

Comparative Myoarchitectural Orientation of the Extrinsic Lingual Muscles of the Egyptian Cattle (*Bos Taurus*), Buffalo (*Bubalus Bubalis*) and Camel (*Camelus Dromedarius*)

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## Abstract

Comparative myoarchitectural anatomical studies were adopted on twelve tongues of apparently health of both adult sexes of cattle, buffalo and camel. The study was aimed to describe the architectural orientation of the extrinsic lingual muscles for each species. As well as statistical data between the tongue and extrinsic lingual muscles. The work declared the properties of potent tongue which allowed the cattle and buffalo to perform their behavioral prehension of food. The study described the extrinsic lingual muscles and spotted a light on the role of the geniohyoid muscle on the tongue. The work concluded that the tongue of cattle was the stronger than the buffalo while both able to depend on their tongue for food prehension. On the other hand the tongue of camel adapted for intraoral function.

## Introduction

Tongue was an important musculo-membranous organ in the oral cavity proper and among the domestic animals, cattle depend up on it mainly for food prehension Iwasaki [1] in vertebrate and Igado [2] in dog. However, horse, camel, sheep and goat utilized their flexible lips for cutting the grasses. Dog and cat used their incisors and canine teeth with jerking movement of the head and neck to peck up their food.

Studying importance of the tongue shifted the interest of many authors, Wedeen et al. [3] in bovine, Chibuzo [4] in goat, Saidu et al [5] in camel, in dog. Other anatomists spotted their studies on the lingual papillae scanning, Parvez and Rahman [6] on cow and Eerdunchaolu et al. [7] in camel. A morphometric study was permitted by Igado [2] in dog, [8] in cat as well as Shoeib et al. [9] in carnivores and camel.

The myoarchitectural configure of the extrinsic lingual muscles among the available literatures were scanty and the present study aimed to spot a light on it to explore the anatomical comparative variations among the Egyptian large ruminants as well as to explain the anatomical abilities of the bovine tongue role on food prehension. Why the bovines and buffaloes depend up on their tongues for food uptake?

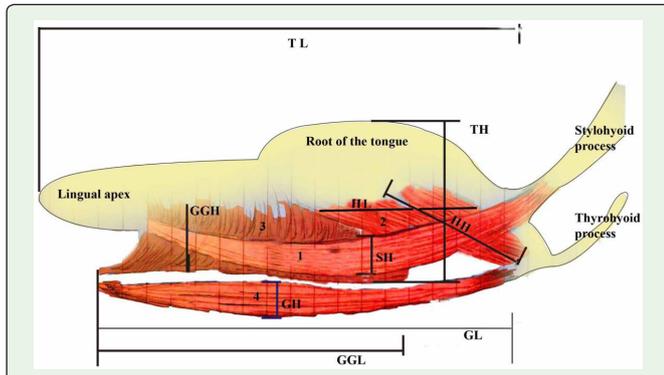
## Materials and Methods

The work based up on obtaining 12 freshly cut heads of cattle, buffalo and camel of both apparently healthy adult sexes, collected from the slaughtering house in Cairo. The collected heads arranged as four heads for each species and were washed perfectly by running water and preserved in the preservative formalin solution 10% for four days (Figures 1-3).

The dissection of the formalized heads started by obtaining the mandible attached with the tongue and hyoid apparatus. The study depends up on describing the extrinsic lingual myoarchitectural features with morphometrical measurements. The latter, determined the ratio between each extrinsic muscle and the tongue to stands up on its powerful configuration. The data were determined by varineir caliper. The width and thickness of each lingual extrinsic muscle as well as the geniohyoideous muscle were reported. The following diagrams explain the standards of measurement.

