



Histology of the lingual vallate papillae of the dromedary camel (*Camelus dromedarius*)

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KEYWORDS

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ABSTRACT

The present study aimed at investigating the histological structures of the vallate papillae of the tongue of the dromedary camel. Samples were taken from the tongues of 5 healthy adult dromedary camels, then processed by standard routine histological technique. The vallate papillae were broad, encircled by a distinctive sulcus, and exhibited concave dorsal surfaces. The papillae were covered with stratified squamous epithelium which was made up of several layers of cells arranged from the basement membrane to the outer surface as follows: basal layer; spinosum layer; squamous layer; corneum layer. The lamina propria sub mucosa showed two well-defined layers. The first one was located beneath the epithelium and characterized by loose connective tissue. The second layer was much thicker and composed mainly of dense irregular collagenous fibres. Deep to the circumvallate papilla was a group of prominent tubulo-acinar glands (von Ebner's glands). The main ducts of the glands opened directly into the surrounding sulcus at different levels. In general, the histological structures of the vallate papillae of the dromedary camel were similar to those of other domestic mammals. The well-developed von Ebner's glands suggested their abundant serous secretion that reflected on the high capability of gustation.

INTRODUCTION

Dromedary camel (*Camelus dromedarius*) is considered as an important livestock species which adapted to live in regions with high temperature and dry climate (Al-Dahash and Sassi, 2009). Large population of this unique animal is existed in the arid lands of Eastern Africa including Sudan, Somalia, Ethiopia, Kenya and Djibouti (Gebreyohanes and Assen, 2017).

Camel has developed several morphological adaptations to live in harsh conditions. One of these adaptations is that the dromedary camel has very sturdy mouth to maintain the efficient feeding of thorny and rough-stem plants which naturally grow in the arid regions (El Sharaby *et al.*, 2012). In addition, several studies on the mouth of camel have described the anatomical features of camel tongue (Qayyum *et al.*, 1988;

Takehana *et al.*, 2001; Peng *et al.*, 2008; Salehi *et al.*, 2010; El Sharaby *et al.*, 2012; Thanvi *et al.*, 2020). With regards to its dorsal surface, similar to ruminants, the tongue of camel is characterized by the presence of fungiform and vallate papillae, and the lack of foliate papillae as well (Thanvi *et al.*, 2020). Generally, the vallate papillae are classified as gustatory papillae with taste buds (Abou-Elhamd *et al.*, 2018). Each papilla is encircled by a papillary groove and an annular pad of the surrounding lingual mucosa (Qayyum *et al.*, 1988). Although several studies have displayed the microstructure of the vallate papillae of camel, it is believed that detailed histological structures are much less documented. Therefore, the present study was conducted to provide histological information on the vallate papillae of the tongue of the dromedary camel.

