



HISTOMORPHOLOGICAL STUDY OF PROVENTRICULAR AND GIZZARD IN ADULT STARLING BIRD (*STURNUS VULGARIS*)

Suhaib A.H. AL-Taai* and Muhammed S. Hasan

Department of Anatomy & Histology, College of Veterinary Medicine, University of Baghdad, Iraq.

Abstract

The stomach of starling bird (*Sturnus vulgaris*) has two external chambers. The first chamber is called the proventriculus (glandular stomach), which is produced the gastric juices. Either the second chamber is mechanical part and which called ventriculus or gizzard. Anatomically the glandular part of stomach is longitudinal expansion of esophagus with appeared external gastric papillae. The location of proventriculus is caudally toward gizzard. The ventricular stomach was spherical sac-like and no surrounded by adipose tissue and larger size than proventricular. The located of gizzard was posteriorly proventriculus toward left side of midline plane, which was covered via part of liver lobe. The muscular stomach had thick wall, internal surface of the gizzard was surrounded by yellow cuticle layer. The proventriculus was thin-walled and short (the mean length was 2.82mm, (1.06g) in weight, (0.5cm³) in volume. The proventriculus wall was composed from four regions, that are tunica mucosa, submucosa, tunica muscularis and tunica serosa respectively. The average thickness of entire tunics was 3146µm, 13270µm, 769 µm and 113 µm, whereas the Gizzard measurements was (3.22mm) in length, (177.32g) in weight and (0.5Cm³) in volume. The ventriculus's wall was constructed from tunica mucosa, submucosa, tunica muscularis and tunica serosa. The average thicknesses of these tunicae about 1556µm, 1765µm, 3256µm and 118µm, respectively.

Key words : Starling bird, proventriculus, gizzard, histology.

Introduction

There more than eight thousand types of the birds distribution around the world. These are different in strain, order and nature of the diet (King and Mclelland, 1975). The starling birds are wide spread and seasonal birds belong originated western Europe, central Asia, Iceland, north India, southern Australia, south Africa and Jamaica (Purcell *et al.*, 2002). Generally, the gastrointestinal tract of birds is variable from bird to other bird according to nutrition and strains which belong that the birds to compare with mammalian, the stomach of birds modified depending on diet nature (Davis, 2007). The important parts of digestive system is the stomach which consist of two parts: the first part is called proventricular and second parts is named gizzard (muscular part). The location of the glandular stomach are forward the muscular stomach in the birds and so shape of the glandular stomach is different in the birds (Thomson, 1996). The proventricular

stomach in chick is spindle-like and continues with esophagus (King and Mclelland, 1975). The internal surface of the glandular stomach (proventriculus) is characterized a raised gastric papillae on upper part of surface, this papillae secreted gastric juices which is mixture of digestive enzyme, hydrochloride acid and mucine (Ahmed *et al.*, 2009 and Sherri, 2003). Histologically, the stomach in birds are consist of four tunica : first tunica is called mucosa, submucosa, muscularis and tunica serosa respectively (Catroxo *et al.*, 1997).

Materials and Methods

Thirteen birds were used to conduct in our study. These birds were bought from Ghizzel market of Baghdad. The birds are put inside cages in my house to purpose current study. Weight of the birds were measured before their euthanized. The birds were sacrificed after give injection sodium pentobarbitone (70 mg/kg) at intravenous (Mitchell and Smith, 1991). We fixed the specimen on

