

Comparative Anatomical, Histological and Histochemical Study of Tongue in Two Species of Insectivorous Vertebrates

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Abstract: This study aimed to determine the anatomical features and histological structure as well as some histochemical aspects of tongue of two species of insectivorous vertebrates, which differ in their classification, habitat and activity (lizard, *Trachylepis vittata* and the Long-eared hedgehog, *Hemiechinus auritus*) by using light microscope. The results show that the tongue of the two species is differ in size, color and shape, three parts are distinguished in the dorsal surface of the tongue, apex, body and root. Histologically, the entire dorsal surface of tongue in the two species is covered by lingual papillae which appear of many types. The filiform and fungiform papillae are main types of lingual papillae which are different among the two species in height, thickness and subtypes. There are distinct lingual papillae appeared in *T. vittata* that was cuboid papillae, also the circumvallate papillae appeared only in the *H. auritus*. The stratified squamous epithelium tissue surrounded tongue in the two species that is almost non keratinized in *T. vittata* but it is keratinized in *H. auritus* and contain a number of taste buds. The lamina propria in the two species is consisted of dense connective tissue which contained many structures that is different among the two species. The mucus glands appeared in *T. vittata* and absent in *H. auritus*. Histochemically, the tongue of the two species is positive for carbohydrates stains and negative with others histochemical stains. In conclusion, the tongue compounds of *T. vittata* are more appropriate to feeding manner on insects from that of *H. auritus* tongue.

Key words: Tongue; Taste buds; Lingual papillae; *Trachylepis vittata*; *Hemiechinus auritus*.

INTRODUCTION

Feeding mechanism is an important factor that determines the success of adaptation and persistence of vertebrates to their environment (Roth and Wake, 1989; Darwish, 2012). The tongue is often considered a key innovation in the evolution of a terrestrial lifestyle as it allows animals to transport food particles through the oral cavity (Iwasaki, 2002; Herrel *et al.*, 2005). Also, the tongue and hyobranchial system has been coopted for a wide diversity of functions such as prey capture, drinking, breathing, and defensive behaviors (Bels *et al.*, 1994; Schwenk, 1995; Darwish, 2012). Moreover, there are fairly strong correlations between tongue anatomy and its functional roles (e.g., food transport and manipulation), and the environmental conditions in which animals use their tongues or hyobranchial system (i.e., water vs. air) (McClung and Goldberg, 2000; Schwenk, 2000; Iwasaki, 2002; Herrel *et al.*, 2005; Darwish, 2012).

The shape and structure of the tongue differ significantly among animal species, reflecting the various functions of each respective tongue (Iwasaki, 2002; Santos *et al.*, 2011). In the anatomy of the tongue, three parts may be distinguished: the apex, the body and the root (Jackowiak and Godynicki, 2005; Dehkordi *et al.*, 2010). On the surface of tongue, there are various kinds of lingual papillae including filiform, fungiform, circumvallate and foliate papillae, each having different morphological structure and shape. Distribution of these lingual papillae has been considered to be related to species eating habits and vocalization (Fawcett, 1986; Park *et al.*, 2009). All the papillae are covered by stratified squamous epithelium that differs by the thickness and keratinization only (Iwasaki and Miyata, 1985; Wassif, 2001).

Among the vertebrates, the reptilian tongues are characterized by morphological and functional variations among species (Cooper, 1995a; Cooper, 2003; El-Sayyad *et al.*, 2011). Lizards are especially interesting group to investigate the tongue function and morphology in, as the tongue is specialized for different functions in different clades (Cooper, 1995b; Schwenk, 2000; Herrel *et al.*, 2005). In most lizards, the tongue is used for different functions, such as lingual prey prehension in *iguanian* lizards (Schwenk and Throckmorton, 1989; Herrel *et al.*, 1995; Herrel *et al.*, 1998), prey transport and swallowing (Delheusy and Bels, 1992; Herrel *et al.*, 1996; Herrel *et al.*, 1997; Herrel *et al.*, 1998) or defensive display in some scincids (Gans and De Vree, 1985; Herrel *et al.*, 2005), spectacle cleaning in geckoes (Simon, 1983; Herrel *et al.*, 2005), and chemical sampling from the external environment by means of tongue flicks or tongue touches (Schwenk, 1993; Cooper, 1995b; Herrel *et al.*, 1998).

In mammals, the tongue is an important tactile organ contributing significantly to food appreciation. It varies in shape and size and demonstrates morphologic diversity that is greatly influenced by feeding

habits (Hussein and AL-Asadi, 2010). With the exception of primates and some species of Procyonidae (Carnivora), which are using their hands during feeding, most mammals use their mouth exclusively for feeding. In all cases, the tongue plays an important role during feeding, together with the teeth (Iwasaki, 2002).

