Journal of Advanced Veterinary Research Volume 6, Issue 3 (2016) 81-88

Journal of Advanced Veterinary Research

http://advetresearch.com/index.php/avr/index

Palate of Turkey (*Meleagris gallopavo*): Gross Anatomical, Light and Scanning Electron Microscopical Study

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ARTICLE INFO

Original Research

Received:
15 April 2016

Accepted:
27 June 2016

Keywords:

Meleagris gallopavo
Oropharynx
Palate; SEM; Turkey

ABSTRACT

This investigation aimed to determine the morphological characteristics of the palate of bronze black turkey by gross anatomy, light and scanning electron microscopy. The oral roof (palate) constitutes 87.73% of the oropharyngeal roof length, comprising two parts; rostral and caudal. The rostral part is characterized by the presence of median palatine ridge, rostral and caudal lateral palatine ridges, narrow part of the choanal slit and three rows of palatine papillae. The median palatine ridge shows rostral continued and caudal interrupted parts. This ridge as shown by scanning electron microscopy (SEM) bears 4-5 transverse furrows at the level of the beginning of the caudal lateral palatine ridges. Numerous Periodic Acid-Schiff (PAS)-positive compound tubular mucous maxillary and palatine salivary glands are distributed in the mucosa of the palate. From all above mentioned, it's clear that the palate in turkey reveals some different anatomical features in compared with that of the other birds.

J. Adv. Vet. Res. (2016), 6 (3),81-88

Introduction

Turkey is a large bird in the genus Meleagris. *Meleagris gallopavo*, species commonly known as the wild turkey, is native to the forests of North America. It is scientifically classified under Animalia kingdom, Chordata phylum, Aves class, Califormis order, Meleagridinae family, Meleagris genus and *M. gallopavo* species (Linnaeus, 1758).

Domestic turkeys were taken to Europe by the Spanish, and in Europe, it many distinct breeds were developed (e.g. Spanish Black, Royal Palm). Breeding of turkeys was gained many advances in the early 20th century (Emett, 2003; Fuller, 2004). Nowadays, turkeys become indispensable traditional food as it is the main course of Christmas feasts in much of the world since appearing in England in the 16th century as well as for Thanksgiving in the United States and Canada (Davis, 2001).

In birds the relation between the pharynx and the oral and nasal cavities is different from that in mammals. The soft palate is absent and therefore the pharynx is not divided into nasal and oral parts (McLelland, 1975). The precise point in the oropharynx at which the oral cavity and pharynx join each other is difficult to define precisely since it is impossible to determine the exact position of the oral plate in the late stage of development, and there is a difference in the caudal extend of the ectodermal component in the roof and floor of the oral cavity (Hamilton, 1952). However, Zweers *et al.* (1977) placed the boundary between both cavities in the duck at the level of the caudal lingual papillae.

This study was previously supported by McLelland (1979) who described in detail the structure of the oropharynx of many domestic species such as fowl, duck and goose. Although the anatomy of this region in the turkeys was reported to be similar to that of the chicken (McLelland, 1975), Sayed *et al.* (2014) revealed a different morphological characteristics in the turkey's horny upper beak. Consequently, this study was performed in order to provide a detailed description about the gross anatomical, light and scanning electron microscopical structure of the palate of Bronze black turkey.

Materials and methods

Animals

Twenty healthy adult 12 months-old turkeys of both sexes of bronze black species were used in this study. The animals

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ISSN: 2090-6277/2090-6269/

were collected from a local farm in Assiut Governorate, Egypt. The birds were sacrificed, and after complete bleeding, the heads of were cut off at the level of the second cervical vertebra.

Gross anatomical examination

To examine the gross anatomical features of the plate, the heads were rinsed in running tap water and following removal of al blood traces, the beak's angles were incised to open the mouth cavity wider, and the roof of oral cavity was dissected. All the structures present in the palate were studied from eight birds. Different measurements in millimeters (mean ± S.E.) were applied on the palatine ridges and rows of the palatine papillae by using Percision Digital Vernier Caliper.

Tissue preparation for histological procedures

Just after sacrificing, cross and longitudinal palate sections from the studied parts were cut from eight birds, fixed in 10% neutral buffer formalin, followed by process of decalcification by keeping the bony samples in formic acid and 10% formol saline (Geoffrey, 1969). Specimens then were washed under running tape water, and passed through ascending graded concentrations of ethanol for dehydration. The samples were cleared in methyl benzoate, following by embedding in paraffin wax. 5 um thickness paraffin sections were cut, mounted on glass slides, and stained with Haematoxylin and Eosin (H&E) stain to demonstrate the general histological structure (Harris, 1900), Crossmon's trichrome stain to differentiate the connective tissue and muscle fibers (Crossmon, 1937) and Periodic Acid Schiff (PAS) to illustrate the neutral mucopolysaccharides (Gurr, 1962). The sections were examined with light microscope and digital images were acquired. 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.

Scanning electron microscopical examination

The palate of four birds was washed for several times in normal saline and acetic acid 2% then fixed in 4% glutaraldehyde solution for 24 hours, followed by post fixation in 2% buffered osmium tetraoxide. 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.

