

Morphological and Histological Study of Tongue in Local Buffalo (*Bubalus bubalis*)

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Abstract. In southern Iraq, the local buffalo holds significant importance as a domestic animal. This study aimed to contribute to the documentation and preservation of buffalo by examining the macroscopic and microscopic characteristics of the tongue and lingual papillae in adult buffalo aged 1-1.5 years. Six tongue specimens from each buffalo were analyzed to investigate both anatomical and histological features, including the comparison of statistical data between the tongues. The study delineated various lingual papillae on the tongue, revealing the presence of five identifiable types on the tongue surface. Among these, three were categorized as mechanical papillae (filiform, conical, and lenticular), while two were identified as gustatory papillae (vallate and fungiform). Although certain morphological features of the buffalo tongue resembled those of other ruminants, the lingual prominence in buffalo was notably higher and more developed. Notably, there were more mechanical papillae, covered by a thicker, keratinized epithelium. The research concluded that the buffalo's tongue exhibited strength, highlighting its crucial role in food prehension. The buffalo's tongue, characterized by a gray or blackish color, a rounded margin without a median groove, and a sharp, rounded anterior edge, was found to possess distinctive properties contributing to its efficient grasping of food. Overall, the study identified key attributes of the buffalo tongue, shedding light on its potency and its role in facilitating the buffalo's feeding behavior.

Keywords. Buffalo, Tongue, Lingual Papillae, Macroscopic and Microscopic.

1. Introduction

The digestive system encompasses a range of tubular organs, accessory glands, and supplementary structures, including lips, teeth, and the tongue. The tongue, characterized as a highly mobile muscular organ covered by a mucous membrane, plays a crucial role in food capture, bringing it to the mouth, and collaborating with the teeth to break it down into a cohesive food bolus ready for swallowing and taste perception. The animal's tongue exhibits distinct characteristics, featuring filiform, fungiform, conical, lenticular, and circumvallate papillae, resembling warts, on its dorsal surface [1,2]. Filiform papillae, with a conical shape and often a single papillary protrusion, vary in height and density at different levels, decreasing as the ventral surface is approached [3]. Fungiform papillae, primarily found on the lateral side, possess truncated projections, while circumvallate papillae are situated at the junction of the anterior two-thirds and posterior one-third of the tongue, surrounded by lingual

mucosa's papillary groove and annular pad [4]. In buffalo (*Bubalus bubalis*) tongues, fungiform papillae are absent from the lingual root, dorsal middle region of the apex and body, as well as the dorsal and ventral surfaces of the lingual tip [5]. The lingual tip specifically contains conical papillae, and the ventral surface is divided into papillary and non-papillary regions by a U-shaped fungiform line [6]. The morphological features of tongues and lingual papillae vary based on an animal's lifestyle, nutrition, adaptations, and taxonomic traits, forming systematic units like orders or families [7]. For herbivores, the tongue plays a major role in feeding, with modifications facilitating mechanical and taste perception [8]. The dorsal surface of the tongue is divided by the transverse lingual fossa into an apical section and a rounded torus linguae, with fine filiform papillae for mastication [8]. Histologically, each main filiform papilla is accompanied by 1-3 secondary papillae, and the taste buds are located at the free surface of fungiform and vallate papillae. The shape of taste buds varies among mammals, being ovoid in bovines. Glands such as Von Ebner's gland in cattle and lingual salivary glands in camels play specific roles in tongue structure and function [9].

2. Material and Methods

Fifteen samples of buffalo tongues were collected from the local market in Basrah. The tongues were obtained from buffalo slaughtered at the Basrah Slaughterhouse, with the age of the animals ranging from one and a half years old to five years old. The samples were taken immediately after the animals were slaughtered and their heads were separated from the carcasses at the atlanto-occipital joint. For the anatomical study, the specimens were washed with a normal saline solution and various biometric measurements were taken, including the total length of the tongue, as well as the length and widest area of the apex, body, and root.

For the histological study, the specimens were washed immediately after being taken from the animals. The fixation process was then carried out, followed by the traditional histological process to prepare the slides for staining. The specimens were placed in alcohol containers of varying concentrations to remove water, underwent a clearance process with xylene, and were embedded with paraffin wax. Finally, the slides were stained with hematoxylin and eosin.