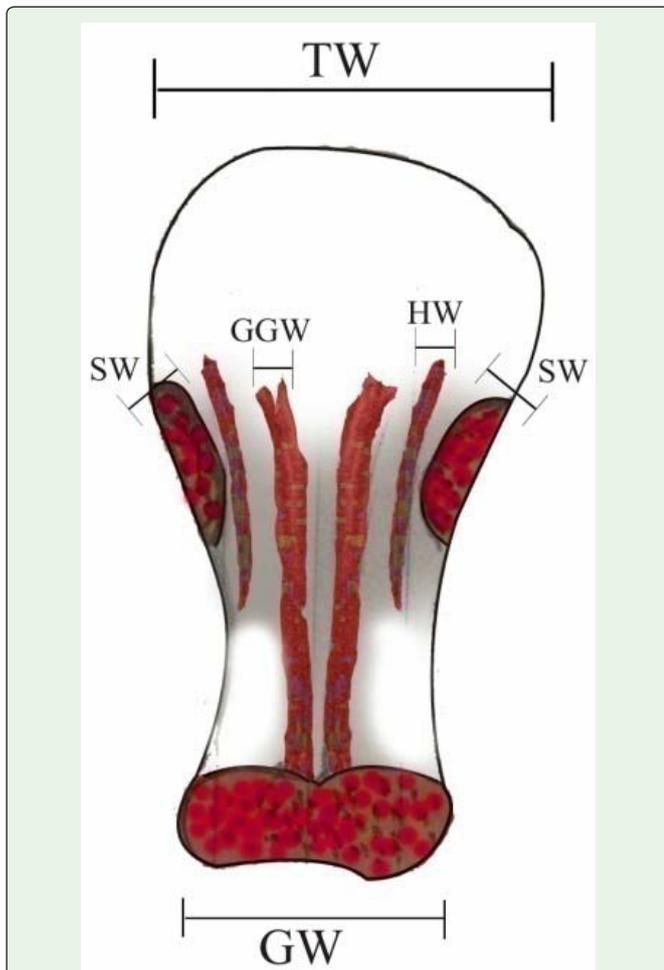
## Results

The extrinsic lingual muscles of cattle, buffalo and camel are styloglossus group, hyoglossus and genioglossus muscle. The former includes major and minor styloglossus muscle. All the extrinsic



**Figure 1:-** A Diagram showing standards of measurement of the extrinsic lingual muscles (Lateral view).

1- Styloglossus M. 2- Hyoglossus M. 3- Genioglossus M. 4- Geniohyoides M.  
 TL- Tongue length TH- Tongue height HL- Hyoglossus length HH- Hyoglossus height SH- Styloglossus height GGH- Genioglossus height GGL- Genioglossus length GH- Geniohyoid height GL- Geniohyoid length



**Figure 2:-** A Diagram showing standards of measurement of the extrinsic lingual muscles (Cross sectional view).

TW- Tongue width; SW- Styloglossus width HW- Hyoglossus width GGW- Genioglossus width GW- Geniohyoid width

lingual muscles have two portions; extra and intra- lingual as well as rostral (apico-corpus) and caudal (torus) terminations, with the exception of minor styloglossus and hyoglossus muscles which included in the torus linguae.

**Styloglossus group** (Figures 4 and 5).

There are two styloglossus muscles exist among the tongue of cattle, major and minor. The former, considered the longest extrinsic muscle described and in cattle and buffalo, it is originated by a very short tendon from the ventrolateral point of the lingual end of stylohyoid process while in camel, it arises with longer tendon.

The muscle passes ventrally and rostrally to cover the orogin of minor one, it descends on the ventrolateral aspect of the lingual torus and proceeds rostrally where it terminates ventrally to the lingual apex.

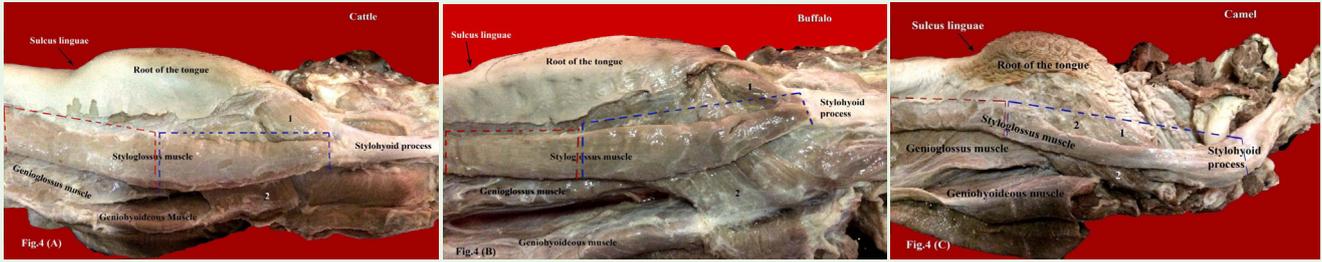
The extra glossal part of the muscle is the thinner and in cattle and buffalo, it is originated by narrow fibers and gradually widen rostrally. It extends from the stylohyoid process crossing the lateral aspect of hyoglossus muscle and ends rostrally at the half level of the lingual torus. In camel, the muscle is flat along its extension, arises from the rostral and angular curvature of stylohyoid process by long fan shaped tendon. The muscle extended straightly rostrally with the longitudinal axis of the tongue, traverses the lateral aspect of minor styloglossus and hyoglossus muscle (Figures 6-9).

