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Morphohistological postnatal developmental study of gustatory papillae in sheep tongue by light and electron microscopy

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Abstract

Objective

Gustatory lingual papillae play a crucial role in taste perception and oral function in mammals. Their postnatal development is associated with structural and functional maturation of the tongue. However, detailed information regarding the morphological, histological, and ultrastructural development of fungiform and circumvallate papillae in Iraqi local sheep at different postnatal stages remains limited. This study aimed to investigate the postnatal morphological, histological,

and scanning electron microscopic (SEM) developmental changes of fungiform and circumvallate gustatory papillae in the tongue of Iraqi local sheep (Ovis aries).

Materials and methods

Twenty tongue samples were collected from Iraqi local sheep obtained from Najaf and Babylon province abattoirs. The samples were divided into two groups according to dentition and age: Group I included lambs aged two months, and Group II included adult sheep aged eight months. Gross morphological examination, routine histological techniques, and scanning electron microscopy were employed to evaluate the developmental features of fungiform and circumvallate papillae and associated lingual glands.

Results

In two-month-old lambs, fungiform papillae appeared immature, flat-shaped, and sparsely distributed among the filiform papillae on the dorsal surface of the tongue, while circumvallate papillae were small to moderate in size and arranged in a double irregular row. At eight months of age, fungiform papillae exhibited marked maturation, appearing as large, flat-topped, mushroom-shaped projections. Circumvallate papillae became relatively larger, well-defined, flattened structures surrounded by prominent circular grooves and were located dorsolaterally on the torus linguae just rostral to the root of the tongue. Histologically, well-developed gustatory papillae were observed at both ages, with fungiform papillae scattered between filiform papillae on the apex and body of the tongue, whereas circumvallate papillae showed variable shapes and sizes according to developmental stage. Two types of lingual glands were identified: von Ebner's serous glands closely associated with circumvallate papillae, and Weber's mucous or mixed glands located deep within the muscular tissue at the root of the tongue.

Conclusion

The gustatory papillae of Iraqi local sheep undergo marked morphological, histological, and ultrastructural maturation during postnatal development. Age-related changes significantly influence the size, shape, organization, and glandular associations of fungiform and circumvallate papillae, reflecting their functional adaptation with growth.

Keywords: circumvallate, fungiform, postnatal development, scanning, sheep tongue

Paper Type: Research Paper.

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Introduction

Small ruminants, particularly native breeds, play a crucial role in the livelihoods of a significant portion of the human population in tropical regions from socio-economic perspectives

(Molaei Moghbeli et al., 2013; Mohammadabadi & Nanaei, 2021; Saadatabadi et al., 2023; Mohammadabadi et al., 2024). These animals are essential sources of meat, milk, wool, and hides, contributing to food security and rural incomes. Furthermore, they are well-adapted to harsh environmental conditions, making them vital for pastoral and small-scale farming systems (Hajalizadeh et al., 2021). Given their importance, combined efforts that focus on both effective management strategies and genetic improvement are crucial to enhancing animal productivity and ensuring sustainable development (Mohammadipour Saadatabadi et al., 2022; Vahabzadeh et al., 2020; Amirteymoori et al., 2021; Mohammadabadi et al., 2022). Genetic improvement programs, such as selective breeding, molecular marker-assisted selection, and genomic approaches, can significantly boost desirable traits like growth rate, milk yield, and resistance to diseases (Nejad et al., 2024). The economic and biological efficiency of small ruminant production enterprises generally improves by increasing both productivity and reproductive performance in these animals (Zamani et al., 2011; Safaei et al., 2022; Barazandeh et al., 2016; Mohammadinejad, 2016; Shokri et al., 2023). Enhanced reproductive performance can be achieved through improved nutrition, strategic breeding practices, and advanced reproductive technologies such as artificial insemination and embryo transfer (Noori et al., 2017). By integrating these approaches, small ruminant breeders can improve flock productivity, ensure food security, and contribute to the economic well-being of rural populations (Mohammadabadi et al., 2022). The Iraqi sheep are disseminated in five strains (Hamdani, Karadi, Arabi, Naeimi and Awassi). Sheep in Iraq are very essential economic ruminants that used for meat, milk and wool production. Embryonic improvement is a sequence of variations undergone by the newly formed individual; zygote and which culminate in production of an adult organism capable of reproduction (Hyttel et.al., 2010). The digestive system consists of mouth cavity and alimentary tube extended from pharynx to anus including accessory digestive glands. These can be divided into several portions such as pharynx, esophagus, stomach, small intestine, large intestine and rectum. Mouth cavity contain tongue, teeth, soft and hard palate (König and Liebich, 2020). Embryologically, the development of the tongue commences in the fourth week of gestation, during which it is formed from five primordial swellings derived from the pharyngeal arche (Sadler, 2006). The dorsal surface of tongue has lingual mucosa was protruding into small projections called lingual papillae that perform a variety function during prehension, mastication and swallowing (Dyce et al., 2019). It classifies into two types depend on present of taste buds as mechanical papillae including filiform, lentiform and conical papillae while the other type called gustatory papillae represented by fungiform and vallate (Eerdunchaolu et al., 2001). There are little information and research was available regarding the development of tongue postnatally in the local Iraqi Awassi sheep. The purpose of current study was to investigate the morphological, histological, and histochemical developmental changes of gustatory papillae in local awassi sheep tongue during different postnatal stages. This is achieved by comparing samples from two age groups: two-month-old lambs and eight-month-old adults to evaluate the structural maturation and allocation of associated lingual glands.

Material and Methods

Ethical approval: Ethical clearance for all experimental procedures was obtained from the ethics committee of the College of Veterinary Medicine, Al-Qasim Green University, Iraq. All experiments were carried out accordance with internationally accepted guidelines for animal care.

Animals study: The present study was designed to demonstrate morpho-histological developmental changes of fungiform and vallate papillae in the lingual tissue of Iraqi local lambs (*Ovis aris*) postnatally. Study was performed on twenty tongue samples collected from lamb in Najaf and Babylon provinces abattoirs for postnatal stages where distributed into two groups (lamb: two-month age and adult: eight months age). The approximate age of the animals was determined depending on milk teeth formula and eruption age as following:

[2(0\3 + 0\1 + 3\3)= 20]

While, the formula for the permanent teeth is [2(0\3 + 0\1 + 3\3 + 3\3)=32] (McGregor and Butler, 2013). Moreover, the information attainable from the owner are regarded to detect the exact age (Mohassen and Al-Jebori, 2020).

