



Research Article

Morph-Metrical Studies on the Tongue (*Lingua*) of the Adult Egyptian Domestic Cats (*Felis domestica*)

El-Bably SH and Tolba AR*

Anatomy and Embryology, Faculty of Veterinary medicine, Cairo University, Egypt

*Corresponding author: draymantolba@hotmail.com

Article History: Received: December 01, 2014 Revised: January 23, 2015 Accepted: February 10, 2015

ABSTRACT

This work was carried out on the heads of ten apparently healthy adult Egyptian domestic cats of both sexes, from ten to nineteen months of age. Manually dissected specimens conducted for studying the morphology and metrical aspects of the tongue of the adult Egyptian cat. Different regions of tongue, position, shape and density of the lingual papillae as well as the lingual muscles origins, insertions and actions are expressed by five figures to study the morphology of tongue. For metrical aspects of the tongue, this study supported by Charts and tables to demonstrate the length, average length, width, average width, thickness and average thickness of each part of the tongue. The obtained results were photographed using Nikon digital camera 20 mega pixel, 16X and discussed with their corresponding features of authors who performed earlier studies in other species. The nomenclature used was adopted according to the Nomina Anatomica Veterinaria (2005).

Key words: Egyptian domestic cats, Morph-metrical studies, Tongue

INTRODUCTION

The present study describes the gross anatomical and biometrical features of the tongue of an adult Egyptian cat (Egyptian Maus). The tongue functionally concerned with taste, prehension & deglutition. It situated in the floor of mouth cavity proper between the horizontal parts of mandible. The Egyptian cat is taxonomically in the Kingdom: Animalia, Phylum: Chordata, Class: Mammalia, Order: Carnivora, Family: Viverridae. The Egyptian Maus are typically slender, muscular, a small-to-medium sized short-haired cat breed. It is a smaller animal whose length is 120 cm. and a tail size of 30 cm. It weighs from 6-7 kg. Maus come in five colors, from most to least common these colors are: silver, bronze, smoke, black and blue/pewter. All Maus must have green eyes, but an amber cat is acceptable in kittens and young adults up to eighteen months old. They are one of the few naturally spotted breeds of domesticated cat; the spots of the Mau occur on only the tips of the hairs of their coat. They have anatomical, metabolic, and behavioral differences from other cat breeds which could be considered evidence of antiquity or at least uniqueness from other cat breeds.

MATERIALS AND METHODS

Ten clinically healthy adult cats of both sexes (four male – six female), aging from ten to nineteen months,

were used in the present investigation. The abdominal aorta was thoroughly flushed with warm (40°C) saline solution and the specimens were then injected with formalin solution (10% formalin, 4% phenol, 1% glycerin) for 3-4 days. The ten heads were used for manual dissection to investigate the anatomical and biometrical features of the tongue, location and density of the tongue papillae as well as to study the origin and insertion of the associated tongue muscles. The Vernier caliper used to measure the length and thickness of each region of the tongue, The specimens were photographed using Nikon digital camera 20 mega pixel, 16X, the nomenclature used was adopted according to the Nomina Anatomica Veterinaria (2005) and the data were statistically analyzed according to Snedecor and Cochran (1982) in Chi square design by computer program of SAS (1995).

RESULTS

The tongue (*Lingua*) (Fig. 1, 2 and 3) is pale pink, composed of two surfaces, the dorsum of the tongue (fig 1A), which is in contact with the hard palate (Fig. 1/23) and the ventral one (Fig.1B), which completely fills the floor of the oral cavity. It consists of three parts; the apex, the body and the root.

The root of the tongue (*Radix linguae*) (Fig. 1A & 2/2), is the caudal third of the tongue attached to the hyoid

Cite This Article as: El-Bably SH and AR Tolba, 2015. Morph-metrical studies on the tongue (*Lingua*) of the adult Egyptian domestic cats (*Felis domestica*). Inter J Vet Sci, 4(2): 69-74. www.ijvets.com (©2015 IJVS. All rights reserved)

bone (Fig. 5B), soft palate by platoglossus fold (Fig. 1A/22A) and epiglottis by glossoepiglottic fold (Fig. 3/22B). The length of the root is ranged from 0.93 cm to 1.21 cm (Chart 1), the width of the root is ranged from 1.32 cm to 1.92 cm (Chart 2) and the thickness of the root is ranged from 0.7 cm to 1.5 cm (Chart 3). The average length, width and thickness of the root of tongue are 1.06 cm, 1.73 cm and 1.01 cm (Chart 4 and table 1) respectively.

