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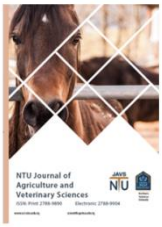

Anatomical study and measurements on the tongue of mature local breed ducks (*Anas Platyrhynchos*) and geese (*Anserinae*)

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Article Informations

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ducks, geese,tongue, weight, thickness papillae lingual elevation.

A B S T R A C T

By studying both species the results showed that the average weights of adult birds were 1445 gm in ducks. the average rate of tongue's weight was 8.87 gm, and a relative weight of 0.61 gm, while the average weights in geese were 2374 gm, 11.28 gm, and 0.47 gm, respectively. The dorsal surface of the apex of the tongue of ducks was spoon-shaped, while the apex of the tongue of geese was round. but the ventral surface was triangular with a white plate termed the nail of the tongue in both species. The caudal part of the duck tongue makes the tongue comb which is placed in front of the lingual elevation, whereas the caudal part of the goose tongue forms the median furrow which is located at the front border of the lingual elevation. The margins of the tongue of both animals include large and small conical mechanical papillae, in addition to filiform papillae. A significant difference has been noted in the thickness of the apex and the root of the tongue between the two birds. Also, there was a significant difference in the width of the lingual elevation and root between the two birds.

Introduction

Birds are group of endothermic (warm-blooded) vertebrates that differ from other organisms in that their bodies are covered with feathers, have a toothless beak, and at the same time lay eggs with a thick outer coat and a strong lightweight skeleton. (Brown and Van Tuinen, 2011). Many birds are economically important to humans because poultry and other birds are major producers of meat and eggs.

Anatidae is a biological family of waterfowl that comprises ducks, geese, and swans as they are distributed in all continents of the world except Antarctica. These birds are adapted for swimming, floating on the surface of the water, and in some cases diving in shallow waters. However, both species are quite popular with many people especially farmers and country inhabitants because both species are dispersed throughout the numerous canals and refineries. (Alonso *et al*., 2004). Birds' tongues can be long or short and they can also have spines of various sizes attached to them. (Iwasaki, 2002)and El-bakery(2011) developed diverse ways to classify birds, including the relationship between a bird's diet and its tongue. - They found that there are five functions performed by the tongue (collecting food, eating, swallowing, tasting and touching).

The tongue also has remarkable dietary adaptations, since it can consume a wide range of food including insects, small seeds, grasses, grains, and so on, depending on the species.

The tongue of most birds is covered with a stratified squamous epithelium that may be keratinized in certain areas and papillae of various shapes and sizes emerge from it. A special structure at the ventral surface of the tongue apex in some birds is associated with a nail-like form and its function aids the bird in eating and withdrawing food (Olsen, 2011).

The duck (*Anas Platyrhynchos*) is a medium-sized waterfowl, and the presence of the tongue in the oral cavity of ducks works in concert with the water filter system and is one of the most fundamental reasons why ducks adapt successfully to life on water (Emura *et al*., 2010a).

Geese are closely related to ducks, swans, and other waterfowl geese whose Scientific name is: (*Anserinae*) it is a family of birds belongs to the duck family of the geese order belongs to the family (Anatinae), which is a subfamily in the waterfowl family.

The food consists primarily of papyrus, grasses, grains, seeds, and aquatic plants, with the occasional addition of insects and fish (Jackowiak *et al*., 2006). In ducks and geese, the beak is rather flat with serrated plates along the edges. This arrangement is particularly common in birds that depend on filter feeding for nutrition. (Parchami *et al*., 2010a).

A variety of conical and filamentous mechanical papillae distributed over the body of the tongue in both birds are important for filtering liquids, digesting food, and moving food particles over the surface of the tongue toward the root (Bels, 2006).

The above-mentioned facts provides a strong reason to study the standard anatomical differences in the tongue of ducks and geese and their differences from other birds. Thus, the current study is intended to understand the comparative anatomy of the tongues.

Materials and Methods:

Specimen collection:

Regardless of sex the study obtained (10) samples, which included (5) ducks (*Anas Platyrhynchos*) and the same number of geese (*Anserinae*) from the local markets in Mosul city. The birds were all adults and clinically healthy. birds were handled and managed according to AVMA guidelines (Underwood and Anthony, 2020). (Most of the birds are processed for food consumption).for the anatomical study. After that, the weight of each animal was recorded before and after slaughtering .the tongue was extracted from each bird and its weight was taken.

