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Comparative anatomical, histological and histochemical studies of the oesophagus in two different Iraqi birds (*Columba palumbus* and *Tyto alba*)

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Abstract

Oesophagus in the both species divided into three regions represented by cervical oesophagus, crop and thoracic oesophagus. Comparative morphological and anatomical results revealed that the cervical oesophagus in the barn owl was longer and narrower than that of the common wood pigeon, crop was with bilobed sac shape protruded out of the neck while in the barn owl, crop was with fusiform shape and not protruded, thoracic oesophagus in the barn owl was shorter than that of the common wood pigeon. Comparative histological study revealed that the oesophagus in both species of birds composed of four essential histological layers, mucosa, sub mucosa, muscularis externa and serosa. These layers showed variances in their thickness and components. Mucosa in the cervical oesophagus of common wood pigeon consisted of keratinized stratified squamous epithelium, while in the barn owl, mucosa consisted of non keratinized stratifies squamous epithelium. Sub mucosa, muscularis externa and serosa were thinner in common wood pigeon than in the barn owl. Inner folds were more and longer in the barn owl than those of common wood pigeon and the oesophageal glands compound tubuloalveolar in the barn owl, while in common wood pigeon there were no glands. In the crop, mucosa consisted of keratinized stratified squamous epithelium in common wood pigeon, while it consisted of non keratinized stratified squamous epithelium in the barn owl. The other three layers in the barn owl were thicker than those of common wood pigeon. Inner folds in the barn owl were more and containing more oesophageal glands in the lamina propria, while in common wood pigeon, glands were less and within the sub mucosa. In thoracic oesophagus, mucosa composed of keratinizes stratified squamous epithelium in the common wood pigeon and non keratinized stratified squamous epithelium in the barn owl. Sub mucosa in the common wood pigeon was thicker than that of the barn owl, while the two other layers were thicker in the barn owl. Inner folds in the barn owl were the most, longest and containing the most number of compound tubualveolar acin-like oesophageal glands within lamina propria, while in the common wood pigeon they were less, shorter and containing less number of compound alveolar flask-like oesophageal glands within the sub mucosa.

Keywords: comparative anatomy, histology, histochemical study, oesophagus, bird, Iraq.

Introduction

The oesophagus is a narrow, muscular, highly-distensible tube extends from the pharynx and joins with the stomach (Hodges, 1974). The avian oesophagus is different from that of mammals, it is thin-walled and distensible with wide diameter. In the opposite side of the mammalian oesophagus, most of the cervical part of it lies on the right side of the neck (King and Mclleland, 1984). At the thoratical part of the avian alimentary tract, oesophagus enlarge to form the crop, so that, the cervical part functionally acts to lubricate the food and contact it into the thoratical part in which the food is stored and released into the other parts of the alimentary tract (Hodges,1974). The distensibility of the avian oesophagus, however, comes from the longitudinal folds in the inner layer of it. Unlike mammals, the avian oesophagus don't have any sphincter in both upper and lower region of it (Parachami and Dehokordi, 2011). According to Rossi

et al (2006), the partridge *Rhynchotus rufescens* (tramidae) oesophagus takes an "S" shape because its cervical part is shorter than the cervical column and then it is not extended but expanded to form the crop. In owls, as a carnivorous birds, crop takes a simple spindle shape while in pigeon as a herbivorous, it took a more complicated structure, whereas some granivorous species have no true crop and can store their food in a very distensible oesophagus (Gelis, 2013). Crop may provide a type of protection for birds by its storage function that allows the ingestion of the stored food in the evening providing the overnight energy needs, in the other hand, it also allows the birds to ingest their food rapidly and softly by swallow the water giving the important security for them (Horseman and Buntin, 1995).

Materials and Methods

The animals under investigation were collected from Najaf desert. Five birds of each species were used to study the different aspects of the present study.

The species of birds under investigation were classified according to Allose (1962) and Salim *et al*.(2006). The studied birds were anesthetized using chloroform. Length and weight of the body of the two species under investigation were measured and the length of oesophagus and different parts of its were also measured. Method of Al-Attar *et al* (1982) and Kiernan (1999) were employed for the paraffin wax histological method and preparation of different stains used in the present study. Routine stain Harris Hematoxylin-Eosin stain used for general histological study and the special stains, Alcian Blue(AB) and Periodic Acid Schiff reagent (PAS) were used for histochemical study .

Results

1.Anatomical and morphological description

Common wood pigeon *Columba palumbus*

Oesophagus appeared as a muscular tube divided into three regions represented by cervical oesophagus, crop and thoracic oesophagus . The cervical part of the oesophagus began with the end of the oropharynx and intertwisted on the trachea, it has a thick wall and many inner folds .The mean length was (6.96 cm),the range of length (4.8 – 9.2 cm) , the mean of diameter (3275.98 µm) , range of diameter (2912.5-3728µm) .

The crop, a temporal distention of the oesophagus began before the entering of the thoratical cavity, it had a thin wall and very low inner folds (Figure 1). The mean length was (4 cm), the range (3.2-5.1 cm), the mean of diameter (33800 µm) and the range of diameter (29000 – 39000 µm). The crop in common wood pigeon *Columba palumbus*, was wide, bilobed, sac-like structure protruded in the upper part of the body of birds. The last part of the oesophagus was the thoratical part where the crop returned to narrow, the mean length of this part was (3.72 cm) with range of (2.6 – 4.8 cm) ,the mean of diameter (4175.36 µm) with range (3029 – 5312.4 µm) . This part had a thick wall and inner longitudinal folds .

The barn owl *Tyto alba*

Morphological study showed that the oesophagus in the barn owl divided into the same three parts of that in common wood pigeon. These parts exhibited clear differences from those of the common wood pigeon, the length of the cervical oesophagus in the barn owl was longer than of the common wood pigeon and narrower. The mean length of the cervical oesophagus in the barn owl was (8046 cm), with the range of (7.4 – 9.2 cm) , the mean of diameter (2246.12 µm) and the range of diameter (1584.4 – 3751.3 µm) .

The crop in the barn owl not distinguished clearly from the cervical oesophagus , it was not swelling and not stored food. The crop in the barn owl was fusiform widening of the oesophagus, it has a thick wall and high inner folds . The crop in the barn owl was shorter and narrower than that of the common wood pigeon. The mean length of crop was (2.5 cm), with range of (2.2 – 2.9 cm) , mean of diameter (3800 µm) and the range (3000 – 5000 µm) . The thoratical part of the oesophagus in the barn owl entered the abdominal cavity with the same way of that in the common wood pigeon. Morphometrical results revealed that the thoratical oesophagus in the barn owl was shorter than that of the common wood pigeon but it was nearly with the same diameter. The mean of length was (1.32 cm), the range (0.9 – 2.2 cm) , the mean of diameter (4128.76µm) and the range of diameter (3238 – 5522.1)µm.