Study sample and histological Procedures: Tongue of lambs was fixed in 10% formalin then prepared for observation under light and scanning electron microscope. The processed tissues were gradually dehydrated through graded alcohol solutions, followed by clearing in xylene and subsequent embedding in paraffin wax to make blocks. Then sectioned by rotary microtome to obtain serial tissue sections with a thickness 4-6 µm. The prepared sections were subsequently stained with hematoxylin and eosin, Masson's trichrome, Periodic acid-Schiff and Van Gieson's stains. The histological sections were examined using a light microscope with an attached digital camera connect to computer monitor with different power magnification settings used to study the histological sections (Niyf and Al-Jebori, 2024; Suvarna, et al., 2018).

Results

At two-month age postnatally: Morphologically, the body weight of lamb was 16±0.45 kg and tongue weight was 40±1.88 g (Table 1). Tongue was muscular membrane mobile organ filling the proper mouth cavity. The body of mandible extended rostrally from incisors teeth to epiglottis. It has gray or whitish color with noticed of pigmentation of tongue and rounded margin to ended pointed in apex (Figures 1 and 2). The dorsum of tongue in lamb has two kinds of gustative papillae. The first one is fungiform papillae with flat shape and immature spreads through filiform papillae which appear at anterior part of dorsum were regarded consider larger and more prominent than others types of papillae (Figure 1and 2). The second is circum-vallate papillae, were moderate or small in size arrangement as pair of rows arranged in an irregular pattern on each side of caudal part of dorsal surface of lamb tongue (about 10-15) in number on each side (Figure 3 and 4). Histologically, the papillae showed less development and maturity where undergo morphohistogenesis to growth and differentiation to several types including, mechanical and gustatory papillae. It is accordance to present of taste buds within the architecture tissue structural fungiform and circumvallate papillae where the first one seen distributed among filiform papillae on dorsum of body and apex to emerge in different patterns. These are according

to age advancement to be smaller than circumvallate papillae which be noted variable morphology, including flask-shaped, rounded, and oval forms.

Table 1. Morphometric parameters of the tongue in lambs at different postnatal ages

Age	Body weight (kg)	Tongue weight (g)	Apex length (mm)	Apex width (mm)	Body length (mm)	Body width (mm)	Root length (mm)	Root width (mm)
2 months	16.00 ± 0.45[a]	40.00 ± 1.88[a]	18.35 ± 0.56[a]	23.90 ± 0.41[a]	40.00 ± 0.23[a]	24.67 ± 0.32[a]	20.34 ± 0.20[a]	28.90 ± 0.12[a]
8 months	37.00 ± 1.10[b]	75.00 ± 2.67[b]	32.63 ± 0.76[b]	27.33 ± 0.30[b]	60.78 ± 0.56[b]	28.56 ± 0.89[b]	25.56 ± 0.28[b]	38.50 ± 0.27[b]

Values are presented as mean ± SE, and Different superscript letters (a, b) within the same column indicate significant differences at $P \leq 0.05$.

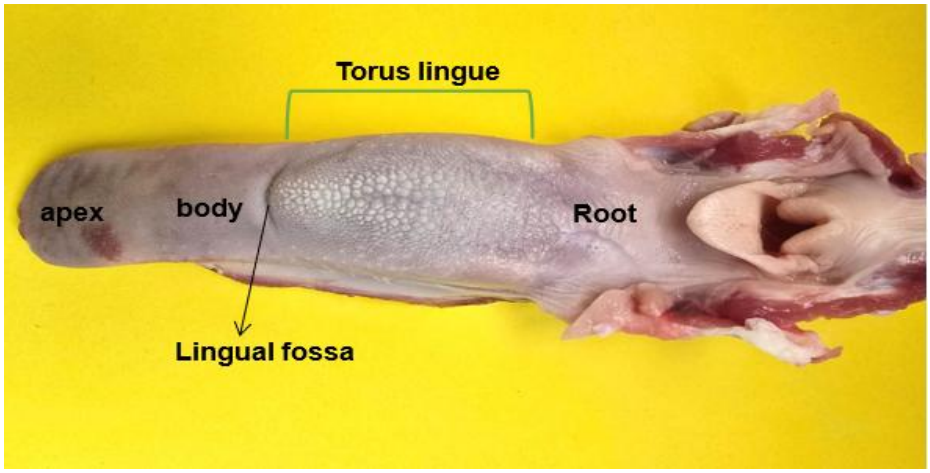

Figure 1. Photomicrograph of the sheep tongue at two months of age, showing different regions of the tongue

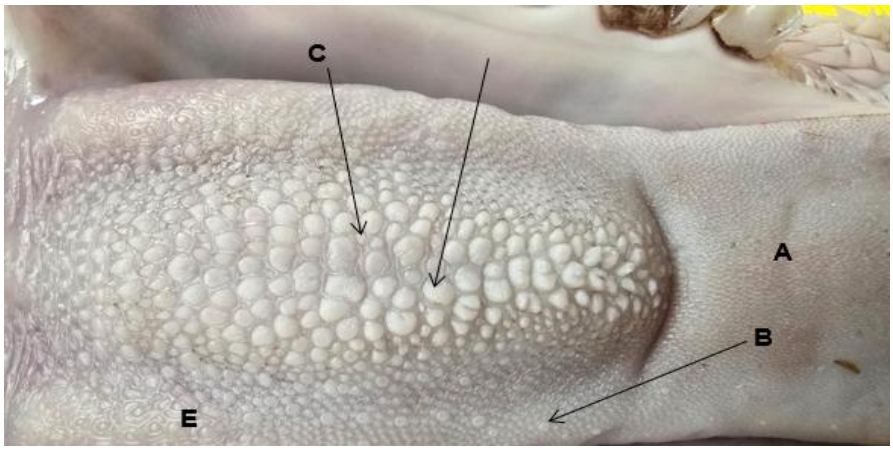

Figure 2. Photomicrograph of the sheep tongue at two months of age, showing lingual papillae: (A) filiform, (B) fungiform, (C) lenticular, (D) conical, and (E) circumvallate papillae

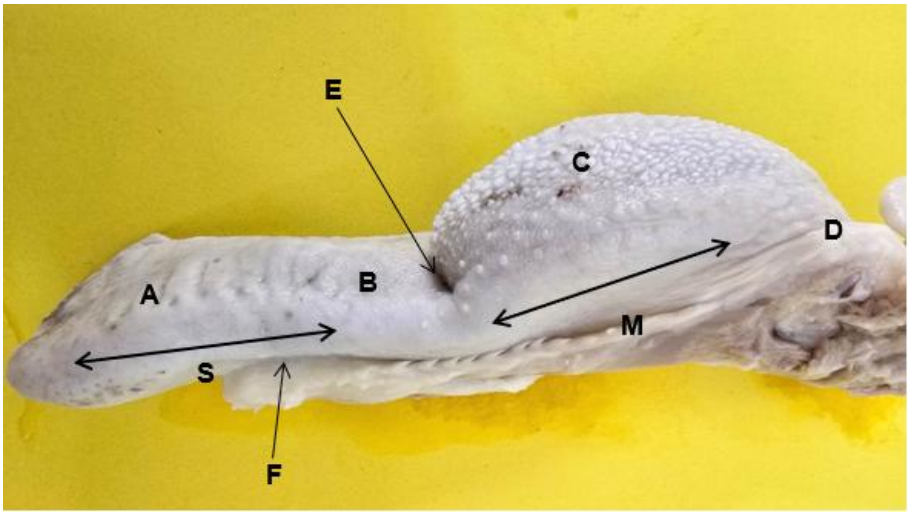

Figure 3. Lateral photomicrograph of the sheep tongue at eight months of age, showing the following anatomical structures: apex (A), body (B), torus linguae (C), root (D), lingual fossa (E), frenulum linguae (F), lateral border (S), and lateral surface of the root (M)

