

Gross Anatomical Features of Tongue of Khaki Campbell Duck (*Anas platyrhynchos domesticus*) At Different Postnatal Ages

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Abstract

The present study aims to investigate the gross morphological structure of the tongue of the khaki Campbell duck at different postnatal ages. The ducks were from four age groups (A total of 25 ducks): day one (1), one (1) month, two (2) months, three (3) months, and four (4) months, having five ducks in each group. The tongues were collected immediately after the ethical killing of the birds for gross anatomical observations. The tongue of the Khaki Campbell duck was located on the floor of the oropharynx. In all examined ages, the tongue did not extend to the total limits of the lower beak. The elongated shaped tongue was divided into three parts, i.e., apex, body, and root. The spatula-shaped apex of the tongue was smooth dorsally and devoid of lingual papillae. On the ventral surface of the apex, there was a flat, triangular, white plate of the lingual nail. The dorsal surface of the body of the tongue was divided into two symmetrical parts by a median groove, which became more prominent at the advancement of age. Large and small conical papillae were found symmetrically along both body edges. The root of the tongue was the smallest part which was located adjacent to the laryngeal prominence. Papillae were found on both sides of the root. A fold of membrane, the frenulum linguae present on the ventral aspect of the body. The length and width of the tongue increased with the advancement of age. The present study revealed the gross anatomical structure of the tongue of the Khaki Campbell duck at different postnatal ages and helped to compare the findings with other avian species.

Keywords: Gross anatomy, tongue, postnatal ages, Khaki Campbell duck.

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1. Introduction

Khaki Campbell (*Anas platyrhynchos domesticus*) duck is becoming more popular as a source of meat and eggs in various parts, including Bangladesh. Rearing the Khaki Campbell duck requires a low investment compared to large animals, and it is very beneficial for small landholders (Hollwarth et al., 2021; Tetel et al., 2022). The feeding mechanism is essential to determine the adaptation and persistence of animals to their environment (Darwish, 2012). In vertebrates, especially birds, the tongue plays a significant role in feeding. Depending on the feeding habits of the birds, the shape and size of the tongue are variable in different species. Many authors stated that the shape and structure of the tongue of the birds differ according to the type of food and method of food intake because they spread out through the different habitats such as the air, the land, and

the water (Jackowiak & Godynicki, 2005; Jackowiak & Ludwing, 2008; Tivane, 2008). Although details information is available on the morphology of the tongue of many domestic and wild birds, such as the white-tailed eagle (Jackowiak & Godynicki, 2005), emu (Crole & Soley, 2008; 2010), ostrich (Jackowiak & Ludwig, 2008), the zebra finch (Dehkordi et al., 2010), African pied crow (Igwebuike & Eze, 2010), European magpie and common raven (Erdogan & Alan, 2012), Chukar partridge (Erdogan et al., 2012), Guinea fowl (Igwebuike & Anagor, 2013), Muscovy duck (Igwebuike & Anagor, 2013), chicken (Bansal et al., 2017), but the information on the gross morphology of the tongue of the Khaki Campbell duck of different age groups is not available. It is an increasingly vital factor to understand the ability to take particular foods and eating habits in rearing this species of birds. Knowledge of the biology of the Khaki Campbell duck is helpful for veterinarians because it will

provide adequate information about the medical and nutritional management of the bird. Furthermore, details information on the anatomy of the tongue of the Khaki Campbell duck is essential to identify structural features and provide a foundation for recognizing the abnormality in this region of the bird. The objective of the present study is to: investigate the anatomy (gross and biometrical) of the tongue of the Khaki Campbell duck (*Anas platyrhynchos domesticus*) at different postnatal ages and compare the tongue of the Khaki Campbell duck at different postnatal ages with other avian species.

2. Materials and methods

The research was conducted in the post-graduate laboratory of the Department of Anatomy and Histology, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. The present study and all experimental procedures were approved and conducted according to the guidelines for the care and use of animals as established by the Animal Welfare and Experimentation Ethics Committee, Bangladesh Agricultural University, Mymensingh, Bangladesh [AWEEC/BAU].

