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A review on histo-architecture and histo-chemistry of hard palate and oropharynx in broiler chicks

Satish Kumar, Ravi Kumar, Sunil Punia and Pawan Kumar

Abstract
Fowl production especially the chicken (Gallus gallus domesticus) is fast growing sector because of popularity of meat having a high content of protein and low levels of cholesterol. The fowl is an omnivorous bird and variation in food resources has resulted in its adaption to different environments leading to difference in shape and structure of the palate and oropharynx. The palate and oropharynx is the first area for food selection and intake and plays a very important role in maintenance of food in oral cavity, movement and in swallowing of bolus as a reflection of the different lifestyle of birds. The tissues of hard palate containing rostral part of median palatine ridge, region of anterior maxillary gland, rostral region of choanal cleft, region having palatine papillae. The thickness of maxillary ramphotheca and other histo-architecture was modified with the advancement of age of birds. The epithelium showed the presence of keratin layer in the areas where the blunt papillae were present and some of these papillae have the lamellated arrangement of the cells. The respiratory epithelium was modified into simple columnar type of follicle associated epithelium (FAE) where the cells similar to the M-cells were also present. Variation in keratinization of mucosal epithelium among avian species may be a reflection of the evolutionary adaptations observed between different birds.

Keywords: Maxillary rampotheca, Choanal cleft, gallus domesticus

Introduction
Birds have different feeding habits with corresponding differences in the structure of their hard palate and oropharyngeal cavity. The tissues of hard palate containing rostral part of median palatine ridge, region of anterior maxillary gland, rostral region of choanal cleft, region having palatine papillae. Lymphoid follicles present in the submucosa of oropharynx act as first line of defense for various microbes as reported in ostrich (Tadjalli *et al.*, 2008) [24], emu (Crole and Soley, 2010) [5], guinea fowl (Jayachitra *et al.*, 2015) [11] and fowl (Gupta *et al.*, 2015) [7]. The macroscopic and microscopic structure of palate differs greatly with the feeding habits (Hodges, 1974) [8]. However, specific information on the microscopic anatomy of the hard palate and oropharyngeal of the fowl is scanty. Keeping in view the importance of histology of the hard palate and oropharyngeal, the present study will be a boon to the avian histologists and pathologists.

Histo-architecture and Histo-chemistry
The hard palate was comprising the median palatine ridge, region of anterior maxillary gland, the region of choanal cleft and palatine papillae. Median palatine ridge: The median palatine ridge presented a blunt papilla like appearance which sloped downward and backward was covered by stratified squamous keratinized epithelium as observed in the emu (Crole and Soley, 2011) [6] and ostrich (Tivane, 2008) [25]. However, the epithelium became non-keratinized in its portion extending to the choana in ostrich (Tivane, 2008) [25]. The epithelium was devoid of the PAS activity however small concentration of neutral mucopolysaccharides was observed in the stratum corneum and in the keratinized layer. The thickness of maxillary ramphotheca was increased with the advancement of age of birds.
Region of anterior maxillary gland: This region was present where the median palatine ridge bifurcated into the lateral palatine ridges and was lined by stratified squamous keratinized epithelium having a few surface papillae. These papillae were mostly blunt in shape and some had laminated arrangement in birds. The size of the papillae increased with advancement of age. Large clusters of tubulo-alveolar mucous type of glands present in the deeper part were anterior maxillary glands localized only towards the mid portion and not observed towards the lateral sides. The glandular tissue was surrounded by a dense connective tissue having collagen bundles and elastic fibers. The alveoli were lined by pyramidal shaped cells.

The alveoli and glandular ducts were strongly positive for acidic mucopolysaccharides, glycogen, weakly sulfated acidic muco-substances, hyaluronic acid and sialomucins mucins. The connective tissue septae, fatty tissue and cartilage showed positive activity of acidic mucopolysaccharides. Just lateral to the median palatine ridge on either side, the epithelium was of similar nature but it was devoid of the papillae and the glands.
The region of choanal cleft: The portion of the hard palate at the level of the narrow part of the choanal cleft was lined by stratified squamous keratinized to non-keratinized epithelium. The epithelium towards the cleft was modified from stratified squamous to the respiratory epithelium. The pseudo-stratified columnar ciliated having few goblet cells showed very strong reaction for the acidic mucopolysaccharides as reported in chhukar partridge. Just deep to the connective tissue cluster of glandular alveoli were lined by pyramidal shaped cells as reported in other birds (Samar *et al.*, 1999; Crole and Soley, 2011) [21, 6]. These glands have been reported as simple branched tubular glands producing mucous secretion (Tivane 2008; Crole and Soley, 2011) [25, 6]. The glands were classified into median and lateral palatine glands as reported earlier in chicken (Samar *et al.*, 2002) [22] were surrounded by connective tissue fibres. Strong Alcianophilic reaction in the median and lateral palatine glands and their ducts indicated the presence of the weakly acidic sulfated mucopolysaccharides, hyaluronic acid and sialomucins. The activity for mucins was moderate in the median palatine glands and was more in the lateral palatine glands. In the partridge, solitary and aggregated lymphoid follicles were noted in the connective tissue and around the glands along the palate and at the periphery of the choanal cleft (Samar *et al.*, 2002; Tivane, 2008; Crole and Soley, 2011) [22, 25, 6].

