Research Article

Proceeding of 8th International Scientific Conference, College of Veterinary Medicine University of Basrah, Dec. 7-8, 2022,Iraq.

BASRAH JOURNAL OF VETERINARY RESEARCH, 2022, 21(S1):185-197
https://bjvr.uobasrah.edu.iq/

Comparative Anatomical, Histological, and Histochemical Study of the Duodenum between Common Moorhen (*Gallinula chloropus*) and Domestic Fowl (*Gallus domesticus*)

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Accepted: Nov. 2022

Abstract

This work was designed to conduct an anatomical, histological, and histochemical comparative study of the duodenum between common moorhen and domestic fowl. Thirty birds of common moorhen and thirty birds of domestic fowl that were obtained from a commercial market (Al Basra city) were used in this study, and the work was conducted at the veterinary medicine collage, University of Basra. The anatomical study showed that the duodenum was a convoluted tube that extended as a U shape and held the pancreas between the two arms of the duodenum. The duodenum has similar histological structures in both domestic fowl and common moorhen where the wall of this tubular organ is composed of four layers (tunica mucosa, sub mucosa, muscularis externa, and serosa). The results of statistical analysis revealed significant differences at level $P<0.05$ in the thickness of (tunica mucosa, crypts, tunica sub mucosa, and tunica muscularis) between two birds. The histochemical study of the duodenum revealed the carbohydrates distribution on the mucous layer and columnar epithelium and around the intestinal glands, while the glycogen granules distribution around the glands and muscle layers.

Key words: Duodenum, *Gallinula chloropus, Gallus domesticus*

Introduction

The small intestine is the primary site for enzymatic breakdown and absorption of carbohydrate and amino acids, so it may play an important role in increasing the digestion rate and minimizing the digestive load (1). The small intestine consists of the duodenum, jejunum, and ileum. The duodenum took a U shape while the jejunum and ileum twisted several times (2). The duodenum of birds is located on the caudal part at the left side of the abdominal cavity, extending as a U- shape tube with proximal and distal parts (descending and ascending parts) and surrounding the pancreas (3). Histologically, the wall of the gastrointestinal tract consists of tunica mucosa, tunica sub mucosa, tunica muscularis, and tunica serosa or adventitia. The thickness of these layers different according to the region in the digestive tract, species, and type of diet (4). The domestic fowls are probably the most numerous birds in the world because of their importance as an important source of protein. In addition, some people breed them for hobbies (5). Moorhen (Gallinula chloropus) was a marine bird descends from the family of Rallidae. They visit Iraq in winter in the southern marshes.(6)

Materials and Methods:

Thirty adult healthy common moorhens (*Gallinula chloropus*) and thirty adult healthy domestic fowls (*Gallus domesticus*), which were obtained from a commercial market in Al Basra city, were used in this study. After total anesthesia by inhalation of chloroform, making longitudinal incisions at the midventral surface and heart puncture to insure complete bleeding occur, the gastrointestinal tract was removed from the esophagus to the vent. Ten birds of common moorhens (Gallinula chloropus) and ten domestic fowls (Gallus domesticus) are used for general internal and external features of the duodenum and to study the length and width of this organ by using Vernia. For histological study, the gastrointestinal tract was carefully dissected and the small intestine removed and fixed in 10 % formalin, then dehydrated with a series concentrations of ethyl alcohol (70%, 90%, 100%, 100%) and embedded in paraffin wax, then sectioned by rotary microtome to 5-6 micrometers (7). The histological sections were then stained with hematoxylin and eosin and special stains (Van Gesion, Masson trichrome, Best Carmin and PAS) (8). Microscopic measurements were used to study and compare between two birds (9), then the results were analyzed statistically using Minitab program testing values using the significant difference $P<0.05$. test rate of SPSS.

Results

The anatomical study revealed that the duodenum was a convoluted tube extended as a U shape, connected with the gizzard cranially by the pyloric sphincter, and with jejunum caudally. Hold the pancreas between the two arms of the duodenum (Fig.1,2). The average lengths of the duodenum in common moorhen and domestic fowl were (7.80± 1.6903mm), (16.600±10.8766mm) respectively, while the average width of the duodenum was (6.0100± 1.76562 mm) in common moorhen and (10.178± 1.38907 mm) in domestic fowl (Table 1). The histological study of the duodenum of domestic fowl and common moorhen showed that the wall of this tubular organ is composed of four tunics: (tunica mucosa, sub mucosa, muscularis externa, and serosa).

Tunica Mucosa: The tunica mucosa of the duodenum subdivided histologically into two layers (epithelium and lamina propria). This tunica is modified as finger- like projection villi in common moorhen (Fig. 3), also in domestic fowl having the same tunic modification (Fig.4) .In domestic fowl, the average villi length is (11.45±2.54) micrometers, and the thickness of the tunica mucosa is (121.95±20.72) micrometers, whereas in common moorhen, the average villi length is (10.80±4.75) micrometers, and the thickness of the tunica mucosa is (92.75 ±20.67) micrometers (Table.2). The results of statistical analysis revealed significant differences at level P<0.05 in the thickness of the tunica mucosa between two species of birds. The type of epithelium found in the tunica mucosa of the small intestine was simple columnar epithelium with goblet cells. In the center of the villi, a core of connective tissue compresses lamina propria. This layer contains tubular glands (crypts of Lieberkühn) which extend from the base of the villi into the underlying lamina propria (Fig.3,4). The average mean of the crypt thickness in common moorhen is (5.10±1.21) micrometers, while in domestic fowl it is (10.00±7.39) micrometers (Table.2).The results of statistical analysis revealed significant differences at the level of P<0.05 in the thickness of the crypts between common moorhen and domestic fowl. In both common moorhen and domestic fowl, the maculates mucosa is not clearly visible (Fig.3,4).