Anatomical Study

After the birds were euthanized, the anatomical characteristics were performed, where the tongue was completely extracted from the apex to the larynx area using anatomical tools, and then the tongue was washed in a physiological saline solution to clean it from nutrients and blood that had adhered to it (Reda Mohamed 2019).
To make the study more accurate and less errors the following steps were taken:
The tongues of each bird (duck and geese) were divided into three sections as indicated in Figure. (1,2):

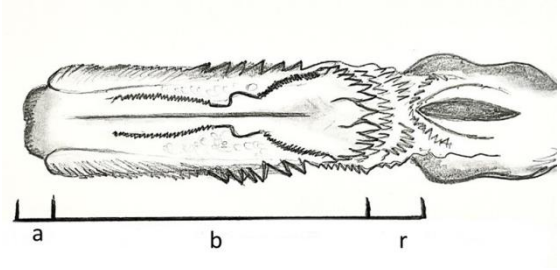


Figure 1: illustration show.....
the imaginary divisions of the tongue in ducks tongue for the anatomical study.

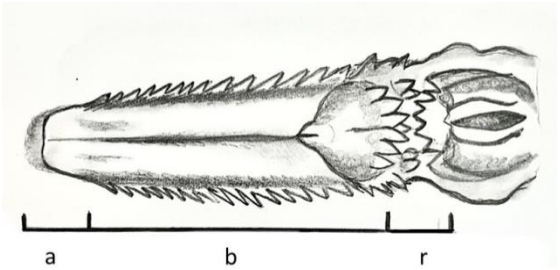


Figure 2: illustration showthe imaginary divisions of the tongue in geese tongue for the anatomical study.

Tongue apex: the point where the free section of the tongue meets the lingual papillae .
Body of the tongue: The area between the initial appearance of the lingual papillae and the area following the lingual elevation subdivided into body and lingual elevation
Tongue root: situated between the end of the lingual elevation and the entrance of the larynx.
The outer surface of the tongue was studied macroscopically using the anatomical microscope (Huma scope stereo14900/5, Germany) the microscope was equiped with microscope camera (OMAX, 16MP, China) provided with picture analysis software. The software was clibrated to the four objective lenses of microscope by the aid of the stage micrometer to achieve the wanted measurementsto identify the following 1- the diverse types of papillae in different areas of the tongue.
2- measure the height and diameter of each papilla in various parts of the tongue (the diameter of all lingual papillae was measured from the middle of the height of the papilla).
3- Using a Vernier caliper (LOUISWARE, China), measure the length, width, and thickness of each section of the tongue (apex, body, root) the measuring unit (mm), as well as the total length (Hasso,2015).

Statistical analysis
Means and standard errors were calculated for anatomical and histological measurements in the current study between adult domestic ducks and geese using (IBM Spss V25,UK) software. It was confirmed that there are statistically significant differences using the T-test for independent samples at a significant value of $p \leq 0.05$ (Petrie and Watson, 2013).

Results:

Anatomical study:

The present research on both birds revealed that the average weights of adult animals used in the study were 1445 gm in ducks, and the average tongue weight were 8.87 gm, with a relative weight of 0.61 gm. In geese, the weights were 2374 gm and 11.28 gm, with a relative weight of 0.47 gm, respectively, as shown in Table (1).

Table 1: shows the mean and standard error of body weight, tongue weight and the relative weight between the tongue in ducks and geese,

animal species	body weight (gm) M±SE	tongue weight (gm) M±SE	relative weight(%) M±SE
duck	1445±33.60	8.87±0.72	0.61%*
geese	2374±52.35*	11.28±0.55*	0.47%

(*) indicates that there are statistically significant differences at ($p \leq 0.05$) between ducks and geese.