Results

Gross anatomy

Figure 1 shows the gross anatomical examination of the palate. The roof of the oral cavity (*Cavitas oralis*) in the turkey is occupied by the palate. The oral cavity continues caudally with the pharyngeal cavity (*Cavitas pharyngealis*), without demarcated line of separation, forming oropharyngeal cavity. The length of palate is 72.12 ± 1.63 mm and constitutes about 87.73% of the oropharyngeal roof length. The palate (Palatum) can be divided into two parts; rostral and caudal. The line of demarcation of the two parts lies at the junction of the rostral narrow and caudal wide parts of the choanal slit. The rostral part of the palate is characterized by the presence of median palatine ridge (*Ruga palatine mediana*), the rostral and caudal lateral palatine ridges, about three rows of palatine papillae and the rostral narrow part of the choanal slit.

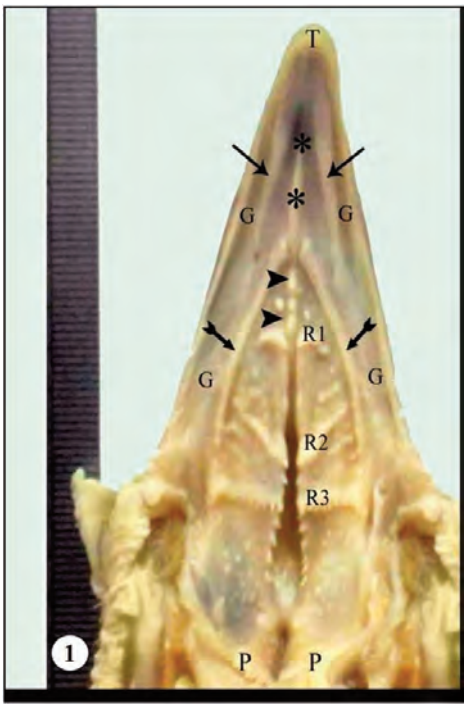

Fig. 1. Photograph of the oropharyngeal roof extending from tip of the upper beak (T) to the pharyngeoesophageal junction (P) showing median palatine ridge with its continued (stars) and interrupted (arrow heads) parts, rostral (arrows) and caudal (barbed arrows) lateral palatine ridges, lateral palatine groove (G) and rows of palatine papillae (R1, R2, R3).

The median palatine ridge lies rostral to the choanal slit. It begins 10.64 mm behind the tip of the upper beak. The ridge measures 30.72 ± 0.75 mm long, it consists of two parts; the rostral continued and the caudal interrupted parts. The rostral part of the median palatine ridge measures 18.10 ± 0.53 mm long and terminates caudally at the level of the rostral end of the caudal lateral palatine ridges. This level is opposite to the medial angle of the nostril. The rostral continued part of the median palatine ridge is continuous caudally by an interrupted part which measures 12.62 ± 0.42 mm long and bears 2-3 projections in the shape of caudally directed papillae. It terminates caudally at the rostral end of the narrow part of the choanal slit.

The two rostral lateral palatine ridges begin directly in front of the median palatine ridge. They run at first caudally in close relation to the median ridge then they diverge to extend caudolaterally parallel to the free edge of the upper beak to terminate by the junction into the corresponding caudal lateral palatine ridge 7.10 ± 0.20 mm behind the beginning of the latter ridge. The rostral lateral palatine ridges measures 30.32 ± 0.31 mm long. It is thicker rostrally and becomes thinner caudalwards.

The two caudal lateral palatine ridges begin from both sides of the caudal end of the continued part of the median palatine ridge opposite to the level of the medial angle of the nostril. They have a curved appearance with the convexity directed laterally. Each caudal lateral ridge begins from the corresponding side of the median ridge and extends caudolaterally to terminate at the lateral end of the last caudal transverse row of the palatine papillae at the level of the angle of the mouth, opposite to the level of the junction between the narrow and wide parts of the choanal slit. The caudal lateral palatine ridge measures 30.73 ± 0.92 mm long. It is thick

rostrally and becomes thinner caudalwards. The areas of the palate bounded by the median palatine ridge medially, the caudal lateral palatine ridge caudally and the rostral lateral palatine ridge laterally appears grossly smooth.

Between the edge of the upper beak laterally and the rostral as well as the caudal lateral palatine ridges medially being the longitudinal lateral palatine groove (*Sulcus palatinus lateralis*). This groove is narrow rostrally as it measures 5.23 ± 0.13 mm wide where it is situated between the edge of the beak and the rostral lateral palatine ridge and becomes deeper and wider caudally as it measures 5.71 ± 0.17 mm wide where it is located between the edge of the upper beak and the caudal lateral palatine ridge.