Tunica sub-Mucosa: The submucosa was a thin; it consists of connective tissue with blood and lymphatic vessels (Fig 3,4). The average mean of sub mucosal thickness in common moorhen is (4.50±0.76) micrometers, while in domestic fowl it is (3.10±1.58) micrometers (Table 2). The results of statistical analysis revealed a significant difference at the level of P<0.05 in the thickness of the tunica submucosa between common moorhen and domestic fowl.

Tunica Muscularis: The tunica muscularis form smooth muscle fibers arranged in circular manner (Fig.3,4). The average thickness of this tunic in common moorhen is (20.20±5.04) micrometers, while in domestic fowl it is (11.15± 2.39) micrometers (Table 2). The statistical analysis revealed a significant difference at the level of P<0.05 in the thickness of the tunica sub mucosa between common moorhen and domestic fowl.

Tunica Serosa: The last layer of the wall of small intestine is composed of simple squamous epithelium with flattened nuclei in the connective tissue (Fig.3,4). The average thickness of this tunic in common moorhen is (2.10±1.02) micrometers, while in domestic fowl it is (1.80±0.83) micrometers (Table 2). The histochemical study of the duodenum revealed the distribution of carbohydrates on the mucous layer and columnar epithelium and around the intestinal glands, which gave positive results for the Schiff reagent. The section of duodenum stained with Best carmine stain showed the distribution of glycogen granules around the glands and muscle layers (Fig.5,6). Table (1): the length and width (mm) of duodenum of common moorhen and domestic fowl.

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Parameters	Species	Mean± Stander Deviation
Length	Common moorhen	7.080± 1.6903
	Domestic fowl	16.600±10.8766
Width	Common moorhen	6.0100± 1.76562
	Domestic fowl	10.178±1.38907

***Significant Differences P<0.05.**

Table (2): The dimensions (micrometer) of the duodenum of common moorhen and domestic. Fowl.

Duodenum	Species	Mean Stander Deviation
Tunica mucosa	Common moorhen	92.75 ±20.67
	Domestic fowl	±20.72*121.95
Tunica submucosa	Common moorhen	4.50*±0.76
	Domestic fowl	3.10±1.58
Muscularis externa	Common moorhen	±5.04*20.20
	Domestic fowl	11.15±2.39
Tunica serosa	Common moorhen	2.10±1.02
	Domestic fowl	1.80±0.83
Crypts thickness	Common moorhen	5.10±1.21
	Domestic fowl	±7.39*10.00

