OPEN ACCESS
Advances in Animal and Veterinary Sciences

Research Article

Morphological, Histological and Histochemical Comparative Investigations of the Liver in Young Homing Pigeon (Columba Livia Domestica) and Cattle Egret (Bubulcus Ibis)

Sozan A.A. Ismaeil[1]*, Hassan Emam[2]

[1]Department of Histology and Cytology, Faculty of Veterinary Medicine, Zagazig, Egypt; [2]Department of Anatomy and Embriology, Faculty of Veterinary Medicine, Zagazig, Egypt.

Abstract | The current investigation on 30 healthy slaughtered young homing pigeons and Ibis. The samples were fixed and processed for the histological and histochemical examination of the liver. Pigeons were collected from the squab breeder while Ibis were collected from streets at Shariq province. The morphological findings showed that the liver of two species of birds is located in a hepato-peritoneal cavity, and each is composed of two undivided lobes, a large right lobe and a small left one which have light brown to dark red in pigeon and dark red in ibis. The histological structure of the organ in both species was different, were consisted of several lobules that were not separated from each other by trabeculae and covered by connective tissue capsule. The liver tissue of pigeon without a gall bladder. Histologically in both lobes beneath the thin capsule, while liver Ibis with gall bladder in both lobes covered with thick c.t capsule contains also many lymphatic cords especially under the capsule and hemopoietic tissue around the central vein, portal areas and between hepatocytes. Histochemical: in the liver of pigeons gave few amounts of reticular, collagen, and elastic fibers with silver, Crossman, and Orcein stains respectively and faint positive reaction with PAS while in the liver of Ibis was vice versa. This study aims to understand normal gross anatomy and histology of the liver in Young Homing Pigeons and Cattle Egrets. It can be concluded that the presence of gall bladder and absence of it and habit of feeding significantly affected the gross and histological structure of the liver.

Keywords | Cattle egret, Histology, Liver, Morphology, Pigeon

Received | October 24, 2021; **Accepted** | December 26, 2021; **Published** | February 15, 2022
***Correspondence** | Sozan A.A. Ismaeil, Department of Histology and Cytology, Faculty of Veterinary Medicine, Zagazig, Egypt; **Email:** sozy_mh@yahoo.com
Citation | Ismaeil SAA, Emam H (2022). Morphological, Histological and histochemical comparative investigations of the liver in young homing pigeon (Columba Livia Domestica) and cattle egret (Bubulcus Ibis). Adv. Anim. Vet. Sci. 10(3): 607-620.
DOI | http://dx.doi.org/10.17582/journal.aavs/2022/10.3.607.620
ISSN (Online) | 2307-8316

INTRODUCTION

Poultry production has full a main role between agricultural industries in several parts of the world, Chicken meat production has been increasing in all regions with the principal in Asia and South America, Asia is important the world in poultry meat production, followed by North and Central America which had the lead until 1990 (Daghir, 1995). Poultry meat is the then maximum extensively eaten meat in the world, accounting for about 30% of meat production worldwide (Raloff, 2003).

The liver is the largest gland in the body and it can be regarded as the central organ in the maintenance of energy supply, moreover, the liver catalyzes biosynthetic and biodegrative processes and excretes final metabolic products (Whitlow, 2000). The liver has secretary capabilities, this organ also is able to excrete, provide, storage, detoxify, metabolize, esterifies, and phagocytize, in short, it plays roles as the control center for the digestive system also functions as both endocrine and exocrine gland (Whitlow, 2000; Dyces et al., 2002). It is divided into right and left lobes which are joined cranially at the midline, the right lobe is larger in the domestic fowl and turkey, the left lobe is subdivided into the dorsal and ventral parts (Whitlow, 2000; Caceci, 2006). The liver parenchyma of birds resembles the liver of mammalian but there is some difference in histological features such as the absence of

lobules and interlobular trabeculae, its fact the principal cell of the liver is the hepatocyte (Whitlow, 2000; Dyce et al., 2002; Caceci, 2006).

Anatomically

The adult chicken usually has a dark red to brown red-colored liver (Clark, 2005). The liver is separated into right and left portions which are fused cranially at the midline, the right lobe is larger in the domestic fowl and turkey the left lobe is divided into the dorsal and ventral parts (Whitlow, 2000). The parenchyma of the liver in birds resembles the liver of mammalian but there is some unlike in histological features such as lacking lobules and interlobular trabeculae, the principal cell of the liver is the hepatocyte (Caceci, 2006).

Birds have a single body chamber and do not have separation of the abdomen and thorax as in mammals (Dyce et al., 2010). In avian species, the liver is a bilobed organ that lies in the mid-coelomic cavity of the body, ventrally and posteriorly to the heart associated with proventriculus and spleen (Clark, 2005; Al-Abedi, 2015). In most avian species, the left lobe is slightly smaller than the right lobe. The liver is the largest gland of the body, it is dark brown or red-brown in color and the liver is both endocrine and exocrine gland releasing several substances directly into the bloodstream and secreting bile into the duct system (Hamdi et al., 2013), Embryologically, it derived from endoderm (hepatocyte and biliary epithelium) and mesoderm (stroma cells, satellite cells, kupffer's cells and blood vessels (Strick-Marchand and Weiss, 2003; Zhao and Duncan, 2005).

Histologically

liver of avian similar to that in mammals but there are some differences such as absent connective tissue septa between lobules except in the portal area (Illanes et al., 2006), duck liver consists of several lobules separated from each other by thin trabeculae of connective tissue extending from the delicate capsule that enclosed the liver (Al-Abdulla, 2015). in turkey, the hepatocytes are usually arranged as two cell thicknesses between the liver sinusoids. The portal area contained a branch of the portal vein, a branch of the hepatic artery, and 2-3 interlobar bile ducts (Al-Aarajii, 2015).

The liver of coot bird, surrounded by a thin capsule of connective tissue that continues to subdivided the liver into lobules, the hepatocyte which arranged radially around the central vein. These cells are polygonal in shape and have rounded nucleus and there is present of sinusoids between hepatocyte which lined by flattened endothelial cells (Hanan, 2013).

The liver of Iraqi Falcon (Flacon Perigord), divided into several lobules contains polyhedral cells (hepatocyte) arrange like plates around the central vein which are separated from each other by blood sinusoid. The sinusoid is blood capillaries have two types of cells kupffer's cell and flatted endothelium cell (Strick-Marchandandweiss, 2003; Aughey and Frye, 2010). The portal area is located between liver lobules and compost of the branch of the hepatic artery, portal vein, and bile duct which is lined with the one layer of cuboidal cells on basal lamina (Al-Abdulla, 2015). The liver is invested by a delicate connective tissue capsule (Glisson's capsule) that becomes thicker at the hilum where the portal vein and hepatic artery enter the liver (Dyce et al., 2010). liver composed of epithelial cells hepatocyte) arranged in branching and anastomosing plates (Junqueira et al., 1992; Safer et al., 1998), the hepatocyte storage the glycogen (Krause and Cuts, 1986), the hepatocyte plate has a radial pattern about the central vein. the portal area contains a branch of the hepatic artery. the portal vein, bile duct, and lymphatic channel (Dyce et al., 2010).

The liver parenchyma of birds resembles the liver of mammalian but there is some difference in histological features such as the absence of lobules and interlobular trabeculae, its fact that the principal cell of the liver is the hepatocyte (Dyce et al., 2002).

Histochemically

The liver of Mallard showed different sizes of glycogen granules in the cytoplasm of hepatocytes and in some specimens, the glycogen large granules were arranged around the central vein because the bird was in starvation period (Maha, 2015). The cytoplasm of hepatocytes in Iraqi and Falcon (Flacon Perigord) contained the number of glycogen granules when staining by PAS (periodic acid Schiff) the granules needed for energy to Animal (Attia and Soliman, 2005; Jabbar and Diyar, 2016). Strick-Marchand and Weiss (2003). Referred the lipid droops appeared in the cytoplasm of hepatocytes with different levels in birds.

MATERIALS AND METHODS

Animals and tissue samples

The current study was conducted on 30 healthy, freshly slaughtered young homing pigeons and cattle egret (Ibis) taken from Zagazig, Sharkia Province, Egypt. liver was dissected from the healthy animals immediately after slaughter. Where young homing pigeons were purchased from the squab breeders in El Sharkia Province Egypt, while cattle egret (Ibis) were collected from local surroundings. Birds were healthy with (300–400 g) average body weights. This work has been reviewed and approved by the ZU-IACUC committee with approval number ZU-IACUC/2/F/163/ 2021.

Gross anatomical evaluation

Various measurements including weight, length, width, thickness, and circumference of liver and gall bladder were recorded using a measuring tape, vernier caliper, and electric balance. For the morphological study, fifteen adult healthy birds for each species (Columba Livia Domestica and Bibulous Ibis) of both sexes were collected from different areas of El-Sharkia province. All Birds were scarifying immediately after they were anesthetized by ethyl ether inhalation. The coelomic cavity was opened; the liver and duodenum were dissected out. Most anatomical measurements including length, width, and thickness of the right and left lobes of the liver were measured using measuring tape and ruler; also the mean length, width, and thickness were evaluated.

Statistical analysis

The data were analyzed by SPSS version 25 (Armonk, NY: IBM Corp) and Graph Pad Prism 8.0.2 (GraphPad Software, Inc.). The results were reported as Mean ± SE. independent samples t-test was run to test differences in length and width of the right and left lobe of pigeon and ibis species. Statistical significance of results was considered to be at $P < 0.05$.

Tissue for histological and histochemical preparations

The specimens (liver) were preserved and fixed in 10% buffered neutral formalin for 24 hours at room temperature, then dehydrated followed by clearing in Xylol. All specimens were infiltrated with soft melted paraffin and were embedded in hard paraffin. Paraffin sections were stained with Harris's Hematoxylin and Eosin (H and E) stain as a routine staining technique to show the general histological structure, Crossmon's trichrome stain for collagen and muscle fibers, Silver impregnation for reticular fibers, Orcein stain for Elastic fibers, Periodic Acid Schiff (PAS) for neutral mucopolysaccharides and some acidic ones (Suvarna et al., 2018).

