by a moderately cornified stratified squamous epithelium which is thicker on the surface than

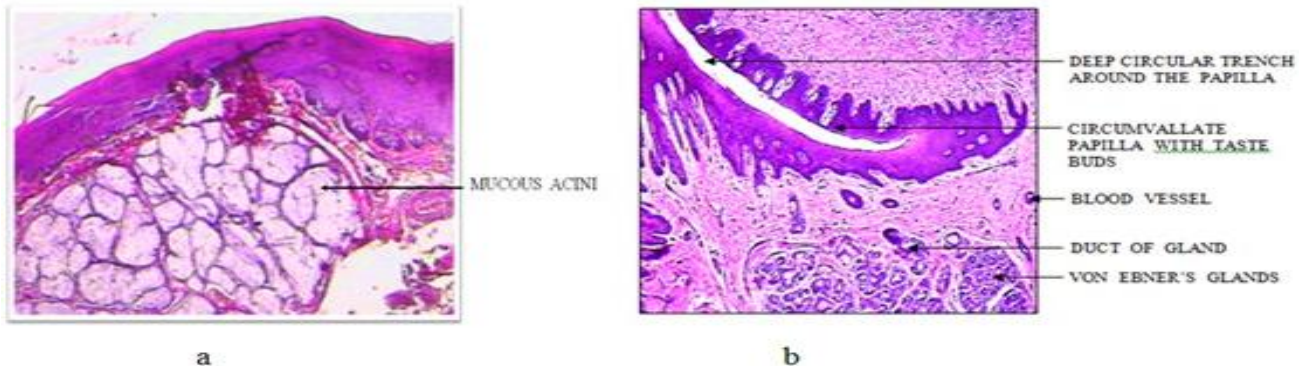
**Fig. 1. Tongue of Buffalo (a), Human (b) and Goat(c)**



**Fig. 2. Photomicrographs of buffalo tongue showing lingual papilla (H&E stain) . (a)Papilla Filiformis (b) Fungiform (c) Circumvallate Papilla (d) Simple Conical (e) Giant conical (f) Circumvallate Papilla trench**

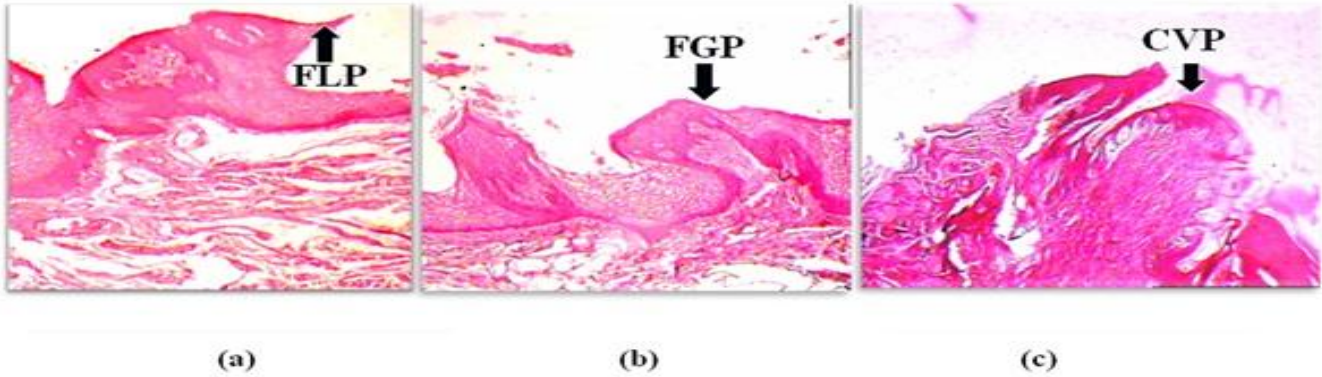


**Fig. 3. Photomicrograph of buffalo tongue showing mucous acini in pharyngeal part (a) and Von Ebner's Glands (b) X10 (H&E)**