***Significant Differences P<0.05.**

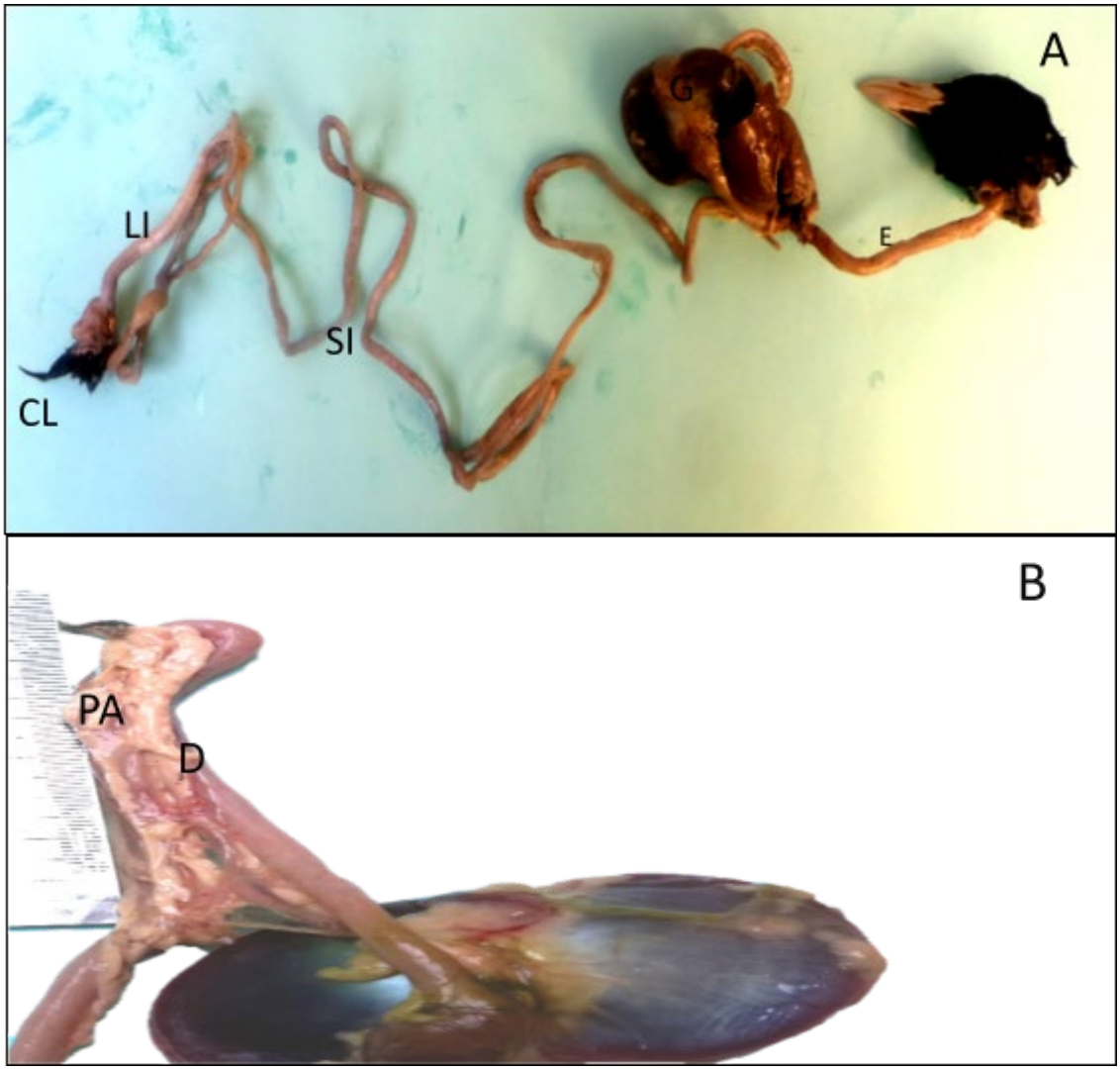

Figure (1) Anatomical structures of gastrointestinal tract of common moorhen. A-Esophagus (E), liver(L), gizzard (G), small intestine (SI), large intestine (LI),cloaca (CL).B- Duodenum (D), pancreas(PA).

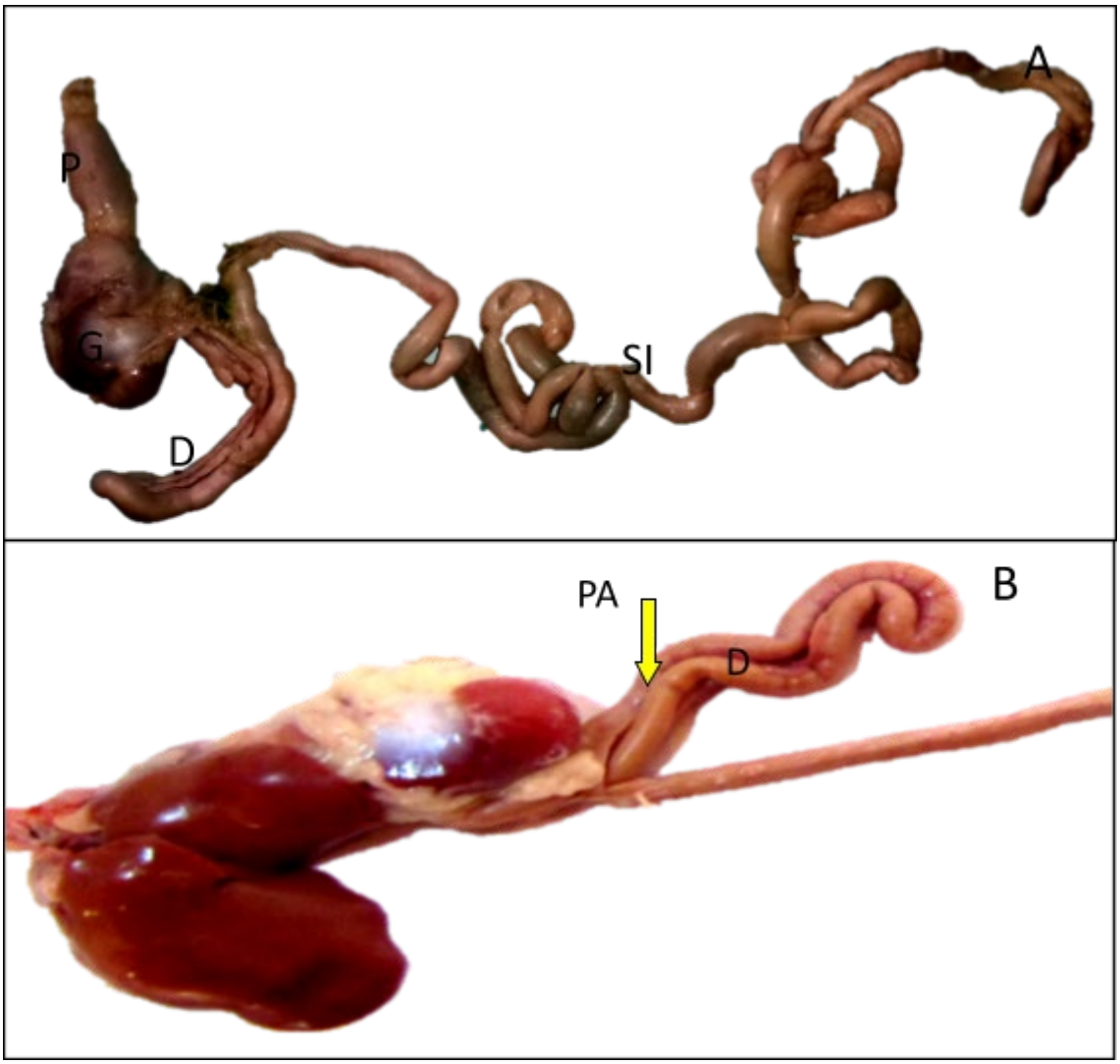

Figure (2) Anatomical structures of gastrointestinal tract of domestic fowl. A- Esophagus (E), Proventriculus (P), gizzard (G), duodenum(D), small intestine(SI). B- Duodenum (D), pancreas (PA)

