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Morphometric study on the tongue of White New Zealand Rabbit (*Orycotolagus cuniculus*) with special reference to its arterial supply.

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ABSTRACT

The present study describes the general morphology with statistical analysis of the biometrical records of different parts of the white New Zealand rabbit tongue in addition to the muscular mass with its main blood supply. Nineteen adult white New Zealand rabbits of both sexes are used in this study. Fifteen rabbit's tongues are used fresh to examine its morphology while different parts measurements taken by Vernier caliber are statistically analyzed by SPSS software. Two rabbit's tongues are sectioned and stained with (H&E) and Crossman's trichrome stain for histological investigation. Last two rabbit's tongues are fixed and latex injected through common carotid artery to examine the extrinsic muscles and arterial blood supply. The tongue is composed of Apex, body and root and has two characteristic feature; torus linguae and lyssa. The mean lengths of entire tongue, Apex, Body, Root, Sulcus linguae, Torus linguae, Lyssa and frenulum linguae are 4.59, 0.44, 3.88, 0.27, 1.71, 2.17, 0.81 and 1.21 cm respectively. The mean widths of Apex, body in front of torus, body at first mandibular molar tooth, root, torus rostral end, torus at first mandibular molar tooth, and torus at caudal end are 0.76, 0.86, 1.17, 1,14, 0.45, 0.84 and 0.86 cm respectively. The mean thicknesses of body in front of torus, body at first mandibular molar tooth, torus, root, lyssa and frenulum linguae are 0.26, 0.69, 0.94, 0.23, 0.87, 0.17 and 0.12 cm respectively. The tongue distinguishes four types of papillae; thread like filiform, dome-shape fungiform, 2 circumvallate and 14 – 15 folds foliate papillae. Tongue has three extrinsic muscles, styloglossus, genioglossus and hyoglossus, and the intrinsic muscles run in different directions. The tongue arterial supply is through the lingual artery of the linguofacial artery. The findings are discussed and compared with those reported by other literature.

Keywords: Tongue, Rabbit, Anatomy, Biometry, Histology, Lingual Artery

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INTRODUCTION

The rabbit is a herbivorus animal belongs to the family Leporidae, order Lagomorpha and is phylogenetically closer to human than rats and larger in size to facilitate monitoring of physiological parameters (Graur et al., 1996). New Zealand white rabbits are commonly being used for research activities as it is the least aggressive and have less health problems as compared with other rabbit breeds with short vital cycles and low rearing cost (Mapara et al., 2012).

The white New Zealand rabbit (Oryctolagus cuniculus) is an adequate model used as an experimental animal for several studies, including reconstruction after squamous cell carcinoma (Kummoona, 2010) and tongue wound healing following partial resection (Yonezawa et al., 2012). However, more data on using it as a model is required Maia (2009).

Most of the anatomical and Microscopical features of rabbit tongue was previously mentioned by Abumandour and El-Bakary (2013) and AL-Mahmodi (2016).

The present study describes the anatomical, histological, and biometrical features of the tongue of sexually mature White New Zealand Rabbit (Orycotolagus cuniculus) to aid in providing further details for researchers in future experimental research.

MATERIALS AND METHODS

Nineteen mature apparent healthy White New Zealand rabbits of both sexes (10 males and 9 females) aged 12 – 13 weeks weighing 3.1 - 3.25 Kg obtained from Faculty of Agriculture – Cairo Uni. Egypt. Rabbits were slaughtered and Fifteen rabbits tongue (8 male & 7 females) were used for the geometric data measurements of length, width, and thickness by using Vernier Caliber. All measurements were statistically analyzed using the SPSS statistical software package (version 22.0, SPSS, Inc. Chicago, IL, USA), and all the obtained data are measures of central tendency (mean, median & mode) as well as measures of dispersions (Range, minimum, maximum, variance & standard deviation) according to (Armitage et al., 2008) (Dimitrov et al., 2012).

For the arterial supply study, two rabbits (male & female), were cannulated through the common carotid artery and flushed with normal saline solution then fixed by injection with 50-80 ml of embalming solution (10% formalin, 2% phenol, and 1% glycerin), followed by immersion in formalin solution then stored in a cold room (5^{o} C) for 2 days. Subsequently, specimens injected with latex colored with red ROTRING® ink and the specimens then immersed in formalin solution for 3-4 days in the cold room before manual dissection (Hildebrand, 1968).

For the Microscopical studies, two rabbits (male & female) tongues were immediately dissected out and sectioned into small pieces. Some of these specimens were fixed in neutral buffer formalin 10% and others fixed in Bouin's fluid. The blocks dehydrated in grades of ethanol, cleared by xylene and embedded in paraffin wax. Serial and step serial sections of 5-6 µm were obtained by rotatory-microtome and stained with Hematoxylin and Eosin (H&E) and Crossman's trichrome stain (Bancroft and Gamble, 2008).

The specimens were photographed using Panasonic lumix digital camera 8 megapixels. The nomenclature used was adopted according to the Nomina Anatomica Veterinaria (2012).

RESULTS

The tongue (Lingua) (Fig.1 & 2) of the White New Zealand rabbit is pale pink in color, elongated flattened with rounded apex and the mean length is 4.59 cm (Chart 1 &Table 1). The entire tongue has four surfaces (Dorsal, ventral and 2 laterals), the dorsum of the tongue (Fig. 1/A & 2/A, B) has a shallow lingual sulcus on the anterior part (Fig. 2/B), tongue prominence (torus linguae) on the caudal part (Fig. 1/A). The ventral surface of the tongue (Fig.1/B &2/D) is shiny-smooth completely fills the floor of the oral cavity, has lyssa like structure (Fig.1/B &3/A) on the free part rostral to the lingual attachment to the floor of the oral cavity; the frenulum linguae (Fig.1/B &3/A). The 2 lateral surfaces have several premolar teeth impressions (Fig. 2/C).

The tongue consists of three parts; the apex (the rostral free part), the body (the middle part) and the root (the caudal part) (Fig.2/A).

The tongue root (Radix linguae) is the smooth caudal narrow part of the tongue beyond torus linguae (Fig. 1/A & 2/A) and slopes ventrocaudally toward the base of the epiglottis. The root attaches to the epiglottis through Plica glossoepiglottica (Fig. 2/A) and to the soft palate by Arcus palatoglossus (Fig. 2/A). The length of the root is ranged from 0.18 cm to 0.38 cm with mean length 0.27 cm (Chart 1 & Table 1), the width of the root is ranged from 0.63 cm to 1.54 cm with mean width 1.14 cm (Chart 2 & Table 2) and the thickness of the root is ranged from 0.62 cm to 1.05 cm with mean thickness 0.87 cm (Chart 3 & Table 3).

The tongue body (Corpus linguae) (Fig. 2/A) has four surfaces; dorsal, ventral and 2 lateral. It has mean length 3.88 cm (Chart 1 & Table 1), the mean width of the body in front of torus linguae and at level of first molar are 0.86 cm and 1.7 cm respectively (Chart 2 & Table 2), and the mean thickness of same levels are 0.69 cm and 0.93 cm respectively (Chart 3 & Table 3)

The dorsal surface of the tongue body (Corpus linguae) (Fig. 2/B, C) extended from the beginning of the sulcus medianus linguae to the caudal end of the lingual prominence; the torus linguae. The sulcus medianus linguae (Fig. 2/B) extends from the beginning of the body to the anterior end of the torus linguae in the form of a shallow dorsal median groove with length ranged from 1.61 cm to 1.81 cm and mean length 1.71 cm (Chart 1 & Table 1). The lingual prominence (torus linguae) (Fig. 1/A & 2/A, B, C) is triangular in shape with narrow rostral end and gradually widens posteriorly, its length ranged from 1.80 cm to 2.62 cm with mean length 2.17 cm (Chart 1 & Table 1), the mean width of the torus linguae at its rostral end, level of first molar and at its posterior end, are 0.46 cm, 0.84 cm, and 0.86 cm respectively (Chart 2 & Table 2), and the mean thickness is 0.23 cm (Chart 3 & Table 3).

