A comparative anatomical and histological study of the tongue and lingual papillae in adult Awassi rams (*Ovis ovis*) and Billy-goat (*Capra hircus*)

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Abstract

The purpose of the study was to unveil the comparative of macroscopic and microscopic features of the tongue and lingual papillae in adult rams and billy-goat (1.5-2 years old). Ten tongue specimens of each rams and billy-goat were used to study the anatomical and histological features. Results were demonstrated that the mean total length of the tongue in rams was longer than that in billy-goat. The tongue of rams has gray or blackish color with nearly round apex and not has median groove, while the tongue of billy-goat was pink in color with a sharp rounded anterior edge and the apex of tongue was flattened like spatula shaped and has median groove, black spot was found on the dorsal surface in tongue of billy-goat only. In both species the body of tongue presented a well developed torus linguae and fossa linguae, the root was shorter part of the tongue lies caudally to the body of the tongue and slopes ventrally and caudally toward the base of the epiglottis, and the root was has conical papillae on each side of its. There were five types of papillae in tongue of both rams and billy-goat; the filiform, fungiform, conical, lenticular and vallate papillae. The filiform papillae were soft horny threadlike papillae found on dorsal, lateral and ventral surfaces of tongue, and were lined by keratinization stratified squamous epithelium. Mean number and diameter of the fungiform papillae in rams were more than that in billy-goat, it was round, convex, mushroom-like, distributed on the dorsal and ventral surfaces of the apex and body of tongue and have numerous taste bud and lined by keratinized epithelium. The conical papillae have a round base and a blunt tip, they were found rostral to the torus linguae in each species and this papilla was lined by keratinized epithelium. The lenticular papillae were convex lens in shape found in the middle part of torus linguae, and were covered by keratin layer. Mean number of vallate papillae in rams were more than that in billy-goat, it was round to oval in shape found on the lateral side to torus linguae arranged in two rows has V shape and were covered by a cornified layer. Foliate papillae were absent in both species. The Von Ebner's glands of rams were serous, while in billy-goat were mucous, Weber's glands were sero-mucous in both species, which located under the vallate papillae. In conclusion: The morphology of tongue, the number, distribution and morphological characteristics of lingual papillae of ram and billy-goat were related to the species of animal, kind of diet and feeding habits.

Key words: Comparative anatomy, tongue, lingual papillae, ram, goat.

دراسة تشريحية ونسجيه مقارنة للسان والحليمات اللسانية للخراف المحلية البالغة (*Ovis ovis*) وذكور الماعز (*Capra hircus*)

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الخلاصة

تهدف الدراسة الحالية لمعرفة الفروقات في المظاهر العيانيه والمجهرية للسان والحليمات اللسانية بين الخراف وذكور الماعز البالغة (1.5-2 سنة). أجريت الدراسة على 10عينات من اللسان لكل من الخراف وذكور الماعز لدراسة المظاهر