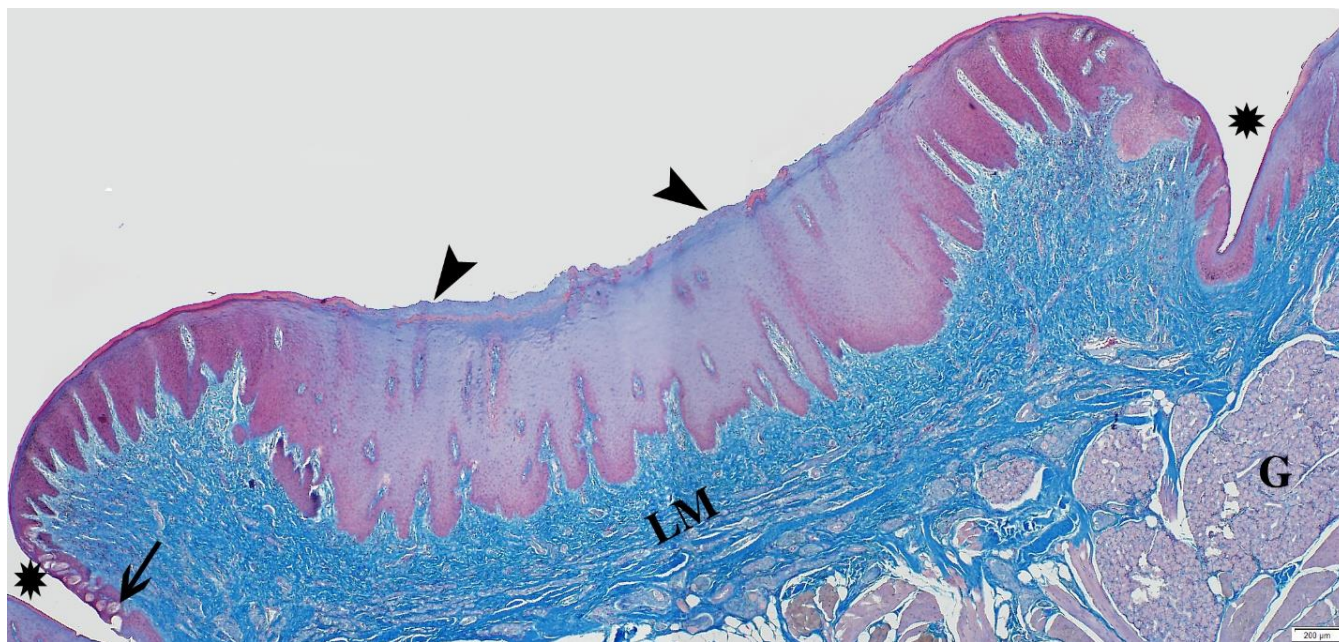


Figure 1: Photomicrograph of vallate papilla showing the concave dorsal surface with non-keratinized stratified squamous epithelium (arrowheads), sulcus (stars), taste buds (arrow), lamina propria submucosa (LM), and von Ebner's glands (G). **Masson's trichrome stain.**

MATERIALS AND METHODS

Five apparently healthy adult dromedary camels (aged 5 to 7 years) were used in this study. The animals were slaughtered at a local abattoir in Omdurman city, Sudan. Histological samples were taken from the dorsal surface of the animal tongues within

20 min after slaughter. Samples were fixed in 10 % neutral buffered formalin (pH 7.4) for 5 days and then processed for routine histological technique (Bancroft and Gamble, 2008). Briefly, specimens were dehydrated in a series of alcohol dilutions, cleared in xylene, and embedded in paraffin wax.

Sections of 4-5 μm were cut, deparaffinized in xylene, and rehydrated in decreasing concentrations of alcohol. In the next steps, sections were stained with heamatoxylin and Eosin (H&E), or Masson's trichrome stains.

The stained sections were examined using a light microscope (Olympus BX63-Japan) connected to a digital camera (Olympus DP72). Photomicrographs were captured using video image software (Cell Sens 510- Olympus).