All the stained sections were examined with a standard light microscope (Olympus BX 21) and photographed by a digital Dsc-W 800 super steady cyber shot camera (Sony-Japan) at the Department of Histology and Cytology, Zagazig University).

RESULTS AND DISCUSSION

Anatomically

The liver of pigeons (Figure 1) was centrally located in the ventral part of the coelomic cavity intervenes between the thoracic cavity cranially and abdominal cavity caudally just caudo-ventrally to the heart. The color of the liver was ranged from red-brown to dark brown and has two surfaces, convex parietal surface and concave visceral one which related to proventriculus, gizzard, and spleen. It is subdivided into two lobes; the right lobe was bigger and longer than the left one (Figure 2) while both lobes of the liver are connected by the interlobar portion. Bile secretion of the liver poured into the first part of the duodenum through the hepatic duct (Figure 3), without a gall bladder.

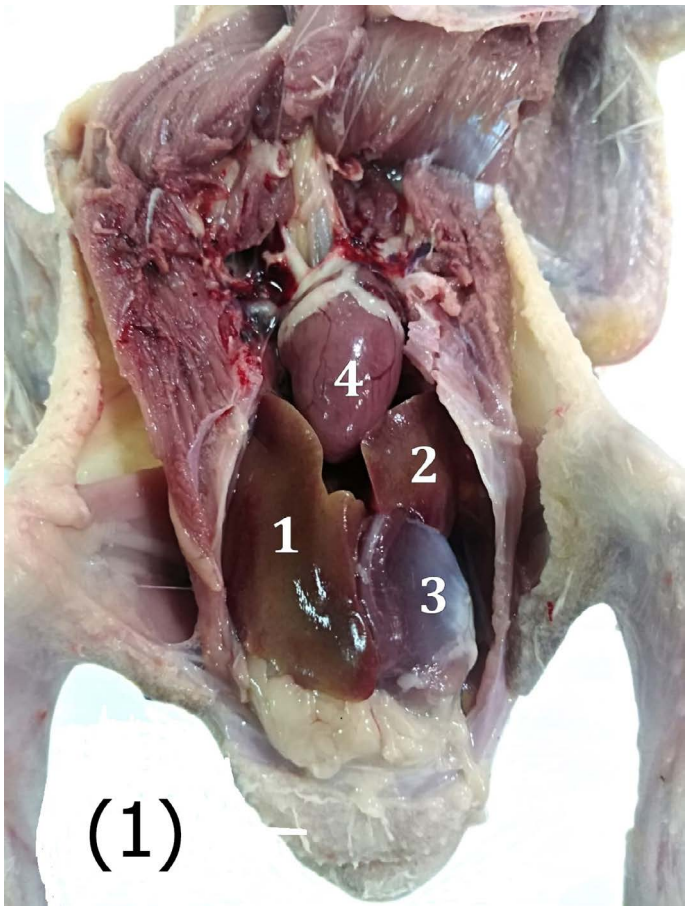

Figure 1: Dissected abdominal cavity of pigeon showing the relation and position of liver :- 1- right lobe of Liver 2- left lobe of Liver, 3- Gizzard and 4- Heart.

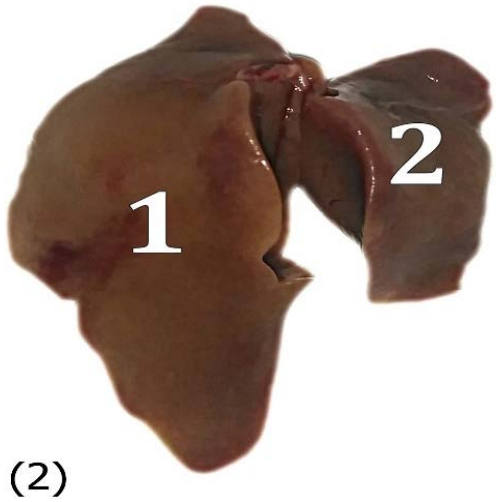

Figure 2: Photomacrograph of the liver of pigeon parietal view showing: 1- Right lobe 2- left lobe.

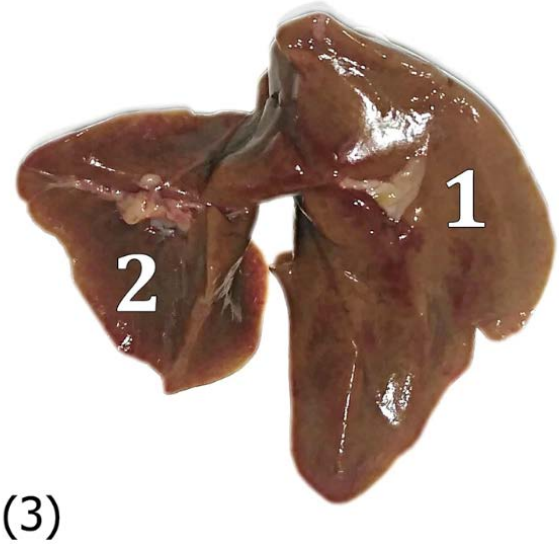

Figure 3: Photomacrograph of the liver of pigeon visceral view showing: 1- Right lobe 2- left lobe. No gall bladder.

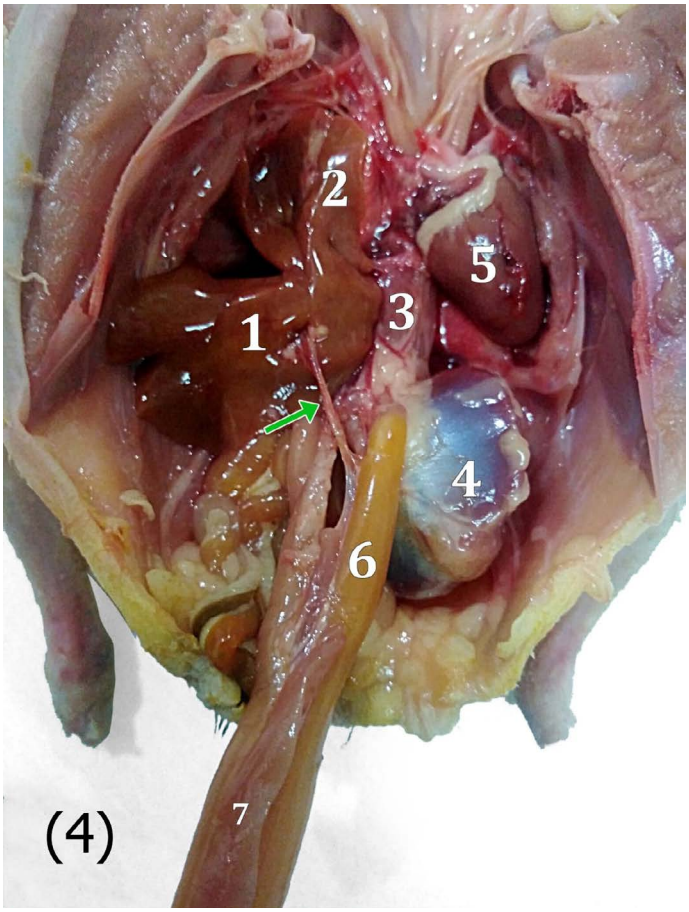

Figure 4: Dissected abdominal cavity of pigeon with reflected liver showing:- 1- right lobe of Liver, 2- left lobe of Liver, 3- proventriculous, 4- Gizzard, 5- Heart, 6- Duodenum, 7- Pancreas and common hepatic duct(green arrow) with no gall bladder.

The liver of the ibis was situated in the cranial part of the abdominal cavity, dark brown color (Figure 4), and subdivided into two unequal lobes; the right lobe was larger than the left one (Figure 5). The caudal end of the left lobe has a prismatic shape (Figure 6). With gall bladder (Figure 7) was dissected on the visceral surface of the right lobe which empties their bile in the duodenum through the common bile duct (Figure 8).

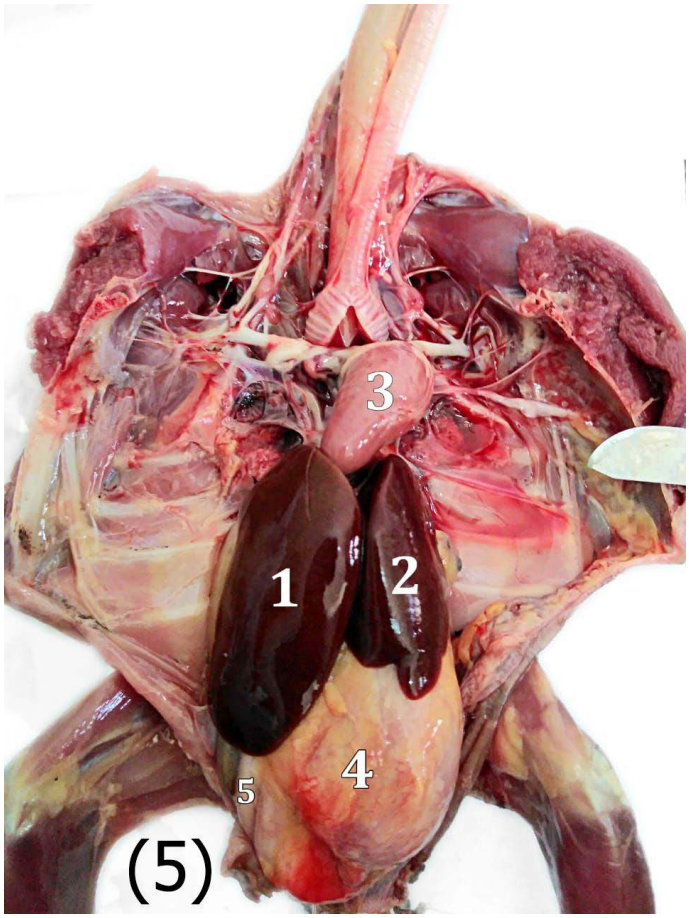

Figure 5: Dissected abdominal cavity of Ibis showing the relation and position of liver :- 1- right lobe of Liver, 2- left lobe of Liver, 3- Heart, 4- Gizzard and 5- Duodenum.

