



Histological and histochemical studies of the stomach in the Iraqi falcon (*Falcon berigora*)

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Abstract

The study aimed to find out the histological and histochemical structures of the walls of the stomach parts in Iraqi Falcon (*Falcon berigora*). To conduct this investigation, six healthy birds which obtained from a commercial market in (Al Basra city). the stomach of the falcon is constituted by two chambers: the proventriculus (pars glandularis), the gizzard (ventriculus or pars muscularis). Under the light microscopy There is no papilla on the gastric epithelium surface of the proventricular. Both, the mucous tunic of the proventriculus and of the gizzard present folds lined by simple columnar epithelium. The tunica mucosa of the proventriculus is extensively folded due to the presence of well-developed longitudinal muscle bundles. There is no intermediate zone between the proventriculus and the gizzard. The luminal surface of the ventriculus have cuticle, which is sloughed and shed small fine area (around the pyloric opening) and very thin membrane and highly closely adherent to the lining surface of gizzard. Histochemical study of the proventriculus and ventriculus layers showed positive reaction with PAS, Toldian and Mallory stain.

Keywords: falcon, proventriculus, ventriculus, histology

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INTRODUCTION

The digestive apparatus comprises the organs concerned with the reception mechanical reduction chemical digestion and absorption of food and drink (Dyce 2010). The birds gastrointestinal tract morphology, digestive strategy have been intimately intertwined during evolution to match the nutrient content of foods available in its natural habitat (Kadhim et al., 2011) carvers species possess and sizeable crop or an expandable esophageal pouch for storing food so that large meals can be consumed. Generally carnivores birds have less complicated digestive system than those eatiy complex carbohydrates rotes (Duke, 1997). However in birds the stomach consist of two chambers the proventriculus and gizzard the proventriculus varying in sized shape among species being large and distensible in aquatic carnivores while being relatively small in carnivores species (Hassouna, 2001a).

Histological the wall of the proventriculus consists of large compound tubular gland. The secretory cell product both pepsinogen and hydrochloric acid thus containing the function of mammalian chief of parietal cell. While ventriculus is highly muscular grinding organ (Bacha and Bacha, 2000).

The aim of the present study is to give a detailed description of histological architecture of stomach in falcon.

MATERIAL AND METHOD

Healthy six adult falcon were used in present study (as a model of carnivores birds) which obtained from a commercial market in (Al Basra city). The specimens well anesthetized by chloroform and then dissed by making along it incision and the digestive tube was exposed. A specimens of stomach disseated and fixed imndiuly in 10% formaldehyde then of processing for pre the histology picture (dehydrated and on bedded in paraffin histological section of 5-6mm thick were obtained al stained with Hematoxylin and Eosin routine stain for general features identification. The following staining using for the show the general carbohydrate were using periodic acid Schiff (PAS) technique to I din blue stain were using for muco boly scharide Mallory stain was used for connective tissue (Bancroft and Stevens, 2010).

RESULT

The present study showed The falcon stomach is muscular organ which divided into two distinct different structures, the first structure is the proventriculus (Glandular stomach, Ventriculus glandularis) and the

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second structure is the ventriculus or muscular stomach (Gizzard, *Ventriculus muscularis*), in which the first part is a cranial glandular and muscular part while the second part is a caudal muscular part which are not separated by an isthmus or intermediate zone from each other.

Histologically: the histological sections, under light microscopy, revealed that the wall of the stomach (proventriculus and gizzard) is constituted by the following layers: mucous membrane (*tunica mucosa gastris*), submucosa (*tela submucosa gastris*), muscular (*tunica muscularis gastris*) and serosa (*tunica serosa*). The *tunica mucosa* of the proventriculus is extensively folded separated by grooves due to the presence of well-developed inner longitudinal layer of the *tunica muscularis* these lined with simple columnar epithelial tissue. The submucosa is constituted by dense connective tissue with lobules proventriculus glands. These lobules somewhat large and elongated in shape with narrow lumen. The proventriculus gland arranged around central secondary with narrow lumen duct which drains several lobules. The connective tissue in submucosa was intrapted and there were blood supply of nerve (**Fig. 1A**). The *tunica muscularis* presents an inner layer of longitudinal disposed smooth muscular fibers and another outer, of circularly disposed fibers. The longitudinal layer is more developed than the circular layer. This thick muscular layer occupies the greater part of the thickness of the wall of the proventriculus. The *tunica serosa* of the proventriculus is constituted by connective tissue (**Fig. 1B**).

