

## Macroscopic and Light Microscopic Structure of Fungiform Papillae on the Tongue of Squirrels (*Sciurus vulgaris*)<sup>[1]</sup>

Esin ÜNSALDI \* 

[1] *This study was taken from doctorate thesis named Macroscopic and light microscopic structure of taste papillae in squirrels (sciurus vulgaris)*

\* Selçuk Üniversitesi, Veteriner Fakültesi, Cerrahi Anabilim Dalı, 42003, Konya - TÜRKİYE

**Makale Kodu (Article Code): KVFD-2009-530**

### Summary

This study was carried out to examine macroscopic and light microscopic structure of papillae fungiformes in squirrels. In this study, 10 tree squirrels (5 female and 5 male) were used. Macroscopically, squirrel tongue was relatively long and narrow. The tongue was about 2.77 cm in length and 0.75 cm in wide. There were two types of taste papillae in squirrel tongue. These were papillae fungiformes and papillae vallatae. In addition to, mucosa crimps that consist of 12 laminae on each posterolateral edge were determined macroscopically in foliata area. However, there was no finding about foliata papillae at the light microscopic observations. It was observed that fungiform papillae were distributed among the filiform papillae, being fungus-shaped protuberances on the surface of the tongue. The number of fungiform papillae was reported to be 310 on anterior part of the tongue. On the posterior part, 53 fungiform papillae were observed. Papillae fungiformes were covered with a stratified squamous epithelium and there were keratine lamellae on the outer of it. An intraepitelial taste bud (*Calculus gustatorius*) was located in the middle of the top of the papillae and this taste bud was connected to mouth cavity with a taste pore. Same findings were obtained in female and male squirrels.

**Keywords:** *Squirrel, Papillae Fungiformes, Light Microscopy*

## Sincaplarda (*Sciurus vulgaris*) Papillae Fungiformes'in Makroskopik ve Işık Mikroskopik Yapısı

### Özet

Bu çalışma, sincaplarda papilla fungiformislerin makroskopik ve ışık mikroskopik yapısını incelemek amacıyla yapılmıştır. Bu çalışmada, 10 adet ağaç sincabı kullanıldı. Makroskopik olarak sincap dili nispeten uzun ve dardı. Dil yaklaşık 2.77 cm. uzunlukta ve 0.75 cm genişlikteydi. Sincap dilinde iki tip tat papillası bulunmaktaydı. Bunlar papillae fungiformes ve papillae vallatae idi. Buna ek olarak foliata papillaların bulunması gereken bölgede her bir yarımda posterolateral olarak 12 yapraklı oluşmuş mukoza kriptleri saptandı. Buna rağmen ışık mikroskopik incelemelerde foliata papillaya ait herhangi bir bulguya rastlanmadı. Papilla fungiformis'lerin dilin üst yüzünde mantar biçiminde çıkıntılar olarak papilla filiformisler arasında dağıldıkları görüldü. Fungiform papillalar, dilin ön yarımında 310 adet sayıldı. Arka yarımında ise 53 adet sayıldı. Papilla fungiformis'ler çok katlı yassı bir epitel ile örtülüydü ve dışında keratin lamelleri bulunmaktaydı. Papilla'nın tepesinin ortasında intraepitelial olarak yerleşmiş bir adet tat tomurcuğu (*Calculus gustatorius*) yer almaktaydı ve bu tat tomurcuğu bir adet tat porusu ile ağız boşluğuna açılmaktaydı.

**Anahtar sözcükler:** *Sincap, Papilla Fungiformes, Işık Mikroskop*

### INTRODUCTION

In mammals, fungiform papillae are distributed among the filiform papillae, being fungus-shaped protuberances on the surface of the tongue. The highest density of

papillae is located on the tip<sup>1,4</sup>. In rats, papillae are distributed equally on two halves of the tongue and they are symmetrical to the dorsal midline.<sup>1,4,5</sup>. Besides,



**İletişim (Correspondence)**



+90 533 7750950



esinunsaldi@gmail.com

there is no papilla on the dorsal midline in rodentia like mouse and hamster <sup>2,6</sup>. In flying squirrel, there are dome shaped fungiform papillae scattered among the filiform papillae, especially at the tip and both lateral edges of the tongue. The diameter of the fungiform papilla are up to 80-100  $\mu\text{m}$  in mouse <sup>7</sup>. Length diameter is 107.2  $\mu\text{m}$  in rat, 95  $\mu\text{m}$  in hamster <sup>8</sup>. The innervation of the fungiform papillae is derived from two sources <sup>9</sup>: The lingual branch of the trigeminal (V. cranial, mandibular division) nerve <sup>10</sup> and the chorda tympani, a sensory branch of the facial (VII. cranial) nerve <sup>11</sup>.

