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Investigation of Chicken (Gallus domesticus) Tongue by Morphometric and Scanning Electron Microscopic Methods

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Abstract

The aim of this study was to investigate the morphology of the tongue which plays an important role in the digestive and sensory system. The tongues of 20 female broilers were examined in this study. Tongues extracted after dissection were fixed in glutaraldehyde and observed under scanning electron microscope (SEM) and photographed. Also, morphometric measurements were performed. Macroscopically, the chicken tongue was triangular, ended with a sharp tip and adapted to the lower bill. It is composed of three parts; apex, body and radix of the tongue. The row of conical papillae (papillary crest) which organized as "V" shape was seen between the lingual body and radix. There were larger conical papillae on both lateral sides of this papillary crest. 2-6 huge conical set of papillae were observed in just the caudal of these larger conical papillae. Numerous orifices of microscopic salivary glands were observed in the radix of the tongue. There was no mechanical papilla on the body of the tongue. The tip of the tongue was very sharp and highly keratinized.

Key Words: Anatomy, SEM, poultry, tongue

Tavuk (Gallus domesticus) Dilinin Morfometrik ve Taramalı Elektron Mikroskobik Yöntemlerle İncelenmesi

Öz

Sindirim ve duyu sisteminde önemli rol oynayan dilin morfolojik olarak incelenmesi amaçlandı. 20 dişi yetişkin broyler bu çalışma için kullanıldı. Diseksiyon sonrası çıkarılan diller glutaraldehit içinde tespit edilerek taramalı elektron mikroskobu altında gözlendi ve fotoğraflandı. Makroskobik olarak tavuk dilinin üçgen şeklinde olduğu, sivri bir uçla bittiği ve formunun alt gagaya uyum sağladığı görüldü. Apex, corpus ve radix lingua olmak üzere 3 bölümden oluştuğu izlendi. Dil üzerinde corpus ve radix arasında "V" harfi formunda organize olmuş konikal papilla sırası görüldü. Bu sıranın her iki lateral kenarında daha iri konikal papillalar bulunmaktaydı. Bu iri konikal papillaların hemen caudal'inde iki ya da üçlü konikal papilla kümeleri görüldü. Dilin kök bölgesinde mikroskobik tükrük bezlerinin çok sayıda akıtıcı kanal delikleri izlendi. Dil gövdesinde belirgin bir mekanik papilla görülmedi. Ancak, median bir oluk dikkat çekti. Dilin uç kısmı oldukça sivri olup, son derece keratinize bir yapıya sahipti.

Anahtar Kelimeler: Anatomi, dil, SEM, kanatlı

INTRODUCTION

The tongue, which takes part a very significant role in the consumption of food for vertebrates, is among the most important morphological changes that provide adaptation to the existing environmental conditions (1). The type of nutrients taken and the processing of these nutrients cause morphological changes of the structures on the surface of the tongue (2). The superior and inferior jaws of the birds are transformed into bill, and their teeth, lips and cheeks is absent. The functional muscles in their oral cavities restrict the manipulation of food. The morphological differentiation of avian tongues and the presence of the beak in these species are directly related to different dietary habits and living conditions (3) The fact that the tongues are different in terms of shape and size between different species indicates that the tongues of these creatures have been modified to obtain and evaluate food (4).

In avians which belongs to the class of Galliformes (chicken, quail, partridge, pheasant etc.), the shape of the tongue conforms to the lower bill and it has a knife-like or triangular shape (5). Morphologically, the parts of the avian tongue are the same as in the mammals (4). In birds, the tongue's dorsal surface is examined in three parts. These parts are apex, body and radix. The most characteristic feature of the avian tongue is the formation of a papillary crest consisting of mechanical conical papilla which directed caudally and it separates the lingual body and root (6,7). The presence of only mechanical papillae in the tongue is a distinctive feature for avians (2,4,6,8-10).

The chicken in the Galliformes class usually consumes small seeds and plants, and sometimes eats small invertebrates (8). Although the birds' eating habits and the foods they consume are different, most of them have papillary crest. This shows that there is not linear relationship between the feeding patterns of birds and papillary crest (11-13). Papillary crest is seen as a form of food that helps to swallow and prevent vomiting (5).

The purpose of this study is to describe the general morphology of the tongue and the organization of the lingual papillae in chicken by using scanning electron microscope, gross observations and morphometric measurements.

