Morphological Comparison of the Filiform Papillae of New Zealand White Rabbits (*Oryctolagus cuniculus*) as Domestic Mammals and Egyptian Fruit Bat (*Rousettus aegyptiacus*) as Wild Mammals Using Scanning Electron Microscopic Specimens

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**SUMMARY:** This paper presents a comparison of the morphological structure of the filiform papillae in New Zealand white rabbits as domestic mammals and Egyptian fruit bats as wild mammals. This study was carried out on the tongues of adult healthy New Zealand white rabbits and Egyptian fruit bats of both sexes. There were four types of lingual papillae in both animals. In the Egyptian fruit bats, there were six subtypes of the filiform papillae; three on the anterior part (small, conical and giant), two on the middle part (cornflower and leaf-like papillae) while the posterior part contain rosette shape filiform papillae, in addition to transitional papillae and conical papillae. In New Zealand white rabbits, there were four subtypes of filiform papillae; spoonful conical (on the lingual anterior part), processed (at the anterior edge of lingual prominence), leaf-like (on the posterior area of lingual prominence) and triangular filiform papillae (on the lingual root). The shape, size, number and orientation of the lingual papillae itself and its processes varied according to their location within the tongue (region-specific) in relation to the feeding habits, strategies for obtaining food, climate conditions, and types of food particles.

**KEY WORDS:** Filiform papillae; Egyptian fruit bat; New Zealand white rabbits; Scanning electron microscope (SEM).

**INTRODUCTION**

The bat is considered the second largest mammalian order (Altringham *et al*., 1996), has an arboreal character (Ogunbiyi & Okon, 1976). The bats are the only mammals that have the ability of flight, in which the anterior member transforms into wings (Wilson & Reeder, 1993). The bat belongs to the Chiroptera order, suborder Megachiroptera, family Pteropodidae. Pteropodidae were feed on the fruit, flowers, nectar and pollen, and have Rousettus genus, there is only one species in Egypt called *Rousettus aegyptiacus* (Altringham *et al*.).

The New Zealand white rabbits belong to Leporidae family of Lagomorpha order. Once classified as a rodent, the rabbit was given a separate order because of dentition differences, chiefly the incisors. The rabbit was considered one of most a widely distributed mammalian species, used for economical, medical experiments and teaching purposes, and in recent years, kept as pet animals, all these facts put the rabbit in the focus of research (Romer, 1960).

The mammalian tongue varies in shape from species to species. The reasons for this morphological diversity are generally the result of different strategies for capturing and manipulating food, grooming, or vocal modulation. The tongue is a taste organ in the buccal cavity and with its species-specific lingual papillae on the dorsal surface plays an important role in food intake, digestion in many mammals (Iwasaki, 2002; Kobayashi & Shimamura, 1982; Abumandour & El-Bakary, 2013; Pastor *et al*., 1993).
Previous studies on the distribution of lingual papillae on the dorsal surface of the tongue in the Egyptian fruit bat indicated its considerable species-specific character, resulting from the adaptation of the lingual mucosa to the intake of liquid and semi-liquid food (Jackowiak et al., 2009; Emura et al., 2012; Trzcielinska-Lorych et al., 2009; Abumandour & El-Bakary, 2013). The arrangement and structure of the mechanical lingual papillae, aiding the transfer of food, documented in vertebrates, constitutes general traits typical of individual taxonomic units, for example, orders or families (Azalli et al., 1991; Emura et al., 2002b; Emura et al., 2000; Jackowiak & Godynicki, 2004). On the other hand, an important factor affecting the structure of the lingual papillae is the type of ingestion of food, the method of its grinding in the oral cavity, as well as the method of its passage to further segments of the alimentary tract.

In the end, there is a true question, is there a relationship between the morphological structures of the tongue, feeding habits, geographic position and the type of feed. This research was conducted to show morphostructural studies of the filiform papillae in the New Zealand white rabbits and Egyptian fruit bats fed as herbivorous animals and adapted to geographical distribution. Thus, the results were discussed and compared with those reported by the literature.