The morphological characteristics and histological structure of the tongue and lingual papillae have been studied, by using light and electron microscopes, in most vertebrates classes such as amphibians (Mahabady *et al.*, 2010), reptiles (Herrel *et al.*, 1998; Herrel *et al.*, 2001; Wassif, 2001; Herrel *et al.*, 2005; Jamniczky *et al.*, 2009; El-Sayyad *et al.*, 2011; Darwish, 2012), birds (Crole and Soley, 2009; Emura *et al.*, 2008a,b, 2009; Dehkordi *et al.*, 2010; El-Bakary, 2011a; Santos *et al.*, 2011) and Mammals (Ciuccio *et al.*, 2008, 2010; Abayomi *et al.*, 2009; Adeniyi *et al.*, 2010; El-Bakary, 2011b; Nasr *et al.*, 2012; Yoshimura *et al.*, 2012). The aim of this study is to complement the previous studies on the anatomical features and histological structure with emphasis on some histochemical aspects of the tongue in two species of animals from two different classes of vertebrates, which is feed almost the same type of food. (These insectivorous animals are the lizard, *Trachylepis vittata* (Reptilia: Squamata: Olivier, 1804) and Long-eared hedgehog, *Hemiechinus auritus* (Mammalia: Insectivora: Gmelin, 1770)).

MATERIALS AND METHODS

Tongue from eight *T.vittata* and six *H. auritus* of both sexes was used in this study. The animals were collected from different agriculture regions around Mosul area north Iraq. The tongue was dissected out the oral cavity, cleaned, and different morphological features were examined, recorded, and photographed by using digital Sony camera (DSC-W530). The tongue was cut into 5cm specimens and immediately fixed in neutral buffered formalin (8%). Tongue specimens were then dehydrated in ascending series of ethanol alcohol, cleared in xylene, embedded in paraffin wax and Sectioned at (5 μ m) (Drury and Wallington, 1983). The sections were stained for general histological purposes with Delafieds Heamatoxylin and Eosin (HE), Mallory's triple (TS)) and Toluidin blue (TB) Stains (Bancroft and Stevens, 1986). For histochemistry processing, sections were stained with Periodic Acid - Schiff technique (PAS) and Alcian Blue (AB) (pH 2.5) for carbohydrates, with Promophenol blue (PB) for proteins and with Sudan black B (SB) for lipids (Pears, 1985). Histological examination carried out using light microscope (Reichert Neovar Type 300422) and photographed by using MDCE- 5A digital camera.

Result:

Gross Morphology:

Tongue of the *T.vittata* and *H. auritus* lies in the floor of the buccal cavity and is connected posteriorly by means of the frenulum linguae. The tongue of the *T. vittata* appears triangular flattened structure, broad base, conical free border and mostly white in color. It is about 0.9 cm long and 2-4mm width, three parts are distinguished in the dorsal surface of the tongue, apex, body and root. All these parts are covered by lingual papillae which its kind can't recognize by naked eye and overlapped with each other like fish scales. The apex of the tongue is black in color and the tips are bifid and root has the V shape (Fig. 1a). The ventral surface of the tongue is free from lingual papillae and it is colored in the apex and partially in the root of tongue. The trace of bifid that present in apex of the tongue noticed in the ventral surface which almost extend to the middle of the tongue. There is structure resembles the pillow in the root of the tongue that helps the tongue to move more freely.

The morphology of tongue of *H. auritus* is much differs from the tongue of *T.vittata*. It is muscular organ, relatively of midium size, light hazel in color, elongated in shape with a rounded apex and broader caudally toward the base. It is about 1.9 cm long and 6-8mm width and it appears thicker than the tongue of *T.vittata*. Also three parts can be distinguished in the dorsal surface of the tongue. These parts, as well, covered by lingual papillae which give the dorsal surface velvety appearance. There is no fissure in the apex of the tongue of *H. auritus* that appeared in the tongue of *T.vittata* (Fig. 1b). The ventral surface of the tongue is free from lingual papillae as in the tongue of *T.vittata* and also doesn't contain pillow that appeared in *T.vittata*.