3. Result

Tongue of buffalo was found as a muscular organ located on the floor of the mouth between the bodies of the mandible extended rostrally and fill the oral cavity. The tongue are composed of apex, body, and root sections (Fig.1). In buffalo, it has gray or blackish color, rounded margin and not median groove, with a sharp rounded anterior edge . The buffalo tongue measured (from the tip to the glossoepiglottic fold) a mean of 1.43 cm in total length and 17.24 cm at its maximum width. The lingual was formed, and lingual prominence was shown on the lingual body. Papillae were distributed not only on the dorsal surface of the tongue, but also on the anterior and ventral surfaces. Three types of mechanical papillae (filiform, conical, and lenticular) and two types of gustatory papillae (vallate and fungiform) were observed on the surface of the tongue. The apex of the tongue of buffalo was increased gradually in width, thickness and then narrowest in the beginning of the body (Fig.2), black spot or pigmentation was found on the dorsal surface in buffalo only (Fig. 2). The body of tongue in both buffalo and camel was quadrilateral, it begins narrow and gradually increased in width and thickness until reach to the beginning of root then return narrow, and presented a well-developed torus linguae and fossa linguae. The root of tongue in both species was the shorter part of the tongue lies caudally to the body and slopes ventrally and caudally toward the base of the epiglottis (Fig.3). The mucosa of the buffalo tongue has different characteristics depending on its location. The dorsal surface of the tongue is covered with a thick, rough, and keratinized stratified squamous epithelium, while the ventral and lateral surfaces have a thin, keratinized stratified squamous epithelium. The lamina propria, which is the underlying connective tissue, is dense and contains a network of blood vessels. The tongue itself is composed of skeletal muscle bundles that run in transverse, longitudinal, and oblique directions.

There are different types of lingual papillae present on the buffalo tongue. The most numerous type is the filiform papillae, which are soft, horny thread-like structures. They are distributed on the dorsal, lateral, and ventral surfaces of the tongue and extend caudally at the level of the vallate papillae.

Another type of papillae is the fungiform papillae, which are cylindrical, convex, mushroom-like structures. They are scattered among the filiform papillae and are more abundant near the tip of the tongue.

These findings are consistent with the histological characteristics of the oral mucosa and the structures of the tongue. The oral mucosa is composed of different types of stratified squamous epithelium, including keratinized and non-keratinized epithelium. The tongue's surface is covered with stratified squamous epithelium, and the filiform papillae provide roughness to facilitate food handling. The fungiform papillae contain taste buds and are dispersed among the filiform papillae.

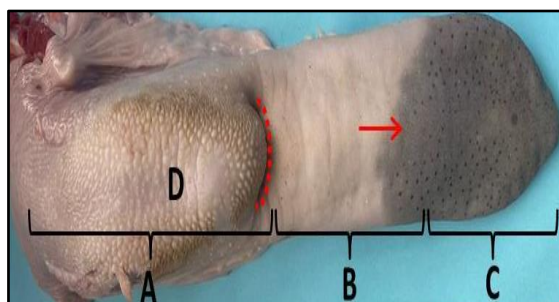


Figure 1. Photograph showing the tongue of the buffalo: lingual root (A), lingual body (B) and lingual apex (C). Lingual fossa (red line), Torus linguae (D), black zone (arrow).

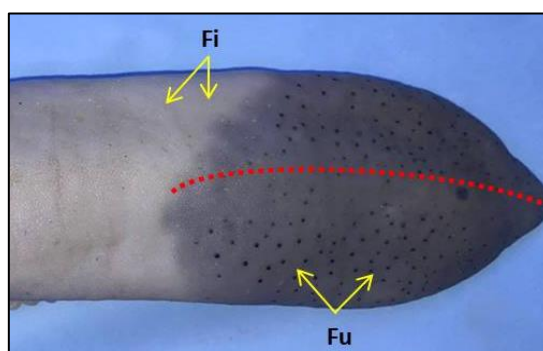


Figure 2. Photograph of the dorsal surface of the camel tongue showing: Filiform papillae (Fi), Fungiform papilla (Fu) and Median longitudinal groove (M).