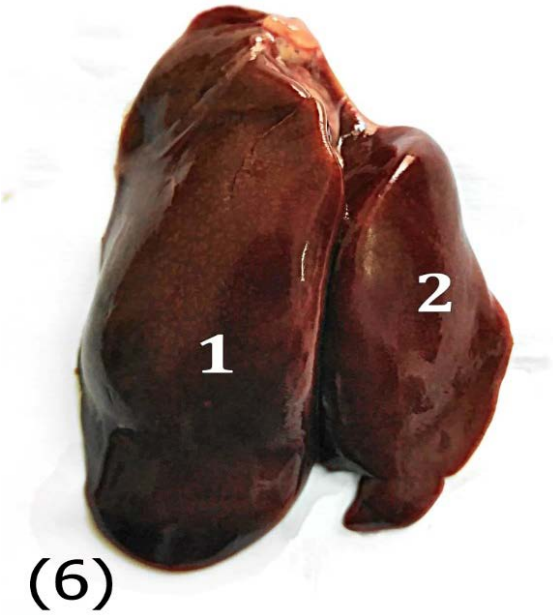

Figure 6: Photomacrograph of the liver of Ibis parietal view showing: 1- Right lobe 2- left lobe.

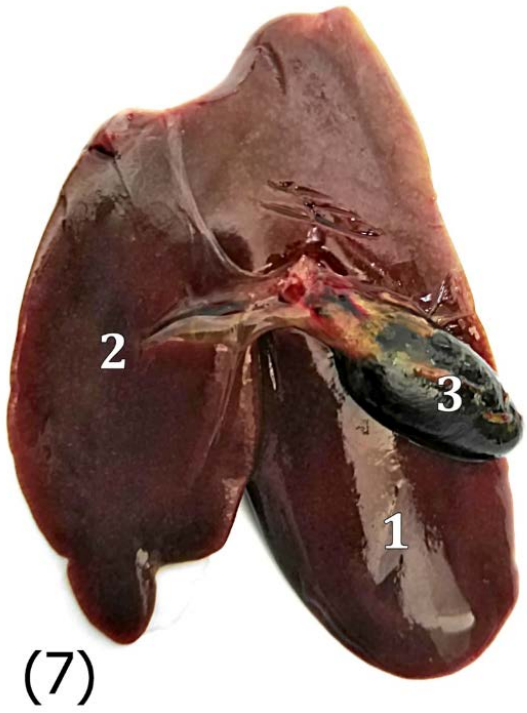

Figure 7: Photomacrograph of the liver of Ibis visceral view showing: 1- Right lobe 2- left lobe and 3- gall bladder.

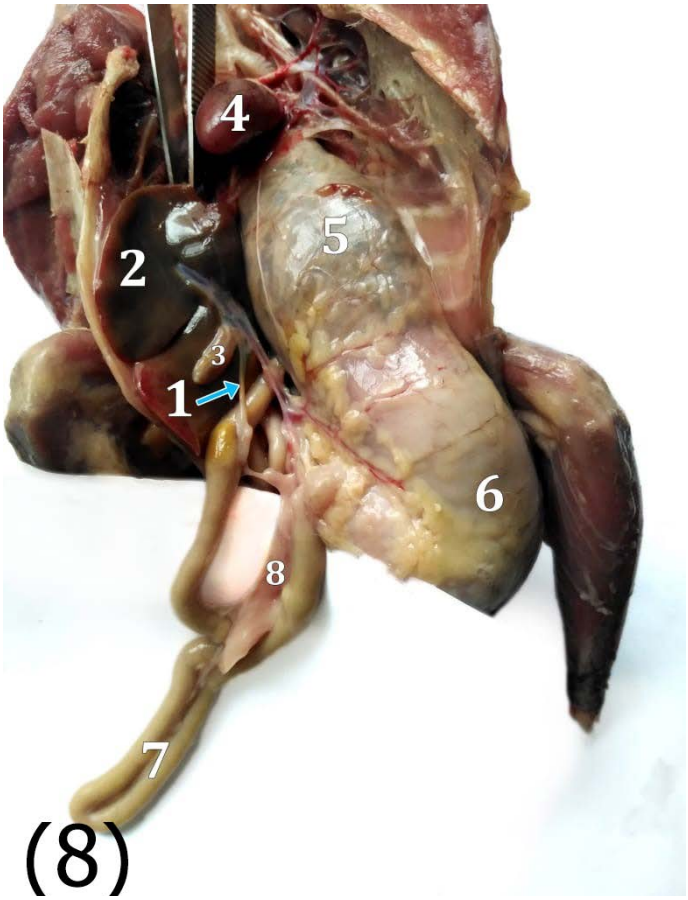

Figure 8: Dissected abdominal cavity of Ibis with reflected liver showing:- 1- right lobe of Liver, 2- left lobe of Liver, 3- gall bladder, 4- Heart, 5- proventriculous, 6- Gizzard, 7- Duodenum and 8- Pancreas. Common bile duct (blue arrow).

The current study illustrated that length of the right lobe in pigeon was (4.62 ± 0.07) cm and its width was (2.48 ± 0.08) cm; while the length of the left lobe was (3.32 ± 0.06) cm and its width was (2.07 ± 0.06). In ibis, the length of right lobe was (5.80 ± 0.07) and its width was (2.31 ± 0.05) cm; while the length of left lobe was (4.65 ± 0.06) cm and its width was (2.13 ± 0.05) (Table 1). The present study showed a significant difference (P<0.05) between the length and width of the right and left lobes in pigeons compared with Ibis (Table 1).

Table 1: Mean ± SEM describing measurements of right and left lobes (lengthand width) for pigeon and ibis.

Points of difference	Pigeon	Ibis	P-value
R. lobe length	4.62 ± 0.07	5.80 ± 0.07	< 0.001***
L. lobe length	3.32 ± 0.06	4.65 ± 0.06	< 0.001***
R. lobe width	2.48 ± 0.08	2.31 ± 0.05	> 0.05^{NS}
L. lobe width	2.07 ± 0.06	2.13 ± 0.05	> 0.05^{NS}

***denotes highly significant difference P< 0.001, NS denotes non-significant difference P> 0.05

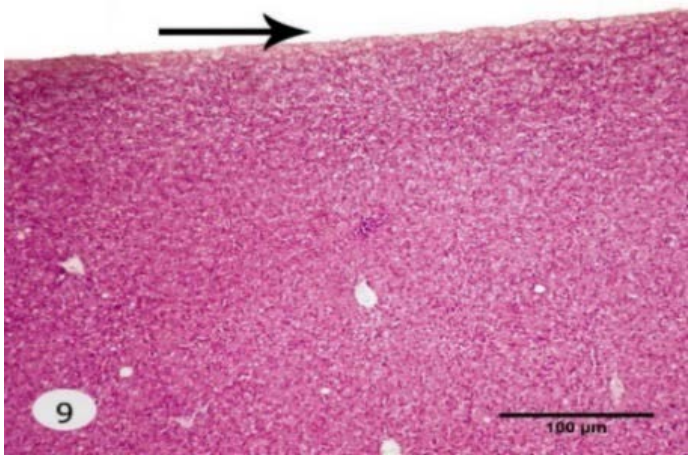

Figure 9: Photomicrograph of the pigeon's liver showing the thin capsule (arrow).

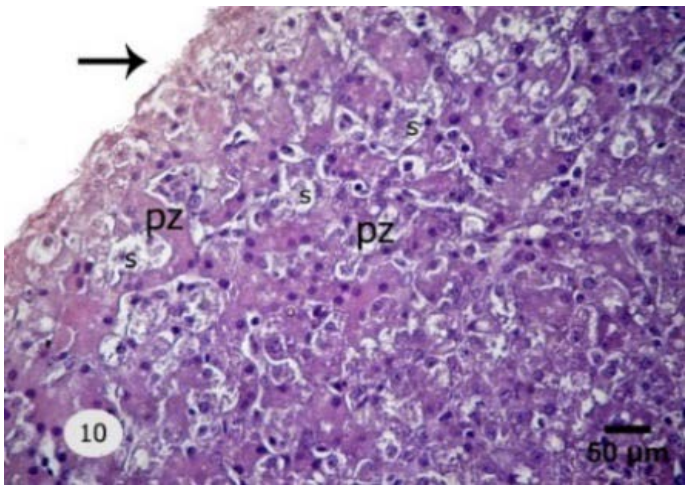

Figure 10: Photomicrograph of the pigeon's liver showing the thin capsule (arrow) and the peripheral dark acidophilic zone (Pz) in-between wide blood sinusoids (S).

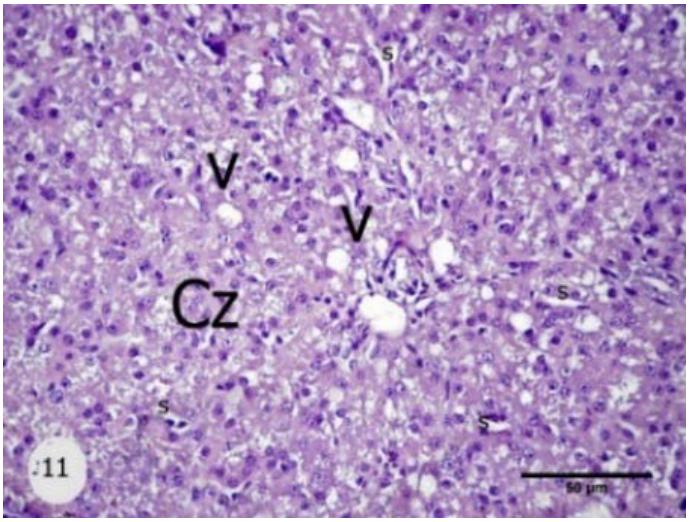

Figure 11: Photomicrograph of the pigeon 's liver showing vacuoles (V) and the central pale acidophilic zone (Cz) in-between narrow sinusoids (S).

