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Histological and Histochemical Study of Some Lingual Papillae in Male Indigenous Camel *Camelus dromedaries*

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ABSTRACT

Background: The goals of this study are to illustrate the properties of lingual papillae of camel. Twenty two tongue specimens for light and scanning electron microscopes. Results were demonstrated that the tongue was 62.31 ± 0.23 cm in length and was gray in color, with a sharp rounded cranial edge and tip flattened like a spatula and had a median groove, tongue was composed of apex, body, and root. Filiform, fungiform, conical, lenticular, and vallate papillae were lingual papillae. Filiform papillae were soft horny threadlike that were many, long, and thin; distributed on dorsal, lateral, and ventral sides of tongue and lined with keratinization stratified squamous epithelium, The fungiform papillae were spherical, convex, mushroom-like dispersed over the dorsal and ventral margins of tongue and were bordered by keratinized epithelium. Conical papillae with a circular base and a blunt tip were toward torus linguae lined with keratinized stratified epithelium. The lenticular papilla was convex lenses in the middle of torus linguae that varied in size and were covered by a keratin layer, Vallate papillae round on lateral side of torus linguae, four in each side, had a V shape, irregular surfaces, covered by a cornified surface. The PAS were positive for Weber's gland, while negative for Von Ebner's gland. In conclusion: The morphology of the tongue, as well as the quantity, distribution, and properties of papillae, were found to be connected to diet and feeding patterns, the histological structures of the lingual papillae were similar to those of other ruminants.

Keywords: Morphological, Histological, Lingual Papillae, Camels.

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INTRODUCTION

The Arabian camel or one-humped camel (*Camelus dromedarius*) is an important source of meat, wool, skins, milk, and transportation. It plays economic, social, and ecological roles in many parts of the world, particularly in developing countries in Africa and Asia. Camelids are well adapted to desert life due to their unique metabolic pathways, more efficient fermentation in the stomach, and high intestinal absorption, which allow the animals to survive for a few days without food or water, and are live in a wide range of climates, therefore their diets, food supplies, and behavior choices for plant growth patterns varies greatly in chemical composition, fiber type, and content, do not use their tongue to manipulate or grab food (1-2), Camel has evolved a number of morphological modifications to survive in harsh environments. One of these modifications is that a dromedary camel has a very robust mouth that allows it to chew efficiently on thorny and rough-

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stem vegetation that grow naturally in desert locations (3-5). Furthermore, various studies on camel mouths have detailed the physical aspects of camel tongue (6).

On the dorsal surface, the tongue of a camel is distinguished by the existence of filiform, fungiform, lenticular, conical and vallate papillae, as well as the absence of foliate papillae (7,8). The tongue of mammals is a mobile muscular organ that contributes considerably to food appreciation, its form and size vary greatly depending on feeding habits and is coated by mucous membrane with several types of salivary glands and nerves buried beneath the muscle tissues (9-14). (15) said the tongue is a highly mobile muscular organ in the digestive system that is responsible for prehension, mastication, and deglutination. It aids with food swallowing and rumination, as well as manipulation of food in the mouth. Because of the presence of attachments and linkages with other tissues such as the oral cavity, soft palate, epiglottic cartilage, and pharynx, the morphological research of the confined and moving structures of the tongue muscle in animals is particularly essential (16). The lingual mucosa was flung into projections termed lingual papillae on surfaces of the tongue. Although various studies have shown the architecture of camel lingual papillae (17), particular histological structures are thought to be significantly less described. As a result, the current study was carried out to give histological data on papillae of the camel tongue.