Twenty-five male Khaki Campbell ducks of day one (1), one (1) month, two (2) months, three (3) months, and four (4) months were used for this study. The experimental Khaki Campbell ducks (*Anas platyrhynchos domesticus*) were collected from the poultry farm of BAU, Mymensingh, having good health and devoid of any external deformities. The ducks were reared in a semi-intensive farming system under the close supervision of a veterinarian. The age and health condition of the ducks were determined by farm record books and the farm manager and verified by a veterinarian.

The healthy experimental ducks were killed ethically. After completion of the bleeding, the bird's heads were cut off. The oropharyngeal cavity was opened and washed with normal saline (0.9 %) to remove food and dust particles from the oropharyngeal cavity. Then the samples were immediately collected for gross study. Gross biometrical parameters of the tongue were recorded for each bird separately using Vernier Calliper and scale. Various measurements (length and width) of the tongue were correctly recorded. Unit of length and width measurement was millimeter (mm).

Necessary photography was done during the gross investigation to illustrate the result better. The gross anatomical pictures were taken directly from organs during dissection and measurement. The digital camera was used to take snaps of gross pictures for illustration.

The data obtained from various parameters were analyzed using Statistical Package for the social science (SPSS, version 22) software and revealed the results in tabular form. Results were expressed as mean \pm standard error (SE).

3. Results and discussion

3.1. Results

The tongue of the Khaki Campbell duck of 1 day age (Figure 1) was located in the floor of the oropharyngeal cavity and attached to the lower bill by the frenulum linguae (Figure 1). The tongue occupied the oropharyngeal cavity without extending to the free tip of the bottom of the bill (Figure 1). The shape of the tongue was narrow and elongated (Figure 2A).

The tongue of the Khaki Campbell duck consisted of three parts, i.e., apex, body with the lingual prominence, and root (Figure 2A). The total length of the tongue was 23.98 ± 1.76 mm, of which the apex length was 4.18 ± 0.27 , the length of the body with the lingual prominence was 15 ± 1.58 mm, and the length of the root was 4.8 ± 0.54 mm. The average width of the tongue was 4.68 ± 0.43 mm on the apex, 6.36 ± 0.59 mm on the body, and 3.3 ± 0.43 mm on the root (Table 1).

The tongue apex was spatula-shaped (Figure 2A) which dorsal surface was smooth and devoid of lingual papillae (Figure 2A). On the ventral surface of the apex, a flat, wide triangular, white plate called a lingual nail was found (Figure 2B).

A shallow median groove divided the dorsal surface of the body of the tongue into two symmetrical halves (Figure 2A), the length of which was 15.82 ± 0.64 mm at one day old Khaki Campbell duck (Table 1). Two slight bell-shaped elevations of the mucosa called lingual prominence were observed at the caudal part of the body, symmetrically on the sides of the median groove, which formed the left and suitable lingual combs with spiky edges (Figure 2A). In front of the lingual prominence, the lingual comb turned up and subsequently merged with the rostral edges of the lingual prominence (Figure 2A). Caudal to the lingual prominence, two rows of conical papillae directed obliquely (Figure 2A) were observed. A distinct mucosal elevation was observed, the base of which was located at the second rows of papillae that divided the first and second rows of papillae into two left and right groups (Figure 2A). The length of the lingual prominence was 3.96 ± 0.28 mm, and the width at its base was 2.04 ± 0.05 mm (Table 1). The papillae of different sizes and shapes were located at the lateral margins of the body. Numerous small, long, brush-like conical papillae were found in the rostral half of the lateral margins of the tongue body (Figure 2A and 2B). The conical papillae in the caudal half of the lateral edges of the tongue body were few, broader, and larger with flattened plate-shaped and serrated edges (Figure 2A and 2B). Small threads like filiform papillae were located in between these papillae (Figure 2A).

The ventral aspect of the body of the tongue showed two elongated mucosal eminences started at the tip of the tongue and extended caudally to terminate just rostral to the frenulum linguae (Figure 2B). The length and width of the ventral mucosal eminence on day one old age of duck were 6.34 ± 0.07 mm and 0.9 ± 0.64 mm, respectively (Table 1).