The palate of the turkey is characterized by the presence of a triangular area lying between the caudal lateral palatine ridges laterally and the most caudal transverse row of the palatine papillae caudally. The apex of this area is directed rostrally and demarcated by the rostral ends of the caudal lateral palatine ridges. This area contains the narrow part of the choanal slit and is characterized by the presence of three rows of the generally caudally directed palatine papillae. In addition, smaller freely distributed papillae are demonstrated between these rows. The position, direction and length of these rows as well as the number of papillae they contain are different.
The caudal part of the roof of the oral cavity inturn is the caudal part of the palate lies caudal to the last or third row of palatine papillae. It is occupied in its middle by the wide part of the choanal slit. This part of the oral cavity is bounded rostrally by the before mentioned row of palatine papillae, laterally by longitudinal row of the openings of the lateral palatine salivary glands (*Glandulae Palatinae*) and caudally it continues with the roof of the pharyngeal cavity without clear line of separation.

Electron microscopy

According to the scannng electron microscopical observations, the rostral third of the continued part of the median palatine ridge has in generally a spindle shaped appearance. However, in three cases this spindle shape structure couldn't be observed and is replaced by a thin ridge. The rest of the continued part of the median palatine ridge runs caudally to continue as interrupted part. This part continues caudally within the choanal slit at its proximal end as a median fold. At the level of the beginning of the caudal lateral palatine ridges the median ridge becomes thinner. At higher magnification this region of the median ridge is characterized by the presence of 4-5 transverse furrows which are arranged at nearly regular intervals. The beginnings of the caudal lateral palatine ridges are closely related to the sides of the median palatine ridge. It's cleared that the two structures aren't joined with each other, but there is a line of demarcation separates them. The scanning electron microscopical observations show the presence of two openings of maxillary salivary glands, each opening lies in the area bounded by the beginning of the interrupted part of the median ridge and the beginning of the caudal lateral palatine ridge (Fig. 2).

The rostral or the first row of palatine papillae extends laterally and slightly rostrally from the edge of the choanal slit for about 3.73 ± 0.18 mm to terminate at a point approximately half way between the choanal slit and the caudal lateral palatine ridge. The papillae of this row are so small that can't be identified grossly and closely related to each other forming one mass or sometimes two masses one large and other small. Corresponding to the scanning electron microscopy, the large mass of the rostral row contains 5-8 elongated caudolaterally directed papillae; all of these papillae are surrounded by connective tissue. The other small mass which is located caudolateral to the large one contains 5-7 different sized nearly rounded shaped caudomedially directed papillae with blunt apices. They are surrounded also by connective tissue (Fig. 3A-3C).

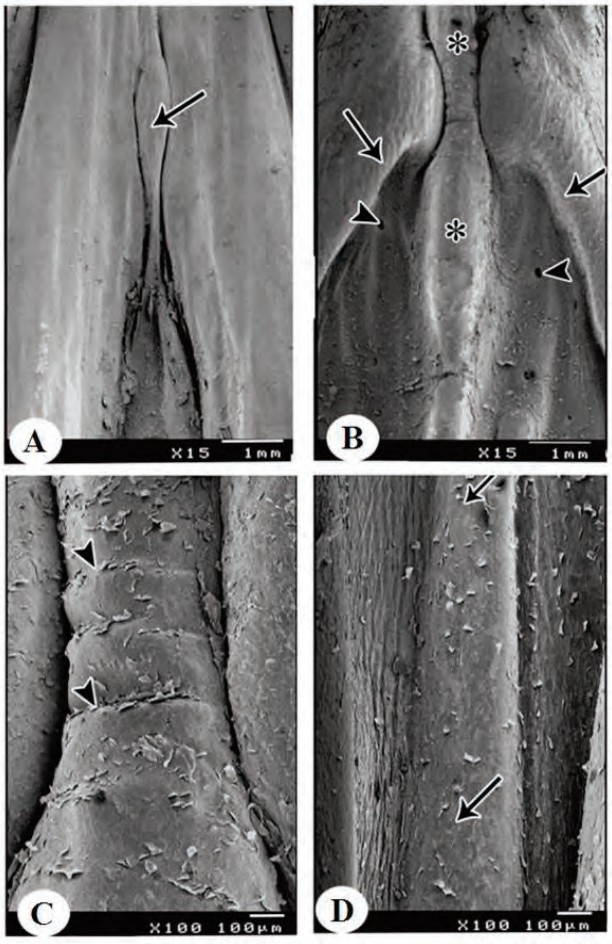

Fig. 2. Scanning electron micrograph of the palate. A) Rostral part of the palate showing the median palatine ridge (arrow) with its spindle shape appearance. B) Median palatine ridge (stars), beginning of the caudal lateral palatine ridges (arrows), and the openings of the maxillary salivary glands (arrow heads). C) Higher magnification of the median palatine ridge at level of the beginning of the two lateral ridges showing presence of 4-5 transverse furrows (arrow heads). D) The beginning of the choanal slit showing the median fold (arrows) which represents the caudal continuation of the medial palatine ridge.