Region of palatine papillae: The region of the hard palate having the palatine papillae was lined by stratified squamous non-keratinized epithelium. This epithelium was further modified in the deeper portion of the choanal cleft into the respiratory type i.e. the pseudostratified columnar ciliated epithelium. The median palatine glands were surrounded by the connective tissue layer forming a capsule like structure. The lateral palatine glands were comparatively lesser in number and extended up to the last papilla towards the lateral side. The lateral palatine glands showed the presence of the acidic mucopolysaccharides whereas; neutral mucopolysaccharides were observed in a few cells of the median palatine glands as reported earlier in chicken (Samar *et al.*, 2002) [22]. Samar *et al.* (1999) [21] also reported that all mucous cells of the palatine glands gave PAS-positive activity in the penguins. The rostral and caudal palatine glands of the other bird's species also contained neutral mucins (Samar *et al.*, 1995, 1999, 2002) [20, 21, 22]. However, the findings obtained in the present study showed that, similar to the findings in the penguin (Samar *et al.*, 1995, 1999) [20, 21] and the seagull (Samar *et al.*, 1995) [20], where cells producing a mucous secretion, gave a stronger reaction with PAS which indicated the presence of greater amount of acidic mucins. In chicken, Samar *et al.* (2002) [22] reported that the lateral glands were made of mucous secretory units, whilst the medial glands were made of serous secretory units. In fowl only mucous secretory units were present and the presence of alveolar glandular structures producing mucous secretion has been demonstrated in the penguin and seagull (Samar *et al.*, 1995, 1999) [20, 21]. The medial and lateral palatine glands and the respiratory epithelium showed very strong Alcianophilic reaction indicating the presence of the weakly acidic sulfated mucopolysaccharides, hyaluronic acid and sialomucins which was in similar with the observations found in chicken (Samar *et al.*, 2002) [22]. Furthermore, it was observed that the secretion of the palatine glands contained glycoproteins, carboxylated proteoglycans, weakly and strongly sulphated mucins, sialic acid and hyaluronic acid, but lacked glycogen in chhukar partridge (Sagsoz *et al.*, 2013) [19]. Mayer's mucicarmine method showed that the glandular acini/alveoli were positive for acidic mucopolysaccharides but glandular ducts showed comparatively weak activity. Very strong reaction for the glycogen was observed in the medial and lateral palatine glands as demonstrated by McManus' PAS method which was contradictory to the presence of glycogen resulted in a negative reaction in both the rostral and caudal glands, which demonstrated that the palatine glands of the partridge (Sagsoz *et al.*, 2013) [19] were lacking glycogen. The main function of the salivary glands was to secrete lubricating molecules which helped to protect the oral mucosa from desiccation, mechanical damage, external toxic substances and microbial toxins by constituting a barrier (Samar *et al.*, 1995; Crole and Soley, 2011; Sagsoz *et al.*, 2013) [20, 6, 19].