Gizzard: The gizzard covered with mucous membrane (*tunica mucosa*) presents low folds, which are lined by simple low columnar epithelium the tissue. the small area of the mucous membrane of ventriculus, which is situated at the area around the pyloric opening only is lined with secretory product of mucosal glands, which solidifies at the surface to form a small weak cuticle layer while the rest of luminal surface not have cuticle layer, in which the cuticle is sloughed and shed small fine area and very thin membrane and highly closely adherent to the lining surface of gizzard and it is often green or yellow in color because of reflux of bile pigments from the small intestine. The surface lining of the *tunica mucosa* consists of low columnar cells this cells were rounded nucleus at the blue of cells, and the simple tubular gland that located under the *tunica mucosa* followed by lamina mucosa, which is constituted by a dense connective tissue. The lamina mucosa is separated by a thin connective tissue, adjacent to lamina muscularis mucosae; there is the well-developed *tunica muscularis* with thick inner circular layer and outer longitudinal layer. A submucosa is present. The *tunica serosa* is constituted by connective tissue and there were small tubular glands in compound with the proventriculus glands the epithelia of this glands were cuboidal cells have rounded nucleus in the basement

membrane. The lumen of glands were irregular depend shape of gland (**Fig. 1C**).

Histochemical results

Microscopic examination of the proventriculus revealed cells in its surface lining of the mucosal folds strongly positive to PAS as the reaction gave rise dark purple coloration. The observed reaction was with the granules located at the supra-nuclear area of these cells. The connective tissue of the lamina propria, which extended between the folds of mucosa showed moderate reaction toward PAS. The submucosal glands in glandular stomach were strongly reacted with such stain. The muscularis mucosa and the walls of the blood vessels in the submucosa showed mild to moderate reactions. Whereas, the *tunica muscularis* showed mild reaction but interspersed collagen fibers showed a moderate reaction (**Fig. 2A**).

The columnar epithelial cells were positively reacted with Toldin blue stain (acid mucopolysaccharides) in the glandular part of the stomach. However, the lamina propria, muscularis mucosa, walls of the blood vessels in the submucosa and the *tunica muscularis* showed mild reaction. The mucosal glands were positively reacted to this combined stain (**Fig. 3A**).

The connective tissue in the lamina propria, submucosa and in *tunica muscularis* showed Mallory stain positive reaction in proventriculus (**Fig. 4A**).

The thin cuticle covering which was detected in the ventriculus of falcon showed positive reaction to PAS stain (pink color) as it present above their epithelial lining and negative reaction with Toldin blue falcon ventriculus. The epithelium, which lined the mucosal folds in the mucosal layer and the secretory material within the lumina of the glandular tubules were strong positive reaction with PAS and Toldin stain. The connective tissue in the lamina propria, submucosa and in *tunica muscularis* showed PAS positive reaction and negative reaction with Toldin blue in ventriculus, while the smooth muscles fibers which constructed the *tunica muscularis* reacted weakly with PAS and negatively with Toldin stain (**Figs. 2B and 3B**). The connective tissue in the lamina propria, submucosa and in *tunica muscularis* showed Mallory stain positive reaction in ventriculus (**Fig. 4B**).