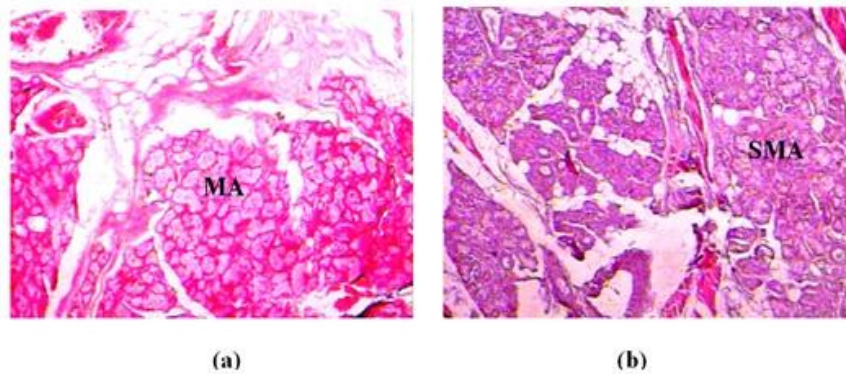




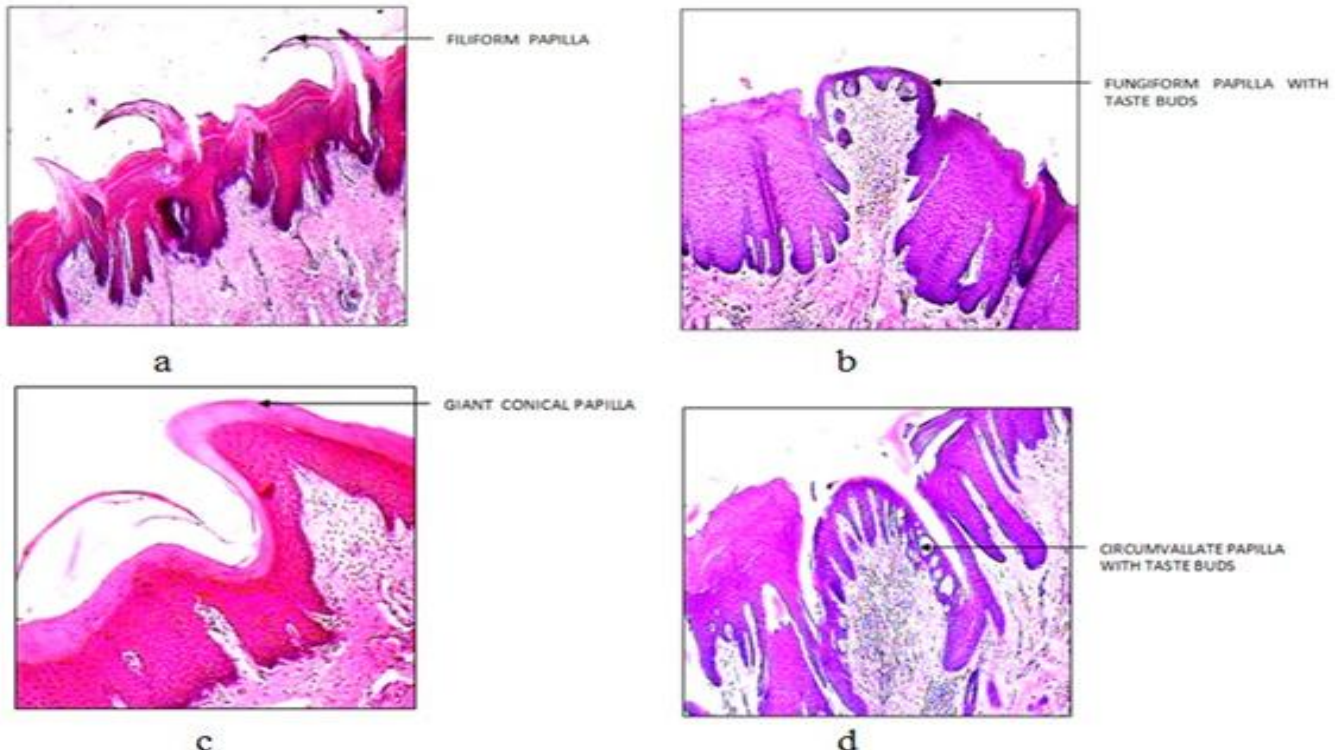
**Fig. 5. Photomicrographs Of Human Tongue Showing Lingual Papilla X10 (H &E). (a) filiform papilla(FLP) (b) Fungiform papilla(FGP) (c) Circumvallate papilla(CVP)**