MATERIALS AND METHODS

The tongues of 20 adult female broilers were examined in this study. The broiler heads were obtained from slaughtered materials of the project which was approved by Local Ethical Committee of Animal Experiments in Namık Kemal University (Approval number: T2017-7-5). The tongues were extracted from heads and washed in 0.1M chilled phosphate buffer (pH-7.4), fixed in 2.5% glutaraldehyde for 6 h and again washed twice in 0.1M phosphate buffer (pH-7.4). The samples were examined and photographed under a scanning electron microscope (SEM) (Quanta FEG 250; ThermoFisher Scientific, USA).

RESULTS

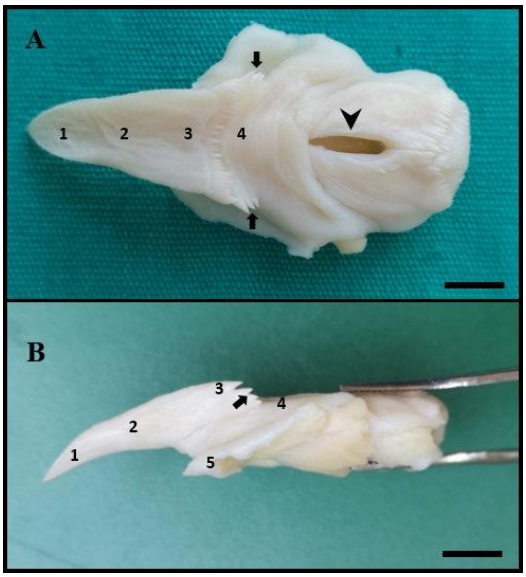
Macroscopic Observations

The tongue in chicken was triangular with knife-like ended apex. The tongue fitted into the shape of the lower bill. In general, the tongue composed of three parts; lingual apex, body and radix. Width of the tongue expanded from lingual apex to lingual radix. In gross observation, the papillary crest was the most distinctive structure between the lingual body and root. The smooth ventral surface of the tongue attached to the lower bill by a strong frenulum (Fig. 1). The morphometric data of tongues was showed as mean ± SE (Table 1).

Table 1. Measurements of the lingual parts (mm)

Parts of the tongue	Mean ± SE
Total length of the tongue	23.69 ± 1.95
Width of the lingual body	2.55 ± 0.34
Width of the lingual radix	6.16 ± 0.62
Width of the lingual apex	10.15 ± 0.95
Width of the papillary crest	9.25 ± 0.86
Thickness of the lingual apex	1.11 ± 0.09
Thickness of the lingual body	3.17 ± 0.35
Thickness of the lingual radix	6.01 ± 0.56

Figure 1. Dorsal (A) and lateral (B) views of the tongue. Apex (1), body (2), papillary crest (3), radix (4), lingual frenulum (5), large conical papillae (arrows), glottis (arrowhead). Scale bars: 4.5 cm.



Scanning Electron Microscopic Observations

The row of conical papillae (papillary crest) was situated just behind the deep transversal groove (Fig. 2). Papillary crest which organized as letter "V" shape was seen between the lingual body and root, also directed caudally. This papillary crest was composed of average 25 medial conical papillae (Fig. 3). In our samples, we observed a large number of thin sulci on the pointed tips of these medial conical papillae (Fig. 4). There were larger conical papillae on both lateral sides of this papillary crest (Fig. 3). These large conical papillae had smooth surface in contrast to medial conical papilllae. In 30% of our samples, these large conical papillae were bifurcated (Fig. 5). A smaller papilla originated from the base of each large papilla located laterally (Fig. 3). However, in 20% of the samples, another weak smaller papilla was found on the base of these large papillae (Fig. 5). Moreover, 2-6 huge conical set of papillae were observed in caudolateral side of the large conical papillae of the papillary crest (Fig. 6).

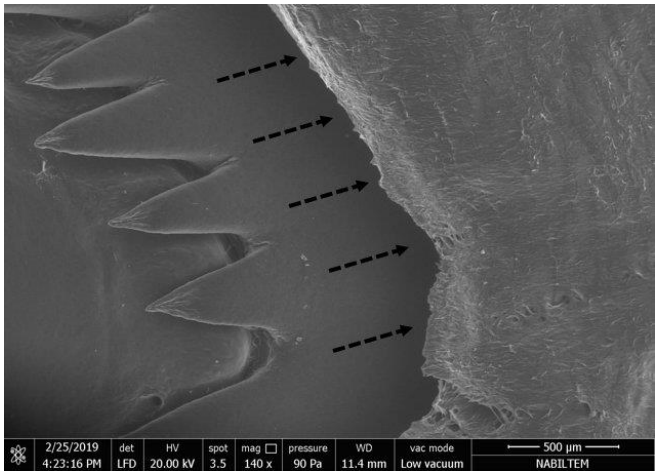


Figure 2. Transversal deep groove (arrows) just behind the medial papillary row of the papillary crest.