The body of the tongue (Corpus linguae) (Fig. 1A, 1B & 2/3) is uniformly wide, long and slender shape, has dorsal, ventral and two lateral borders; the dorsum linguae (Fig. 1A) has no Fossa linguae and torus linguae. From the ventrum linguae (Fig. 1B) arises a sickle fold of mucous membrane to form a frenulum linguae (Fig. 1B/6) which extends from the middle of the ventral surface of the body of the tongue to connect it with the floor of the oral cavity, and this fold measures 2.18 cm to 2.64 cm (Chart 1) with the average length 2.43 cm (Chart 4 and table 1). The body of tongue is divided according to the density of the papillae into rostral part and caudal part. The former is considered the middle part of the tongue (Fig. 2/3A), its length varies from 2.1 cm to 2.6 cm (Chart 1), width is varying from 1.87 cm to 2.33 cm (Chart 2) and the thickness is varying from 1.08 to 1.31 cm (Chart 3). The average length, width and thickness of the middle part of the tongue are 2.4 cm, 2.12 cm and 1.22 cm (Chart 4 and table 4) respectively. The caudal part; called area of vallate (Fig. 2/3B), its length varies from 0.5 cm to 0.81 cm (Chart 1), width is varying from 2.11 cm to 2.31 cm (Chart 2) and the thickness is varying from 1.25 to 1.35 cm (Chart 3). The average length, width and thickness of the vallate part of the tongue are 0.66 cm, 2.24 cm and 1.31 cm (Chart 4 and table 4) respectively.

The apex of the tongue (Apex linguae) (Fig. 1A & 2/4); the tip of the tongue is rounded with its ventral margin thinning out gradually, rests against incisors, the ventral surface of the apex of the tongue is characterized by the presence of white colored rod shaped appearance structure called lyssa (Fig. 1B/12). It lies along the median plane, two third of lyssa embedded in the mucosa of the tongue. The average length of the lyssa is about 1.21 cm (Chart 4 and table 1). The apex of the tongue length varies from 1.9 cm to 2.4 cm (Chart 1), width is varying from 0.85 cm to 1.11 cm (Chart 2) and the thickness is varying from 0.21 to 0.26 cm (Chart 3). The average length, width and thickness of the apex of the tongue are 2.2 cm, 0.96 cm and 0.23 cm (Chart 4 and table 1) respectively.

The dorsum of the tongue (Fig. 1A & 2) is rough due to five types of lingual papillae observed on the dorsal surface of the tongue. These papillae are filiform, fungiform, vallate, foliate and conical papillae.

The filiform papillae (Fig. 3/7) present on the dorsum of the tongue, especially on the caudal part of tip and rostral part of the body, these papillae have broad bases with pointed ends directed caudally. The number of filiform papillae is numerous in the cat (table 2). The lateral edges of the body of the tongue and the rostral part of the tip of the tongue are devoid of filiform papilla; these areas are smooth.

The fungiform papillae (Fig. 3/8), are smaller in diameter, button shaped and present on the dorsum linguae located in between and rostral to the vallate papillae at the midline, at the caudal part of the body of

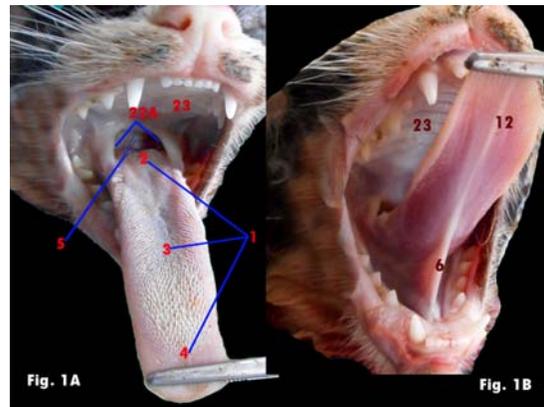


Fig. 1: A photograph showing the surfaces of the tongue of the Egyptian cat (in situ): A. Dorsal View – B. Ventral View