التشريحية والنسجية. أظهرت النتائج ان متوسط الطول الكلي للسان في الخراف يكون أطول مما هو عليه في ذكور الماعز. اللسان في الخراف يمتلك لون رمادي أو اسود مع قمة تكون تقريبا مستديرة ولا تمتلك أخدود وسطي ،لكن في ذكور الماعز يكون اللسان ورديا في اللون مع حافة أمامية مدورة حادة وقمة اللسان تكون مسطحة تشبه شكل الملعقة وتمتلك أخدود وسطي. توجد بقعة سوداء على السطح الظهري في لسان ذكر الماعز فقط . في كلا النوعين جسم اللسان يمتلك مرتفع لساني وحفرة لسانية متطورتان جدا والجذر يمثل اقصر أجزاء اللسان ويقع خلفيا لجسم اللسان وينحدر بطنيا وخلفيا نحو قاعدة لسان المزمار ويمتلك حليمات مخروطية على كلا جانبيه. أحتوى اللسان في كل من الخراف وذكور الماعز على خمسة أنواع من الحليمات اللسانية تتضمن الخيطية والفطرانية والمخروطية والعدسية والكاسية . الحليمات الخيطية في كلا النوعين لها شكلا" خيطيا مقرنا ناعما ، وجدت هذه الحليمات على السطوح الظهرية والوحشية والبطنية للسان في كلا النوعين وتبطن هذه الحليمات بنسيج حرشفي مطبق متقرن. متوسط عدد وقطر الحليمات الفطرانية في الخراف كان أكثر مما هو عليه في ذكور الماعز والحليمات الفطرانية في كلا النوعين لها شكلا يشبه الفطر محدب ومستدير وتتوزع على السطوح الظهرية والبطنية لكل من قمة وجسم اللسان وتمتلك عدد من البراعم الذوقية وهذه الحليمة تغطى بنسيج طلائي متقرن.الحليمات المخروطية تمتلك قاعدة مدورة وقمة غير حادة وتوجد هذه الحليمات أماميا للمرتفع اللسان في كلا النوعين وسطحها مبطن بنسيج طلائي متقرن. الحليمات العدسية في كلا النوعين لها شكل يشبه حبة العدس المحدبة وتتواجد في الجزء الوسطي لمرتفع اللسان وهذه الحليمات مغطاة بطبقة متقرنه. متوسط عدد الحليمات الكاسية في الخراف يكون أكثر من ذكور الماعز و الحليمات الكاسية في كل النوعين لها شكل مدور الى بيضوي وتوجد جانبيا للمرتفع اللساني وتترتب في صفين على شكل حرف (V). الحليمات الورقية غير موجودة في كلا النوعين. غدد فون ابنير في الخراف تكون مصلية ، لكنها مخاطية في ذكور الماعز ، وغدد وبيرز تكون مختلطة في كلا النوعين ، تقع كل هذه الغدد أسفل الحليمات الكاسية. نستنتج ان شكل اللسان ، عدد وتوزيع والمواصفات الشكلية للحليمات اللسانية للخراف وذكور الماعز لها علاقة بنوع الحيوان والغذاء والسلوك الغذائي.

الكلمات المفتاحية: التشريح المقارن ، اللسان ، الحليمات اللسانية ، الخراف ، الماعز.

Introduction

The tongue of mammals is a movable musclomembranes organ contributing significantly to food appreciation, its varies in form and size that is greatly influenced by feeding habits (1). The tongue of sheep and goat has free apex, body and attached root. The lingual surface is covered by a variety of papillae (filiform, fungiform, conical, lenticular, and vallate) and there are a few small salivary glands associated with the tongue (2,3,4,5,6 and 7).(8) mention absent the conical papillae in tongue of each *Garole sheep* and *Black Bengal goat*. The filiform papillae in sheep and *bakerwali goat* tongue are present in both the dorsal and ventral surfaces (9,10).(6) mention the filiform papillae in goat tongue are present on the anterior, posterior and ventro-lateral aspects of the tongue, while (8) said the filiform papillae are distributed on the dorsal surface only of the tongue of both sheep and goat. The fungiform papillae are round to oval shaped in sheep, scattered among the filiform papillae in the anterior two-thirds of the dorsal and lateral surfaces (10). The goat tongue has fungiform papillae on the ventral, as well as the dorsal surface (7). The conical papillae of goat tongue are present on both rims of the torus linguae (6), in *Zavot cattle* distributed mainly on the lingual root (11). There are two types of lenticular papillae in goat both possessing a prominent surrounding papillary groove, the pyramidal-shaped type I lenticular papilla has a pointed apex, while the round-shaped type II lenticular papilla possessed a blunt apex (6). The vallate papillae of sheep have a vallum papilla separated from annular pad by sulcus papilla (9). Histologically, The mucosa of goat tongue is consists of keratinized stratified squamous epithelium beneath which was a dense network of connective tissue called the lamina propria, in which are found numerous blood capillaries and the tongue consists largely of skeletal muscles bundles that run in transverse longitudinal and oblique directions (12). Each main filiform papillae on the body of tongue in cattle was accompanied by 1-3 secondary papillae, however, there is no any secondary papilla on the main papilla at the apex of the tongue. The fungiform papillae are lined by keratinized epithelium and presented taste pores mainly towards their centre. The conical papillae are covered with a thick layer of keratin. Lenticular papillae are conical like shape. The vallate papillae are round to oval in shape (11). The taste buds are at the free surface of the fungiform and vallate papillae. The shape of taste buds

varies widely among mammals, being ovoid in the bovine (13). The Von Ebners gland of cattle tongue well located under the vallate papillae as large groups among the lingual skeletal muscles (14), (15) mention the Von Ebner's glands and lingual salivary glands of camel tongue are found at the root of it.