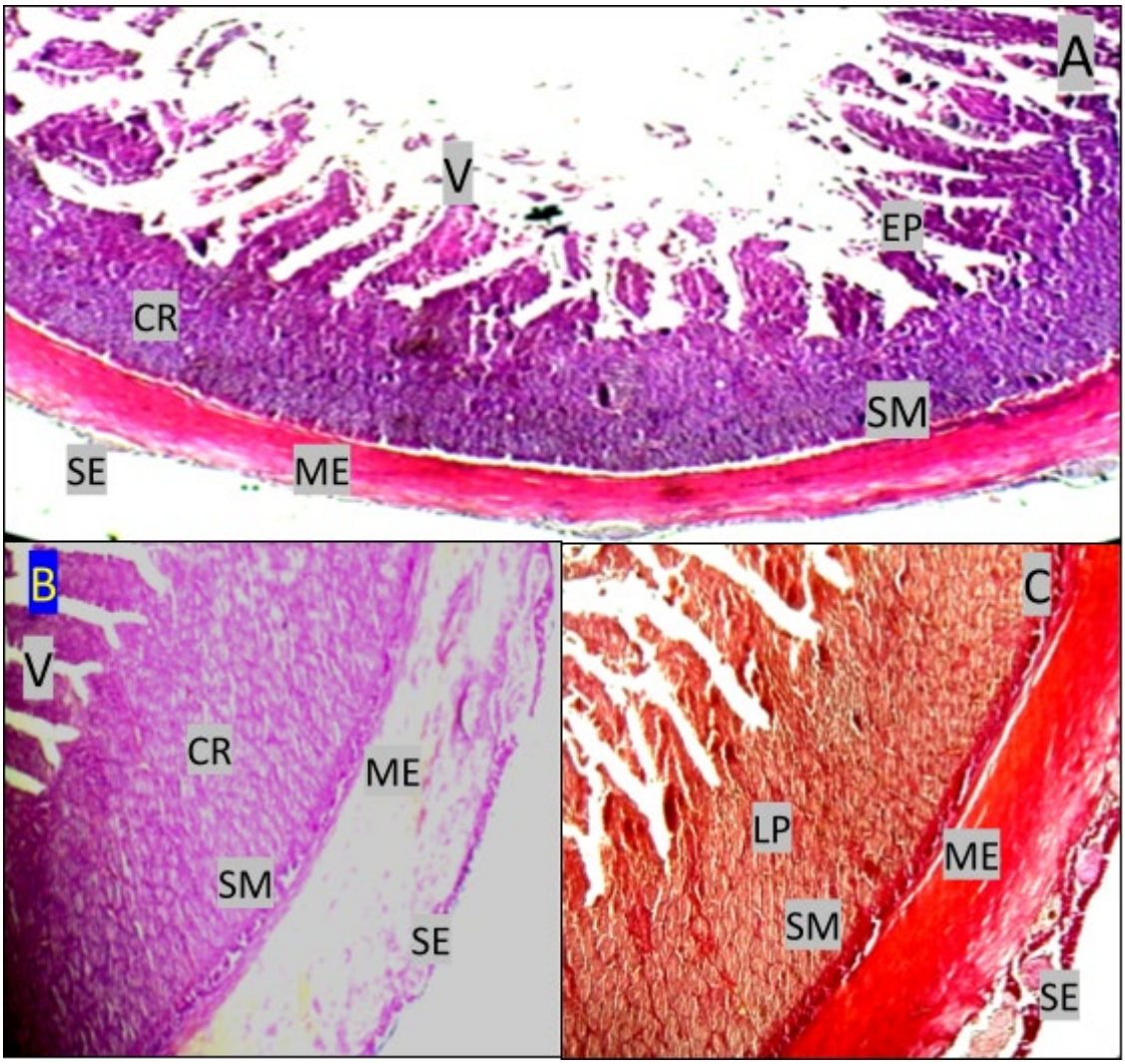

Figure (3) Cross section of duodenum of common moorhen showing: A- Epithelium (EP), villi (V), crypt (CR), tunica sub mucosa (SM), muscularis externa (ME), tunica serosa (SE) (H&E stain 10x). B- Villi (V), crypt (CR), tunica sub mucosa (SM), muscularis externa (ME), tunica serosa (SE)(Masson trichrome stain 10x). C- The distribution of collagen fibers, Villi (V), lamina propria (LP), tunica sub mucosa (SM), muscularis externa (ME), tunica serosa (SE) (Van Gesion stain 10x).