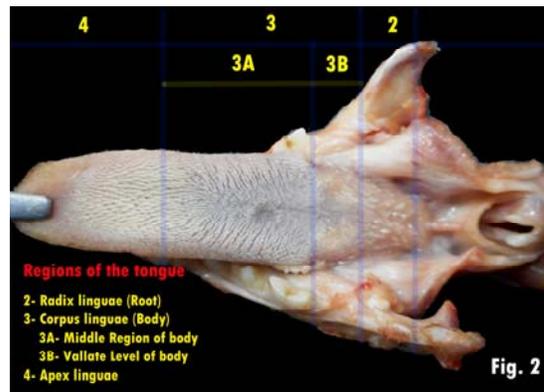


Fig. 2: A photograph showing the different regions of the tongue of the Egyptian cat: Dorsal View.

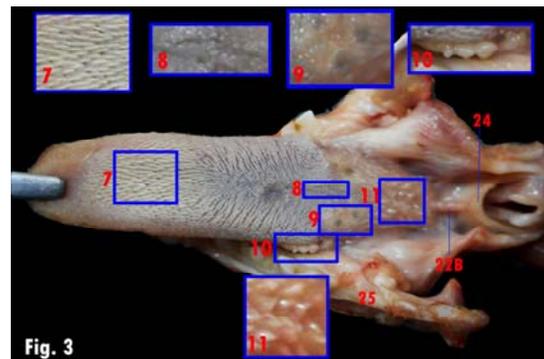


Fig. 3: A photograph showing the different papillae on the tongue of an adult Egyptian cat: Dorsal View.

the tongue. From eighteen to twenty fungiform papillae are present at the middle level of tongue and the numbers become fewer, from eight to ten papillae at the vallate level of the body (table 2).

The vallate papillae (Fig. 3/9) are rounded but in 3 tongues are oval in shape, they are surrounded by a groove that conformed to the papillae's shape, the vallate papillae considered the largest papillae in diameter. They are located in the caudal third of the tongue at the junction between the body and root, in the area of vallate. The number of vallate papillae (table 2) vary from four to six arranged symmetrically or asymmetrically on each side of

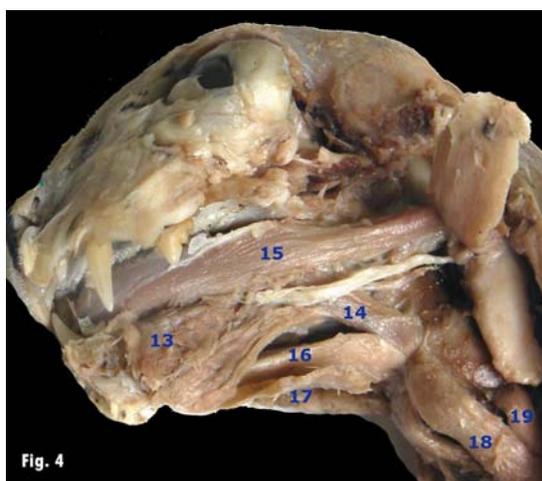


Fig. 4: A photograph showing the muscles associated with the tongue of an adult Egyptian cat: Lateral view.

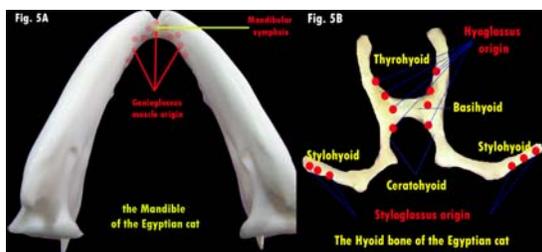


Fig. 5: A photograph showing the bony origin of the muscles associated with the tongue of an adult Egyptian cat A: Mandible B: Hyoid bone.

Legend of figures (1-5):

| | |
|-------------------------|---------------------------|
| 1- Lingua | 14- M. hyoglossus |
| 2- Radix linguae | 15- M. styloglossus |
| 3- Corpus linguae | 16- M. geniohyoideus |
| 4- Apex linguae | 17- M. mylohyoideus |
| 5- Isthmus fucium | 18- M. sternohyoideus |
| 6- Frenulum linguae | 19- M. sternothyroideus |
| 7- Papillae filiformes | 20- Masseter |
| 8- Papillae fungiformes | 21- Digastricus |
| 9- Papillae conicae | 22A- platoglossus fold |
| 10- Papillae vallatae | 22B- glossoepiglotic fold |
| 11- Papillae foliatae | 23- Palatum durum |
| 12- Lyssa | 24- Epiglottis |
| 13- M. genioglossus | 25- Mandibula. |

the tongue in two rows containing two or three papillae in each row, and placed in a “V” shape whose apex faced the root of the tongue.