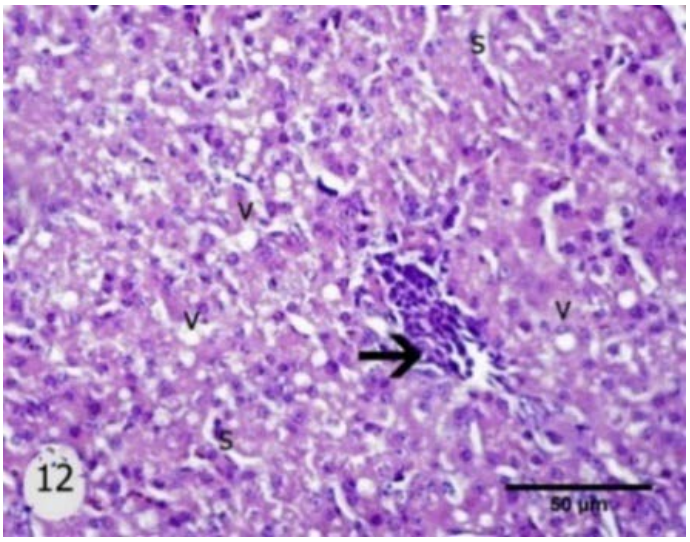

Figure 12: Photomicrograph of the pigeon 's liver showing many vacuoles in different size (V), lymphatic tissue (arrow) and narrow sinusoids (S).

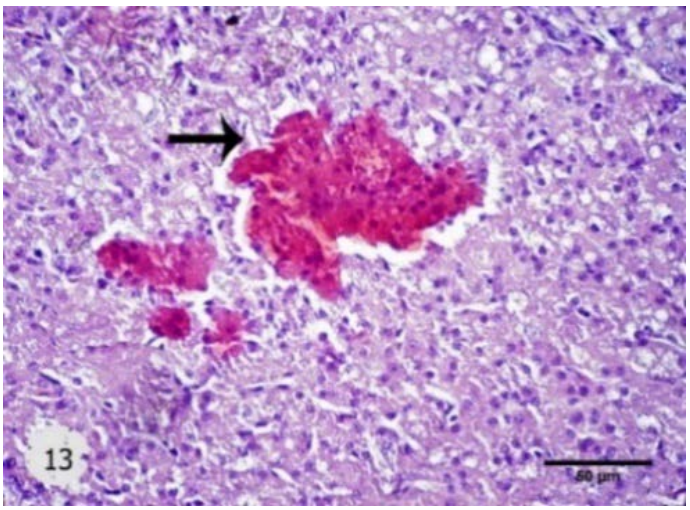

Figure 13: Photomicrograph of the pigeon 's liver showing dark red areas in hepatocytes (arrow)

Histologically

The liver of pigeon hasn't gall bladder in both lobes and is covered with thin c.t capsule and without connective tissue septa (trabeculae) as found in mammals and animals so no lobulation was found, beneath the capsule (Figure 9), a- A peripheral dark acidophilic zone of polygonal hepatocyte with round nuclei containing one to two nucleoli and dark basophilic cytoplasm which runs in irregular manner in-between large wide sinusoids lined by flattened endothelial cells with elongated nuclei and dark cytoplasm also Kupffer's cells which is spherical, larger than endothelial cells and with dark cytoplasm and embedded in a cavity of blood sinuses as phagocytic cells (Figure 10). b- A central pale acidophilic zone of round hepatocytes with a round to spherical nuclei containing one to two nucleoli and faint basophilic cytoplasm which consists of a central vein with diffuse cords of hepatocytes randomly organized around it and mutually separated by narrow sinusoids (Figure 11), also, many vacuoles of different sizes (Figure 12), pale red areas are high in number and round to irregular in shape (Figure 13), dark red areas (Figure 14), lymphatic tissue are also found especially around blood vessels and portal areas which consist of one branch of the hepatic vein, hepatic artery, and 1-2 bile ducts (Figures 15, 16), and large spaces were also detected which differ in shape and size (Figures 17, 18), while liver in cattle egret (Ibis) with gall bladder (Figure 19), in both lobes covered with thick c.t capsule (Figure 20) beneath it a- A peripheral dark red zone was arranged as a network of hepatocyte with large polygonal nuclei with 1-2 nucleoli and dark basophilic cytoplasm, in-between wide sinusoids lined by Kupffer's cells and nucleated RBCs (Figure 21). b- A central zone of spherical hepatocytes with round nuclei containing 1-2 nucleoli and faint basophilic cytoplasm, consists of a central vein surrounded by hepatocytes arranged in clusters like the excretory unit of the pancreas (Figure 22), few pale red areas all over the liver (Figure 23), many lymphatic cords especially under capsule (Figure 24), also hemopoietic tissue between hepatocyte as islets of the pancreas and around the central vein (Figure 25), portal area which consists of one branch of the hepatic vein, branch of hepatic artery and 1-2 bile duct that lining by one cuboidal cell resting on the basal lamina and lymphatic tissue, and between hepatocytes (Figure 26).

Histochemical

In the liver of pigeon gave few amounts of reticular, adequate amount of collagen fibers, and delicate amounts of elastic fibers with silver and Crossman and Orcein stains respectively (Figures 27, 28, 29). and faint positive reaction with PAS in capsule and around the central vein and few glycogen granules in hepatocytes (Figure 30) while in the liver of cattle egret (Ibis) gave high amounts of reticular, collagen elastic fibers with silver, Crossman, and Orcein

stains respectively (Figures 31, 32, 33), and strong positive reaction with PAS in capsule and around the central vein and glycogen granules in hepatocytes like a rose (Figure 34).

Anatomically

The liver of pigeons was centrally located in the ventral part of the coelomic cavity intervenes between the thoracic cavity cranially and abdominal cavity caudally just cauda -ventrally to the heart, has two surfaces, convex parietal surface and concave visceral one which related to proventriculus, gizzard, and spleen. This accord with Jabbar and Diyar (2016) who reported that a gross examination of the liver in the two species of birds is the largest gland in domestic fowl *(Gallus Gallus),* common moorhen *(Gallinula chloropus).*it located caudally and ventrally to the heart and was associated with the gizzard that lied in the mid-coelomic cavity of the body. The liver has two surfaces. This surface character is smooth convex, concave and the gland is subdivided into two parts right and left lobe. The lobe left declines to represent proventriculus sites, part of the gizzard and spleen as there are declines in the right lobe also represent sites both part of the gizzard and both ends of the duodenum upward and downward, while in (Mclelland, 1990) who mentioned that, anatomically, the liver of the starling bird located in the cranial third of the abdominal cavity like other studies. But the previous studies showed the liver of Mallard (Maha, 2015) was located in the cranial part of the abdominal cavity behind the diaphragm, it lies caudally and ventrally to the heart and is associated with the proventriculus and the spleen.

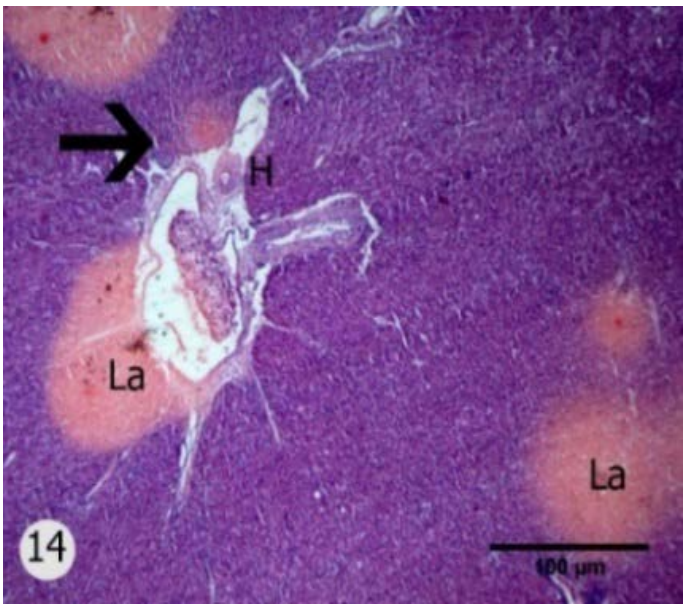

Figure 14: Photomicrograph of the pigeon 's liver showing round irregular pale red area (La) around portal area (arrow); which consists of one branch of portal vein , one branch of hepatic artery, 1-2 bile ducts and may be lymphatic tissue.

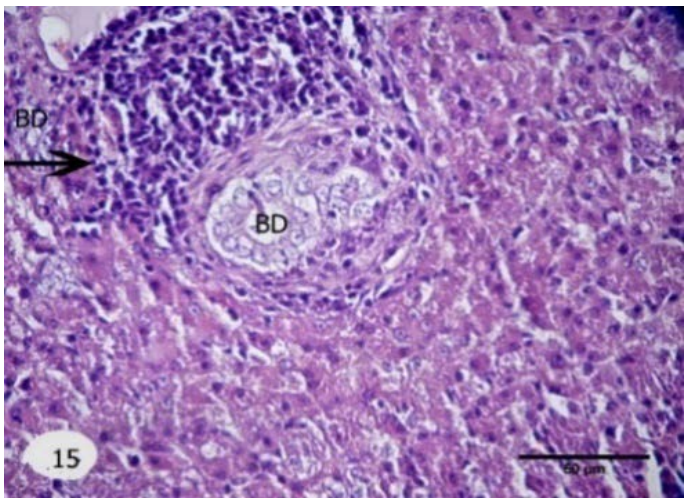

Figure 15: Photomicrograph of the pigeon 's liver showing portal area which consists of one branch of hepatic vein (HV) , one branch of hepatic artery (HA), 1-2 bile ducts and may be (arrow).

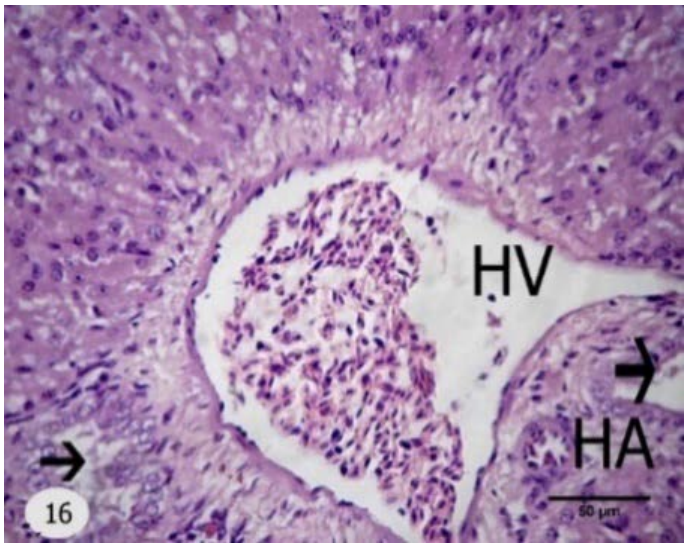

Figure 16: Photomicrograph of the pigeon 's liver showing lymphatic tissue (arrow) around bile duct (BD).

