

Morphological Studies on the Upper Beak of Turkey (*Meleagris gallopavo*)

Ramy K.A. Sayed^{1*}, Kamal E.H. Abdalla², Ahmed K. Ahmed², Abdel Elmohaimen M. Saleh²

¹Department of Anatomy and Embryology, Faculty of Veterinary Medicine, Sohag University 82524, Egypt.

²Department of Anatomy and Histology, Faculty of Veterinary Medicine, Assiut University 71526, Egypt.

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Abstract

This study was carried out to provide a detailed description about the upper beak of turkey, regarding its gross anatomical, light and scanning electron microscopic morphology. The upper beak extends in a hook like in front of the lower beak. It measures 53.80 mm long. The height and width of the upper beak increase caudalwards. SEM shows that the tip and the lateral sides of the upper beak are covered with numerous flakes of keratin. At the free tip of the beak, these keratinized flakes have an irregular appearance which may be due to desquamation of the epithelium during manipulation of foods. Immediately in front of the angle of the mouth, the lateral edge of the upper beak is characterized by the presence of transverse furrows which giving it a serrated appearance. The upper beak of the turkey consists of a bony support covered by dermal and epidermal layers.

Keywords: Morphology; Upper beak; Turkey; SEM

Introduction

A turkey is a large bird in the genus *Meleagris*. One species, *Meleagris gallopavo*, commonly known as the Wild Turkey, is native to the forests of North America. The domestic turkey is a descendant of this species (Farner and King, 1971).

A distinctive characteristic of birds is the absence of lips, teeth, soft palate and jaw muscles (King and McLelland, 1984; Whittow, 2000; Durson, 2002). Instead, the bird has a hard beak that can be used for grasping, tearing and scooping food. With the moistening and mastication of the food primarily taking place further along the digestive system, the absence of teeth may be advantageous. As feed enters the gizzard, rhythmic movement of the muscles grinds and crushes the particles and mix them with the digestive juices, thus replacing the mastication function of teeth (Moreng and Avens, 1985).

The mouth is bounded by the horny beaks which grow constantly and must be worn by normal use in order to maintain their shape for opti-

mal. The mouth is divided into an oral cavity, bounded by the horny beak, and a pharynx, into which the nasal passages open. The angles of the mouth when formed by soft keratin are known as rictus, and in some birds they exhibit a prominent fold which aids in prehension (Evans, 1996).

In the turkey, studies on the morphological features of the upper beak is scanty, so this study aimed to provide a detailed description about the upper beak of the turkey (Bronze black species), regarding its gross anatomical, light and scanning electron microscopic morphology, in addition to comparing our findings with other literatures.

Materials and methods

This study was applied on a total number of twenty five healthy adult turkeys of both sexes of bronze black species, collected from a local farm in Assiut Governorate. The heads of birds were cut off at the level of the second cervical vertebra after complete bleeding.

For the gross anatomical examination, ten birds were used. The heads were rinsed in running tap water to remove traces of blood. To open the mouth cavity wider, the beak's angles were incised and

*Corresponding author: Ramy K.A. Sayed

E-mail address: ramy.kamal@vet.sohag.edu.eg

fixed in 10% formalin. The different measurements in millimeters (mean \pm S.E.) of the studied parts were taken using Precision Digital Vernier Caliper.

For the study of the bony support, the head of three birds was fixed in 10% formalin, dehydrated with ethyl alcohol, diaphenized with potassium hydroxide (KOH 2%). Bone is stained with Alizarine red stain and conversed of the material in glycerin (Davis and Gore, 1936).

For the scanning electron microscopical examination, the upper beak of four birds was washed for several times in normal saline and acetic acid 2%, then fixed in 4% glutaraldehyde solution for 24 hours then post fixed in 2% buffered osmium tetroxide. The fixed samples were washed in 0.1 M cacodylate buffer at PH 7.3 then dehydrated in ascending grades of ethanol, critical point dried in liquid carbon dioxide, and mounted on metal stubs then coated with gold palladium in sputtering device. Specimens were examined and photographed by using JSM_4500 LV scanning electron microscope operated at 20 KV.

