



Morphology of Lingual Papillae of Bear: Light Microscopic and SEM Study

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ABSTRACT

The morphology and histology of the tongue in two adult Asian bears were examined by light and scanning electron microscopy. Four types of papillae; filiform, conical, fungiform and vallate were observed on the dorsum lingua. Numerous filiform papillae were visible on the lingual apex and body, while, fungiform papillae were scattered among them. The discoid-shaped fungiform papillae were more densely on the lingual apex. The filiform papillae were extended to the lateral margin of the lingual body. They were transformed into the conical papillae on the caudal part of the lingual body and root. Totally, 14-16 of spheroid and oval vallate papillae at different sizes were present on the root of the tongue. The foliate papillae were absent. Histological sections showed that the conical papillae represented a flat pyramidal shape with several slender accessory processes. The tongue was covered by a keratinized stratified squamous epithelium. A dense connective tissue composed the lamina propria and thick masses of striated muscles constituted the bulk of the tongue. The lamina propria didn't penetrate completely into the filiform papillae of the lateral margin. Numerous forms of lingual salivary glands with seromucous secretions were intermingled with the lingual muscles in the lingual root.

INTRODUCTION

The tongue is a principle organ, has a direct functional role in the prehension, mastication, and swallowing of food and indirect effect in helping the animal to adapt to its environment (Darwish, 2012). The anatomical and morphological features of the tongue are determined by the feeding habits of a given animal species and habitat in which animal lives (McClung and Goldberg, 2000; Schwenk, 2000; Iwasaki, 2002; Darwish, 2012).

Lingual papillae, distributed on the dorsal surface of the tongue, are the most important features that can be

investigated from an anatomical point of view. Generally, there are four types of lingual papillae on the dorsal lingual surface of mammalian species namely; filiform, fungiform, vallate and foliate papillae (Kobayashi *et al.*, 1989). However, the shape, size, organization and presence of these papillae can be different among mammalian species (Jackowiak and Godinicki, 2005; Witt and Miller, 1992; Emura *et al.*, 2000). For instance, foliate papillae are seen usually in equine species and lenticular papillae are a distinct feature of ruminant species (Goodarzi and Shah-hoseini, 2015).

The tongue of various species of the order Carnivora such as cat (Boshel *et al.*, 1982), dog (Iwasaki and Sakata, 1985), Bush dog (Emura *et al.*, 2000), tiger (Emura *et al.*, 2004), lion (Emura *et al.*, 2003) and silver fox (Jackowiak and Godinicki, 2004) were subjected to anatomical

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Authors' Contribution

EHI designed the research. AFE and AA wrote the manuscript. MK and RY provided the samples. SD revised the paper and DM performed histological techniques.

Key words

Bear, Lingual papillae, Morphology, Tongue, SEM

inspection.

The purpose of the present study was to examine the macroscopic and microscopic morphology of the lingual papillae of the bear and compare the results with those previously reported in other species.

MATERIALS AND METHODS

Sampling

The specimens of the present study were provided from two male individuals that were collected after dying due to shooting by hunters. The animals were found in a poor physical condition and referred to the Faculty of Veterinary Medicine, Razi University. The cooperation of Natural Resources Organization of the Kermanshah city is highly appreciated. Immediately after dying, the whole tongue was dissected and removed from the oral cavity and fixed in 10% neutral buffered formaldehyde.

Gross examination

For macroscopic observations, the tongues were examined using a stereomicroscope (UNICO, ZM191, USA) connected to a digital camera (Dinocapture V.2) and anatomical features on the dorsal surface of the tongues were photographed.

SEM examination

For scanning electron microscopy, the tongues were fixed in 2.5% glutaraldehyde for 48 h. The samples were then post-fixed with 1% osmium tetroxide solution. After dehydration in ascending concentrations of ethanol, the specimens were dried in a freeze dryer, mounted on the aluminum stubs and coated with gold. Finally, the specimens were examined under a scanning electron microscope (Quanta 450, FEI, USA) at accelerating voltages of 15 kV (Goodarzi, 2014).