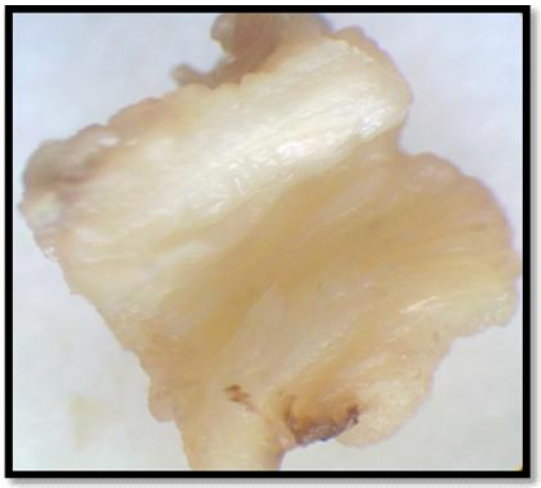


Figure (1): Inner view in the crop of the barn owl *Tyto alba* show the inner folds. 16x.

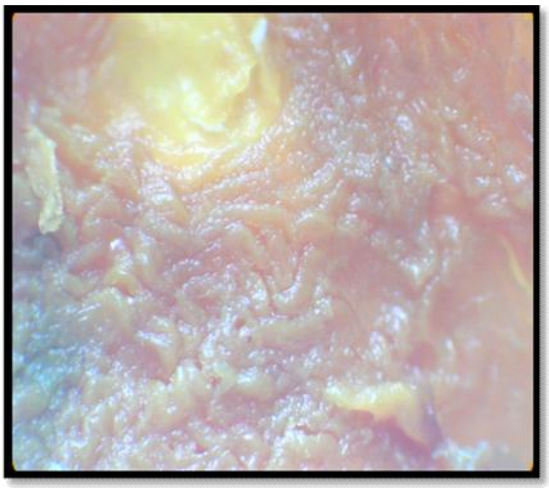


Figure (2): Inner view in the crop of the common wood pigeon *Columba palumbus* show the inner folds.16x.

2. The histological and histochemical descriptions

The common wood pigeon

Histological results showed that the histological structure of the oesophagus differed among the three parts , the differences represented by the number of the folds , the height of these folds , the presence of the esophageal glands , number of these glands and then the thickness of the wall layers . The mucosa of the cervical oesophagus in the common wood pigeon composed of keratinized stratified squamous epithelium that extended making the epithelial papillae and giving the wavy appearance. The epithelial cells of mucosa in this part of oesophagus contained oval nuclei and granular cytoplasm , these cells and their nuclei become flatter progressively as they migrate toward the free surface of epithelium. The lamina propria represented by a connective tissue containing arterioles and capillary tubes , then the muscularis mucosa which composed of smooth muscle fibers. The mean of thickness of the mucosa in the cervical oesophagus in the common wood pigeon was (79.22 µm) with range of (69.9 – 93.2 µm).

The results showed that the second layer was the submucosa , have no glands in the cervical oesophagus of common wood pigeon. The mean thickness was (55.92 µm) with range (46.6 – 69.9 µm). The third layer was the muscularis externa , the present study observed that this layer in the cervical oesophagus composed of inner longitudinal and outer circular skeletal muscle fibers separated by connective tissue. The mean of thickness was (167.76 µm) with range (93.2 – 442.7 µm) . The outer layer that around the oesophagus was the serosa which was rich in nerves, veins and artery. The mean of thickness was (97.86 µm) with range (69.9 – 116.5 µm).

The results showed that the folds in the cervical oesophagus appeared as finger-like shape of (20) folds with height (699 µm) and width (349.5 µm). The crop differed from the cervical oesophagus, the folds appeared with few, shallow and wide waves. The height of these folds was (477.18 µm), the width (559.2 µm) and the number was (4 – 5) folds only.

The histological examination declare that the mucosa in the crop composed of keratinized stratified squamous epithelium , this layer straighten slightly and the wavy appearance of the papillae reduced while the keratinized layer was thicker than that of the cervical oesophagus. Lamina propria composed of connective tissue and the muscularis externa contained lymphatic nodules. The mean of thickness was (144.46 µm) with range (69.9 – 256.3 µm). Submucosa in the crop of common wood pigeon contained cells of adipose tissue. The mean of the thickness was (158.44 µm) with range (46.6 – 442.7 µm).

The results showed that the muscularis externa in the crop was thicker than that of the cervical oesophagus and it consisted of developed outer longitudinal smooth muscle layer and inner circular smooth muscle fibers, notably, the outer longitudinal layer was the biggest. The mean of thickness was (181.74 µm) with range (116.5 – 326.2 µm). The outermost layer was the serosa which was rich with veins, arteries and nerves. The mean of thickness was (60.58 µm) and the range (23.3 – 93.2 µm).

In the thoracic part of the oesophagus , mucosa consisted of keratinized stratified squamous epithelium and this epithelium appeared as wavy papillae. The results showed that the mucosa extended toward the lumen of oesophagus making a leaf- like folds , but these folds were less and wider than those of the cervical oesophagus and they invaded with the esophageal glands opening. The results showed that the number of these folds was (11) and the number of the esophageal glands per fold was (8) , the height of these folds was (745.6 µm) and the width (582.5 µm). The mean of thickness was (79.22 µm) and the range (69.9 – 93.2 µm). The lamina propria and muscularis mucosa in this part of oesophagus not differed from those of the cervical part.

The histological examination revealed that the esophageal glands presented in the submucosa , this layer exhibited a flask-like compound alveolar glands , these glands lined with columnar secretory epithelium. The mean of thickness was (163.1 µm) with range (116.5 – 209.7 µm).

The histological results showed that the muscularis externa of the thoracic oesophagus bigger than that of the two previous parts and it composed of inner thin circular smooth muscles and outer thick longitudinal smooth muscle fibers. The mean of thickness was (186.4 µm) and the range (116.5 – 279.6 µm). The outermost layer of the thoracic oesophagus was the serosa that was rich with nerves , veins and arteries. The mean of thickness was (83.88 µm) and the range (46.6 – 163.1 µm).