Histological Structure:

The mucosa of dorsal surface of lingual apex of the *T.vittata* is covered by a large number of lingual papillae, which appears in several types including filiform, fungiform and cuboid papillae. These papillae have, almost, the same height, ($59.965 \pm 7.74\mu\text{m}$), whereas, fungiform papillae are numerous in number and thicker than other two types, it is thickness average ($67.936 \pm 5.32\mu\text{m}$) (Fig. 2a). All papillae types and ventral surface of tongue covered by stratified squamous epithelium relatively thicker and keratinized in some area. The thickness average of stratified squamous epithelium covering the papillae is ($26.203 \pm 1.61\mu\text{m}$), while it is thickness average in the ventral surface ($27.180 \pm 1.81\mu\text{m}$), a few taste buds are observed in the epithelium of the lingual papillae. The connective tissue core of lingual papillae is rich in blood vessels, pigment cells and penetrates deeply into the center of each papilla (Fig. 2b,c). The lamina propria is consisting of dense connective

tissue which is rich in blood vessels, pigment cells, striated muscle fibers that have different arrangement and density and there were no any type of glands noticed in this part of tongue. The pigment cells form a continuous row down the basement membrane of the epithelial tissue that covering the ventral surface (Fig. 2a,b,c).

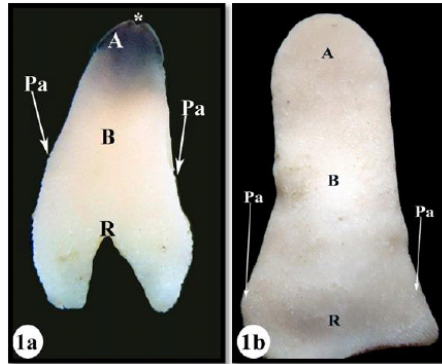


Fig.1: Photograph of the tongue of *T.vittata* (a) and *H. auritus* (b) showing lingual apex (A), body (B), root (R) and Lingual papillae (Pa). (*) tongue of *T.vittata* separated into two parts.

Whereas, the mucosa of dorsal surface of lingual apex of the *H. auritus* is covered by a large number of filiform papillae and there were no another type of lingual papillae found in this part of tongue. The filiform papillae appears in several shapes including, fork shape with primary and secondary process, Saw-shaped, curve- shaped and Cone-shaped, the height average of these papillae are $(201.375 \pm 16.75\mu\text{m})$ and their thickness average $(44.649 \pm 4.86\mu\text{m})$ (Fig.3a). The epithelial tissue that covered the dorsal and ventral surface of this part of tongue are keratinized stratified squamous epithelium. The thickness average of this tissue in dorsal surface is $(98.019 \pm 8.25\mu\text{m})$, while it is thickness average in the ventral surface $(47.556 \pm 5.13\mu\text{m})$. The shape and components of the epithelial cells in the ventral surface are clearer than that of dorsal surface where the cells are highly compact and difficult to identify their contents, but these cells in both surfaces are less clear than in the *T.vittata*. There are no taste buds observed either in the epithelium of the lingual papillae or in the epithelium of interpapillary spaces (lateral parts of papillae). The connective tissue core of lingual papillae is less developed than that in the *T.vittata*, and it's composed from a dense connective tissue (Fig.3a,b). The lamina propria is consisted from dense connective tissue which is rich in blood vessels and the striated muscle fibers that are more developed than that in the *T.vittata*. These muscles have two arrangement, longitudinal and circular, and it constitute the greater component of the lamina propria between the dorsal and ventral surface, there are also no any type of glands noticed in this part of tongue as described in *T.vittata*, as well as there are no pigment cells that appeared in *T.vittata* (Fig.3a,b,c).

The mucosa of dorsal surface of tongue body of *T.vittata* is containing a large number of lingual papillae, most of them are filiform papillae beside there are fungiform and cuboid papillae among the first type. These papillae is differ in height and their average are $(91.719 \pm 7.43\mu\text{m})$ while fungiform height average are $(94.621 \pm 5.87\mu\text{m})$, and they are also different in thickness. Filiform thickness average is $(73.273 \pm 7.74\mu\text{m})$ and fungiform thickness average is $(66.960 \pm 3.56\mu\text{m})$. The stratified squamous epithelium covers all papillae types and also the ventral surface of tongue, this tissue is non keratinized. The thickness average of stratified squamous epithelium covering the papillae is $(19.408 \pm 2.23\mu\text{m})$ while it thickness in the ventral surface is $(30.082 \pm 3.62\mu\text{m})$ (Fig.4a). Few taste buds are observed in the epithelium of interpapillary spaces and in the lingual papillae as in the tongue apex (Fig.4b). The connective tissue core of lingual papillae in this part of tongue has the same structure in the tongue apex. The lamina propria, as in tongue apex, is consisted of dense connective tissue which is rich in blood vessels, pigment cells, striated muscle fibers and no glands are noticed in this part of tongue, these components appear more numerous and larger than in the tongue apex. The pigment cells are scattered between lamina propria components and form continuous row down the basement membrane of the epithelial tissue that cover the ventral surface as in the tongue apex. This part of the tongue is distinguished by the presence of the hyoglossus muscle that appears in a mass, circular block of muscles in the middle of it, that represent the supporting tissue of the tongue. Its diameter average is $(114.030 \pm 8.09\mu\text{m})$ (Fig.4a), also, the stratified squamous epithelium that cover the ventral surface of this part of tongue is characterized by containing folds in the lateral side. There are a large number of goblet cells penetrate epithelial cells in this surface, these goblet cells containing a heavy mucus secretion as appeared by using PAS stain (Fig.4c). The mucosa of dorsal surface of tongue body of the *H. auritus* is covered by a large number of filiform papillae and there are fungiform papillae found in the dorsolateral side of this part of tongue. The filiform papillae appears in several shapes, in addition to the types that mentioned in the apex of the tongue, there is