MATERIAL AND METHOD

Samples. This study was carried out on the tongues of eight adult normal healthy Egyptian fruit bats of both sexes collected from fruit farms and old houses from Edfina, Rashid, and Behera Governorate, Egypt, and eight a healthy adult New Zealand white rabbits (Oryctolagus cuniculus) of both sexes (1 year old, and 5.2±0.4 kg) collected from farms from Desouk, Kafre El-Sheik Governorate, Egypt.

For gross morphology. Five Egyptian fruit bats and five New Zealand white rabbits of both sexes were euthanized to demonstrate the gross morphological features. Two Egyptian fruit bats and two New Zealand white rabbits were used as fresh and three were formalized. The oral cavity was opened; the specimens were then fixed in 10% formalin.

For scanning electron microscopy. A tongue of the three adult Egyptian fruit bats and three New Zealand white rabbit tongue of both sexes, fixed in (2% formaldehyde, 1.25% glutaraldehyde in 0.1 M sodium cacodylate buffer, pH 7.2) at 4°C. Once fixed, the samples were washed in 0.1 M sodium cacodylate containing 5% sucrose, processed through tannic acid, and finally dehydrated in increasing concentrations of ethanol (15 min each in 50, 70, 80, 90, 95 and 100% ethanol). The samples were then critical point dried in carbon dioxide, attached to stubs with colloidal carbon and coated with gold palladium in a sputtering device. Specimens were examined and photographed with a JEOL scanning electron microscope operating at 15 KV, at the faculty of science, Alexandria University.

RESULTS

New Zealand white rabbits

A- Gross anatomical studies of the tongue:
Macroscopically, the non-protrusible tongue of rabbit is characterized by an elongated corpus, which relatively flat and ends with a rounded apex. The tongue of the rabbit could be divided into three areas: the anterior (lingual apex), middle (lingual body) and posterior (lingual root) areas (Fig. 1: An, M and P). The characteristic feature of the dorsal surface of anterior part is the presence of a shallow dorsal median groove (Fig. 1: Lg), while the characteristic feature of the dorsal surface of middle part is the presence of the lingual prominence (torus lingua) (Fig. 1: Lp).

B- Scanning electron microscopic studies of lingual filiform papillae: The dorsal surface of tongue contain four types of the lingual papilla; one mechanical (filiform) and three gustatory (fungiform, foliate and circumvallate). There are four subtypes of the mechanical filiform papillae; the anterior lingual part contains only one subtype of the filiform papillae called spoonful conical filiform papillae, and the lingual prominence contains two subtypes of the filiform papillae; processed filiform papillae and leaf-like filiform papillae, while the dorsal surface of the lingual root contains only one subtype of filiform papillae called triangular filiform papillae.

(1) SEM characteristic of spoonful conical filiform papillae. These posteriorly directed papillae (Fig. 1: Sf) were distributed on the dorsal surface of the anterior lingual part. Theses papillae were vertical spoonful, conical-shaped with an oval-shaped base and a body, having a posterior convex surface and anterior concave surface with a slightly posteriorly bent blunt tip. There are high numbers of the spoonful filiform papillae with small number of the fungiform papillae on the rostral round edge of the tongue. There are high number of microridges and microgrooves especially on the convex surface of the body.

(2) SEM characteristic of processed filiform papillae. These anteriorly directed papillae were distributed at the anterior
narrow part of the lingual prominence (Fig. 1: Pf). These papillae had a pointed long main process with only a pointed tip. There are microridges and microgrooves on its surface.

(3) SEM characteristic of leaf-like filiform papillae. These posteriorly directed papillae (Fig. 1: Lf) were distributed on the posterior wide area of lingual prominence, posterior to the anterior directed long processed filiform papillae. These papillae have a sharp convex ventral surface and sharp concave dorsal surface with two elevated lateral edges. There are high number of prominent microridges and microgrooves on the sharp convex surface of the papillae body.

(4) SEM characteristic of triangular filiform papillae. These posteriorly directed papillae (Fig. 1: Tf) were distributed on the lingual root surrounding the circumvallate papillae rostrally and medially and surrounding the foliate papillae.