For histological investigation, cross and longitudinal sections from the studied parts of the upper beak were cut from eight birds just after sacrificing, washed then fixed in 10% neutral buffer formalin. After proper fixation the bony samples were kept in formic acid and 10% formol saline for the process of decalcification (Geoffrey, 1969). After decalcification the specimens were washed for 24 hours under running tape water, and then dehydrated in ascending graded concentrations of ethanol. The samples were cleared in methyl benzoate and embedded in paraffin wax. Sections of 5 μ m thickness were cut, mounted on glass slides, and stained with Haematoxylin and Eosin (H&E) stain for general histological examination (Harris, 1900), Crossmon's trichrome stain for differentiation of connective tissue and muscle fibers (Crossmon, 1937) and Periodic Acid Schiff (PAS) for demonstration of neutral mucopolysaccharides (Gurr, 1962). The sections were examined with a light microscope. All stain techniques were adopted after (Bancroft and Gamble, 2002). The terminology used is that of Nomina Anatomica Avium (Baumel *et al.*, 1979) whenever possible.

Results

The mouth of the turkey is bounded by horny beaks in which that of the upper beak (Rostrum maxil-

lare) extend in a hook like in front of the lower beak. The turkey has a pointed triangular shaped upper beak with a mean length of 53.80 mm. It consists of a bony support covered by a horny keratin sheath (Figs. 1-3).



Fig.1. Photograph of the lateral aspect of the turkey head showing upper beak (arrow), lower beak (arrow head), nostril (N) and eye (E).

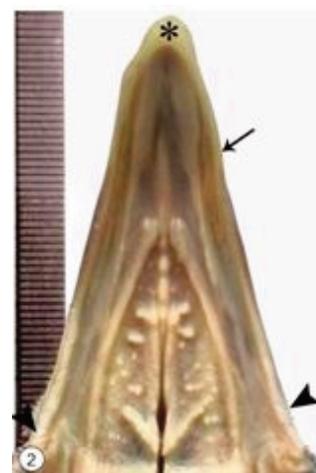


Fig. 2. Photograph of the ventral aspect of the upper beak of the turkey showing its tip (star), lateral edge (arrow), serrated area (arrow heads) of the lateral edge in front angle of the mouth.

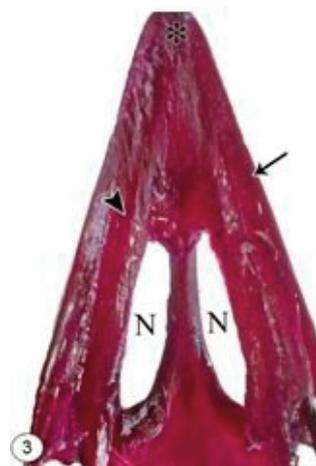


Fig. 3. Photograph of the bony support (premaxilla) of the upper beak stained by Alizarine red stain showing lateral edge (arrow), lateral palatine ridge (arrow head), nostril (N) and tip of the upper beak (star).

The height of the upper beak increases caudal-wards as it measures 5.57, 14.38 and 22.84 mm at the level of its rostral tip, nostril and the angle of the mouth respectively. The width of the upper beak increases also caudal wards. It measures 7.91, 20.34 and 32.46 mm at the level of its rostral tip, nostril and the angle of the mouth respectively (Table 1).

Table 1. The dimensions (mm) of the upper beak.

Upper beak	Dimensions (mm)
Length of upper beak	53.80±0.81
Height of upper beak at level of:	
- Rostral tip	5.57±0.15
- Nostril	14.38±0.46
- Angle of mouth	22.84±0.24
Width of upper beak at level of:	
- Rostral tip	7.91±0.25
- Nostril	20.34±0.32
- Angle of mouth	32.46±0.56

The upper beak consists of three surfaces; two dorsolateral and ventral as well as two lateral edges (Tomia) which are sharp. The ventral surface of the upper beak is concave along its length, forming the roof of the oral cavity which is occupied by the palate. Near the base of the upper beak and on both sides of its dorsolateral surfaces present the nostrils which are oval in shape. The morphometrical data indicate that the nostril lies 27.19 mm caudal to the tip of the upper beak and 25.52 mm rostral to the eye. Therefore, it is located nearly in the midway between the rostral tip of the upper beak and the eye. The nostril is situated above the lateral edge of the upper beak by 5.85 and 9.58 mm at the level of the medial and lateral angles of the nostril respectively. Therefore, the nostril is obliquely rostroventrally directed where its lateral angle is higher than the medial one. The nostril measures 10.08 mm long, while its width is 4.23 mm. It is cleared that the length of the nostril is 2.5 folds of its width (Table 2).