The middle or the second row of palatine papillae lies 14.27 ± 0.82 mm caudal to the rostral row. It extends from the edges of the choanal slit rostrolaterally for about 7.99 ± 0.22 mm to end shortly before the caudal lateral palatine ridge. Therefore, this row is obliquely directed. It contains 8-15 papillae. The medially situated papillae are noticed to be larger than the lateral ones. By scanning electron microscope, the middle row contains caudally and slightly laterally directed papillae. The medially situated ones have generally blunt apices while the laterally located ones have generally pointed apices. The caudal or the third row of the palatine papillae begins from the edges of the choanal slit at the junction of its narrow and wide parts. It extends laterally in a transverse direction for about 9.20 ± 0.19 mm to terminate by the junction with the caudal end of the caudal lateral palatine ridge opposite to the angle of the mouth. This row contains 15-20 papillae. These papillae decrease in size lateralwards. Hence, the medially situated papillae are larger than the laterally located

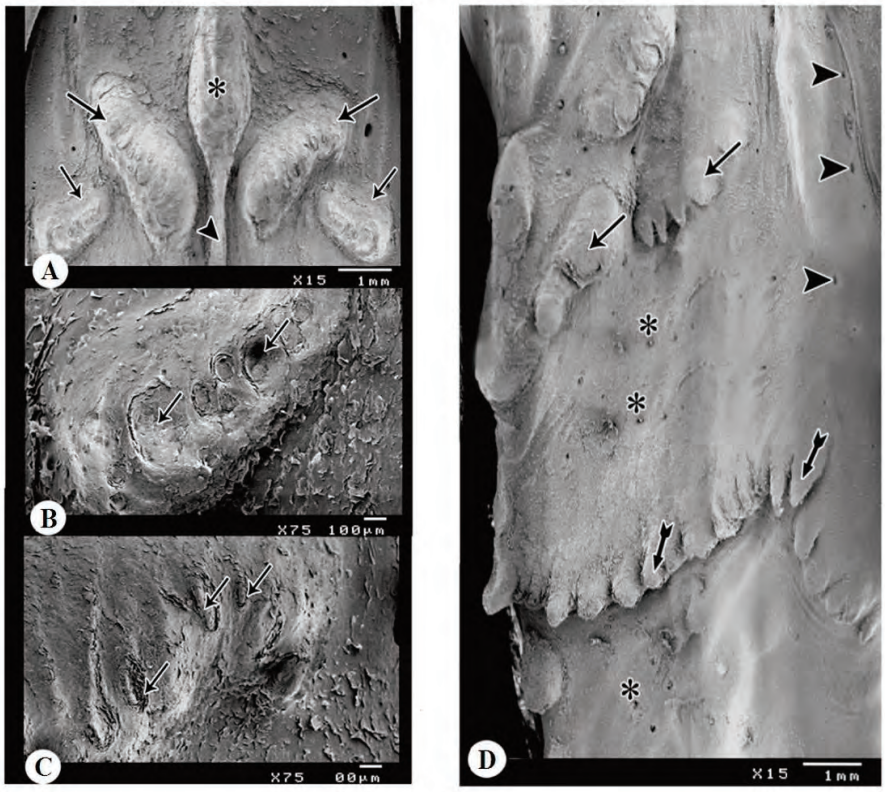

Fig. 3. Scanning electron micrograph of the palatine papillae. A) Termination of the median ridge (star) and its caudal continuation as a median fold (arrow head) within the choanal slit at the level of the first row of palatine papillae (arrows). B) Higher magnification of the previous figure showing the small mass of the first row of papillae with different sized papillae (arrows). C) Higher magnification of the large mass on figure (3A) showing presence of small papillae (arrows). D) The palate showing the middle row (arrows), caudal row (barbed arrows) of caudally directed palatine papillae and openings of the medial (stars) and lateral (arrow heads) palatine salivary glands.

ones. The caudal row of papillae has a curved appearance with its convexity directed rostrally as shown by scanning electron microscope. The papillae of this row are directed caudally. They have the shape of finger like projections except the most laterally situated papillae are conical in shape (Fig. 3D). An additional row of palatine papillae could be demonstrated in all examined female birds and in 50% of the male cases. This row is mostly present in one side of the choana in the contrary to the before mentioned three rows which are present in both sides of the choanal slit. This row lies between the rostral and the middle rows. It is mainly obliquely rostrolaterally directed and situated close to the caudal lateral palatine ridge and away from the edge of the choanal slit. It measures 3.88 mm long and contains 6-9 small papillae.

Moreover, numerous caudally directed papillae are irregularly scattered in this triangular area of the palate. Their distribution and size vary in the different parts of this area. They are relatively larger and concentrated laterally in the region between the first and second rows of the palatine papillae. In addition, some small papillae are scattered in front to the rostral row. Fine papillae are noticed in the region between the middle and the caudal rows of the palatine papillae (Fig. 4).