In rat <sup>1,5,12,13</sup> and hamster <sup>14</sup>, one papilla usually contains only one taste bud. In mouse, papilla fungiformes contain one or a few taste buds <sup>15</sup>. And a taste pore is found in the central region at the top of each taste bud of fungiform papillae <sup>7,15</sup>. In the porcupine and the opossum, fungiform papillae don't contain taste buds <sup>16,17</sup>.

Average diameters of the taste buds are declared to be 44  $\mu\text{m}$  by Mistretta and Baum <sup>5</sup>, 59  $\mu\text{m}$  by Mistretta and Oakley <sup>13</sup> and 50-70  $\mu\text{m}$  by Farbman and Hellekant <sup>18</sup>. The numbers of the papillae is declared to be average 113 by Mistretta and Baum <sup>5</sup>, 187 by Miller and Preslar <sup>1</sup>. In hamster, it is observed that the taste buds of fungiform papillae contain light, dark, basal and peripheral cells <sup>6,14</sup>.

The aim of this study is to examine macroscopic and light microscopic structure of papillae fungiformes in squirrels.

## MATERIAL and METHODS

In this study, 10 tree squirrels (5 male and 5 female) were used to examine macroscopic and light microscopic structure of papillae fungiformes. After the squirrels were killed, the tongues were removed and anatomical and histological methods were applied. As anatomical methods; squirrels tongue were examined and the shape, distribution and the place of the papillae was determined. As histological methods; Light microscopic methods were used. So, tongues were removed and placed in 10% formalin. After macroscopical examination, the pieces containing fungiform papillae were excised and fixed. They were passed through alcohol and xylol series and embedded in paraffin wax. Serial sections 5-7  $\mu\text{m}$  thick were cut parallel to the surface of the tongue, from dorsal to ventral surfaces. All sections were stained with haematoxylin and eosin <sup>19</sup>. Micrometric measurements were taken by ocular micrometer. Photographs were taken with Nikon brand microscope (Eclipse 80 i) which is connected with computer.

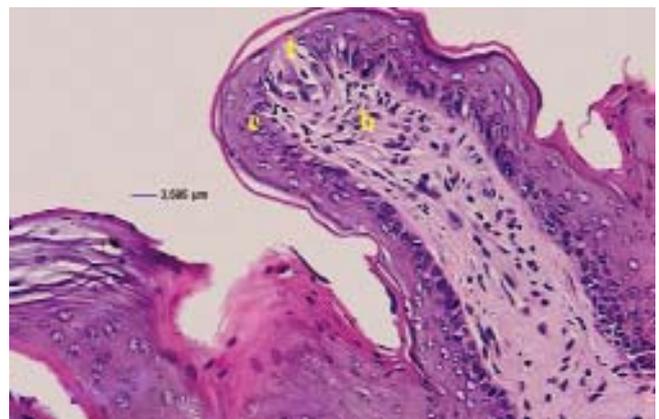
## RESULTS

Squirrel tongue was relatively long and narrow. The average length was 2.75 cm, width was 0.65 cm, height was 0.50 cm. It was observed that fungiform papillae were distributed among the filiform papillae, being fungus-shaped protuberances on the surface of the squirrel tongue. These papillae were more numerous in the anterior part than in the posterior part of the tongue. The highest density of papillae is found on the tip and on the each lateral edges. On the lateral edges, fungiform papillae were observed in form of two rows symmetrical to the dorsal midline and they were absent on the median sulcus. Fungiform papillae were distributed irregularly between this dorsal midline (*sulcus medianus*) and two rows on the edges of the tongue (*Fig. 1*). The number of fungiform papillae was reported to be 310 on anterior part, 53 on the posterior part of the tongue. In total, 363 fungiform papillae was counted. Length and width of papilla and taste bud, thickness of epithelium, taste bud length/width ratio was demonstrated at *Table 1*.