Corresponding to the scanning electron microscopy, the tip of the beak is separated from the palate by a clear line of separation. At higher magnification, this line is occupied by fine longitudinal mucosal folds. The tip and the lateral sides of the upper beak are covered with numerous flakes of keratin which have a scaly appearance. At the free tip of the beak, these keratinized flakes have an irregular appearance which may be due to desqua

Table 2. The dimensions (mm) of the nostril.

Nostril	Dimensions (mm)
Length of nostril	10.08±0.33
Width of nostril	4.23±0.30
Distance between:	
- Tip of upper beak and eye	62.79±1.22
- Tip of upper beak and nostril	27.19±0.70
- Nostril and eye	25.52±0.62
Distance between nostril and edge of upper beak at level of:	
- Lateral angle of nostril.	9.58±0.27
- Medial angle of nostril.	5.85±0.14

mation of the epithelium during manipulation of foods. Immediately in front of the angle of the mouth, the ventral aspect of the upper beak is characterized by the presence of transverse furrows which giving it a serrated appearance (Figs. 4-7).

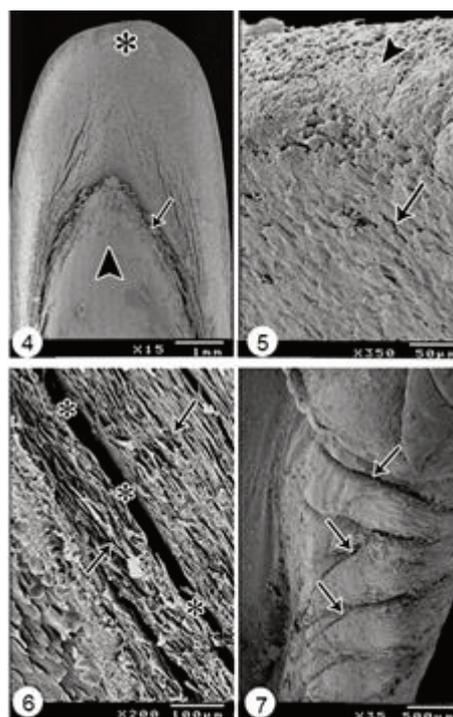


Fig. 4. Scanning electron micrograph of the tip of the upper beak (star) showing beginning of the palate (arrow head) and a line of separation between them (arrow).
 Fig. 5. Scanning electron micrograph of the tip of the upper beak showing numerous flakes of scaly appearance (arrow). These flakes appear irregular at the free tip (arrow head).
 Fig. 6. Scanning electron micrograph of the line of separation (stars) between the upper beak and the palate. It is occupied with fine longitudinal mucosal folds (arrows).
 Fig. 7. Scanning electron micrograph of the edge of the upper beak just in front of angle of the mouth showing transverse furrows (arrows).

By light microscope, the upper beak of the turkey consists of a bony support covered by dermal and epidermal layers. The supporting bony basis of the upper beak forms of premaxillary bone of compact type. It is situated in the center of the beak and consists of a thick outer bony shell filled with numerous bony trabeculae. The spaces between the trabeculae are occupied by adipose tissue. These trabeculae are separated by bone marrow spaces which contains bone marrow. The bone marrow contains mature and immature cellular elements of the blood. The epidermis is a thick, highly keratinized stratified squamous epithelium made of several layers of cells. The stratum basale consists of a single layer of columnar cells showing inter-

digitations with the dermal layer. The stratum spinosum is made of 3-5 layers of cells. The stratum germinativum consists of multiple layers of the epithelial cells. The outer layer of the epidermis is the keratinous stratum corneum with very flat and dead cells without a nucleus. The dermis is made of a single layer of dense irregular connective tissue in which distinct dense bundles of collagen fibers, blood vessels, nerve bundles and sensory corpuscles can be demonstrated. The large corpuscles are rounded structures formed of central axon surrounded by nuclei of Schwann cells and a concentric network of collagen fibers. These corpuscles could not be demonstrated in front the tip of the bone (Figs. 8-12).