Materials and methods

Ten tongue specimens of each rams *Ovis ovis* and billy-goats *Capra hircus* (1.5-2 years old) were collected from AL-Muthana abattoir during the period extend from November to December 2014 to study the anatomical and histological features. Specimens were divided into two groups: Five specimens for anatomical study and five specimens for histological study. Specimens about the anatomical study were collected immediately after slaughtering animals, then washed with the normal saline solution (0.9 %), and the following biometric measure-ments were taken. 1-Total length of the tongue, length of the apex, body and root. 2-Widest area in the apex, body and root of the tongue. 3-Thickest area in the apex, body and root of the tongue. 4-Total number of the fungiform and vallate papillae. 5-Diameter of the fungiform papillae at widest point. Data were expressed as mean (X) and standard error (SE) (16). Specimens about the histological study were collecting after dissecting the head and washed with normal saline solution (0.9%), then fixed by formalin 10% for 24 hours at room temperature, and then treated by routine histological processing (17). Five samples from each tongue specimen were taken; 1- Dorsal surface of the tongue to study filiform and fungiform papillae. 2-Ventral surface of the tongue to study filiform and fungiform papillae. 3-Lateral surface of the tongue to study filiform papillae. 4-Conical papillae in region the root of the tongue. 5-Lenticular and vallate papillae.

Results

Tongue of both rams and billy-goat 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. It was divided into three parts apex, body and root. In rams it has gray or blackish color, rounded margin and not has median groove, with nearly round apex. While in billy-goat the tongue was pink or gray in color with a sharp rounded anterior edge and the apex of tongue was flattened like spatula in shape and has shallow median longitudinal groove on the dorsal surface of apex. The apex of the tongue of rams and billy-goat was increased gradually in width, thickness and then narrowest in the beginning of the body (Fig. 1, 2), black spot or pigmentation was found on the dorsal surface in billy-goat only (Fig. 2). The body of tongue in both species 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.1, 2). The mean total length of the tongue in rams was (17.24 ± 1.43) cm, while in billy-goat was (15.54 ± 1.56) cm. The mean length, widest and thickest areas of the apex of rams tongue were (4.83± 1.74), (2.87 ± 0.65) and (1.15 ± 0.23) cm respectively, while in billy-goat tongue were (4.13± 1.45), (2.14 ± 0.43) and (1.09 ± 0.02) cm respectively. The mean length, widest and thickest areas of the body of rams tongue were (11.5± 1.75), (2.89 ± 0.5), and (2.12 ± 0.29) cm respectively, while in billy-goat tongue were (10.3± 2.54), (2.11± 0.7), and (1.98 ± 0.54) cm respectively. The mean length, widest and thickest area of the root of rams tongue were (2.14± 0.78), (2.93 ±0.77) and (1.73 ±0.12) cm respectively, while in billy-goat tongue were (1.84 ± 0.42), (2.53 ± 0.57) and (1.86 ± 0.24) cm respectively (Table 1). Five types of papillae were present on the tongue of each of rams and billy-goat included, filiform, fungiform, conical, lenticular, and vallate papillae (Fig. 3, 4). The filiform papillae in each species were soft horny thread like structure, their distributed on dorsal surface, lateral surface, ventral surface and extend caudally at level of vallate papillae (Fig. 3). Fungiform papillae were round, convex, mushroom-like papillae in both species, were