The intra- glossal part of the major styloglossus muscle is that furnishes muscular bundles which embedded in the intrinsic lingual muscular fibers and considered a stout part of the muscle. It extends rostrally as a direct continuation of proceeding minor part on the ventral aspect of corpus linguae. At the level of sulcus linguae, the muscle is massively thicker with fan shaped terminated fibers. In cattle and buffalo, (Figure 8A & B) it receives enforcement muscular fibers derived from the intrinsic longitudinal lingual fibers. The latter forms thick band descends from the dorsal and caudolateral angle of torus linguae. The fibers pass in rostro ventral direction on the medial aspect of hyoglossus muscle. At the anterior border of latter, it meets the fibers of styloglossus muscle. In cattle, the band measures about 7-7.3cm length, 0.6-0.7cm width and 1.6-1.8cm height while in buffalo it is about 10.2-10.4cm length, 0.3-0.4cm width and 2.8-3cm height. This muscular band is absent in camel and found thin fibers arise from the stylohyoid process and cross the deep face of hyoglossus muscle to join the styloglossus one.

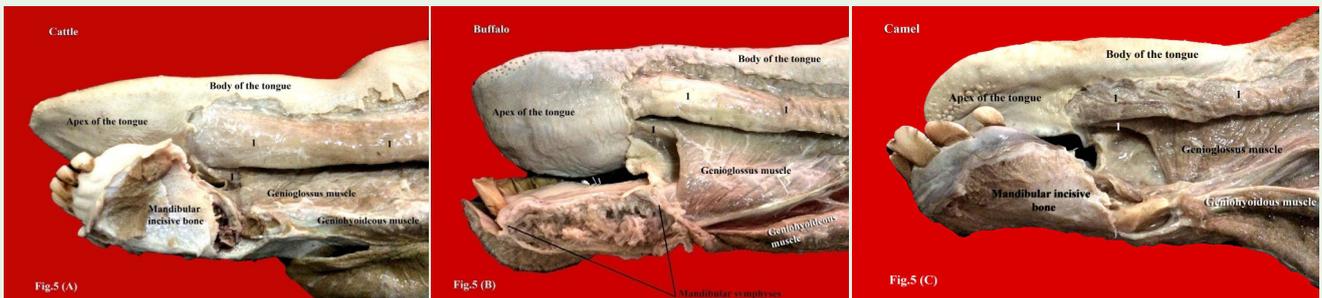
At the level of frenulum linguae, the styloglossus muscle passes with the opposing one on the floor of the lingual apex (Figure 5). The rostral end of the muscular fibers of genioglossus muscle, separate between the opposing styloglossus. In cattle and buffalo, the styloglossus muscle of both sides meet together rostrally to the



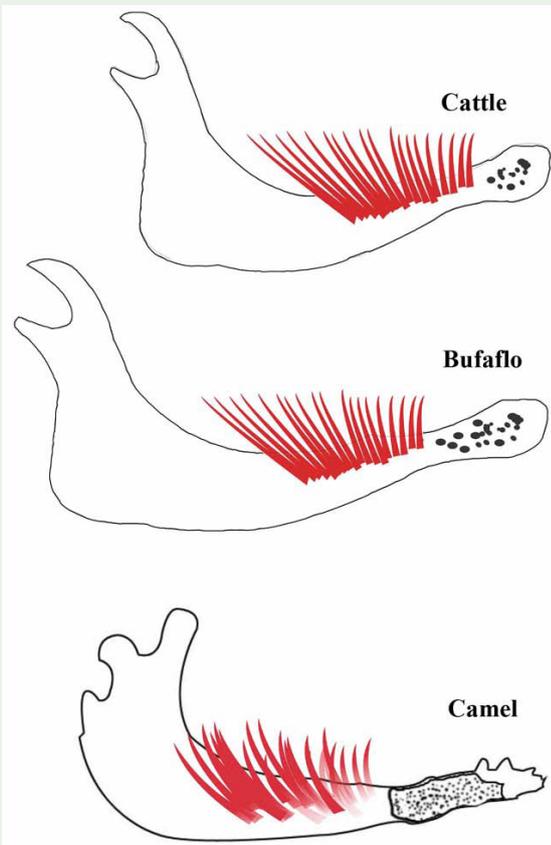
**Figure 3:-** A photograph showing the vernier caliper.