**Table 1.** Average measurements that were taken from fungiform papillae

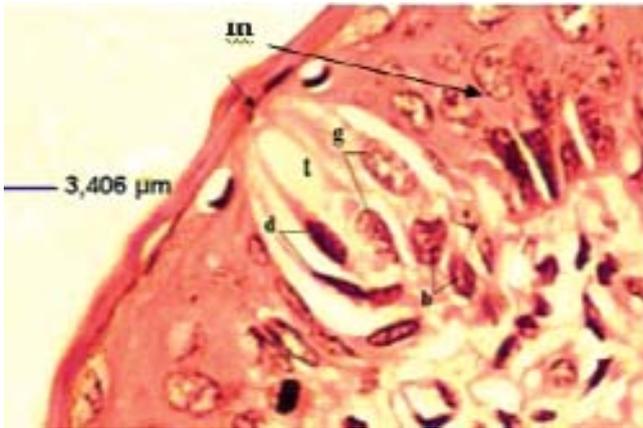
**Tablo 1.** Fungiform papilla'dan alınan ortalama ölçümler

Parameter	General average	Anterior half	Posterior half
Length of the papilla ( $\mu\text{m}$ )	183.1 $\pm$ 11.6	177.1 $\pm$ 15.7	210 $\pm$ 5.64
Width of the papilla ( $\mu\text{m}$ )	177.58 $\pm$ 7.76	177.1 $\pm$ 11.5	178.33 $\pm$ 7.96
Length of the bud ( $\mu\text{m}$ )	43.17 $\pm$ 1.93	45 $\pm$ 2.67	40 $\pm$ 1.10
Width of the bud ( $\mu\text{m}$ )	35 $\pm$ 1.95	36.25 $\pm$ 2.63	32.5 $\pm$ 2.5
Thickness of epithelium ( $\mu\text{m}$ )	38.1 $\pm$ 1.12	36.92 $\pm$ 1.75	40 $\pm$ 1.10
Taste bud length/width ratio	1.23	1.24	1.23



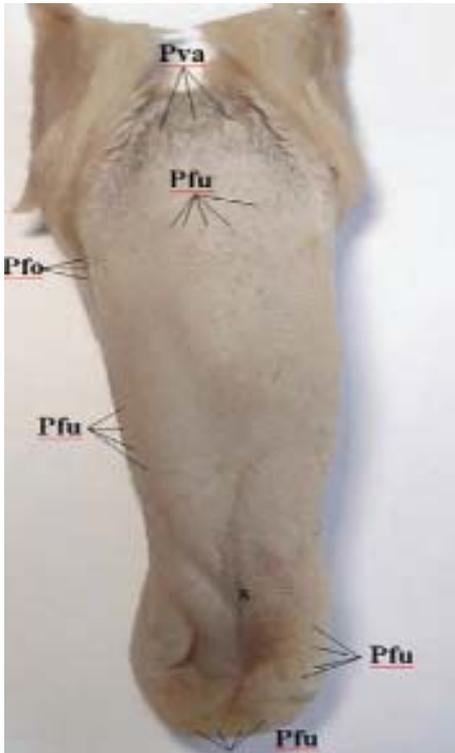
**Fig 1.** General view of fungiform papilla on the dorsal surface of the anterior half of the tongue. Taste bud (*Calculus gustatorius*) (t), stratified squamous epithelium (e), connective tissue (*Lamina propria*) (b) H&E

**Şekil 1.** Dilin ön yarımının dorsal yüzündeki fungiform papilla'nın genel görünümü. Tat tomurcuğu (*Calculus gustatorius*) (t), çok katlı yassı epitel (e), bağ doku (*Lamina propria*) (b) H&E



**Fig 2.** Taste bud in fungiform papilla (*Caliculus gustatorius*) (**t**), taste bud cells; dark cells (*Epitheliocytyus sustentans*) (**d**), light cells (*Epitheliocytyus sensorius gustatorius*) (**g**), and basal cells (**b**), taste pore (*Porus gustatorius*) (arrow), mikroskopik papillae (**m**) H&E