The ventral surface of the tongue body (Fig. 1/B, 2/D & 3/A) has a sickle fold of mucous membrane; frenulum linguae (Fig. 1/B, & 3/A) 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 length measures 0.97 cm to 1.33 cm with the mean length 1.21 cm (Chart 1 & Table 1), and the thickness of the frenulum is ranged from 0.1 cm to 0.13 cm with mean thickness 0.12 cm (Chart 3 & Table 3). The presence of white colored rod shaped structure characterizes the ventral surface; lyssa (Fig. 1/B & 3/A), The lyssa length measures 0.77 cm to 0.86 cm with the mean length 0.82 cm (Chart 1 & Table 1), and the thickness of the lyssa is ranged from 0.14 cm to 0.20 cm with mean thickness 0.17 cm (Chart 3 & Table 3). Microscopically the lyssa (Fig. 3/ B &C), is a core of dense irregular connective tissue contains white adipose cells and the average thickness of lamina propria at the lyssa level is 377 µm while the lamina propria thickness at the dorsal surface of tongue is 68 µm (Fig. 3/D).

The apex of the tongue (Apex linguae) (Fig. 1/A & 2/A) is the rostral free tip of tongue. It is narrow with rounded borders. The mean length, width, and thickness of the apex of the tongue are 0.44 cm, 0.75 cm and 0.26 cm (Chart 1, 2 & 3 and table 1, 2 & 3) respectively.

The dorsum of the tongue (Fig. 4/A) has four types of lingual papillae. These papillae are filiform, fungiform, circumvallate and foliate papillae.

The filiform papillae (Fig. 4/D) are thread like papillae present all over the dorsum, and lateral walls of the tongue. Microscopically (Fig. 4/D1) they look like conical cornified projections with wide base and narrow apex, and covered with cap of keratinized stratified squamous epithelium.

The fungiform papillae (Fig. 4/E), are smaller in diameter, Dome-like shape papillae and are distributed among filiform papillae on the anterior dorsal and lateral parts of tongue. Microscopically (Fig. 4/E1) they look mushroom shaped with narrow base and wide apex raised above the tongue surface level. It has a connective tissue core higher than the level of adjacent filiform connective tissue core and surface is covered with stratified squamous epithelium and contains taste buds.

The circumvallate papillae (Fig. 4/B) are one round pair present on the dorsal surface of the tongue at the junction between body and root. They have a small elevation from lingual surface, surrounded by a furrow. Microscopically (Fig 4/B1), it appears as smooth dome shape surrounded by narrow furrow and lined by

stratified squamous epithelium rich in taste buds in the lateral surface of the papilla. The connective tissue core extends inside the papilla.

The foliate papillae (Fig. 4/C) are 14-15 folds closely packed together, which are located on both lateral parts of the tongue body, rostral to the Arcus palatoglossus. Microscopically (Fig 4/C1), a foliate papilla is formed from numerous folia separated by furrow. Each folium has a connective tissue core and covered by an epithelium cap of stratified squamous epithelium and two epithelial streaks extends into the connective tissue core. The lateral walls of folium are rich in taste buds.

The muscles of the tongue (Fig. 5) are divided into intrinsic and extrinsic muscles, the extrinsic muscles (Fig. 5/A) are three pairs of the muscles, which are styloglosuss, hyoglossus and genioglosuss. M. styloglossus is a large ribbon-shaped muscle, originates from the jugular process, lies on the lateral sides of the tongue, passes rostroventrally and expands at the base of the tongue to a wide sheet, then narrows and continues rostrally to insert in the tip of tongue. The M. hyoglossus originates from the body of the hyoid bone (basihyoideum), Thyrohoideum and Ceratohyoideum (Fig. 5/B). It is inserted in the root of the tongue, lies medial to the M. stylogossus. The M. genioglossus originates from the medial surface of the mandible just caudal to the mandibular symphysis, and passes dorsally and caudally inside the body of the tongue. It is related laterally to the M. geniohyoideus and M. styloglossus. Microscopically (Fig. 5/C), the intrinsic muscles of the tongue are skeletal muscles fibers that run in different directions.

The arterial supply of the white New Zealand rabbit tongue (Fig. 7), is achieved by the lingual artery of the lingofacial artery.

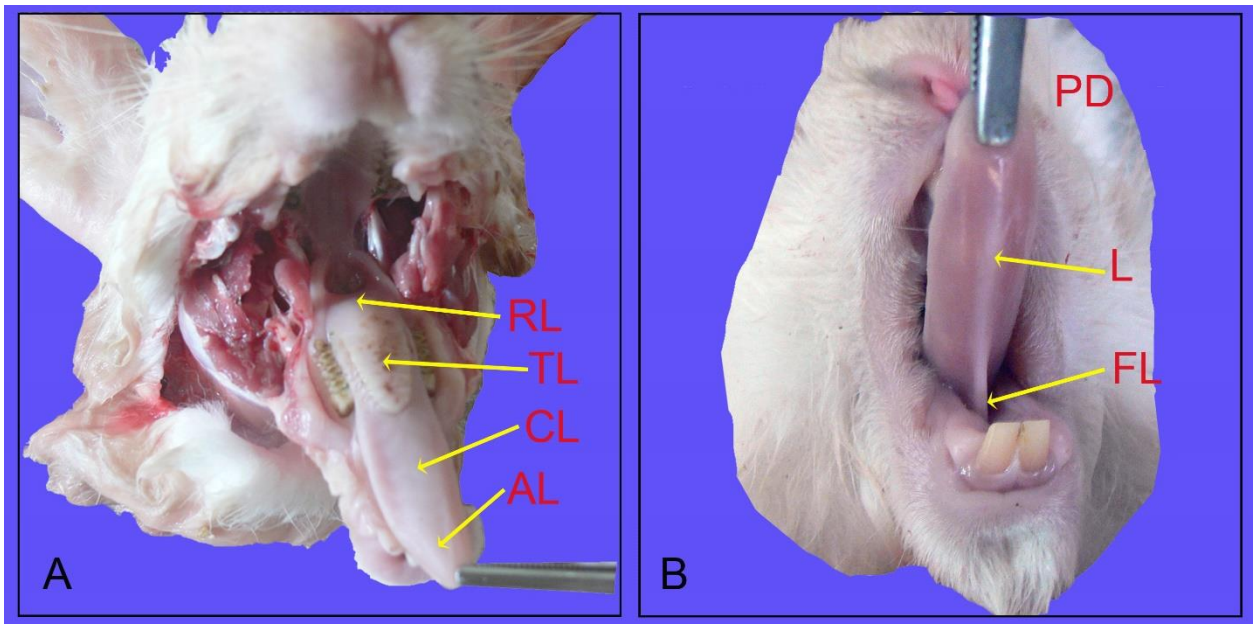

Fig 1. Photography showing the surfaces of the New Zealand Rabbit tongue (in situ) (A: Dorsal view), (B: Ventral view). Showing: Apex linguae (AL), Corpus linguae (CL), Torus linguae (TL), Radix Linguae (RL), Palatum Durum (PD), Frenulum linguae (FL), and Lyssa (L).

A. Linguofacialis: The linguofacial artery is a short stout vessel and measures about 0.3 cm. it originates from the craniomedial aspect of A. carotis externa, it passes obliquely rostroventrally lateral to the caudal border of M. hyoglossus where it bifurcates into the lingual and facial arteries.

A. Lingualis: The lingual artery is a long vessel that measures about 3.46 cm. It emanates from the rostral aspect of the parent trunk opposite to the facial artery. It courses rostrodorsally between the medial surface of M. styloglossus and the lateral aspect of M. hyoglossus. During its course, it gives off tongue root, sublingual and deep lingual arteries.