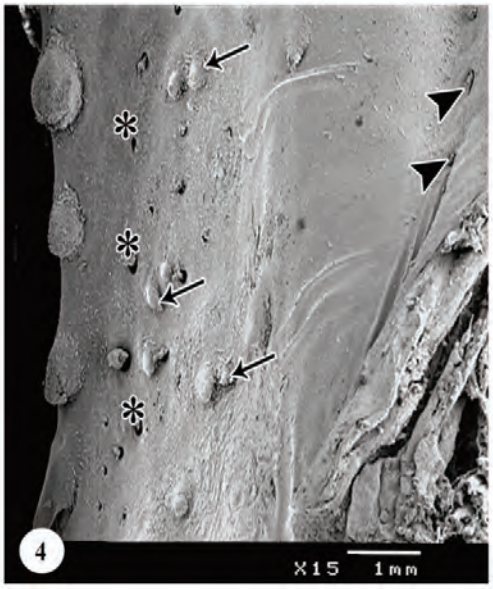

Fig. 4. Scanning electron micrograph of the palate at the level of the wide part of the choanal slit clarifies the presence of scattered small papillae lateral to the choanal slit (arrows) and openings of the medial (stars) and lateral (arrow heads) palatine salivary glands.

Histological structure

The mucosa of the palate in the turkey is formed of lamina epithelialis and lamina propria. The lamina epithelialis consists of highly cornified stratified squamous epithelium contains intraepithelial sensory corpuscles, while the lamina propria consists of dense connective tissue layer rich in dense collagenous fibers, blood vessels, nerve bundles and sensory corpuscles. The large corpuscles are rounded structures formed of central axon surrounded by nuclei of Schwann cells and a concentric network of collagen fibers. The mucosa of the palate becomes thicker and folded at the level of both median and lateral palatine ridges. Periodic Acid-Schiff (PAS)-positive compound tubular mucous maxillary and palatine salivary glands are demonstrated in the lamina propria of the palate mucosa. The glands are surrounded by a connective tissue capsule from which connective tissue septa extend inwards dividing these

glands into lobules. Each lobule consists of secretory units lined by columnar epithelium with flat basally located nuclei and lightly stained basophilic foamy vacuolated cytoplasm (Figs. 5-6).

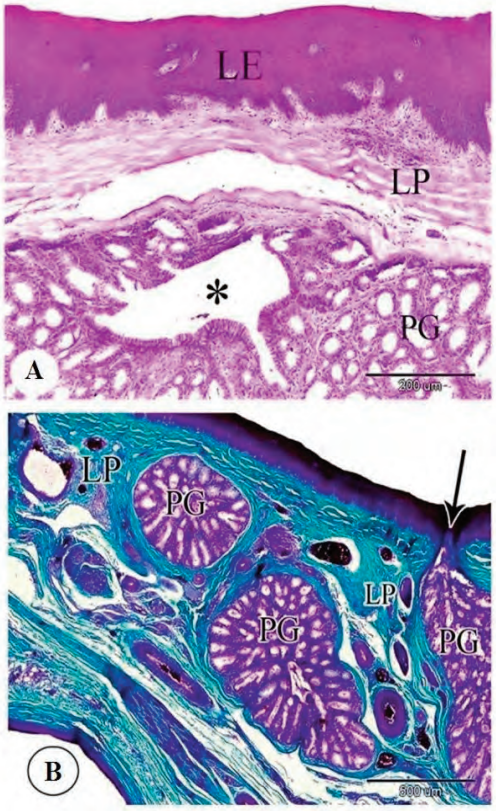

Fig. 5. Photomicrograph illustrates cross section of the palate. A) Palatine mucosa showing lamina epithelialis (LE), medial palatine salivary glands (PG) and their ducts (star) distributed in lamina propria (LP), H&E stain. B) The palate showing palatine salivary glands (PG) open on the epithelial surface (arrow) and dense connective tissue in the lamina propria (LP), Crossmon's trichrome stain.

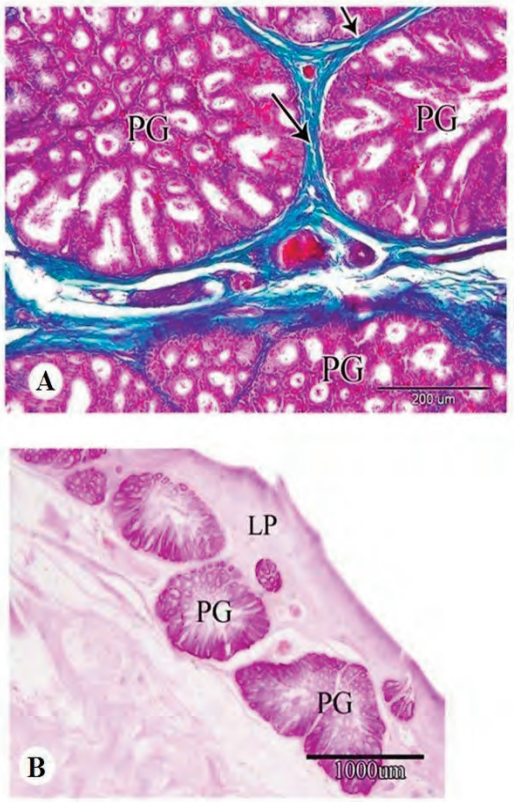

Fig. 6. Photomicrograph of the longitudinal section of the palate showing A) palatine salivary glands (PG) surrounding by connective tissue capsules (arrows), Crossmon's trichrome stain. B) PAS-positive palatine salivary glands (PG) distributed in the lamina propria (LP), PAS stain.