**Figure 4:** A photograph showing the extrinsic lingual muscles 1- Minor styloglossus 2- Hyoglossus muscle. The dotted blue area is the extraglossal part of styloglossus M. The redish area is the intraglossal part of styloglossus M.



**Figure 5:** A photograph showing the extrinsic lingual muscles rostral aspect.



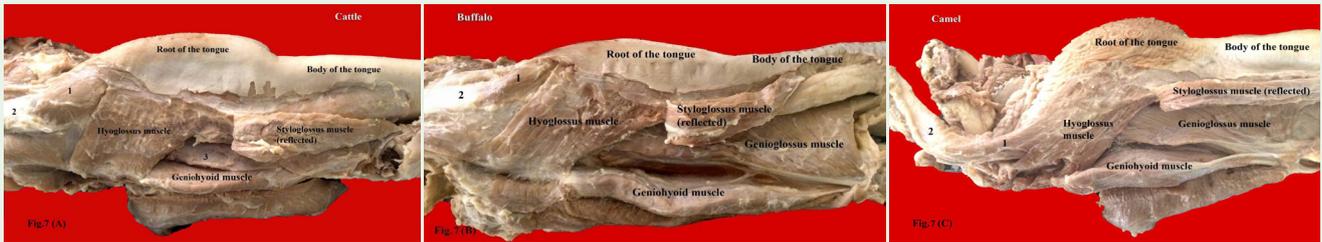
**Figure 6:** A diagram showing the eruption level of the genioglossus muscle (red colored) in the mandible.

genioglossus muscle by a very short distance ranged between 1.4-1.5cm in cattle and 1.9-2cm in buffalo, while in camel they meet after long distance of about 2.3-2.5cm.

The minor styloglossus muscle is a band originated from the stylohyoid process on the medial aspect of the proceeding muscle. It covers the lateral side of the lingual end of the stylohyoid process, the muscle fibers ascends rostrally to the caudolateral border of the torus linguae. At the rostral aspect of palatoglossal fold, the fibers blend superficially with the intrinsic lingual muscle fibers. The muscle in cattle is quadrilateral in shape (Figure 4A & 6A) and measures about 2.7-2.9cm at horizontal axis and 3.6-4cm in its longitudinal one, while in buffalo, (Figure 4B & 6B) is fuciform and reaches about 1.8-2cm in horizontal axis and 4-4.2cm in its longitudinal one. In camel, (Figure 4C & 6C) it is originated from the lateral surface of stylohyoid process medially to that of the major one. Its fibers are long and form one unit with the muscular fibers of the hyoglossus muscle.

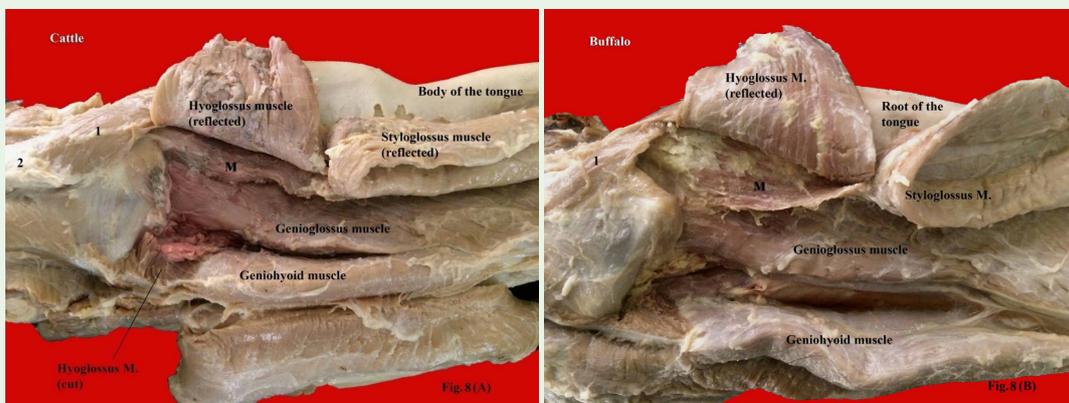
**Hyoglossus muscle** (Figures 4,7 & 8).