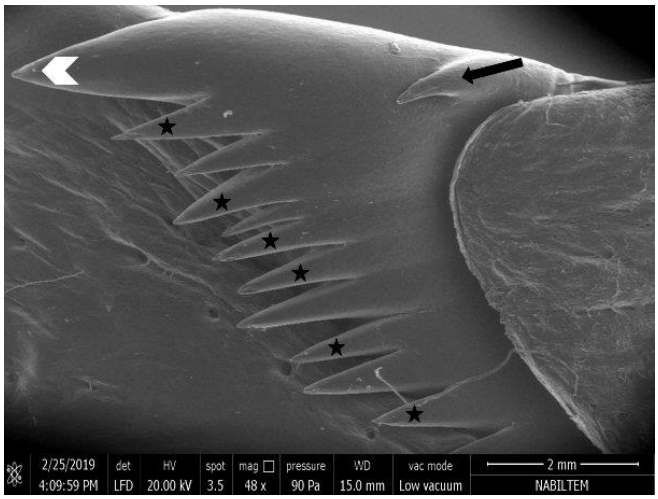


Figure 3. Papillary crest between the lingual body and radix. Weak smaller papilla (arrow) originating from base of each lateral huge conical papilla (arrowhead) and medial papillary row (stars).

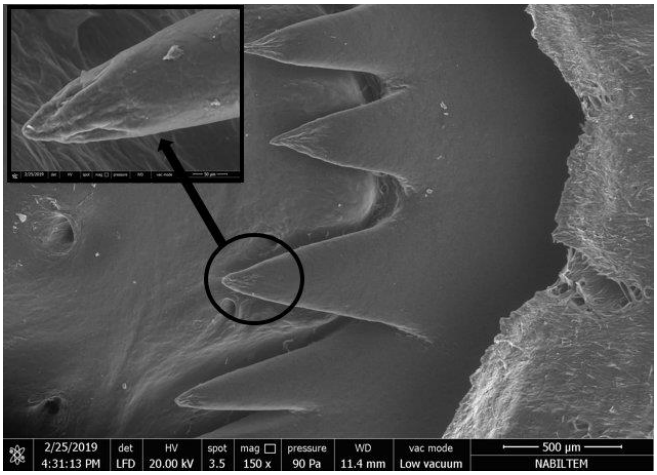


Figure 4. Thin sulci on the pointed tips of medial conical papillae of the papillary crest.

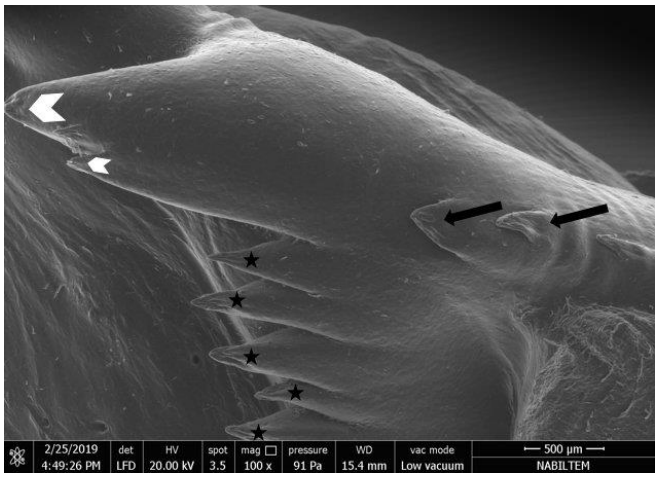


Figure 5. Bifurcated huge conical papilla (arrowheads) of the papillary crest. Numerous weak smaller papillae (arrows) and medial papillary row (stars).

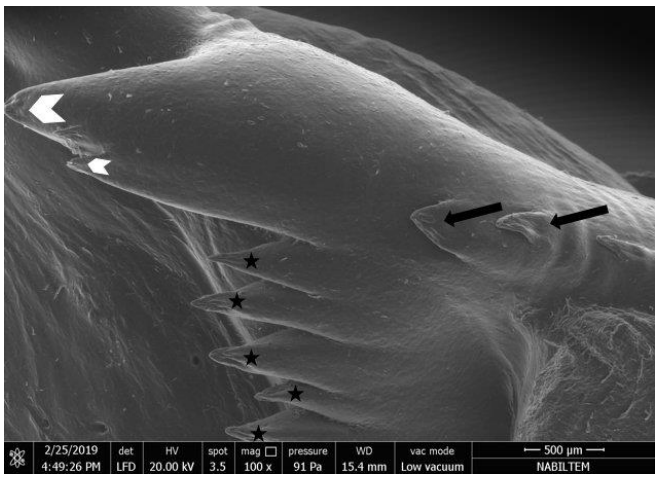


Figure 6. Large conical papillae row (arrows) on the caudolateral side of the bifurcated huge conical papilla (arrowheads) of the papillary crest.