2.2. The barn owl *Tyto alba*

In the cervical oesophagus ,the number of folds of the mucosal epithelium were(23) and appeared as leaf-like extensions with height (745.6 µm) and width (279.6 µm). The histological examination showed that the folds occupied with compound tubuloalveolar acin-like glands in their epithelium i.e. these glands contained by lamina propria. The number of these was about (57) gland per fold. The mucosa of the cervical oesophagus in the barn owl built of non-keratinized stratified squamous epithelial tissue represented by the mucosal epithelium. The lamina propria consisted of connective involving the esophageal glands abundantly and containing lymph and blood vessels. The muscularis mucosa composed of connective tissue separate the esophageal glands and with the other hand separate the mucosa from the submucosa. The mean of thickness was (99.22 µm) with range (93.2 – 116.5 µm). The submucosa composed of dense connective tissue containing blood vessels. The mean of thickness was (123.26 µm) with range (100 – 140 µm). The muscularis externa consisted of inner longitudinal and outer circular skeletal muscle fibers separated by connective tissue. The mean of thickness was (409.58 µm) with range (233 – 675.7 µm) represent the biggest thickness among the three parts of the oesophagus and between the cervical oesophagus of the two studied birds. The serosa composed of thin layer of connective tissue containing blood vessels and nerve ends. The mean of thickness was (163.88 µm) with range (93.2 – 400 µm).

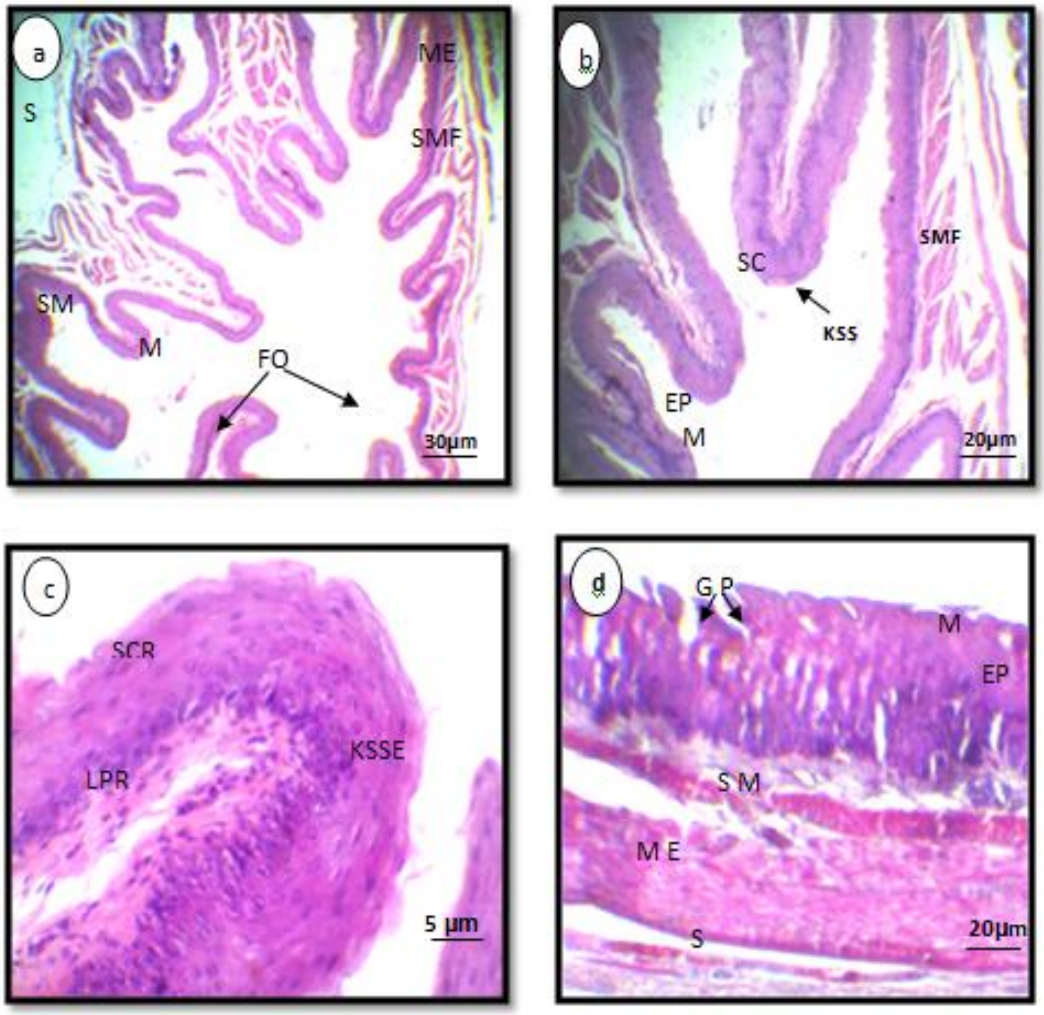
The histological examination showed that the crop in the barn owl possessed plenty of compound tubuloalveolar glands in the lamina propria . The mucosa appeared as non keratinized epithelial cells with oval nuclei and granular cytoplasm. Mucosal epithelium of the crop in the barn owl appeared as wide papillae-like folds and the underling lamina propria contained the glands. The number of the folds was about (34) with height (419.4 µm) and width (233 µm) and each fold contained about 29 glands. The muscularis mucosa composed of muscle fibers separated the mucosa from the underling layer. The mean of thickness was (466 µm) with range (69.9 – 652.4 µm). The submucosa was similar to that of the cervical oesophagus , it composed of dense connective tissue containing blood and lymph vessels. The mean of thickness was (321.54 µm) and the range (93.2 – 466 µm). The muscularis externa in the crop of the barn owl was also similar to that of the cervical oesophagus , it was a thick layer consisting of inner circular and outer longitudinal skeletal muscle bundles. The mean of thickness was (358.82 µm) with range (139.8 – 605.8 µm). The serosa composed of the same composition of the other parts of oesophagus. The mean of thickness was (83.88 µm) with range (23.3 – 116.5 µm).

In the thoracic part of the oesophagus in the barn owl, the mucosa consisted of non keratinized stratified epithelial cells with dark nuclei and granulated cytoplasm. The thoracic oesophagus possessed the biggest and the highest number of folds among the three parts of the oesophagus in the two studied birds , the number of the folds in this part was (24) folds , each fold contains about (67) glands. The height of these folds was (978.6 µm) and width (256.3 µm).