METHODS

This study was performed using Twenty animal of the healthy *male adult camel Camelus dromedaries,* immediately after slaughtering (15-20) minutes, their weight 350-500 kg and 3.5-5 years old) collected the specimens from AL-Muthanna abattoir during December 2023. These camels were slaughter with no diseases in their mouth cavities. Tongues were quickly removed and repaired for future evaluations. After that, the camel was positioned dorsally, and a caudolateral skin incision was made in the intermandibular fossa, ventral to the base of the throat. The organs were evaluated both in situ and outside the body. Each section of the tongue; the total length was measured from the cranial pole (tip) to the the caudal pole (root) along the longitudinal axis, while the tongue width was measured at the apex or tip, mid-length (body), and root for light microscope; specimens were collected from a variety of the lingual parts, which were subsequently stored in formalin then examined with histological techniques, the stains that used; hematoxylin and Eosin (H&E); For the histological components, the Masson's trichrome; demonstrate collagen and smooth muscles, Periodic acid Schiff (PAS); for mucopolysaccharides, Alcian blue ph 2.5 to acid mucopolysaccharides, and companied Alcian blue plus Periodic acid Schiff to the neutral mucin, for Scanning electron microscopy; Tongue specimens were preserved in 2.5% glutaraldehyde mixture for 48 hours immediately after slaughter. After that, two washes with 0.1 M phosphate buffer mixture were performed. After 1 hour in a 1% osmium tetroxide solution, the tissues were treated with acetone series and dehydrated using critical point drying (CPD). The specimens were Gold-Palladium plated and examined under a scanning electron microscope with various magnifications (18). Thickness of tunicae (mucosa, submucosa, muscularis) and The longest filiform papillae were measured from the base to the pointed apex of the papilla, and the largest diameters of fungiform papillae were measured on the lateral, dorsal and ventral surfaces of the tongues. Mean (x-) ± standard error (S E) calculated to each the measurements, ten slides from each part (root, body and apex) of the tongue (19) .

RESULTS

The camel tongue was lengthened muscular, a spatula shaped, smooth and extremely malleable, the cranial portion of the tongue was flat, and oval at its lowest point, the tongue rests on the floor of the mouth cavity, among both horizontal rami of mandible, and was pale pink-greyit was divided into three distinct components: apex (cranial portion was free, flattened out wide and rounded), body (in the middle of part), and root (caudal part) (Fig.1). Mean total length of tongue was 62.31 ± 0.23 cm, thickness of tongue at torus linguae was 9.25 ±0.09 cm, at lingual fossa 5.61 ± 0.82 cm and at tip 2.35 ± 0.03 cm. The width of tongue at root was 10.15 ±0.07 cm, at lingual fossa 5.11 ± 0.31 cm and 6.76 ± 0.14 cm at the tip, five forms of papillae have been found. Filiform, conical, and lenticular papillae were classified as mechanical papillae, whereas fungiform and circumvallate papillae were classified as gustatory papillae (Fig. 1,2,3). Many structures held the tongue in place. The frenulum linguae, a mucosal median fold, connected the ventral surface of the free portion of the tongue to the floor of the mouth, the lingo-mandibular folds to the mandible, the glosso-palatine folds to the soft palate, the glosso-piglottic folds to the epiglotic cartilage, and the glosso-pharyngeal folds to the pharynx wall. Furthermore, the tongue muscles responsible for movement were styloglossus, hyoglossus, and geniglossus. The dorsal surface of the tongue had a median groove. The caudo-dorsal section was convex, forming an oval dorsal prominence (torus linguae) and was rostrally bordered by the fossa linguae. The lyssa was a median fibrous ridge-like feature found on the rostral portion of its ventral surface (Fig. 1).

Histological examination revealed three layers of the tongue: tunica mucosa, tunica submucosa, and tunica muscularis (Fig. 4). The tongue was a striated muscular organ that is covered by a mucous membrane that is covered by a large number of papillae. The papillae are conic structures that cover the surface of the tongue and are partially keratinized (Fig. 5,6,7). Filiform papillae were leaf-like shape with a sharp tip pointed backward and were among the most numerous papillae, scattered on the anterior half of the tongue's surface, elongated projections of connective tissue covered with extensively keratinized stratified squamous epithelium, giving them a gray or whitish appearance and lacking taste buds. These papillae perform a mechanical purpose by creating a rough surface that helps food movement during chewing. They are scattered across the entire front dorsal surface of the tongue, with the tips pointing backward, and have varying heights and thicknesses. These were abundant on dorsal surface, from the beginning of the fossa linguae all the way to the tip, and moderately occupied on the ventral side, there were no filiform papillae observed on torus linguae or root (Fig.8). The height of these papillae on the tongue's tip was low, while rose towards the tongue's body. The filiform papillae become more inclined towards the fossa linguae (Fig. 9).