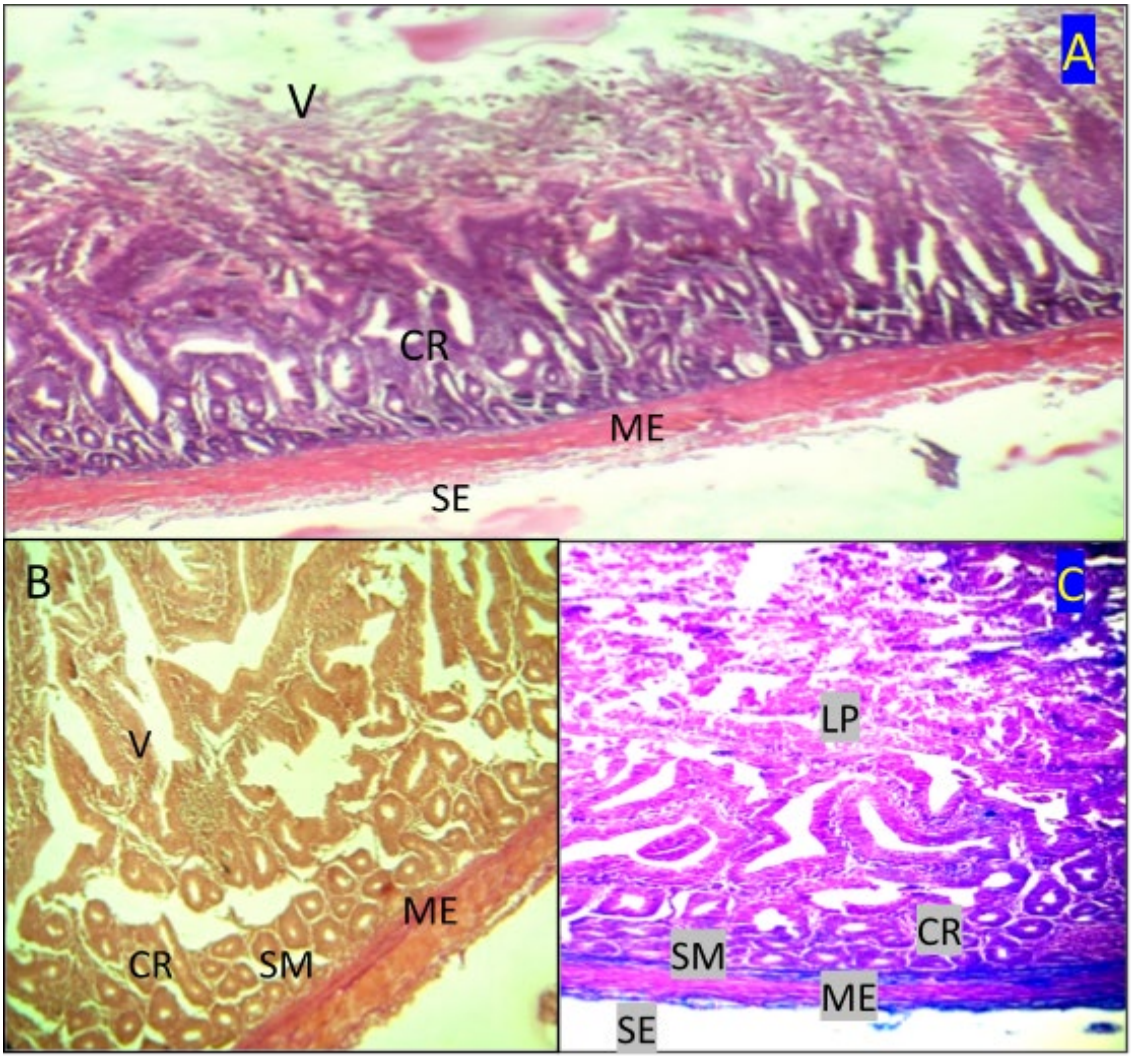

Figure (4). Cross section of duodenum of domestic fowl showing: A- Villi (V), crypt (CR), muscularis externa (ME), tunica serosa (SE) (H&E stain 10x). B- The distribution of collagen fibers, Villi (V), crypt (CR), tunica sub mucosa (SM), muscularis externa (ME) (Van Gesion stain 10x). C- lamina propria (LP), crypt (CR), tunica sub mucosa (SM), muscularis externa (ME), tunicaserosa (SE) (Masson trichrom stain 10x).