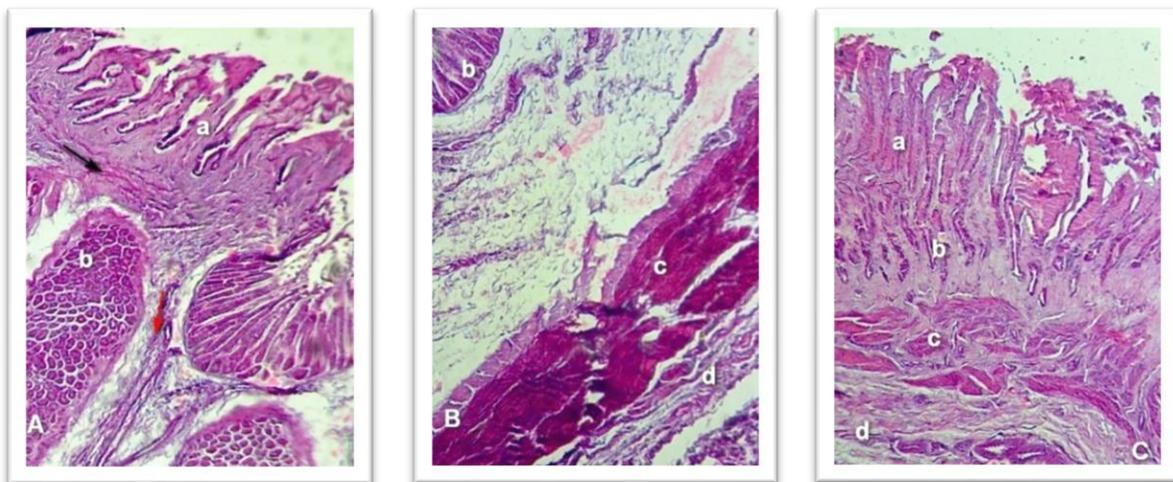


Fig. 1. (A). Proventriculus wall of falcon showed a. T. mucosa b: T. submucosa. connective tissue in lamina propria(black arrows) and submucosal glands (red arrows), (B): b.T. submucosa c.T muscularis d.T serosa, (C):Gizzard of falcon showed a. T. mucosa b. T. submucosa c. T. muscularis d. T. serosa. H&E stain 10X

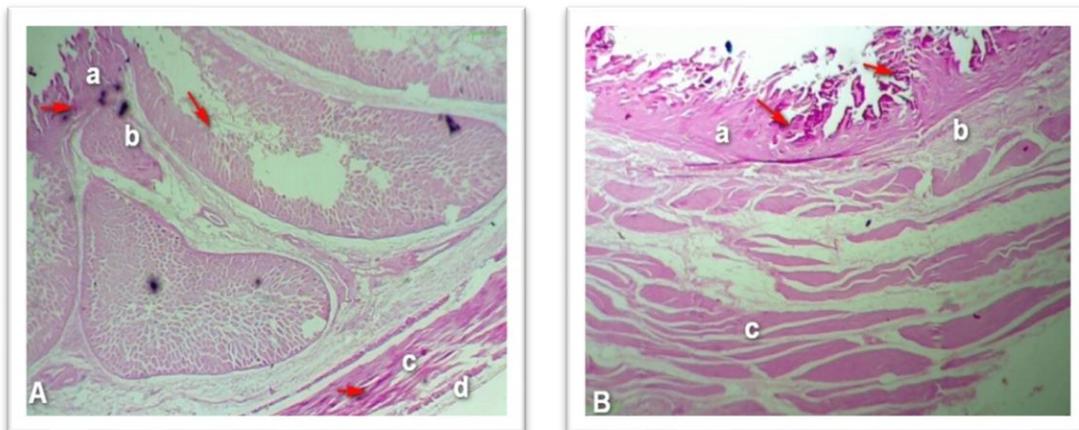


Fig. 2. (A). Proventriculus wall of falcon showed a. T. mucosa(red arrow) b: T. submucosa(red arrows) and T. muscularis (red arrows), (B): Gizzard of falcon showed a. T. mucosa (red arrows) b. T. submucosa c. T. muscularis. PAS stain 10X