Only the torus linguae had two forms of conical papilla, large and small. The bigger papillae were mostly found on the caudal margin of the torus linguae and were oriented caudally, with a flat and pointed free end. The tiny papillae were positioned forward to the circumvallate papilla on the lateral borders of the torus and oriented cranially. Conical papillae had pointed free ends. A few keratin conical papillae were additionally found on the tip's ventral side (Fig. 6). The mechanical papillae were dominated by lenticular papillae, which were restricted to torus linguae. The larger papillae were positioned in the center of the front two-third of the torus in two parallel rows, whereas the smaller papillae were dispersed laterally in the back third of the torus. Their free surfaces had either spherical or flattened (Fig. 7). Small, spherical, and club-

shaped fungiform papillae The round fungiform papillae were dome-shaped prominent positions on the lingual mucosa with cylindrical bodies with round bases and convex upper the surfaces, resembling mushrooms with a narrow stalk and smooth surface, dilated at the top and less numerous, lightly keratinized nevertheless larger, broader, and taller compared with the filiform papilla and more commonly found in the anterior part of the tongue. These papillae have dispersed taste buds on their upper surface and are found among the filiform papillae (Fig. 6,8).

Table (1): Measurement of thickness of the wall layers and dimensions of papillae in tongue of camel µm (X^{-} ± S.E).

Tunica / Part	Mucosa	Submucosa	Muscularis Externa	Length of filiform	Diameter of fungiform		
					Dorsally	Ventrally	Laterally
Root	253.6±1.4	102.6±2.7	324.5±3.1	76.3±1.2	-	-	-
Body	296.1±6.2	115.2±3.8	310.7±4.2	105.4±3.8	82.5±0.1	91.7±1.2	102.1±2.3
Apex	261.6±2.5	92.4±2.1	228.5±2.1	82.3±2.3	67.8±0.4	71.4±0.2	73.4±0.6

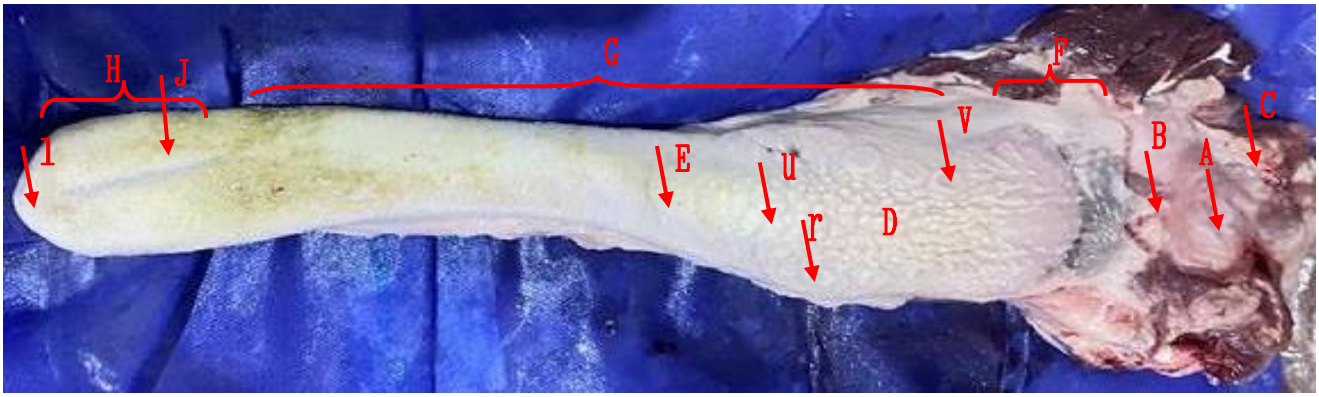

Fig.(1): **Gross section of camel tongue**; **showing: A. Aditus laryngis, E - Epiglottis, G.Glossoepiglottic fold, T- *Torus linguae*, C - *Fossa linguae*, , T - Tip of tongue, , M Median longitudinal groove, R- Root. filiform papillae, Fu - Fungiform papilla, Cp - Conical papilla, L - Lyssa, T - Tip of tongue.**