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A. Radix lingualis: The tongue root artery is a short vessel that measures about 0.4 cm. It arises from the dorsal wall of the parent trunk, it passes dorsally to supply the tongue root, hyoid bone, and palatoglossal fold by 3-4 fine branches.

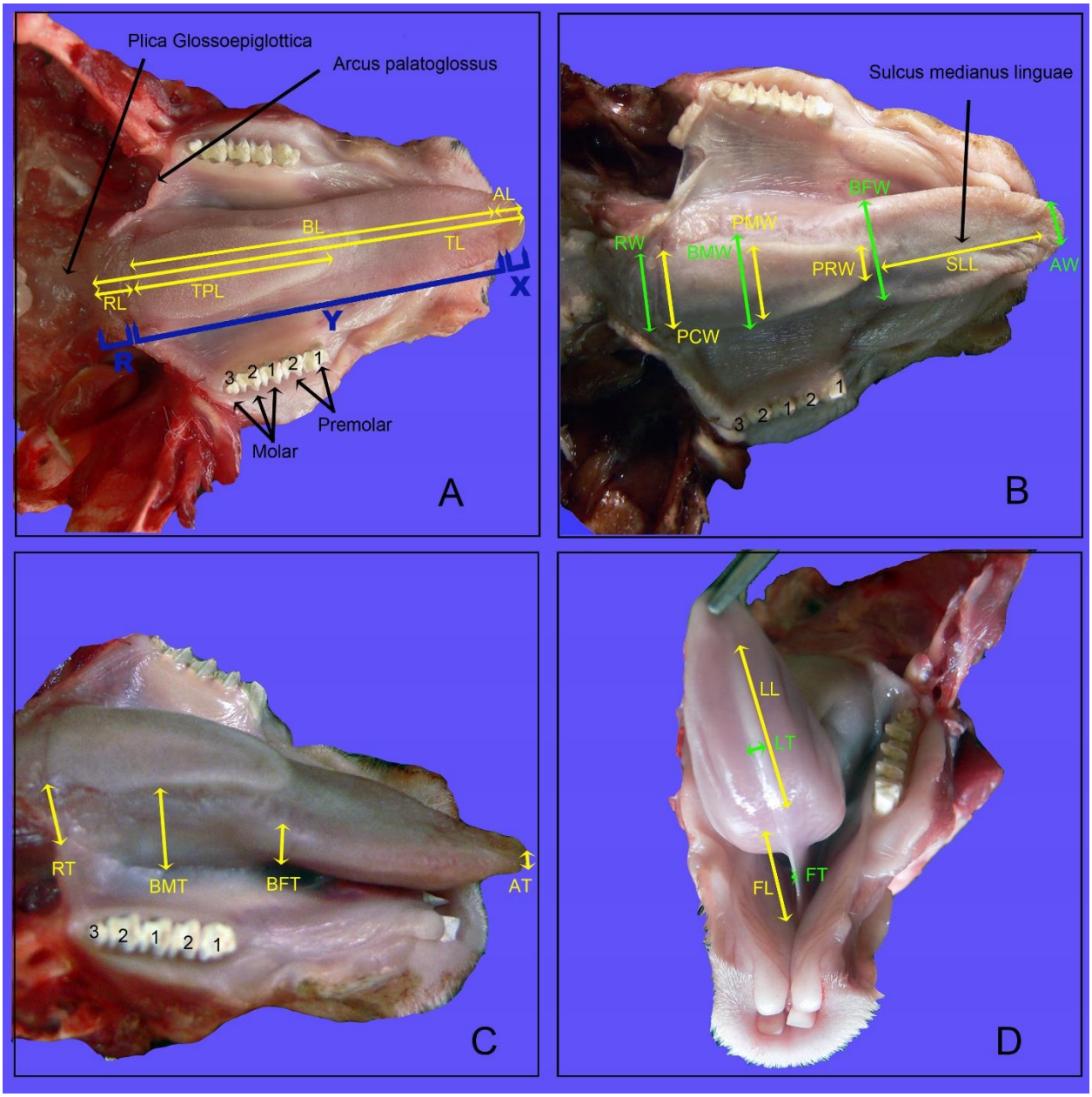

Fig.2 Photography of New Zealand rabbit tongues showing lines of measurements for statistical analysis. A: Dorsal view showing; Apex (X), Body (Y), Root (R), Tongue entire length (TL), Apex Length (AL), Body length (BL), Root Lens (RL), and Tongue torus length (TPL). B: Dorsal view showing; Sulucus Linguae length (SLL), Tongue Apex width (AW), Tongue body width in front of Torus (BFW); Tongue Body Width at first Mandibular Molar (BMW), Tongue Root Width (RW), Torus width rostral (PRW), Torus Width at first Mandibular Molar (PMW), and Torus width Caudal end (PCW). C: Dorso-lateral view showing; Tongue Apex Thickness (AT), Tongue Body Thickness in front of Torus (BFT), Tongue Body Thickness at first Mandibular Molar (BMT), and Tongue Root Thickness(RT). D: Ventral view showing: frenulum linguae length (FL), Frenulum linguae thickness (FT), Lyssa length (LL), and Lyssa Thickness (LT).

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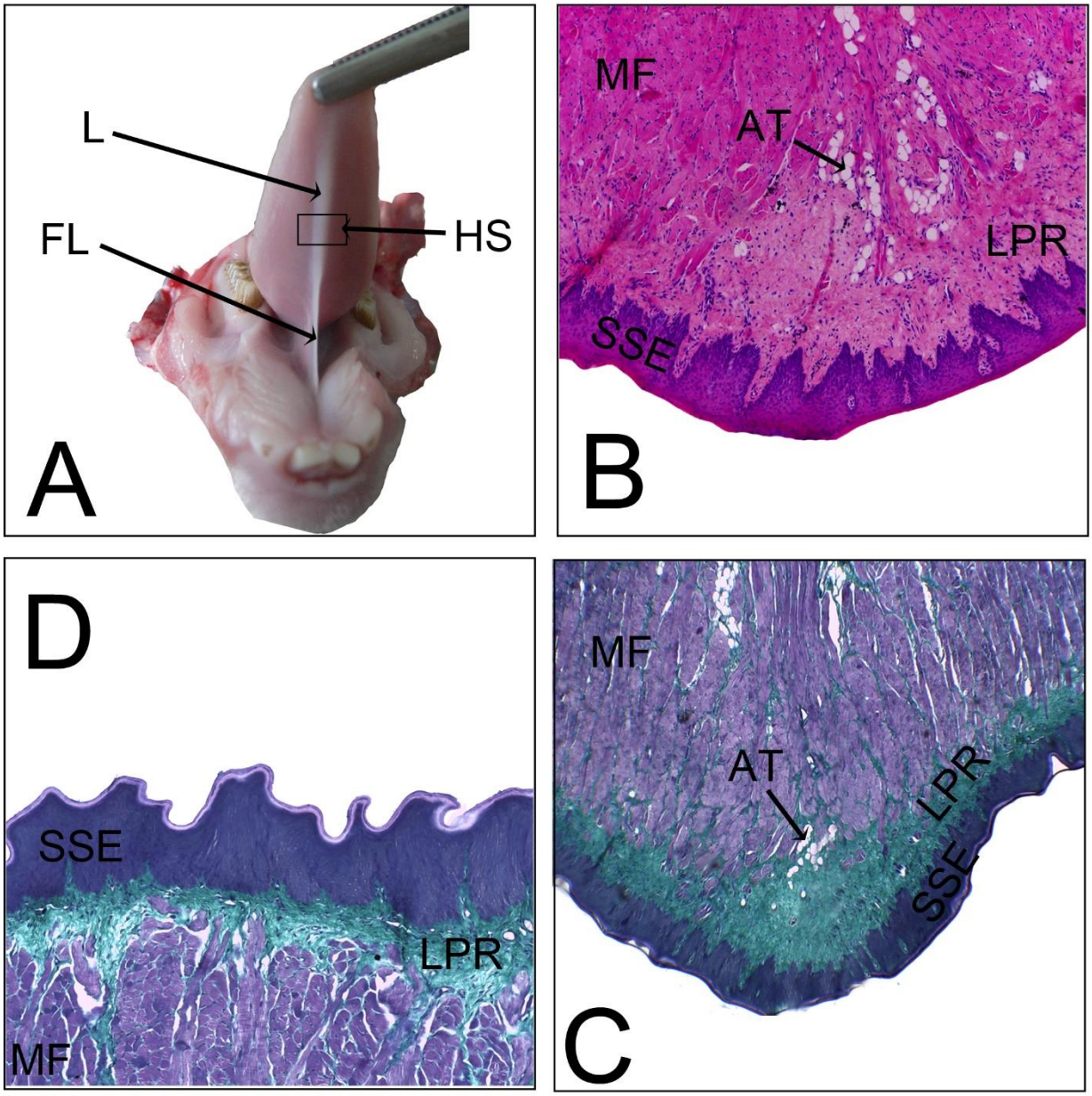
Fig 3. Lyssa like structure in the ventral surface of the tongue of the New Zealand rabbit. A: Ventral view of