Mid of the pharynx: Oropharynx was lined by stratified squamous non-keratinized epithelium as reported in fowl (Hodges, 1974) [8], laughing dove and Japanese quail (Madkour, 2020) [16]. However, the epithelium was keratinised only towards rostral pigmented portion in emu (Crole, 2011) [4] and turkey (Sayed *et al.*, 2016) [23]. The deeper surface presented the papillary pegs, whereas the free surface was almost uniform. Variation in keratinization of mucosal epithelium among avian species may be a reflection of the evolutionary adaptations observed between different birds (Sagsoz *et al.*, 2012) [19]. Furthermore, lack of keratin on the epithelium of this region may be an indication that this region was not subject to much abrasion.
The stratified squamous epithelium towards the infundibular cleft was modified into the respiratory epithelium. The goblet cells were showing the strong positive reaction towards the acidic mucopolysaccharides. A strong positive Alcianophilic reaction indicated the presence of hyaluronic acid and weakly sulfated mucopolysaccharides.
Glandular tissue formed a major component of the sub-epithelial connective tissue in both dorsal and ventral walls of the pharynx which was similar to that has been demonstrated in the chicken (Samar *et al.*, 2002) [22] and some wild species of bird (Crole and Soley, 2011; Sagsoz *et al.*, 2012) [6, 19]. It had been reported that glands were best developed in birds that fed on dry diet such as seeds and grains (King and McLelland, 1984) [12]. Definitive large salivary gland did not occur in birds; rather there were numerous independent glandular units that formed glandular fields (Banks, 1993) [2]. The glands were categorized into simple tubular mucus-secreting glands and larger simple branched tubular mucus-secreting glands in emu (Crole and Soley, 2011) [6] and ostrich (Tivane, 2008) [25]. The lymphoid tissue was present as reported in other birds (Samar *et al.*, 2002; Tivane, 2008; Crole and Soley, 2011; Sagsoz *et al.*, 2012; Igwebuike *et al.*, 2016) [22, 25, 6, 19, 10] whereas, pharyngeal tonsil was demonstrated in the emu and ostrich (Crole and Soley, 2012) [3]. These lymphocytic aggregations were part of the well-organized gut-associated lymphoid tissues (GALT).
In the deeper part, the mucous glands were thought to secrete lubricating molecules (Samar *et al.*, 1995; Liman *et al.*, 2001)

[20, 14] which formed a protective layer on the oral cavity against desiccation, mechanical damage, external toxic substances and microbial toxins (Samar *et al.*, 2002; Crole and Soley, 2011; Sagsoz *et al.*, 2012) [22, 6, 19]. In addition, secretions of the glands may aid in swallowing of food by lubricating the caudal part of the oropharynx and probably, the initial part of the esophagus as reported in the African pied crow (Igwebuike and Eze, 2010) [9].

Region of pharyngeal papillae: The pharyngeal papillae present in the transverse row at the caudal end of infundibular cleft were lined by stratified squamous non-keratinized epithelium. The papillae presented the concentric arrangement or the laminated appearance and the adjacent papillae were attached to each other through stratum corneum cells. Papillae were directed downward and backward. The surface of the pharyngeal roof was devoid of papillae in the dove (Madkour, 2018) [15] and young pigeons (Mahdy, 2020) [17] whereas, conical papillae were present in quail (Madkour, 2018) [15], turkey (Sayed *et al.*, 2016) [23], and hooded crow (Moussa and Hassan, 2013) [18]. The pharyngeal papillae played an important role in transporting bolus toward esophagus (König *et al.*, 2016) [13].

These glands showed the strong positive reaction for acidic mucopolysaccharides and few neutral mucopolysaccharides were also present. The glands and their ducts showed strong Alcianophilic reaction. The glands have been identified as tubular type (Sağsöz *et al.*, 2013) whereas, simple branched tubuloalveolar type in the birds (Samar *et al.*, 1999, Crole and Soley, 2011, Al-Nefeiy and Alahmary, 2015) [21, 6, 1].

Conclusion

The hard palate was bounded on either side by maxillary ramphotheca. It presented a median swelling, from the caudal ends of which the lateral palatine ridges were diverging caudally and medially. In between the lateral palatine ridges orbital folds were localized. At the point of union of palatine ridges the openings of anterior maxillary glands were present. The orbital folds were separated by choanal cleft. On either side of the orbital folds the openings of medial and lateral palatine glands were present. These glands were showing the presence of more acidic mucopolysaccharides and were showing the presence of glycogen. The transversally arranged rows of papillae were present on the orbital folds which were of varying shapes and size. Caudally, the lateral border of the choanal cleft was having a row of very large sized papillae which were linearly arranged. The number of papillae were increased and their shapes were changed with advancement of age of bird. The pharyngeal folds presented few scattered papillae at earlier age of bird which formed many irregular rows of papillae during the later stage of development. The pharyngeal folds on either side of the choanal cleft was smooth however towards the infundibular cleft rows of papillae were present. The aggregations of lymphoid follicles were observed in the submucosa of oropharynx.