*Author for correspondence : E-mail : dr.suhaibaltaai@gmail.com

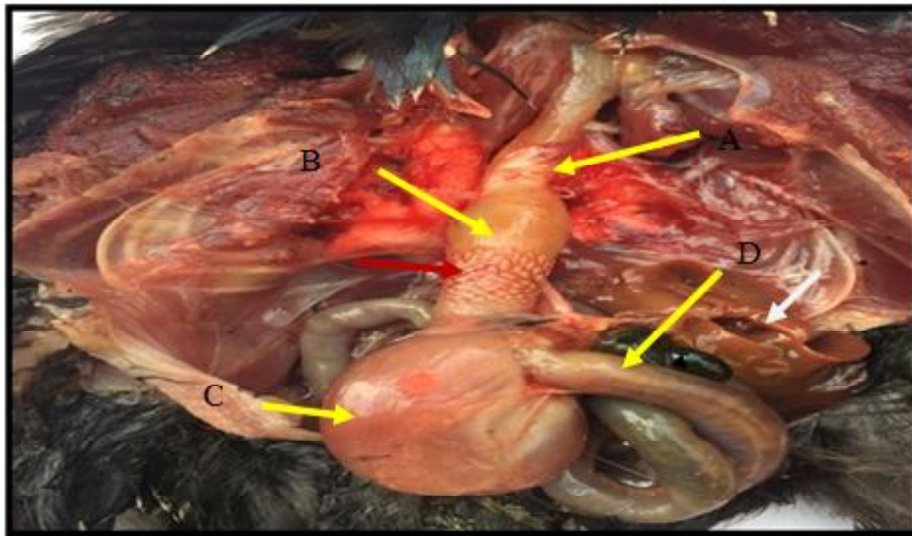


Fig. 1 : Morphological picture of starling bird shows esophagus (A), proventricular (B), gastric papillae (red arrow), gizzard (c), duodenum (d) and liver (white arrow).

dissected board for dissection and later we are done mid-line incision in abdomen region and after that we washed viscera of bird by tap water for clean from blood and other adheres particle and pressure by hands on two sides for remove contents of the stomach, so that, after that we removed the proventricular and ventricular stomach from the body for the morpho-histological preparation. Then the study are used the measurements for length, weight and volume of the stomach (proventricular and ventricular), the length are measured by ruler while the weights of bird were measured via sensitive electron balance. The volume are measured by using the volumetric cylinder contain the water after the sample was dipped in cylinder and read amount of the water before and after putting the sample in volumetric cylinder was read. For histological measurements, the study were used buffer formalin for fixative the samples after dissected birds. 10./ formalin are used for keeping samples. The histological technique for the sample dehydration by passing them across alcohol for each two hour (70, 80, 90 and 100./) and then that specimen is clearing by xylene through one hour after that embedded inside paraffin wax and block and the section serially about (6 μ m) in size and then staining by Hematoxylin and Eosin for general structure, Periodic Acid Sschiff and van Gieson stain (Luna, 1968).

Results

The stomach of starling birds consist of two chambers, the first chamber is called proventricular (glandular stomach), whereas the second chamber is named ventricular (muscular stomach) (fig. 1). The present study showed gastric papillae, which is appeared

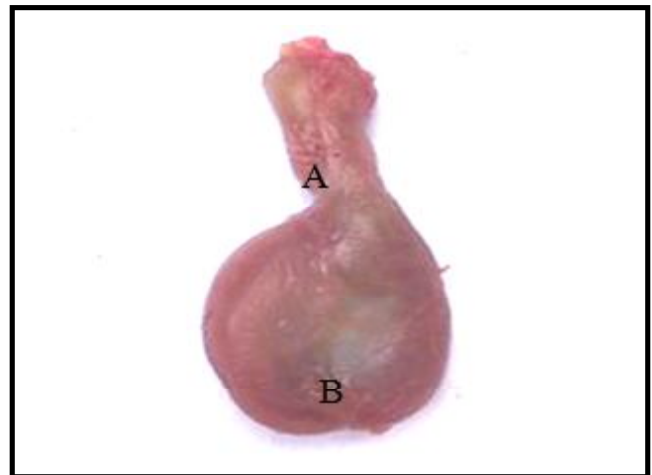


Fig. 2 : Morphological picture of starling bird showed proventricular (A) and ventricular (B).

on external wall of proventricular that is secreted gastric juice (figs. 1, 2). The muscular portion of stomach have mechanical function (figs. 1, 2). Morphologically the present study is explained the location of the stomach; the proventricular is situated forward the gizzard (muscular part of stomach) and continues with esophagus caudally (fig. 1). The proventricular is characterized longitudinal in shape and expansion from esophagus with appeared papillae extensions (figs. 1, 2). The ventricular stomach is spherical sac in shape and no surrounded by adipose tissue and larger size than proventricular and located to proventricular posteriorly toward left side of midline plane and covered via part of liver lobe (figs. 1, 2). The study included anatomical measurements, mean of body length, bird weight and length and weight proventricular and gizzard with measured their volumes. The mean of length (12.80mm), (132.15g), (2.82mm),