another shape appears in this part of tongue that is horn like filiform papillae. These papillae are different in the height, and its average is $(318.817 \pm 25.51\mu\text{m})$ while fungiform height average is $(249.551 \pm 23.75\mu\text{m})$. They are also different in thickness, filiform thickness average is $(84.924 \pm 8.38\mu\text{m})$, and fungiform thickness average is $(168.415 \pm 11.64\mu\text{m})$ (Fig.5a,b). The papillae and ventral surface of this part of tongue are covered by the same epithelial tissue that covers the apex of tongue, the thickness of this epithelial tissue on the dorsal surface is $(129.370 \pm 10.41\mu\text{m})$, while its thickness on the ventral surface is $(147.028 \pm 13.27\mu\text{m})$. There are taste buds observed in the epithelium of the lingual papillae especially in the tip of fungiform papillae, where two taste buds are noticed, in the epithelium under the lingual papillae where the taste buds are larger in size (Fig.5a,b,c). The connective tissue core of lingual papillae is composed of a dense connective tissue, the lamina propria has the same pattern that appeared in the apex of tongue but muscles are thicker (Fig.5b).

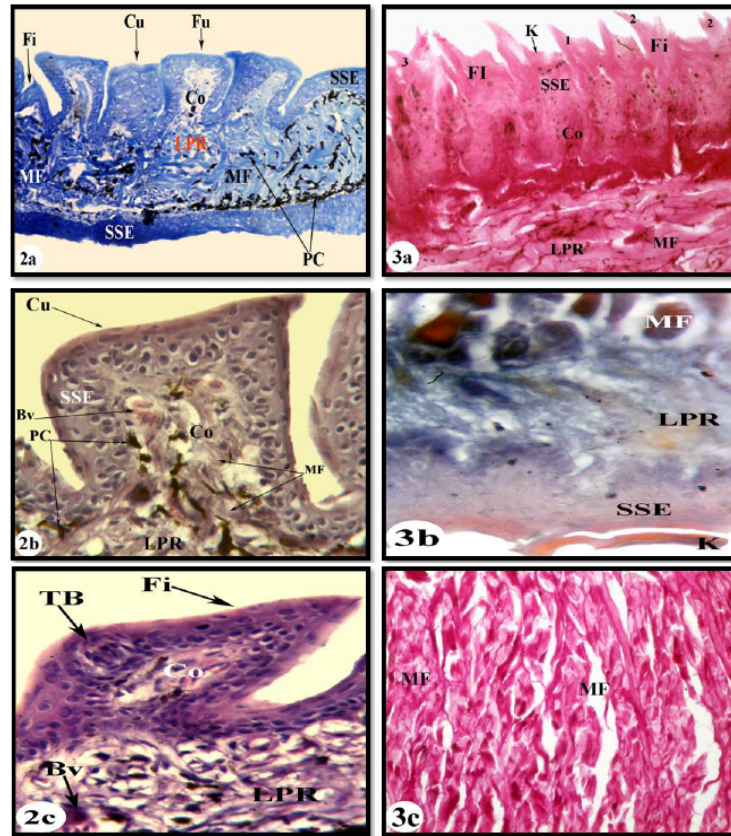


Fig. 2: Tongue apex of *T.vittata*. (a) General structure. TB / 100X. (b) Cuboid papillae. HE / 400X. (c) Filiform papillae and Taste bud. HE / 400X.

Fig. 3: Tongue apex of *H. auritus*. (a) Filiform papillae types. (1) Cone shape. (2) Fork shape. (3) Curve shape PAS / 100X. (b) Ventral surface. TS / 400X. (c) Lamina propria. PAS / 100X.

Fi: Filiform papillae, Cu: Cuboid papillae, Fu: fungiform papillae, Co: connective tissue cone, LPR: lamina propria, SSE: stratified squamous epithelial tissue, MF: muscle fibers, PC: pigment cells, Bv: blood vessel, K: keratinized epithelium.