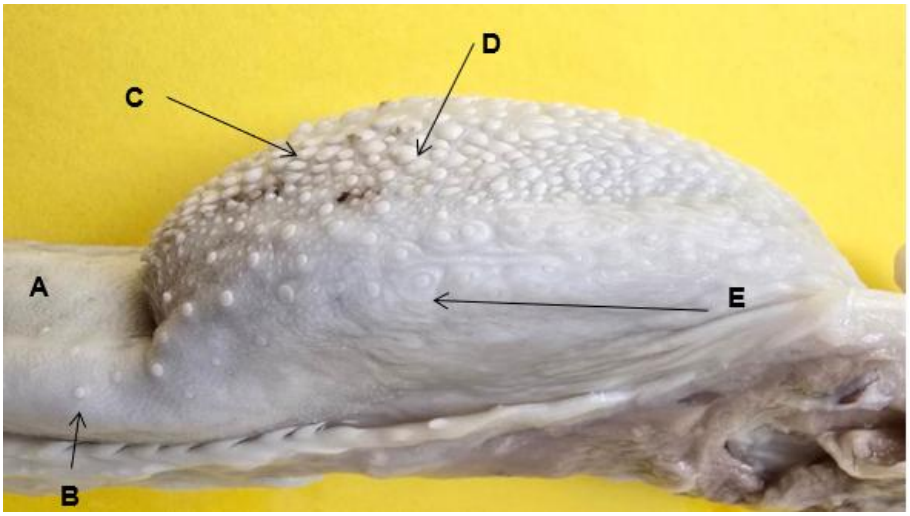

Figure 4. Photomicrograph of the lateral surface of the sheep tongue at eight months of age, showing lingual papillae: (A) filiform, (B) fungiform, (C) lenticular, (D) conical, and (E) circumvallate papillae

Evagination of mesenchymal layer to epithelium with taste buds were variably present, being embedded within the epithelial layer in some papillae and absent in others. The papillae were composed of a connective tissue core continuous with the lamina propria and enclosed by stratified squamous epithelium, with associated glands and rich vascularization containing lymphocytes, fibroblasts, and macrophages. Collagen fiber bundles were arranged parallel arrays and extended into secondary papillae (Figures 5, 6, and 7). Circumvallate papillae in current stage are relatively small, flattened, and well-circumscribed. They exhibit slight elevation above dorsum to observed in different morpho-histological developmental stages.

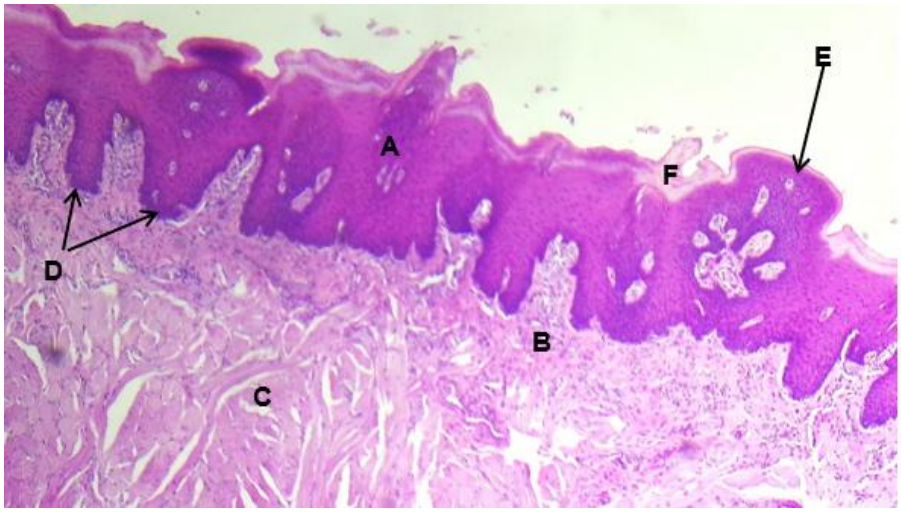

Figure 5. Low-power histological section of the dorsal surface of the apex of the sheep tongue at two months of age, showing: epithelium (A), tunica submucosa (B), muscular layer (C), dermal papillae (D), keratin layer (E), and primitive fungiform papilla (F). (H&E stain, ×4)

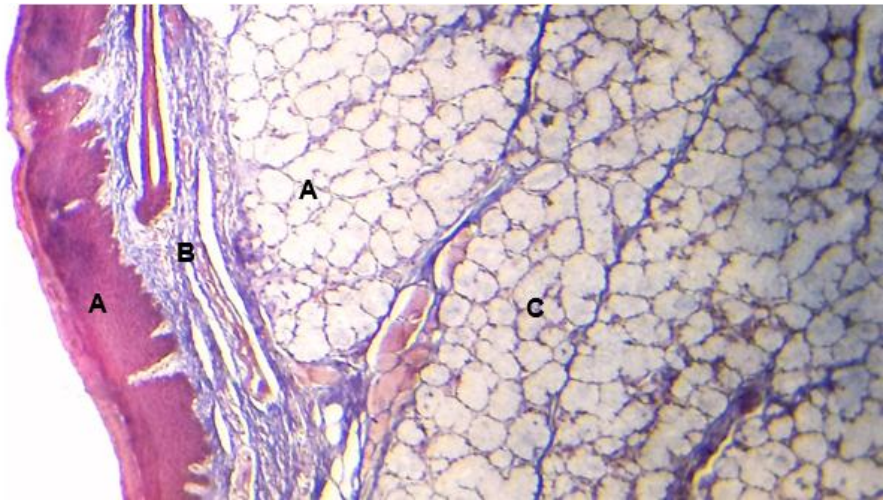

Figure 6. Low-power histological section of the dorsal surface of the root of the sheep tongue at two months of age, showing the epithelium (A), tunica submucosa (B), and primitive seromucous lingual glands (C). (V.G. stain, ×10)

They display diverse forms, ontogenetic patterns and sizes correspond to development and growth phases to be bounded by slight circular trenches on dorsolateral sides of posterior portion of torus linguae, aligned in paired rows on both sides of the dorsal aspect of tongue. The papillae were completely overlaid by a delicate to moderate degree of cornified stratified squamous epithelial tissue. It was noticeably thick on dorsum and nearly absent along the lateral aspects of the papillae. The epithelial covering exhibited surface invaginations corresponding to taste buds embedded within the epithelium, indicating that these papillae serve as specialized sensory structures for gustatory perception (Figures 8, 9, and 10).