**Şekil 2.** Fungiform papilla'da tat tomurcuğu (*Caliculus gustatorius*) (**t**), tat tomurcuğu hücreleri; koyu hücreler (*Epitheliocytyus sustentans*) (**d**), açık hücreler (*Epitheliocytyus sensorius gustatorius*) (**g**) ve basal hücreler (**b**), tat porusu (*Porus gustatorius*) (ok), mikroskopik papillalar (**m**) H&E



**Fig 3.** General view of the tongue. **Pfu**= Papillae fungiformes, **Pva**= Papillae vallatae, **Pfo**= mucosa crimps of foliata area, **s**= sulcus linguae

**Şekil 3.** Dilin genel görünümü. **Pfu**= Fungiform papillalar, **Pva**= Vallata papilla'lar, **Pfo**= Foliata bölgesindeki mukoza kıvrımları, **s**= Dil oluğu

These measurements were same in female and male squirrels.

Papillae fungiformes were covered with a stratified squamous epithelium and on the outer side of it there were keratine lamellae. Keratinization of the covering epithelium was only weak (*Fig. 2*). Papilla had made a prominence with some connective tissue. This connective tissue was observed that made microscopic papillae. The epithel thickness in the middle and the top area of the papilla was same. An intraepithelial taste bud was located in the middle of the top of the papillae and this taste bud was connected to mouth cavity with a taste pore. Taste buds had light (*Epitheliocytyus sensorius gustatorius*), dark (*Epitheliocytyus sustentans*) and basal cells in it (*Fig. 3*).

## DISCUSSION

It was declared that fungiform papillae were distributed among the filiform papillae, being fungus-shaped protuberances in man and monkey<sup>20</sup>, rat<sup>1,4</sup>, mouse<sup>3</sup> and hamster<sup>2,6</sup> and being dome-shaped protuberances in flying squirrel<sup>21</sup> and squirrel monkey<sup>22</sup> on the surface of the tongue. The highest density of papillae was found on the tip and each lateral edges<sup>2,20,21</sup>, and these papillae were located paralelly to the dorsal midline where they were absent<sup>2</sup>. In our study, we obtained the same findings, In addition to, in the lateral edges, fungiform papillae were observed in form of two rows, parallel to the dorsal midline where they were absent. Fungiform papillae were distributed irregularly between this dorsal midline (*sulcus medianus*) and two rows on the edges of the tongue.

It was informed that fungiform papillae were covered with a stratified squamous epithelium<sup>9,16,23,24</sup> and had a connective tissue<sup>9</sup>. In our study, we obtained the same findings.

It was informed that each fungiform papilla contained a single taste bud which is distinguished by slender, lightly staining cells oriented parallel to the long axis of the papilla and this taste bud emerged through a pore at the top surface of the papilla in mouse<sup>25</sup>, rat<sup>4</sup> and hamster<sup>2,6,14</sup> but in the opossum and the porcupine, fungiform papillae had not any taste buds<sup>16,17</sup>. In our study, we observed that an intraepithelial taste bud was located in the middle of the top of the papillae and this taste bud was connected to mouth cavity with a taste pore.

In light micrographs, Whitehead et al.<sup>14</sup> informed that taste buds of fungiform papillae had dark and light cells in hamster, besides Miller and Chaudry<sup>6</sup> also informed that hamster fungiform papillae taste buds had basal

and peripheral cells. We observed that taste buds of fungiform papillae had dark, light and basal cells.

In conclusion, we examined macroscopic and light microscopic structure of fungiform papillae in squirrels and we observed that fungiform papillae were also found posterior area of the tongue unlike other rodentia.