The smallest part of the tongue located below the lingual prominence was its root (Figure 2A), situated adjacent to the laryngeal prominence. Two lateral mucosal swellings were found on the root of the tongue (Figure 2A). These two swellings were separated by a median ridge extending from the base of the tongue to the laryngeal mound (Figure 2A). On the lateral sides of the root, two round papillae with smaller spinal processes resembling filiform papillae were detected (Figure 2A).

The tongue of the birds at one month of age (Figure 3A and 3B) was slightly larger than those of the previous birds. All structures were similar but more distinct than those of the birds of day one, such as the median groove in the dorsal surface of the tongue was well developed, lingual prominence and lingual combs became more apparent, and the papillae were more prominent (Figure 3A and 3B).

The tongue of the birds at two months of age (Figures 4A and 4B) showed more developmental growth in terms of

size and shape. No distinct differences were observed at this age. All features were similar to birds of day 1 and 1 month of age.

At the age of three months, the median groove became more prominent. The papillae became stronger and larger than in the previous ages (Figures 5A and 5B).

The tongue of the birds at four months of age (Figures 6A and 6B) was larger in dimensions than those of the previous

birds. The caudal papillae were more prominent. All structures were similar but more prominent and distinct than the birds of the one day, one month, two months, and three months of ages.

In all examined ages, the mean length, width of the tongue, length of the median groove, length and width of the lingual prominence, and ventral mucosal eminence were increased with age, as shown in Table 1.

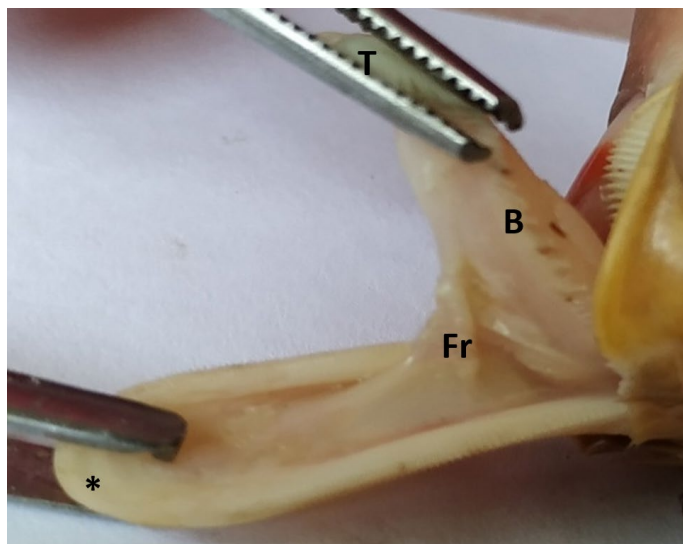


Fig. 1. Photograph of the ventral surface of the tongue and the lower beak of the Khaki Campbell duck on day one showing the free tip of the lower beak (Star), the tip of the tongue (T), a body of the tongue (B), and frenulum linguae (Fr)