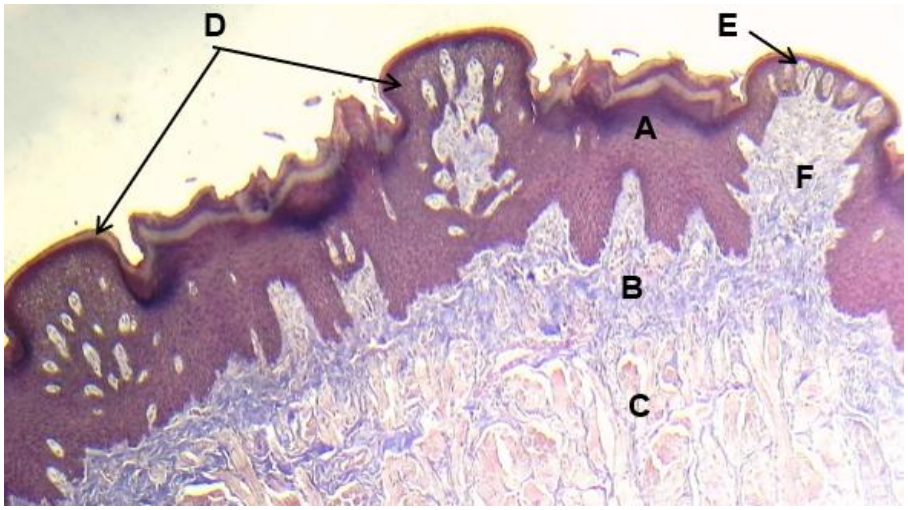

Figure 7. Low-power histological section of the dorsum of the sheep tongue at two months of age, showing the epithelium (A), tunica submucosa (B), muscular layer (C), primitive fungiform papilla (D), primitive taste buds (E), and connective tissue core (F). (Masson's trichrome stain, ×4)

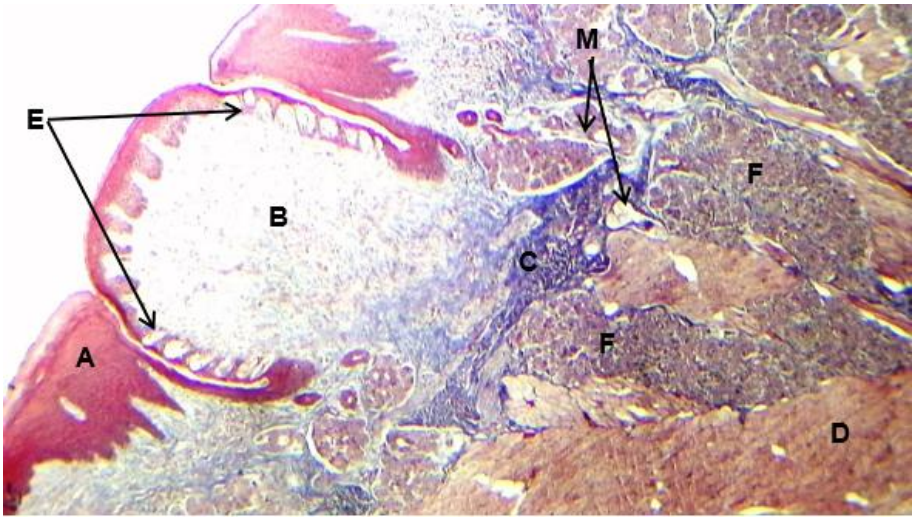

Figure 8. Low-power histological section of the torus linguae and root of the sheep tongue at two months of age, showing the development of circumvallate papillae: epithelium (A), connective tissue core (B), tunica submucosa (C), muscular layer (D), primitive taste bud (E), seromucous glands (F), and excretory duct (M). (Van Gieson stain, ×10)

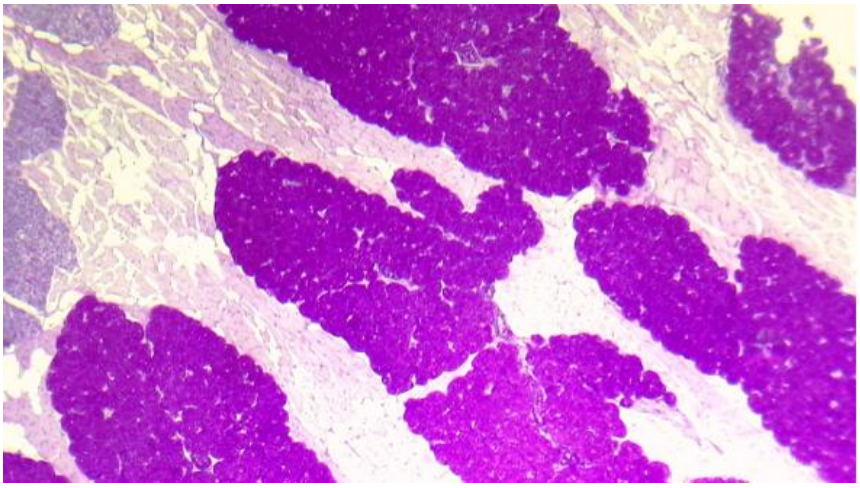

Figure 9. Low-power histological section of the root of the sheep tongue at two months of age, showing the development of Weber's glands in the deep muscular layer. (PAS stain, ×4)

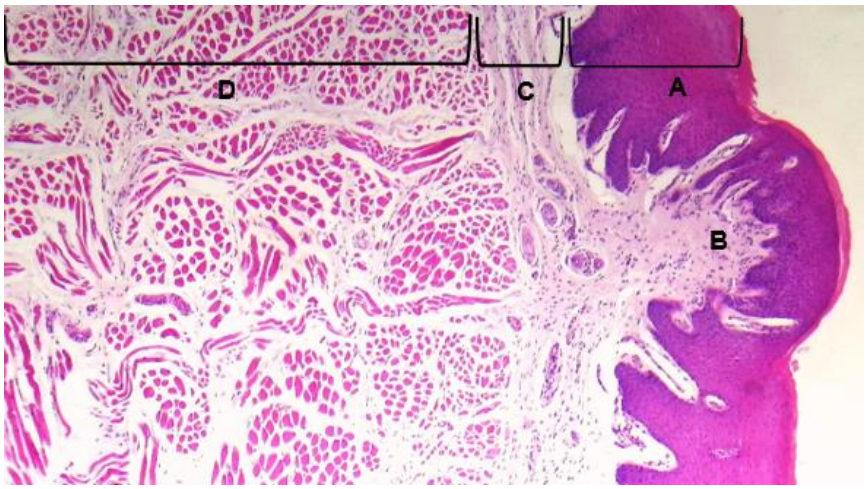

Figure 10. Low-power histological section of the apex of the sheep tongue at eight months of age, showing the development of fungiform papillae: epithelium (A), connective tissue core (B), tunica submucosa (C), muscular layer (D). (H&E stain, ×4)