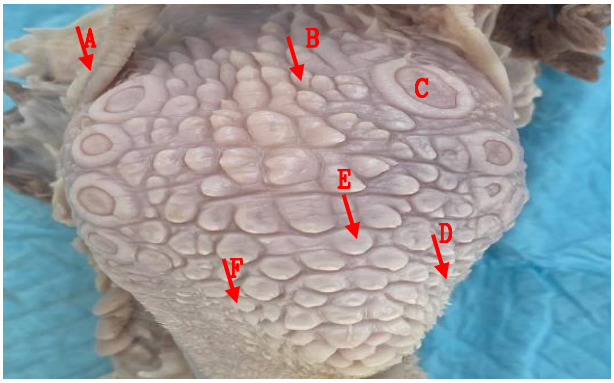

Fig.(2): **Gross section of camel tongue; fold (A), conical (B), vallate (C), filiform (D), fungiform (E), lenticular (F).**

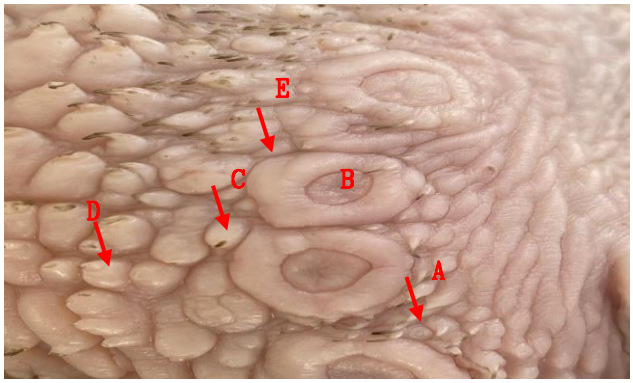

Fig.(3): **Gross section of camel's lingual papillae; filiform (A), vallate (B), conical (C), fungiform (D), lenticular (E), .**

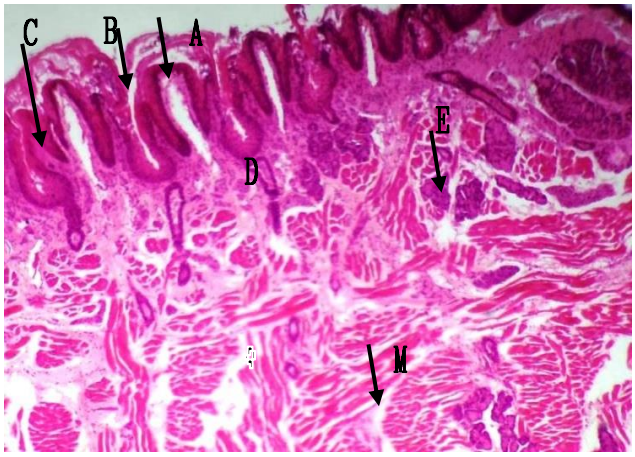

Fig.(4): **Cross section of tongue apex; fungiform papilla (A), groove (B), filiform papilla (C), submucosa (D), gland (E), muscles (M), H@E 200X.**

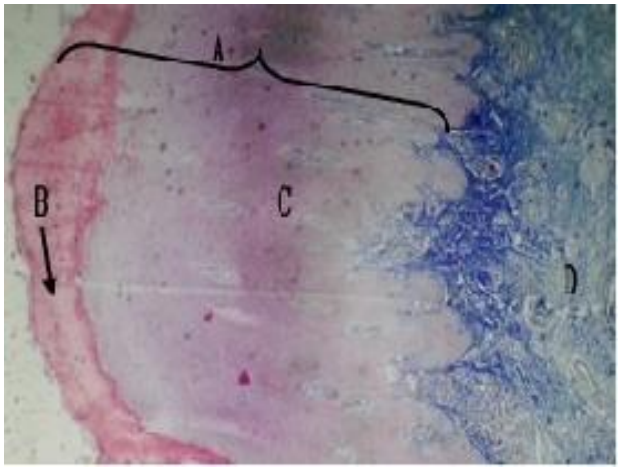

Fig.(5): **longitudinal section of tongue body; mucosa (A), keratinized epithelium (B), second layer of epithelium (C), collagen fibers (D), Masson 200X.**