The root tongue in the two species is more developed than that of the apex and body tongue. In *T.vittata*, the fungiform papillae are many than other papillae types, its height average is $(117.922 \pm 10.93\mu\text{m})$ and its thickness average is $(91.224 \pm 9.76\mu\text{m})$, as well as, there are few filiform papillae with fungiform papillae (Fig.6a). The taste buds are also observed in the epithelium of interpapillary spaces and in the lingual papillae and they are many in number than that of the former parts of the tongue (Fig.6b,c). The stratified squamous epithelium that covers lingual papillae and the ventral surface of tongue are also non-keratinized. The thickness of stratified squamous epithelium of dorsal surface is $(18.445 \pm 0.87\mu\text{m})$, while its thickness on the ventral surface is $(21.843 \pm 1.51\mu\text{m})$. The connective tissue core of lingual papillae in this part of tongue has the same structure that appeared in former parts (Fig.6a,b,c). The lamina propria has special arrangements, it is rich in blood vessels and the components are separated by bundles of muscle fibers. These fibers originate from the

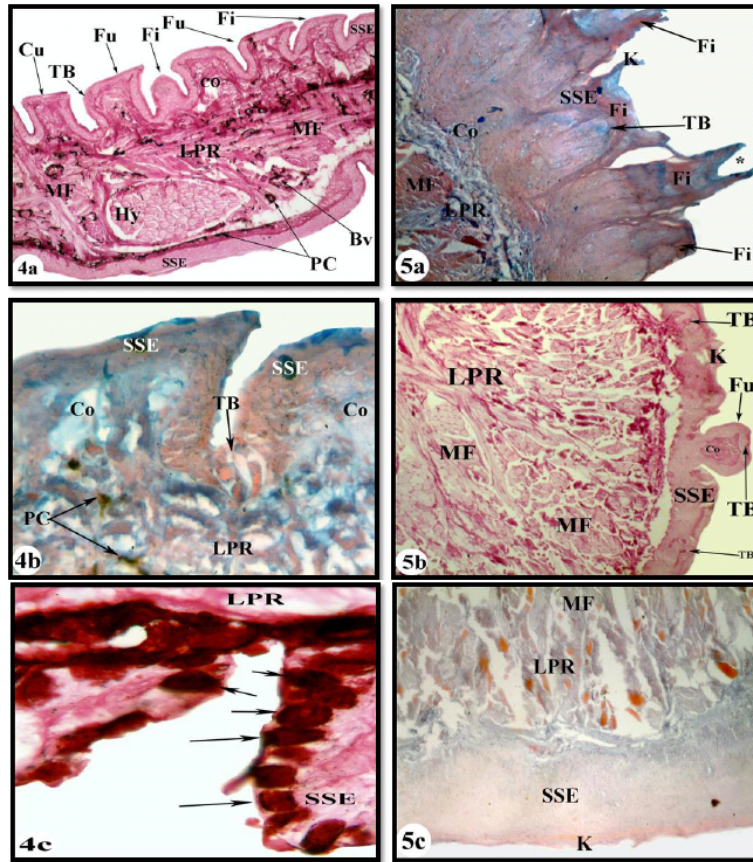


Fig. 4: Tongue body of *T.vittata*. (a) General structure. PAS 100X. (b) lingual papillae and Taste bud. AB / 400X. (c) The goblet cells (arrows) in ventral surface. PAS / 400X.

Fig. 5: Tongue body of *H. auritus*.(a) Filiform papillae types.(*) horn like shape AB / 100X. (b) Dorsolateral side. PAS / 40X. (c) Ventral surface. TS / 100X.

Fi: Filiform papillae, Cu: Cuboid papillae, Fu: fungiform papillae, Co: connective tissue cone, LPR: lamina propria, SSE: stratified squamous epithelial tissue, MF: muscle fibers, PC: pigment cells, Bv: blood vessel, K: keratinized epithelium, Hy: hyoglossus muscle.