The foliate papillae (Fig. 3/10) are leaf shaped. There are two rows of foliate papillae (table 2); each row is located on the lateral margin of the tongue, at the level body of the tongue, rostral to palatoglossal fold. The conical papillae (Fig. 3/11) (table 2) are marked rounded elevations, with pointed tip, occupied the root of the tongue and caudal to vallate level. The muscles of the tongue (Fig. 4 and table 3) are divided into internsic and externsic muscles, the externsic muscles are three pairs of the muscles, which are styloglossus, hyoglossus and genioglossus. The styloglossus muscle (Fig. 4/15) is a large ribbon-shaped muscle, originates and completely encircles the upper third of the styloid process of the

hyoid bone (Fig. 5B), lies on the lateral side of the tongue, passes rostroventrally and is inserted in the middle of the tongue. It retracts and elevates the tongue. The hyoglossus (Fig. 4 /14) originates from the thyrohyoid, ceratohyoid and basihyoid (Fig. 5B). It is inserted in the root of the tongue, lies medial to the tongue. It retracts and depresses the tongue. The genioglossus (Fig. 4/13) arises from the symphysis and adjacent surface of the body of the mandible (Fig. 5A). It is bounded medially by geniohyoid and laterally by hyoglossus. The genioglossus is considered large in size.

DISCUSSION

Our findings had a similar opinion to what was suggested by some available literatures where the tongue was composed of two surfaces, the dorsum of the tongue and the ventral one.

Our study in the adult Egyptian cat was In agreement with, Sarma *et al.* (2009) in the adult civet cats, Besoluk *et al.* (2006) in the domesticated cats and dogs, Miller *et al.* (1996) in the dog, Nickel *et al.* (1986) in the dog and the cat, Sisson *et al.* (1975) in the dog, Kubota (1967) in the elephant and Habel (1975) in the ox and sheep had the opinion that the tongue was divided into three parts; apex, body and root.

The tongue of the adult Egyptian cats was pale pink and its tip was rounded with the margin thinning out gradually and rostrally. Similar findings were reported by Miller *et al.* (1996) in the dog, Nickel *et al.* (1986) in the dog and the cat and Sisson *et al.* (1975) in the dog and fox. In contrast, the apex of the tongue was pointed as said by Habel (1975) in cattle, free flattened with a notch at the centre as per Lahkar *et al.* (1985) in the goat, spatula shaped as Sisson *et al.* (1975) mentioned in the horse, blunt pointed as said by Prakash *et al.* (1980) and Dhingra *et al.* (1979) in buffalo and nearly spatula shaped with undulating lateral edges in the Himalayan black bear as Sarma *et al.* (2003) described.

In the investigated tongues, the average measurements of the length, width and thickness of root of the tongue were 1.06 cm, 1.73 cm and 1.01 cm respectively on the other hand Sarma *et al.* (2009) in civet cat, reported that the average measurements were 1.5 cm width and 1 cm thickness and he did not mention the average length. Moreover Besoluk *et al.* (2006) in the domesticated cats and dogs mentioned that the average length of the root of tongue was 1.3 cm.

Sarma *et al.* (2009) in the adult civet cats, Besoluk *et al.* (2006) in the domesticated cats and dogs, Miller *et al.* (1996) in the dog, Nickel *et al.* (1986) in the dog and the cat and Sisson *et al.* (1975) in the dog and our findings were similar that, the body of the tongue was uniformly wide, long and slender shape, had dorsal, ventral surfaces and two lateral borders; the dorsum linguae has no fossa linguae and torus linguae. In contrast to our results Kubota (1967) in the elephant and Habel (1975) in the ox and sheep had a very clear fossa linguae and promanant torus linguae.