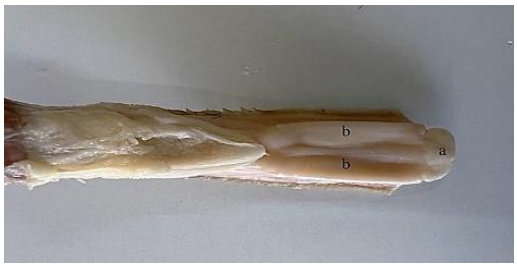
According to table 1, there are significant differences in body weight, tongue weight, and relative weight between ducks and geese, where it was noted that the body weight and tongue weight in geese are greater than it is in ducks. But relative weight in ducks being greater than the relative weight in geese.

The external appearance of the tongue:

The apex of the duck's tongue has a spoon-like shape, with a smooth dorsal surface free of lingual papillae. see figure(3a).

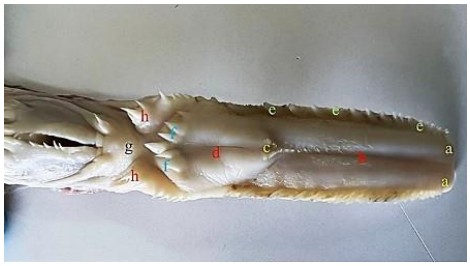
photograph **3:** shows the dorsal surface of duck's tongue a- apex b- middle groove c- tongue combs d- lingual elevation e- mechanical papillae f- conical papillae in posterior border of lingual elevation g- lingual root h- prominent regions.

The ventral surface is triangular in shape and flat. It has a white plate called the lingual nail and protruding frontal and lateral margins figure (4).



photograph **4:** shows the ventral surface of duck's tongue a- lingual nail b- lingual body.

The apex of the tongue in the local geese is rounded, smooth, with no lingual papillae on its dorsal surface figure(5a),



photograph **5:** shows the dorsal surface of geese tongue a- apex b- middle groove c- median furrow d- lingual elevation e- mechanical papillae f- conical papillae in posterior border of lingual elevation g- lingual root h- prominent regions.

The ventral surface of the apex was covered with a triangular plate of smooth white color structure known as the lingual nail, figure (6a).

photograph **6:** shows the ventral surface of goose tongue a- lingual nail b- lingual body.

The dorsal surface of the body of the duck's tongue was divided into two parts by the middle groove that runs along the body, and there are elevations of the epithelium in the back of the tongue's body and on both sides of the middle groove, forming what is known as tongue combs that lie in front of the lingual elevation, as shown in the figure (3b,3c), While the dorsal surface of the tongue of the local geese shows a medium to shallow depth longitudinal groove that runs along the length of the body figure (5b). It was also observed that there is a rise in the mucous epithelium at the back of the tongue's body, which represents the lingual elevation and is surrounded by a few hairy-like papillae and small conical papillae, with the lack of lingual combs as mentioned in ducks' figure (5d).

There are three types of mechanical papillae seen symmetrically along the two borders of the body of the tongue in both ducks and geese. These are large to small conical papillae, and filiform papillae. See figure (3e,5e).

The lingual elevation is located in the posterior third part of the duck's tongue, just before the root. It is divided into two symmetrical parts by a slight middle groove. The anterior border of the lingual elevation is toothed and lies above the body of the tongue, while its posterior border creates rows of conical papillae directed towards the root of the tongue. figure (3d,3f).

While the lingual elevation in the geese's tongue takes the form of a triangular cushion located in the posterior third of the tongue, the median furrow located at the beginning of the lingual elevation contains a few small conical papillae and a hairy-like papillae, figure (5d,5c). Whereas the posterior border of the lingual elevation had somewhat overlapped conical mechanical papillae located above the anterior part of the root of the tongue figure (5f).

The results showed that the root area in the duck's tongue occupies the part between the lingual elevation and the pharynx, which is the smallest region of the tongue found below the lingual elevation. There are several conical papillae pointed toward the pharynx on both sides of the root. figure(3h).

Whereas the root in the geeses' tongue composed of a smooth triangular area surrounded by prominent regions on both sides of the root. The prominent regions are identified by the presence of about (2-3) papillae on each side directed towards the pharynx figure (5h)making multiple transverse sections in it.

Anatomical measurements of the tongue:

the length, width and thickness of all segments of the tongue were measured (apex, body, lingual elevation, and root), to observe the variations in these sections between the two species, ducks, and geese.

Table(2) shows a significant difference in the rate of measuring the lengths of all parts except the root region, where the average of measuring the lengths of the apex, body, and lingual elevation of the tongue in geese was higher than that in ducks, respectively, while the average measurement of root length in ducks is slightly higher than that of geese.