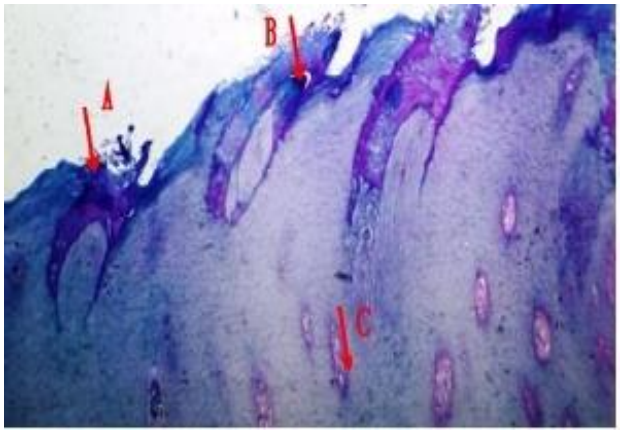

Fig.(6): **longitudinal section of tongue root; fungiform papilla (A), filiform papilla (B), layer of mucosa (C), PAS 200X.**

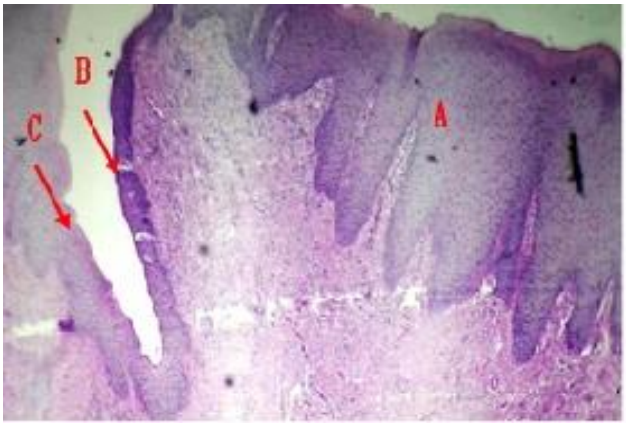

Fig.(7): **Cross section of vallate papillae (A), taste bud (B), non keratinized stratified squamous epithelium (C), Masson 200X.**

