Al-Qadisiyah Journal of Veterinary Medicine Sciences
(P-ISSN 1818-5746/ E-ISSN 2313-4429)
www.qu.edu.iq/journalvm

Histomorphological investigation of the liver of swan geese

Fatima Saad[1] Iman Ibrahim Dle[1]
[1]Department of anatomy and histology, College of Veterinary Medicine, University of Al-Qadisiyah, Al-Diwaniyah City, Iraq

Abstract

The morphological and histological research on the liver was carried out on twenty (20) adult swan geese, ten (10) of which were male and ten (10) of which were female. The study was performed on twenty (20) adult swan geese. According to the morphological findings, the livers of both male and female geese are placed in the right and left hepatoperitoneal cavities, respectively. According to the morphological findings, the livers of both male and female geese are placed in the right and left hepatoperitoneal cavities, respectively. The liver in this bird is situated in a huge space in the abdomen. It is pointed cranially and toward the center of the thoracic and rib regions, and it has a hue that is somewhere between red and brown. The liver consists of two undivided lobes, the right and the left, as well as two surfaces, the parietal and the visceral surface, and many processes can also be seen. Additionally, the liver has two borders, the dorsal and the ventral, and a cardiac notch can be found on the dorsal border. The right lobe of the liver is also penetrated by the caudal vena cava. The gall bladder is an ovoid-shaped sac that is dark green in color and is located in a deep cystic fossa. It is linked to the visceral surface of the right lobe of the liver and does not have a neck. Histological results have revealed that the liver is composed of hepatocytes arranged as two-cell thicknesses between the hepatic sinusoids, which are bound by the bile canaliculus. The intralobular duct is lined by simple cuboidal epithelial cells, also extending within the organ septa of connective tissue that contains branches of the hepatic artery and portal vein, and the interlobular bile duct is lined by simple columnar epithelial cells. Conclusion The hepatic parenchyma of swan geese looks like two-cell-thick hepatocytes when viewed in longitudinal section, but when viewed transversely, it appears as tubules containing hepatocytes that are surrounded by bile canaliculi.

keywords: liver, histology, hepatocytes, geese

Introduction

Anser cygnodies, are large geese that can grow to lengths of between 81 and 94 centimeters. Their weight is about 3150 g on average, and their wing breadth can range anywhere from 160 to 185 cm. (1). The liver is responsible for a number of different metabolic processes, such as the production of bile and the breakdown of lipids, carbohydrates, and proteins, among other things. This organ is able to quickly adjust to new dietary habits and environmental conditions. The liver is both the largest gland tissue and the largest internal organ in the body. Morphologically, it is the largest gland in the body. The digestive system has a number of auxiliary glands, one of which is the liver. It occupies the most anterior part of the cavity of the body (2,3). The liver is a bilobed organ that is located in the midcoelomic cavity of the body in animals that are classified as birds. The left lobe is significantly more diminutive than the right one, and it is linked to the right lobe at the midline. Each lobe of the liver has its own set of bile ducts, which empty into the distal ascending loop of the duodenum(4,5,6) .

Histologically Despite the fact that the liver differs from species to species, there are some general traits that are shared by the majority of them (3). The acinus, which is comprised of the portal triad as well as the hepatic lobules, serves as both the structural and functional unit of the liver. The hepatic lobule is the location of hepatocytes, which are the functional center of the liver. This is also the location where the hepatocyte-sinusoidal formations are formed. The sinusoids are capillary networks that are localized in the space between the hepatic plates where the hepatocytes are arranged. The portal triad is located in the portal spaces between the hepatic lobules and contains

Al-Qadisiyah Journal of Veterinary Medicine Sciences
(P-ISSN 1818-5746/ E-ISSN 2313-4429)
www.qu.edu.iq/journalvm

branches of the portal vein, the hepatic artery, and the bile duct in addition to lymphatic and nerve tissue.(7,8) .

Material and Method

Bird collection

Twenty apparently healthy adult males and females swan geese were divided into two equal groups based on sex, this study was carried out on twenty (20) adult swan geese from both sex. Each sex group was further subdivided equally into two equal subgroups with 5 each bird. The first subgroup of each sex was used for morphological study, while the second group was used for histological studies. These birds were purchased from local suppliers in common markets in aldwiynia province from (September 2021-March 2022) .