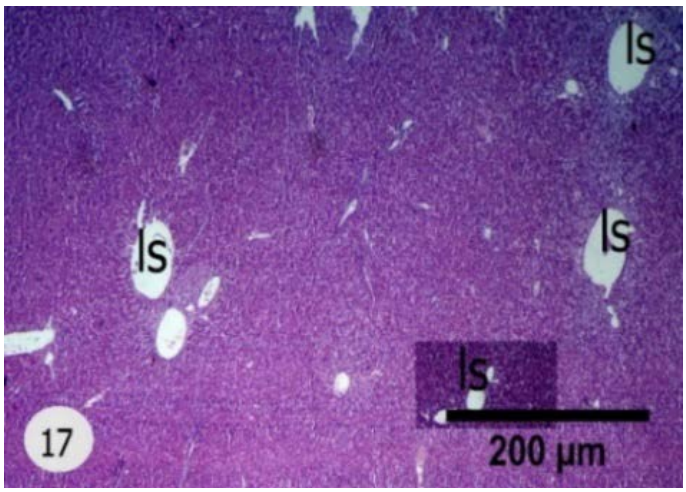

Figure 17: Photomicrograph of the pigeon 's liver showing large spaces in different size and shape (LS) between hepatocytes.

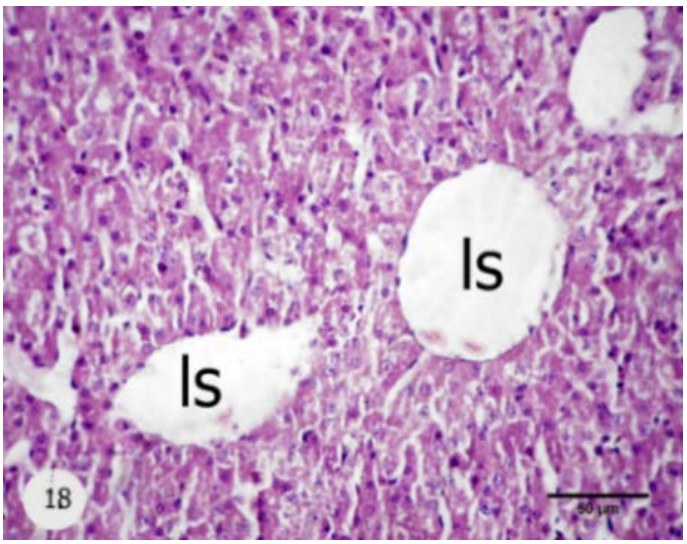

Figure 18: High magnification of rectangular area in (Fig. 17) showing large spaces in different size and shape (LS) between hepatocytes.

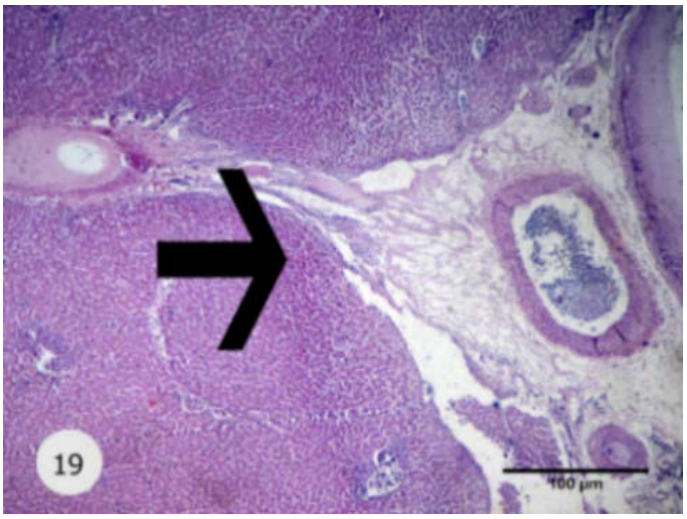

Figure 19: Photomicrograph of the Cattle Egret 's (Ibis) liver showing gall bladder (arrow)

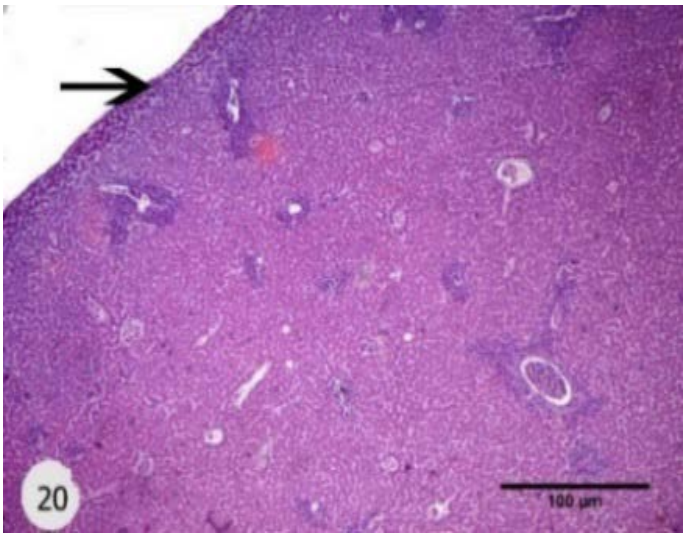

Figure 20: Photomicrograph of the Cattle Egret 's (Ibis) liver showing thick capsule (arrow)

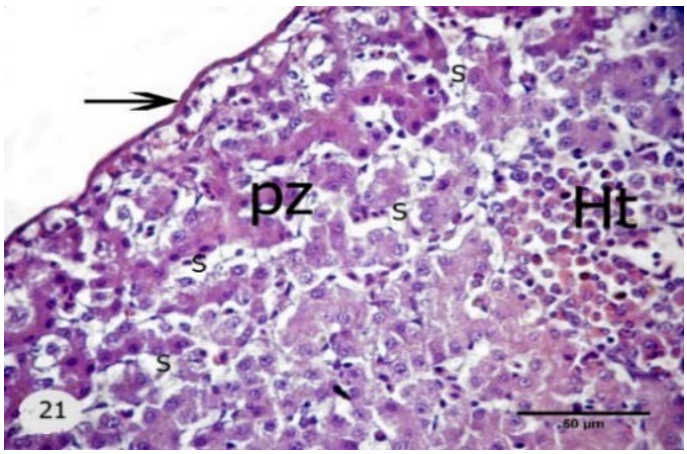

Figure 21: Photomicrograph of the Cattle Egret 's (Ibis) liver showing the peripheral dark red zone (Pz), wide sinusoids (S) lined by kupffer's cell and nucleated RBCs, thick capsule (arrow) and haemopoietic tissue(Ht).

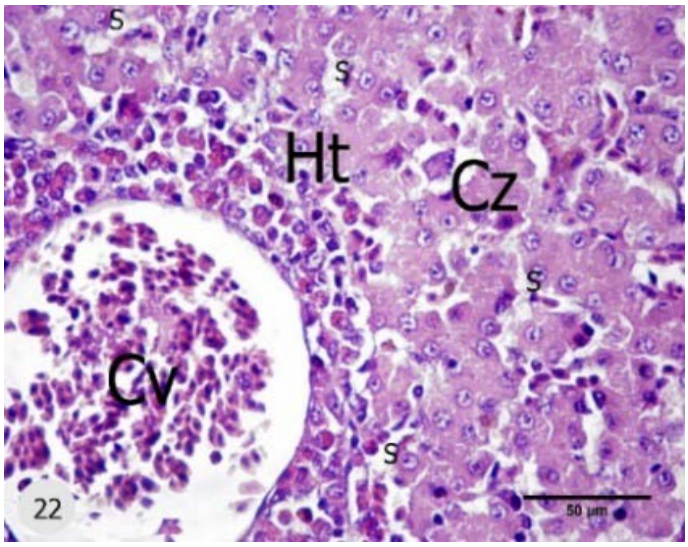

Figure 22: Photomicrograph of the Cattle Egret 's (Ibis) liver showing the central faint red zone (Cz), narrow sinusoids (S) lined by kupffer's cell and nucleated RBCs, and haemopoietic tissue(Ht) around the central vein (CV).

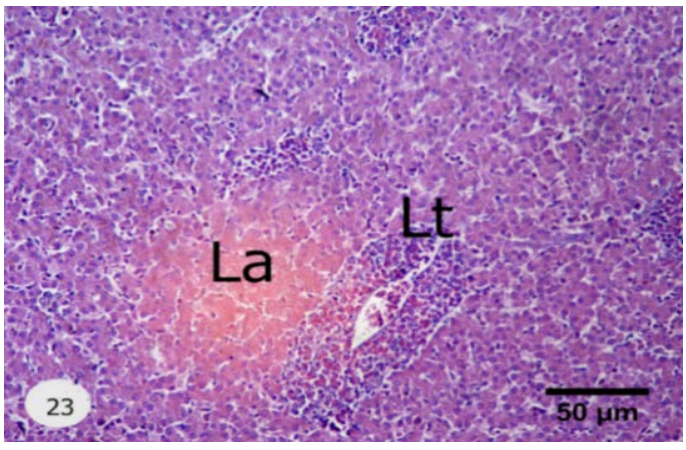

Figure 23: Photomicrograph of the Cattle Egret 's (Ibis) liver showing few pale red area all over the liver (La) and lymphatic tissue around it (Lt).