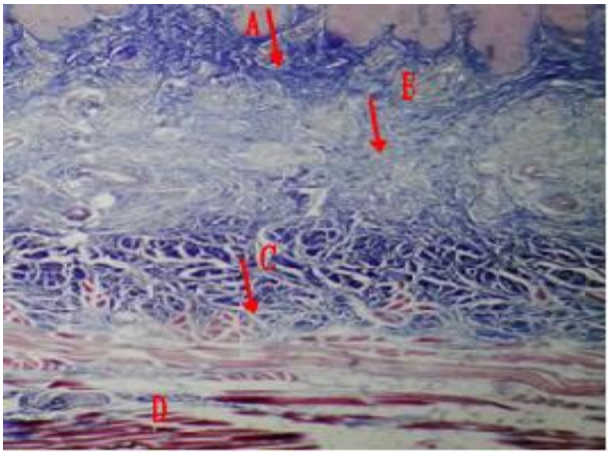

Fig.(8): **Cross section of tongue; epithelium (A), submucosa(B), gland(C),**

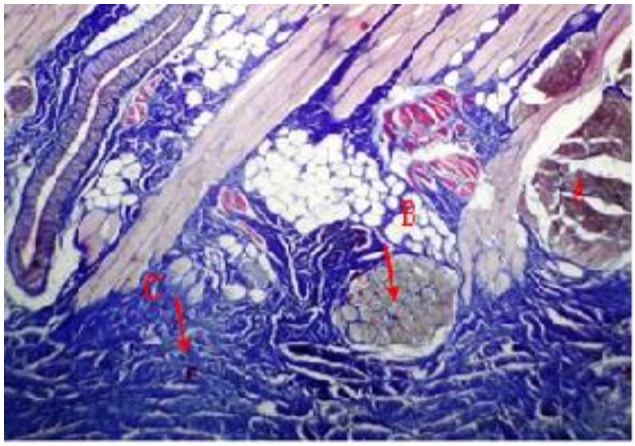

Fig.(9): **Cross section of tongue; muscle (A), gland (B), fiber (C), PAS-AB 200X.**

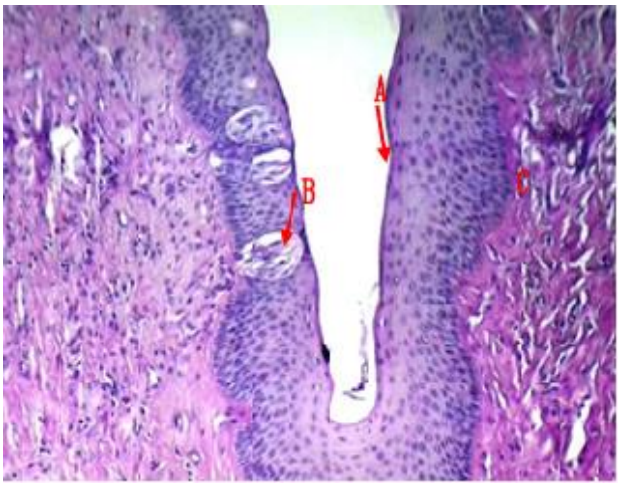

Fig.(10): **longitudinal section of vallate papillae; epithelium (A), Taste bud (B), collagen fibers (C), AB 200X.**

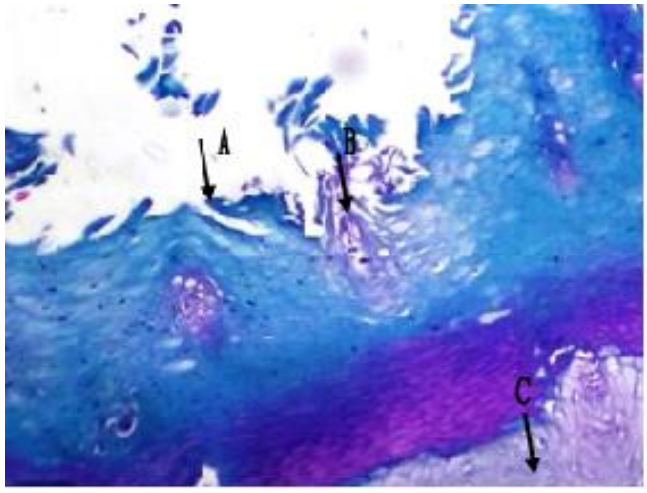

Fig.(11): **Cross section of tongue root; filiform papillae (A), fungiform (B), collagen fibers (C), Masson 200X.**

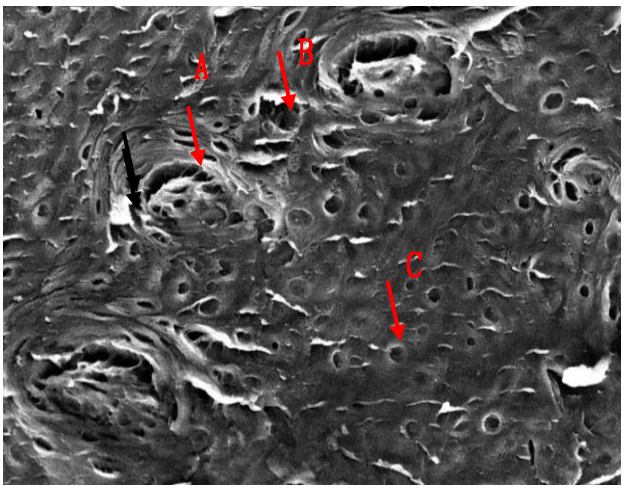

Fig.(12): **Scanning electron micrograph of the lingual papillae; fungiform (A), vallate (B), lenticular (C), (×35).**