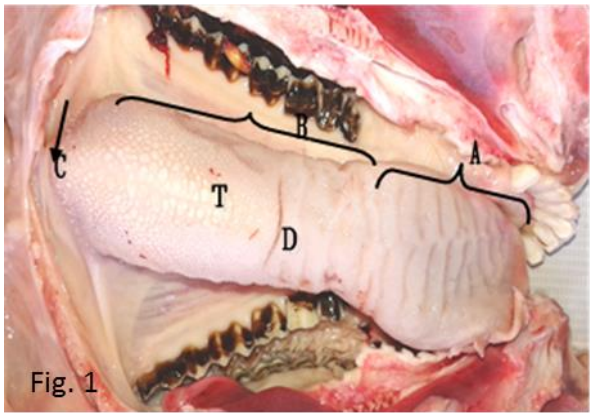
Table (1): Biometry of the tongue of rams and billy-goats (cm) (X ± SE).

Measure / Species	Length of tongue (cm)				Widest area of tongue (cm)			Thickest area of tongue (cm)		
	Total	Apex	Body	Root	Apex	Body	Root	Apex	Body	Root
Rams	17.24 ± 1.43	4.83 ± 1.74	11.5 ± 1.75	2.14 ± 0.78	2.87 ± 0.65	2.89 ± 0.5	2.93 ± 0.77	1.15 ± 0.23	2.12 ± 0.29	1.73 ± 0.12
Billy-goats	15.54 ± 1.56	4.13 ± 1.45	10.3 ± 2.54	1.84 ± 0.42	2.14 ± 0.43	2.11 ± 0.7	2.53 ± 0.57	1.09 ± 0.02	1.98 ± 0.54	1.86 ± 0.24

Table (2): Total number of the fungiform and vallate papillae and diameter of fungiform papillae at widest point in each rams and billy-goats (µm) (X ± SE).

Measure / Species	Total number of fungiform papillae	Diameter of fungiform papillae at widest point µm	Total number of Vallate papillae	
			Left Side	Right Side
Rams	433.7 ±12.72	589.67±22.02	16.5 ± 1.84	14.8 ± 0.39
Billy-goats	381.6 ± 11.58	543.25 ± 23.02	14.5 ± 0.84	13.8 ± 0.39

distributed among filiform papillae and were more concentrated around the tip of the tongue and on lateral cranial edges (Fig. 3). The mean total number of the fungiform papillae in rams tongue was (433.7 ± 12.72), while in billy-goat tongue was (381.6±11.58) , and the mean diameter of the fungiform papillae at widest point in rams tongue was (589.67±22.02) µm, while in billy-goat tongue was (543.25 ± 23.02) µm (Table 2). The conical papillae in tongue of both rams and billy-goat were elongated, conical in shape have a round base and a blunt tip, observed rostral to the torus lingua and continuous caudally on dorsolateral to the torus lingua, also on both side of tongue root. The lenticular papillae in both species were convex lens in shape, located as a zone of papillae on the middle part of the torus lingua. The vallate papillae of both species were round to oval in shape, with minute elevation from the lingual surface, located on dorso-lateral surface of caudal part of the torus lingua, arranged in two rows on both side of tongue in (V) shape (Fig. 4), their number in rams tongue (16.5 ± 1.84) on the left side, and (14.8 ± 0.39) on the right side, while in billy-goat tongue, on left side was (14.5 ± 0.84) and on right side was (13.8 ± 0.39) (Table 2). The epithelium of mucosa of the tongue in each of rams and billy-goat dorsally was thick rough and keratinized stratified squamous epithelium whereas the mucosa of the ventral and lateral surfaces was thin keratinized stratified squamous epithelium. The lamina propria was a dense network of connective tissue, blood vessels in which, and the tongue consists of skeletal muscles bundles that run in transverse, longitudinal and oblique directions (Fig. 5, 6, 7). Mucous membrane of tongue were presented highly papillated; filiform, fungiform, conical, lenticular and vallate papillae. The filiform papillae were soft horny thread like structure, covered by keratinized stratified squamous epithelium in tongue of each rams and billy-goat (Fig. 6). The fungiform papillae in both species were more densely distributed on the dorsal and ventral surfaces of lingual apex than the other parts, it was dome shapes has numerous taste buds in the epithelium of dorsal and lateral of papilla, it was covered by keratinized squamous epithelium (Fig.5,7,8). The surface of the conical papilla in both species was heavy keratinized epithelial cells (Fig. 9). The lenticular papillae were round to oval, its dorsal surface was covered by keratin layer. The vallate papillae were large flattened circumscribed papillae, covered by a cornified layer (Fig. 10). The Von Ebner's glands of rams tongue were tubuloalveolar serous, they stained darkly with (H&E) (Fig. 10), while in billy-goat tongue these the glands were mucous and have strong PAS reaction (Fig. 11). The Weber's glands were sero-mucous in tongue of both species. Glands were located in the lamina propria, sub mucosa and between the muscle bundles of the root of tongue in both species (Fig.12).