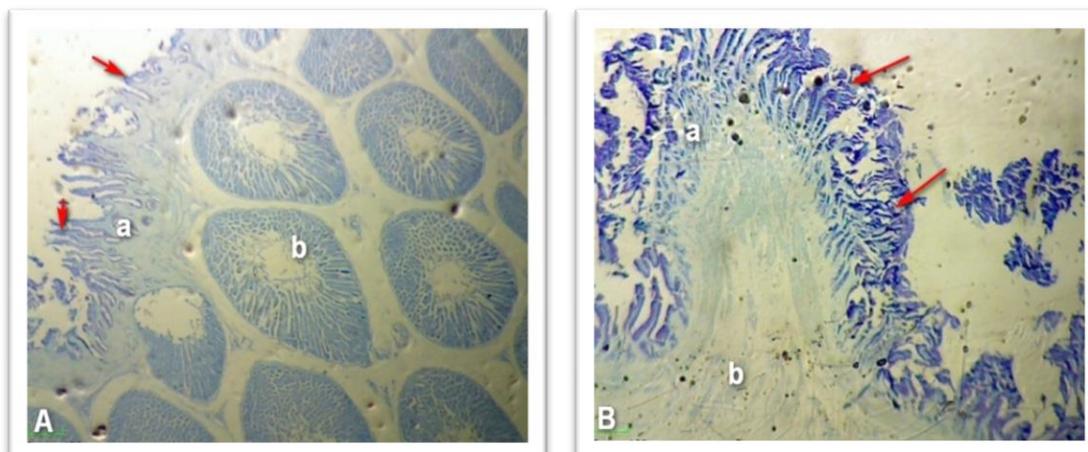


Fig. 3. (A). Proventriculus wall of falcon showed a. T. mucosa(red arrow) b: T. submucosa, (B):Gizzard of falcon showed a. T. mucosa (red arrows) b. T. submucosa. Toldin stain 10X.

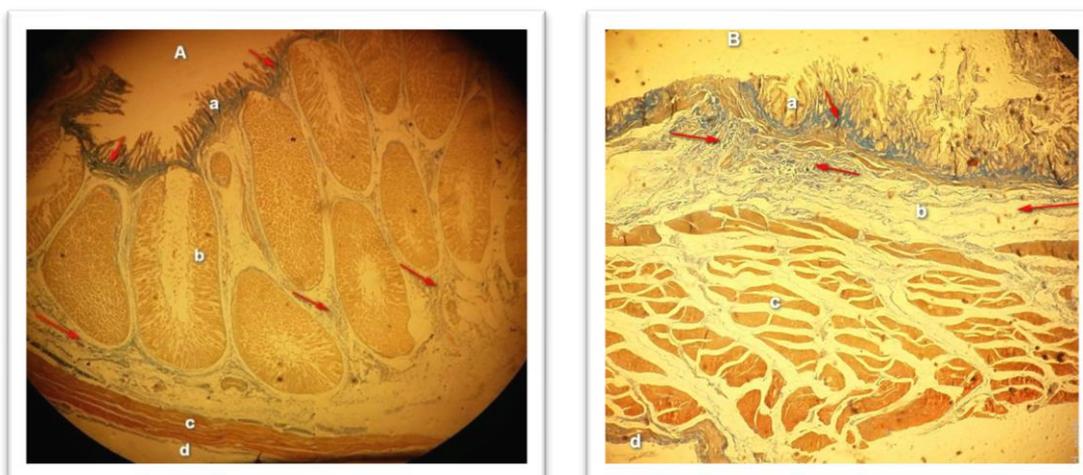


Fig. 4. (A). Proventriculus wall of falcon showed a. T. mucosa, (red arrow connective tissue) b: T. submucosa (red arrow connective tissue), (B): Gizzard of falcon showed a. T. mucosa (red arrows connective tissue) b. T. submucosa (red arrows connective tissue). Mallory stain 10X.

DISCUSSION

Our histological results disclosed that the structure of the proventricular and of the gizzard is nearly similar to those of other birds, according to what is described by several authors (Hodges 1974) and (Fieri 1984). So, we could observe that the mucous membrane of the proventriculus and of the gizzard present several folds, as in other birds (McLelland 1979; Fieri 1984) the folds of the gizzard are lower. In the gizzard, among several kinds of birds, the folds of the mucosa are described as longitudinal ((Jain 1976) in *P. krameri*; (Menin, David et al. 1990) in *Coragyps atratus foetens*), and high ((Lima 1979) in *Columba livia*) but in our study in the falcon, the folds of proventriculus in the form of elongated folds which separated by grooves due to presence of well-developed thick longitudinal layer of tunica muscularis, while the folds of gizzard in form of low fold with not characteristic shape. (King and McLelland 1975) and (Bacha and Bacha 2000) reported that the mucosa of proventriculus is thrown into folds and sulci. (Hodges 1974) agrees with that (Banks 1993) reported that the tunica mucosa of proventriculus is extensively folded into flattened ridges separated by grooves.