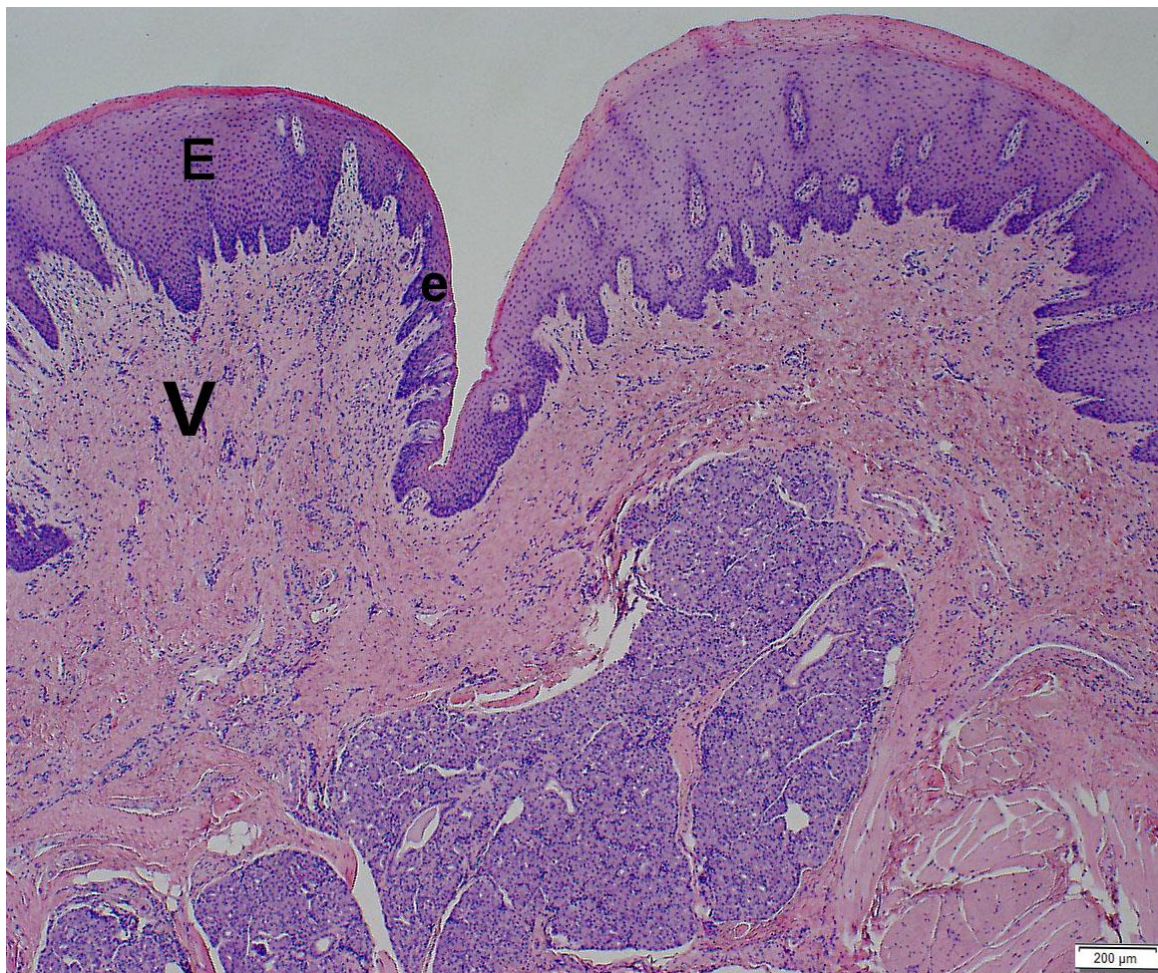


Fig. 2: Photomicrograph of vallate papilla (V) showing thick epithelium (E) at the dorsal surface and thin epithelium at the lateral surface (e). **H&E stain.**

RESULTS

The vallate papilla was broad, encircled by a distinctive sulcus, and exhibited a concave dorsal surface. It was covered by stratified squamous epithelium. Immediately beneath the epithelium was a well-defined lamina propria submucosa (Fig. 1).

The stratified squamous epithelium covered the papilla was either non-keratinized or parakeratinized. The non-keratinized

epithelium was seen at the concave part of the dorsal papillary surface (Fig. 1). The parakeratinized epithelium was observed in the other regions of the papilla. The thickness of the epithelium varied distinctively according to the region. The greater thickness was seen on the upper surface of the papilla whereas the lesser one was located at the lateral surface of the sulcus (Fig. 2).