Egyptian fruit bats

A- Gross anatomical studies of the tongue: Macroscopically, the Egyptian fruit bat is characterized by the protrusible, elongated flat tongue with a rounded apex. The tongue could be divided into three areas: anterior (lingual apex), middle (lingual body) and posterior (lingual root) areas (Fig. 2: An, M and P), in which each area was divided into three regions; median and two lateral part regions (Fig. 2: 2, 3, 4, 5, 6, 7 and 8), in addition to the apical part to the anterior part (Fig. 2: 1).

B- Scanning electron microscope of the lingual filiform papillae: There are four types of lingual papillae; two mechanical (filiform and conical) and two gustatory (fungiform and circumvallate) were recognized. There are six subtypes of the mechanical filiform papillae were observed throughout the whole tongue. The ones close to
the middle part of tongue were posteriorly directed toward the pharynx, while theses present on the lateral edge of tongue are directed medioposteriorly to help in the collection and gathering of food particles in the middle part region of posterior part of tongue then to pharynx (Fig. 2). The anterior part was subdivided into four region in form of U-shape; apical part, two lateral and median regions (Fig. 2: 1, 2 and 3), there are three subtypes of filiform papillae were region-specific distributed on the four regions of the anterior lingual part; lingual apex contain large number of the posteriorly directed small filiform (Fig. 2: Sf) surrounding a small number of the rectangular fungiform papillae (Fig. 2: Fu), while the two lateral regions contain large number of the medioposteriorly directed conical filiform papillae (Fig. 2: Cf) surrounding a very small number of the fungiform (Fig. 2: Fu), moreover the median region contain large number of the posteriorly directed giant filiform papillae only (Fig. 2: Gf).

The middle part subdivided into three region; two lateral regions (Fig. 2: 5) and one median region (Fig. 2: 4). The middle part contains two subtypes of filiform papillae; the two lateral regions contain medioposteriorly directed cornflower filiform papillae (Fig. 2: Ff) surrounding a small number of round fungiform papillae, while...
the median region contain posteriorly directed leaf-like filiform papillae only (Fig. 2: If).

The posterior part of tongue was subdivided into three region; two lateral regions (Fig. 2: 8) and median region (Fig. 2: 7); the two lateral regions contain medioposteriorly directed conical papillae (Fig. 2: Tp). The median region contains posteriorly directed rosette-shape filiform papillae (Fig. 2: Rf).

1) SEM characteristic of small filiform papillae (Fig. 2: Sf): These papillae were round and small and its dorsal surface have microtubercles and microgrooves, and have posterior directed several pointed processes originated from all anterior, posterior and lateral margin of papillae (25–35 processes), this processes bearing microtubercles and microridges and terminated posteriorly by one or two posterior processes.

2) SEM characteristic of conical filiform papillae (Fig. 2: Cf): These papillae having posteriorly directed several pointed processes originated from all margins of the papillae (40–45 processes).

3) SEM characteristic of giant filiform papillae (trifid or tridentate) (Fig. 2: Gf): These papillae were overlap on each other, and reach to about 0.8–1 cm in long and 0.4 cm in wide. Each papilla has 13–18 small posteriorly directed anterior processes. The body terminated posteriorly by three large posteriorly directed posterior processes.

4) SEM characteristic of cornflower filiform papillae (Fig. 2: Ff): These papillae were characterized by its two lateral edges was bent on the dorsal surface of papillae and the papillae ended by posteriorly directed round end with a secondary one to three posterior processes. Some of these papillae were orientated medioposteriorly and some orientated medially.

5) SEM characteristic of leaf-like filiform papillae (Fig. 2: Lf): These papillae ended with posteriorly directed main posterior process and posteriorly directed 2 to 4 accessory lateral processes.

6) SEM characteristic of rosette shape filiform papillae (Fig. 3: Rf) These rosette-shape papillae have round base and its apex ended with posteriorly directed many small posterior processes (10–12 processes).

7) SEM characteristic of transitional papillae (Fig. 3: Tf). These papillae represent a transitional stage, which present between the rosette shape filiform and conical papillae in the two lateral region of posterior part near the median region, which take the tongue shape with central groove and posterior pointed end. These papillae overlap each other and orientated medioposteriorly.