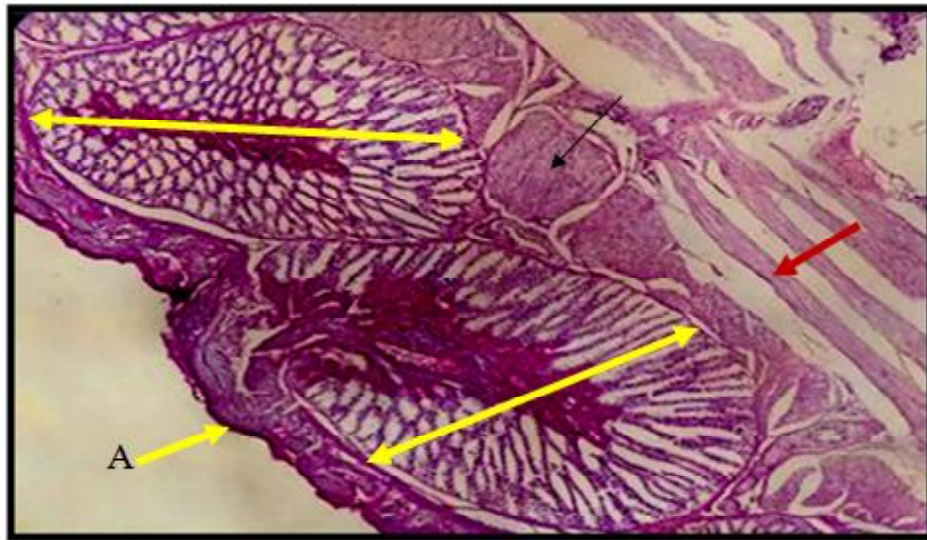


Fig. 3 : Cross section of glandular stomach of starling bird shows proventricular glands (←→), simple columnar epithelium (A), circular smooth muscle fibers (small arrow) and longitudinal muscle fibers (red arrow) PAS stain 100x.

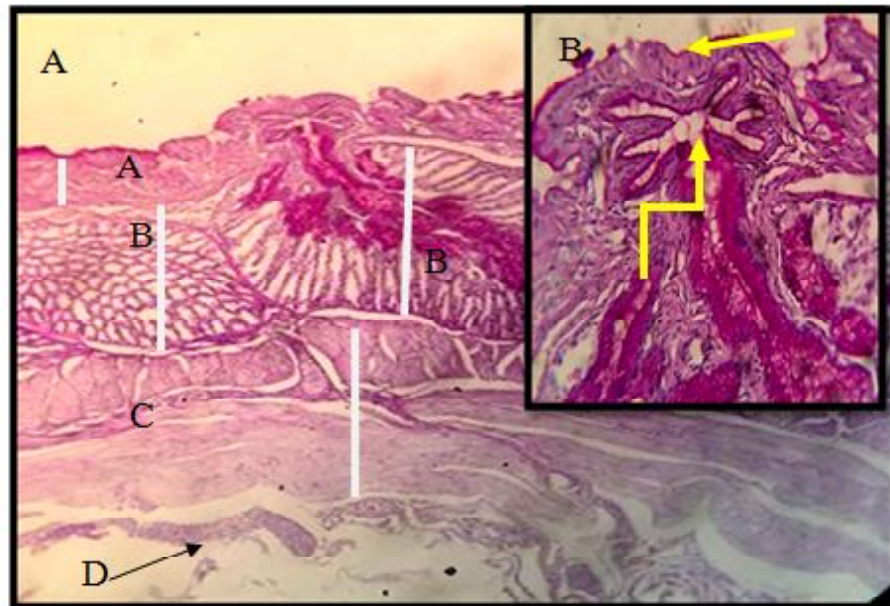


Fig. 4 : Cross section of glandular stomach shows A): tunica mucosa (A), tunica submucosa (B), tunica muscularis (c) and serosa (D) 100x. (B) is magnifying of showing ducts of the glands (↕) and simple columnar cells (→) PAS stain 400x.

(1.06g), (0.5cm³) in proventricular stomach, but mean of measurement in gizzard was (3.22mm) in length, (177.32g) in weight and mean of volume was (0.5cm³). The present study explained the glandular stomach of starling bird is included four layers is called tunicae: first layer is called tunica mucosa, tunica sub mucosa, muscularis and serosa respectively (figs. 4, 6). The histological findings of starling bird showed surface of *Tunica mucosa* of glandular stomach was lined by simple columnar epithelium and appeared invagination mucosal folds on the surface of mucosa (figs. 5, 6). Its mean thickness (3146µm), this tunicae mucosa was included epithelium, lamina propria and muscularis layers, this

epithelium is lined by simple columnar (figs. 3, 4). Lamina propria is included connective tissue, blood and lymphatic vessels. The propria is extended toward folds of mucosa which is included simple gastric tubular gland which is mucus secretion (fig. 5A and B). These glands are drained (opened) inside the lumen on the epithelial surface (fig. 5). Muscularis mucosa is consisted of smooth muscle fibers which spread along lamina propria which be scattered and bounded apical portion of deep sub mucosal glands (fig. 5A). *Tunica submucosa* is constructed by the connective tissue with blood vessels. The mean of thickness for tunica submucosa (13270µm). This tunica is largest than other wall thickness of tunicae