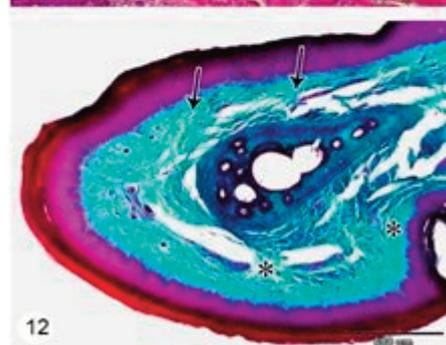
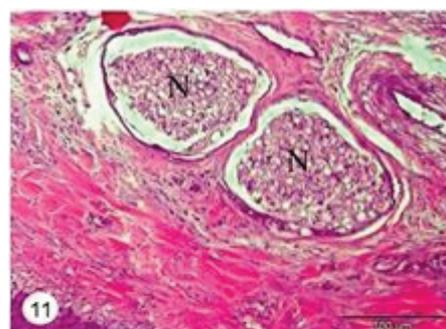
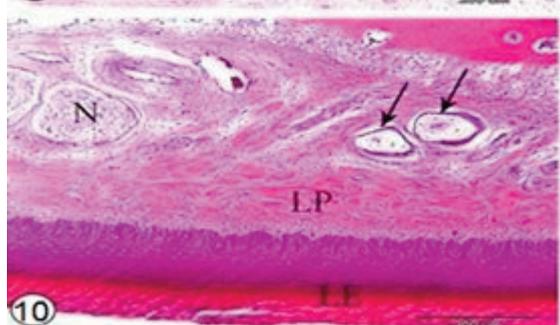
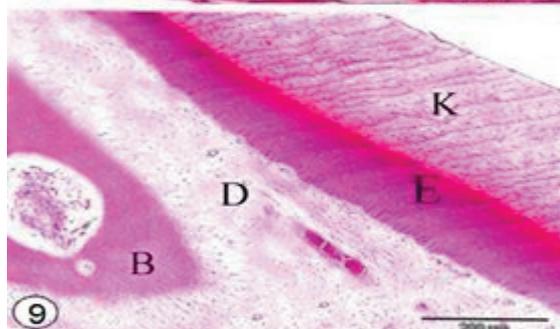
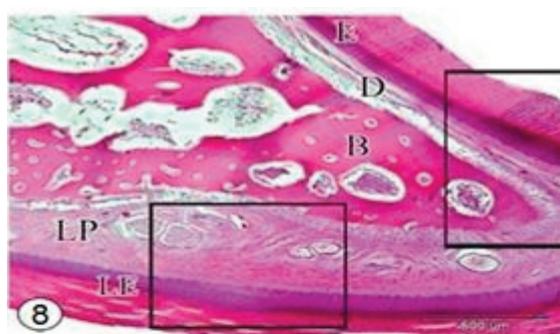


Fig. 8. Photomicrograph of cross section of the upper beak and oral roof showing epidermis (E), dermis (D) of the upper beak, premaxillary bone (B), lamina epithelialis (LE) and lamina propria (LP) of the oral roof, H&E stain.

Fig. 9. Photomicrograph of cross section of the upper beak showing keratinized layer (K), epidermis (E), dermis (D) and premaxillary bone (B), H&E stain.

Fig. 10. Photomicrograph of cross section of the oral roof showing lamina epithelialis (LE), lamina propria (LP), sensory corpuscles (arrows) and nerve bundles (N), H&E stain.

Fig. 11. Photomicrograph of higher magnification of the previous figure showing the nerve bundles (N), H&E stain.

Fig. 12. Photomicrograph of cross section of the upper beak and oral roof showing dermis of the skin (arrows) and lamina propria of the oral roof (stars), Crossmon's trichrome stain.

Discussion

In the present work, the mouth of the turkey is bounded by a horny beaks in which that of the upper beak extends in a hook like in front of the lower beak. Similar results were demonstrated in the sea gulls (Ince *et al.*, 2010). Nickel *et al.* (1977) in fowl and pigeon and Tadjalli *et al.* (2008) in ostrich stated that the hard horny sheath of upper beak extends in a hook beyond that of the lower beak. However, Whittow (2000) mentioned that the birds from charadriiformes order have totally soft beaks. In our study, the tip of the beak in the turkey is covered with numerous flakes of keratin as shown by scanning electron microscope, while in the goose this keratin completely covers the tip, but in the duck it is limited to a small median part of the tip (McLelland, 1975).