Morphological study

All studied birds were weighed, then euthanized by inhalation of chloroform (9). Each bird was dissected by fixing it on a suitable dissecting board to view the thoracic and abdominal viscera including the liver. A midline incision in the thoracic-abdominal wall was made, and after that, the liver were identified and photographed in situ using a digital camera (Sony Dsc-H90). The location and relationships of each liver of the (5 males and 5 females) studied birds were well described. samples were extirpated and washed with normal saline to remove adhered debris and blood, then they have cleaned again with normal saline. the weights of studied organs were measured in grams by using a sensitive digital scale (Notebook Series-Digital scale). The macroscopic measurements (length and diameters) of the collected segments were conducted in centimeters and millimeters by using the electronic Vernier caliber, while the volume was measured by the water displacement method .

Histological study

For the histological study, males and females were used. After liver removal, they were washed using normal saline solution, then fixed by (10%) formalin for 48h and some of the samples were fixed in Bouin's solution Then proceed with routine histological technique ..(31)

Results

The liver of the male and female swan goose is located in the right and left hepatoperitoneal cavities and occupies a large space in the abdomen. The heart is connected to the liver's dorsal border (Figs. 1 and 2).

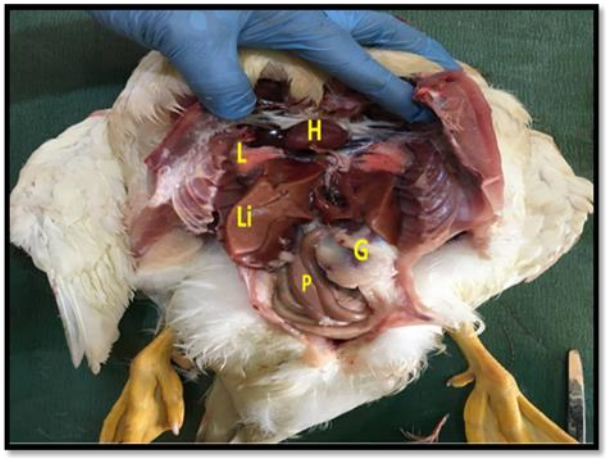

Figure 1: Anatomical position of goose liver. H: Heart, Li: Liver, L: lung, G: Gizzard, P: Pancreas.

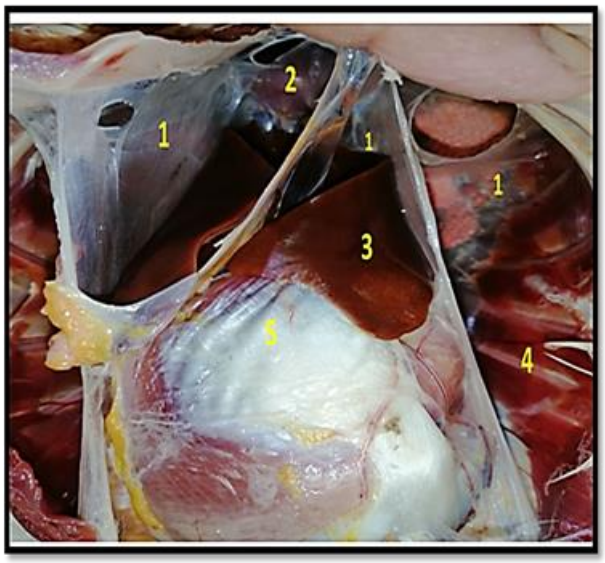

Figure 2: Anatomical position of the goose liver show: 1-hepatoperitoneal cavities, 2-Heart 3-Liver, 4- Ribes, 5-Gizzard

Al-Qadisiyah Journal of Veterinary Medicine Sciences
(P-ISSN 1818-5746/ E-ISSN 2313-4429)
www.qu.edu.iq/journalvm

The liver is reddish brown (Fig. 2). It has four borders: dorsal, ventral, right, and left, as well as two surfaces: parietal and visceral. Additionally, it has two undivided lobes: the right and left lobes. It is possible to discern both the right ventral processes and the left dorsal processes on the surface of the parietal bone. A cardiac notch can also be found along the dorsal border of both lobes of the liver, and this notch can be observed on the parietal surface of the liver (Fig. 3).