## REFERENCES

- 1. Miller IJ, Preslar AJ:** Spatial distribution of rat fungiform papillae. *Anat Rec*, 181, 679-684, 1974.
- 2. Miller IJ, Smith DV:** Quantitative taste bud distribution in the hamster. *Physiol Behav*, 32 (2): 275-285, 1984.
- 3. Iwasaki S, Miyata K, Kobayashi K:** Comparative studies of the dorsal surface of the tongue in three mammalian species by scanning electron microscopy. *Acta Anat*, 128, 140-146, 1987.
- 4. Dinç G, Girgin A, Yılmaz S:** Ratlarda *papilla fungiformis*'in prenatal ve postnatal gelişimi. *Firat Üniv Sağlık Bil Derg*, 9 (2): 161-163, 1995.
- 5. Mistretta CM, Baum BJ:** Quantitative study of taste buds in fungiform and circumvallate papillae of young and aged rats. *J Anat*, 138, 323-332, 1984.
- 6. Miller RL, Chaudry AP:** Comparative ultrastructural of vallata, foliate and fungiform taste buds of golden Syrian hamster. *Acta Anat*, 95, 75-92, 1976.
- 7. Iwasaki S, Yoshizawa H, Kawahara I:** Study by scanning electron microscopy of the morphogenesis of three types of lingual papilla in the mouse. *Acta Anat*, 157, 41-52, 1996.
- 8. Parks JD, Whitehead MD:** Scanning electron microscopy of denervated taste buds in hamster: Morphology of fungiform taste pores. *Anat Rec*, 251, 230-239, 1998.
- 9. Agungpriyono S, Yamado J, Kitamura N, Nisa C, Sigit K, Yamamoto Y:** Morphology of the dorsal lingual papillae in the lesser mouse deer, *Tragulus javanicus*. *J Anat*, 187, 635-640, 1995.
- 10. Ahpin P, Ellis S, Arnett C, Kaufman MH:** Prenatal development and innervation of the circumvallate papilla in the mouse. *J Anat*, 162, 33-42 1989
- 11. Farbman AI, Mbiene JP:** Early development and innervation of taste bud-bearing papillae on the rat tongue. *J Comp Neurol*, 304, 172-186, 1991.
- 12. Beidler LM, Smallman RL:** Renewal of cells with taste buds. *J Cell Biol*, 27, 263-272, 1965.
- 13. Mistretta CM, Oakley IA:** Quantitative anatomical study of taste buds in fungiform papillae of young and old fischer rats *J Gerontol*, 41 (3): 315-318, 1986.
- 14. Whitehead MC, Beeman CS, Kinsella BA:** Distribution of taste and general sensory nerve endings in fungiform papillae of the hamster. *Am J Anat*, 173, 185-201, 1985.
- 15. Kinnamon CJ, Henzler DM, Royer SM:** HVEM ultra-structural analysis of mouse fungiform taste buds, cell types and associated synapses. *Microsc Res Tech*, 26, 142-156, 1993.
- 16. Kubota K, Fukuda N, Asakura S:** Comparative anatomical and neurohistological observations on the tongue of the porcupine (*Hystrix cristata*). *Anat Rec*, 155, 261-268, 1966.
- 17. Krause WJ, Cutts JH:** Morphological observations on the papillae of the opossum tongue. *Acta Anat*, 113, 159-168, 1982.
- 18. Farbman AI, Hellekant G:** Quantitative analyses of the fiber population in rat chorda tympani nerves and fungiform papilla. *Am J Anat*, 153, 509-522, 1978.
- 19. Luna LG:** Manuel of Histologic Staining Methods of the Armed Forces Institute of Pathology. Third ed. Mc. Graw- Hill Book Company. Toronto, London, 1968.
- 20. Arvidson K:** Scanning electron microscopy of fungiform papillae on the tongue of man and monkey. *Acta Otolaryngol*, 81, 496-502, 1976.
- 21. Emura S, Tamada A, Hoyokowa D, Chen H, Jamali M, Taguchi H, Shoumura S:** SEM study on the dorsal lingual surface of the Flying Squirrel (*Petaurista leucogenys*). *Ann Anat*, 181 (5): 495-498, 1999
- 22. Iwasaki S, Miyata K, Kobayashi K:** Scanning electron microscopic study of the dorsal lingual surface of the squirrel monkey. *Acta Anat*, 132, 225-229, 1988.
- 23. Kubota K, Togowa S:** Comparative anatomical and neurohistological observations on the tongue of japanese dormouse (*Glirus japonicus*). *Anat Rec*, 154, 545-552, 1966.
- 24. Toprak B:** Mouse'de tat papillalarının postnatal gelişimi üzerine Sem ve Işık Mikroskopik İncelemeler. *Doktora Tezi*, Firat Üniv Sağlık Bil Enst, Elazığ, 2002.
- 25. Mistretta CM, Goosens KTA, Forinos I, Reacardt LF:** Alterations in size, number and morphology of gustatory papillae and taste buds in BDNF null mutant mice demonstrata neuro dependence of developing taste organs. *J Comp Neurol*, 409, 13-24, 1999.