The current results demonstrated two types of glands, von-Abner's and weber gland. The first associated with circumvallate papillae and tongue root (Figures 9 and 10). Von Ebner's glands were identified as well-developed serous compound tubular alveolar glands beneath circumvallate papillae within the lamina propria. Histologically, these glands extended deeply into the submucosal layer and reached the underlying muscular layers of the tongue. They were composed of multiple lobules that varied in size and arrangement, separated by connective tissue septa. The secretory acini displayed typical serous characteristics, and the excretory ducts were clearly observed opening at basal portion of circumferential groove surrounding circumvallate papillae that facilitating the discharge of their secretions into the trench area (Figure 10). The lobules were distinctly separated by bundles of muscle fibers, fatty tissue, and loose connective tissue that was richly supplied with blood vessels and nerve fibers. Each lobule comprised closely

packed serous acini lined by pyramidal epithelial cells. Histologically, the serous acinar units exhibited intense staining by Hematoxylin and Eosin, ranging from pink to purple. While lightly stained with Periodic Acid-Schiff due to the presence of serous secretions rich in enzymatic content. The cells possessed round, basally located nuclei, and only a limited number of serous demilunes were observed (Figures 9 and 10).

At eight-month age postnatally

Morphologically, the body weight of adult sheep was 37±1.1 kg and tongue weight wa 75±2.67 g (Table 1). Tongue was muscular membrane filling the proper mouth cavity. It has pinkish or whitish more development than in lamb. In some samples the study showed that the pigment found on the apex of the tongue which extended in some animals to including the corpus and radix of tongue. The present study has proven existence of two kinds of gustatory papillae were recognized at dorsocaudal region of dorsum, fungiform and circumvallate papillae (Figures 3 and 4). The fungiform papillae large-flat topped mushroom shape projected papillae. Their distribution irregularly on both side of apex and body where irregularly dispersed among densely crowded filiform papillae. The fungiform papillae are shorter, broader and less number than vallate with increasing in diameter caudally to apex towered lingual fossa. They were become broader and larger where are less density nearest tip, on lateral cranial edges of apex, ventral surface periphery and absent on ventral surface. While, they found more concentration on the dorsum and along the lateral surface of the tongue and less fungiform papillae but larger suited on lateral surface of lingual torus (Figures 3 and 4). The circumvallate papillae are characterized by their large, flattened morphology and are bordered by deep circular trenches. Dorso-laterally of the tours lingual just rostrally to the root of tongue in situ and not project above the surface of the tongue relatively. More pronounced and elevated in adult compared to lambs. The circumvallate papillae were larger than fungiform papillae and arranged in V-shape pattern with the apex pointing caudally more evidence than pervious with 8-9 pairs in number (Figure 4). Histologically, the growth of lingual papillae continues with growth to become more mature with advancement of age to revealed two types of mature gustatory papillae scattered on dorsum. Fungiform papillae were dome-shaped and flattened bodies with narrow connective tissue core which scarcely distributed within dense filiform papillae. The epithelial surface was composed of moderate degree of cornified stratified squamous epithelium in which primary papillae displayed a broad architecture and branches into distinct secondary papillae (Figure 9). The connective tissue core composed of areolar connective tissue with irregular taste buds that continuous with lamina properia without seen glands beneath these papillae and notice a large number of dermal papillae in stratum spinosum. Taste buds are present on dorsal surface of lateral fungiform with her absence in epithelium of dorsum same papillae (Figure 9). The findings of this study indicated that the circumvallate papillae appear large and flattened in shape encircled by deep annular grooves embedded in both sides of torus linguae and these papillae entirely enveloped by moderate cornified layer, being markedly thicker dorsally than laterally. The dorsal portion of papillae has no taste buds in contrast of lateral surfaces. The circumvallate papillae showed narrow at their points of attachment with dorsum and the connective tissue core have profuse

arterioles, venules and capillaries with dense irregular connective tissue with lymphocytes, macrophages and fibroblasts. Von Ebner's glands, characterized as simple branched tubular acinar serous glands located within lamina propria reaching into tunica muscularis and their ducts drained into moats (Figures 11 and 12). The nuclei were large rounded to ovoid in shape with clear nucleoli and located in the distal half of acinar cells, usually towards the basement membrane and the serous acinar have narrow lumen (Figure 12). Acini appear elongated or star-shape cells surrounds the secretory portion of these acini named myoepithelial cells between the basal lamina and basal pole of secretary cells, also called Basket cells. The posterior lingual gland (Weber's glands) suite within root region composed of variably sized and numbered lobules in lamina propria as well as between tunica muscularis and opened near lingual at root region (Figure 12).

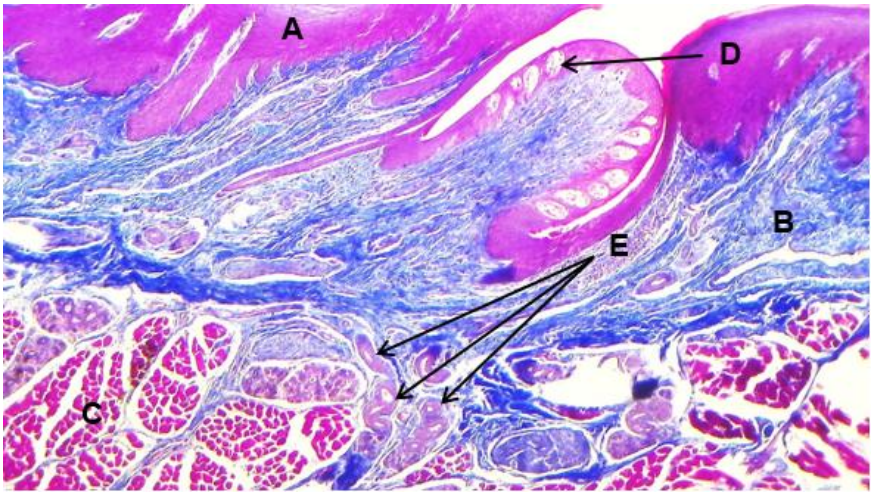

Figure 11. Low-power histological section of the torus linguae at eight months of age, showing the development of circumvallate papillae: epithelium (A), tunica submucosa (B), tunica muscularis (C), taste buds (D), and excretory ducts of seromucous glands (von Ebner's glands) (E). (H&E stain, ×4)