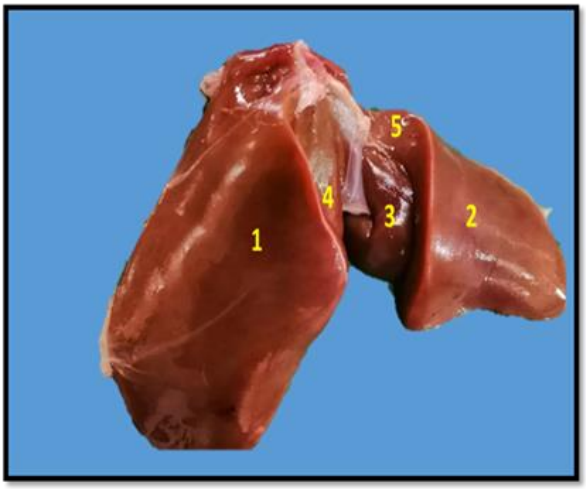

Figure 3: Groose section of parietal surface of liver shows: 1-Right lobe 2-Left lobe 3-left dorsal process 4-Right ventral process.5-Cardiac notch.

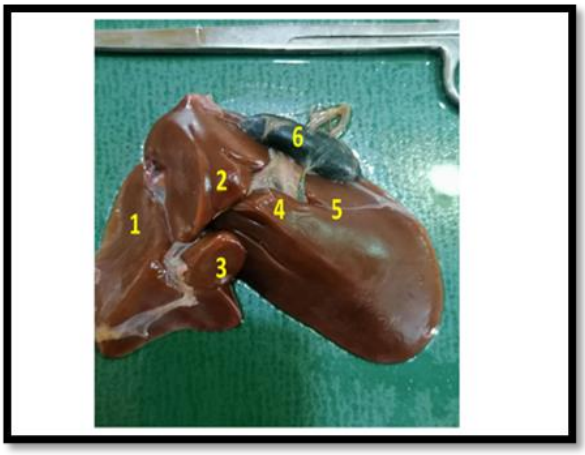

Figure 4: Groose section of visceral surface of liver shows: 1-Left lobe 2-Cranial process 3-Left lobe process 4-Right lobe process 5-Right lobe 6- Gallbladder

The visceral surface of the liver has cranial processes, right dorsal processes, and left ventral processes (Fig. 4). The portal fissure was connective tissue septa from where the portal vein and hepatic arteries enter the liver (Fig.5).

There are also many impressions on the visceral surface of the liver, like the duodenal impression on the lateral margin of the right lobe dorsally, the proventriculus impression on the left lobe dorsolaterally, and the gizzard impression on both lobes caudodorsally. While the cardiac notch at the dorsal border of both lobes of the liver that can be seen at its parietal surface (Fig.6).

Figure 5: Groose anatomy of visceral surface of liver show: Right lobe(R), Left lobe(L), cystic fossa (yellow arrow), Right dorsal fissure (green arrow), left ventral fissure (blue arrow) and caudal vena cava (black arrow)

Al-Qadisiyah Journal of Veterinary Medicine Sciences
(P-ISSN 1818-5746/ E-ISSN 2313-4429)
www.qu.edu.iq/journalvm

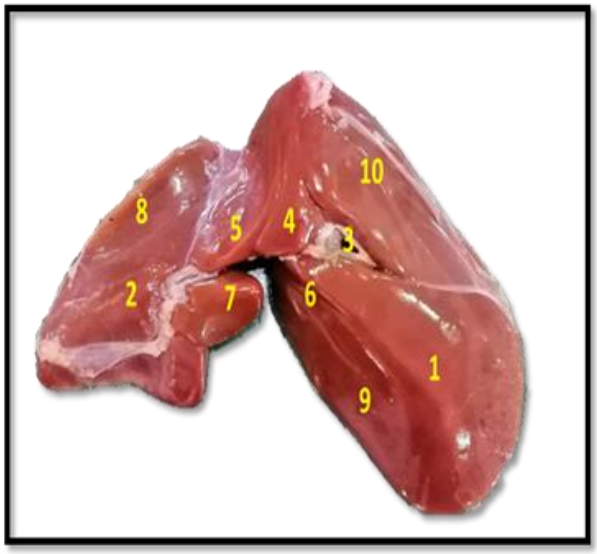

Figure 6: Groose section of visceral surface of liver show: 1-Right lobe, 2-Left lobe, 3-cystic fossa, 4-crainal process,5-Right dorsal process,6-Left dorsal process,7-Proventricularimpression,8, Ventricular.impression, 9-Duodenal impression, 10-Gallbladder impression