muscles in the middle of the lamina propria and extend vertically toward the tip of lingual papillae, which leads to divide the components of connective tissue into independent units, spherical or oval surrounded by muscle fibers (Fig.6c). The pigment cells are missing in this part of tongue, also the lamina propria of this part of tongue is characterized by the presence of the mucus glands that don't appeared in the other parts of tongue. These glands consists from single-layered cylindrical epithelium, they have oval shape and located in the interpapillary spaces. These glands contain heavy mucous secretion as shown by PAS stain and secrete their contents directly to interpapillary spaces and from there to the surface of the tongue (Fig.6a). The muscles fibers of lamina propria appear as large block of muscles its thickness is $(121.306 \pm 12.49\mu\text{m})$ and have circular arrangement only. The hyoglossus muscle that appears in the body of tongue is also found in this part and divided into two mass, circular block of muscles separated by a barrier composed of dense connective tissue, its diameter average is $(237.290 \pm 18.72\mu\text{m})$ (Fig.6c). In the mucosa of dorsal surface of tongue root of the *H. auritus*, there are a new type of ling- ual papillae appeared that is the circumvallate papillae, which doesn't appeared either in the other parts of tongue or in the tongue of *T.vittata*, other types of lingual papillae appeared in former parts were found, these are filiform papillae in all its types and fungiform papillae. The height of these papillae are different, filiform height average is $(124.222 \pm 14.37\mu\text{m})$, fungiform $(158.672 \pm 10.21\mu\text{m})$ and circumvallate $(217.881 \pm 17.88\mu\text{m})$, while the thickness of filiform papillae is $(60.660 \pm 4.58\mu\text{m})$, fungiform $(144.328 \pm 12.82\mu\text{m})$ and circumvallate $(159.642 \pm 15.71\mu\text{m})$ (Fig.7a,b).These papillae and ventral surface of this part of tongue are covered by keratinized stratified squamous epithelium as in the other parts of tongue. The thickness of this tissue in dorsal surface is $(105.295 \pm 14.23\mu\text{m})$, while it is thickness in the ventral surface $(170.330 \pm 17.83\mu\text{m})$. There are numerous taste buds observed in the epithelium of the lingual papillae especially in the tip of fungiform, circumvallate papillae and in the epithelium under the lingual papillae which

are situated very deep in the epithelium. The small taste pores are very hard to locate between superficial keratinized epithelial cells (Fig.7a,c). The connective tissue core of lingual papillae has the same pattern that appeared in the apex and body of tongue. The lamina propria is consisted of loose connective tissue which is more developed than that in the *T.vittata*. The striated muscle fibers have the same arrangement that appeared in apex and body of tongue but it is look more thicker. There are also no any type of glands were noticed in this part of tongue as described in other parts and in *T.vittata*, as well as there are no pigment cells founded (Fig.7b).

Histochemical Study:

The microscopical examination revealed that the tongue is positive for PAS and Alcian Blue (pH 2.5) in the ventral surface of body and glands of lamina propria at root of tongue, whereas their effect moderately positive in other parts of tongue in of *T.vittata* (Fig.4a,c;6a,b), as well, it is strongly positive in connective tissue core of lingual papillae and lamina propria in all parts of tongue with moderate positive effect on other parts of tongue in of *H. auritus* (Fig.3a;5b). On the other hand, the tongue of the two species shows a negative reaction with PB stain for the proteins and SB stain for the lipids.

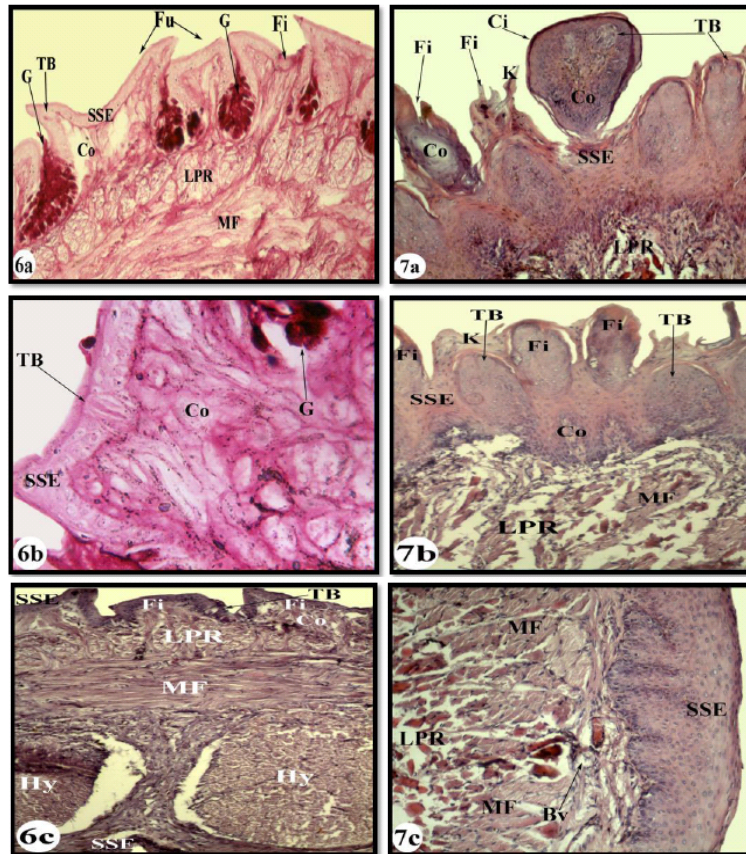


Fig. 6: Tongue root of *T.vittata*. (a) Lingual papillae and mucus glands. PAS / 100X. (b) Taste bud. PAS / 400X. (c) general structure. HE / 100X.