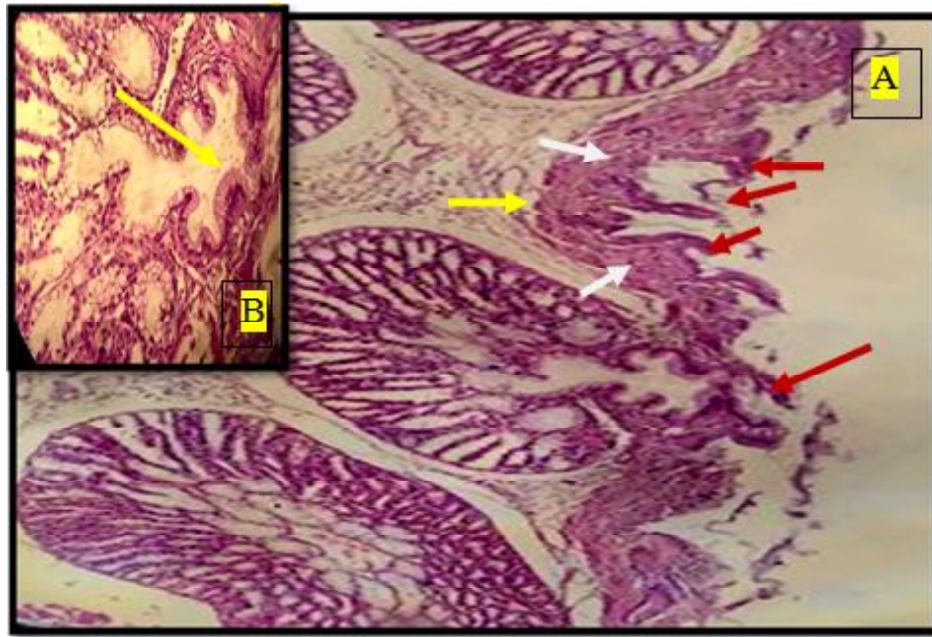


Fig. 5 : Cross section of glandular stomach (A) shows mucosal folds (red arrows), Lamina propria (white arrow) and muscularis (yellow arrow) H&E 100x. (B) Is magnifying shows epithelium is lining of primary duct (H&E stain 400x)

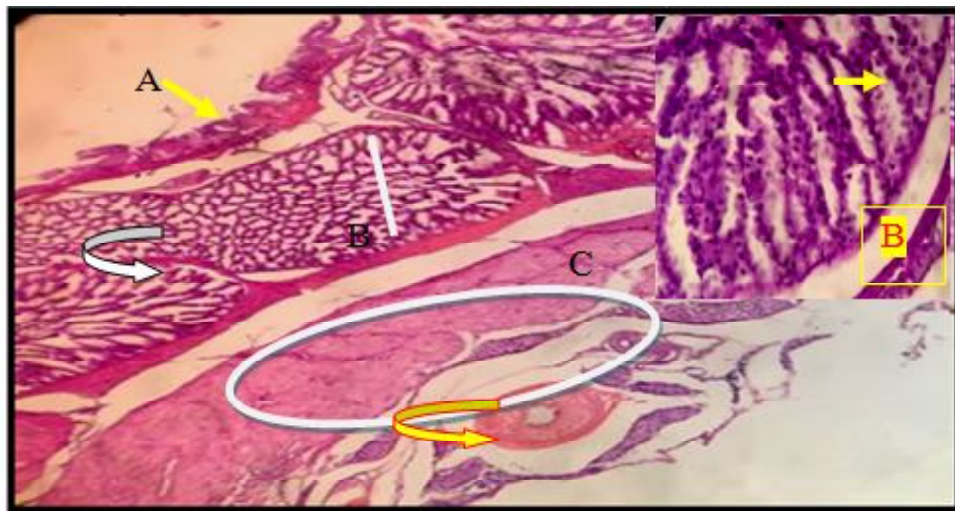


Fig. 6 : Cross section of glandular stomach shows mucosal folds (A), proventricular glands (B), septa between the glands (white curved arrow), smooth muscle fibers (C) and blood vessels of serosa (curved yellow arrow). H&E 100x. (B): magnifying is showing groups of secretory units or lobules (yellow arrow) H&E 400x.