It is flat nearly quadrilateral muscle, its fibers originated from the ventrolateral border of thyrohyoid and basihyoid. And in cattle and buffalo, it attached to the lingual process of hyoid bone. The muscle fibers fan out in rostradorsal direction and incremented with the intrinsic lingual muscular fibers of torus linguae. It have two surfaces and borders; the former comprises the lateral and medial one; the lateral surface is related to the medial aspect of the extraglossal part of styloglossus muscle. While the medial one is facing the genioglossus muscle and the deep muscular enforcement of styloglossus muscle. Rostral and caudal borders of the muscle is existed, the former is thicker and forms an acute angle with the geniohyoideous muscle. The thicker size is noticed in cattle and buffalo where it is referred to existence of a stout muscular bundle arises from the lingual



**Figure 7:** A photograph showing the extrinsic lingual muscles (Right side).

1. Minor styloglossus muscle
2. Stylohyoid process
3. Genioglossus muscle



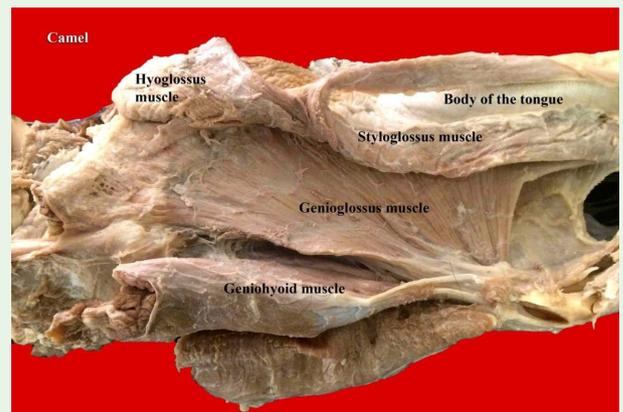
**Figure 8:** A photograph showing the extrinsic lingual muscle deep dissection (Right side).

1. Minor styloglossus muscle.
2. Stylohyoid Process; M: longitudinal muscular band

process of hyoid bone. It joins and supports the rostral border of hyoglossus muscle. In camel this bundle is absent for absence of the lingual process and the hyoglossus muscle is thinner than that in cattle and buffalo. The caudal border of hyoglossus muscle, appears nearly vertical with mildly inclined rostrally. The extraglossal part of the muscle, represented the muscular fascicles which originated and reaches the level of the dorsal border of styloglossus muscle. At the latter mentioned border, the muscle fibers embedded with the intrinsic lingual muscular fibers of torus linguae. In camel, (Figures 4C & 6C) the extraglossal fibers share the neighboring ones of the minor styloglossus forming common broad muscular band.

**Genioglossus muscle** (Figures 4,5,7 & 8).

The largest extrinsic muscle arises commonly with the geniohyoid muscle, in a fan shaped manner from the depressed fossa which located caudally to the mandibular symphysis. Both genioglossus muscles separated to each by an arolar space and they support the tongue to the median plane of the floor of mouth. The extraglossal part of the muscle, comprise the fibers which ascend in a fan shaped manner with a caudo-dorsal direction to terminate in the body and root of the tongue. The rostral group of fibers, attached to the body intrinsic lingual muscular fibers while the caudal ones end at the root of the tongue. The former fibers are thinner and ascend in a nearly vertical manner while they thicken gradually and incline caudally



**Figure 9:** A photograph showing the extrinsic lingual muscles deep dissection, Right side. TL- Tongue length TH- Tongue height HL- Hyoglossus length HH- Hyoglossus height SH- Styloglossus height GGH- Genioglossus height GGL- Genioglossus length GH- Geniohyoid height GL- Geniohyoid length

forming the caudal group. The rostral muscle fibers in cattle, (Figure 5A) erupt by a distance about 6.8-7cm from the rostral level of the lower incise gum. In buffalo, (Figure 5B) it existed by about 10-10.3cm while in camel, (Figure 5C) it furnishes about 13-13.3cm. In

cattle and buffalo, (Figure 8A & B) the caudal group of the muscle fibers inserted in the intrinsic lingual muscle fibers of torus linguae, lingual end of stylohyoid process and basihyoid. While in camel, (Figure 8C) there are no attached fibers to the hyoid bone. The intraglossal part of the muscle appears at the level of the dorsal border of styloglossus muscle.