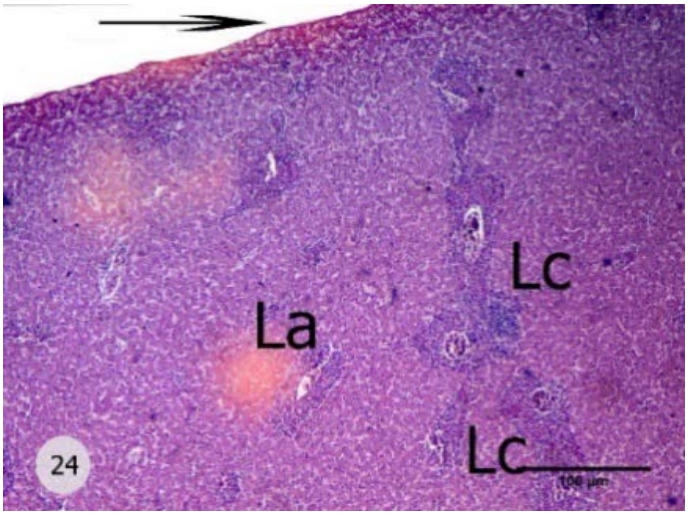

Figure 24: Photomicrograph of the Cattle Egret 's (Ibis) liver showing few pale red area all over the liver (La) and lymphatic cords (Lc) under the capsule (arrow).

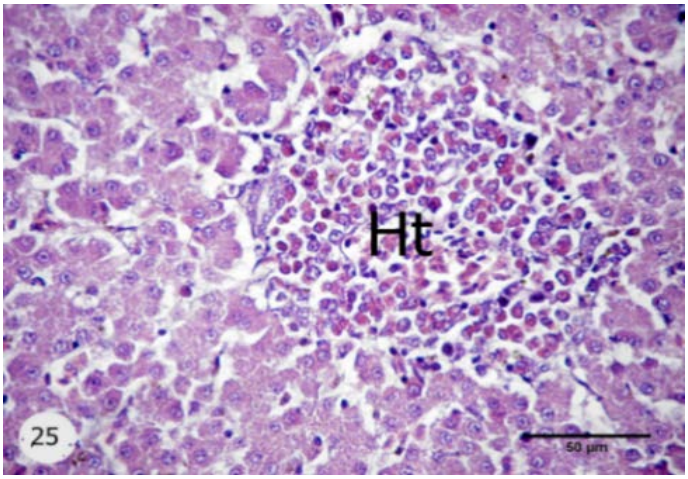

Figure 25: Photomicrograph of the Cattle Egret 's (Ibis) liver showing haemopoietic tissue (Ht) as islet of pancreas between hepatocyte.

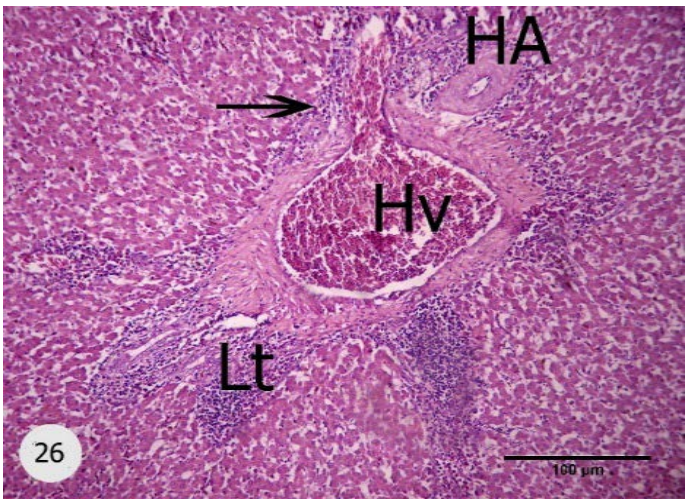

Figure 26: Photomicrograph of the Cattle Egret 's (Ibis) liver showing the portal area (arrow) which consists of one branch of hepatic vein (HV) , one branch of hepatic artery (HA), and lymphatic tissue (Lt).

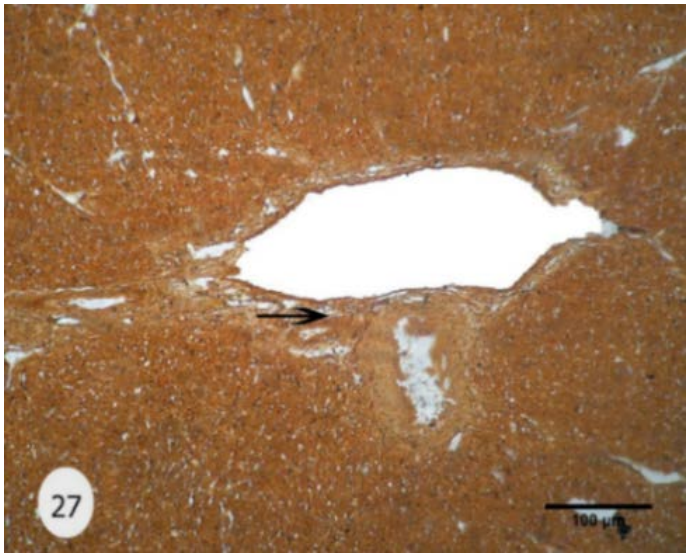

Figure 27: Photomicrograph of the pigeon 's liver showing few amount of reticular fibers (arrow)

Figure 28: Photomicrograph of the pigeon 's liver showing a dequate amount of collagen fibers (arrows)

Figure 29: Photomicrograph of the pigeon 's liver showing a delicate amount of elastic fibers (arrow).

Figure 30: Photomicrograph of the pigeon 's liver showing faint positive reaction with PAS around portal area (arrows) and in hepatocyte.

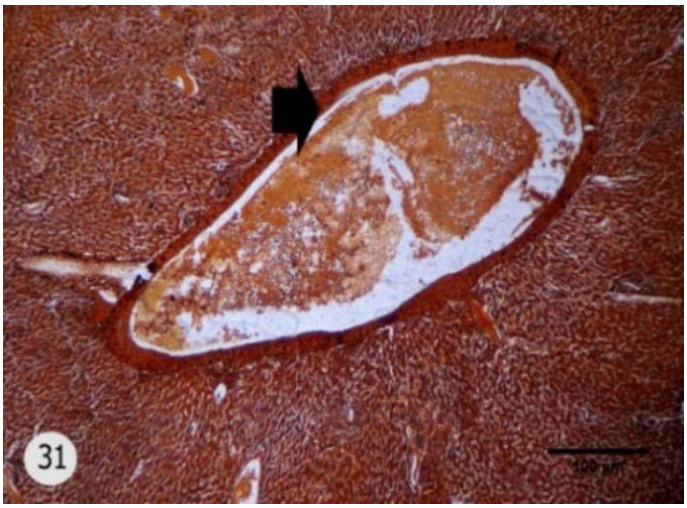

Figure 31: Photomicrograph of the Cattle Egret 's (Ibis) liver showing high amount of reticular fibers (arrow) around central vein.

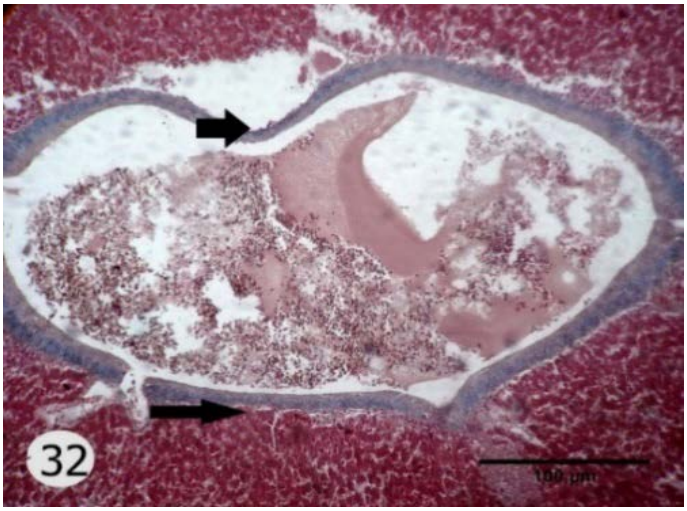

Figure 32: Photomicrograph of the Cattle Egret 's (Ibis) liver showing high amount of collagen fibers (arrow) around central vein.

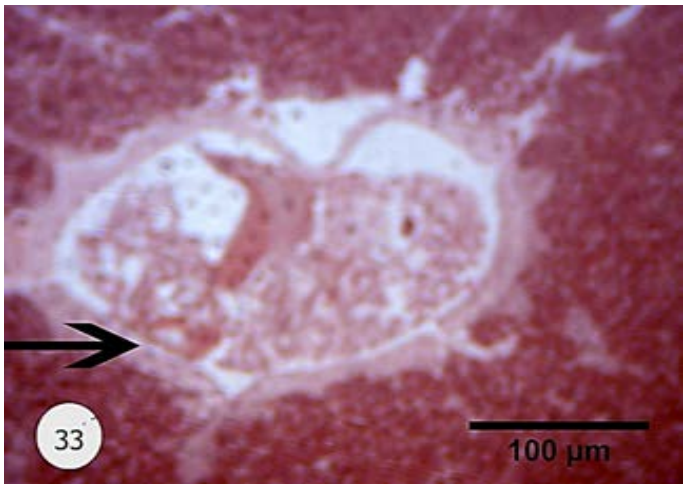

Figure 33: Photomicrograph of the Cattle Egret 's (Ibis) liver showing high amount elastic fibers (arrow) around central vein.

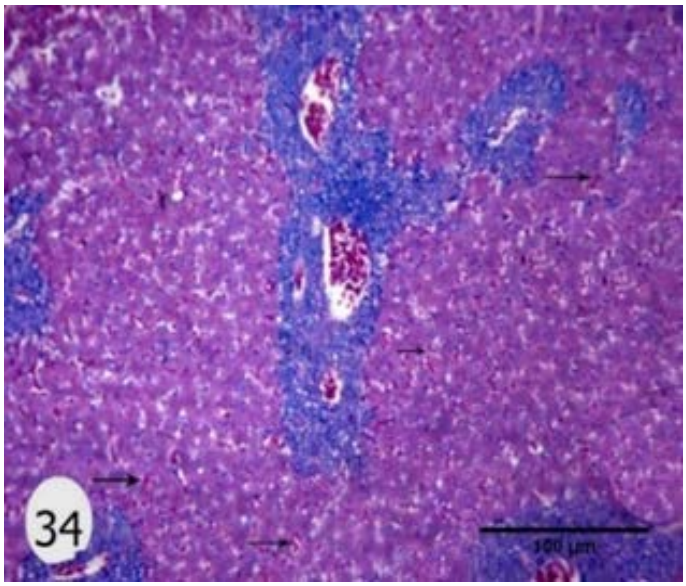

Figure 34: Photomicrograph of the Cattle Egret 's (Ibis) liver showing glycogen granules in hepatocyte like a rose (arrows).