In the present investigation, it is noticed that the turkey has a pointed triangular shaped upper beak. In the fowl and pigeon, the beak is pointed, while in the duck and goose it is spoon shaped (Nickel *et al.*, 1977). In ostrich, the beak is flat and spoon shaped (Tadjalli *et al.*, 2008).

The length of the upper beak in the examined turkey is 53.80 mm. The mean length of the upper beak is 65.52 mm in the duck at 60 days old (Madkour, 2011), 61.03 mm in the sea gulls (Ince *et al.*, 2010), 6.3 cm in the ostrich (Tadjalli *et al.*, 2008) and 4.90 cm in the partridge (Rossi *et al.*, 2005). The size and shape of the beak are related not only to the type of food the birds eat, but also to their means of food prehension. Avian beaks are remarkable for their diversity in shape and size and provide elegant illustrations of the process and power of natural selection (Amadon, 1947; Newton, 1967; Grant, 1986; Grant and Grant, 2006; Badyaev *et al.*, 2008; Badyaev, 2010). The size of beak seems to be an important factor in the regulation of ingestion (Nickel *et al.*, 1977; Tadjalli *et al.*, 2008). The beak may also serve a function in thermoregulation as demonstrated in Toco Toucans, which exhibit vascular mechanisms for controlled heat exchange (Tattersall *et al.*, 2009).

This study confirmed the basic observation by previous authors (Koch, 1973; Madkour, 2011) that the nasal openings are located near the beak base. The oval nostrils are located on the dorsolateral aspect of the caudal one-third of the bill in the domestic duck (Dyce *et al.*, 2002). In the duck and goose, the nostril is more caudal and is a large elongated oval rather than a narrow slit (Daniel, 1967).

Perrins (1982) recorded that in Kiwi; the nostrils are placed near to the bill tip and probably enable the bird to smell food underground when it is probing for food. As in duck (Madkour, 2011) the nostril of the turkey is located nearly in the midway between the tip of the upper beak and the eye.

Morphometrically, the nostril in turkey measures 10.08 mm long and 4.23 mm wide. However, the length of the nostril in the duck at 60 days old is 9.13 mm, while its width is 3.96 mm (Madkour, 2011). In this concern, King (1975) reported that the opening of the nostril is about 5-7 mm long in the duck and is about 7-9 mm in the fowl.

Scanning electron microscopy shows that the tip of the beak in the turkey is separated from the palate by a clear line of separation. This line at higher magnification is occupied by fine longitudinal mucosal folds. The tip of the upper beak is covered by numerous keratinized flakes which have irregular appearance at its free end which may be due to desquamation of the epithelial cells during manipulation of foods. The free tip of the upper beak in duck contains two transversely curved rows of small ventrally directed dome shaped dermal papillae. In addition, 18-20 transversely curved rows of small papillae are demonstrated behind the dermal papillae at 60 days old (Madkour, 2011).

The lateral edge of the upper beak in turkey in front of the angle of the mouth as shown by scanning electron microscope is characterized by presence of transverse furrows which giving it a serrated appearance. However, in the duck, the lateral edge of the upper beak contains a medial row of lamellae. The shape of these lamellae depends upon the age of the bird (Madkour, 2011).

Structurally, the present study shows that the upper beak of the turkey consists of bony support (premaxillary bone) covered by dermal and epidermal layers. This bone is formed of outer bony shell filled with bony trabeculae which are separated by bone marrow spaces containing bone marrow. Nearly similar findings were recorded in the Black-capped chickadee by Van Hemert *et al.* (2012).

Rounded sensory corpuscles with central axon are demonstrated in the dermis of the examined turkeys. While, Genbrugge *et al.* (2012) and Van Hemert *et al.* (2012) informed the Herbst sensory corpuscles occur throughout the dermis and are often present immediately close to the bone. The number and site of these corpuscles in the avian bill

is related to the way the bill is used as a tactile exploring organ during feeding (King and McLelland, 1984).

The outer layer of the epidermis in the turkey is a keratinous stratum corneum. This cornified layer is very hard in the fowl, and extends over the tip of the beak to form its hard cutting edge (Hodges, 1974).

Conclusion

The upper beak of the turkey consists of a bony support covered by dermal and epidermal layers. Its tip and the lateral sides are covered by numerous flakes of keratin. Its height and width increase caudalwards. It concluded that this study will be a reference data for future avian investigations.

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