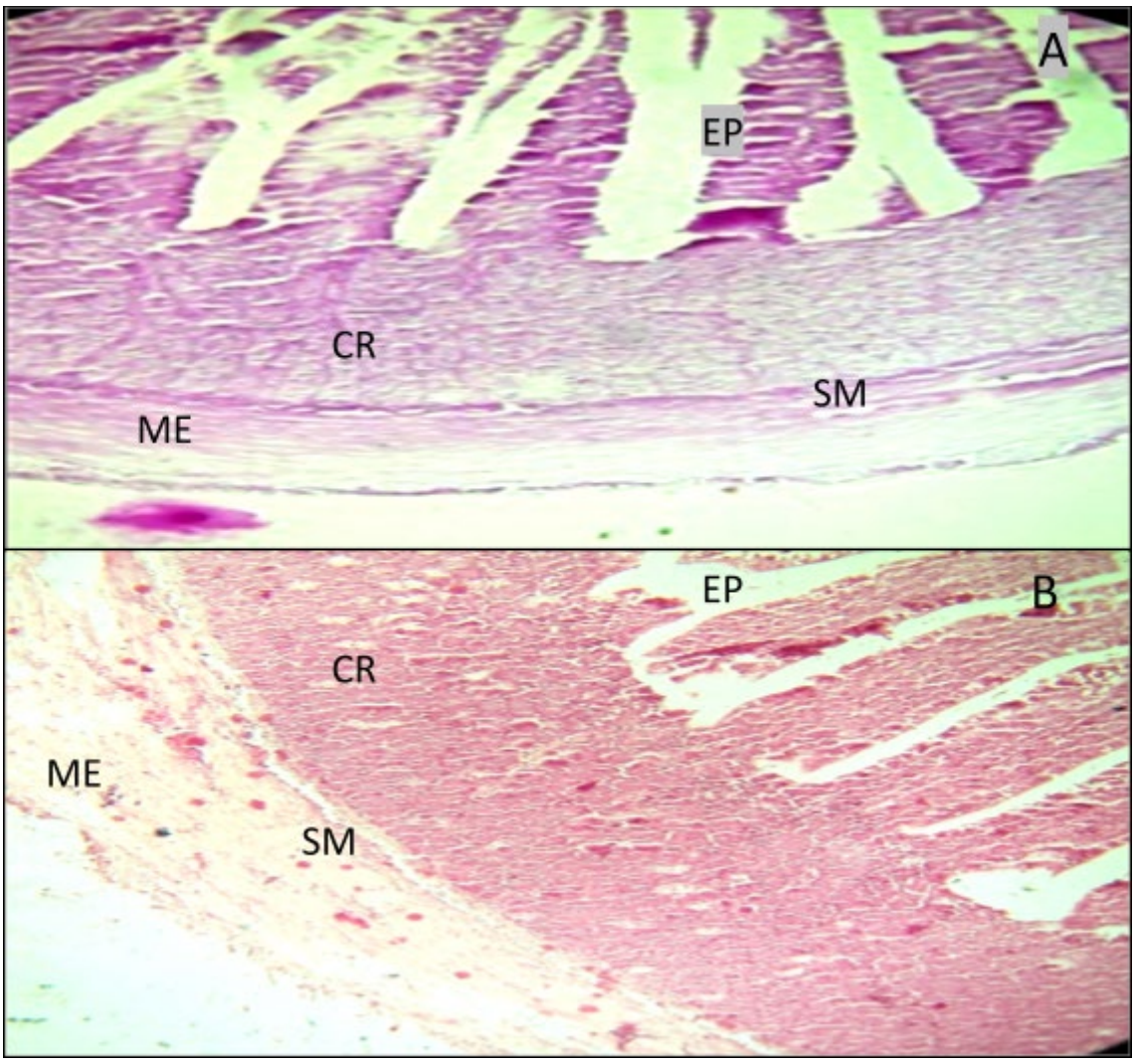

Figure (5). Cross section of duodenum of domestic fowl showing: A- The distribution of polysaccharides, Villi (V), crypt (CR), Sub mucosa (SM), muscularis externa (ME) (P.A.S_ stain10x). B- The distribution of glycogen granules, Villi(V), crypt (CR), Sub mucosa (SM), muscularis externa (ME) (Best Carmen stain 10x).