The frenulum linguae of the examined cats were insinuated between the ventral surface of the tongue and the floor of the oral cavity, its average length was 2.43 cm. This statement was similar to that described by Sarma

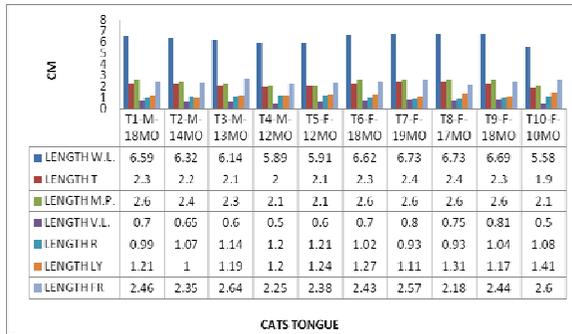


Chart 1: Biometry of the length of ten tongues of the Egyptian cat.

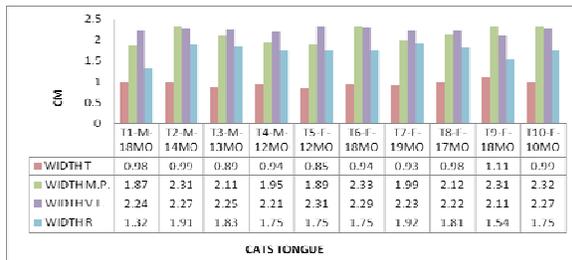


Chart 2: Biometry of the width of ten tongues of the Egyptian cat.

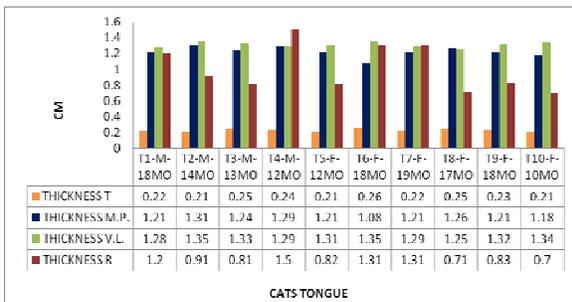


Chart 3: Biometry of the thickness of ten tongues of the Egyptian cat.

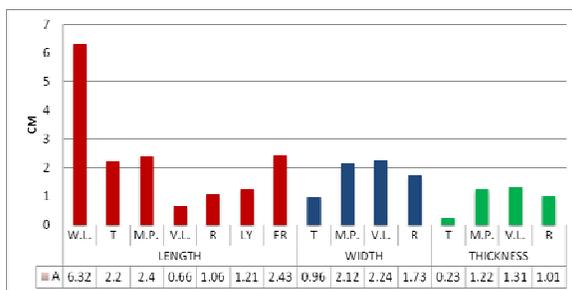


Chart 4: Biometry of the average length, width and thickness of ten tongues of the Egyptian cat

| Abbreviations of Charts (1-4) | | | |
|-------------------------------|--------------|------|-----------------------|
| T | Tongue | LY | Lyssa |
| M | Male | FR | Frenulum Linguae |
| F | Female | T | Tip of the tongue |
| MO | MONTHS | M.P | Middle part of body |
| W.L | Whole Length | V.L. | Vallate level of body |
| F.P | Free part | R | Root of tongue |

Table 1: Biometry of the tongue of the Egyptian cat

| No. | Parameters | At the level of | Average value (cm) |
|-----|------------|--------------------------------|--------------------|
| 1- | Length | Whole length of the tongue | 6.32 |
| 2- | | The Tip of the tongue | 2.2 |
| 3- | Width | The Middle of the tongue | 2.4 |
| 4- | | Vallate Papillae of the tongue | 0.66 |
| 5- | Thickness | The Root of the tongue | 1.06 |
| 6- | | Lyssa | 1.21 |
| 7- | Length | Frenulum linguae | 2.43 |
| 8- | | The Tip of the tongue | 0.96 |
| 9- | Width | The Middle of the tongue | 2.12 |
| 10- | | Vallate Papillae of the tongue | 2.24 |
| 11- | Thickness | The Root of the tongue | 1.75 |
| 12- | | The Tip of the tongue | 0.23 |
| 13- | Length | The Middle of the tongue | 1.22 |
| 14- | | Vallate Papillae of the tongue | 1.31 |
| 15- | Width | The Root of the tongue | 1.01 |

et al. (2009) in civet cat, Besoluk et al. (2006) in the domesticated cats and dogs, Miller et al. (1996) in the dog and Nickel et al. (1986) in the dog and the cat. Also, Sarma (2009) added that the average length was 2.3 in the adult civet cat.