The color of the liver in pigeons was ranged from red-brown to dark brown and subdivided into two lobes; the right lobe was bigger and longer than the left one while both lobes of the liver connected by interlobar portion. Bile secretion of the liver poured into the first part of the duodenum through the hepatic duct, without the gall bladder. While the liver of the ibis was dark brown in color and subdivided into two unequal lobes; the right lobe was larger than the left one. The caudal end of the left lobe has a prismatic shape, with gall bladder, this disagrees with Jabbar and Diyar (2016) who found that the liver of the common moorhen *(Gallinula chloropus)* was appeared-brown in color and divided into parts of the left and right lobes like the liver of *(Gallus gallus)* but it is smaller in size. The left lobe was subdivided into the dorsal and ventral parts smaller in size from the right lobe and it has

a concavity in its top where is the gizzard was stabilized. The right lobe is greater and longer than the left lobe. Also differ with the adult chicken usually has a dark red to the brown red-colored liver (Clark, 2005).

The liver is separated into right and left portions which are fused cranially at the midline, the right lobe is larger in the domestic fowl and turkey the left lobe is divided into the dorsal and ventral parts (Whitlow, 2000). On contrary with the ostrich where the left lobe of the liver was subdivided into three secondary lobes while the right lobe was undivided (Stornelli et al., 2006) while there were no further lobular subdivisions in the liver of Houbara Bustards (Bailey et al., 1997), the result agreed with (Al-Abedi, 2015) that described the liver in Coturnix Coturnix was the left lobe divided into two portions, dorsal and ventral lobe. We thought that the normal color of the avian liver depends on the nutritional state, breed, and age of the bird so it is maybe red-brown or it may be light brown but it is yellow if the bird is on a high-fat diet. Also differ with (Faraj and Al-Bairuty, 2018) who mentioned that the liver of the starling bird is dark red-brown in color. The liver consists of undivided left and right lobes which were connected cranially at the midline by an interlobar portion. The top of the left lobe has a concave shape where the heart stabilized, whereas the ventral side of the right lobe has a concave shape where the gizzard was stabilized (Hamid et al., 2013). The right lobe of the liver was larger than the left lobe.

Histologically

The liver in pigeon was covered by a thin capsule of connective tissue without septa; so no lobulation is found, this in agreement with (Hanan, 2013) who reported that the liver of coot bird was surrounded by a thin capsule of connective tissue but differ in that c.t continue to subdivided the liver into lobules indicate the liver of coot bird is a large lobed gland enclosed by serosal lining that contain a thin capsule of connective tissue which continue to subdivide the liver into lobes and to a lesser extent into lobules that provided physical support, this finding respected (Hodges, 1974), this indicates that liver of chicken covered by mesothelium called Glissons capsule. Also, different from the common moorhen *(Gallinula chloropus),* which is large lobed liver lining by a capsule which composed of irregular dense connective tissue that continues to subdivided the liver into lobes and appears thicker in these agreed which appears thicker in the Larus cousin (Hanan, 2013).

This capsule was also reported in other birds and vertebrates (Schmidt et al., 2003; Illanes et al., 2006). Also, in accord with a study on the liver of Indian black Ibis that enclosed with sealing which contains thin capsule (*Glasson s capsule),* this result agreement with (Enoschenko, 2008; Aughey and Frye, 2010) and different from (Attia and Soliman, 2005) when a study on ostrich liver. And with the histological study saw the liver of mallard is consist of numerous lobules separated from each other by a thin layer of connective tissue which is continuous from thin liver tissue capsule and this observed agreed with (Eroschenko, 2008; Esfahani et al., 2009; Aughey and Frye, 2010).

In our work, present sinusoids lined by flattened endothelial cells also Kupffer's cells which were spherical in shape, this similar to that sinusoid vessels were irregular shape as well as lined by endothelial cells, flattened shape contact with another cell called Kupffer's cells which contain large nuclei, this study conformable with (Hamid, 2013; Al-Abdulla, 2015) when a study on the liver in Larus Conus, Stgoporins Fischer, Numida Meleagris, and local duck respectively. And there was a presence of sinusoids between hepato-cords, these results were in agreement with (Randall and Reece, 1996). But found a difference with (Hanan, 2013), that revealed that there was the presence of sinusoids between hepatocytes lined by flattened endothelial cells. Also (Wardle, 1987) recorded that lumen of sinusoids contained erythrocytes and macrophages also the wall of sinusoids contained Kupffer's cells which were important for the maintenance of liver functions under physiological and pathological circumstances. They play an important role in the modulation of immune responses via antigen presentation and suppression of cell activation and proliferation of T-cells (Sun et al., 2003). Present similarity also with the sinusoids lined by endothelial cells which were flattened in shape that contracted with the more prominent phagocytically active kupffer's cells that cell has a large nucleus with some debris in cytoplasm this depend on its immunocytes function. Also, sinusoids are connected to the hepatic vein and portal vessels which are lined by a thin layer of endothelial cells (Hanan, 2013).

Also as the sinusoids in local adult homing Pigeon are lined by a layer of fenestrated endothelial cells and Kupffer's cells (Kadhim et al., 2019). As well as, the hepatic sinusoid space was large and irregular in shape and lined by two types of cells flattened endothelial cells, which formed an un-continuous lining layer and von Kupffer's or hepatic macrophage. Endothelial cells were small cells and have a weakened cytoplasm with a small nucleus. Von Kupffer cells were large cells with large basophilic nuclei and had several processes with an irregular or stellate outline that projects into the sinusoids. However, Von kupffer cells were located between the endothelial cells of the hepatic sinusoids and might play a role in removing foreign and toxic material from the portal blood and releasing beneficial mediators (McCuskey and McCuskey, 1990). And also the sinusoids were large and irregular in shape and it lining with two types of cells stellate cells called (Kupffer's or hepatic macrophage cells and flattened endothelial cells (Stornelli et al., 2006; Esfahani et al., 2009; Aughey and Frye, 2010).

In our study, found the portal area which consists of a branch of portal vein, branch of the hepatic artery, and bile duct that lining by one cuboidal cell resting on the basal lamina, this is similar to sinusoids connected to the hepatic vein and portal vessels which lined by a thin layer of endothelial cells (Hanan, 2013), and there were bile ducts lined by cuboidal epithelial cells, these results are similar to those observed by (Bacha and Wood, 1990) who reported that the presence of bile ducts and blood vessels is distributed throughout the liver tissue. Also as the portal triad in the starling liver were consists of a branch of the hepatic artery, one or more branches of the hepatic portal vein, and bile duct. Both small and large sizes of bile duct observed in the portal triad, and this triad also contains 1-4 of bile ducts.

In the present study, we noticed many lymphatic cords in Ibis but in pigeons found aggregations of lymphocytes were observed between the hepatic cords and closed to the central vein. This may point to a focal area of lymphocytes as immune area as that recorded in the liver of ostrich (Attia and Soliman, 2005).

Histochemically

In our result noticed that, in the liver of pigeon, gave faint positive reaction with PAS in the capsule and around central vein and hepatocytes, while in the liver of cattle egret (Ibis) gave strong positive reaction with PAS in capsule and around the central vein and in hepatocytes. That is similar to the liver of Mallard which showed different sizes of glycogen granules in the cytoplasm of hepatocytes and in some specimens, the glycogen large granules arranged around the central vein because of the bird in starvation period (Maha, 2015). Also showed that the hepatocytes were weakly reactive to PAS in the two species of birds (domestic fowl and common moorhen). These results check the importance of the liver in the metabolism of fats, carbohydrates, and other nutrients, and this also is agreed with the results of previous studies on the liver in different vertebrates (Petcoff et al., 2019; Sayrafi et al., 2011). But during of histochemical study of the Flacon liver present carbohydrates in the cytoplasm of hepatocytes and on the parts of the liver where appeared pink to red color in these tissues, which corresponds to (Attia and Soliman, 2005; Eyhab et al., 2016; Jabbar and Diyar, 2016). Also different from the cytoplasm of hepatic cells in starling birds had a foamy appearance and contained bright red or brown glycogen granules which have irregular distribution within the cytoplasm (Faraj and al-Bairuty, 2018). This may be due to the deposition of glycogen in the liver, which can be considered as a source of energy for the bird in case of hunger or early pre-hatching life (El-Zoghby, 2005). On the other hand, the histochemical observation of the study by using PAS staining revealed that the glycogen granules arranged close to the central vein and in the rim of liver lobules. The content of these granules was different from one bird to another. This could indicate that some birds were in starvation period and need energy. Therefore, the animal could get the energy from the rim of liver lobules firstly and then from the area close to the central vein (Junqueira et al., 1992).

In our work, in the liver of pigeons, gave few amounts of reticular and collagen fibers with silver and Crossman stains respectively, while in the liver of cattle egrets (Ibis) gave a high amount of reticular and collagen fibers with silver and Crossman stains respectively. Additionally, there was a fine network of connective tissue fibers (collagen fibers) support the sinusoid, the results of (Attia and Soliman, 2005) as well as (Moslem, 2015) confirmed this finding of the study (Faraj and Al-Bairuty, 2018) who showed that the central vein in starling liver was lined by endothelial cells and surrounded by a thin layer of connective tissue. Also (Hanan, 2013) found that the portal area contains a network of collagen fibers in *Fulica Atra.*

In our study, we found peripheral dark red zone in-between narrow sinusoids lined by Kupffer's cells and nucleated RBCs (Faraj and Al-Bairuty, 2018) who noticed that the lumen of the sinusoid of the starling liver was filled with an enormous number of erythrocytes.