proventriculus and contain on submucosal (proventricular) glands, which is occupied most submucosae (fig. 3). These the glands are composed from group of the small secretory units or lobules, which are characterized numerous rounded and polyhedral lobule in shape. The glands are separated between them by connective tissue called septa (fig. 6). *Tunica muscularis* is mean of thickness about (769 μm). The microscopic examination showed that tunicae muscularis consist of two layers from muscles; the outer layer is called longitudinal smooth muscle fibers and other inner layer, which is included circular smooth muscle fibers (fig. 3). These muscles

are supplied a rich blood vessels and nerves. The last tunicae is called *serosa*, mean of thickness was about (113 μm), which is constructed many connective tissue with blood vessels and nerves (fig. 6). Histological results of the ventriculus wall (gizzard) in the adult starling birds are included four layers of tunics similar that presented in the glandular stomach (fig. 7). *Tunica mucosa* is considered the first layer of tunics, which occur invagination extend into the lamina propria then forming variety of gastric pit size. Then the gastric pits are extended toward thickness of mucosa (figs. 8 & 9). Mean height of thickness mucosa about (1556 μm).



Fig. 7 : Cross section of gizzard's wall shows cuticle layer (white star), tunica mucosa (blue arrow), tunica sub mucosa (red arrow) and muscularis (small arrow) H&E stain 40x.

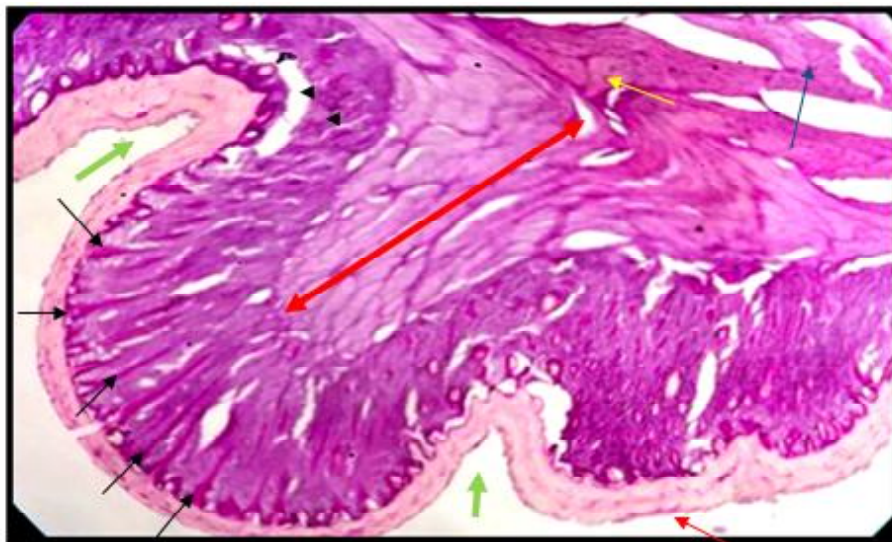


Fig. 8 : Cross section of gizzard's wall shows cuticle layer (small red arrow), tunicae sub mucosa (large red arrow), muscularis layer (yellow arrow), gastric pits (small black arrows), lumen (green arrows), lamina properia (arrow heads) and tunica serosa (blue arrow). PAS stain 100x.

Generally, the tunica mucosa is constructed of three regions; epithelium, lamina propria and muscularis mucosa. The epithelia lined the muscular stomach are called simple columnar in addition to simple tubular gland (figs. 9 & 10). The epithelia are covered by cuticle layer, which is protected the epithelium from the exposure, also this layer found in most the birds (figs. 7, 8 & 9). The lamina propria is constructed from loose connective tissue with spread simple gastric glands, rich blood and nerve pluxes (figs. 8 & 9). The muscularis mucosa is included bands of the smooth muscle fibers separated between lamina properoia and tunicae sub mucosa. Tunica submucosa of ventriculus is a rich dense connective tissue with supplied by blood vessels and nerves (fig. 8). Mean of sub mucosa thickness was (1765 μ m). Third layer of tunicae is composed from smooth muscle fibers, this layers arranged by external

layer be longitudinal layer and inner layer is circular smooth muscle (figs. 8 & 10). The mean this tunicae about (3256 μ m) in thickness. Either the last layer is called tunica serosa is constructed by loose connective tissue, blood vessels lymphatic vessels and nerve, which is covered by simple squamous mesothelium (figs. 7 & 8). The mean thickness of this layer about (118 μ m).