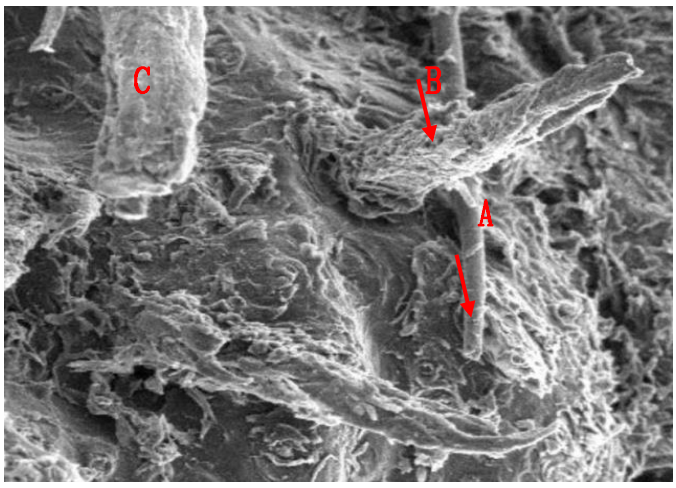

Fig.(13): **Scanning electron micrograph of papillae; primary filiform (A), secondary filiform (B), fungiform (C), (×45).**

DISCUSSION

The camel tongue, like the tongues found in other mammals, is spatula-shaped, elongated, soft, and highly active and muscular organ, with an apex, body, and root. Similar findings were observed in bactrian camels by (7), cows by (20), and sheep by (21), The tongue is an essential part for the animal since it aids in tasting, gripping, chewing, deceiving, and food ingestion. In camels, apex was free, flattened, wide, and rounded, as previously described (22). It had dorsal and ventral surfaces, as well as a median groove on the dorsal surface. (23,24) discovered similar results in goat. Although (7) observed wrinkled appearance of tongue apex on dorsal surface, no similar observations were documented in the current investigation. The presence of papillated features on the ventral border of the apex was consistent with the findings of (25) in camel, as the presence of a median fibrous ridge-like structure called a "lyssa" on the rostral third of the tongue's ventral surface, 2 - 3 cm distant from the tip, and extending caudally to the level of the frenum linguae, was consistent with observations in camel (26).

A median fold of the mucosa frenulum linguae, connected the ventral part of the free section of the tongue to the bottom of the oral cavity. It matched the findings of (27) in ruminant and (28,29) in rams. Styloglossus muscle shortens and drags the tongue caudodorsally, hyoglossus muscle pulls the tongue caudoventrally, and genioglossus muscle pushes the tongue inward and ventrally. These skeletal muscles allow the camel's tongue to move forward, backward, left, and right (30). The tongue's body was larger; thicker caudally than tip, but narrower rostrally. These findings contradicted the findings of (31), who reported a thin and long body of tongue in goat. It had four surfaces: dorsal, two lateral, and one ventral. The rostral section of the tongue's dorsal surface was flat, while the caudal part was convex and created an oval dorsal protrusion - torus linguae. These findings were consistent with previous findings in bos (32), and lambs (33). The torus linguae was discovered to be bounded rostrally by a fossa linguae, which constrained the torus between the 2nd and 3rd cheek molars in the center of the tongue. (28) observed similar phenomena in rams tongue. (34) discovered no fossa linguae in camel language. According to (35), the fossa linguae in sheep was crescent in shape. in the most part, the sides were almost flat, but rostrally they became rounder and thinner. The rostral portion of the ventral side of the tongue was free, while the caudal part was attached to mylohyoid muscle, as observed in cattle (36).