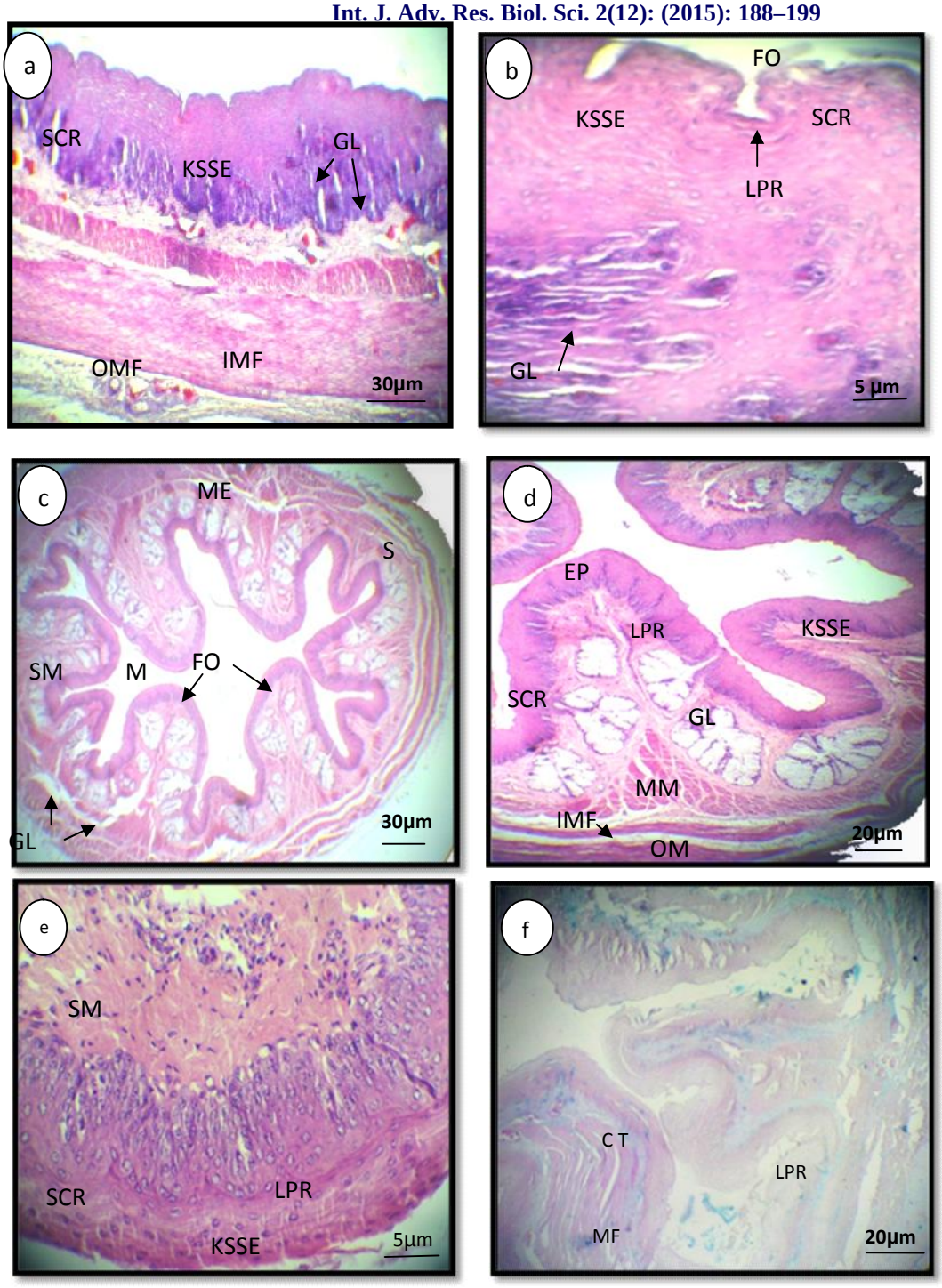
The esophageal glands in the thoracic oesophagus were compound tubuloalveolar with acni-like shape , they involved by the lamina propria. The muscularis

mucosa not differed from that of the other parts. The mean of thickness was (83.88 µm) with range (69.9 – 93.2 µm).

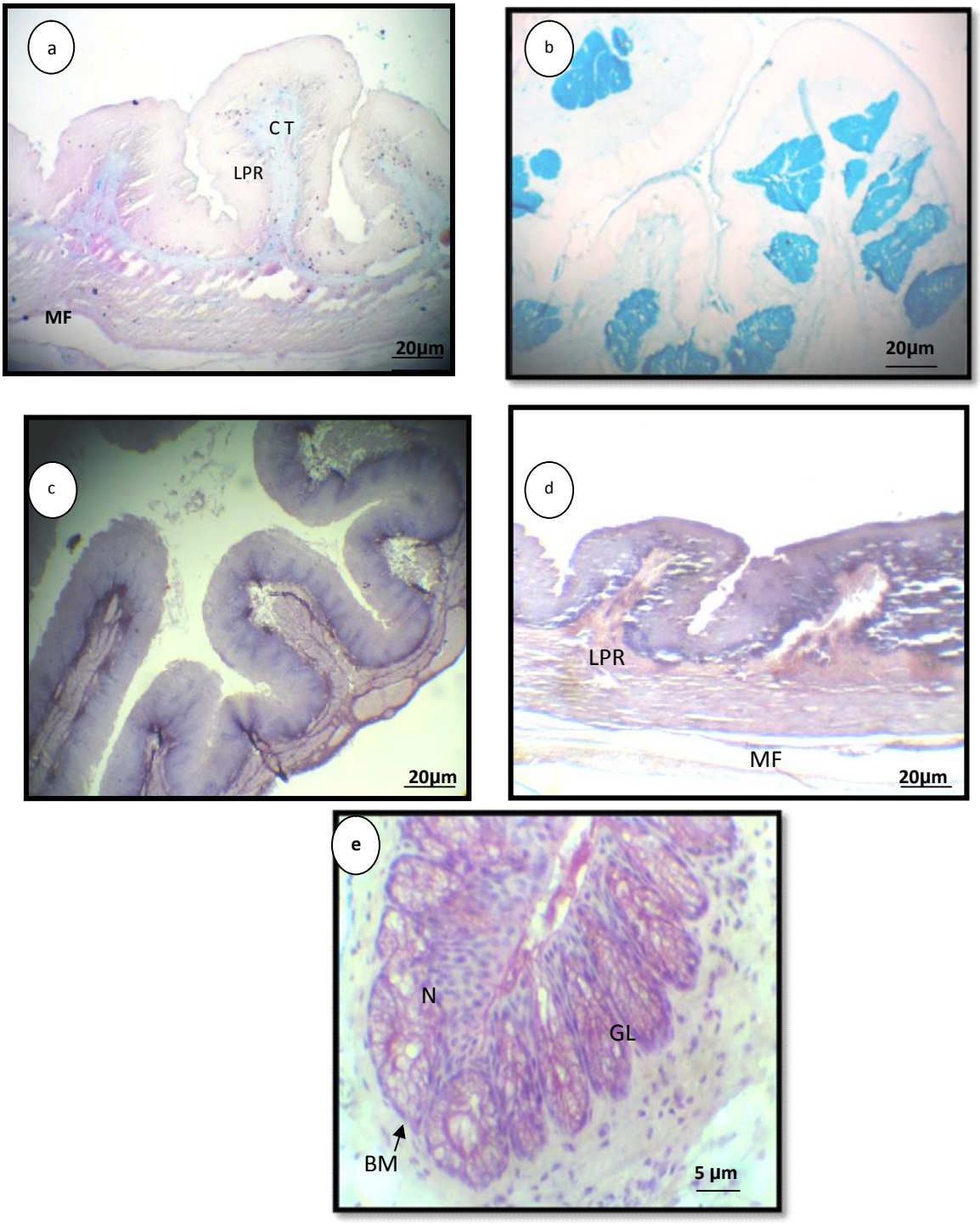
The histological structure of the submucosa not differed from that of the other parts. The mean of thickness was (121.16 µm) with range (93.2 – 163.1 µm). The muscularis externa and serosa consisted of the same histological structures of those in the other parts of oesophagus. The mean of thickness was (302.9 µm) and (125.82 µm) respectively and the range was (163.1 – 489.3 µm) and (93.2 – 233 µm) respectively.