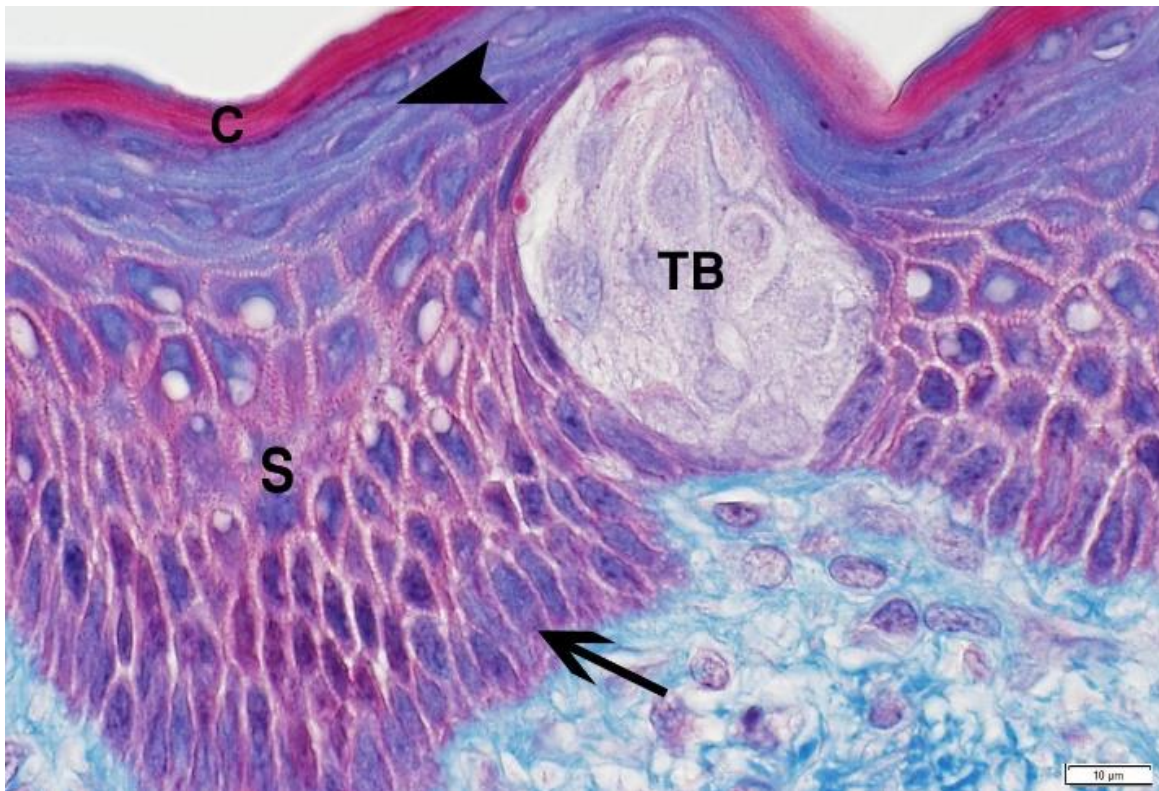


Fig. 3: Photomicrograph of the vallate papilla showing the layers of the stratified squamous epithelium. The basal layer of columnar cells (arrow), spinosum layer (S) of stratified cells with prominent spinous processes, squamous layer (arrowhead), and corneum layer (C). Taste bud within the epithelium (TB). **Masson's trichrome stain.**

The epithelium was composed of several layers of cells arranged from the basement membrane to the outer surface as follows: basal layer; spinosum layer; squamous layer; corneum layer. The basal layer consisted of a single layer of columnar cells. Some of these cells showed tiny spinous processes in their lateral and upper surfaces. The spinosum was composed of multiple layers of cells which were predominantly polyhedral in shape. They exhibited numerous well-developed spinous processes, as compared to the cells of the basal layer, radiated from their outer surfaces (Fig. 3). The squamous layer comprised different layers of flattened cells which had small spinous processes. The latter reduced gradually in the layers towards the outer surface (Fig. 3).

Taste buds were located in the lateral side of the vallate papilla. They were spherical in shape and connected to the groove by taste pores (Fig. 4A). The taste buds presented two types of cells, large spindle-shaped neuroepithelial cells with prominent nuclei, and small sustentacular cells, some of which showed mitotic activity (Fig. 4B, C). Nonmyelinated nerve was

observed emerging from the basal area of the taste buds (Fig. 4A).