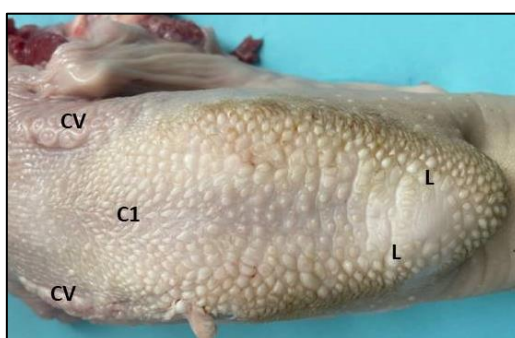


Figure 3. Photograph of the dorsal surface of the buffalo tongue showing: Conical papillae (C1), Lenticular papillae (L), circumvallate papilla (CV).

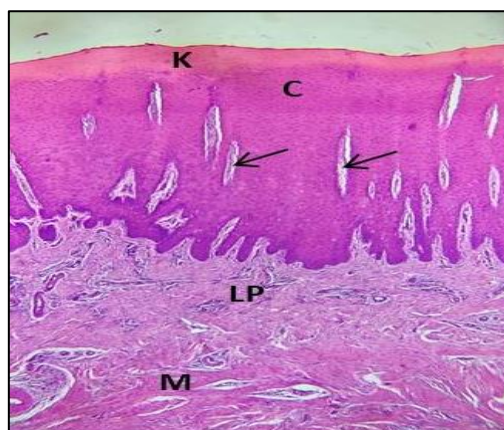


Figure 4. Photomicrograph of tongue of the buffalo, keratinized stratified squamous epithelium (K) , conical papillae (C) , skeletal muscle bundles (M) , lingual gland ducts (arrow) , lamina propria(LP) . (H&E stain X40).

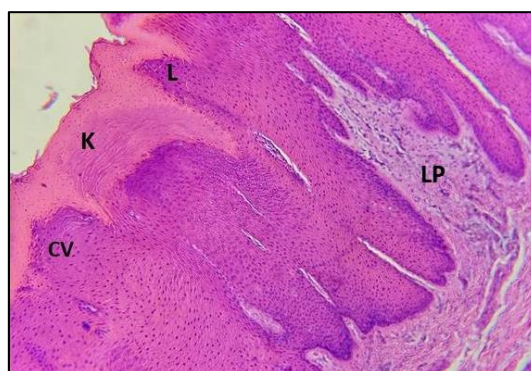


Figure 5. Photomicrograph of tongue of the buffalo, keratinized stratified squamous epithelium (K), CV- Circumvallate papilla (CV) , lenticular papilla (L) , lamina propria(LP) (H&E stain X40).

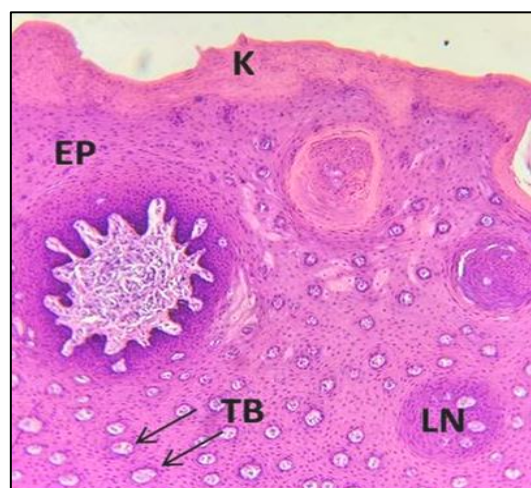


Figure 6. Photomicrograph of tongue of the buffalo, keratinized stratified squamous epithelium (K), taste buds ((arrow) TB)) , epithelium (Ep), lymph nodules (LN). (H&E stain X100).

4. Discussion

In the present study, we investigated into the general anatomy and histology of tongue in buffalo. The tongue has gray or blackish color, rounded margin and not median groove, with a sharp rounded anterior edge [10-14]. The results show that there were five types of papillae identifiable on the tongue surface: filiform, conical, lenticular, vallate, and fungiform. In domestic animals, morphological

studies on the tongue papillae have been reported for the dog [15], pig [16], goat [17], sheep [18], cow [19], horse [20], yak and cattle [21].