The tongue's root slightly narrower than the body and slanted caudo-ventrally. The camel's tongue was bright pink on the dorsal surface and brownish pink on the ventral area. On the ventral side of tip and body, black pigmented spots or dots were infrequently seen, this similar into (37) in camel. (9) found pigmented patches on the dorsum of the mucous membrane of the ox tongue. Filiform papillae are the most abundant papillae along the front part of the tongue's surface, and they were absent from torus linguae and roots. It agreed with (37,38) in camel, (39) in sheep and goat, but disagreed with (40) in roan. Only the torus linguae had two forms of conical papilla large and small. According to (41), large conical papillae in goat and sheep were found in the adjacent two-thirds of the dorsum was of the tongue, with more of them in the middle section of the tongue. As reported by (31) in sheep, lenticular papillae were the most numerous among mechanical

papillae and were restricted to the torus linguae. The fungiform papillae were tiny, circular, and club-shaped, as reported by (5). These papillae were most abundant on the dorsal and lateral surfaces of the tongue tip, with only a few on the ventral surface, which was in line with (23) in sheep. On torus linguae and root, no fungiform papillae were discovered, which contradicted the results of (24) in sannnen goat. In camel, they were somewhat elevated above the lingual surface, according to research conducted by (25). The number of fungiform papillae dropped but rose in size towards the tip to the lingual fossa, which was consistent with the finding of (40) in antelope.

Fungiform papillae were seen on both the ventral and dorsal lingual surfaces, and every fungiform papilla was shiny and convex, with multiple taste pores, as seen in many other ruminants, such as cow goats and lambs (9), have been found to have, Circumvallate papillae were four papillae located on the two rims the torus linguae, grouped in a single row. The vallate papillae were placed on the torus, across its lateral borders while and comprised of a single row from 3 to 6 conspicuous papillae in the same species, which was in partial contradiction with 41. Although (25) found 15 or more vallate papillae in the posterior portion of lingual prominence in cattle, 20 found 12-20 papillae on each side of cow tongue. Furthermore, (30) recorded 4-6 big vallate papillae on each side in a one-humped camel, but (5) mention there are 4 circumvallate papillae on the right side and 5 on the left side on the caudo-lateral side of the tongue in a camel. The papillae were spherical in shape and raised somewhat from the surface of the tongue. A conspicuous furrow separated each papilla from its neighboring thick annular fold. The shape and size of those papillae varied widely, and they were not equal in the lines of both sides even in the same specimen, which had previously been described in goat (31). The basic histological structure of the camel's vallate papillae was similar to that reported in domestic animals (9). In the current study, taste buds were found on the outside of the vallate papillae, but no buds were found on the dorsal side of the papillae, similar results in yak (32).

Von Ebner's glands were in lamina propria submucosa down beneath the circumvallate papilla in this investigation. Each gland discharged into the sulcus via its own duct. The constant flow of serous secretions over the taste buds is believed to wash away food particles, allowing the taste buds to acquire and interpret fresh gustatory impulses (9,41). As a result, the existence of well-developed von Ebner's glands and their numerous ducts may imply profuse gland secretion, leading in effective tasting of the dromedary camel. The lingual papillae were distinct from those of other domestic ruminants. These physical properties of the camel tongue may have developed to aid the animal in prehension and manipulation of the inorganic rigid plants that grow in its environment, and so may be related to the animal's diet and feeding habits (5,7).The general histological characteristics of the camel's papillae resembled those of ruminant. The well-developed von Ebner's glands suggested their extensive serous secretion, which reflected on their exceptional capacity of gestation, and empty discharge into the moat's base, which apparently flushes debris from the moat, allowing taste receptors to respond quickly to changing stimuli.

CONCLUSION

Camel tongue, like those of other ruminants, are totally durable organs with relatively tiny proportions in comparison to the animals' overall sizes. Many structures held the tongue in place, including the

frenulum linguae and lingo-mandibular folds. The glosso-palatine folds, glosso-piglottic folds, and glosso-pharyngeal folds were absent, as were all three tongue muscles responsible for movement: the styloglossus, hyoglossus, and Geniglossus muscles. The histological structures of the camel's lingual papillae were exactly like those of other ruminants.

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Author contributions

All authors contributed equally.

Conflict of interest

The authors state that there were no conflict of interest the writing of the journal and associated activities.

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