The maxillary salivary glands are two groups located on both sides of the median palatine ridge at the level of the beginning of the caudal lateral palatine ridge. While the palatine salivary glands (lateral and medial) are situated lateral and medial to the caudal lateral palatine ridges (Fig. 7).

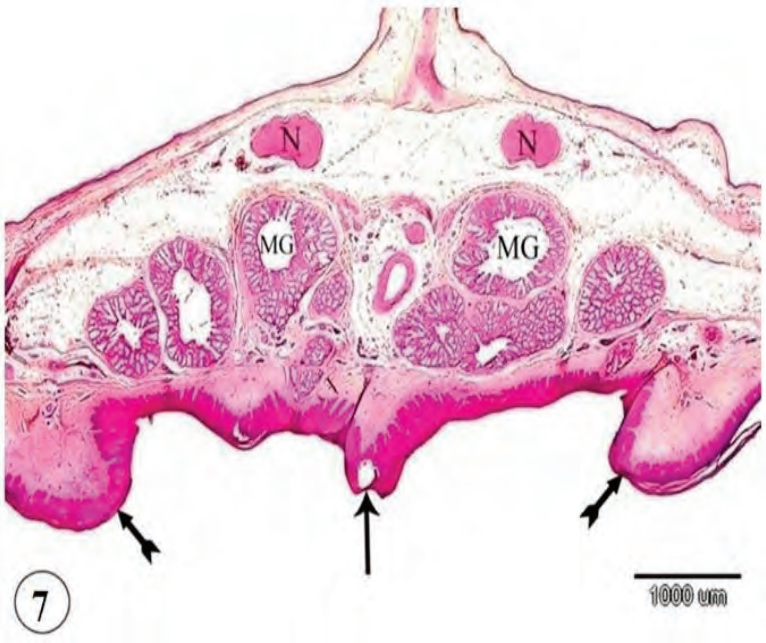

Fig. 7. Photomicrograph of cross section of the rostral part of the palate showing median palatine ridge (arrow), caudal lateral palatine ridges (barbed arrows), two maxillary glands (MG) and two nerve trunks (N), H&E

Discussion

The oropharyngeal roof of the turkey is concave along its length and slightly concave in a transverse direction. Mohamed and Zayed (2003) reported that, the palate is concave along its length in the chicken and pigeon, but the degree of concavity is greater in the chicken. In the goose, the palate is concave transversely. The present study confirmed the basic observations by previous authors (Tadjalli *et al*., 2008; Crole and Soley, 2010; Madkour, 2011; Tivane *et al*., 2011) that the oropharynx divided into oral cavity and pharyngeal cavity without clear line of separation.

In the present study, the boundary between the oral and pharyngeal cavities lies behind the level of the angle of the mouth by 14.10 mm. This distance was measured 25.62 mm by Madkour (2011) in the duck at 60 days old. Embryologically, this boundary is stretching laterally to the angles of the jaws (Lucas and Stettenheim, 1972a,b).

The present morphometrical study explains that the length of the palate in the turkey is 72.12 mm. In 60 days old duck, the length of the oral roof is 82.96 (Madkour, 2011). The length of the palate in the chicken, pigeon and goose is 43, 32 and 85 mm respectively (Mohamed and Zayed, 2003), while that in the European magpie is 31.44 mm and in Common raven is 40.05 mm (Erdogan and Alan, 2012).

The present investigation reveals that in the turkey the palate constitutes 87.73% of the total oropharyngeal roof length. Madkour (2011) informed that in the duck at 60 days old, the oral roof constitutes 84.47% of the oropharyngeal roof length. The length of the palate forms about 78% of the total length of the oropharynx in the pigeon and goose, but in the chicken it forms only 67% (Mohamed and Zayed, 2003). It is concluded that the oral roof forms nearly 67-87% of the oropharyngeal roof length depending on the species of the bird.

In regard to the median palatine ridge, it is worthy to mention that its shape, extension, beginning and termination are variable in different species of birds as shown from the obtained literature. In turkey, the rostral part of the palate is characterized by the presence of the median palatine ridge which consists of two parts; rostral continued and caudal interrupted. Nearly a similar result was described in ostrich by Ali (2004) who stated that the median ridge has a rostral well developed part and a caudally faint part. In the latter bird (Tivane, 2008) and in emu (Crole and Soley, 2010) the median palatine ridge ends abruptly between the two regions of the roof of the oropharynx. In common pigeon, Igwebuike *et al*. (2014) clarified the presence of dub-shaped median palatine. The rostral part of the palate in 30-60 days old ducks is characterized by presence of the median palatine ridge which continues caudally by 4 wide based rostrally directed papillae (Madkour, 2011). The median ridge lies in the rostral third of the palate in the chicken and is weakly developed in the goose as compared to that in the duck; it is continuous caudally in the latter bird by four wide based papillae (McLelland, 1975).