The lamina propria sub mucosa showed two well-defined layers. The first layer was located beneath the epithelium, and characterized by loose connective tissue. The second layer was much thicker and composed mainly of dense irregular collagenous fibres (Fig. 5). Deep to the circumvallate papilla, the lamina propria submucosa exhibited a group of small tubulo-acinar glands (von Ebner's glands). Each gland was covered by a connective tissue capsule predominantly composed of collagenous fibres. Many thin trabeculae were observed extending from the capsule, and divided the gland into lobules. Serous acini separated by collagenous fibres existed within each lobule. The duct system included intralobular and interlobular ducts, both of which were lined by simple cuboidal epithelium, and the main duct was almost lined with stratified cuboidal epithelium. The main ducts of the glands opened directly into the surrounding sulcus at different levels (Fig. 6).

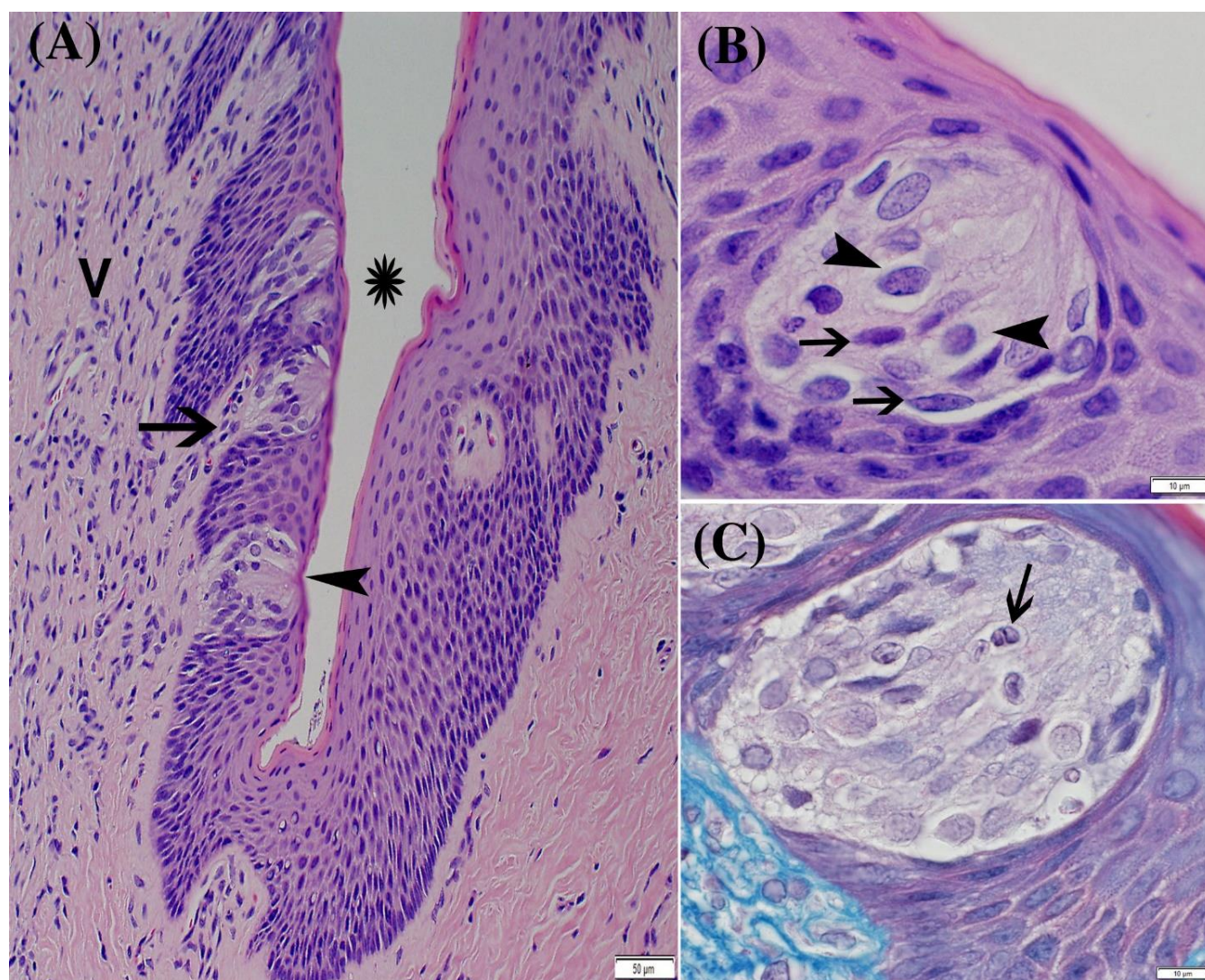


Fig. 4: Photomicrograph of the lateral surface of a vallate papilla (V). A: gustatory sulcus (star), taste pore (arrowhead), nonmyelinated nerve (arrow) arising from the base of the taste bud. B: spindle-shaped neuroepithelial cells with prominent nuclei (arrowheads), sustentacular cells (arrows). C: sustentacular cell showing mitotic activity (arrow). A, H&E stain. B & C, Masson's trichrome stain

DISCUSSION

In the present study, the general histological structure of the vallate papillae of the camel was similar to the findings reported in camel by Qayyum *et al.* (1988) and El Sharaby *et al.* (2012), as well as in other domestic animals (Kobayashi *et al.*, 2005; Eurell and Frappier, 2006).

In this study, the first three layers (basal, spinosum, and squamous layers) of the stratified epithelium displayed cells with spinous processes. However, such spinous processes were less developed in the basal and squamous layers as compared

to the spinosum layer. Similar observation was indicated in previous study carried out on donkey by Abd-Elnaeim *et al.* (2002).

Taste buds in the current findings were located at the lateral side of the vallate papillae but no buds were observed within the dorsal surface of the papillae. Similar findings have been reported by Takehana *et al.* (2001) in bactrian camel and El Sharaby *et al.* (2012) in dromedary camel. However, taste buds were reported in the dorsal surface of the tongue of camel foetus during the third trimester of gestation (Abou-Elhamd *et al.*, 2018). The absence of the taste buds in the dorsal surface

of the tongue of adult camel might have been due to a postnatal development as a result of cellular involution that may

accompany increasing depths of the papillary circular grooves (Abou-Elhamd *et al.*, 2018).