Scanning Electron Microscopic Observations: In the two ages studied, fungiform were few in number and scattered between filiform papillae positioned at cranio-dorsal surface of tongue (Figures 13 and 14). While, circumvallate papillae, along with their taste buds, were evident on tongue dorsal surface (Figures 14 and 15). The scanning electron microscope image reveals present of fungiform papillae were few in number and scattered among the filiform papillae where the surface is densely covered with filiform papillae, which are numerous, elongated, slender, and tapering structures. In the central area of the image, a rounded, dome-shaped structure can be observed, a fungiform papilla. Unlike the filiform papillae, the fungiform papilla is short, smooth, flat and non-keratinized, and it typically contains taste buds, suggesting its role in gustatory perception. The soft surface of fungiform papilla contrasts with the surrounding keratinized filiform papillae This smooth texture facilitates the reception of gustatory stimuli, as fungiform papillae house taste buds responsible for taste perception. The fungiform

papilla is wider and gently elevated, resembling a button or mushroom cap which is the origin of the term fungiform (Figure 14).

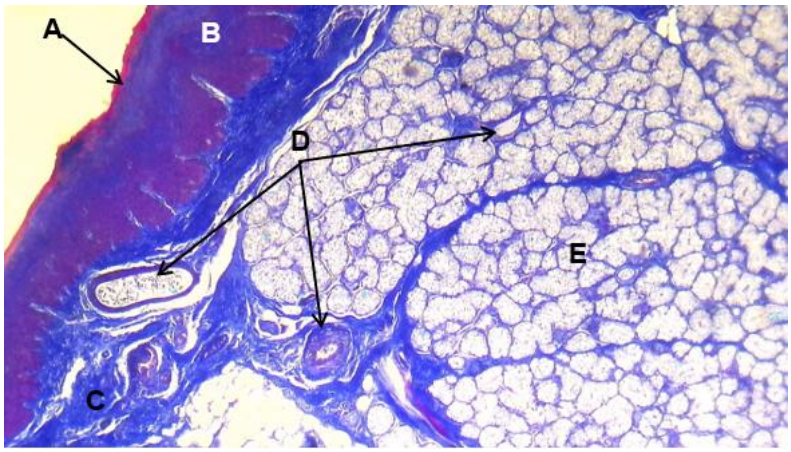

Figure 12. Low-power histological section of the dorsum of the root of the sheep tongue at eight months of age, showing lobules of Weber's glands within the muscular layer and their excretory ducts: thin keratin layer (A), epithelium (B), tunica submucosa (C), excretory ducts of seromucous glands (von Ebner's glands) (D), and seromucous acini (E). (Masson's trichrome stain, ×10)

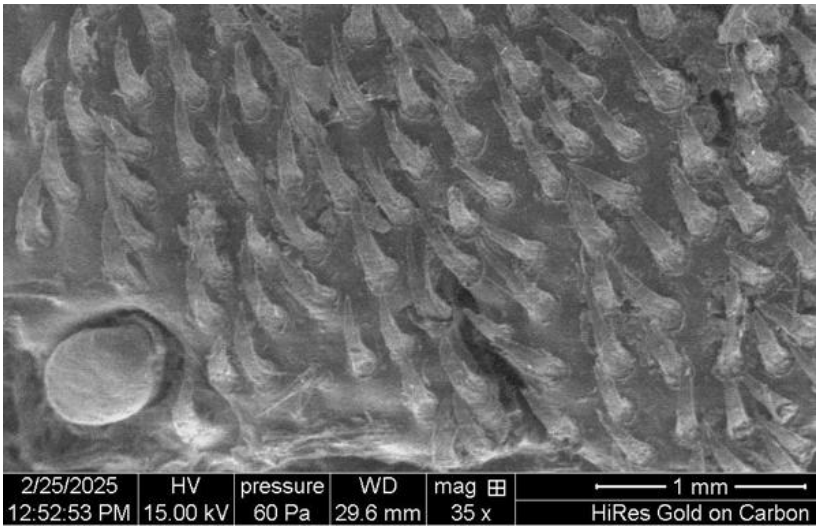

Figure 13. Scanning electron micrograph (SEM) of developing fungiform papillae from the apex of the tongue in local Awassi sheep at two months of age. Scale bar = 1 mm

The circumvallate papilla appears well-demarcated, oval large in shape, and is prominently raised from the tongue surface. The surface of each circumvallate papilla shows numerous taste pores and shallow grooves, which serve as openings for taste buds within lateral walls of vallate papillae and bounded by a deep annular trench or moat, clearly visible in the image, which distinguishes them from other types of papillae. The epithelium covering the circumvallate papilla is non-keratinized or lightly keratinized stratified squamous epithelium, allowing for the passage of tastes to the taste buds.

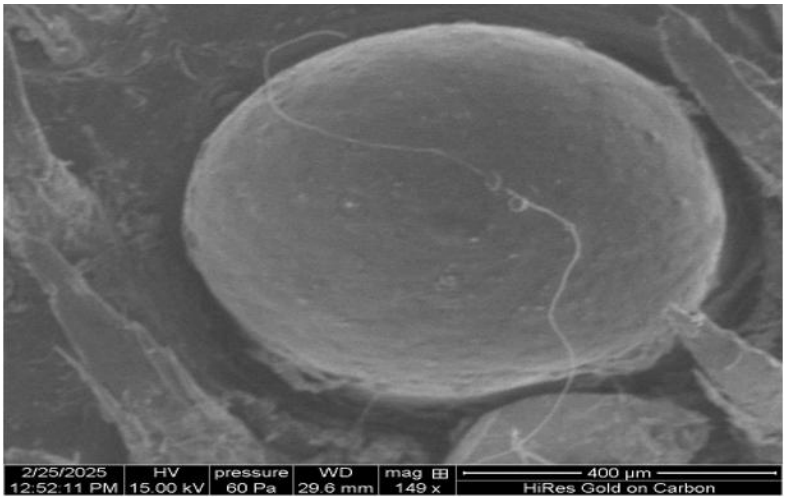

Figure 14. Scanning electron micrograph (SEM) showing the development of fungiform papillae from the apex of the tongue in local Awassi sheep between two and eight months of age. Scale bar = 400 µm