tongue. B: H&E stained (X100) middle part of Lyssa. C: Crossman's trichrome stained (X100) middle part of Lyssa. D: Dorsal surface of tongue. Showing Lyssa (L), Frenulum linguae (FL), Histological section place (HS), Skeletal muscle fibers (MF), Stratified squamous epithelium (SSE), Lamina propria (LPR) and Adipose tissue (AT).

A. Sublingualis: The sublingual artery is a long thin vessel that measures about 1.7 cm. it detaches from the ventromedial aspect of the lingual A. It passes obliquely rostroventrally medial to the caudal part of the genioglossus muscle. Along its course, it gives off 3-4 fine branches that supply the ventral aspect of the tongue and the lateral aspect of the genioglossus muscle.

Ramus mylohyoideus: The Mylohyoid branch originates from the ventral surface of the sublingual artery to supply the sublingual salivary gland and M. mylohyoideus.

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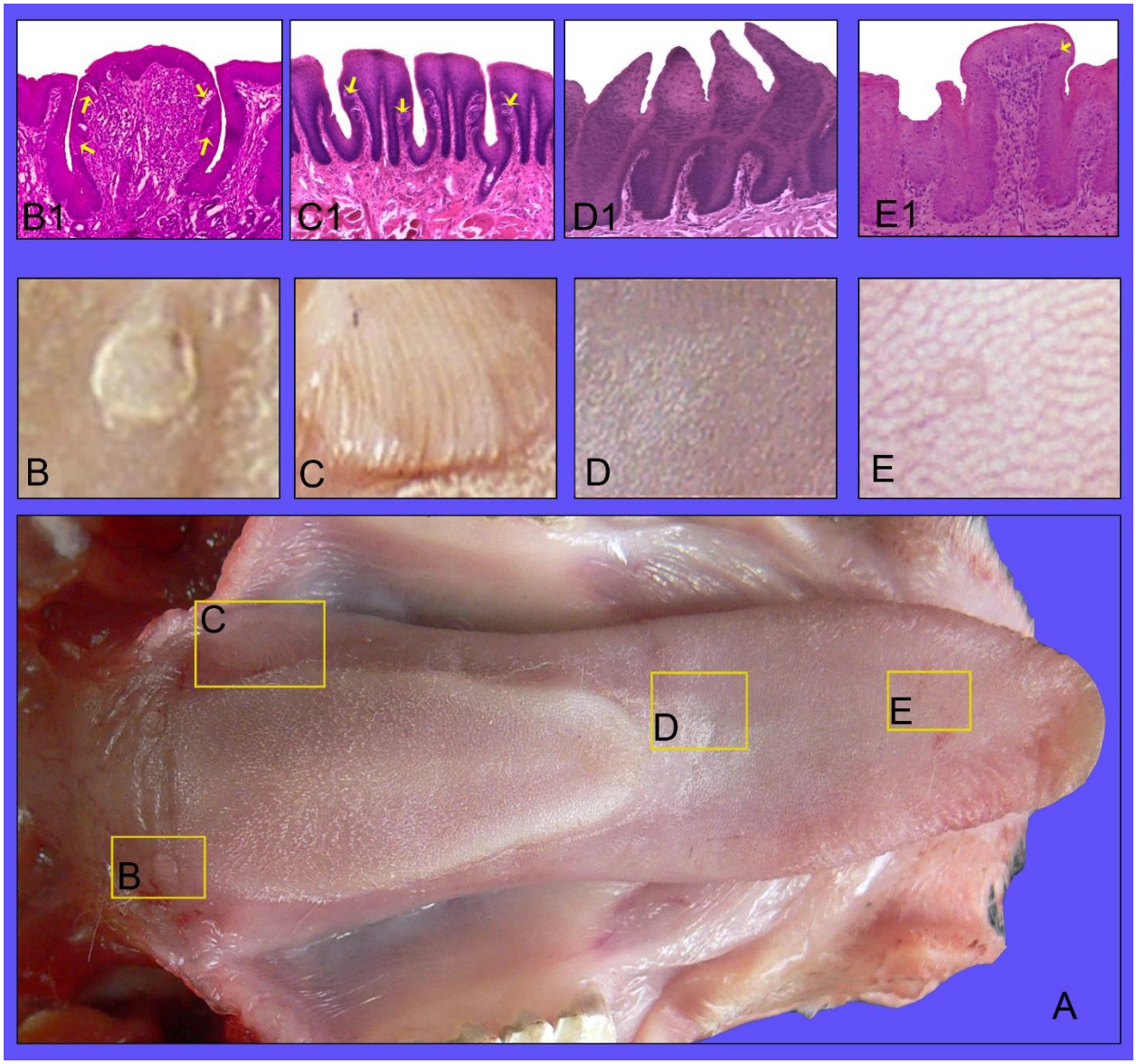

Fig. 4. Papillae of the New Zealand rabbit tongue. A: Dorsal surface of the tongue. B& B1: Circumvallate papillae. C & C1: Foliate papillae. D & D1: Filiform papillae. E & E1: Fungiform papillae. B1, C1, D1 & E1 are H&E stained sections (X100). Taste buds (Yellow arrows).