![Fig. 3. Dorsal view macrograph of the posterior part of the Egyptian fruit bat tongue with scanning electron micrographs photo to show; Cv- circumvallate papillae, Rf- Rosette shape filiform papillae, Cp- conical papillae, Tp- transitional papillae.](image-url)
**DISCUSSION**

Different morphological structures of the vertebrates tongue are specialized to fulfill different functions, such as swallowing, water uptake, capturing and manipulating the food, grooming, vocal modulation, and suckling (Pastor et al., 2011; Kilinc et al., 2010; Mancanares et al., 2012). Morphological differences and variations appearing in the tongue are directly associated with dietary specializations and food type, as well as adaptations to various environmental conditions (Iwasaki). The distribution of the different papillae on the various surfaces of the tongue is characteristic of a genus and may even be distinctive among different species. One of the elements that contribute most to the morphological, distribution, and type of papillae is the diet (Pastor et al., 2008; Abumandour & El-Bakary).

In the present study, the Egyptian fruit bat was characterized by elongated protrusible tongue with round long free anterior part to facilitating the movement of tongue while swiping the extracts of fruit pulp, agree with (Birt et al., 1997; Abumandour & El-Bakary; Mqokeli & Downs, 2012), while the New Zealand white rabbit tongue is characterized by elongated non-protrusible tongue with thin round apex to be adapted for eating form the ground as in; rabbit (Ojima et al., 2000), Japanese Badger (Yoshimura et al., 2008). The lingual median prominence was a characteristic feature in some mammals, which agree with our observation in New Zealand white rabbit tongue, and in; bank vole (Jackowiak & Godynicki, 2005), rabbit (Nonaka et al., 2008) and herbivorous artiodactylas (Zheng & Kobayashi, 2006), while omnivorous artiodactylas (pig) and carnivores animals not have a lingual prominence (Emura et al., 2006; Kumar & Bate, 2004). While (Pastor et al., 1993) in common European bat reported that there was a prominent of intermolar tubercle, moreover, molossid bats have a prominent mid-dorsal lobe as noted by Gregorin (2003), but Emura et al. (2001b), Jackowiak et al. (2009), Gregorin and Mqokeli & Downs (2012) reported that, there is no typically intermolar tubercle in all bats, while our study in the Egyptian fruit bat noted that, the characteristic feature of the dorsal surface of the middle part of tongue is the presence of a shallow intermolar tubercle, located close to the posterior half area of the tongue. Our study in New Zealand white rabbit confirmed that, the presence of a lingual prominence is regarded as a characteristic of herbivores and this muscle-rich prominence with filiform papillae allows herbivores to grind food by crushing it between the tongue and the upper palate, while in the Egyptian fruit bat, the main function of the filiform papillae to help in catching of foods.

The food habits of the bats are diversified: insectivorous, fruit-eating, flower-eating, vampire and carnivorous feeding. These differences resulted in various adaptations in the number and the morphology of the filiform papillae as noted in different study as in; six species of long-nosed bats (Greenbaum & Phillips, 1974), Japanese long-fingered bat (Kobayashi & Shimamura, 1982), European common bat (Pastor et al., 1993), lesser dog-faced fruit bat (Emura et al., 2001a), large flying fox (Emura et al., 2002b) and Japanese common pipistrelle (Emura et al., 2009), in which this clear in our study in the Egyptian fruit bat. The previous studies on the distribution and structure of the mechanical papillae on the dorsal surface of the mammalian tongue constitute general traits typical for individual taxonomic units, such as orders or families, as well as traits characteristic of a particular species (Iwasaki; Abumandour & El-Bakary). Our study noted that the lingual papillae distributed on the Egyptian fruit bat’s tongue have some characteristics that are different from those of land mammals.