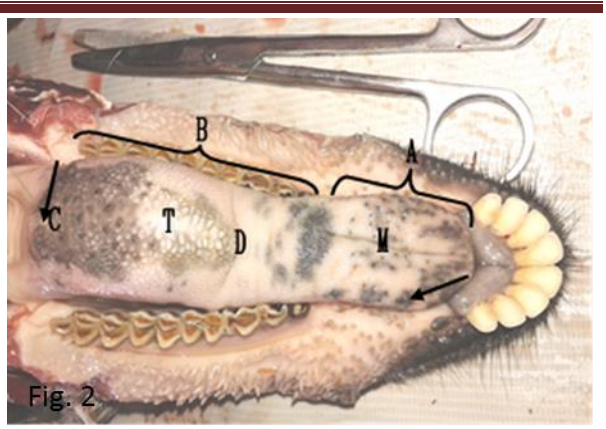
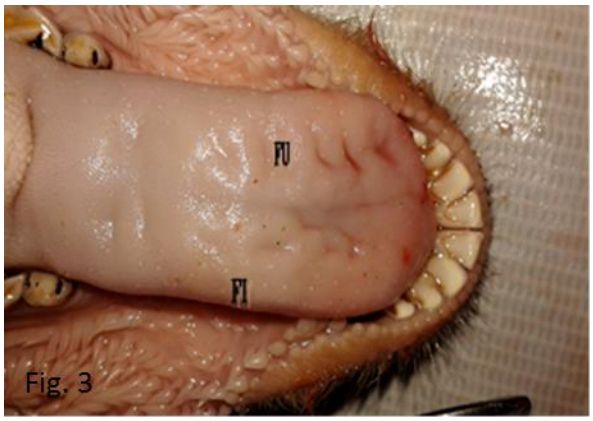


Fig. (1): Ram tongue, dorsal surface shows: Rounded apex (A), Body (B), Root (C) (arrow) Lingual fossa (D), Torus linguae (T).
Fig. (2): Goat tongue, dorsal surface, shows: Flattened apex (A), Body (B), Root (C) (arrow), Lingual fossa (D),Torus linguae (T), Median groove (M), black spot (arrow).



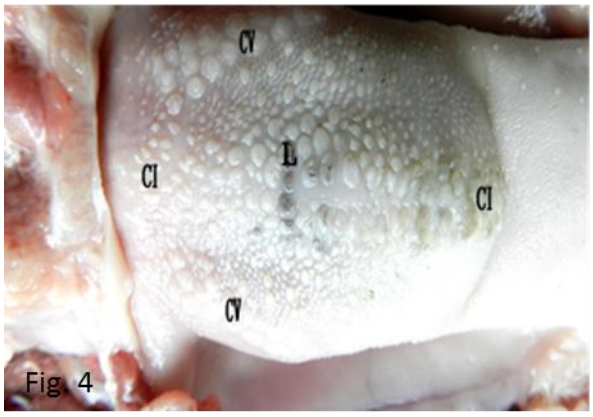


Fig. (3): Ram tongue, dorsal surface shows: Filiform papillae (FI), Fungiform papillae (FU).
Fig. (4): Goat tongue, dorsal surface shows: Conical papillae (C1), Lenticular papillae (L), Vallate papillae (CV).

