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## RESEARCH ARTICLE

### GROSS MORPHOLOGY AND HISTOLOGY OF OESOPHAGUS IN ADULT EMU BIRDS (*DROMAIUS NOVAEHOLLANDIAE*)

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#### ABSTRACT

Twenty apparently healthy adult emu birds of either sex were utilized for gross and histomorphological observations. The oesophagus was a long, muscular tubular organ with highly distensible tube which is important for easily transport of food from oral cavity to proventriculus. The oesophagus originated from the caudal aspect of the oropharynx and divided into cervical and thoracic parts and no crop was found. The internal surface of the oesophagus was cream colored with number of longitudinal folds. The thickness of the tunica mucosa of cervical and thoracic oesophagus was  $50.70 \pm 22.62$  and  $60.70 \pm 8.49$   $\mu\text{m}$  respectively. The mucous membrane of the oesophagus had irregular folds which was lined by thick non keratinised stratified squamous epithelium with numerous openings of the glands occupied on the sides of the folds. Diffuse and aggregation of lymphocytes also observed in the lamina propria. The oesophageal glands were lined by single layer of columnar cells with small, round basal nuclei, basophilic cytoplasm and clear marked borders. The tunica muscularis was consisted of a thicker inner circular and thinner outer longitudinal layer of smooth muscle. Between these two layer was showed a nerve plexus and associated neurons and blood vessels.

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#### INTRODUCTION

The emu is one of the most important wild bird providing oil, leather, feather and meat to the human population. Four distinct types of emus occurred in native of Australia before European settlement; only the main land form survives (*Dromaius novaehollandiae*). Emu stand up to 1.8 meters height and weigh about 50 kg with the female being the taller and heavier of the sexes. The upper gastrointestinal tract comprises of oral cavity, tongue, pharynx, oesophagus, proventriculus and gizzard. The oesophagus is a thin walled highly distensible tube that delivers food from the oropharynx to the proventriculus. Though elaborate work have been done on avian upper gastrointestinal tract, very little information is available regarding the gross morphology, histology and histochemistry of the oesophagus in emus. The gross and microscopic anatomy will describe the landmarks to diagnose various pathological conditions in emu.

#### MATERIALS AND METHODS

The materials for the study were collected from 20 apparently healthy adult emu birds of either sex procured from a well

organized farm in the neighborhood of Namakkal. The body weights of the live birds were recorded. The cervical oesophagus, thoracic oesophagus were collected immediately after slaughter of birds. The collected samples were washed in normal saline and mopped in blotting paper. The gross morphological and morphometrical parameters viz., colour, length and weight of oesophagus were recorded.

The tissues collected from cervical oesophagus, thoracic oesophagus, were fixed in 10 per cent neutral buffered formalin, Bouin's fluid and Zenker fluid. Fixed tissues were processed through ascending grades of alcohol, cleared in xylene and embedded in paraffin wax at 58-60°C. Paraffin sections of 3-5  $\mu\text{m}$  thickness were cut and utilized for this study. Freshly collected unfixed frozen tissues and post fixed in formal calcium were cut at 20  $\mu\text{m}$  thickness were utilized for demonstration of lipids and enzymes. For histological observations, Ehrlich's Haematoxylin - Eosin method. Van Gieson technique for collagen fibres. Gomori's method for reticular fibres. PTAH method for muscle fibres, Standard toluidine blue method for mast cells, Periodic acid-Schiff (PAS) technique for carbohydrates, Alcian blue method at pH 2.5 for acid mucopolysaccharides (Bancroft and Stevens, 1996) were employed. Microanatomical parameters were recorded using an image analyzer to record the thickness of tunica mucosa of both cervical and thoracic oesophagus.