Our study was divided the body of tongue according to the density of the papillae into rostral part, the middle part of the tongue and caudal part, area of vallate similar division was reported by Samra et al. (2009) in the adult civet cat.

The average length, width and thickness of the middle part of the tongue were 2.4 cm, 2.12 cm and 1.22 cm respectively. While the average length, width and thickness of the vallate area were 0.66 cm, 2.24 cm and 1.31 cm respectively. On the other hand Samra (2009) in the adult civet cat tabulate that the middle part of the tongue was measured 1.82 cm width and 1.13 cm thickness while the author did not report the length.

The results under discussion achieved that the ventral surface of the apex of the tongue characterized by the presence of white colored rod shaped appearance structure called lyssa. It was lied along the median plane, two third of lyssa embedded in the mucosa of the tongue. The average length of the lyssa is about 1.21 cm. These statements might be attributed to that noted by Capellari et al. (2001) in the cats who reported that the lyssa had a rod-shaped appearance in the cat and dog, but Besoluk et al. (2006) in the domesticated cats and dogs revealed that it was spiral-shaped in the cat and J-shaped in the dog.

The average length, width and thickness of the apex of the tongue were 2.2 cm, 0.96 cm and 0.23 cm respectively but Sarma et al. (2009) in civet cat, reported that the average measurements were 2.22 cm length, 0.91 cm width and 0.14 cm thickness.

Sarma et al. (2009) in the adult civet cat, Besoluk et al. (2006) in the domesticated cats and dogs, Miller et al. (1996) in the dog, and Nickel et al. (1986) in the dog and the cat, Sisson et al. (1975) in the dog and our findings were agreed that the dorsum of the tongue was rough due to five types of lingual papillae observed on the dorsal surface of the tongue. These papillae were filiform, fungiform, vallate, foliate and conical papillae.

The filiform papillae were thickly populated on the dorsum of the body, but their number decreased towards the tip where they increased in length. This was in

Table 2: Density and number of papillae on the tongue of an adult Egyptian cat

| No. | Papillae | Tip of tongue | Body of tongue | | Root of tongue |
|-----|-----------|---------------|----------------|---------------|----------------|
| | | | Middle level | Vallate level | |
| 1- | Filiform | +++ Numerous | ++++ Marked | + Few | -- Nil |
| 2- | Fungiform | -- Nil | ++ 18-20 | ± 8-10 | -- Nil |
| 3- | Vallate | -- Nil | -- Nil | +++ 4-6 | -- Nil |
| 4- | Foliate | -- Nil | ++ 2 | -- Nil | -- Nil |
| 5- | Conical | -- Nil | -- Nil | -- Nil | ++++ Marked |

Table 3: Muscles associated with the tongue of an adult Egyptian cat

| No. | Muscles | Origin | Insertion | Action |
|-----|--------------|--|---|--|
| 1- | Styloglossus | Upper third of the Styloid process of hyoid bone | At the Apex of the tongue | withdraw the tongue caudally and to its side |
| 2- | Hyoglossus | Body of hyoid bone and thyrohyoid | At the Root of the tongue | Depress the tongue during deglutition |
| 3- | Genioglossus | Mandibular symphysis | In the ventral aspect of the whole tongue | Protrude the tongue outside |

contrast to the earlier reports of numerous filiform papillae that were distributed on the rostral portion of the dorsum linguae Miller *et al.* (1996) in the dog, Nickel *et al.* (1986) in the dog and the cat, Kubota (1967) in the elephant and Habel (1975) in the ox and sheep. Also, the filiform papillae on the tip of the tongue were short and exhibited several conical processes from the base of each papilla (Boshel *et al.* 1982) in the cat. This particular arrangement of filiform papillae on the dorsum linguae of the tongue of the Egyptian cat may depict its specific species characteristics. While, Sarma (2009) in the civet cat mentioned that in the region of the vallate area, the filiform papillae were shorter and more conical than those on the mid-portion of the tongue.

In the investigated cats, the fungiform papillae were button-like and present on the dorsum linguae. Maximum numbers of fungiform papillae were noted located in between and in front of the vallate papillae at the midline. Similar pattern of distribution of fungiform papillae were also documented Mariappa *et al.* (1986) in the elephant, Nickel *et al.* (1986) in the pig and cat.