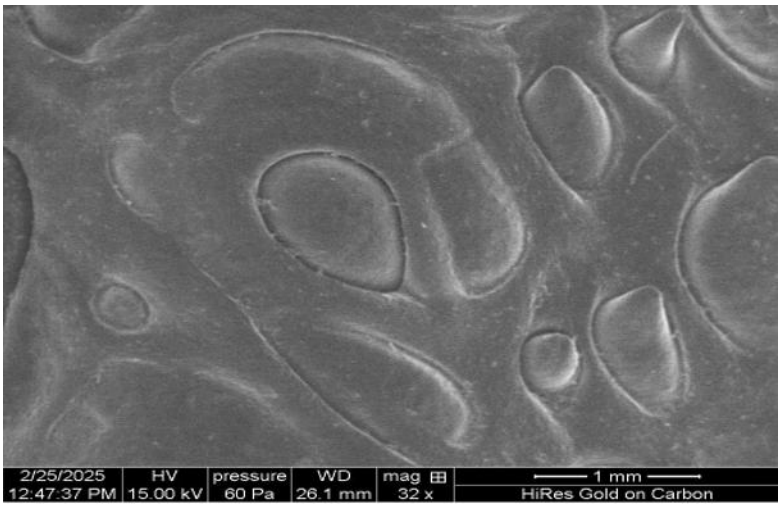

Figure 15. Scanning electron micrograph (SEM) of developing circumvallate papillae from the root of the tongue in local Awassi sheep at two months of age. Scale bar = 1 mm

The trenches are typically filled with serous secretions from von Ebner's glands, which help flush the area and clear tastants between stimuli. No obvious ridges are seen at this magnification, though taste pores and microvilli would be evident at higher optical magnification. The papilla surface appears relatively smooth and compact, lacking the keratinized spikes observed in filiform papillae (Figure 16).

Discussion

The results showed in the study animals in two ages that fungiform papillae appear flat in shape and immature papillae distributed within filiform papillae of anterior portion of dorsum to appear as large and more prominent bodies compare with remaining papillary forms. The present work in corresponding with Kumar et al. (2015) and Ali and Al-Jebori (2024). Studies conducted

in goats and sheep have confirmed that fungiform papillae exhibit a characteristic mushroom-like morphology and are widely sparsely on dorsum of lingual tip and lateral borders of tongue. Furthermore, lateral fungiform papillae were reported to be relatively larger than those on tongue dorsal surface, notably in pre-pubertal animals according to İşbilir et al. (2025) in ewe.

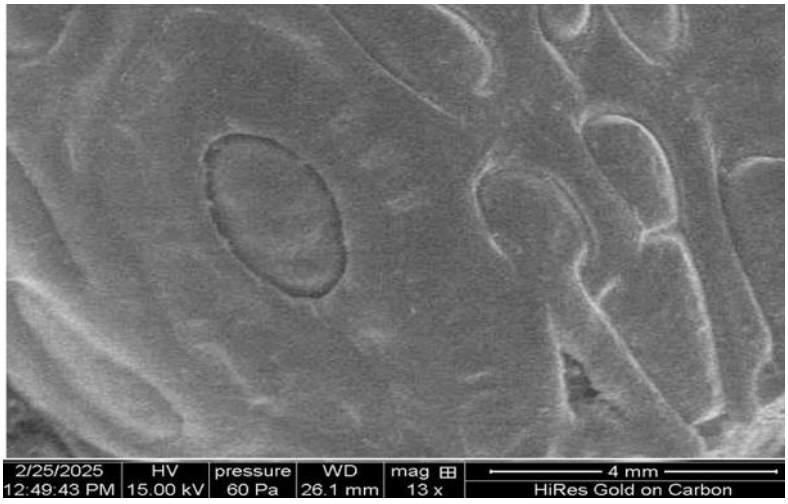

Figure 16. Scanning electron micrograph (SEM) of developing circumvallate papillae from the root of the tongue in local Awassi sheep at eight months of age. Scale bar = 4 mm

They reported that fungiform were domelike structures with multiple taste buds. While, vallate papillae appear moderate or small organization organized into double, uneven rows bordering the caudal part of the dorsal surface with 10-15 in number on each side. Collectively, these results demonstrate a clear morphological transformation of the lingual papillae from flat and immature structures at small lambs to more specialized and functionally adapted forms during the pre-pubertal stage. It reflects the tongue's progressive development to meet increasing sensory and dietary demands. The results of current study not corresponding with Bello et al. (2018) in camel. They mentioned that numerous large circumvallate papillae order left and right side of torus linguae closer to each other forming two lines parallel to the rim of torus linguae. Pronounced age-dependent differences were observed in the shape and size of these papillae with evident asymmetry and non-uniformity between the two rows in individual specimens. The pervious results were agreement with İşbilir et. al. (2025) in aged sheep and with Prakash and Rao (1980) in buffaloes (Prakash and Rao, 1980). They mentioned that five kinds of papillae present on dorsum classify as filiform, fungiform, conical, lenticular and circumvallate papillae. The results were disagreement with Ibrahim et al. (2024) in cat. They approved that dorsum was very rough because containing on various types of lingual papillae: filiform, cylindrical papillae, fungiform, circumvallate and foliate papillae. The variety in number, type and size of tongue papillae among domestic animals are mainly attributed to variations in diet, feeding habits, and evolutionary adaptation. Herbivores generally possess a larger number of well-developed filiform and fungiform to facilitate the manipulation and grinding of fibrous plant material. Whereas,