The current study reported that in the buffalo, the filiform papillae, which were the most numerous type of lingual papillae, were soft, horny thread-like structures that were distributed on the dorsal, lateral, and ventral surfaces as well as extended caudally at the level of the vallate papillae. It was in agreement with [22].

In the pig, the filiform papillae very little in size on different areas of the tongue whereas filiform papillae on the rat tongue do show a variation in size in that there are small papillae on the anterior and posterior portions of the tongue and larger papillae in the mid-portion [23,24]. On the cat tongue the number of large filiform papillae is much greater than that on the tongue of the rat [24], whereas the dorsal surface of the cow tongue displays multiple posteriorly curved filiform papillae [25] According to the last-named authors observations.

The current study found that the number of papillae gradually decreased from the lingual body to the apex, and each fungiform was enclosed by a deep and evident groove, and some taste buds were distributed in the epithelium. Taste pores have been observed on the surface of the fungiform papillae of the buffalo in conformity with the findings of other investigators [26-29], confirming a gustatory function.

The present study reported that the conical papillae in the tongue of buffalo were elongated, conical in shape, have a round base and a pointy edge, and were observed rostral to the torus lingua and continuous caudally on the dorsolateral to the torus lingua, as well as on both ends of the tongue root. In most ruminants [30-35], the conical papillae were located on the torus linguae.

The completely absence of the conical papillae from the tongue was observed in Bactrian camel [36]. The presence of the conical papillae was related to the mechanical effect during the mastication of the grasses in all ruminants, but these conical papillae were absent in the non-ruminants herbivores as in the donkey [16].

The current research found that lenticular papillae in both species were convex lenses in shape, located as a zone of papillae on the middle part of the torus lingua. Both the buffalo and the camel have round to oval-shaped vallate papillae with little elevation from the lingual surface. They were arranged in two rows, one on each side of the tongue, on the dorso-lateral surface of the caudal portion of the torus lingua this result in agree with [37].

The vallate papillae are covered by cornified layer and containing taste buds on lateral wall similar to that in [38] in sheep and goat. which were in agreement [39].

References

- [1] Dellmann H D and Brown E S (1987). Textbook of Veterinary Histology. 3rd ed. Lea and Febiger, Philadelphia.
- [2] Samuelson (2007).Text book of Veterinary Histology. University of Florida.
- [3] BEIDLER, L. M. Innervation of rat fungiform papilla. In; Olfaction and Taste. In: Proc. Int. Symp., 3rd. 1968. p. 352-369.
- [4] ARVIDSON K.I. : Human taste: response and taste bud number in fungiform papillae. Science, 1980, 203, 807-808. <http://dx.doi.org/10.1126/science.7403846>
- [5] Gebreyohanes M.G. and Assen A.M. (2017). Adaptation mechanisms of camels (*Camelus dromedarius*) for desert environment: a review. J. Vet. Sci. Technol., 8(6): 1000486. <http://dx.doi.org/10.4172/2157-7579.1000486>
- [6] El Sharaby A.A., Alsafy M.A., El-Gendy S.A. and Wakisaka S. (2012). Morphological Characteristics of the Vallate Papillae of the One-Humped Camel (*Camelus dromedarius*). Anat. Histol. Embryol., 41: 402-409. <http://dx.doi.org/10.1111/j.1439-0264.2012.01149.x>
- [7] Wannprasert T. Morphological characteristics of the tongue and lingual papillae of the large bamboo rat (*Rhizomys sumatrensis*). Anat Sci Int. 2018 Jun;93(3):323-331. <http://dx.doi.org/10.1007/s12565-017-0414-x>.
- [8] Getty R (1975). The Anatomy of Domestic Animals. 5th ed. W.B. Saunders Company. Philadelphia. London. UK.
- [9] MILLER I.J. : Variation in human fungiform taste bud densities among regions and subjects. Anat. Rec., 1986, 216, 474-482. <http://dx.doi.org/10.1002/ar.1092160404>