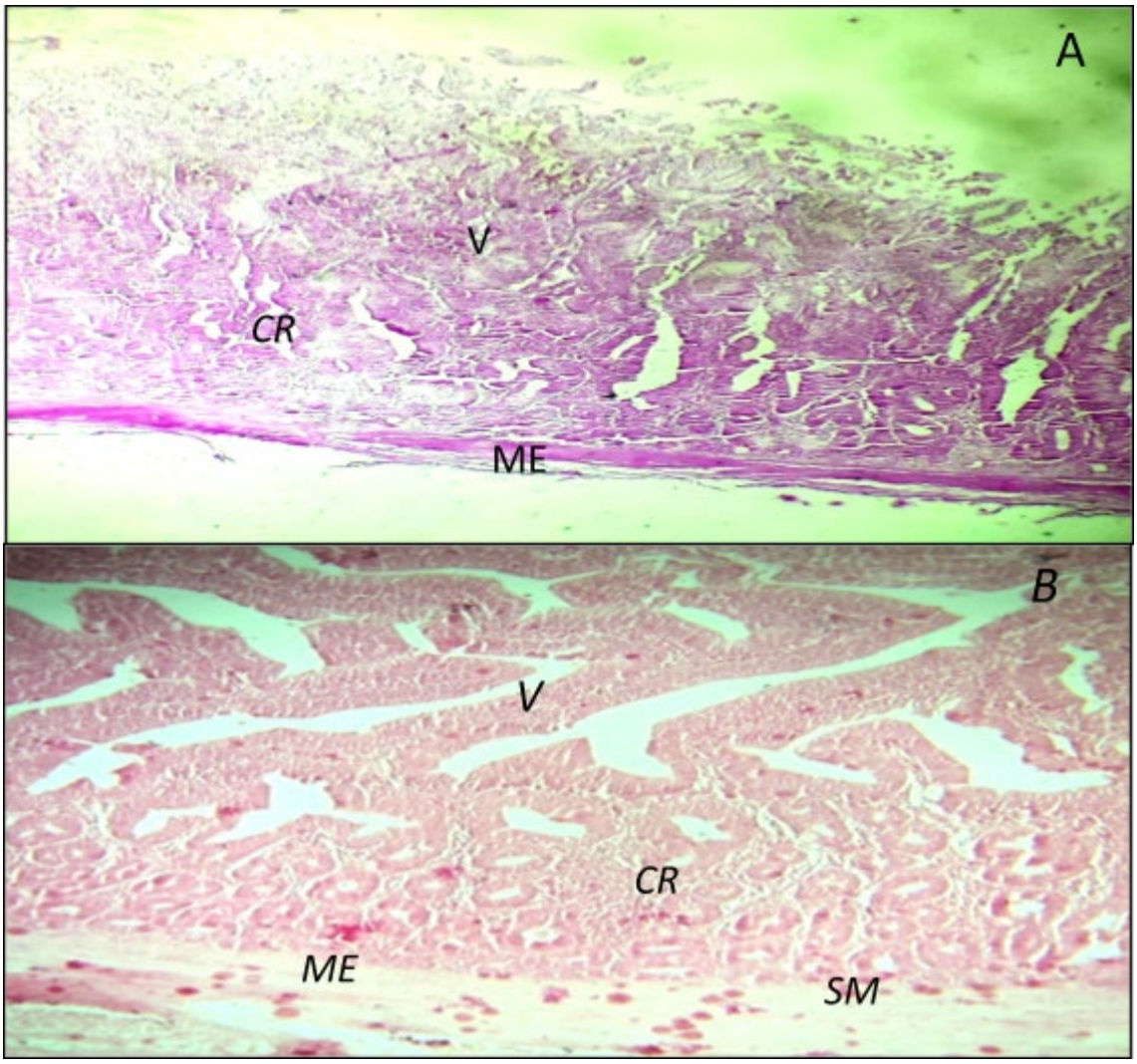

Figure (6). Cross section of duodenum of common moorhen showing: A- The distribution of polysaccharides, crypt (CR), Sub mucosa (SM), muscularis externa (ME) (P.A.S_ stain10x). B- The distribution of glycogen granules, epithelium (EP), crypt (CR), Sub mucosa (SM). muscularis externa (ME) (Best Carmen stain 10x).

Discussion

The duodenum of both common moorhen and domestic fowl was a tubular organ with U shape consisting of right and left loop, the pancreas lies between the arms of the loops and being attached to each arm of the duodenum and holds the two arms together these results identify with (10) in *Coturnix coturnix*. The statistical analysis showed that there are no differences $P<0.05$ in the diameter of duodenum also in the diameter of jejunum-ileum when compared between two birds.

Histologically the duodenum, of both birds formed by four layers which were tunica mucosa, tunica sub mucosa, tunica muscularis, and tunica serosa) (11). The tunica mucosa of the small intestine was modified into finger like projection (villi) which covered with columnar epithelium, these villi provide for increase mucosal surface area for enzymatic breakdown and absorption of the digested food, in agreement with (12) and thus lead to increasing the digestive rate and minimizing the digesta load. Minimizing digesta load may be important for flying birds because it has been demonstrated that takeoff and maneuverability during flight can be impaired by heavy masses (13). The lamina propria in both birds consist of connective tissue containing blood and lymphatic vessels, while the muscularis mucosa was absent, these results in agreement with (14) in African pied crow. The lamina propria in both common moorhen and domestic fowl can be invaginated at the bases of the villi into straight tubular glands (crypts of Lieberkühn) which are continuous with the columnar epithelium lining the villi. The same condition has been found by (15). The goblet cells are more concentrated in common moorhen than domestic fowl, these results similar with (16) who mentioned that the numbers of goblet cells are greatly correlated with the consistency of the bird's food items. There are largely variations in the depth of crypts and length of villi between common moorhen and domestic fowl. The researchers considered that the crypt depth may be an important factor that determines the ability of the crypt to sustain the increase in the villus height and width as well as to maintain the villus structure (17). The sub mucosa in both common moorhen and domestic fowl was thin layer containing sub mucosal gland responsible to secret large amounts of various digestive enzymes that facilitate breakdown and absorption of the digestive food (18).The sub mucosal layer in the wall of small intestine didn't have any activity in birds due to absence of Brunner glands compared with mammals, that in agreement with (19) who suggest that the wall of intestine of the chicken was similar to that of the mammals but the absence of duodenal glands and an extremely thin sub mucosa in the chicken are notable difference. The muscularis externa of duodenum is composed of two layers of smooth muscles, internally having circular arrangement and the external layer of arranged longitudinally, this tunica responsible for peristalsis movement of intestine that aids in propelling the digesta and other materials contained in the lumen of the small intestine. While the tunica serosa of both birds of study composed of connective tissue covered by mesothelium these results in agreement with.(18) The statistical analysis showed that there is a significant variation in the length of villi, thickness of tunica mucosa, thickness of muscularis externa and width of crypts due to the differences of food habit, this

in agreement with (20). The present study showed that the cells and the crypts of Lieberkühn of small intestine have neutral muco polysaccharide secretions and the lamina propria of the intestine contains proteins, these findings in agreement with (15).

REFERENCES

1-Riesenfeld, D.; Sklan, D.; Barr, A.; Eisner, U. and Hurwitz, s. (1980). Glucose absorption and starch digestion in the intestine of chicken. *Journal of Nutrition,110:*117-121.

2-Dyce, K.; Sack, W.O. and Wensing, C.J.G. (1987). Text book of veterinary anatomy. W.B. Sounders Co. Philadelphia. London. Pp.: 779-784.