Discussion

The stomach of the starling bird (*Sturnus vulgaris*) is consisted of two external distinguishable regions that are glandular (proventriculus) stomach, which give the gastric juice and second chamber which that muscular (gizzard) stomach, which is characterized mechanical function, this result similar with finding Striated Scope Owl (*Otus Scors brucei*) bird (Al- Saffar and Eyhab, 2014). The present study in starling bird showed gastric

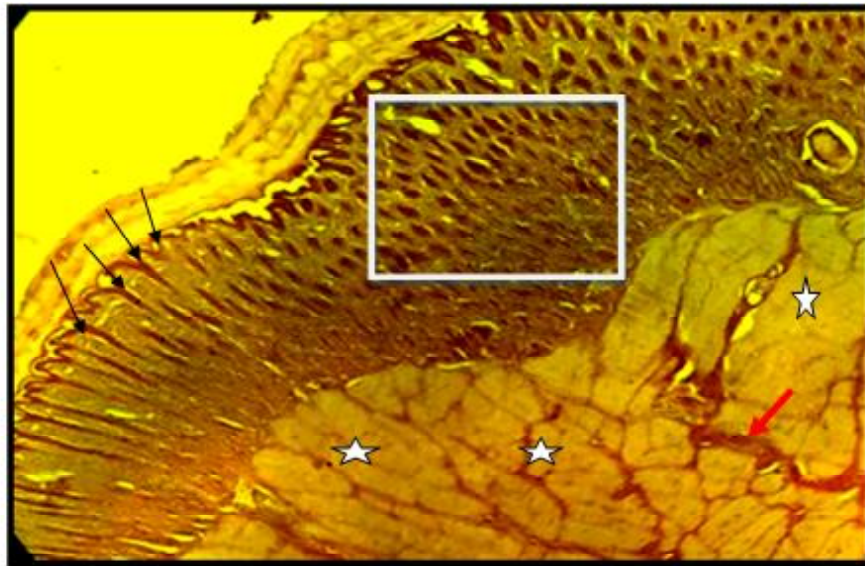


Fig. 9 : Cross section of gizzard's wall shows gastric pits (small black arrow) and simple tubular glands (white box), tunicae submucosa (white star) and collagen fibers (red arrow). Van Gieson stain 100x.

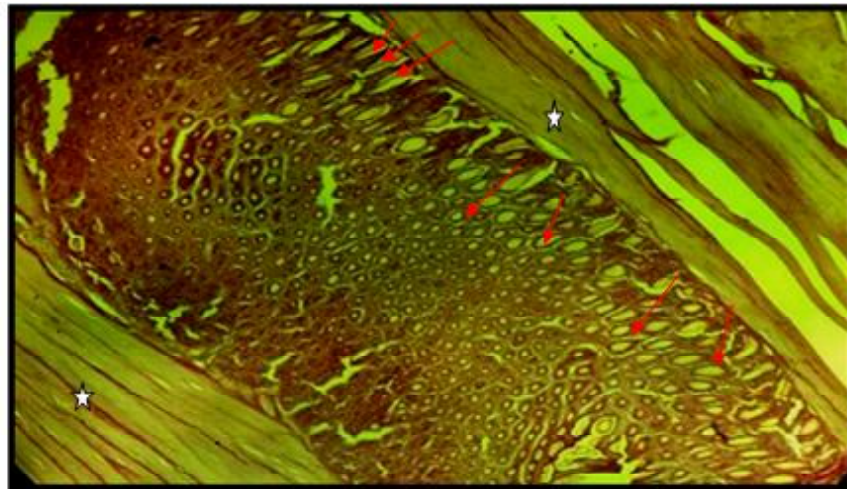


Fig. 10 : Longitudinal section of gizzard's wall shows simple gastric glands (red arrows) and longitudinal smooth muscle fibers (white stars). Van Gieson's stain 100x.