Table 2: Shows the mean of length, thickness, width and standard error of parts of the tongue in both ducks and geese.

animal species	Tongue parts	Length (mm) M±SE	Thickness (mm) M±SE	Width (mm) M±SE
Duck	Apex	6.09±0.24	2.65±0.13	10.08±0.18
	Body	46.85±3.74	8.79±0.33	14.01±0.46
	lingual elevation	16.04±2.80	10.69±0.60	12.71±0.42
	Root	8.49±0.40	8.98±0.64	11.24±0.31
Geese	Apex	9.74±1.60 *	3.87±0.19*	9.65±0.52
	Body	55.30±8.20*	8.50±0.12	14.69±0.36
	lingual elevation	18.65±0.68*	11.27±0.27	15.36±0.42*
	Root	7.97±0.69	10.85±0.29*	14.48±0.57*

(*) indicates that there are statistically significant differences at ($p \leq 0.05$) between ducks and geese.

While the mean thickness of tongue of tongue thickness was higher in all parts of the tongue in geese except the body part; it was higher in ducks than in geese. According to the table, there is a significant difference in the thickness of the apex of the tongue and the root between the two species. the mean width of tongue was higher in geese than in ducks, except for the apex of the tongue, which was higher in ducks. There is a significant difference in the lingual elevation and root parts of both animals.

Lingual papillae

Small conical papillae

According to our study, it was found that the anterior part of the body of the duck's tongue, and on both sides of it, contains several small conical papillae,. Each papilla is in the form of a flat plate with rough ends. it is directed toward the tongue's root and the pharynx figure (7).

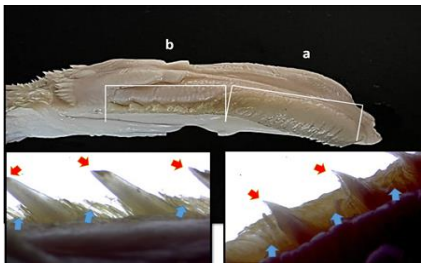


Figure 7: photograph the body of the duck's tongue a- small conical papillae(orange arrow small conical papillae , blue arrow filiform papillae) b- large conical papillae(orange arrow large conical papillae , blue arrow filiform papillae).

Whereas the small conical papillae in the geese's tongue had pointed ends on both sides and were directed laterally and slightly posteriorly towards the root of the tongue and pharynx figure(8).

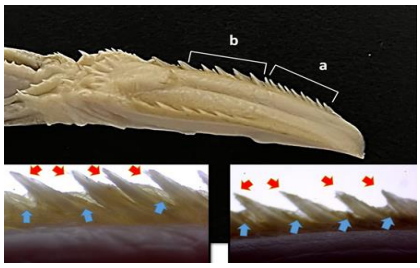


Figure 8: photograph the body of the goose tongue a- small conical papillae (orange arrow small conical papillae , blue arrow filiform papillae) b- large conical papillae(orange arrow large conical papillae , blue arrow filiform papillae).

Large conical papillae

In both species, this type of papillae was found in the middle and posterior parts of the tongue's body. They are found just behind the small conical papillae in pairs of various forms. The first pairs of these papillae resemble slightly flattened cones with a concave surface, whereas the other pairs resemble the tip of a ballpoint pen, and the latter pairs of large papillae resemble frayed cones. These papillae are oriented toward the tongue's root figure (7).

This type of papillae is found also in the middle and posterior parts of the body of the geese's tongue, as there are multiple pairs of large conical papillae visible on each side with a pointed end or protrusion figure (8).

Filamentous papillae

This type of papillae was found on the sides of the body of the tongue in both species, where they are distributed between small and large conical papillae and take the form of twisted and dense hair-like protrusions. But their density in geese is lower than in ducks, as shown in the figures (7)(8).

Discussion:

The research revealed that the average weights of adult birds used in the study were 1445 gm in ducks, and the average rates of tongue weight were 8.87 gm, with a relative weight of 0.61 gm, while in geese the weights were 2374 gm and 11.28 gm, with a relative weight of 0.47 gm, respectively.