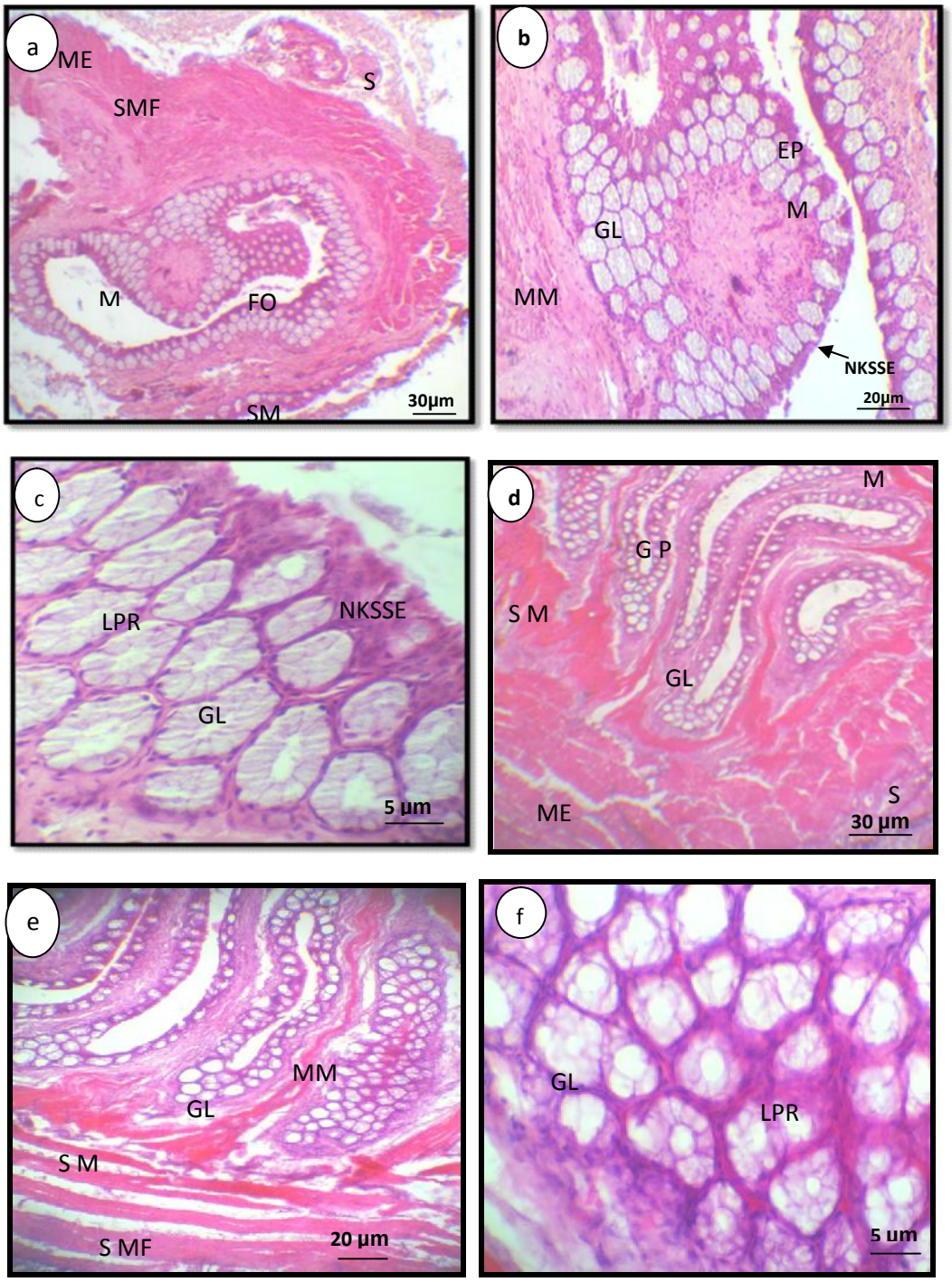
Figure(3)a: Cross section in the cervical part of the oesophagus of the common wood pigeon *Columba palumbus* showed the four layers : M: mucosa , SM :sub mucosa , ME: muscularis externa and S: serosa. Note the folds F and the skeletal muscle fibers SKMF.(H&E) 4x. b: Cross section in the folds of the cervical part of the oesophagus of the common wood pigeon *Columba palumbus* showed the epithelial mucosa EP, stratum corneum SCR , keratinized stratified squamous epithelium and the skeletal muscle fibers SKMF. (H&E) 10x. c: Cross section in the fold of the cervical oesophagus of the common wood pigeon *Columba palumbus* showed the lamina propria LPR , the keratinized stratified squamous epithelial tissue KSSE and the stratum corneum SCR. H&E 40x. d: cross section in the crop of the common wood pigeon *Columba palumbus* showed the four layers: M mucosa , SM sub mucosa, ME muscularis externa , S serosa , EP mucosal epithelium, smooth muscle fibers SMF and GP the gastric pits. H&E 4x .