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## RESULTS AND DISCUSSION

### Gross Morphology

The oesophagus was a long, muscular tubular organ with highly distensible tube which is important for easily transport of food from oral cavity to proventriculus. The oesophagus originated from the caudal aspect of the oropharynx and divided into cervical and thoracic parts and no crop was found. This is in agreement with (Fowler, 1991) in all ratites. In the anterior part of the neck, the cervical oesophagus was located in the midline and dorsal to the trachea. In the posterior part of the neck, the oesophagus location was changed more caudally where it was placed to right of the midline between trachea laterally and the jugular vein dorsally. The oesophagus was very wide in its initial portion. This is accordance with the course of oesophagus mentioned by Tivane (2008) in ostrich. In contrast, Zaher *et al.* (2012) reported that the oesophagus consisted of cervical, crop and thoracic parts in quail.

The thoracic oesophagus passed dorsal to the bronchi and then lies between the heart and lungs and was closely related to the cervical, clavicular and anterior thoracic air sacs. At the level of the 5<sup>th</sup> vertebral rib the oesophagus dilates and opens into the proventriculus, although there is no clear demarcation between these two organs. No cardiac sphincter was observed at the oesophageal proventricular junction as noted by Tivane (2008) in ostrich. The internal surface of the oesophagus was cream colored with number of longitudinal folds (Fig.1). The proximal oesophagus observed well demarcated longitudinal folds approximately 12-16 in number. In the distal region, the folds were sparse with large spaces between them. The average weight of the oesophagus was 80.0 – 83.0 g and total length was 76.0- 78.0 cm. This result is not agreeable with the findings of Bailey *et al.* (1997) reported that the length and total weight was 0.6 m and 27.6 g in captive bustards respectively, in female and male partridge and Attia *et al.* (2011) stated that the length was 83 cm in ostrich. This variation might be due to the size of the birds.

### Histology

The oesophageal wall of the emu was composed of tunica mucosa, submucosa, tunica muscularis and tunica adventitia and serosa (Fig.2). The thickness of the tunica mucosa of cervical and thoracic oesophagus was  $50.70 \pm 22.62$  and  $60.70 \pm 8.49$   $\mu\text{m}$  respectively. This is not reported any of the authors in the reviewed of any other species. The mucous membrane of the oesophagus had irregular folds which was lined by thick non keratinised stratified squamous epithelium with numerous openings of the glands occupied on the sides of the folds. The mucosal epithelium, which protects the luminal surface of the oesophagus from mechanical and microbial damage etc. The lamina propria consisted of loose connective tissue and connective tissue cells, blood vessels and nerve fibers. Loose connective tissue consisted of collagen fibers, elastic fibers (Fig.4) and few reticular fibers and mucus glands and mast cells were also noticed. Diffuse and aggregation of lymphocytes also observed in the lamina propria. The present study revealed the oesophageal glands were observed within the lamina propria (Fig. 3). The glands were arranged along the length of the oesophagus and composed of compound tubular mucous glands as stated by Shibata *et al.* (1991) in

domestic chicken whereas this observation is contrary with Shyla *et al.* (1991) in duck was simple tubular or simple branched glands. The glands were surrounded by connective tissue capsule with blood vessels and nerve fibers. The glands were lined by single layer of columnar cells with small, round basal nuclei, basophilic cytoplasm and clear marked borders. In contrast, Rajabi and Nabipour (2009) reported that the oesophageal glands were purely mucous in house sparrow, kestrel and linnet and seromucous in rock dove, rose ringed parakeet and collared dove. The oesophageal glands are important to lubricate the feed material. The muscularis mucosa was well developed and separated from the lamina propria. It was arranged in the form of longitudinal smooth muscle fibers. This layer was not extended into the mucosal folds. This study is agreeable with Parchami and Dehordi (2011) in common quail, but in contrary to Sagsoz and Liman (2009) in japanese quail that the muscularis mucosa was extended into the mucosal folds. The submucosa was poorly developed with connective tissue it contained arteries, veins and nerve fibers. Contrast to the present study, Zaher *et al.* (2012) who found that the simple branched mucus glands were scattered throughout the submucosa in both the cervical and thoracic part of the oesophagus.