The median ridge is represented by a median swelling in the chicken, pigeon and duck, but by a median longitudinal row of blunt papillae in goose (Nickel *et al*., 1977). The palate in chicken and pigeon is characterized by presence of three longitudinal palatine ridges; one median and two laterals. The palate of the goose has a median longitudinal palatine ridge and 2-3 paramedian rows (King and McLelland, 1984; Mohamed and Zayed, 2003), and that of the Muscovy duck has median palatine ridge as a prominent median longitudinal mucosal fold, as well as the lamellae which orderly arranged rows of notches (Igwebuike and Anagor, 2013). In most species of birds the palate is ridged both lateral and rostral to the choana (king and McLelland, 1984). In finches, canaries, budgerigars and cockatiels the rostral part of the palate contains two ridges that facilitate removal of shell from seeds before consumption (klasing, 1999).

The current study indicates that the median palatine ridge begins 10.64 mm behind the tip of the upper beak and terminates caudally at the rostral end of the choanal slit. This ridge begins behind the upper beak by 6 mm in the chicken and 5 mm in goose and terminates rostral to the choanal slit by 8 mm in the former bird and 12 mm in the latter one. In the pigeon it begins just caudal to the tip of the upper beak and ends at the choanal slit (Mohamed and Zayed, 2003). In the ostrich, the median ridge extends from the tip of the upper beak to the rostral end of the choanal slit (Ali, 2004). In 60 days old duck, it begins behind the upper nail by 4.54 mm and terminates rostral to the choanal slit by 19.18 mm (Madkour, 2011). In the emu, the median palatine ridge extends from the maxillary nail along the rostral maxillary palate and pigmented roof to the border of the pigmented and non pigmented regions of the roof (Crole and soley, 2010).

The present scanning electron microscopical findings indicate that the rostral third of the continued part of the median palatine ridge has in generally a spindle shaped appearance, while at the level of the beginning of the caudal lateral palatine ridge, the median ridge becomes thinner. At higher magnification this region is characterized by the presence of 4-5 transverse furrows arranging at nearly regular intervals. On the other hand, the scaning electron microscopical results of Elner *et al*. (2005) in western sandpiper showed that the maxilla is characterized internally by a median canal (instead of median ridge) runs from buccal region to the distal extremity. In the duck, the rostral part of the dorsal surface of the tongue has a median longitudinal groove which when the mouth is closed, contains the median longitudinal mucosal ridge of the palate (McLelland, 1975).

The present study shows the presence of two rostral lateral palatine ridges which begin directly in front of the rostral end of the median palatine ridge. Each measure 30.32 mm long and runs caudally at first in close relation to the median ridge then they diverge to extend caudolaterally to terminate by the junction into the corresponding caudal lateral palatine ridge. In the chicken, the median palatine ridge is flanked by two small swellings which are united rostral to the ridge (Mohamed and Zayed, 2003). In the seed-eating passerines, the longitudinal median ridge is flanked by longitudinal intermediate ridges and longitudinal lateral ridges (King and McLelland, 1975).

As shown in the present work, the caudal lateral palatine ridges are two in number begin from both sides of the caudal end of the continued part of the median palatine. Each ridge is 30.73 mm and extends caudolaterally to terminate at the lateral end of the last caudal transverse row of the palatine papillae, opposite to the level of the junction between the narrow and wide parts of the choanal slit. Mohamed and Zayed (2003) mentioned that the lateral palatine ridge in the chicken is 19 mm long. It begins at the caudal end of the median ridge, and terminates opposite to the level of the junction between the narrow and wide parts of the choanal slit. In the pigeon, it measures 17 mm long, begins at the junction of the rostral and caudal two third of the median ridge and terminates opposite to the caudal end of the choanal slit. On contrast, the goose has three paramedian rows of caudally directed papillae, the lateral one is the homologous to the lateral palatine ridge of the chicken and pigeon. McLelland (1975) reported that in the duck, the most rostral part of the palate has several, short, broad rostral and rostrolaterally directed ridges, the largest of which joins the median ridge. Madkour (2011) stated that the rostrally located ridges of the 30-60 days old ducks increase in size and extend rostrolaterally from both sides of

the rostral part of the median longitudinal ridge. Moreover, several thin ridges are demonstrated on the lateral side of the palate. Bailey *et al*. (1997) pointed up that the lateral palatine ridge in the captive bustards extends longitudinally along each side of the palate and caudally to the level of the junction of the narrow and wide parts of the choanal slit.

The work under investigation shows that, between the edge of the upper beak and the rostral as well as caudal lateral palatine ridges is found the lateral palatine groove. This groove is narrow rostrally but becomes deeper and wider caudally. Mohamed and Zayed (2003) stated that in both chicken and pigeon the lateral ridges are bounded medially and laterally by two longitudinal grooves. These grooves are shallow and confined to the rostral part of the palate in the chicken, but they are deep and extend in both rostral and caudal parts of the palate in the pigeon. Ince *et al*. (2010) in the sea gulls mentioned that, at the caudal part of the palate at both sides of choana, a lateral palatine groove started with V shaped nicked blister getting shallower and narrower towards cranial were witnessed. In this concern, Ziswilar (1965) reported that the ridge formation on the palate of seed eating passerines is highly complex dividing the palate into a series of arch-like grooves. According to King and McLelland (1975), in some groups e.g. the Emberizidae the region of the palate between the right and left lateral ridges is the median palatine groove, that between the lateral ridge and the edge of the bill being the lateral palatine groove. The median groove fails to extend caudally to the level of the choana. Moreover, Feder (1969) informed that a transverse oriented V-shaped groove occurs in the palate of the budgerigar. It has been stated that the groove described above hold the seeds that become wedged in these grooves during husking process (McLelland, 1979; King and McLelland, 1984). The lateral grooves contain the lower mandible when the bill is closed, and during the husking process holds the seed. The pigeon depends mainly on grains in its feeding; the palate in this species is characterized by deep longitudinal grooves that may be used as a passage to the fed grains toward the pharynx (Mohamed and Zayed, 2003).