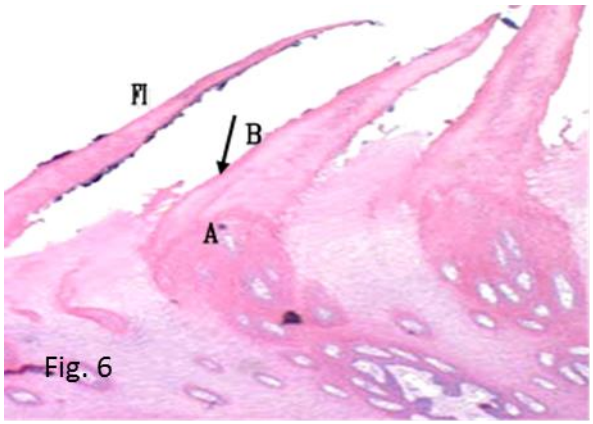
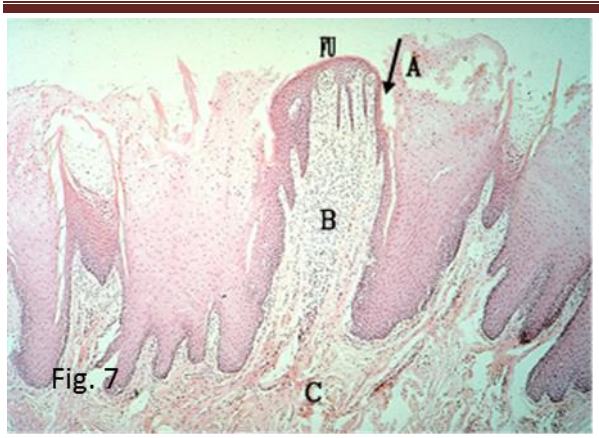


Fig. (5): Ram tongue, dorsal surface illustrated: Fungiform papillae (FU), thick keratinized stratified squamous epithelium (A) (arrow), Lamina propria (B), Muscular fibers (C). (X40 H&E).
Fig. (6): Goat tongue, dorsal surface illustrated: Filliform papillae (FI), Base of papillae (A), Stratum cornum (B) (arrow). (X40 H&E).



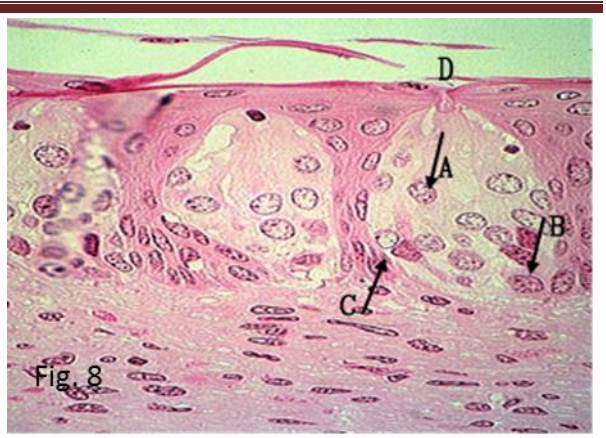
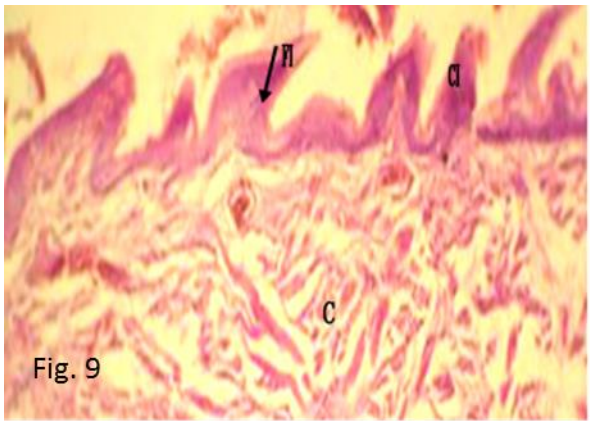


Fig. (7): Ram tongue, ventral surface illustrated: Fungiform papillae (FU), thin keratinized stratified squamous epithelium (A) (arrow), Lamina propria (B), Muscular fibers (C). (X40 H&E).

Fig. (8): Goat tongue, dorsal surface illustrated: Taste buds (A, B, C) (arrows), Pore (D). (X1000 H&E).