CONCLUSIONS AND RECOMMENDATIONS

Missing data about the morphological and histological structure of the liver in young homing pigeons and cattle egrets led us to design this research. Generally, the liver in young homing pigeons differs from the liver of Ibis anatomically, histologically, and histochemical, whereas the young homing pigeon, both lobes of liver connected by interlobar portion. Bile secretion of the liver poured into the first part of the duodenum through the hepatic duct, without the gall bladder. While in Cattle Egret has a gall bladder. On the basis of the above findings, it can be concluded that the presence of gall bladder and absence of it and habit of feeding significantly affected the gross and histological structure of the liver.

ACKNOWLEDGEMENTS

This work was supported by Faculty of Veterinary Medicine, Zagazig University, Egypt.

NOVELTY STATEMENT

The young homing pigeon, both lobes of liver connected by interlobar portion. Bile secretion of the liver poured

into the first part of the duodenum through the hepatic duct, without the gall bladder. While in Cattle Egret has a gall bladder.It can be concluded that the presence of gall bladder and absence of it and habit of feeding significantly affected the gross and histological structure of the liver

AUTHOR'S CONTRIBUTION

Sozan Ismaeil: Conceived and designed the analysis; Collected the data; Contributed data or analysis tools; Performed the analysis(Histology); Wrote the paper. Hassan Emam: Make Anatomyin tow species, Wrote the result of anatomy only

Conflict of interest

The authors have declared no conflict of interest.

REFERENCES

Aughey E, Frye L (2010). Comparative veterinary histology with clinical correlates. Manson publisher the veterinary Press , pp. 124-125.

Al-Aarajii A (2015). Study of some anatomical and histology characteristics in liver of male indigenous turkey (*Meleagris gallopava*). Bas. J. Vet. Res., 14(2): 150-157.

Al-Abdulla MA (2015). Histological and Histochemical study of the liver of Iraqi local ducks. Bas. J. Vet. Res., 14(1): 70-79. https://doi.org/10.33762/bvetr.2015.99862

Al-Abedi, SJG (2015). Anatomical and histological study of the liver in three species of adult Iraqi birds. M.Sc. thesis University of Kufa. Najaf. Iraq, pp. 56-66.

Attia HF, Soliman SM (2005). Histological and histochemical studies on the Ostrich's liver. Benha Vet. Med. J., 16(2): 1-11.

Bacha WJ, Wood GLM (1990). Avian digestive system. Color atlas of veterinary histology. William and Wikins. Waverlly Company Hong Kong, 3rd Ed. pp. 113-150.

Bailey TA, Mensah-Brown EP, Samour JH, Naldo J, Lawrence P, Garner A (1997). Comparative morphology of the alimentary tract and its glandular derivatives of captive bustards. J. Anat., 191: 387–398. https://doi.org/10.1046/j.1469-7580.1997.19130387.x

Caceci T (2006). Avian digestive system. Academic Press, Itheca, New York. 1st Ed, pp. 1-94.

Clark FD (2005). Normal birds. A review of avian anatomy. Avian Advice,7: 1.

Daghir NJ (1995). Poultry production in hot climates, (2nd Ed.) Published by CAB International, Wallinford, Oxfordshire, UK, Damerow, G. A guide to raising chickens. Storey Books. pp. 387.

Dyce K, Sack WO, Wensing GJG (2002). Text book of veterinary anatomy. W.B. Sounders Co. 94 U.S.A. pp. 806-811.

Dyce KM, Sack WO, Wensing CJG (2010). Textbook of veterinary anatomy. 4th ed. The anatomy of birds. WB. Saunders company. Philadelphia. 2010; p:794-796.

Dyce KM, Sack WO, Wensing CJG (2016). Textbook of veterinary anatomy 5th ed. The anatomy of birds. WB Saunders company. Philadelphia, pp. 794-796.

El-Zoghby IMA (2005). Pre and post hatching developmental studies of the quail's liver.

Eroschenko VP (2008). Difior's. Atlas of histology with functional correlations, 11th Ed Lippincott Williams and Wilkins/a Wolters Kluwer health, Philadelphia, USA, pp. 235.

Esfahani RT, Vicker K, Cossart Y (2009). The early host immune response to duck hepatitis Bvirus infection. Gen. Virol. J., 91(2): 509-520. https://doi.org/10.1099/vir.0.015529-0

Eyhab RS, Ahmed SJ, Ahmed AM (2016). Histo-Morphometric and Histochemical comparative study of the liver in COLLARD Dove (Frivaldszky).

Faraj SS, Al-Bairuty GA (2018). Morphological and histological study of the liver in migratory starling bird (Sturnus vulgaris), Al-Mustansiriyah J. Sci., 27(5): 2521-3520. https://doi.org/10.23851/mjs.v27i5.161

Hamid HM, Abed AA, Zand TA (2013). Comparative anatomical, histological, histochemical study of liver in three species of birds. Raf. J. Sci., 24: 12-23. https://doi.org/10.33899/rjs.2013.78754

Hanan, AS (2013). Morphological and histological study for liver in local coot birds Fulca Atra, Department of Anatomy and Histology, Collage of Veterinary Medicine, University of Basrah, Iraq. Bas. J. Vet. Res., 12(1): 152-158. https://doi.org/10.33762/bvetr.2013.76197

Hodges RD (1974). The histology of fowl. Academic animal. W.B. Saunders Co. London, New York, San Francisco, 2: 1837-1880.

Illanes J, Fertilio B, Quijada M, Leyton V, Verdugo F (2006). Histologic description of the annexedglands from the ostrich digestive system (*Struthio camelus*). Int. J. Morphol., 24(3): 297-302. https://doi.org/10.4067/S0717-95022006000400001

Jabbar AH, Diyar MH (2016). Morphology, histology and histochemical comparative study of common Gallus Gallus, (domestic fowl adult female the Liver in in South Iraq) (Gallinula chloropus moorhen. Department of Anatomy and Histology, College of Veterinary Medicine, University of Basrah. Basrah, Iraq. College of Veterinary Medicine, AL-Muthanna University. Muthanna, Iraq. J. Vet. Med. Sci., 7(1): 36-45.

Junqueira LC, Carneiro J, Kelley RO (1992). Basic Histology seventh edition. pp. 320-331.

Kadhim H, Khalid DH, Sadiq DMH (2019). Histomorphological and histochemical study of the healthy liver and pancreas of local adult homing pigeon (Columba Livia Domestica). Indian J. Publ. Health Res. Dev., 10(5): 1-6. https://doi.org/10.5958/0976-5506.2019.01052.0

Krause WJ, Cuts JH (1986). Concise text of Histology, Second edition. pp. 330.

Maha AA (2015). Histological and histochemical study of the liver of Iraqi local, Ducks. Coll. Vet. Med. Univ.

Al-Qadissyia JI, Abdul LB, Muhammad GS, Ghulam ML, McCuskey RS, McCuskey PA (1990). Fine structure and function of Kupffer cells. J. Elec. Microsc. Tech., 14: 237-246. https://doi.org/10.1002/jemt.1060140305

McCuskey RS, McCuskey PA (1990). Fine structure and function of Kupffer cells. J. Elec. Microsc. Tech., 14: 237-246. https://doi.org/10.1002/jemt.1060140305.

Mclelland J (1990). A colour Atlas of the avian anatomy. pp. 58-59.

Moslem D (2015). Histological study of the African ostrich liver and anatomical comparison of it with poultry liver. Biol. Forum Int. J., 7(1): 1185-1188.

Petcoff GM, Diaz AO, Escalante AH, Goldemberg AL (2019). Histology of the liver Oligosarcus 498. Indian J. Publ.

Health Res. Dev., 10(5): 205-208.
Raloff J (2003). Food for thought: Global food trends. Science, News. Online. http://www.sciencenews.org/view/generic/id/3902/description/GlobaFood Trends.
Randall J, Reece R (1996). Color atlas of avian histopathology. Mosby Wolfe, London, 75-77. Rec., 235: 131-143.
Safer AM, Meakins R, Akbar L, Abou-Salem K (1998). Cytotoxicity of Kuwait weathered lake crude oil on rat hepatocytes: Histological and ultrastructural study. Histol. Histopathol., 13: 599-610.
Sayrafi R, Najafi G, Rahmati-holasoo H, Aref H, Ramin A, Shokrpoor S, Ghadam M (2011). Histological study of hepatopancreas in Hi Fin Pangasius (*Pangasius sanitwongsei*). Afr. J. Biotech., 10(17): 3463-3466. https://doi.org/10.5897/AJB10.1054
Schmidt RE, Reavill DR, Phalen DN (2003). Pathology of Pet and Aviary Birds. A Blackwell Publishing Company. Pp 67.
Stornelli MR, Ricciardi MP, Giannessi E, Coli A (2006). Morphological and histological study of the ostrich (*Struthio camelus* L.) liver and biliary system. J. Anat. Embryol., 111(1): 1-7.
Strick-Marchand H, Weiss MC (2003). Embryonic liver cells and permanent lines as models for hepatocyte and bile duct cell differentiation. Mech. Dev., 120: 89-98. https://doi.org/10.1016/S0925-4773(02)00335-0
Sun Z, Wada T, Maemura K, Uchikura K, Hoshino S, Diehl AM, Klein AS (2003). Hepatic allograft-derived Kupffer cells regulate T cell response in rats. Liver Trans., 9(5): 489-497. https://doi.org/10.1053/jlts.2003.50091
Suvarna KS, Layton C, John D (2018). Bancroft's theory and practice of histological techniques 8th ed., Churchil. livingstone, New York, London, Ch. 6: 83-92; Ch. 21: 440-450.
Wardle EN (1987). Kupffer cells and their function. Liver, 7: 63-75. https://doi.org/10.1111/j.1600-0676.1987.tb00319.x
Whitlow GG (2000). Gastrointestinal anatomy and physiology. Avian physiology. 6th ed., Academic Press, Honoiula. Hawaii. pp. 299-230. https://doi.org/10.1016/B978-012747605-6/50013-4
Zhao R, Duncan SA (2005). Embryonic Development of The Liver Hepatology J. 41:956-967. https://doi.org/10.1002/hep.20691