Light microscopy

Following immediate dissection, the tongues were fixed in 10% neutral buffer formaldehyde for two weeks. Afterwards, the 1×1 cm specimens were removed from the apex, body and root and were processed and embedded in paraffin for light microscopic observations. The paraffin-embedded blocks were sectioned at 5µm thickness and stained with Masson's trichrome method (Goodarzi *et al.*, 2019).

RESULTS

In macroscopic observation, the filiform papillae covered the dorsal surface of the lingual apex and lingual body, while, fungiform papillae were scattered among

them (Fig. 1a). The discoid-shaped fungiform papillae were more densely on the tip of the lingual apex. The filiform papillae were extended to the lateral margin of the lingual body (Fig. 2a). The filiform papillae were transformed into the conical papillae on the caudal part of the lingual body and lingual root (Fig. 3a). Totally, 14-16 of spheroid and oval vallate papillae at different sizes were present posteriorly on the root of the tongue (Fig. 4a). There were no foliate papillae on the lingual root. In SEM examination, the dorsal surface of the lingual apex was covered with numerous long and slender filiform papillae which their sharp tips directed caudally (Fig. 1b, 1c). The discoid fungiform papillae were scattered among the filiform papillae mainly on the lingual apex (Fig. 1b). At higher magnification, some taste pores could be seen between the shingle-like flattened cells of a stratified squamous epithelium covered the surface (Fig. 1b). The lateral surface of the tongue was covered with caudally-directed filiform papillae (Fig. 2b). The conical papillae on the lingual body were represented by a flat pyramidal shape with several slender accessory processes (Fig. 3b). On the lingual root, the body of the vallate papillae was encircled by a wide continuous gustatory groove and a thick annular pad of the lingual mucosa. The dorsal surface of the vallate papillae was highly irregular which appears to be lobulated and epithelial lining revealed irregular microplacae (Fig. 4b, 4c).

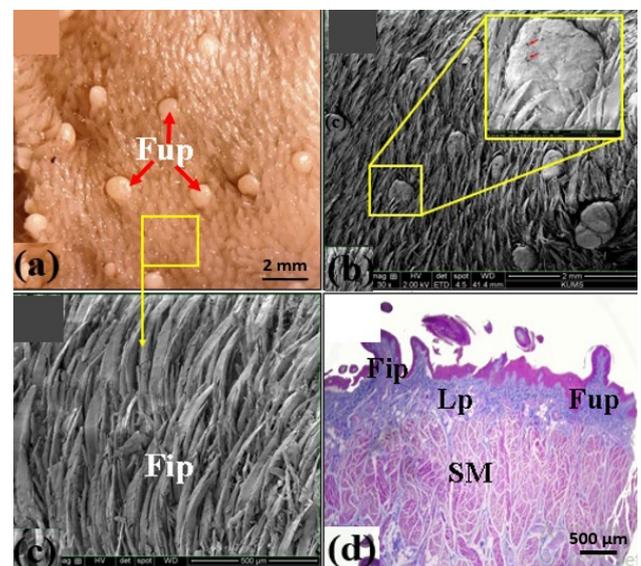


Fig. 1. Light microscopical (a), scanning electron microscopic structure (b, c), and structure of the dorsal surface of the tongue of bear (d). Fup, fungiform papillae; red arrows, taste pores; Fip, filiform papillae; Lp, lamina propria; SM, striated muscles; yellow rectangles magnify the fungiform and filiform papillae in (b) and (c), respectively.

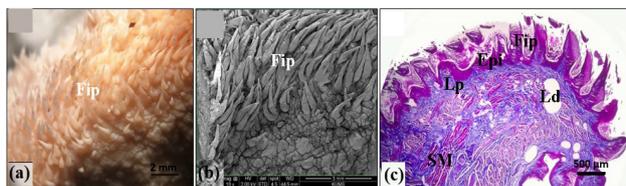


Fig. 2. Light microscopical (a), scanning electron microscopic (b), and histological (Masson's trichrome staining) of the lateral border of the tongue of bear (c). Lp, lamina propria; Ld, lipid droplets. For other abbreviations, see Fig. 1.