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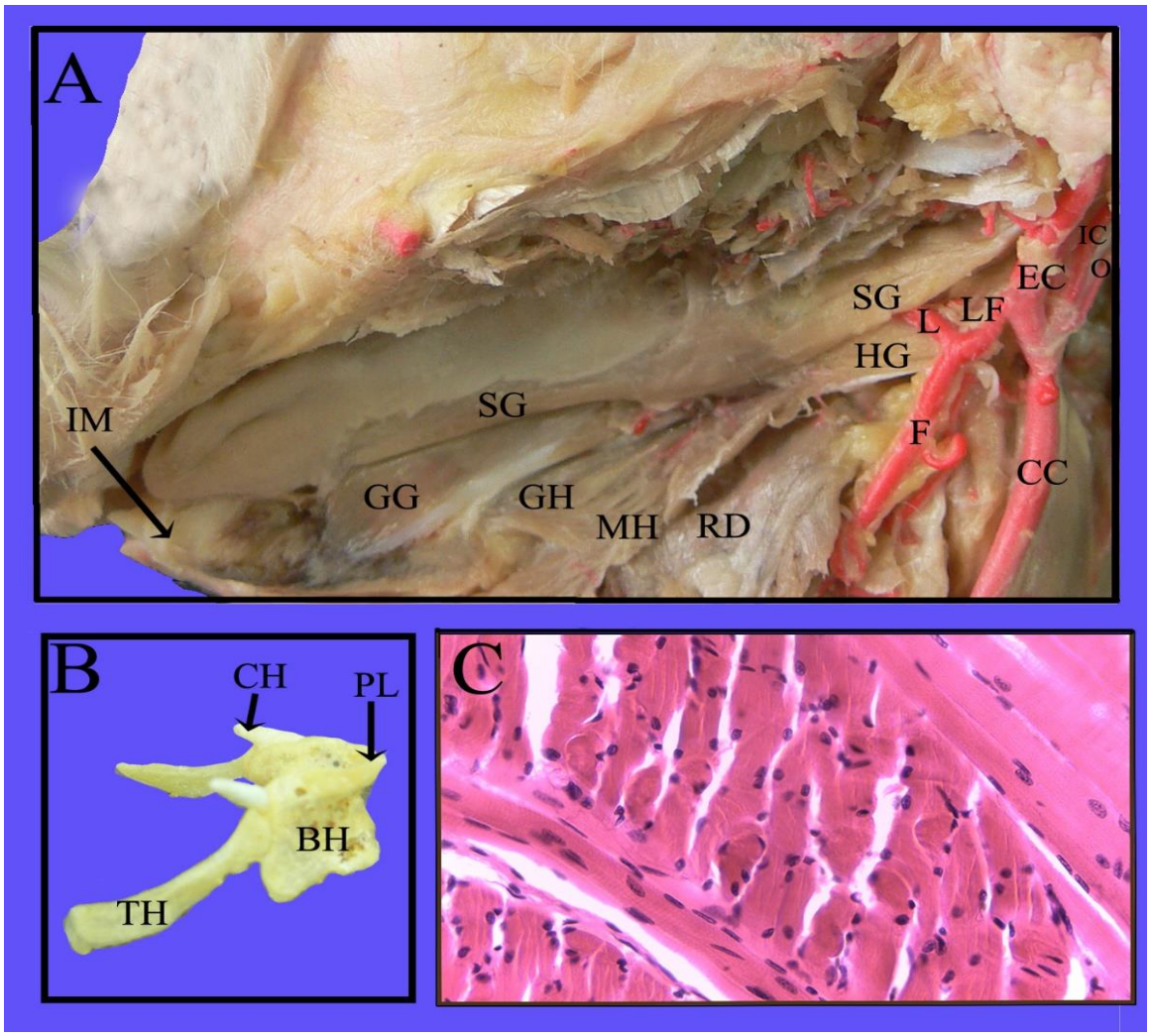

Fig. 5. Muscles of the New Zealand rabbit tongue. A: Photography of Lateral view of tongue showing extrinsic muscles. B: H&E stained section (X400) showing the Intrinsic skeletal muscles of the tongue running in different directions. Incisura mandibular IMM), M. genioglossus (GG), M. hyoglossus (HG), M. styloglossus (SG), M. geniohyoideus (GH), M. mylohyoideus (MH), M. digastricus Venter rostralis (RD), Arteria carotis communis (CC), A. occipitalis (O), A. carotis externa (EC), A. carotis interna (IC), Truncus linguofacialis (LF), A. lingualis (L), A. facialis (F), Basihyoideum (BH), Thyrohyoideum (TH), Ceratohyoideum (CH), Processura lingualis (PL).

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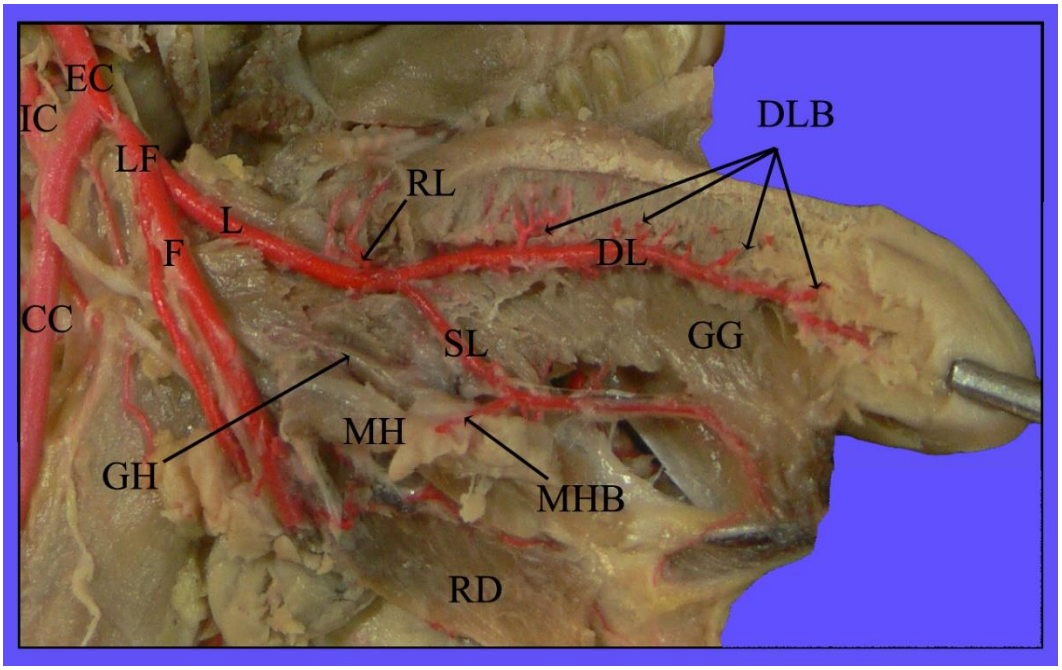

Fig. 6. Arteries of the New Zealand rabbit tongue. A: Photography of Lateral view of tongue showing: M. genioglossus (GG), M. geniohyoideus (GH), M. mylohyoideus (MH), M. digastricus Venter rostralis (RD), Arteria carotis communis (CC), A. carotis externa (EC), A. carotis interna (IC), Truncus linguofacialis (LF), A. lingualis (L), A. facialis (F), A. radix linguae (RL), A. profunda linguae (PL), Rami dorsales linguae (DLB), A. sublingualis (SL), Ramus mylohyoideus (MHB).

Table 1. Length of white New Zealand Rabbit tongueLength

		Tongue Whole length (TL)	Apex length (AL)	Body L length (BL)	Root length (RL)	Sulcus linguae length (SLL)	Tongue Torus length (TPL)	Lyssa length (LL)	Frenulum length (FL)
N	Valid	15	15	15	15	15	15	15	15
	Missing	0	0	0	0	0	0	0	0
Mean		4.5927	.4373	3.8793	.2760	1.7093	2.1700	.8153	1.2100
Median		4.5500	.4300	3.8200	.2700	1.7100	2.1200	.8200	1.2400
Mode		4.51	.42[a]	3.82	.18[a]	1.72	2.10	.78[a]	1.30
Std. Deviation		.24967	.02017	.23450	.06738	.05063	.19570	.02973	.11539
Variance		.062	.000	.055	.005	.003	.038	.001	.013
Range		.91	.06	.95	.20	.20	.82	.09	.36
Minimum		4.19	.42	3.48	.18	1.61	1.80	.77	.97
Maximum		5.10	.48	4.43	.38	1.81	2.62	.86	1.33