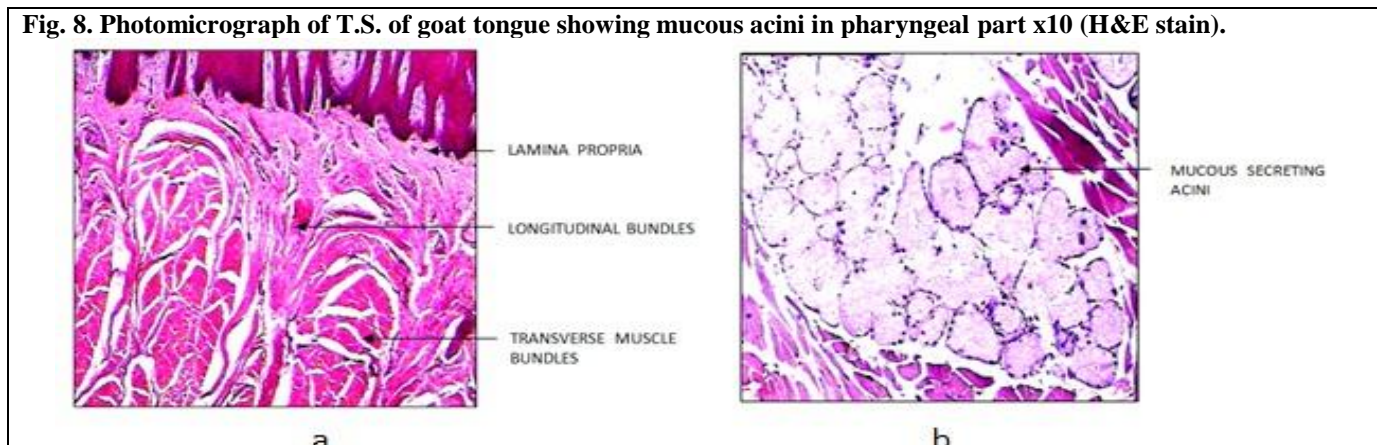
**Fig. 6. Photomicrographs of human tongue showing lingual glands x10 (H & E).(a) Mucous glands in pharyngeal part (b) Apical lingual glands (glands of nuhn)**



**Fig. 7. Photomicrograph of goat tongue showing filiform papilla ( a ), fungiform papilla ( b ), giant conical papilla ( c ), circumvallate papilla ( d ) with taste buds x10 (H&E).**



**Fig. 8. Photomicrograph of T.S. of goat tongue showing mucous acini in pharyngeal part x10 (H&E stain).**



on the sides. The upper epithelium revealed several small secondary papillae. In the epithelium of lateral wall small oval shaped taste buds are seen. These taste buds are oriented at nearly right angles to the lateral border of these papillae.

- II) **Muscle mass** : Same as part 'A' (Fig. 8)
- III) **Glands** : Same as part 'A' (Fig.7B)
- IV) **Nerves** : Same as part 'A'
- V) **Vessels**: Same as part 'A'.