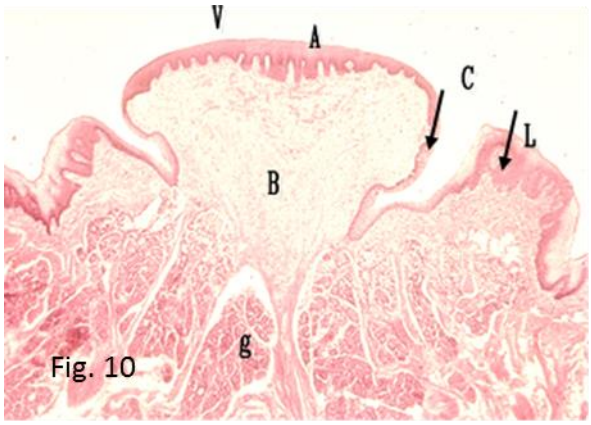
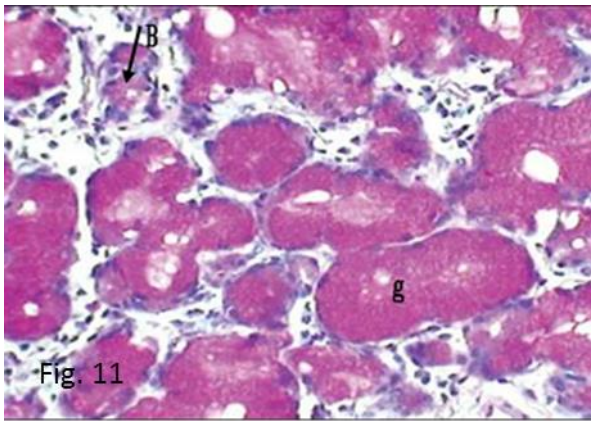


Fig. (9): Goat tongue, lateral surface illustrated: Filiform papillae (FI) (arrow), Conical papillae (CI), Muscles fibers (C). (X100 H&E).

Fig. (10): Ram tongue, dorsal surface illustrated: Stratified squamous epithelium (A), Lamina propria (B), Vallate papillae (V), Taste buds (C), Lenticular papillae (L) (arrow), Von Ebners glands were serous (g). (X40 H&E).



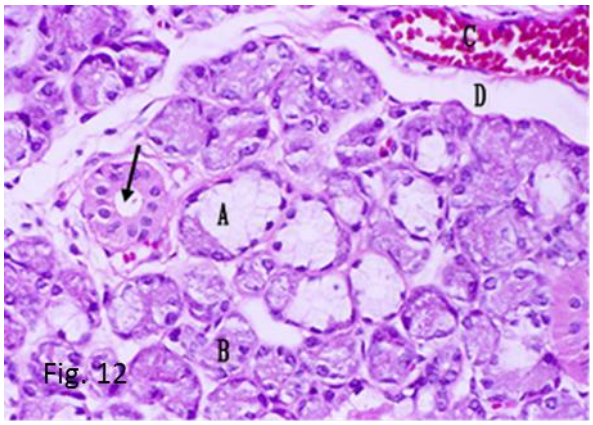


Fig. (11): Goat tongue, dorsal surface illustrated: Von Ebners glands were mucous (g), duct of gland (B) (arrow). (X100 PAS).

Fig. (12): Ram tongue, dorsal surface illustrated: Weber's glands were mixed, Mucous (A), Serous (B), Vein (C), Septum (D), duct of gland (arrow). (X100 H&E).