The average mandibular length from the level of incisive gum up to the mandibular angle in cattle reaches about 35.4-35.6 cm and 44.7-44.9 cm in buffalo while in camel is about 37-37.3 cm. as well as the mandibular symphysis depth reaches about 6.8-6.9 cm in cattle and 10-10.3 cm in buffalo (Figure 5A & 5B) while in camel (Figure 5C) it extends for about 13-13.2cm. That's mean that, the considerable point of eruption of the genioglossus muscle is so close to the mandibular rostral end in cattle and buffalo (Figure 6). While in camel (Figure 6) it is existed nearly to the midpoint of the mandible. An adaptation that allows the effort of the muscle of camel to retreat than protrude the tongue and vice versa in cattle and buffalo.

### Geniohyoid muscle (Figures 4, 5, 7 & 8)

It is a fuciform muscle fills the median plane of the ventral aspect of the intermandibular space, it runs along the ventral border of the genioglossus muscle. Both geniohyoids arise commonly with the tendon of genioglossus one, the muscle thickening increases gradually at the level of the caudal half of the body of the tongue. It passes caudally to attaches to the lingual process of hyoid bone in cattle and buffalo while in camel, the muscle is triangular in shape as it is thickened at the caudal attachment, so the lingual process is missing and the muscle fibers inserted in the thyrohyoid process.

### Extrinsic lingual muscles and powerful tongue

The myoarchitectural orientation of the extrinsic lingual muscles determines the powerfulness of the tongue. The potency of the latter in the examined samples for each species based on the supporting enforcement muscle fibers, average muscular sizes rationally to that of the tongue and the role of geniohyoid muscle. The former, represents the muscular bands which enforces the muscle fibers of the intraglossal part of styloglossus muscle as well as the muscular fibers which support the rostral fibers of the hyoglossus muscle as described in cattle and buffalo. In camel, the supportive fibers of minor styloglossus muscle unite to that of hyoglossus one.

The tables attached, declare the differences between the average sizes of the tongue and correlated extrinsic muscles for each species. They explained that each of the extrinsic muscles is different, so the styloglossus muscle of cattle is the relatively larger than that of buffalo and camel. The hyoglossus of camel is rationally larger than that of cattle. The genioglossus muscle is larger in cattle than camel and smaller in buffalo.

The genioglossus muscle is not an extrinsic lingual muscle, while it assists the tongue indirectly so it is attached to the lingual process of hyoid bone. The latter is embedded in the root of the tongue and the action of the muscle allows the hyoid bone to protrude the tongue in cattle and buffalo. In camel, the hyoid bone missed the lingual process and accordingly, the effect of the geniohyoid is to attract the thyrohyoid processes although the larynx to the rostral aspect. It should be notified that the average data of the muscle is listed in the tables among the extrinsic lingual muscles.

The examined samples of the tongue of cattle, buffalo and camel, reveals that the cattle and buffalo's tongue is the strongest than that of camel. An adaptation that assists the cattle and buffalo to perform their behavioral prehension. On the other hand the anatomical architectural orientation of the camel's extrinsic lingual muscles restricts the tongue function intraorally.

### Discussion

The present study compared the extrinsic lingual muscles of the large Egyptian ruminants; cattle, buffalo and camel, to stand up on the tongue powerfulness. It revealed that the extrinsic muscles were classified according to their action into direct and indirect; the former considered the styloglossus group (minor and major), hyoglossus and genioglossus. The indirect one was the geniohyoid muscle. In this aspect, Sisson and Grossman [10] in horse, Koing et al. [11] and Dyce et al. [12] in dog and El-Bably and Tolba [8] in cat reported that the extrinsic lingual muscles were styloglossus, hyoglossus and genioglossus. The reviewed article of Wedeen et al. (2001) [3] in cattle had opinion that the rostral part of the tongue consisted of an intrinsic muscles while its posterior aspect composed of centrally located extrinsic lingual muscles distributed in a fan shaped appearance. Regarding the findings of Chibuzo [4] and Saidu et al. [5] in camel which were mentioned that the extrinsic lingual muscles entered the tongue from both sides.