**PART C (Pharyngeal part)**

- I) **Mucous membrane**: Same as part 'A'.
- a) **Epithelium**: Same as part 'A'.
- b) **Lamina propria**: Same as part 'B'.
- II) **Muscle mass**: Same as part 'A'.
- III) **Glands**: Numerous small lobules of mucous secreting acini are present in the lamina propria and intermuscular connective tissue. Serous demilunes also present. The ducts opening on the surface are also seen.
- IV) **Nerves**: Same as part 'A'.
- V) **Vessels**: Same as part 'A'.

**Goat Tongue**

**Macroscopic Observations**

The dorsum of the tongue is divisible into an anterior (oral) part and a posterior (pharyngeal) part by the presence of circumvallate papillae. Anterior part is approximately 3-4 times longer than the posterior part. Ventral surface is smooth and unapillated except near the tip and cranial margin. It shows large frenulum. Dorsum of the oral part presents posteriorly an intermolar eminence. Its whole surface carries numerous lingual papillae such as filiform, simple conical, giant conical, fungiform and circumvallate papillae. Filiform papillae are present anterior to the intermolar eminence up to the tip. Simple conical papillae are present on the sides of the giant conical papillae. Giant conical papillae are present on the intermolar eminence. These are flat leaf like papillae. Fungiform papillae are scattered in the filiform papillae. These are more aggregated near the tip and margins. Circumvallate papillae are present on the posterior limit of the intermolar eminence. There are 12-14 circumvallate

papillae on each side of the median plane. They are disposed in two oblique rows directed anterolaterally. Foliate papillae are not seen in any of the specimens. Dorsum of the pharyngeal part is smooth and unapillated.

**Microscopic Observation**

In the anterior <sup>2</sup>/<sub>3</sub> and Post <sup>1</sup>/<sub>3</sub> of oral part the mucous membrane consists of epithelium (squamous heavily keratinized). It shows following layers from within outwards stratum basalis, stratum spinosum, stratum granulolum and stratum corneum. In the anterior <sup>2</sup>/<sub>3</sub> the lamina propria composed of fine interlacing dense connective tissue fibers. It is abundant and continuous with the similar tissues between the lingual muscle bundles. Numerous blood vessels and nerve fibers are present within it. On the dorsum it shows elevated projections above the lingual surface and forms the core of various lingual papillae as filiform and fungiform papillae. Filiform papillae are the narrow, cylindrical, sharp structures, with pointed processes directed posteriorly. Fungiform papillae are larger and slightly raised, above the surface. Some of the papillae bear taste buds The glands were present in some lobules of serous and mucous secreting acini are present in the connective tissue of lamina propria and intermuscular septa.

In posterior <sup>1</sup>/<sub>3</sub> the Lamina propria : Papillary projections are giant conical, simple conical and circumvallate papillae. Giant conical papillae are large, broadened papillae with flattened top. Simple conical papillae are the cone shaped papillae covered with highly keratinized epithelium drawn into a tough conical process. Circumvallate papillae are dome shaped, and large, surrounded by a deep trench on all sides. The covering epithelium is slightly keratinized on the top but non-keratinized on the sides which bear many taste buds. At the bottom of the trench opening of the ducts from deeper glands. The numerous small lobules of the serous secreting acini (Von Ebner's glands) are present in the subvallate region while in pharyngeal the numerous small lobules of mucous secreting acini are present in the lamina propria and intermuscular connective tissue. Serous demilunes also present. The ducts opening on the surface are also seen.

## DISCUSSION

Division of the tongue into anterior and posterior parts seems to vary from one species to another. According to Labh and Mitra [5] the anterior (oral) part is longer than the posterior (pharyngeal) part in various species of mammals. In buffalo and goat is 4:1. The same is observed in this study, The larger proportion of the oral part in the animal series might be due to greater mobility required for grasping of food. [5, 6] Intermolar eminence is found on the posterior aspect of the oral part of tongue in the goat.