carnivores have fewer but more keratinized papillae suited for tearing flesh. Omnivores show intermediate characteristics, reflecting their mixed diet. Additionally, species-specific differences in taste bud distribution, salivary secretion, and mechanical requirements of the tongue influence papillary morphology. Genetic and developmental factors, along with the functional demands of mastication, grooming, and sensory perception, also contribute to the diversity of papillae in shape, size, and number across animal species. The previous studies in monkey showed that the fungiform were mush room-shape in both ages (last stage of gestation and adult) (Arvidson et al., 1981) and corresponding with Bello et al. (2018). Histological observations in camels revealed taste buds of circumvallate localization on lateral sides of the secondary grooves and within deep sinuses epithelial tissue lining of lateral papillary wall at late gestation. While, Gad-Allah et al. (2015) and Abou-Elhamd et al. (2018) in camel approved that fungiform reaching to 110 days of gestation, growth in the form of epithelial projection extending from mesenchymal cores. Tadjalli and Pazhoomand (2004) studied lamb and reported that the fungiform were oval, mushroom like structures with fine elevation from dorsum to scattered through filiform papillae on tip and corpus of tongue. The recorded variations in shape, dimeter and size of these papillae are adaptation with food type, dietary intake, feeding and mastication pattern. At eight months of age, the circumvallate papillae appear as large in size, flattened, and well-circumscribed structures comparatively with the pervious results of same papillae, exhibiting noticeable morpho-histological heterogeneity across different developmental stages. These papillae display considerable diversity in shape, pattern, and size, reflecting progressive stages of growth and characteristically surrounded by deep circular trenches with aligned in two parallel rows on either side of tongue. These observations are consistent with the findings reported in camel by Gad-Allah et al. (2015) and Abou-Elhamd et al. (2018). They described the initial appearance of vallate papillae as circular grooves formed due to desquamation of superficial epithelial layers accompanied by differential growth of the deeper epithelial components along the groove. These results were in contrast with Dougbag (1988). They conform that taste buds distributed on dorsal surface of vallate papillae. The shape and size of the lingual papillae undergo changes during postnatal development due to a variety of physiological, anatomical, and functional factors. These changes are part of normal growth and are influenced by genetic, environmental, and functional factors. The differences in results with others animals elucidated different in species and the variation in the process of onset of appearance of the lingual papillae during prenatal life in different species might be due to variations in the development of tongue period according to species. Results obtained using scanning electron microscopy indicated distinct spatial organization and morphological features of the papilla. They reflect functional adaptation of ruminant tongue to its dietary habits where some the fungiform papillae have no taste buds act to increase surface friction, aiding in the movement of rough, fibrous plant materials and the fungiform and circumvallate papillae with taste buds are involved in sensory reception. Morpho-structural and situation of the fungiform papilla were comparable to previously documented by Kurtul and Atalgın (2008) in Saanen goat, by Tadjalli and Pazhoomand (2004) in lamb and de Paz Cabello et al. (1988) in cattle. A distinct gustatory groove accompanied by a prominent annular fold encircling the vallate papillae has been previously reported in the Saanen goat by Kurtul and

Atalgın (2008), in lamb by Tadjalli and Pazhoomand (2004), in cow by de Paz Cabello et al. (1988), in camel by Eerdunchaolu et al. (2001), and in buffalo by Scala et al. (1995). In these studied animals, the surface of the vallate papillae appears flat with an irregular contour.

Conclusions: This study revealed age-dependent morphological and histological changes of fungiform and vallate papillae lamb tongue. At two months, the nipples appeared immature, with flat-shaped fungiform nipples and moderately sized circumvallate nipples arranged in irregular rows. By eight months, these papillae showed advanced development. Fungiform papillae became large, mushroom-shaped, and more numerous. Circumvallate papillae became larger, well-organized in V-shaped patterns, and surrounded by deeper trenches. Histologically, both types showed increased keratinization, vascularization, and glandular development, particularly von-Ebner and weber glands. These findings highlight the dynamic nature of postnatal tongue development and the maturation of gustatory structures in sheep.

Novelty statement

The current study outlines the first integrated postnatal morphological, histological, developmental and ultrastructural analysis of fungiform and circumvallate gustatory papillae in the tongue of Iraqi lambs. It reveals age-dependent structural maturation of gustatory papillae and documents, for the first time, the histological association of von-Ebner and weber glands with circumvallate papillae during postnatal development.

Author's contribution

All authors confirm that they contributed equally to the paper.

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Data availability

The datasets used for analysis during are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The experimental procedures were approved by the Institutional Animal Ethics Committee and conducted at the Veterinary Medicine College, Al-Qassim Green University, Iraq. Ethical regulation of this work was assigned by the university research committee and adhered to the

guidelines of the American Veterinary Medical under approval number (qgec/2/2025 in 13/9/2025).

Conflict of interest

The authors declare no conflict of interest.

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چکیده

هدف: پاپیلاهای چشایی زبان نقش اساسی در درک مزه و عملکرد دهانی در پستانداران دارند. تکامل پس از تولد آن‌ها با بلوغ ساختاری و عملکردی زبان مرتبط است. با این حال، اطلاعات دقیقی درباره تغییرات مورفولوژیک، بافت‌شناسی و فراساختاری پاپیلاهای قارچی (fungiform) و حلقوی (circumvallate) در گوسفندان بومی عراق در مراحل مختلف رشد پس از تولد محدود است. هدف این مطالعه بررسی تغییرات مورفولوژیک، هیستولوژیک و میکروسکوپ الکترونی روبشی (SEM) در پاپیلاهای چشایی زبان گوسفند (Ovis aries) در مراحل مختلف رشد پس از تولد بود.

مواد و روش‌ها: بیست نمونه زبان از گوسفندان بومی عراق از کشتارگاه‌های استان‌های نجف و بابل جمع‌آوری شد. نمونه‌ها بر اساس سن و دندان‌بندی به دو گروه تقسیم شدند: گروه اول شامل بره‌های دو ماهه و گروه دوم شامل گوسفندان بالغ هشت ماهه بود. بررسی ماکروسکوپی، روش‌های استاندارد هیستولوژی و میکروسکوپ الکترونی روبشی برای ارزیابی ویژگی‌های رشدی پاپیلاهای قارچی و حلقوی و غدد زبانی مرتبط استفاده شد.

نتایج: در بره‌های دو ماهه، پاپیلاهای قارچی نابالغ، صاف و پراکنده در میان پاپیلاهای فیلی‌فرم در سطح پشتی زبان مشاهده شدند، در حالی که پاپیلاهای حلقوی کوچک تا متوسط بوده و به صورت دو ردیف نامنظم قرار داشتند. در سن هشت ماهگی، پاپیلاهای قارچی به‌طور واضح بالغ شده و به شکل برجستگی‌های بزرگ، صاف و قارچی شکل ظاهر شدند. پاپیلاهای حلقوی نیز بزرگ‌تر، مشخص‌تر و دارای شیارهای دایره‌ای واضح شدند و در بخش دورسال جانبی تنه زبان در نزدیکی ریشه زبان قرار گرفتند. از نظر بافت‌شناسی، پاپیلاهای چشایی در هر دو سن مشاهده شدند، اما در مراحل مختلف رشد تفاوت‌هایی در شکل و اندازه آن‌ها وجود داشت. دو نوع غده زبانی شناسایی شد: غدد سروزی فون ابنر که با پاپیلاهای حلقوی مرتبط بودند و غدد موکوسی یا مختلط وبر که در عمق عضلات ریشه زبان قرار داشتند.

نتیجه‌گیری: پاپیلاهای چشایی در گوسفندان بومی عراق طی رشد پس از تولد دچار تغییرات قابل توجه مورفولوژیک، بافت‌شناسی و فراساختاری می‌شوند. این تغییرات وابسته به سن، در اندازه، شکل، سازمان‌دهی و ارتباط غددی پاپیلاهای قارچی و حلقوی نقش داشته و نشان‌دهنده سازگاری عملکردی آن‌ها با رشد است.

کلمات کلیدی: پاپیلا حلقوی، پاپیلا قارچی، تکامل پس از تولد، زبان گوسفند، میکروسکوپ روبشی

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