Figure 1. Internal lining of the oesophagus in adult emu showing Longitudinal folds

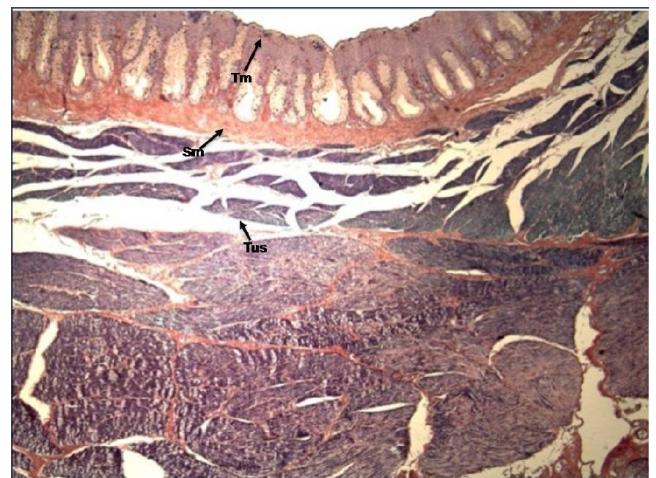


Figure 2. Tunics of oesophagus in adult emu. Tm - Tunica mucosa, Sm - Submucosa and Tus - Tunica muscularis (PTAH x 40)



Figure 3. Oesophageal glands located in lamina Propria in adult emu. (H&E x 100)

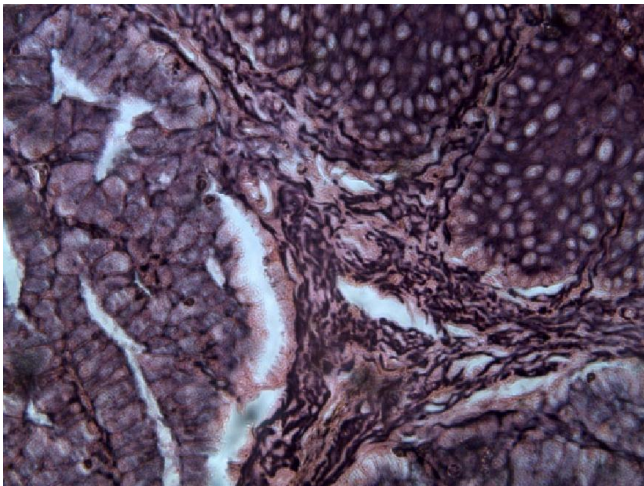


Figure 4. Reticular fibers between the oesophageal glands in adult emu. (Gomori's method x 100)

The glands were less developed in the cervical part than thoracic part of the oesophagus in *Coturnix coturnix*. The tunica muscularis was consisted of a thicker inner circular and thinner outer longitudinal layer of smooth muscle (Fig.2). Between these two layers showed a nerve plexus and associated neurons and blood vessels. The cervical part of the oesophagus was externally covered by loose adventitial connective tissue with large blood vessels, nerves and adipose tissue. The thoracic part of the oesophagus was covered by serosa which was lined by mesothelium. This present finding is agreement with Preddi and Cornila (2009) in ostrich.

### Conclusions

The oesophagus originated from the caudal aspect of the oropharynx and divided into cervical and thoracic parts. The internal surface of the oesophagus was cream colored with number of longitudinal folds. The mucous membrane of the oesophagus had irregular folds which were lined by thick non

keratinised stratified squamous epithelium. The lamina propria was consisted of loose connective tissue fibers and cells, blood vessels and nerve fibers. Diffused and lymphoid aggregation also observed in the lamina propria. The oesophageal glands were arranged along the length of the oesophagus and composed of branched tubular mucus glands. The glands were lined by single layer of columnar cells with small, round basal nuclei and basophilic cytoplasm with clearly marked borders was noticed. The tunica muscularis was consisted of a thicker inner circular and thinner outer longitudinal layer of smooth muscle fibres separated by nerve plexus with associated neurons and blood vessels.

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