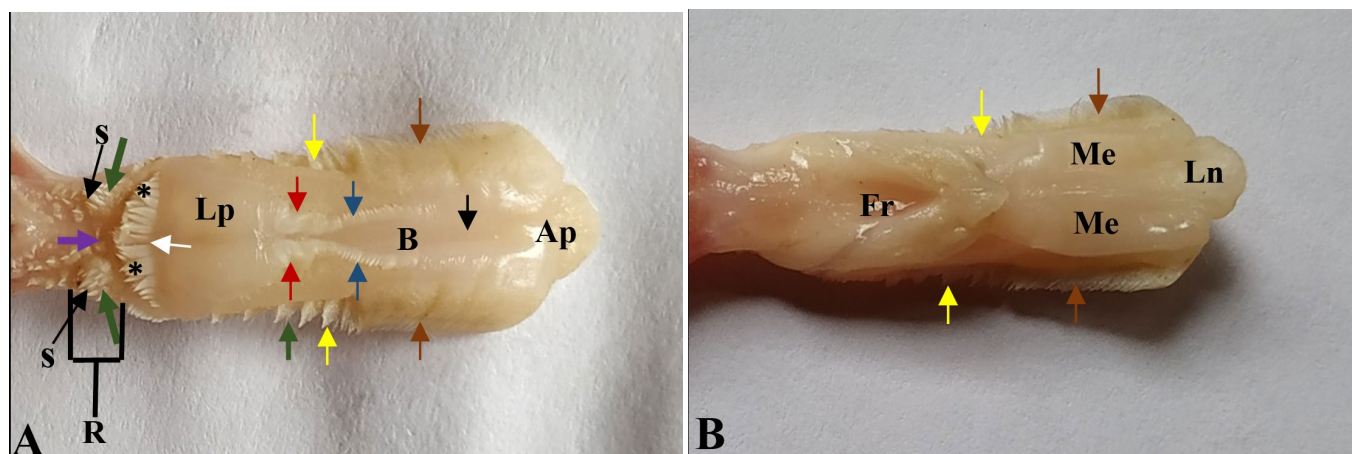


Fig. 2. Photographs of the dorsal (A) and ventral (B) surface of the tongue of the Khaki Campbell duck on day one showing the apex of the tongue (Ap), the body of the tongue (B), median groove (Black arrow), lingual prominence (Lp), lingual comb (Blue arrow), turned up lingual comb (Red arrow), conical papillae on the caudal border of the lingual prominence (Black star), mucosal elevation (White arrow), Small conical papillae (orange arrow), large conical papillae (Yellow arrow), filiform papillae (green arrow), the root of the tongue R, mucosal swellings (S), median ridge (Purple arrow), attachment of the frenulum linguae (Fr), lingual nail (Ln), mucosal eminence (Me)



A



B

Fig. 3. Photograph of the dorsal (A) and ventral (B) surface of the tongue of the Khaki Campbell duck at one month of age



A



B

Fig. 4. Photograph of the dorsal (A) and ventral (B) surface of the tongue of the Khaki Campbell duck at two months of age



A



B

Fig. 5. Photograph of the dorsal (A) and ventral (B) surface of the tongue of the Khaki Campbell duck at three months of age



A



B

Fig. 6. Photograph of the dorsal (A) and ventral (B) surface of the tongue of the Khaki Campbell duck at four months of age

Table 1

The different parameters (mm) of the tongue ((Mean ± SEM)

Parameters	Day 1	1 Month	2 Months	3 Months	4 Months
Total length of tongue	23.98 ± 1.76	46.76 ± 2.59	61.1 ± 1.92	67.76 ± 0.91	77.34 ± 01.28
-Length of apex	4.18 ± 0.27	6.6 ± 1.82	7.44 ± 0.57	8.66 ± 0.72	9.8 ± 0.86
-Length of body	15.0 ± 1.58	30.46 ± 2.40	42.6 ± 1.74	47.5 ± 0.72	54.56 ± 1.32
-Length of root	4.8 ± 0.54	9.7 ± 1.33	11.06 ± 0.55	11.6 ± 0.38	12.58 ± 1.06
Width of the tongue at					
-Apex	4.68 ± 0.43	6.6 ± 0.21	7.9 ± 0.23	11.24 ± 0.20	12.36 ± 0.33
-Body	6.36 ± 0.59	10.38 ± 0.35	11.72 ± 0.40	12.78 ± 0.47	17.36 ± 0.44
-Root	3.3 ± 0.43	6.6 ± 0.23	7.36 ± 0.20	7.98 ± 0.22	11.44 ± 0.64
Length of the median lingual groove	15.82 ± 0.64	39.7 ± 0.51	45.52 ± 0.50	54.9 ± 0.79	64.1 ± 1.23
Ventral mucosal eminence					
-Length	6.34 ± 0.07	18.0 ± 0.18	24.02 ± 0.09	30.36 ± 0.32	35.72 ± 0.41
-Width	0.9 ± 0.64	3.94 ± 0.10	4.42 ± 0.24	6.50 ± 0.33	10.26 ± 0.20
Lingual Prominence					
-Length	3.96 ± 0.28	12.26 ± 0.95	17.46 ± 0.25	22.24 ± 0.56	25.86 ± 0.22
-Width (At its base)	2.04 ± 0.05	4.98 ± 0.04	7.28 ± 0.10	11.04 ± 0.17	13.82 ± 0.14