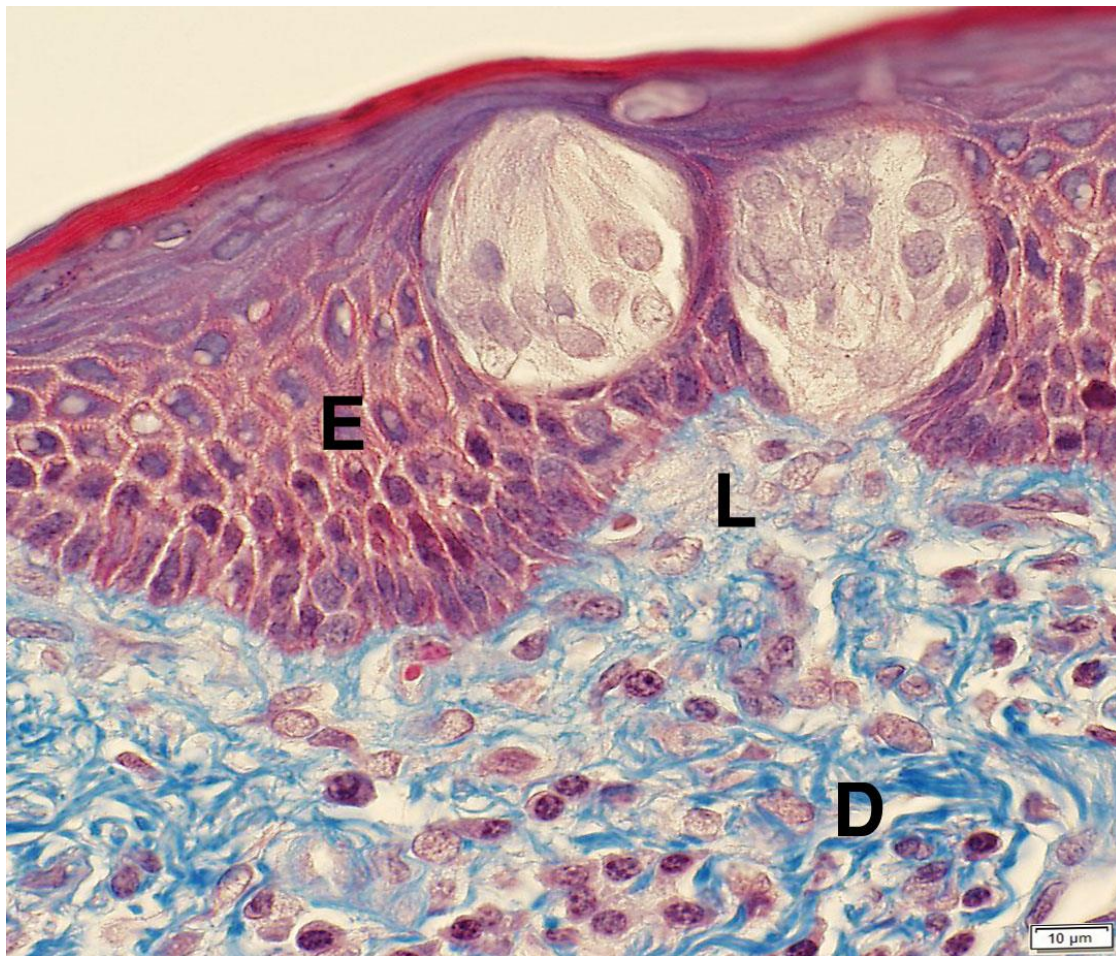


Fig. 5: Photomicrograph of a vallate papilla showing the lamina propria submucosa. Loose connective tissue (L) with fine collagenous fibres located beneath the epithelium (E). Dense connective tissue (D) with irregular connective tissue fibres. **Masson's trichrome stain**

The histological structures of the taste buds in this study were similar to previous investigations conducted in mammals (Abd-Elnaeim *et al.*, 2002; Shao *et al.*, 2010; El Sharaby *et al.*, 2012; Mescher, 2018). Nonetheless, the taste buds of camel need further electron microscopical investigations to identify their fine cellular structures.

In this study, prominent von Ebner's glands were observed in the lamina propria submucosa deep to the circumvallate papilla. Each gland emptied into the sulcus through a separate duct. It is known that the continuous flow of the serous secretion over the taste buds would wash away food particles and subsequently the taste buds can receive and process new

gustatory stimuli (Mescher, 2018). Therefore, it is plausible that the presence of well-developed von Ebner's glands along with their numerous ducts may indicate the abundant secretion of the glands, resulting in effective gustation of the dromedary camel.

The general histological structures of the vallate papillae of the dromedary camel were similar to those of other domestic mammals. The well-developed von Ebner's glands suggested their abundant serous secretion that reflected on the high capability of gustation. Further electron microscopical studies are suggested in camels to elucidate the fine structures of the taste buds.