In our study the mucous membrane of falcon gizzard is clear developed low folds, whereas (Vittoria and Richetti 1974) noted that the gizzard of carnivorous and omnivorous birds, as composed by circular crypts which unfolds. (Akester 1986) stated that in *Gallus* the elliptical crypts may reach the shape of large and narrow fissures.

The folds of mucous membrane of the proventricular lining epithelium of simple columnar type, which coincides with the observations of most of the authors ((Calhoun 1954; Selander 1963). The folds of gizzard is lining epithelium of simple prismatic type. Similar to our observations (Rossi, Baraldi-Artoni et al. 2005) in

partridge, (Glerean and Katchburian 1964) describe a high prismatic type epithelium of *Gallus*. (Hodges 1974) and (Elizabeth and Fredric 2001) noted that the gastric epithelium of proventriculus is simple columnar. (Bacha and Bacha 2000) agree with that except that at the base of the sulci, where it is cuboidal. (Mina, Paria et al. 2011) in ostrich noted that it is simple columnar.

(Lima and Sasso 1985) described cuticle in owl as a thick covering plate, lining the mucous membrane of the gizzard, agree with (Catroxo, Lima et al., 1997) in red-capped Cardinal, (Dyce, Sack et al. 2010). In our observation, we found that, over the small area of the mucous membrane of gizzard, which is situated at the area around the pyloric opening only is a small weak cuticle layer while the rest of the luminal surface not have cuticle membrane, in which this cuticle is sloughed and shed small fine area and very thin membrane and highly closely adherent to the lining surface of gizzard and it is often green or yellow in color.

In our study the tunica muscularis of proventricular in the falcon, found well-developed, presents an inner layer of longitudinal muscular fibers and another outer, of circular fibers, in which, this thick muscular layer occupy the greater part of the thickness of proventricular wall. In proventriculus of birds in general, the muscle tunic as constituted by external layer of longitudinal muscle fibers and a circular inner layer, have noted (Calhoun 1954). (Hodges 1974) reported that the inner circular layer is thicker than the external longitudinal. (Turk 1982) in owl noted that a well-developed tunica muscularis is arranged as inner circular and outer longitudinal layers of smooth muscle. (Denbow 2000) noted that the outer longitudinal layer is poorly developed or absent in parrots, waterfowl and some passerines.

Our result, we find the muscle tunic of gizzard is constituted by an inner circular layer and longitudinal arranged external layer, much developed, our results agreed to some authors (Fieri 1984), in *Nothura maculosa*, (insectivorous and granivorous bird); Rocha in *Speotyto cunicularia* (carnivorous bird); (McLelland 1979; Turk 1982), in birds in general. Some observations in Literature refer to the presence of three layers in the muscle tunic; (Espinola and Galliussi 1990) described three layers in the muscle tunic of gizzard of *Fulica armillata* (granivorous bird). Also related the existence of three muscular layers in the gizzard of *Uroloncha domestica* (Imaizumi and Hama 1969).

Histochemical results of the proventriculus stricture strongly positive to PAS stain These results were comparable to those observed by Hamdi *et al.* (2013) in the glandular stomach of the black-winged kite (*Elanus*

caeruleus). Similarly, in the proventriculus of the quail, Zaher *et al.* (2012) observed PAS-positive mucin granules occupying the supra-nuclear area of the cells in the surface lining epithelium of the mucosal folds. Proventriculus results with Tolidin stain coincided well with those observations in domestic fowl (Abumandour, 2014) and in the ducks (Shyla *et al.*, 1992).

The results of the ventriculus stricture positive reaction with PAS stain was similarly observed by Hamdi *et al.* (2013) in the ventriculus of the black-winged kite (*Elanus caeruleus*) and Selvan *et al.* (2008) in the Guinea fowl (*Numida meleagris*). Ventriculus results with Tolidin stain coincided well with Alcian blue stain was similarly, observed in other birds such as Guinea fowl (*Numida meleagris*) (Selvan *et al.*, 2008).

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