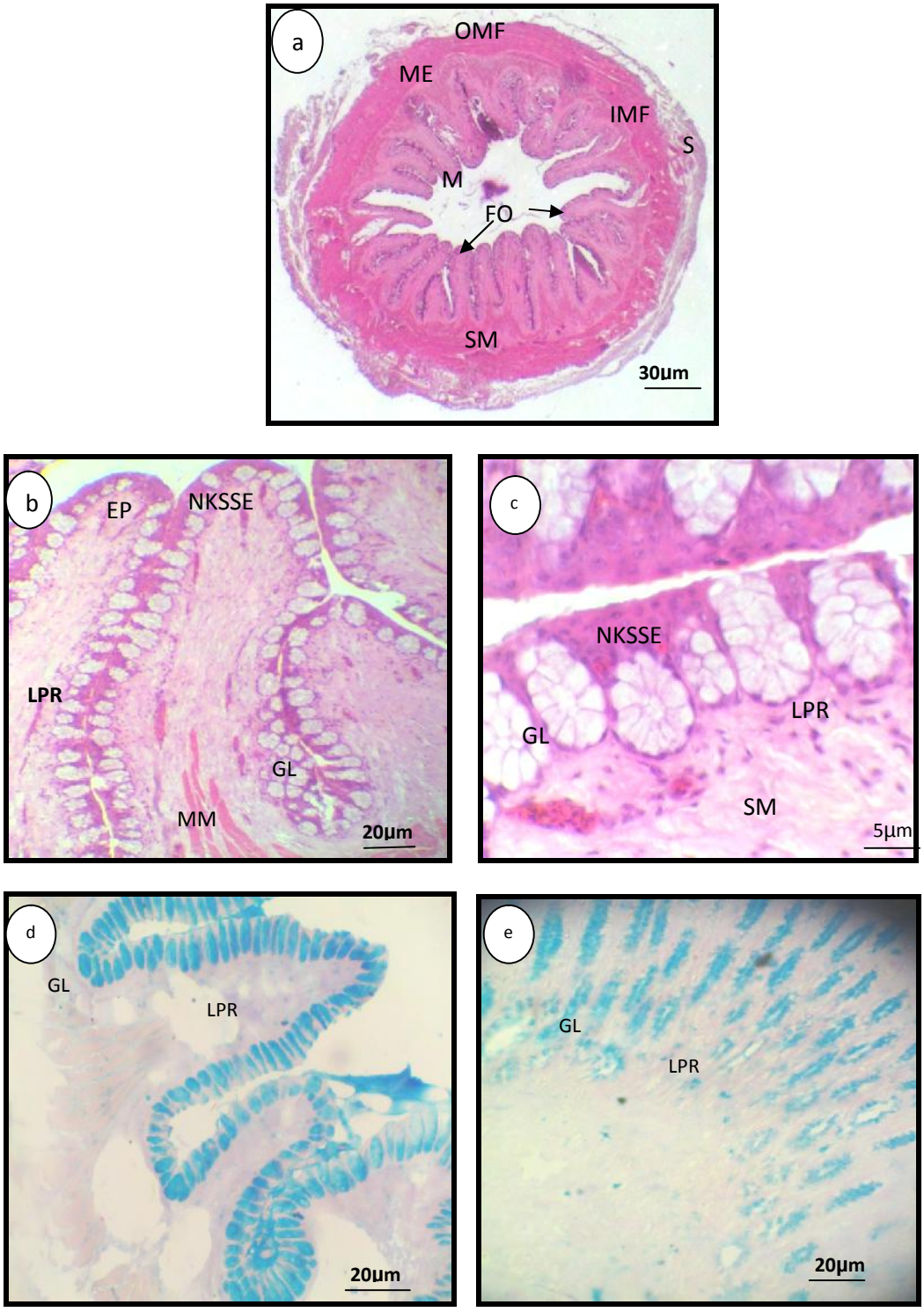
Figure(4) a: cross section in the crop of the common wood pigeon *Columba palumbus* showed the glands GL , stratum corneum SCR , the keratinized stratified squamous epithelial tissue KSSE , the inner muscle fibers IMF and the outer muscle fibers OMF. H&E 10x. b: Cross section in the folds FO of the crop of the common wood pigeon *Columba palumbus* showed the lamina propria LPR , glands GL , stratum corneum SCR and the keratinized stratified squamous epithelial tissue KSSE. H&E 40x. c: Cross section in the thoracic oesophagus of the common wood pigeon *Columba palumbus* showed the four layers: mucosa M , sub mucosa SM , muscularis externa ME , serosa S, folds F and the glands GL. H&E ,4x. d: Cross section in the thoratical oesophagus of the common wood pigeon *Columba palumbus* showed the folds FO , oesophageal glands GL , the keratinized stratified squamous epithelial tissue , stratum corneum SCR , mucosal epithelium EP , lamina propria LPR , inner circular muscle fibers IMF ,and outer muscle fibers OMF. H&E , 10x. e: Cross section in the fold of the thoratical oesophagus in the common wood pigeon *Columba palumbus* showed the lamina propria LPR , stratum corneum SCR , keratinizes stratified squamous epithelial tissue KSSE , and the sub mucosa SM .H&E 40x. f: Cross section in the folds of the cervical oesophagus of the common wood pigeon *Columba palumbus* showed the lamina propria LPR , connective tissue CT , muscle fibers MF. Note the weak reaction with the stain . AB stain , 10x.