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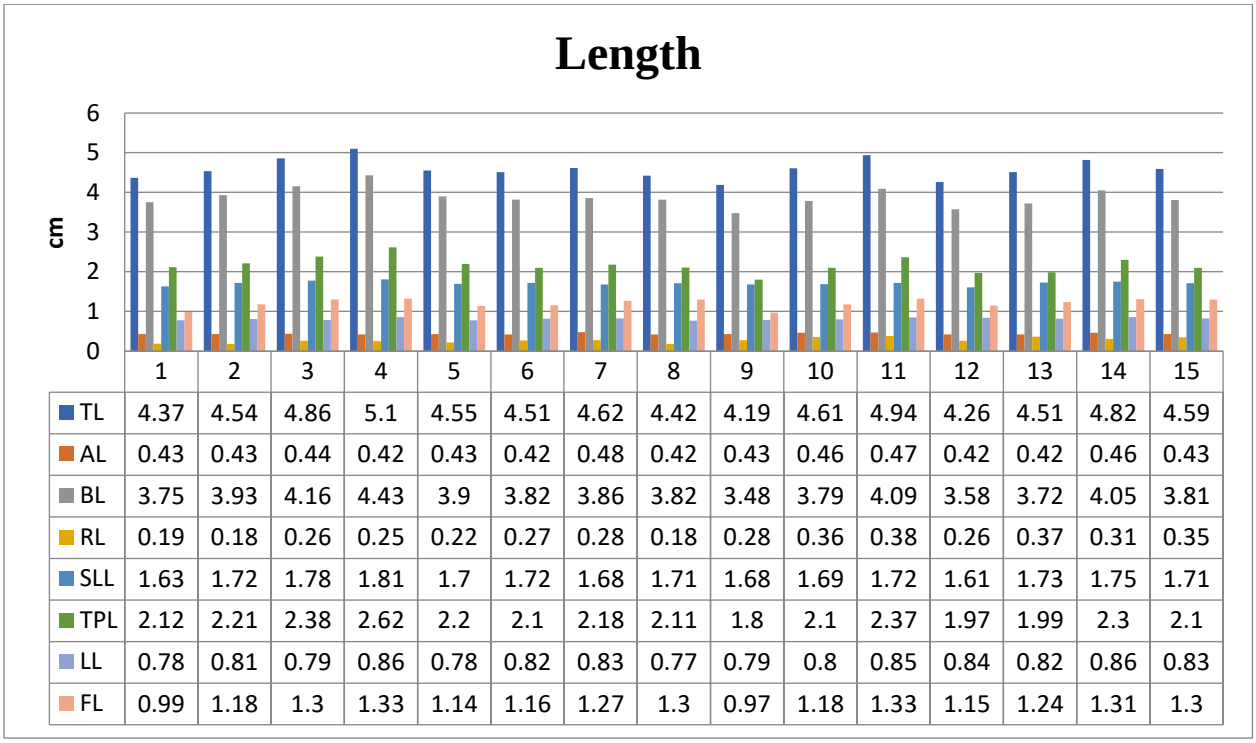
Chart 1. Length of white New Zealand Rabbit tongue



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
TL	4.37	4.54	4.86	5.1	4.55	4.51	4.62	4.42	4.19	4.61	4.94	4.26	4.51	4.82	4.59
AL	0.43	0.43	0.44	0.42	0.43	0.42	0.48	0.42	0.43	0.46	0.47	0.42	0.42	0.46	0.43
BL	3.75	3.93	4.16	4.43	3.9	3.82	3.86	3.82	3.48	3.79	4.09	3.58	3.72	4.05	3.81
RL	0.19	0.18	0.26	0.25	0.22	0.27	0.28	0.18	0.28	0.36	0.38	0.26	0.37	0.31	0.35
SLL	1.63	1.72	1.78	1.81	1.7	1.72	1.68	1.71	1.68	1.69	1.72	1.61	1.73	1.75	1.71
TPL	2.12	2.21	2.38	2.62	2.2	2.1	2.18	2.11	1.8	2.1	2.37	1.97	1.99	2.3	2.1
LL	0.78	0.81	0.79	0.86	0.78	0.82	0.83	0.77	0.79	0.8	0.85	0.84	0.82	0.86	0.83
FL	0.99	1.18	1.3	1.33	1.14	1.16	1.27	1.3	0.97	1.18	1.33	1.15	1.24	1.31	1.3

Table 2. Width of white New Zealand Rabbit tongue Width

		Tongue Apex width (AW)	Tongue Body width in front of Torus (BFW)	Tongue Body width at first Mandibular Molar (BMW)	Tongue Root width (RW)	Tongue Torus width rostral end (PRW)	Tongue Torus width at first Mandibular Molar (PMW)	Tongue Torus width Caudal end (PCW)
N	Valid	15	15	15	15	15	15	15
	Missing	0	0	0	0	0	0	0
Mean		.7507	.8573	1.1720	1.1360	.4580	.8400	.8600
Median		.7500	.8600	1.1600	1.1400	.4600	.8300	.8600
Mode		.75	.83	.91[a]	1.11[a]	.48	.78	.86
Std. Deviation		.05548	.03555	.22669	.20472	.03342	.07081	.03464
Variance		.003	.001	.051	.042	.001	.005	.001
Range		.17	.11	.63	.91	.11	.26	.13
Minimum		.66	.80	.91	.63	.41	.72	.78
Maximum		.83	.91	1.54	1.54	.52	.98	.91

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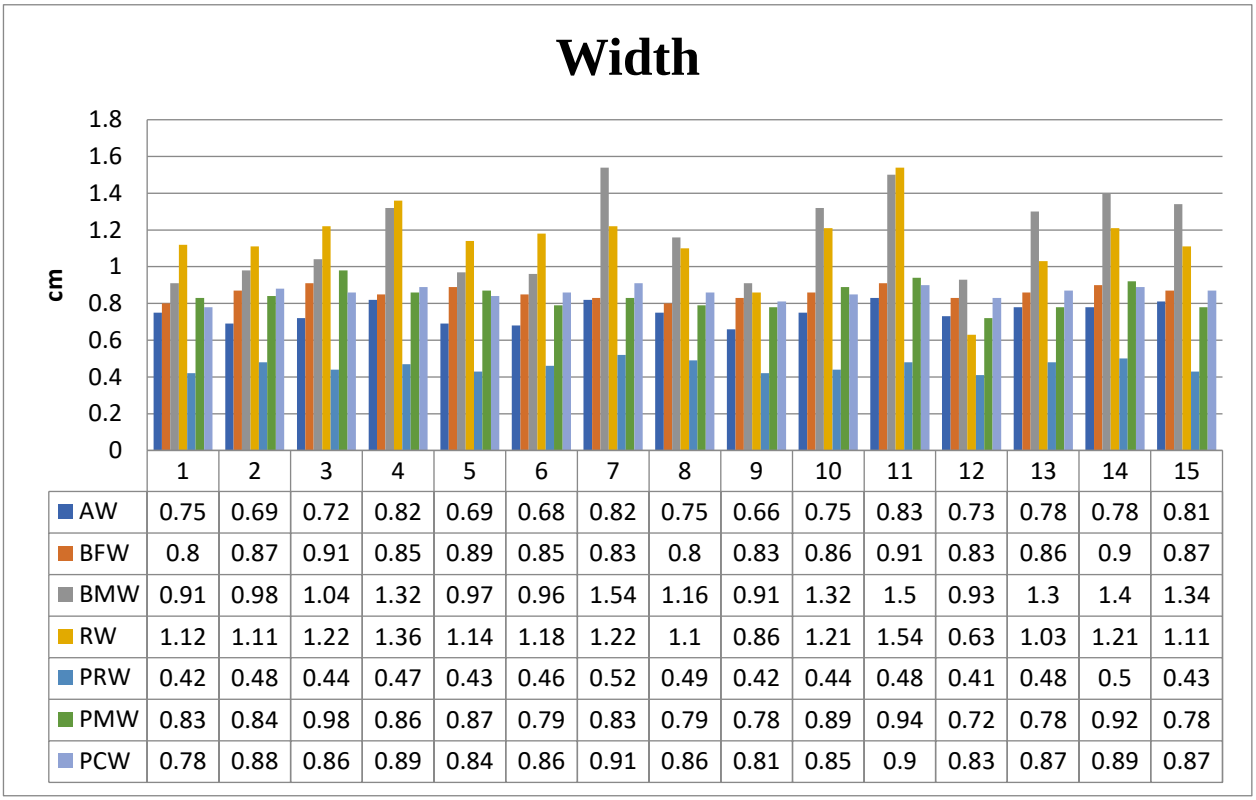
Chart 2. Width of white New Zealand Rabbit tongue