Discussion

The tongue of the rams in the present study has apex was nearly rounded and not has median groove, while the tongue of the billy-goat has apex was flattened like spatula and has shallow median longitudinal groove, this result was nearly accordance to (18) in goat, but in contrast with (5) who mention the sheep tongue has median groove and also disagree with (12) in goat and (19) in sheep and goat who mentioned that the apex of the tongue is notched in the center. In buffalo the apex of the tongue was free and pointed with blunt rounded margin (20), these differences related to the species of animal, the morphology of the tongues showed a relationship with the feeding. The tongue mucosal surface of rams and billy-goat in this study is covered by a variety of papillae, filiform, fungiform, conical, lenticular, and vallate, this result was accordance to (21) in *Barbary sheep*, and (18) in goat, while disagree with (8) in each *Garole sheep* and *Bengal goat* who mention there are only four types of lingual papillae (filiform, fungiform, lenticular and vallate). Some papillae have mechanical and other gustatory functions and variety of the distribution and morphological characteristics of the lingual papillae related to be kind of diet and feeding habits (1). The filiform papillae in rams and billy-goat were soft horny thread like structure. Fungiform papillae were round, convex, mushroom-like papillae in each rams and billy-goat, and their number in rams was more than that in billy-goat tongue, this result similar to (4, 8). In tongue of horse the fungiform papillae have clear groove surrounding their base (22), the differences in the shapes of these papillae is related to food, feeding and mastication pattern. Fungiform papillae in sheep and goat were distributed among filiform papillae in each dorsal and ventral surfaces, this result is agree with (18) in goat, (23) in *akkaraman sheep* and (5) in adult ram. The location and numbers of fungiform papillae in sheep and goat are comparable to those of many ruminants, in *Bactrian camel* were found on the lateral margins of the rostral two-third of tongue (24), in *India goat* were scattered over the entire dorsum and being in abundance at the tip (12), the adaptive changes in the microanatomy of their tongue, the tongue performs sensory and secretory functions, its equipped with chemo sensitive taste buds that test food quality, mechanoreceptors that monitor texture, and salivary glands that lubricate its epithelial surface (1). The conical papillae in both rams and billy-goat in this study were rostral to the torus lingua and continuous caudally on dorsolateral to the torus lingua, also on both side of tongue root. This result agree with (12) in goat and (25) in *Bos Indicus*, while disagreement with (11) in cattle who mentioned that the distribution of the conical papillae started from the root of the tongue and extended caudally, this difference due to the species different and due to differ in eating habit, this work similar to results in ox, buffalo, and camel (26) and in buffalo (27). The lenticular papillae is convex lens in shape in each species, its largest mechanical papillae, located on the middle part of the torus lingua, this result agrees with (7) in goat. The number of vallate papillae in each species were in the left side more than that at right side, this result in agreement with the results of (4) in adult ram, while disagree with (19) in sheep and goat who mention the number of vallate papillae in left side less than that in right side, and mean number of vallate papillae in sheep was more than that in goat these result agree with (8),this difference may be due to the animal type, age and food type. The tongue of sheep and goat at this study devoid from the foliate papillae, this result in agree with (28) in ruminant, and disagree with (22) who mention the tongue of horse has the foliate papillae. The epithelium of mucosa of tongue dorsally is thick, rough and keratinized stratified squamous. The degree of keratinization in different animals may be influenced by the type of food. The epithelium of the apex of sheep and goat tongue is more extensively keratinized than that of the body and root which provide the tongue with greater rigidity to be efficient for feeding (28).The epithelium of filiform papillae of each rams and billy-goat was keratinization, this result is in agree with result of (29) in sheep. The fungiform

papillae are more densely and have numerous taste buds in the epithelium of dorsal and lateral of papilla, these results in agreement with the result of (11). The fungiform papilla is covered by keratinized epithelium, this result is coincided with the result (15) in camel and (30) in sheep and goat. The conical papillae of the sheep and goat tongue are distributed on the dorsal surface of the torus lingua, and the surface of the papilla has keratinized epithelial cells, like the result of (28 and 30).The lenticular papillae are located on the middle part of the torus lingua and are round to oval, this result in agree with (28).The vallate papillae are covered by cornified layer and containing taste buds on lateral wall similar to that in (30) in sheep and goat. The Von Ebner's glands of rams were serous, while in billy-goat were mucous. The Weber's glands were sero-mucous in both the rams and billy-goat, this is accordance with (1) in sheep and goat, but was disagreement with (12) in goat and (4) in sheep. The presence of mixed gland may be due to consuming mixed food. The muscle bundles arranged in transverse, longitudinal and oblique directions to give the tongue highly motility, this agree with (28).

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