- [10] Emura, S., D. Hayakawa, H. Chen, and S. Shoumura, 2003: Scanning electron microscopic and gross study on the lingual surface of the lion, *Panthera leo*. *Mamm. Sci.* 43, 45–50.
- [11] Emura, S., D. Hayakawa, H. Chen, and S. Shoumura, 2004: Morphology of the lingual papillae in the tiger. *Okajimas Folia Anat. Jpn.* 81, 39–44. <http://dx.doi.org/10.2535/ofaj.81.39>
- [12] Kumar, S., and L. A. Bate, 2004: Scanning electron microscopy study of the tongue papillae in the pig (*Sus scrofa*). *Microsc. Res. Tech.* 63, 253–258. <http://dx.doi.org/10.1002/jemt.20036>
- [13] Shao, B., R. Long, Y. Ding, J. Wang, L. Ding, and H. Wang, 2010: Morphological adaptations of yak (*Bos grunniens*). <http://dx.doi.org/10.2527/jas.2009-2398>
- [14] Ojima K (2001). Functional role and angioarchitectural arrangement of the filiform and fungiform papillae on the medial-dorsal surface of the beagle dog tongue. *Ann Anat*, 183(4): 325–329. [http://dx.doi.org/10.1016/s0940-9602\(01\)80172-2](http://dx.doi.org/10.1016/s0940-9602(01)80172-2)
- [15] Kumar P, Kumar S, Singh Y (1998). Tongue papillae in goat: a scanning electron-microscopic study. *Anat Histol Embryol*, 27(6): 355–357. <http://dx.doi.org/10.1111/j.1439-0264.1998.tb00207.x>
- [16] Emura S, Tamada A, Hayakawa D, Chen H, Shoumura S (2000a). Morphology of the dorsal lingual papillae in the barbary sheep. http://dx.doi.org/10.2535/ofaj1936.77.2-3_39
- [17] Steflik D E, Singh B B, Mckinney R V Jr, Boshell J L (1983). Correlated TEM, SEM, and histological observations of filiform papillae of the cow tongue. *Acta Anat (Basel)*, 117(1): 21–30. <http://dx.doi.org/10.1159/000145767>
- [18] Pfeiffer C J, Levin M, Lopes M A (2000). Ultrastructure of the horse tongue: further observations on the lingual integumentary architecture. *Anat Histol Embryol*, 29(1): 37–43. <http://dx.doi.org/10.1046/j.1439-0264.2000.00232.x>
- [19] Shao B, Long R, Ding Y, Wang J, Ding L, Wang H (2010). Morphological adaptations of yak (*Bos grunniens*) tongue to the foraging environment of the Qinghai-Tibetan Plateau. *J Anim Sci*, 88 (8): 2594–2603. <http://dx.doi.org/10.2527/jas.2009-2398>
- [20] Smuts MS and AJ Bezuidenhout, 1987. *Anatomy of the Dromedary* Clarendon Press. Oxford.
- [21] Kumar S, Bate L A (2004). Scanning electron microscopy of the tongue papillae in the pig (*Sus scrofa*). *Microsc Res Tech*, 63(5): 253–258. <http://dx.doi.org/10.1002/jemt.20036>
- [22] Steflik, D. E., B. B. Singh, R. V. Mckinney, and J. L. Boshell. 1983. Correlated TEM, SEM and histological observations of filiform papillae of the cow tongue. *Acta Anat. (Basel)* 117:21–30. <http://dx.doi.org/10.1159/000145767>
- [23] Abumandour, M. M. A., and R. M. A. El-Bakary, 2013a: Anatomical reference for morphological and scanning electron microscopic studies of the New Zealand white rabbits tongue (*Oryctolagus cuniculus*) and their lingual adaptation for feeding habits. *J. Morphol. Sci.* 30, 1–12. <http://dx.doi.org/10.1007/s11259-013-9567-9>
- [24] Barone, R. 1976. *Anatomie comparée des mammifères domestiques*. Tome troisième, Splanchnologie, Laboratoire d'Anatomie. Ecole National Vétérinaire, Lyon, France.
- [25] QAYYUM, M. A., VIDYASAGAR, P. S. P. V. & KHAN, A. H. (1975). Anatomical and neurohistological studies on the tongue of the Indian hedgehog, *Hemiechinus auratus*. *Indian Journal of Zoology* 3, 17-24.
- [26] AYYUM, M. A. & BEG, M. A. (1975). Anatomical and neurohistological observations on the tongue of goat, *Capra aegagrus*. *Acta anatomica* 93, 554-567. <http://dx.doi.org/10.1159/000144533>
- [27] ARVIDSON, K. (1976). Scanning electron microscopy of fungiform papillae on the tongue of man and monkey. *Acta otolaryngologica* 81, 496-502. <http://dx.doi.org/10.3109/00016487609119990>
- [28] ARVIDSON, K. & FRIBERG, U. (1980). Human taste response and taste bud number in fungiform papillae. *Science* 209, 807-808. <http://dx.doi.org/10.1126/science.7403846>
- [29] ARVIDSON, K., CORRILLER, F. M. & FRIBERG, U. (1981). Taste buds of the fungiform papillae in *Cynomolgus* monkey. *Journal of Anatomy* 133, 271-280.
- [30] GRAZIADEI, P. P. C. (1969). The ultrastructure of vertebrate taste buds. In *Olfaction and Taste* (ed. C. Pfaffman), pp. 315-330. New York: Rockefeller University Press.
- [31] SHIMAMURA, A. & TOKUNAGA, J. (1972). Scanning electron microscopic observations on the taste pores and taste hairs in rabbit gustatory papillae. *Archives of Histology of Japan* 34, 51. <http://dx.doi.org/10.1679/aohc1950.34.51>
- [32] ARVIDSON, K. (1976). Scanning electron microscopy of fungiform papillae on the tongue of man and monkey. *Acta otolaryngologica* 81, 496-502. <http://dx.doi.org/10.3109/00016487609119990>
- [33] CHAMORRO, C. A., DE PAZ, P., SANDOVAL, J. & FERNANDEZ, J. G. (1986). Comparative scanning electron microscopic study of the lingual papillae in two species of domestic mammals (*Equus caballus* and *Bos taurus*). I. Gustatory papillae. *Acta anatomica* 124, 83-87. <http://dx.doi.org/10.1159/000146141>