papillae which is appeared on external and internal wall of proventricular that is secreted gastric juice, this finding is same with Avain (Rossi *et al.*, 2005). Also, this result is different with common Moorhen bird (Eman *et al.*, 2015). The proventriculus is situated forward the gizzard (muscular part of stomach) and continues with esophagus caudally. The proventriculus is characterized longitudinal in shape and expansion from esophagus extensions, this result accepted with Common Moorhen bird, which the proventriculus appeared as short longitudinal portion and situated behind esophagus forward gizzard stomach, the current study no parallel previous in chicken which said that proventriculus appeared elliptical-like and organ lying upper part of liver (Davis, 2007). The histological preparation proved, the stomach wall constructed by four layers of typical tubular tract; tunicae mucosa, submucosa,

muscularis and adventitia respectively, this results are similar with those found in the glandular stomach of Guinea fowl (Selvan *et al.*, 2008). The histological findings of starling bird showed surface of *Tunica mucosa* of glandular stomach was lined by simple columnar epithelium and appeared invagination mucosal folds on the surface of mucosa and this tunicae is constructed from epithelia, lamina propria and muscularis, these findings are same to those watched in jungle fowl (Kadhim *et al.*, 2011). The epithelium of proventriculus is simple columnar, this trait accepted with said by in Guinea fowl (Selvan *et al.*, 2008). The laminae propria is extended toward folds of mucosa which is included simple gastric tubular gland, which is mucus secretion. These glands are drained (opened) inside the lumen on the epithelial surface, a result same with to those of the

fowl (Hodges, 1974). *Tunica submucosa* is constructed by the connective tissue with blood vessels and group of proventriculus glands, this finding agreed with features of submucosal glands in proventriculus wall in chicken (Jackwood, 2003). The microscopic examination showed that tunicae muscularis consist of two layers from smooth muscle fibers. These findings similar to those of (Samuelson, 2007). The last tunicae is called *serosa*, which is constructed by many connective tissue with blood vessels and nerves, these notes are good coincided with those in the glandular organ of the burrowing owl (Rocha and Lima, 1998). The ventricular (gizzard) stomach is spherical sac in shape and no surrounded by adipose tissue, these findings are not consistence with previous states those mention from Striated Scope Owl (*Otus Scors brucei*) (AL-Saffar and Eyhab, 2014) and accepted with previous findings those said with a vain ventriculus, which no cover by fatty tissue (Rossi *et al.*, 2005). The present study found smooth muscle fibers in wall's gizzard and also keratinoid layer of mucosal surface, these findings are different with previous finding of AL-Saffar and Eyhab (2014), whom mentioned in Striated Scope Owl (*Otus Scors brucei*) which said the gizzard wall absent keratinoid lining of mucosal surfaces. Also this result is not accepted with observations in *Accipiter nisus*, AL Sheshani (2006), whom said that kolin lining do not envelope the epithelium surface of ventriculus, and parallel with states (Zaher *et al.*, 2012) whom said the cuticle layer is well developed thick and strong in the common quail. The ventriculus (gizzard) wall of starling bird is included four layers is called tunics, this trail is similar to proventriculus, also parallel whom said with observed by Abbas *et al.* (2012). The epithelia lined the muscular stomach are called simple columnar with simple tubular gland. Such as results are appeared with those mentioned in *Rhynchotus rufescens* by Rossi *et al.* (2005), which is omnivorous bird. *Tunica submucosa* of ventriculus is a rich dense connective tissue with supplied by blood vessels and nerves, these findings are same with those notes in the Red-Capped Cardinal (*Paroaria gularis gularis*) by Ahmed *et al.* (2009). The muscularis tunicae is composed from smooth muscle fibers, this region is arranged by external layer which be longitudinal, while inner layer is circular smooth muscle, this findings same as those observation in coot bird by Bank (1993). Either the last layer is called tunicae serosa is constructed by losse connective tissue, blood vessels lymphatic vessels and nerve. This results accepted with those previous report in Red-Capped Cardinal (*Paroaria gularis gularis*) and *Rhynchotus rufescens* (Catroxo *et al.*, 1997; Rossi *et al.*, 2005).