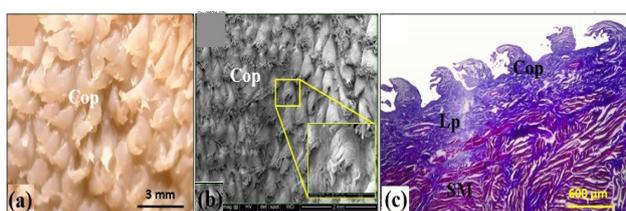


Fig. 3. Light microscopical (a), scanning electron microscopic (b), and histological (Masson's trichrome staining) structure of the lingual body in bear (c). Cop, conical papillae; Lp, lamina propria; SM, striated muscles. Yellow rectangle shows higher magnification of a conical papilla.

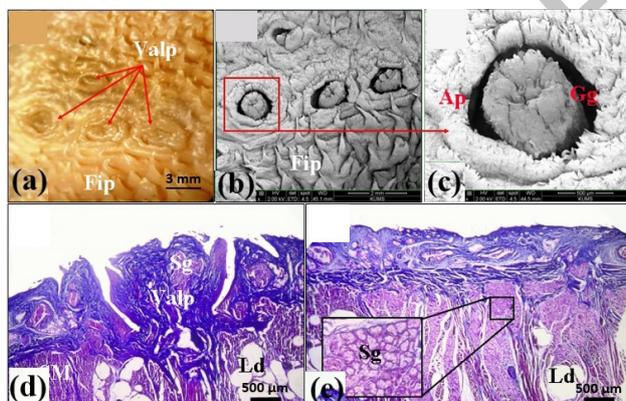


Fig. 4. Light microscopical (a), scanning electron microscopic (b), and histological (Masson's trichrome staining) structure of the lingual root in bear. Valp, vallate papillae; Fip, filiform papillae (c,d,e); Ap, annular pad; Gg, gustatory groove; Sg, salivary gland. For other abbreviations see Figure 1, 2 and 3. Red and black rectangles in (b) and (e) show higher magnification of a vallate papilla and a salivary gland accini.

Light microscopic evaluation showed that the tongue was covered by a keratinized stratified squamous epithelium. A dense connective tissue composed the lamina propria and thick masses of striated muscles

constituted the bulk of the tongue (Fig. 1d). The lamina propria didn't penetrate completely into the filiform papillae of the lateral border (Fig. 2c). Some lingual gland were present in the lamina propria of the vallate papillae (Fig. 4d). Furthermore, numerous lingual salivary glands with seromucous appearance were intermingled with the lingual muscles in the lingual root (Fig. 4e).

DISCUSSION

The lingual prominence presents in many species such as rodents (Ciena *et al.*, 2013; Kilinc *et al.*, 2010) and ruminants (Zheng and Kobayashi, 2006), while it was not seen in carnivores and Pigs (Emura *et al.*, 2006; Kumar and Bate, 2004). In general, lingual prominence is a characteristic feature of many herbivorous mammals which helps them to cellulose-rich materials against hard palate (Massoud and Abumandour, 2019). The tongue of the bear has no lingual prominence nor median sulcus.

Due to difference in feeding habits, diet, and handling of food inside the buccal cavity, the lingual papillae might be varied among species in their shape, size, number, orientation and distribution (Iwasaki, 1992; Iwasaki *et al.*, 1996; Abumandour and El-Bakary, 2013; Emura *et al.*, 2002).

In the present study, four types of lingual papillae were found on the lingual mucosa of the bear tongue. Two of them were mechanical type and represented by filiform and conical forms, while the other two represented the gustatory papillae which were fungiform and vallate papillae. Numerous types of the filiform papillae can be seen among mammalian species. Moreover, different shapes of filiform papillae may be present according to their location on the lingual mucosa (Yoshimura *et al.*, 2009). Three types in rats and mice (Iwasaki *et al.*, 1987a, b), and six types of filiform papillae in Egyptian fruit bat were reported previously (Abumandour and El-Bakary, 2013).

Emura *et al.* (2001) reported smooth finger-like projections as filiform papillae on the margin of the lingual apex of newborn Asian black bear, while, they were bud-shaped on the lingual body. In the present study, the filiform papillae had a long and slender appearance with caudally-directed sharp tips. These observations were similar to those reported in the tiger (Emura *et al.*, 2004), fishing cat (Emura *et al.*, 2014), raccoon dog and fox (Emura *et al.*, 2006). The shape and number of the papillae showed a marked change from the lingual apex toward the lingual body. This finding is consistent with the observations in the cat (Bushell *et al.*, 1982), newborn panther (Emura *et al.*, 2001), and lion (Emura *et al.*, 2003). The lingual papillae on the mid-portion of the tongue of the bear were

conical with several accessory processes, similar to those reported in the raccoon dog and fox (Emura *et al.*, 2006).