It is obvious that the geese's size and weight play a significant role in the net result in terms of tongue weight.. In addition, the relative weight of the duck's tongue is greater than the relative weight of the goose's tongue because the duck's tongue involves a larger bone mass than the goose's tongue.

The apex of the duck's tongue has a spoon-like shape, with a smooth dorsal surface free of lingual

papillae. The ventral surface is triangular in shape and flat. It has a white plate called the lingual nail and protruding frontal and lateral margins, while the apex of the tongue in the local geese was circular, smooth, and rounded, with no lingual papillae on its dorsal surface The ventral surface of the apex was covered with a triangular plate of smooth white color known as the lingual nail.

It is well known that the duck at the time of feeding, inserts its head into the water to touch the bottom of the water pool, but sometimes its entire body dives into the water to pick up its food from the ground of the pool, which requires this structure, while the geese rarely need to dive into the water because it feeds on tall grass which is above the surface of the water or on land.

Our findings on duck's tongue are consistent with other studies (Bello *et al*., 2015) and (Abdalla *et al*.,2011). Also, other studies performed by (Bels and Baussart,2006) in geese, supported our description of the mechanism of filter feeding in animals.

The dorsal surface of the body of the duck's tongue is divided into two parts by the middle groove that runs along the body, and there are elevations of the epithelium in the back of the tongue's body and on both sides of the middle groove, forming what is known as tongue combs that lie in front of the lingual elevation, while the dorsal surface of the tongue of the local goose shows a medium to shallow depth longitudinal groove that runs the length of the body, with the lack of lingual combs as mentioned in ducks.

The results of the current study are in contrast wito th the results mentioned by (Rico-Guevara 2011) in hummingbirds who specified that the tongue of a hummingbird in the case of non-feeding is coiled and contains two deep longitudinal grooves that start from the apex and end with the root, In the case of feeding, they separate from each other and remain connected by the plate that She envelops both parts to enter the nectar. This difference is due to the difference between the two kinds of animals included in the study, as well as the nature of food intake for both animals and humming birds.

While this was consistent with (Skieresz *et al*., 2021) results mentioned in their study of the turkey's tongue the dorsal surface of the tongue is divided by a longitudinal groove along its dorsal surface.

The tongue was measured in length, thickness, and width in its various parts (apex, body, lingual elevation, and root), to observe the variations in these segments, we summed the average lengths of these segments and discovered that the average of the total length of the tongue in ducks was 11.91 cm while in geese was 24.34 cm.

Results of the present study disagree with (El-Fattah 2013) in the kingfisher where the tongue's length reached 1.8 cm, because of the differences in the type of animal, size, and style of feeding. it suggests different outcomes in comparison to (Abdalla *et al*., 2011) in ducks, who found that the length of the tongue was up to 60.87 mm at the age of 60 days. This study involves adult ducks which accounts for the differences in findings.

Whereas (Tawfiek and Mahmoud 2020) reported that the average total tongue length for geese was 56.38 2.26 mm, however, the age of the animal was not included.

According to this study, it was found that the anterior part of the body of the duck's tongue, on both sides contains several small conical papillae which are directed toward the tongue's root and the pharynx.

Whereas the small conical papillae in the goose's tongue had pointed ends on both sides of the anterior part of the body tongue and were directed laterally and slightly posteriorly towards the root and pharynx.

Large conical papillae in both species were found in the middle and posterior parts of the tongue's body. They are found just behind the small conical papillae in pairs of various forms.

Filamentous papillae can be found on the sides of the body of the tongue in both ducks and geese where they are distributed between small and large conical papillae.

The results agree with (Bello *et al* 2015) in their study which was done on the tongue of ducks, which are symmetrically on both sides of the body of the tongue There are three types of mechanical papillae, the large and small conical papillae and the filiform papillae located on the smooth lateral surface of the body of the tongue. (Igwebuike and Ukamaka, 2010) mentioned that the shape of the tongue in geese is elongated, and contains three types of lingual papillae, which are conical, threadlike, and capillary-like papillae. The study also agrees with (Parchami and Dehkordi's,2011), who mentioned that the conical lingual papillae can be observed and distinguished into three categories: small and large conical lingual papillae located on the body of the tongue, and conical lingual papillae located on the lingual elevation.

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Competing Interests

The authors declared that there is no conflict of interest.

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