On the lingual root, numerous orifices of the microscopic salivary glands were observed and there were no any mechanical papillae on the root surface. The orifices of the salivary glands are frequently oval or circular shaped (Fig. 7). Similarly, no mechanical papillae were seen on the lingual body and the dorsal surface of the lingual apex. However, a prominent median groove was observed on the lingual surface. It began from lingual apex and run through lingual body (Fig. 8). The tip of the tongue was very sharp and highly keratinized. This highly keratinized structure seemed like a lingual nail (Figs. 8, 9). Besides, there were thread-like projections on the dorsal surface of the lingual body (Fig. 9). Overall the tongue, we did not determine any gustatory papillae.

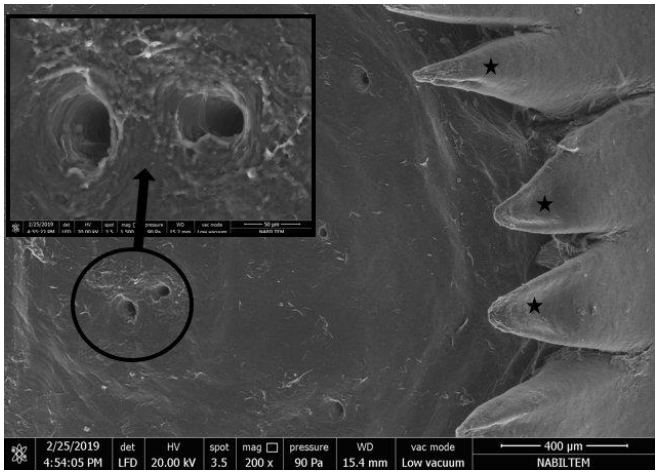


Figure 7. Circular shaped orifices (in circle) of lingual salivary glands on the dorsal surface of the root behind the papillary crest (stars).

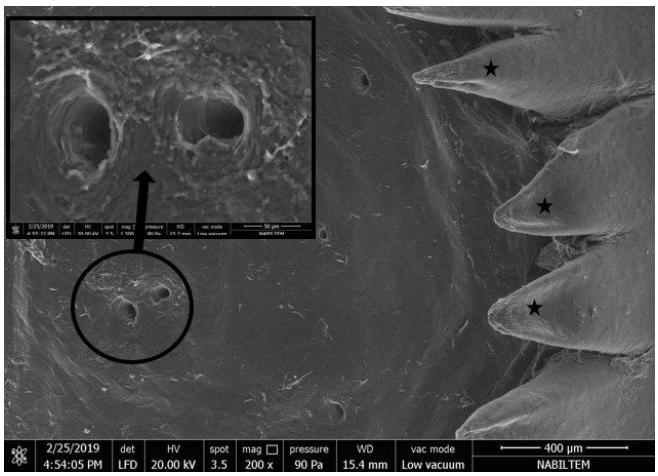


Figure 8. Median groove (between two lines) from the lingual apex (arrowhead) to body.

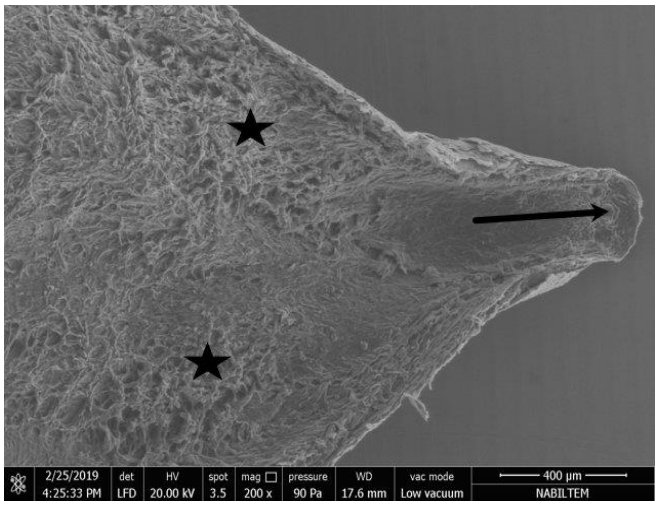


Figure 9. Carpet like projections (stars) and highly keratinized lingual nail (arrow).