3-Hassan,S.A. and Moussa,E.A. (2012). Gross and Microscopic Studies on the Stomach of Domestic Duck (Anasplatyrhynchos) and Domes-tic Pigeon (Columba liviadomestica). *J. Vet. Anat. 5* (2), 105 – 127.

4-Turk, D.E. (1982). The anatomy of the avian digestive tract as related to feed utilization. *Poultry Science, 61* (7): p. 1225-1244.

5-Egwu, O.A.; Ukoha, U.U.; Joseph,I.O. and Tochukwu,G.C., (2012). The skeleton of domestic fowl (Galusdomesticus): a comparative morphologic study. *World J.lifeSci .and Medical Reseach .I*: 2294-0574.

6-Allous,E.B.(1961).Birds of Iraq.1st.ed.Al-Rabette Press.Baghdad.pp;27-29.

7-Bancroft, J & Stevens, A. (1982). Theory and Practice of Histological Technique. (2nd Ed). Churchill Livingston, London.

8-Luna, L. G. (1968). Manual of histology staining methods of armed forces institute of pathology. 3rd ed. New York, U. S. A. PP; 39-110.

9-Galigher AE, and Kozloff EN (1964). Essentials of practical microtechnique.1st ed. lea and febiger. Philadelphia, pp. 40-45.

10-Zaher, M.; El-Ghareeb, A.;Hamdi, H. and AbuAmod , F.(2012). Anatomical, histological and histochemical adaptations of the avian alimentary canal to their food habits: I-Coturnixcoturnix . *Life Science Journal ;9*.

11-Wang, J. X. and Peng, K. M. (2014). Molecular, Cellular, and Developmental Al Biology Developmental Morphology of the Small Intestine of African Ostrich Chicks. College of Animal Science and Veterinary Medicine, Huazhong Agricultural University,Wuhan 430070, P. R. China.

12-Cooper, R. G. and Mahroze, K. M. (2004). Anatomy and physiology of the gastrointestinal tract and growth curves of the ostrich (Struthio camelus). *J. Anim. Sci.,75:* 491-498.

13-Nudds, R. L. and Bryant, D. M. (2002). Consequences of load carrying by birds during short flights and is found to be behavioral and not energetic. *American Journal of Physiology, 283*: 249–256.

14-Igwebuikw, U. and Eze, U. (2010). Morphological characteristics of the small intestine of African pied crow (Corvus albus), *Animal Research International, 7*(1): 1116 – 1120.

15-El-Banhawy, M.; Mohallal, M.E. and Rahmy, T.R. and Moawad, T.I. (1993): Anatomical, histological and histochemical

investigations on the oesophagus of two birds with different diet reference. *Journal of the Egyptian German Society Zoology., 11*(C): 175-193.

16-Leznicka, B. (1971). The effect of diet on the histological structure of the oesophagus and glandular stomach in the coot (Fulicaatra). Zoology.

17-Xia, M. S.; Hu, C. H. and Xu, Z. R. (2004). Effects of copper-bearing montmorillonite on growth performance, digestive enzyme activities, and intestinal microflora and morphology of male broilers. *Poult. Sci. 83*:1868–1875.

18-Southgate, D.A.T. (1995). Digestion and metabolism of suger. American *Journal of clinical Nutrition, 62*: 203S-210S.

19-William, J. and Linda, M. (2000). Color atlas of veterinary histology, second edition, Awolter Klumer company.

20-Hamdi, H.; El-Ghareeb, A.; Zaher,M.andAbuAmod,F.(2013).Anatomical, Histological and Histochemical Adaptations of the Avian Alimentary Canal to Their Food Habits: II- Elanuscaeruleus. *International Journal of Scientific & Engineerin.*

دراسة تشريحية، نسجية، وكيمياء نسجية مقارنة للاثني عشري للدجاج المحلي ودجاج الماء

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الخلاصة

صمم هذا العمل لأجراء دراسة تشريحية و نسيجية وكيمياء نسيجية مقارنة للأثني عشري بين دجاج الماء والدجاج المنزلي.استخدمت ثلاثون طير من دجاج الماء وثلاثون طيرا من الدجاج المنزلي التي ابتاعت من سوق المحلي في محافظة البصرة وتم العمل في مختبرات الطب البيطري جامعة ألبصرة. أظهرت الدراسة التشريحية أن الاثني عشرعبارة عن أنبوب ملتف ممتد على شكل حرف U ويحمل البنكرياس بين ذراعي الاثني عشر. يتميز الاثني عشربتركيب نسجي متشابه في كل من دجاج الماء والدجاج المنزلي حيث يتكون جدار هذا العضو الانبوبي من اربع طبقات هي الطبقة المخاطية ، الطبقة تحت المخاطية ، العضلية و المصلية. أظهرت نتائج التحليل الإحصائي وجود فروق معنوية عند المستوى <0.05 P في سمك الطبقة المخاطية ، الخبايا، الطبقة تحت المخاطية و الطبقة العضلية بين الطيرين. كشفت الدراسة الكيمياء نسجية للاثني عشر عن توزيع الكربوهيدرات على الطبقة المخاطية والظهارة العمودية وحول الغدد المعوية ، بينما تتوزع حبيبات الكلايكوجين حول الغدد و الطبقة العضلية.