References

- Abbas, Lafi Batah, Hanan Ali Selman and Mustafa Saddam (2012). Histological study for stomach of coot bird *Fulica atra*. *Diyala Agricultural Sci. J.*, **4 (1)** : 9 – 16.
- Ahmed, Y. A. E., G. Kamel and A. A. E. Ahmed (2009). Histomorphological studies on the stomach of the Japanese quail. *Asian J. Poult. Sci.*, **5(2)** : 56-67.
- Al-Saffar, F. J. Eyhab and R. M. Al-Samawy (2014). Microscopic and morphometric study of the proventriculus and ventriculus of the Striated Scope Owl (*Otus Scors brucei*) in Iraq. *Kufa Journal For Veterinary Medical Sciences* **5(2)**.
- AL Sheshani, A. S. Y. (2006). Anatomical and histological comparative study of alimentary tract in two types of bird's grainivorous bird, (*Columba livia* Gmelin, 1789) and carnivorous bird (*Accipiter nisus* Linnaeus, 1758). *M.Sc. Thesis*, University of Tikrit.
- Banks, J. W. (1993). *Applied Veterinary Histology*. 3rd edition. Mosby Year Book Co. U.S. A. p: 356-358.
- Catroxo, M. H. B., M. A. I. Lima and C. E. M. P. D. M. Cappellaro (1997). Histological aspects of the stomach (proventriculus and gizzard) of the Red-Capped Cardinal (*Paroaria gularis gularis*). *Rev. Chill. Anat.*, **15(1)**: 19-27.
- Davis, S. (2007). Endozoochory in the subtropical thicket: Comparing effects of species with different digestive systems on seed fate. *M.Sc. Thesis*, Faculty of Science, Nelson Mandela Metropolitan University.
- Eman Sami Jassem, Adel J. Hussein and Alaa A. Sawad (2015). Anatomical, histological and histochemical study of the proventriculus of common moorhen (*Gallinula chloropus*). *Bas. J. Vet. Res.*, **14(4)**.
- Hodges, R. D. (1974). *The histology of fowl*. Academic press, Lodo. Pp:36-63.
- Jackwood, M. J. P. (2003). Proventriculitis in broiler chicken and its relationship to infectious bursal disease virus. *Ph.D. Thesis*, University of Georgia.
- Kadhim, K. K., A. B. Z., Zuki, M. M. Noordin, S. M. A. Babjee and M. Zamri-Saad (2011). Activities of amylase, trypsin and chymotrypsin of pancreas and small intestinal contents in the red jungle fowl and broiler breed. *African J. Biotech.*, **10(1)** : 108-115.
- King, A. S. and J. Mclelland (1975). *Outline of Avian Anatomy*. 1st edition Bailliere, Tindall, London pp. 33-39.
- Luna, L. G. (1968). *Manual of histologic staining method of armed forces institute of pathology*. 3ed. New York, U.S.A. p. 123.
- Mitchell, M. A. and M. W. Smith (1991). The effects of genetic selection for increased growth rate on mucosal and muscle weights in the different regions. *Kufa Journal For Veterinary Medical Sciences* **5(2)**. 2014 11 of the small intestine of the Domestic fowl (*Gallus domesticus*). *Comp. Biochem. Physiol.*, **99A** : 251-258.

- Purcell, K. L., J. Verner and S. R. Mori (2002). Factors affecting the abundance and distribution of European starlings at the San Joaquin Experimental Range. Pages 305- 321 in R. B. Standiford, D.D. McCreary and K. L. Purcell, technical coordinators. Oaks in California's Changing Landscape. USDA Forest Service Gen. Tech. Rep. PSW-GTR184. Albany, CA.
- Rocha, S. and M. Lima (1998). Histological aspects of the stomach of Burrowing owl. *Kufa Journal For Veterinary Medical Sciences*, **5(2)** : 2014 11 *Rev. Chil. Anat.*, **16(12)**: 191- 197.
- Rossi, J. R., S. M. Baraldi, D. Oliveira, D, da Cruz C., V. S. Franzo and A. Sagula (2005). Morphology of glandular stomach (*Ventriculus glandularis*) and muscular stomach (*Ventriculus muscularis*) of the partridge *Rhynchotus rufescens*. *Ciencia Rural*, **35** : 1319–1324 .
- Samuelson, D. A. (2007). *Textbook of Veterinary Histology*. Saunders Elsevier, China. Pp.: 348-352.
- Selvan, P. S., S. Ushakumary and G. Ramesh (2008). Studies on the histochemistry of the proventriculus and gizzard of post-hatch Guinea fowl (*Numida meleagris*). *Internat. J. Poult. Sci.*, **7** : 1112–1116.
- Sherri, C. (2003). Avian Digestive System. Holistic bird. News letter. Devoted to health and healing of a vian mind, body, spirit, **3** : 44-53.
- Thomson, D. S. (1969). Histogenesis of the proventricular submucosal gland of the chick as revealed by light and electron microscope. *The Ohio Journal of Sci.*, **69(2)** : 74-84.
- Zaher, M., A. W. El-Ghareeb, H. Hamdi and F. Abu Amod (2012). Anatomical, histological and histochemical adaptations of the avian alimentary canal to their food habits: I- *Coturnix coturnix*. *Life Sci. J.*, **9(3)** : 253-275.