As in the previous published data, the lingual papillae were species-specific, in which differing in their number among mammalian species, these differences may depend on dissimilarities in diet, feeding habits and handling of food in mouth (Emura et al., 2002b; Abumandour & El-Bakary), the previous data clear in; our study in Egyptian fruit bat, this confirmed by presence of four types of lingual papillae; two mechanical and two gustatory as noted in; bats (Selim et al., 2008; Abumandour & El-Bakary; Abayomi et al., 2009), moreover other mammals have four lingual papillae; as in our study in New Zealand white rabbit; one mechanical (filiform) and three gustatory (fungiform, foliate and circumvallate) as noted in; rats (Nasr et al., 2012), bank vole (Jackowiak & Godynicki, 2005), dog and fox (Emura et al., 2006). However, three types of lingual papillae; one mechanical (filiform) and two gustatory (fungiform and circumvallate) as noted in; bats (Pastor et al., 1993; Emura et al., 2001b; Park & Lee, 2009; Masuko et al., 2007), however, there were two types only of papillae (filiform and fungiform) in hematophagous bats (Masuko et al.).

Our study agrees with the previous published data that, the filiform papillae have some morphological variations according to specialized to fulfill different functions; for example, the filiform papillae are simple in rodents to compound structure in artiodactyls as cattle. This confirmed in the previous articles that, the filiform papillae have many divisions, such as they were classified as seven subtype in; bat by (Park & Hall, 1951), while our study in Egyptian fruit bat and (Kobayashi & Shimamura, 1982;
of canines of Bakary). The greater protrusible tongue with the retention bat (Mqokeli & Downs) and fruit bat (Abumandour & El-Bakary). While there were four subtypes as noted in our study in New Zealand white rabbits and in frugivorous bats (Masuko et al.; Trzezielska-Lorych et al.; Mqokeli & Downs) and ferret (Takemura et al., 2009). While three subtypes as noted in: bats (Jackowiak et al., 2009; Pastor et al., 1993), rat (Ojima et al., 1996), mice (Toprak, 2006), and rabbit (Nonaka et al.), moreover there are two subtypes as in; bat (Park & Lee), Porcupine (Karan et al., 2011) and (Jackowiak, 2006) in European mole. There is only one types as noted in camel by (Qayyum et al., 1988). Functionally in our study in the Egyptian fruit bat, the numerous subtypes of the filiform papillae, suggests the role of filiform papillae in food and liquid intake during the flight and transport toward pharynx, in which this papillae increase the adhesion of food to the surface of tongue; because of eating habits during flight, agree with general information noted by (Ojima et al., 2000).

From the previous published data it becomes clear that, the variation in the morphology of the filiform papillae may be related to masticatory methods and dietary habits, as Yoshimura et al. and Abumandour & El-Bakary; this confirmed in our study in the Egyptian fruit bat, small filiform papillae with its several pointed posterior directed small processes as in (Jackowiak & Godynicki, 2004), and microtubercles, microridges and microgrooves with the conical filiform papillae on the lateral sides of the anterior part of the tongue help in the catching processing and fixing of food materials during the flight, while the giant filiform papillae with its posteriorly directed small anterior and large trifid processes in the median region of the anterior part of the tongue help in the posterior direction of the food materials caught, with the anterior directed canine; it therefore becomes clear that these filiform papillae on the anterior part of the tongue compensate for the absence of upper and lower incisive teeth which leave the space between the canine teeth, this space was adapted for allowing the elongated tongue to move freely when feeding, this agrees with nectar-feeding bat (Mqokeli & Downs) and fruit bat (Abumandour & El-Bakary). The greater protrusible tongue with the retention of canines of S. australis; suggest that it may be more efficient than Pteropus species when collecting nectar from flowers (Birt et al.).

The differences in the filiform morphology among the same animals may be related to type of food eaten, which varied according to geographical distribution; in this study of Egyptian fruit bat (captured from Egypt), there were differences in shape, size, orientation and number of the lingual papillae; there were six subtypes of the filiform papillae, moreover in Egyptian fruit bat (captured from Japan) (Emura et al., 2012) noted that there are five subtypes of the filiform papillae, but in Egyptian fruit bat captured from Poland, there are two status; the first noted by (Trzezielska-Lorych et al.) that there were four subtypes, while the second status noted by (Jackowiak et al., 2009) that there are three subtypes only (Ghassemi & Jahromi, 2013) in Egyptian fruit bat captured from Iran were noted that three subtypes of the filiform papillae, or this variation may reflect the different in subspecies as; certain P. polocephalus adapted to a nectar diet and others to fruit diet (Eby, 1991). This was clear in case of, P. scapulatus having long pointed, and dense giant papillae on a large area of anterior part of tongue, suggest that P. scapulatus prefers a diet of nectar (Eby, 1995), with its migratory behaviour to area with little or no flowering, so P. scapulatus consume fruit (Eby, 1995), so some variation in giant papillae morphology. Also, this variation extended to include the presence or absence of some type of papillae (Jackowiak et al., 2009; Ghassemi & Jahromi) Egyptian fruit bat have bifid filiform papillae in addition to trifid ones, in constant our result agree with (Trzezielska-Lorych et al.; Emura et al., 2012), that there is no presence of bifid papillae.