3.2. Discussions

The tongue of the Khaki Campbell duck occupied the floor of the oropharyngeal cavity except for the free tip of the bottom of the bill, rostrally. It was similar to the findings of Igwebuike and Anagor (2013) in Muscovy duck, Abdalla et al. (2011) in the duck, Mohamed (2004) in quails, Abd El-Fatah et al. (2000) in turkey, Koch (1973) in fish eaters birds, Mohamed (2019) in Caribbean duck and Skieresz-Szewczyk & Jackowiak (2016) in domestic duck. The tongue fills the oral cavity in ducks and geese, as Nickel et al. (1977) reported.

The present study under discussion revealed that the shape of the tongue of the Khaki Campbell duck was narrow and elongated, as reported by Igwebuike and Anagor (2013) in Muscovy duck, Abdalla et al. (2011) in the duck,

Mohamed R. (2019) in Caribbean duck, Skieresz-Szewczyk and Jackowiak (2016) in domestic duck whereas triangular-shaped tongue was reported by Bansal et al., 2017 in chicken, by Calabro et al. (2009) in *Podiceps nigricollis*, *Sula Variegata* and *Ardeola grayii*, elongated triangular-shaped tongue in rock-pigeon was reported by Al-Jumaily et al. (2013), Iwasaki et al. (1997) reported semicircular tongue in male ostrich. The tongue of the Khaki Campbell duck consisted of the root, body with lingual prominence, and apex; similar findings were observed by El Bakary et al. (2016) in *Anas crecca*, by Sridevi et al. (2018) in mute swan, Mohamed (2019) in Caribbean duck, Skieresz-Szewczyk and Jackowiak (2016) in domestic duck. Root, body, apex, raised area, and a line-like extension was found in the tongue in pati duck by Sarma and Anil (2015). The length of the tongue of the Khaki Campbell duck was 23.98 ± 1.76 mm at one day old and increased gradually with the advancement of age to reach about 77.34 ± 01.28 mm at four months old. This result is almost similar to that was reported by Abdalla (1994) in duck and chicken and by Abdalla et al. (2011) in duck.

The spatula-shaped apex of the tongue of the Khaki Campbell duck, which was smooth dorsally with no lingual papillae and having lingual nails on the ventral surface, similar findings were also observed by Igwebuike and Anagor (2013) in Muscovy duck, Abdalla et al. (2011) in the duck, Mohamed (2019) in Caribbean duck, Skieresz-Szewczyk and Jackowiak (2016) in domestic duck. However, a pointed apex was reported by Bansal et al. (2017) in chicken, by Al-Nefeiy (2015) in laughing dove, an elongated tongue with an oval-shaped fissured apex in magpie by Erdogan S. and Alan A. (2012), and an extended tongue with the sharp apex in *Egretta ibis* by Sabry D. A. (2015).

The median sulcus was found on the dorsal surface of the body of the tongue that divided the tongue into two symmetrical halves. This result was in agreement with Igwebuike and Anagor (2013) in Muscovy duck, Abdalla et al. (2011) in the duck, Mohamed R. (2019) in Caribbean duck, Skieresz-Szewczyk and Jackowiak (2016) in domestic duck, Sarma K. and Anil Deka (2015) in pati duck, Bello et al. (2015) in domestic duck, Akbari et al. (2018) in white-headed duck, Mohamed (2004) in quails, Parchami and Dehkordi (2011) in domestic pigeon, in mute swan (2018), Sridevi et al., (2018) in *Anas crecca*, Al-Nefeiy F. A. (2015) in laughing dove. However, a medial sacral crest on the dorsal surface of the body of the tongue was reported by Jackowiak et al. (2006) in the Cormorant *Phalacrocorax Carbo*. The shallow median groove in the tongue of Hawk is mentioned by Mohdy (1993). On the other hand, the lingual