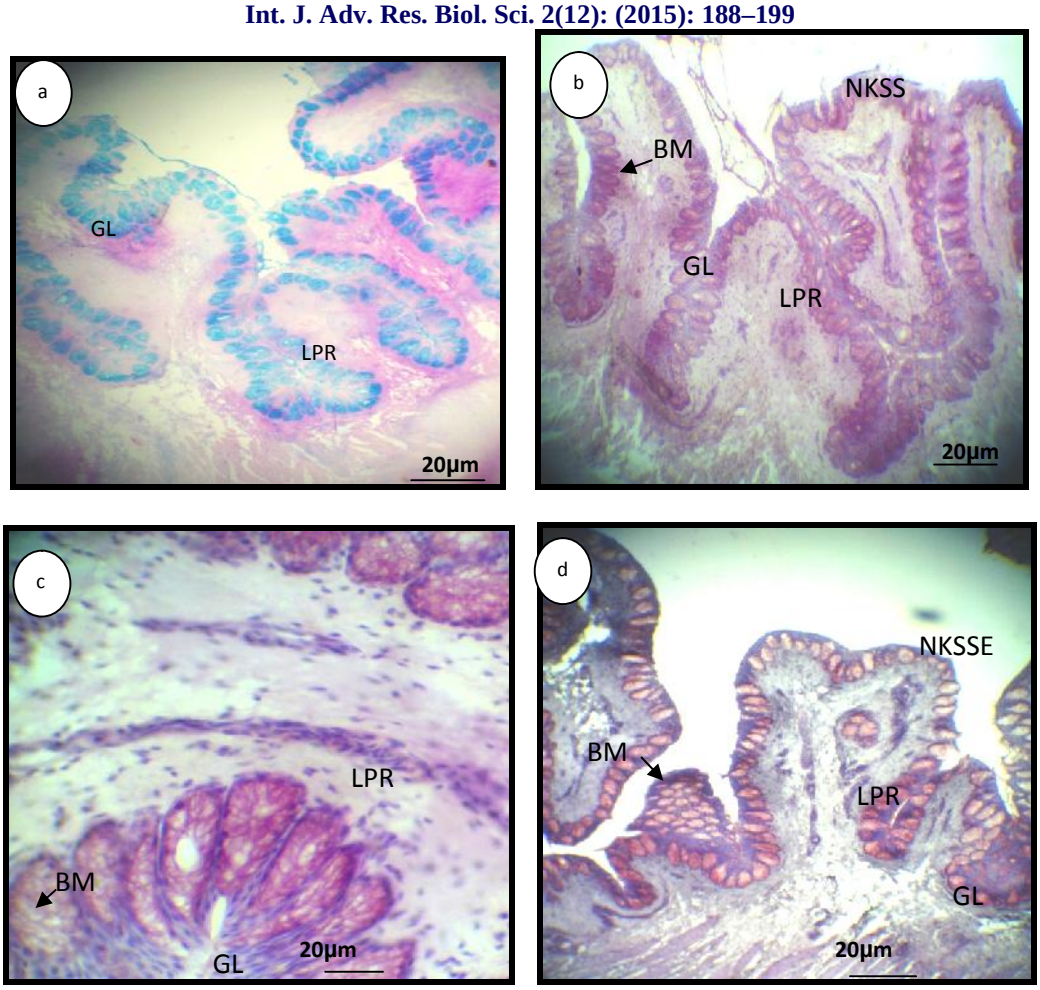
Figure(5)a: Cross section in the folds of the crop of the common wood pigeon *Columba palumbus* showed the lamina propria LPR , connective tissue CT , muscle fibers MF. Note the weak reaction with the stain . AB stain , 10x. a :Cross section in the folds of the thoracic oesophagus of the common wood pigeon *Columba palumbus* showed the oesophageal glands GL and the lamina propria LPR . Note the strong reaction with the stain . AB .10x. c:Cross section in the folds of the cervical oesophagus of the common wood pigeon *Columba palumbus* showed the lamina propria LPR , keratinized stratified squamous epithelium KSSE and the connective tissue papillae CTP . PAS 10x. d :Cross section in the crop of the common wood pigeon *Columba palumbus* showed the lamina propria LPR and the muscle fibers MF. PAS 10x. e:Cross section in the folds of the thoracic oesophagus of the common wood pigeon *Columba palumbus* showed the oesophageal glands GL , basement membrane BM and the nucleus N . Note the strong reaction with the stain . PAS 40x.



Figure(6) a: a: Cross section in the cervical part of the oesophagus of the barn owl *Tyto alba* showed the four layers : M: mucosa , SM :sub mucosa , ME: muscularis externa and S: serosa. Note the folds F, oesophageal glands OG and the skeletal muscle fibers SKMF.(H&E) 4x. b: Cross section in the folds of the cervical part of the oesophagus of the barn owl *Tyto alba* showed the oesophageal glands OG, non- keratinized stratified squamous epithelium NKSSE, lamina propria LPR and oesophageal glands OG. (H&E) 10x. c :Cross section in the fold of the cervical oesophagus of the barn owl *Tyto alba* showed the lamina propria LPR , non- keratinized stratified squamous epithelial tissue NKSSE and the oesophageal glands OG. H&E 40x. d : cross section in the crop of the barn owl *Tyto alba* showed the four layers: mucosa M, sub mucosa SM, muscularis externa ME, serosa S, mucosal epithelium EP and oesophageal glands OG. H&E 4x . e: cross section in the crop of the barn owl *Tyto alba* showed the folds F, oesophageal glands OG, smooth muscle fibers SMF and the muscularis mucosa MM. H&E 10x. f: Cross section in the folds FO of the crop of the barn owl *Tyto alba* showed the lamina propria LPR , oesophageal glands OG and the non-keratinized stratified squamous epithelial tissue NKSSE. H&E 40x.



Figure(7)a: Cross section in the thoratical oesophagus of the barn owl *Tyto alba* showed the four layers: mucosa M , sub mucosa SM , muscularis externa ME , serosa S, folds F and mucosal epithelium EP . H&E ,4x. b: Cross section in the thoratical oesophagus of the barn owl *Tyto alba* showed the folds FO , oesophageal glands OG , the non- keratinized stratified squamous epithelial tissue NKSSE ,muscularis mucosa MM and lamina propria LPR H&E , 10x. c: Cross section in the fold of the thoratical oesophagus in the barn owl *Tyto alba* showed the lamina propria LPR , non-keratinizes stratified squamous epithelial tissue NKSSE , and oesophageal glands OG .H&E 40x. d: :Cross section in the folds of the cervical oesophagus of the barn owl *Tyto alba* showed the lamina propria LPR , oesophageal glands OG, muscle fibers MF. Note the strong reaction with the stain . AB stain , 10x. e:Cross section in the folds of the crop of the barn owl *Tyto alba* showed the lamina propria LPR , and oesophageal glands OG. Note the strong reaction with the stain . AB stain , 40x.



Figure(8) a: Cross section in the folds of the thoratical oesophagus of the barn owl *Tyto alba* showed the oesophageal glands GL and the lamina propria LPR . Note the strong reaction with the stain . AB .10x. b: Cross section in the folds of the cervical oesophagus of the barn owl *Tyto alba* showed the lamina propria LPR ,non- keratinized stratified squamous epithelium NKSSE, basement membrane BM and the oesophageal glands OG . PAS 10x. c :Cross section in the crop of the barn owl *Tyto alba* showed the lamina propria LPR , oesophageal glands OG, non –keratinized stratifies epithelium NKSSE and basement membrane BM. PAS . 40x. d:Cross section in the folds of the thoratical oesophagus of the barn owl *Tyto alba* showed the lamina propria LPR , oesophageal glands OG, non –keratinized stratifies epithelium NKSSE and basement membrane BM . Note the strong reaction with the stain . PAS 10x.