In rabbit, the differences in the filiform morphology among the same animals may be related to type of food eaten, which varied according to geographical distribution; in our study in New Zealand white rabbit (captured from Egypt), there were four subtypes, while there are three subtypes of filiform papillae in New Zealand white rabbit (captured from Japan) as noted by (Nonaka et al.).

There are some variation in the lingual adaptation between the New Zealand white rabbits (domestic mammals eating directly from the ground) and the Egyptian fruit bat (wild mammals eating during the flight), this adaptation is clear in the our study in the Egyptian fruit bat; firstly, the tongue tip not have giant filiform papillae and instead a blunt small filiform papillae, in which this distribution may have an important role in feeding habits, this confirmed by (Hall et al., 1995), while (Paton & Collins, 1989) in nectar-feeding bats, noted that the functions of giant filiform papillae on the tongue tip to increase the surface area to collect nectar. The another adaptation, the giant filiform papillae were rough to touch in help in power catching by piercing the skin of soft fruits to consume fruit and press it between the tongue the ridged hard palate to release the juices (Bonaccorso & Gush, 1987). Also, among the lingual papillae morphology the orientation; in Egyptian fruit bat, cornflower filiform papillae on two lateral regions of middle part; some orientated medioposteriorly and some orientated medially while, in lateral region of posterior part; having the medio-
anterior directed conical papillae in anterior part and medioposteriorly directed conical papillae in posterior part, while (Pastor et al., 1993) in common European bat, at junction of posterior and intermolar eminence, a tuft of filiform papillae was oriented anteriorly in opposition to all the others. While in the filiform papillae these were characterized by the purely mechanical functions of grasping food and grooming in yak and cattle and also serve to protect the fungiform papillae and fulfill a mechanical cleaning function in the interdental spaces of the lower jaw, similar to that which occurs in other mammals (Pastor et al., 2008; Hofer et al., 1993).

There are variation in the distribution of the filiform papillae between animals (species-specific) and there are different form of distribution in the same animal (region-specific) confirm the different feeding methods between the two animals to adapt to its life history; in the Egyptian fruit bat, there arethree subtypes of filiform papillae on the anterior part of tongue; small (Linguaplex), conical (two lateral regions) and giant (median region) filiform papillae, while there are two subtypes in middle region of the tongue at two the lateral regions; medioposteriorly directed papillae (cornflower filiform papillae), while the median region contain posteriorly directed leaf-like filiform papillae only. But only one type of the posterior part of tongue at the median region of contains posteriorly directed rosette-shape filiform papillae. While in New Zealand white rabbits, there is only one subtype of filiform papillae on the anterior part of tongue (spoonful conical filiform papillae), while there are two subtypes in lingual prominence; processed filiform papillae (at the anterior edge of lingual prominence) and leaf-like filiform papillae (on the posterior wide area of lingual prominence), but the lingual root contain only one subtype; Triangular filiform papillae.