The fungiform papillae can be different in their shape and distribution among mammalian species. The shape of the fungiform papillae has a wide variety of rectangle in Egyptian fruit bat (Abumandour and El-Bakary, 2013), dome-shape in dog and fox (Emura *et al.*, 2006), Mushroom-shape in the rat (Nasr *et al.*, 2012; Kurtul and Atalgin, 2008) and elliptical or circular in *Sorex caecutiens* (Park and Lee, 2009). Two types of fungiform papillae including hemispherical and club-shaped papillae were reported in the newborn black Asian bear (Emura *et al.*, 2001), tiger (Emura *et al.*, 2004) and jaguar (Emura *et al.*, 2013). The fungiform papillae of the present study had a discoid shape and the existence of taste pores on the apical periphery of the papillae suggest that they have a gustatory role as revealed in other species (Kilinc *et al.*, 2010; Chamorro *et al.*, 1986; Goodarzi, 2014).

The fungiform papillae in the guinea pig (Kobayashi, 1990), goat (Kurtul and Atalgin, 2008), Persian squirrel (Goodarzi, 2014) and maned sloth (Benetti *et al.*, 2009) are reported to be concentrated on the lingual apex and also on both lateral borders. However, fungiform papillae in the common shrew are restricted to the lingual corpus (Jackowiak *et al.*, 2004). Nasr (2012) reported that fungiform papillae of *Erinaceus auritus* are populated on the apex of the tongue and form clusters of two or three papillae. The fungiform papillae of the bear were scattered on the dorsum lingua with a more population on the tip of the lingual apex.

The vallate papillae can be and absent in Cape hyrax (Emura *et al.*, 2008) and hematophagous bats (Masuko *et al.*, 2007), one in mouse, rat and hamster. (Kobayashi *et al.*, 1989; Iwasaki *et al.*, 1997), two in rabbit, guinea pig and opossum (Kulawik and Godynicki, 2007; Kobayashi, 1990; Krause and Cutts, 1982), three in common tree shrew, flying squirrel, Persian squirrel, American beaver and Egyptian fruit bat (Chunhabundit *et al.*, 1992; Goodarzi, 2014; Abumandour and El-Bakary, 2013), 3–6 in the dog and cat (Boshell *et al.*, 1982; Kobayashi *et al.*, 1988) five in the bush dog (Emura *et al.*, 2000) 10 in panther, 5-9 in the lion (Emura *et al.*, 2003) and 4 papillae in the tiger (Emura *et al.*, 2004). Conclusively, many species-specific characteristics in the morphology of the vallate papillae has been shown. For instance, small conical and filiform projection on the dorsal surface of the papillae in bush dog donkey (Emura *et al.*, 2000) and multiple secondary papillae in giant panda (Pastor *et al.*, 2008) were reported.

In this study, the bear showed 14-16 vallate papillae which were more than that was reported by Emura *et al.* (2001) in the newborn Asian black bear (7-8 papillae). The structure of the vallate papillae can be varied. The vallate

papillae of the jaguar were surrounded by a discontinuous annular pad and a very shallow groove (Emura *et al.*, 2013), while in the newborn Asian black bear (Emura *et al.*, 2001) and equine (Chamorro *et al.*, 1986) the vallate papillae were composed of a primary papilla which was divided into several secondary papillae by intermediate grooves.

In the tiger, the vallate papillae had an irregular surface with the openings of glandular ducts (Emura *et al.*, 2004). Although observation of the this work such as the presence of lingual salivary glands in the connective tissue of the vallate papillae and opening of glandular ducts on the dorsal surface of this papillae indicated similarity between the tiger and bear, however, the structure of the vallate papillae in the bear was similar to that of the panther reported by Emura *et al.* (2001).

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Statement of conflict of interest

The authors have declared no conflict of interest.

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