- [34] Erdogan S and W Perez, 2014. Anatomical and scanni electron microscopic studies of the tongue and lingual papillae in the chital dee. *Acta Zoologica (Stockholm)*, 95: 484–492. <http://dx.doi.org/10.1111/azo.12044>
- [35] Kumar P, Kumar S, Singh Y (1998). Tongue papillae in goat: a scanning electron-microscopic study. *Anat Histol Embryol*, 27(6): 355–357. <http://dx.doi.org/10.1111/j.1439-0264.1998.tb00207.x>
- [36] Adnyane I K, Zuki A B, Noordin M M, Agungpriyono S (2011). Morphological study of the lingual papillae in the barking deer, *Muntiacus muntjak*. *Anat Histol Embryol*, 40(1): 73–77. <http://dx.doi.org/10.1111/j.1439-0264.2010.01041.x>
- [37] Atoji Y, Yamamoto Y, Suzuki Y (1998). Morphology of the tongue of a male Formosan serow (*Capricornis crispus swinhoei*). *Anat Histol Embryol*, 27(1): 17–19. <http://dx.doi.org/10.1111/j.1439-0264.1998.tb00150.x>
- [38] Paz, C. P., C. A. Chamorro, J. Sandoval, and M. Fernandez. 1988. Comparative scanning electron microscopic study of the lingual papillae in two species of domestic mammals (*Equus caballus* and *Bos taurus*). II. Mechanical papillae. *Acta Anat.(Basel)* 132:120–123. <http://dx.doi.org/10.1159/000146562>
- [39] Eerdunchaolu, Takehana K, Yamamoto E, Kobayashi A, Cao G, Baiyin, Ueda H, Tangkawattana P (2001). Characteristics of dorsal lingual papillae of the Bactrian camel (*Camelus bactrianus*). *Anat Histol Embryol*, 30(3): 147–151. <http://dx.doi.org/10.1111/j.1439-0264.2001.t01-1-0317.x>