In all of the tongues examined, the vallate papillae, located on the basal third of the tongue dorsum, were surrounded by a groove that conformed to the papillae's shape. The findings of the present study were in agreement with that reported from Gregório *et al.* (2007), Hudson *et al.* (1993), Tichy (1993), Ojima (1995), Ojima *et al.* (1996) and Ojima *et al.* (1997) in cats, when these papillae appear symmetrically on the cats' tongues they are arranged in two lines forming a rostrally open V on the lingual root, similar to those described in cats by Hudson *et al.* (1993), Ojima (1995), Ojima *et al.* (1996) and Ojima *et al.* (1997). However, when the papillae appear asymmetrically, the V is not clear; the papillae are arranged in two convergent lines. Considering the vallate papillae shapes round and oval in shape, the descriptions of our study were dissimilar with the findings of Gregório *et al.* (2007), Tichý (1993) and Ojima (1995) in cats stated that, these papillae were identified as being oval and spherical, round elliptical and elliptical. But Ojima *et al.* (1996) and Ojima *et al.* (1997) identified them as being oval, elongated oval and circular in shape.

The vallate papillae formed a "V", with its apex facing towards the root of the tongue. This type of orientation of vallate papillae was also reported by Lahkar (1989) in rhinoceros. The vallate papillae were located on both sides of the posterior end of the lingual body as said

by Emura *et al.* (2001) in the Asian black bear and panther.

There were two foliate papillae, each located on the lateral margin of the tongue at the level of vallate papillae. These were also observed by Sisson *et al.* (1975) in the horse, Nickel *et al.* (1986) in the dog and the cat and Sarma *et al.* (2003) in the Himalayan black bear. The foliate papillae were seen on lateral aspect of the tongue, their laminae fused with the bases of the conical papillae that were reported by Emura (2006) in the dog and fox.

In the current study the conical papillae were marked as rounded elevations covered the root of the tongue, caudal to vallate level. Similar findings were reported by Miller *et al.* (1996) in the dog, Nickel *et al.* (1986) in the dog and the cat and Sisson *et al.* (1975) in the dog.

The present study revealed that, the muscles of the tongue were divided into internsic and externsic muscles, the externsic muscles were three pairs of the muscles, which are styloglossus, hyoglossus and genioglossus, this was in agreement with Miller *et al.* (1996), Dyce *et al.* (2010) and Konig *et al.* (2006) in the dog.

The styloglossus muscle is a ribbon-shaped muscle, laid on the lateral side of the tongue passed rostroventrally and inserted in the middle of the tongue. This was in agreement with Miller *et al.* (1996), Konig *et al.* (2006) and Dyce *et al.* (2010) in the dog. The author added that the styloglossus in the cat completely circled the upper third of the styloid process of the hyoid bone while the previous authors did not mention that.

The hyoglossus in the Egyptian cat originated from the thyrohyoid, ceratohyoid and basihyoid and inserted in the root of the tongue. This was in contrast with Miller *et al.* (1996), Konig *et al.* (2006) and Dyce *et al.* (2010) in the dog and cat who mentioned that in the cat, the hyoglossus is also originated from thyrohyoid and basihyoid only.

The genioglossus aroused from the symphysis and adjacent surface of the body of the mandible. This was in agreement with Miller *et al.* (1996), Dyce *et al.* (2010) and Konig *et al.* (2006) in the dog and cat.

REFERENCES

- Besoluk, E Eken, E Sur, 2006. Morphological studies on lyssa in cats and dogs, Veterinarni Medicina, 51: 485-489.