Fig. 7: Tongue root of *H. auritus*. (a,b) Lingual papillae and taste buds. HE / 100X. (c) Ventral surface. HE / 100X.

Fi: Filiform papillae, Ci: circumvallate papillae, Fu: fungiform papillae, Co: connective tissue cone, LPR: lamina propria, SSE: stratified squamous epithelial tissue, MF: muscle fibers, PC: pigment cells, Bv: blood vessel, K: keratinized epithelium, Hy: hyoglossus muscle, G: glands.

Discussion:

Results of current study show morphological variations of tongue of two deferent vertebrate species *T.vittata* and *H. auritus*. The tongue is differing in shape and size among the two species and this probably due to the difference in body size and their taxonomy. There are three parts distinguished in the dorsal surface of the tongue, apex, body and root in the two species. This design appeared also in most vertebrates species (Emura and Chen, 2008; Nonaka *et al.*, 2008; Adeniyi *et al.*, 2010; Darwish, 2012; Nasr *et al.*, 2012). In the present

study, *T.vittata* possessed bifid of lingual apex which completely missing in *H. auritus*, similar structure was appeared in the other reptilians as in Diamondback Water Snake, Black Rat Snake (Morgans and Heidt, 1978), Agamid Lizards (Herrel *et al.*, 1998), scincine lizard (Wassif, 2001), Lacertid Lizards (Herrel *et al.*, 2005), *Eublepharis macularius* (Jamniczky *et al.*, 2009), *Psammophis sibilans* (El-Sayyad *et al.*, 2011) and *Stenodactylus petrii* (Darwish, 2012), also Owl (*Strix uralensis*) and other birds (Emura and Chen, 2008; Emura *et al.*, 2008a; El-Bakary, 2011a). Forked tongues may provide more surfaces available for sensory function in lizards (Darwish, 2012). There is no reflect of feeding habit on the bifurcation of tongue but these structural pattern due to feeding habit in bifurcated insectivores lizards reflected that the insect may swallowing and bifurcation may facilitated swallowing process (Schwenk, 1993; Schwenk, 2000; Darwish, 2012).

Current study also shows that the dorsum of the three parts of the tongue in *T.vittata* and *H. auritus* are covered by various types of papillae. Tongue papillae are differs in shape, size, number, nomenclature and distribution among different groups of vertebrates (Iwasaki, 1990; Iwasaki *et al.*, 1996; Darwish, 2012). These differences depend on diet variety, feeding habits and mouth handling of the food (Iwasaki and Miyata, 1985; Darwish, 2012; Nasr *et al.*, 2012). In the *T.vittata* and *H. auritus* the apex, body and root of the tongue covered by a large number of lingual papillae, their types were filiform, fungiform that also appeared in reptiles (Wassif, 2001; Herrel *et al.*, 2005; Jamniczky *et al.*, 2009; Darwish, 2012), mammals (Ciuccio *et al.*, 2008, 2010; Abayomi *et al.*, 2009; Adeniyi *et al.*, 2010; Nasr *et al.*, 2012; Yoshimura *et al.*, 2012) and other vertebrates (Crole and Soley, 2009; Emura *et al.*, 2008, 2009; Dehkordi *et al.*, 2010; Mahabady *et al.*, 2010; El-Bakary, 2011b; Santos *et al.*, 2011). The encouraging results of this study that highlighted the presence of especial lingual papillae that is a cuboidal papillae in the tongue apex and body of *T.vittata*, this papillae type also founded in the *Eublepharis macularius* (Jamniczky *et al.*, 2009), as well Iwasaki (1990) described the dome-shaped which correspond to the cuboidal papillae in *Gekko japonicas* (Iwasaki, 1990). Presence of many subtype of filiform papillae in the tongue *H. auritus* they are fork shape, Saw-shaped, curve-shaped, Cone-shaped and horn like filiform papillae, all these types also exist in rat *Arvicanthis niloticus* and Feathertail Glider *Acrobates pygmeus* (Jackowiak and Godynicki, 2005; Nasr *et al.*, 2012). The different shapes of the filiform papillae, which changed gradually from the apex to the caudal part of the tongue, have also been observed in the mongoose (Iwasaki and Miyata, 1990). Filiform papillae form the primary pathway of food transport which comes into contact with the palate during mastication and swallowing. It provides tongue with a rough surface suited for the movement and grinding of food (Trzcielinska *et al.*, 2009; Karan *et al.*, 2010; Nasr *et al.*, 2012). Also one of the most encouraging results that appeared in this study is the presence of the circumvallate papillae in the tongue root of *H. auritus*, this papillae also exist in many vertebrates as in the Black Rhinoceros, *Zaedyus pichiy* (Ciuccio *et al.*, 2008).