Our study in Egyptian fruit bat agrees with that noted in the previous articles (Emuraet al., 2001b; Mqokeli & Downs; Birt et al.; Kobayashi & Shimamura, 1982, EmuraHayakawa et al., 2002b), that the giant trifold filiform papilla are common in all bat species, but (Greenbaum and Phillips, 1974) in two species of bats (flower-eating), added that there are also two large, bifid, horny papillae located next to each other along the midline of the tongue, and also (Ghassemi & Jahromi; Jackowiak et al., 2009) noted that there are bifid Filiform Papillae and described as they are similar to giant type but had bifid ends and oriented to the lateroposterior of tongue, moreover (Park & Hall) made comparative studies of the tongue in a total of three families and eight species, nectar-eating, fruit-eating, and vampire bats, and reported that there are large bifid papillae were distributed on the posterior middle area of the tongues of fruit-eating bat (Macrotus and Artibeus), while out distributed near the tongue tip in all bats. Whouber, the trifold and bifid filiform papillae were absent in; molossid bats (Gregorin), common European bat (Pastor et al., 1993), hematophagous bats (Masuko et al.).

The filiform papillae were observed throughout the whole tongue, in which their shape, size, number and orientation of the papillae itself and its processes varied according to their location within the tongue (region-specific) in relation to the feeding habits and types of food particles. The ones close to the middle part of tongue were posteriorly directed toward the pharynx and the base of tongue, while these present on the lateral edge of tongue are directed medioposteriorly to help in the collection and gathering of food particles in the middle part region of the posterior part of tongue then to pharynx. Furthermore in the lesser dog-faced fruit bat (Emura et al., 2001b) and the large flying fox (Emura et al., 2002b) the filiform papillae were not observed in the region of the circumvallate papillae, however, our study in the Egyptian fruit bat agree with (Emura et al., 2012), that the filiform papillae were observed in the region of the circumvallate papillae.

In general, the filiform papillae ended with a pointed apex and are oriented caudally in all species, as reported in our study. Filiform papillae of raccoon dog, fox, silver fox and giant panda have multiple processes (Jackowiak & Godynicki, 2004; Emura et al., 2009; Pastor et al., 2008) that are likely to have a mechanical effect by increasing the friction, but blind mole rats do not have these structures. In the raccoon dog and Japanese marten, each filiform papilla of the apical surface of the tongue has several pointed processes; and filiform papillae of the lingual body consist of a main papilla and some secondary papillae (Emura et al., 2007; Jackowiak & Godynicki, 2004), in the insectivores from the Sorex and Dymecodon species, the filiform papillae lack processes on the apex of the tongue, but on the surface of the body of the tongue they have two well-developed processes, tilted towards the back of the tongue (Kobayashi et al., 1989; Jackowiak et al., 2004). Filiform papillae on the lingual apex are reduced in size, structure and rounded shape as reported in our study in the Egyptian fruit bat, raccoon dog, fox, macaque, monkey and European mole rat (Jackowiak, 2006; Emura et al., 2006; Emura et al., 2002a; Emura et al., 2002b). Besides, the fact that filiform papillae are easily bent in the direction of the radix, but not in the opposite direction could be related to the need to secure in place and move the food taken into the mouth (Iwasaki; Ciuccio et al., 2008), but in our study in New Zealand white rabbits tongue, all the filiform papillae were directed posteriorly except the processed filiform papillae present on the anterior narrow part of the lingual prominence were anteriorly directed, in which this results in contrast with noted by (Nonaka et al.) in rabbit.
La filiforme se considera como tener una función mecánica (Nickel, 1979); pero (Mistretta & Baum, 1984) sugirió la función gustatoria de ella. En el contrario, forma el primer camino para el transporte de alimentos que viene en contacto con la lengua durante la masticación y la deglución, así como observado más intensa incremento en la capa de queratización, que sirve como una protección. Para comparación, la capa de queratización en la parte lateral de la lengua, adyacente a los dientes y las superficies de la lengua, incrementa en espesor de alta 2-fold.

El método mencionado tipos de filiform papilae forman el camino principal para el transporte de alimentos, siendo muy fruita, así como como llegar en contacto con la lengua durante la masticación y deglución, así como observado más intensa incremento en la capa de queratización, que sirve como una protección. Para comparación, la capa de queratización en la parte lateral de la lengua, adyacente a los dientes y las superficies de la lengua, incrementa en espesor de alta 2-fold.

**PALABRAS CLAVE:** Papilas filiformes; Murciélago de la fruta egipcio; Conejo blanco Nueva Zelanda; Microscopio electrónico de barrido.

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