- Boshel J, Boshela, WH Wilborn and BB Singh, 1982. Filiform papillae of cat tongue. *Acta Anatomica*, 114: 97-105.
- Capellari H, M Egerbacher, M Helmreich and P Bock, 2001. Bau und Gewebekomponenten der Lyssa: Fettzellen, myxoide Zellen und Knorpelzellen binden Antikörper gegen S-100 Proteine. *Wiener Tierärztliche Monatsschriften*, 88: 197-202.
- Dhingra LD and AK Barnwal, 1979. Gross anatomical studies on the tongue of Indian buffalo (*Bubalus bubalis*). *Jr Res*, 9: 63-68.
- Dyce KM, WO Sack and CJG Wensing, 2010. Textbook of veterinary anatomy. The digestive system, pp: 102-105.
- Emura S, D Hayakawa, H Chen and S Shoumura, 2001. Morphology of the dorsal lingual papillae in the newborn panther and Asian black bear. *Okajimas Folia Anat Jpn*, 78: 173-177.
- Emura S, T Okumura, H Chen and S Shoumura, 2006. Morphology of the lingual papillae in Raccoon dog and fox. *Okajimas Folia Anat Jpn*, 83: 73-76.
- Gregório Corrêa Guimarães, Márcia Rita Fernandes Machado, André Luiz Quagliatto Santos and Maria Angélica Miglino, 2007. Anatomic study and distribution of the Vallate papillae in domestic cats. *Braz J Vet Res Anim Sci*, São Paulo, 44: 82-88.
- Habel HE, in Sisson and Grossman, 1975. The Anatomy of the Domestic Animals, vol I, 5th edn, WB Saunders Co, Philadelphia, pp: 865-866.
- Hudson LC and WP Hamilton, 1993. Atlas of feline anatomy for veterinarians. Philadelphia: WB Saunders, pp: 151.
- Kubota K, 1967. Comparative anatomical and neurological observations on the tongue of the tongue of elephant (*Elephas indicus* and *Loxodonta Africana*). *Anat Rec*, 157: 505-516.
- Konig HE and HG Liebich, 2006. Veterinary Anatomy of Domestic Mammals. Textbook and Colour Atlas. 4th ed. Schattauer GmbH, Holderlinstrabe3 D-70174 Stuttgart, Germany.
- Lahkar K, 1985. Gross, histomorphological and histochemical studies on the tongue of Assam goat (*Capra hircus*) with a comparative note on that of cattle. M.V.Sc thesis submitted to Assam Agricultural University, Khanapara, Guwahati-22.
- Lahkar K, A Chakraborty and M Bhattacharya, 1989. Gross anatomical observations on the tongue of rhinoceros. *Ind Vet J*, 66: 954-57.
- Mariappa D, 1986. Anatomy and histology of Indian elephant. Indira Publishing House. PO Box 37256, Oale Park, Michigan, USA.
- Miller ME, GC Christensen and HE Evans, 1996. Anatomy of the dog. WB Saunders Co, Philadelphia.
- Nickel, R, A Schummer and E Seiferle, 1986. The viscera of the domestic animals. German Edition. Verlag Paul Parey, Berlin, Hamburg. pp: 485.
- Nomina Anatomica Veterinaria, 2005. 5th Ed. Prepared by the international committee on Veterinary Gross Anatomical Nomenclature .General Assembly of the word Association of veterinary anatomists, Knoxville, TN (USA) 2003. Hannover, Columbia, Gent, Sapporo. (Electronic version).
- Ojima K, 1995. Numerical study of vallate papillae by SEM figure in cat tongue. *Shigaku (Odontology)*, 82: 1006-1018.
- Ojima K, M Takeda and S Matsumoto, 1996. Variational study of number and arrangement type of vallate papillae in cat tongue. *Shigaku (Odontology)*, 83: 1184-1192.
- Ojima K, 1997. Numerical Variation and distributive pattern on microvascular cast specimens of vallate papillae in the crossbred Japanese cat tongue. *Ann Anat*, 179: 117-126.
- Prakash P and GS Rao, 1980. Anatomical and neurological studies on the tongue of Indian buffalo (*Bubalus bubalis*). *Acta Anat*, 107: 373-376.
- Sarma, Kamal, N Nasirudullah and S Islam, 2003. Gross anatomical observations on the tongue of Himalayan Black Bear. *Ind J Anim Sci*, 73: 1027-1028.
- Sisson and Grossman, 1975. The Anatomy of the Domestic Animals. vol. I, 5th edn WB Saunders Co, Philadelphia.
- Tichy F, 1993. The perinatal morphogenesis of selected lingual papillae in the domestic cat observed by scanning electron microscopy. *Acta Vet Brno*, 62: 121-126.
- Snedecor GW and WG Cochran, 1982. Statistical methods 6th edition Iowa State University press Ames, USA.
- SAS: SAS users Guide: Statistical SAS inst. Inc., Cary, NC, 1995.
- Sarma K, M Sarma and SN Kalita, 2009. Gross anatomical and biometrical studies on the tongue of an adult small indian civet cat. *Israel J Vet Med*, 64: 36: 38.