Discussion

Results of the present study showed that the oesophagus in the birds under investigation divided into three anatomical regions these are cervical oesophagus, crop and thoracic oesophagus. The gross anatomical results showed that these regions showed some differences in the two birds under investigation in length, diameter and the inner folds features. In common wood pigeon, the cervical oesophagus was longer than the other parts, and the crop was wider than the others, on the other hand the thoracic oesophagus had the most inner longitudinal folds among the other regions. By contrast, in the barn owl, the cervical oesophagus was longer than the other parts but the thoracic oesophagus was the widest and folded . The variances among the three regions of the oesophagus and between the two studied birds probably came from the variation in the function of each region which differed according to the type of the food intake in the two different birds, carnivorous birds needed to long cervical oesophagus in order to swallow their food (prey), while the granivorous birds needed to presence wide storage represented by crop.(Gelis, 2013). The present study declare an agreement with the results with Saleem (2012) who studied the digestive tract in the broilers chicken; Zaher *et al* (2012) who studied the digestive tract of *Coturnix coturnix* and Hamdi *et al*.(2013) who studied the digestive tract of the carnivorous bird *Elanus carulens*.

In common wood pigeon, result showed that the mucosa of the cervical oesophagus is composed of keratinized stratified squamous epithelium, while the mucosa of barn owl composed of non-keratinized stratified squamous epithelium. The present study expected that there was relationship between the histological structure and the type of nutrition, since the common wood pigeon fed on the grains mostly, the keratinization occurred to prevent the harmful effect of the food and vice versa for the barn owl which fed on the soft flesh (Gelis, 2013). The differences between the thickness of mucosa in the two studied birds probably caused by the presence of the oesophageal glands in the cervical oesophagus in the barn owl and the absence of them in the common wood pigeon. These results were accordant with the results of Rajabi and Nabipour (2009) who studied the oesophagus in the wild birds , Rock dove *Columba livia* , Collared dove *Streptopelia decaocta* , Rose-ringed parakeet *Psittacula krameri* , Kestrel *Falco trinnuculus* , House sparrow *Passer domesticus* and linnet *Cardulis cannabina.*

Submucosa in the cervical oesophagus of common wood pigeon was thinner than that of the barn owl, this results was similar to the study of Rodrigues *et al*.(2012) on the blue and yellow macaw *Ara ararauna* and Zaher *et al*.(2012). The similarity of the present results with the previous studies may came from the presence of more blood and lymph vessels in the submucosa which nourished the glands in the oesophagus of the barn owl than in that of common wood pigeon. Muscularis externa of the cervical oesophagus in the two studied birds showed the same histological arrangement, inner longitudinal and outer circular skeletal muscle fibers, but it was wider in the barn owl than that in common wood pigeon. The muscles that combined the avian digestive tract must organized their mode of action by where the food pass and resisted the big size of the food items, this may be the cause of the bigger muscularis layer in the barn owl and the arrangement of the muscle layers in the two studied birds and may be also the reason of the agreement with the results of Albideri *et al*.(2011) in their study on the digestive tract of *Ardeola ralloides* and *Columba livia* and disagreement with Rajabi and Nabipour (2009) and Rodrigues *et al*. (2012), the disagreement may be due to the differences in the food available in the environment.Serosa in the barn owl was thicker than that of the common wood pigeon. The present study expected that the reason of this results was the nourishment need of the big mass of the muscle in the muscularis externa of the barn owl which was bigger than of the common wood pigeon since the food items was different.

The present study found that the oesophagus in the two studied birds had inner longitudinal folds, in the cervical oesophagus folds were different in size, shape and number of oesophageal glands between the two birds. In common wood pigeon, folds appeared as (20) leaf-like shaped folds with height (699 µm), width (349.5 µm) and without glands, while in the bam owl, folds was (23) finger-like shape with height (745.6 µm) , width (279.6 µm) and had (57) tubuloalveolar flask-like glands per folds involved by lamina propria. These results did not agree neither with the study of Albideri *et al*. (2011) who reported that the *Columba livia* had no folds in its oesophagus nor with the study of Zaher *et al*.(2012) who reported that there were few longitudinal shallow and narrow folds in the cervical oesophagus of Coturnix coturnix. Since the role of the inner longitudinal folds in the oesophagus is to facilitate the dispensability of it (Gelis, 2013), the cause of the differences between the size and number of the folds in the two studied birds was probably the different size of swallowed food between the two birds.

The crop had the same previous aspects in the cervical oesophagus probably due to the same causes, but the notable result in the crop of common wood pigeon the mucosa appeared significantly thickest layer among the mucosa of the other parts of the oesophagus, perhaps, due to the functional needs, the epithelial lining cells of mucosa suffered from continuous proliferation for the stratified squamous epithelium consequated by desquamation (breakdown) of this layer responding to the prolactin hormone in order to mix the produced slouphy fluid with the food to facilitate the digestion of young (Ghali and Dauod, 2014; Kent and Carr, 2001;Kardong, 2006). This result did not found neither in the common quail *Coturnix coturnix* which studied by Parachami and Dehkordi (2011) nor in the partridge *Rhynchotus rufescens* which studied by Rossi *et al*.(2006).

Thoracic oesophagus also showed another differences between the two studied birds in the present study, results revealed that the mucosa of this region in the barn owl was significantly thicker than that of the common wood pigeon. Results showed also that the oesophageal glands were compound tubuloalveolar (tubuloacinar) glands involved by the lamina propria in the barn owl while in common wood pigeon they were flask-like tubualveolar glands involved by submucosa which was therefore thicker than the

submucosa of the barn owl. The folds in the thoracic oesophagus of the common wood pigeon appeared as (11) folds with height (745.6 µm), width(582.2 µm) and (8) glands per folds, while in the barn owl they appeared as (24) folds with height (978.6 µm), width(256.3µm) and (67) glands per fold. These results agreed with Albideri *et al*.(2011) , Hamdi *et al*. (2013) and Nasrin *et al*. (2012), this agreement may be came from the probability of the adaptation in the birds for the food type.(Farner and King,1972).

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