References

1. Al-Nefeiy FA, Alahmary BA. Morphological, histological and histochemical studies of the lingual salivary glands of the rock dove, Patagioenas livia (Columbidae). International Journal of Current Research Academic Review 2015;3:280-289.
2. Banks WJ. Applied Veterinary Histology. 3rd edn. Mosby Incorporated, St. Louis, Missouri, USA. 1993.
3. Crole MR, Soley JT. Evidence of a true pharyngeal tonsil in a bird: a novel lymphoid organ in Dromaius novaehollandiae and Struthio camelus (Palaeognathae). Frontiers in Zoology 2012;9:1-12.
4. Crole MR. A gross anatomical and histological study of the oropharynx and proximal oesophagus of the emu (Dromaius novaehollandiae). University of Pretoria 2011, 46-97.
5. Crole MR, Soley JT. Gross morphology of the intra-oral rhamphotheca, oropharynx and proximal oesophagus of the emu (Dromaius novaehollandiae). Anatomia, Histologia, Embryologia 2010;39:207-218.
6. Crole MR, Soley JT. Distribution and structure of glandular tissue in the oropharynx and proximal oesophagus of the emu (*Dromaius novaehollandiae*). Acta Zoologica 2011;92:206-215.
7. Gupta SK, Pathak Archana, Farooqui MM. Anatomy of oropharyngeal cavity of fowl (Gallus domesticus). Indian Journal of Veterinary Anatomy 2015;27:12-14.
8. Hodges RD. The Digestive System. The Histology of Fowl. Academic Press, London 1974.
9. Igwebuike UM, Eze U. Anatomy of the oropharynx and tongue of the African pied crow (Corvus albus). Veterinary Archives 2010;80:523-531.
10. Igwebuike U, Uqwuoke WI, Udoumoh AF. Morphological features of the dorsal and ventral walls of the oropharynx in the common pigeon (Columba livia). Animal Research International 2016;11:1970-1975.
11. Jayachitra S, Balasundarum K, Iniyah K, Sivagnanam S, Tamilselvan S. Morphology of oropharyngeal cavity in guinea fowl (Numida meleagris). International Journal of Advance Multidisciplinary Research 2015;24:99-102.
12. King AS, McLelland J. Birds: Their Structure and Function. 2nd edn., Bailliere Tindal 1984.
13. König HE, Liebich HG, Korbel R, Klupiec C. Digestive system (apparatus digestorius). In: König, H.E., Korbel, R. and Liebich, H.G. (Eds.). Avian Anatomy: Textbook and Colour Atlas, 2nd edn, UK 2016.
14. Liman N, Bayrarn G, Kocak M. Histological and histo-chemical srudies on the lingual, preglottal and laryngeal salivary glands of the Japanese quail (Cotumix cotumix japonicay) at the post-hatching period. Anatomia Histologia Embryologia 2001;30:367-373.
15. Madkour FA. Characteristic features of the pharyngeal cavity of the laughing dove (Streptopelia senegalensis aegyptiaca) and Japanese quail (Coturnix coturnix). Assiut Veterinary Medical Journal 2018;64:52-59.
16. Madkour FA. Comparative histology and micrometric analysis of pharyngeal cavity of Egyptian laughing dove (Streptopelia senegalensis aegyptiaca) and Japanese quail (Coturnix coturnix japonicum). International Journal of Veterinary Sciences 2020;3:115-129.
17. Mahdy MA. Comparative gross and scanning electron microscopical study of the oropharyngeal roof of young and adult domestic pigeons (Columba livia domestica). Microscopy Research and Techniques 2020;83:1045-1055.
18. Moussa EA, Hassan SA. Comparative gross and surface morphology of the oropharynx of the hooded crow (Corvus cornix) and the cattle egret (Bubulcus ibis). Journal of Veterinary Anatomy 2013;6:1-15.
19. Sagsoz H, Erdogan S, Akbalik ME. Histomorphological structure of the palate and histochemical profiles of the salivary palatine glands in the Chukar partridge (*Alectoris*

chukar). Acta Zoologica (Stockholm) 2012;100:1-10.
20. Samar ME, Avila RE, De Fabro SP, Centurion C. Structural and cytochemical study of salivary glands in the magellanic penguin (*Spheniscus magellamcus)* and the kelp gull (*Larus dominicanus).* Marine Ornithology 1995;23:154-156.
21. Samar ME, Avila RE, De Fabro SP, Poririo V, Esteba FJ, Pedrosa JA *et al.* Histochemical studies of magellanic penguin minor salivary glands during postnatal growth Anatomical Record 1999;254:298-306.
22. Samar ME, Avila RE, Esteban FJ, Olmedo L, Dertin L, Massone A *et al.* Histochemical and ultrastructural study of the chicken salivary palatine glands. Acta Histochemica 2002;104:199-207.
23. Sayed RK, Saleh AM, Ahmed AK, Abdalla KE. Gross anatomical, light and scanning electron microscopic studies on the pharyngeal roof of turkey (Meleagris gallopavo): Comparative study. Journal of Advanced Veterinary Research 2016;6:112-117.
24. Tajali M, Mansouri SH, Poust PA. Gross anatomy of the oropharyngeal cavity in the ostrich (Struthio camelus). Iranian Journal of Veterinary Research 2008;9:316- 323.
25. Tivane C. A morphological study of the oropharynx and oesophagus of the ostrich (*Strutliio camelus*). M.Sc. thesis, University of Pretoria, South Africa 2008.