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
AW	0.75	0.69	0.72	0.82	0.69	0.68	0.82	0.75	0.66	0.75	0.83	0.73	0.78	0.78	0.81
BFW	0.8	0.87	0.91	0.85	0.89	0.85	0.83	0.8	0.83	0.86	0.91	0.83	0.86	0.9	0.87
BMW	0.91	0.98	1.04	1.32	0.97	0.96	1.54	1.16	0.91	1.32	1.5	0.93	1.3	1.4	1.34
RW	1.12	1.11	1.22	1.36	1.14	1.18	1.22	1.1	0.86	1.21	1.54	0.63	1.03	1.21	1.11
PRW	0.42	0.48	0.44	0.47	0.43	0.46	0.52	0.49	0.42	0.44	0.48	0.41	0.48	0.5	0.43
PMW	0.83	0.84	0.98	0.86	0.87	0.79	0.83	0.79	0.78	0.89	0.94	0.72	0.78	0.92	0.78
PCW	0.78	0.88	0.86	0.89	0.84	0.86	0.91	0.86	0.81	0.85	0.9	0.83	0.87	0.89	0.87

Table 3. Thickness of white New Zealand Rabbit tongue Thickness

		Tongue Apex thickness (AT)	Tongue Body thickness in front of Torus (BFT)	Tongue Body Thickness at 1st Mandibular Molar (BMT)	Torus thickness (TT)	Tongue Root thickness (RT)	Lyssa thickness (LT)	Frenulum thickness (FT)
N	Valid	15	15	15	15	15	15	15
	Missing	0	0	0	0	0	0	0
Mean		.2600	.6900	.9313	.2300	.8680	.1680	0.116
Median		.2600	.7000	.9300	.2200	.8900	.1600	0.12
Mode		.26	.73	.92[a]	.22	.78	.16	0.12
Std. Deviation		.03207	.03982	.06534	.01363	.12913	.01699	0.0091
Variance		.001	.002	.004	.000	.017	.000	0
Range		.10	.12	.21	.04	.43	.06	0.03
Minimum		.21	.62	.80	.21	.62	.14	0.1
Maximum		.31	.74	1.01	.25	1.05	.20	0.13

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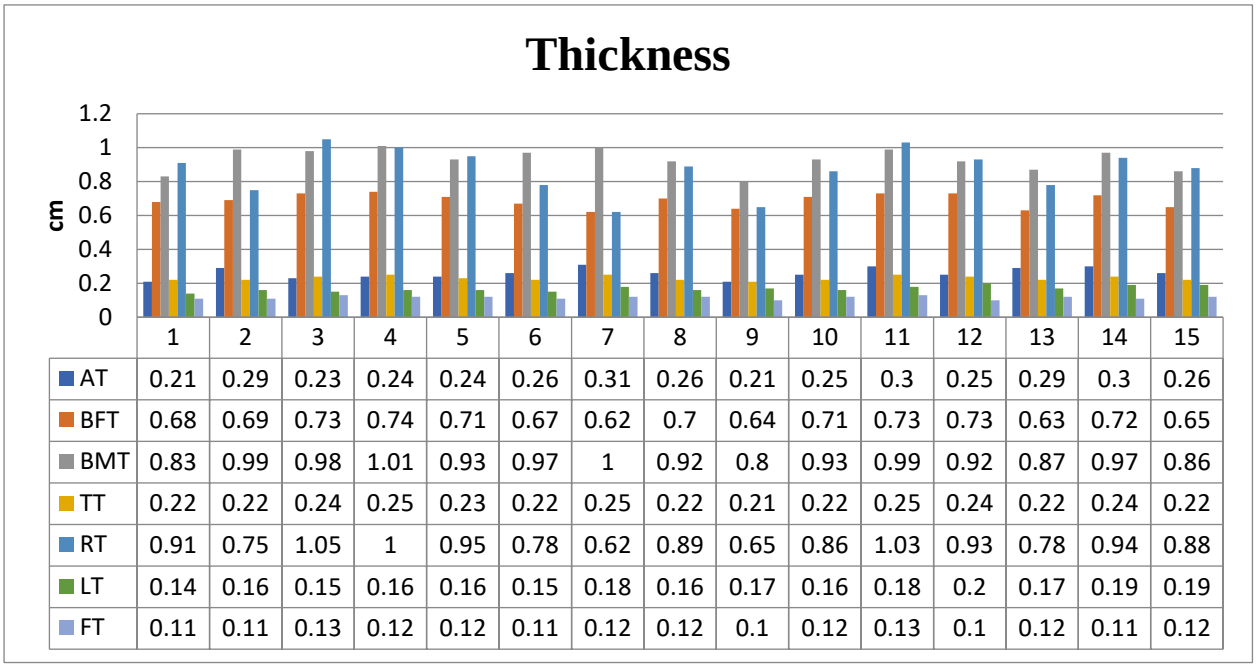
Chart 3. Thickness of white New Zealand Rabbit tongue



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
AT	0.21	0.29	0.23	0.24	0.24	0.26	0.31	0.26	0.21	0.25	0.3	0.25	0.29	0.3	0.26
BFT	0.68	0.69	0.73	0.74	0.71	0.67	0.62	0.7	0.64	0.71	0.73	0.73	0.63	0.72	0.65
BMT	0.83	0.99	0.98	1.01	0.93	0.97	1	0.92	0.8	0.93	0.99	0.92	0.87	0.97	0.86
TT	0.22	0.22	0.24	0.25	0.23	0.22	0.25	0.22	0.21	0.22	0.25	0.24	0.22	0.24	0.22
RT	0.91	0.75	1.05	1	0.95	0.78	0.62	0.89	0.65	0.86	1.03	0.93	0.78	0.94	0.88
LT	0.14	0.16	0.15	0.16	0.16	0.15	0.18	0.16	0.17	0.16	0.18	0.2	0.17	0.19	0.19
FT	0.11	0.11	0.13	0.12	0.12	0.11	0.12	0.12	0.1	0.12	0.13	0.1	0.12	0.11	0.12

A. Profunda linguae: The deep lingual artery is long vessel that measures about 2.2 cm in its length. It is considered the direct continuation of the lingual artery where it passes rostrally lateral to M. genioglossus. Along its course, it detaches 12-15 fine dorsal lingual branches; Rami dorsales linguae. They supply the torus linguae, body and apex of the tongue, the first of them is short stout vessel measures about 0.3 cm and ramifies into 4-5 branches to supply the torus linguae.

DISCUSSION

The present study described the general morphology with statistical analysis of the biometrical records of different parts of the white New Zealand rabbit tongue in addition to the muscular mass, extrinsic and intrinsic with its main blood supply.

The examined tongues had four surfaces and divided into apex, body and root as agreed with AL-Mahmodi (2016) in wild rabbit, while Abumandour and El-Bakary (2013) in the white New Zealand rabbit divided it into anterior, middle, and posterior parts. The mean length of the entire tongue in the present study was 4.59 cm with near results to AL-Mahmodi (2016) in wild rabbit, and much smaller than the finding recorded by Abumandour and El-Bakary (2013) of 5.3 cm in the same investigated species.

The tongue root in the present work was the narrow part and attached to the epiglottis and soft palate as agreed with Abumandour and El-Bakary (2013) in the same species, AL-Mahmodi (2016) in wild rabbit, Konig and Liebich (2004) and Dyce et al. (2010) in domestic animals, El-Bably and Tolba (2015) in Egyptian domestic cat, and Smith (1999) and Evans and De Lahunta (2013) in the dog. The biometrical records of root statistically analyzed mean length, width and thickness were 0.27 cm, 1.14 cm and 0.87 cm respectively, in contrast to Abumandour and El-Bakary (2013) in same species recorded of average length was 0.6 cm and average width was 4.8 cm.