The palate of the examined turkey demonstrated a triangular area lying between the caudal lateral palatine ridges laterally and the most caudal transverse row of the palatine papillae caudally. This area contains the narrow part of the choanal slit and three rows of the generally caudally directed palatine papillae, in addition, smaller freely distributed papillae. The position, direction and length of these rows as well as the number of papillae they contain are different. This triangular area is characterized in the chicken by the presence of five rows of caudally directed papillae, in addition, smaller irregularly scattered papillae also demonstrated between these rows (Mohamed and Zayed, 2003). The palate of the captive bustards demonstrates on both either side of the choana three rows of papillae (Bailey *et al*., 1997). These caudally directed papillae which reportedly form a typical feature of the palate are totally absent in the ostrich (Tivane *et al*., 2011), and also in the common pigeon (Igwebuike *et al*., 2014). In hooded crow, the horny conical papillae were widely distributed in the roof of the oropharynx, while in cattle erget it was absent except two rows (Moussa and Hassan, 2013). These well developed caudally directed papillae may serve principally as mechanical obstacles to the involuntary return of food that has passed over them; in addition, the papillae may assist with swallowing by ensuring that the bolus of food is moved in only one direction, towards the oesophagus, and prevent regurgitation (McLelland, 1979; Mohamed and Zayed, 2003).

In agreement with the results of Madkour (2011) in all studied ages of ducks, the current scanning electron microscopical observations show the presence of two openings of maxillary salivary glands. One opening in each side of the rostral part of the median ridge was demonstrated in duck. But in examined turkey the opening lies in the area bounded by the beginning of the interrupted part of the median ridge and the beginning of the caudal lateral palatine ridge. Koch (1973); McLelland (1975) and Mohamed and Zayed (2003) also described these glands in chicken as monosomatic. The maxillary gland in birds lies against the incisive bone reach the end of the palatine cleft (Nickel *et al*., 1977). In the chicken, the maxillary glands are close to the midline in the rostral part of the middle third of the palate, rostral to the choanal slit. The single relatively large opening of each gland lies in the angle at the junction of the median and lateral ridges (McLelland, 1975). In this bird, the opening of the maxillary gland lies immediately beside the midline at the gum directly over the tip of the tongue (Koch, 1973). The maxillary gland in the fowl lies in the angle of the premaxilla (Hodges, 1974). On the other hand, in the goose several small openings of these glands are demonstrated on either side of the median ridge shortly caudal to its rostral end. In the pigeon, four openings arranged in the form of longitudinal row on both sides of the median ridge 5 mm rostral to its caudal end (Mohamed and Zayed, 2003).

The present investigation shows that the mucosa of the oral roof (palate) has a highly cornified stratified squamous epithelium which becomes thickened and folded at the level of the both medial and lateral palatine ridges. In duck at 60 days old, the lamina epithelialis of the oral roof consists of stratified squamous cornified epithetlium which becomes gradually thicker lateralwards to continue with the cornified epithelium of the medial horny lamellae (Madkour, 2011). In this connection, the epithelium of the oropharynx on the fowl is stratified squamous epithelium whick can be keratinized in regions where abrasions occur (Orosz, 1997). On the other hand, in the chicken the mucous membrane of the palate has a stratified squamous epithelium which not keratinized (King, 1975).

Corresponding to the present findings in the turkey and the statement of Samar *et al*. (2002) in the chicken, the lateral and medial palatine salivary glands are Periodic Acid Schiff (PAS)-positive. The latter authors concluded that the morpho-function characteristics of these salivary glands suggest that their products are involved in lubrication and humidification of food ingested, and probably in protection of the oral surface. In the ostrich, the scanning electron microscopic findings of the palate show that the cell surface features are exclusively covered by the keratin layer of the epithelium and few numbers of minute openings of the salivary glands (Ali, 2004).

Conclusion

Studying the anatomical features of the oral roof (palate) of the turkey revealed different morphological characteristics in comparing with that of the other birds. These features include the median palatine ridge that comprises rostral continued and caudal interrupted parts, presence of two rostral lateral palatine ridges side by side two caudal lateral palatine ridges, and also appearance of an additional row of palatine papillae as well as the cranial, middle, and caudal ones.

Acknowledgement

The authors are grateful to the members of Anatomy and Histology Department, Faculty of Veterinary Medicine, Assiut University, Egypt for their kind help and support.

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