In human being this ratio is 2:1, which is similar with the other workers [7, 8, 9, 10]. In all the samples of human tongue, the sulcus terminalis is well defined forming a V-shaped line, arms of which are directed antero-laterally as described by Bloom and Fawcett. In buffalo, it is not found in any of the samples, which is similar to the findings of Labh and Mitra [5].

It is similar as described by many authors. Qayyum and Beg [11] in goat; Habel [12] in ruminant and Prakash [13] in buffalo described that the oral part of the dorsum is marked posteriorly by a raised intermolar eminence or torus linguae. Human do not possess intermolar eminence.

In goat, the epithelium is comprised of many layers of cells with the superficial cells are thickly keratinized as compared to human.

Intermolar eminence is found on the posterior aspect of the oral part of tongue in buffalo described that the oral part of the dorsum is marked posteriorly by a raised intermolar eminence or torus linguae [13]. Kutuzov and Sicher [14] and Labh and Mitra [5] believed that this specialized prominence probably compensates for the deficient masticatory mechanism caused by incomplete dental formula. Thus it may help to rub the food against hard palate. Human do not possess this eminence

In human samples the dorsum of the oral part is densely beset with the thread like narrow, conical filiform papillae. These findings are similar with the Gray [10].

Filiform papillae have been classified in three subtypes by differing structure and distribution on the dorsum. These are simple conical, giant conical and true filiform papillae. Labh and Mitra [5] and Qayyum and Beg [11] described them in goat.

Filiform papillae have been classified in three subtypes by differing structure and distribution on the dorsum. These are simple conical, giant conical and true filiform papillae. Prakash *et. al.* [13] described them in buffalo tongue as lenticular papillae on the torus linguae.

The fungiform papillae are scattered on the dorsum of the tongue, but are found to be aggregated at the

tip and cranial margins of buffalo tongue. Prakash *et. al.* [13] described them in buffalo tongue that they are more numerous around the tip and on the lateral cranial margin. They also scattered on the rest of the dorsum including torus linguae.

The fungiform papillae in human tongue are scattered among the filiform papillae, which are more numerous at the tip and margins [7, 8, 10]. In this study similar findings are obtained as mentioned by these workers.

The number of circumvallate papillae varies from species to species. In buffalo observed 13-22 circumvallate papillae on each side and are arranged in a v-shaped pattern on the caudo-lateral part of torus linguae with the apices of the V directed towards the root of the tongue. The numbers of circumvallate papillae in human tongue are variable. They are about 7-12; 6-12; 8-12, form a V-shaped row immediately in front of the sulcus terminalis [7, 9, 10].

In the present study the circumvallate papillae show great variations in their number and distribution. In human 8 to 10 circumvallate papillae are arranged in v-shaped pattern with the apex directed posteriorly

## CONCLUSION

From the given observation we can conclude that the anterior part of the tongue is longer than Posterior, in buffalo and goat it is found to be 4:1 and in human it is 2:1. Intermolar eminence is present in the tongue of buffalo and goat while it is absent in human.

Three sub types of filiform papillae have been noted in buffalo and goat tongue these are simple conical, giant conical and true filiform papillae. Circumvallate papillae in buffalo tongue form row on the posterolateral part of the intermolar eminence while Fungiform papillae are well developed in goat tongue.

All of the circumvallate, foliate papillae (Except human) and most of the fungiform papillae bear taste buds. Epithelium consists of four layers. The superficial most layers are heavily keratinized in goat and buffalo. It is slightly keratinized in the anterior part of human tongue.

Serous glands are present in the oral part of all studied tongue, while mucous glands are present in the pharyngeal part, while apical lingual gland is present only in human and goat tongue. Foliate papillae are rudimentary in human, absent in buffalo tongue. All of the circumvallate, foliate papillae (except human) and fungiform papillae bear taste buds. Serous glands are present in the oral part of the tongue, while mucous glands are present in the pharyngeal part. Apical lingual gland is present in human tongue.

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