sulcus is absent was observed by Iwasaki and Kobayashi (1986) in chicken, Jackowiak et al. (2004) in pheasants as well as Igwebuike and Eze (2010) in African pied crow, Igwebuike and Anagor (2013) in guinea fowl. The base of the tongue of the Khaki Campbell duck was formed by two bell-shaped mucosal elevations, the lingual prominence, which was also observed by Abdalla et al. (2011) in duck, by Abd-Elmohdy and Ghattas (1995) in fowl and duck, by Mclelland (1979) in birds, by Sarma and Anil (2015) in pati duck. Caudal to the lingual prominence, two rows of conical papillae directed obliquely were observed. This result was in line with that revealed by Abdalla et al. (2011) in duck, Sarma and Anil (2015) in pati duck, Mohdy (1993) and Mohamed (2004) in quail and Hawk, Sridevi et al. (2015) in mute swan, Mohamed R. (2019) in Caribbean duck. On the contrary, this papilla was arranged in one transverse row in Muscovy duck (Igwebuike & Anagor, 2013), in turkey (Abd El-Fatah, 2000), in chicken, duck, and pigeon (Abdalla, 1994), and in goose (Iwasaki et al., 1997), While V-shaped arrangement of papillae was observed in white-tailed eagle (Jackowiak & Godynicki, 2005) and U-shaped arrangement in the domestic pigeon (Parchami & Dehkordi, 2011). On the other hand, no caudal papillae were observed in ostrich (Jackowiak & Ludwig, 2008) and Japanese Pygmy Woodpecker (Emura et al., 2009). A backward pointed conical papillary crest was found between the body and root of the tongue in magpie stated by Erdogan and Alan (2012). The function of these papillae is to transport and swallowing of the food, prevent the regurgitation of food, and prevent the falling of food from an oropharyngeal cavity, similar to that reported by Igwebuike and Anagor (2013) in Muscovy duck, Abdalla et al. (2011) in duck, Sarma and Anik (2015) in pati duck, Skieresz-Szewczyk and Jackowiak (2016) in domestic duck and Parchami and Dehkordi (2011) in domestic pigeon.

The gross study revealed that the length and width of the apex and body and length of the median lingual groove were increased significantly, and the highest length and width were found at four months old. Abdalla (1994) reported an almost similar result in duck and chicken, and Abdalla et al. (2011) in duck.

The ventral aspect of the body of the tongue showed two elongated mucosal eminences; a similar finding was reported by Abdalla et al. (2011) in duck, Sarma, and Anil (2015) in pati duck, Sridevi et al. (2018) in mute swan and

Mohaamad R. (2019) in Caribbean duck. This statement differs from Abd-Elmohdy and Ghattas (1995), who reported that the middle part of the ventral surface of the tongue of the duck has ventral papillae, which are formed of two different mucosal folds. The ventral aspect of the tongue of the chicken and pigeon (Abdalla, 1994) and that of the turkey (Abd El-Fatah et al., 2000) has two ventrolateral surfaces that meet together, forming a ventral border.

On the lateral sides of the root, two round papillae with smaller spinal processes resembling filiform papillae were detected. These observations were also reported by of

Igwebuike and Anagor (2013) in Muscovy duck, Skieresz Szewczyk and Jackowiak (2016) in domestic duck, Akbari et al. (2018) in white-headed duck, and El Bakary et al. (2016) in *Anas crecca*. The length and width of the root of the tongue of the Khaki Campbell duck were increased gradually with the advancement of age, which is nearly similar to that was reported by Abdalla (1994) in duck and chicken and by Abdalla et al. (2011) in duck.

4. Conclusions

The result of the present study explored the gross morphological structure of the tongue of the Khaki Campbell duck at different postnatal ages. All the tongue structures showed gradual growth with the advancement of the age of birds. Despite being a fundamental study, it will provide valuable information for the anatomist, poultry or duck researchers, poultry farmers, veterinarians, and autonomous learners in this realm.

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Conflict of interest.

The authors state that there is no conflict of interest.

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