Also results of present study shows that all parts of tongue in the two species surrounded by stratified squamous epithelium tissue that is almost non keratinized in *T.vittata* and keratinized in *H. auritus*. The non keratinized stratified squamous epithelium appeared also in some vertebrates (Herrel *et al.*, 2005; Crole and Soley, 2009; Hussein and AL-Asadi, 2010), while in other vertebrates covered by keratinized tissue (Wassif, 2001; Igbokwe and Okeoli, 2009; Jamniczky *et al.*, 2009). There are a few taste buds observed in the epithelium either in the lingual papillae or in of interpapillary spaces of the three parts of the tongue in *T.vittata*, whereas a numerous taste buds observed in the epithelium of the lingual papillae especially in the tip of fungiform and circumvallate papillae and in the epithelium lie under the lingual papillae in *H. auritus*. A similar structure was reported in few lizards (Herrel *et al.*, 1998; Wassif, 2001) and many mammals (Ciuccio *et al.*, 2008; Abayomi *et al.*, 2009; Nasr *et al.*, 2012; Yoshimura *et al.*, 2012). Taste buds are the peripheral sensory organs of gestation, these structures have the task of monitoring the chemical environment of the oral cavity and particularly of sensing ingested foods are palatable, toxic, aversive, nutritive, etc. In summary, taste buds help oversee the first stage of energy balance, food intake (Roper, 2009). The presence of taste buds on the tongue tip and on the fore-tongue may play an important role in receiving chemical and mechanical information of food (Nasr *et al.*, 2012).

Lamina propria in the three parts of tongue of the two species is consisted of dense connective tissue which is rich in blood vessels, many other structures and it is differ among the two species. Among these structures are the pigment cells that appeared in apex and body tongue in *T.vittata* and absent in *H. auritus*. These pigment cells reported in Lacertid Lizards (Herrel *et al.*, 2005) and emu bird (Crole and Soley, 2009), this could be the reason of the dark color in the apex tongue in *T.vittata*. Striated muscle fibers appeared in different arrangement and density in the two species, it was thicker and constituted the greater component of the lamina propria in *H. auritus*. These muscles documented in all vertebrates studied and the muscular organization helped the tongue in its movement and performed various function efficiently. The hyoglossus muscle appears clearly in the body and root of tongue of *T.vittata*, this muscle as well is reported in other reptiles (Herrel *et al.*, 1998; Herrel *et al.*, 2001; Herrel *et al.*, 2005; Jamniczky *et al.*, 2009). In chameleons, both the extrinsic (hyoglossus) and intrinsic (verticalis) tongue muscles that function to project and retract the tongue are hypertrophied (Herrel *et al.*, 2001; Herrel *et al.*, 2005). In the current study, there are a large number of goblet cells in the ventral surface of body tongue of *T.vittata* penetrated epithelial cells, these cells also described in Gekkonidae species *Eublepharis macularius*, *Ptyodactylus guttatus* and *Stenodactylus petrii* (Jamniczky *et al.*, 2009; Darwish, 2012). The lamina

propria of root of tongue of *T.vittata* is characterized by presence of the mucus glands that didn't noticed in the other parts of tongue and absent in *H. auritus*, this glands also reported in Lacertid Lizards (Herrel *et al.*, 2005). Histochemically, results of present study showed that the tongue is strongly positive for carbohydrates stains in *T.vittata* and *H. auritus* in most portions, that indication high of diffusion of mucous secretion cells in all parts of tongue in the two species, as well as, a strongly positive result of the PAS reaction of the glands of root of tongue in of *T.vittata* indicates a considerable activity of this glands in the production of the mucous secretion containing glycoproteins. This was refer that these substances are helping the tongue adhesion and swallowing of the insects easily, this also documented in other vertebrates (Crole and Soley, 2009; Jamniczky *et al.*, 2009; Santos *et al.*, 2011). The tongue of the two species shows negative reaction with PB stain for the proteins and SB stain for the lipids which is indicated by the lack of aggregations of protein and lipids inside the tongue.

Conclusions:

Tongue in the lizard *T.vittata* and hedgehog *H. auritus* suggested that the tongue of these vertebrates' species exhibit significant anatomical and structural variations that may be reflect an adaptations respond to their feeding pattern. The results of current study also a knowledge previous studies on a functional subdivision among the three parts of tongue in papillary structure, muscular anatomy and taste buds, in allowing the *T.vittata* to use its tongue effectively during both chemoreception and prey transport, as well as allowing the *H. auritus* to be use its tongue effectively in choosing its food with a high nutritional value. One can conclude that the tongue of *T.vittata* is similar to other lizards' tongues and it's more appropriate in feeding on insects from *H. auritus* tongue because the lingual papillae helped the tongue in capturing prey more efficiently than in the hedgehog tongue (from this study point of view).

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