The recent comparative work declared out that the styloglossus group comprised the minor and major parts. The former, was missed in the respected previous reviewed articles. The major one had an extraglossal and intraglossal parts. The former arose by a short tendon from the distal end of stylohyoid process in cattle and buffalo while in camel by a longer tendinous band from the angular curvature of the stylohyoid process. A result which were differed than that of El-Bably and Tolba in cat they had observed that the muscle encircled the upper third of the stylohyoid process. The present results revealed that the extraglossal part of the major styloglossus muscle, crossed the ventrolateral aspect of torus linguae. A finding which was nearly met by Miller et al. [13], Dyce et al. [12] and Koing et al [14] in dog and Saidu et al in camel. The work recorded that the extraglossal part of the muscle ended at the half level of torus linguae. While the intraglossal one extended to the floor of the apex linguae. A results which were in contrast to that of the available literatures which considered that the styloglossus muscle ends at the middle of the tongue Chibuzo in camel, Koing et al. in dog, Saidu et al. in camel and El-Bably and Tolba in cat.

The comparative work recorded enforcement muscular band of longitudinal intrinsic fibers arose from the caudo-dorsal aspect of torus linguae. It joined the fibers of the intraglossal part of the styloglossus muscle in cattle and buffalo, were it was absent in camel. These findings weren't reported in the reviewed articles.

Regarding the anatomical configure of the hyoglossus muscle among cattle, buffalo and camel, the recent article reported that it arose from the basi hyoid, thyrohyoid and lingual process of hyoid bone. Similar findings were cited by Miller et al., Koing et al and Dyce et al. in dog. While it was attached to the basihyoid and thyrohyoid processes in camel. A result which differed from that mentioned by Saidu et al. in camel which had the opinion that it was originated from the lingual process, basihyoid and thyrohyoid process.

On the other hand, the hyoglossus muscle was supported by thick muscular fibers from the lingual process of hyoid bone to the rostral aspect of the muscle in cattle and buffalo. While in camel this fibers were absent and the fibers of the minor styloglossus muscle joined the caudal ones of the genioglossus muscle. A results which weren't mentioned by respected available literatures.

The genioglossus muscle was compared among cattle, buffalo and camel recently and declared that it was erupted from a fossa caudal to the mandibular symphysis by a common tendon with the geniohyoid one. Nearly achieved findings were cited by Sisson and Grossman [10] in horse and Chibuzo and Saidu et al. in camel. The genioglossus fibers ascended caudally in a fan shaped manner and grouped into rostral and caudal fibers; the former for the body of the tongue while the caudal ones for the root. Sisson and Grossman in horse had the opinion that it furnished three group of fibers; rostral, middle and caudal. In the recently finished article, the eruption level of the muscle was relatively differed to the longitudinal axis of the mandible in each species. So in cattle was the rostral one than that in buffalo while in camel it may arose nearly to the midpoint of the mandibular length.

Studying the anatomical structure of the geniohyoid muscle in the present work had a significant reason that the muscle affected the tongue movement. It attracted the lingual process of the hyoid bone with the root of the tongue rostrally in cattle and buffalo. Similar observations were cited by Sisson and Grossman in horse and Evans and La Hunta in dog. Generally the muscle was fuciform in cattle and buffalo while it was stout and triangular in camel.

It should be notified that the potency of the tongue was concluded from the enforcement supporting muscular fibers, role of the geniohyoid muscle and statistical data that determined the rational average between the tongue and different extrinsic muscles. The study scheduled the average data for each extrinsic muscles of the tongue. In this aspect, El-Bably and Tolba in cat cited a metrical data of the tongue and its lingual papillae and missed the extrinsic muscle. As well as the scheduled listed by Igado in dog which measured the dimensions of the whole tongue as a general? According to the metrical data in cattle, buffalo and camel were apparently similar and this was in agreement with the observations of Saidu et al. in camel. While the recently permitted study suggested that the tongue of cattle and buffalo were stronger than that of camel. The anatomical configure of the extrinsic lingual muscles in cattle and buffalo adapted their tongues for prolonged protrusion and flexible curving. On the other hand, the camel's tongue was restricted intraorally. Similar results were concluded by Saidu et al. in camel.

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