DISCUSSION AND CONCLUSION

In order to survive in the nature, feeding apparatus of avians, in particular the tongue must be adapted to their diet. As a result of this, we can see different tongue forms in birds because of having varied dietary habits (5). Morphological studies in avian tongues have shown that the shape of the tongue is closely related to the type of habitat, food intake and anatomy of the beak (5,11,13-16). In the present study, form of the tongue is triangular, but naturally it is not triangular in all bird species. In the species such as eagle, hawk, vulture, which belong to the class of Falconiformes, the shape of the tongue is spade-like and oval tip (6,12,14-16). In the owls belonging to the class of Strigiformes, the shape of the tongue is bifid and oval tip. The goose, duck, and swan of the Anseriformes class have an elongated with rounded tip (10).

The tongue in the birds has three parts; lingual apex, body and radix (3,5). Even though, white tailed eagle (6), Middendorff's bean goose (10) and nutcracker (4) have distinctive median sulcus on the dorsal surface of the tongue. Although it was reported that this groove was absent in chicken (8,9,13), we determined a groove on the lingual body in the present study. Dorsal surface of the lingual body seems like a carpet because of lingual projections such as filiform papillae in chicken as reported previously (5,8,9,17). However, we did not observe these protrusions on the other parts of the tongue.

The most distinguished structure of the avian tongue is the prominent conical papilla row which named as papillary crest. This papillary crest provides the transmission of food to esophagus (5,11). In this study, papillary crest was found in a transversal ridge, but the tongues were reported in different structures in other species. The papillary crest were formed of caudally oriented conical papillae were arranged as single "V" shape in white-tailed eagle (6), quail (16), partridge (13), kestrel (15) and Northern goshawk (18) as well as chicken. In Anseriforms such as Middendorff's bean goose (10), domestic goose (2) and Egyptian goose (19) papillary crest composed of well-developed papillae in two transverse row. Interestingly, zebra finch had "W" shaped papillary row (20). In contrast to our samples, papillary crest was absent in some species such as Japanese pygmy woodpecker (18).

The main papillary row of the papillary crest generally consists of bilateral large conical papillae which are higher than those in the medial row (3,5,6,15,16). These large conical papillae have a very simple structure and do not show any other formation (3,6,13). Interestingly, we detected weak smaller papillae was originated from the base of these large papillae. These smaller weak papillae were also reported on the papillary crest of Southern lapwing (3). Moreover, some of these large papillae were bifurcated in our study.

Chicken (9), parrot (21), penguin (22) and white-tailed eagle (6) have a large epithelial keratinization covering the ventral surface of the apex. The keratinized epithelial layer covering the dorsal and ventral surface of the tongue is composed of superficially exfoliated cells, and they revealed microridges (6,10,11,16,20,23). In this study, the apex of the tongue has resemblance to lingual nail due to extreme keratinization. Similarly, Anseriformes class such as goose has much more strongly keratinized tongue (2,10,19, 24).

In this study, there are numerous orifices of the microscopic salivary glands on the surface of lingual root. These microscopic salivary glands may lubrify the foods before transferring them to esophagus (25), and lubricating molecules which secreted from salivary glands play a protective role for mucosa and make a barrier against microbial agents in the oral cavity (26). The present study indicated that we can observe these orifices on the dorsal surface of the root and the lingual body as well as hoopoe (25), quail (16), partridge (13). The openings of the salivary glands are mostly oval and circular shaped. In contrast to our samples, the orifices of the salivary glands may be ellipsoid or spindle shaped in chicken, round or semilunar shaped in ostrich (27-29). We also think that these numerous openings of salivary glands serve for production of much more saliva in order to lubricate the dry seeds and ease swallowing. This may indicate that it is a morphological adaptation to diet type.

In conclusion, we determined one row papillary crest, large conical papillae and their protrusions and caudoventral papillary row on the lateral surface of the papillary crest.

We detected thin sulci at the pointed part of conical papillae of the medial row. On the dorsal surface of the root, there were numerous ellipsoid shape orifices of the salivary glands. The apex of the tongue looked like a lingual nail because of highly keratinization. In general, the basic anatomical feature of the tongue of chicken were very similar to other members of Galliformes family such as quail, partridge, pheasant. All of the structures like conical papillae of papillary crest, lingual nail, median sulcus, secondary papillary projections and triangular form of the tongue reflects the lifestyle which adapted to feeding type with dry fodder mostly.

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