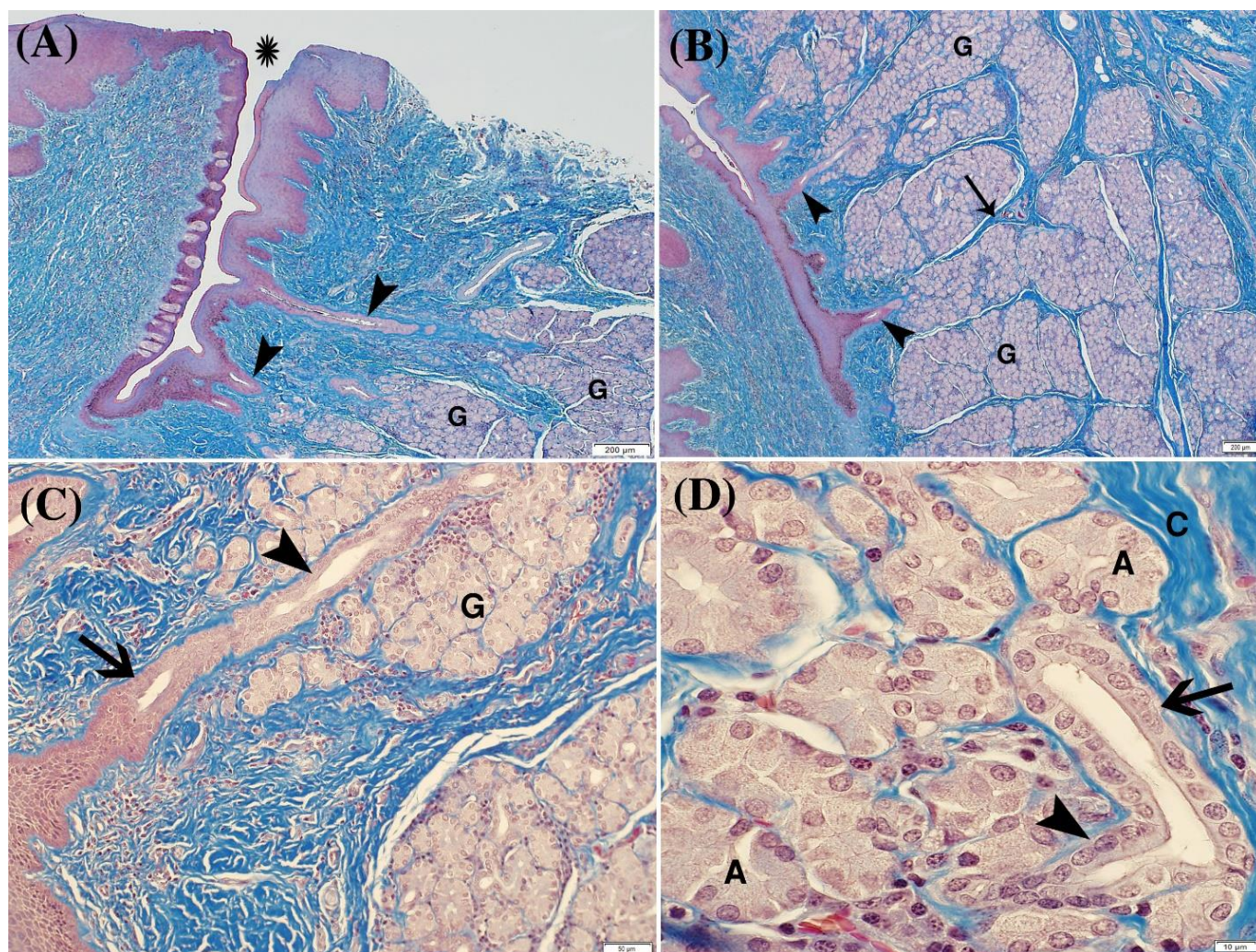


Fig. 6: Photomicrograph of vallate papilla showing von Ebner's glands. A and B: main ducts (arrowheads) of the gland (G) open into the gustatory sulcus (star). B: connective tissue capsule (arrow) surrounding the gland. C: Interlobular duct with simple cuboidal epithelium (arrowhead), and the main duct with stratified cuboidal epithelium (arrow) of the serous gland (G). D: dense collagenous fibres of the capsule (C) surrounding the gland; serous acini (A); intralobular duct (arrowhead) opens into the intralobular duct (arrow). **Masson's trichrome stain.**

CONCLUSION

The general histological structures of the vallate papillae of the dromedary camel were similar to those of other domestic mammals. The well-developed von Ebner's glands suggested their abundant serous secretion that reflected on the high capability of gustation. Further electron microscopical studies are suggested in camels to elucidate the fine structures of the taste buds.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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