In the present study, sulcus medianus linguae was shallow and extending to the beginning of torus linguae with mean length 1.7 cm that in accordance with AL-Mahmodi (2016) in wild rabbit, while Abumandour and El-Bakary (2013) in same investigated species reported its termination by 0.4 cm before the torus linguae and was 1.5 cm length. In contrast with El-Bakary (1989) noted it was absent in both Balady and Bouscate rabbits.

The presence of torus linguae in the present investigation denoted to the fact that most of grass eating herbivorous had a torus to help in grinding of food against the hard palate and formation of food bolus as agreed with El-Bakary (1989), AL-Mahmodi (2016) and Abumandour and El-Bakary (2013) in rabbits, Kadhim (2016) in adult Awassi rams and Billy-goat, Takehana et al. T (2001) in camel, and Parvez and Rahaman (2005) in the cow. Kobayashi et al. (2004) in horse and Jackowich et al. (2016) in the donkey named the posterior part of tongue dorsum as torus linguae. The statistically analyzed biometrical records of white New Zealand Rabbit tongue torus of mean length and width at level of first molar were 2.17 cm and 0.84 cm respectively, while Abumandour and El-Bakary (2013) in same species were 2.3 cm length and 1.1 cm width at its middle part.

The frenulum linguae of the rabbit tongue was attached to the sublingual floor and its biometrical records measured 1.21 cm mean length and 0.12 cm mean thickness, while Abumandour and El-Bakary (2013) measurements were 1.5 cm length and 0.1 cm thickness.

The Lyssa in current work was white colored rod shaped structure with mean length 0.82 cm and 0.17 cm mean thickness. This result was in consistent with shape finding of El-Bably and Tolba (2015) in Egyptian domesticated cat but measured 1.21cm length, Shoeib et al. (2014) in dog but measured. 3-4 cm length and Capellari, et al (2001) in dog and cat. On the other hand, Besoluk et al. (2006), reported lyssa was j- shaped in the dog and spiral shape in Cat while Shoeib et al. (2014) found it was strip like but spiral in cat and ridge like structure in the camel.

Microscopically the lyssa in the present work was a core of dense irregular connective tissue contained white adipose cells, in accordance with Shoeib et al. (2014) finding in dog, cat and camel. Shoeib et al. (2014) and Capellari, et al (2001) added the presence of striated muscle fibers in those species and presence of dense connective tissue sheath around lyssa in dog and cat. On the other hand, Besoluk et al. (2006), stated absence of skeletal muscle fibers in the cat's lyssa and presence of muscle spindle in the capsule of dog lyssa. Capellari, et al (2001) also added the presence of lyssa a streak of adipose tissue without connecetive tissue sheath. Moreover, Konig and Liebich (2004) added that, islands of cartilage were present occasionally in the rod shaped lyssa of carnivores.

The Apex of the tongue of white New Zealand rabbit was narrow with rounded end in agreement with El-Bakary (1989) in Balady rabbit.

Lingual papillae characteristically differ in number, shape, types, and distribution among different mammalian species Konig and Liebich (2004). This study concluded the presence of four type of papillae in agreement with Nonaka et al. (2008), Abumandour and El-Bakary (2013) and AL-Mahmodi (2016) in rabbits, Nasr et al. (2012) in rat, and Emura et al. (2006) in raccoon dog and fox.

The filiform papillae in this study was mostly conical in shape and distributed all over the tongue dorsum and lateral surfaces as agreed with Abumandour and El-Bakary (2013) and AL-Mahmodi (2016) in rabbits, the authors added different complex bundles among different parts of tongue.

The fungiform papillae in this study was elevated above the surface like a dome and were mushroom shape with wider apex and narrow base in similar findings to Kulawik and Godynicki (2007) in rabbit, and present on the anterior part and edges in agreement with Abumandour and El-Bakary (2013) in same species while AL-Mahmodi (2016) recorded its presence only on dorsal surface in wild rabbits.

Circumvallate papillae in the current study were two in number in agreement to Nonaka et al. (2008), Abumandour and El-Bakary (2013) and AL-Mahmodi (2016) in rabbits, Nasr et al. (2012) in rat, Jackowiak et al. (2016) in donkey, Kobayashi et al. (2004) in the horse. Kobayashi et al. (2004) added that circumvallate papillae in goat and cattle were at least 15 papillae, while Kadhim, K. H. (2016) counted 13-18 papilla on each side of tongue in adult Awassi rams and Billy-goat and Takehana et al (2001) counted 12-18 in Camel. The circumvallate papillae were 4-6 in Egyptian domestic cat (El-Bably and Tolba, 2015). Microscopically, it appeared smooth dome shape, while Abumandour and El-Bakary (2013) found the papillae were irregular and lobulated.

The foliate papillae in present work were 14- 15 ridges located on the lateral margins of torus linguae rostral to the palatoglossal fold as agreed with Nonaka et al. (2008) and Abumandour and El-Bakary (2013) in rabbits. Nasr et al. (2012) reported 4-5 ridges in the rat, while present study showed 12-14 ridges. Foliate papillae were well developed and reported by El-Bably and Tolba (2015) in Egyptian domestic cat, Emura et al. (2006) in

raccoon dog and fox. The present finding of two epithelium streaks invaginated into the connective tissue core was a similar finding to Watanabe et al. (2002) in rabbit.

Our results were in accordance with AL-Mahmodi (2016) in wild rabbit, Konig and Liebich (2004) and Dyce et al. (2010) in domestic animals, El-Bably and Tolba (2015) in Egyptian domestic cat, Evans and De Lahunta (2013) in the dog, the tongue muscles were classified into extrinsic and intrinsic muscles.

The styloglossus muscle in the present study originated from the jugular process in the present work in agreement with King et al. (2007) in the White New Zealand rabbit. It originated from stylohyoid as mentioned by Dyce et al. (2010) in domestic animals, by El-Bably and Tolba (2015) in Egyptian domestic cat and Smith (1999) and Evans and De Lahunta (2013) in dog. The hyoglossus muscle originated from different parts of the hyoid bone in agreement with El-Bably and Tolba (2015) in Egyptian domesticated cat. On the other hand, Dyce et al. (2010) in domestic animals mentioned its origin from the basihyoid only and Evans and De Lahunta (2013) in dog mentioned its origin from basihyoid and thyrohyoid. The genioglossus originated just caudal to the symphysis of the body of the mandible in agreement with El-Bably and Tolba (2015) in Egyptian domestic cat, Evans and De Lahunta (2013) in the dog, Dyce et al. (2010) in domestic animals. The intrinsic muscles were arranged in different directions as reported by Oliveira et al. (2004) in the rabbit and Konig and Liebich (2004) and Dyce et al. (2010) in domestic animals.

The lingual artery in the present study originated from the linguofacial trunk in accordance with Nakajima et al. (1982) in rabbit, and Wilkens and Münster (1981) and Dyce et al. (2010) in horse and cattle, while originated directly from the external carotid artery in Dog (Smith, 1999, Dyce et al., 2010, and Evans and De Lahunta., 2013), Rashwan et al. (2011) in dog and sheep, Daghash (2007) in goat and Wilkens and Münster (1981) in Carnivores, small ruminants, and pig.

The lingual artery terminated by deep lingual and sublingual arteries in examined specimens in accordance with Nakajima et al. (1982) in rabbit, Wilkens and Münster (1981) in ruminants and pig, Daghash (2007) in goat Dyce et al. (2010) in ruminants and Rashwan et al. (2011) in sheep. On the other hand, the sublingual artery arose from facial artery in the Dog (Wilkens and Münster, 1981, Smith, 1999, Rashwan et al., 2011, and Evans and De Lahunta, 2013) and in the horse (Wilkens and Münster, 1981, and Dyce et al., 2010).

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