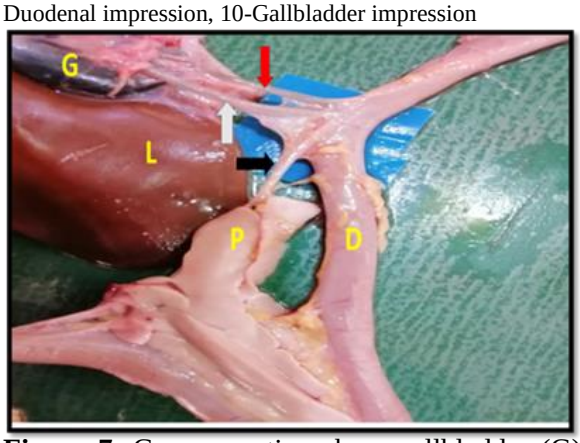

Figure 7: Groose section show gallbladder (G), Liver (L), Pancreas (P), Duodenum (D), Hepatoenteric duct (red arrow), Cysticoenteric duct (White arrow) and pancreatic duct (black arrow).

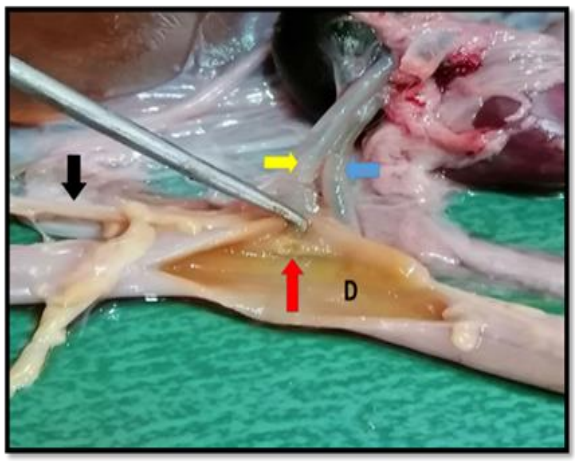

Figure 8: Groose section show Biliary duct which open in Duodenum(D), Cysticoenteric duct (yellow arrow) and Hepatoenteric duct (blue arrow), duodenal papilla (red arrow) and pancreatic duct (black arrow)

The mean swan goose liver weight was (62.97 ± 1) g, mean right and left lobe weight was (42.23 ± 0.05) g. (20.77±0.7) g. respectively. While the mean relative weight was (2.105 ± 0.071) g, total volume was (38.2 ± 0.02) ml (Table 1).

Table 1: Anatomical Measurements of liver of goose N =10

Measurements	**Liver** Mean±SE	**T-Test**
Weight (g)	62.97 ± 1	0.002
Relative Weight	2.105 ± 0.071	0.01
Volume (ml)	38.2 ± 0.02	0.00
*** (P<0.05) significant.**		

In the right lobe, the mean (weight, mean relative weight, length, width, thickness, and volume) values of the right lobe were (42.23 ± 0.05) g.(1.55±0.219) g., (9.5 ± 0.17) mm, (5.14 ± 0.13) mm, (3.60 ± 0.11) mm and (19.98 ± 0.04) ml respectively (Table 2). while the same parameters of the left lobe were (20.99 ± 0.07)g, (1.50 ±0.08)g., (6.9 ± 0.2) mm, (3.82 ± 0.1) mm, (3.67 ± 0.02) mm and (18.7 ± 0.3) ml, respectively (Table 2) .

Al-Qadisiyah Journal of Veterinary Medicine Sciences
(P-ISSN 1818-5746/ E-ISSN 2313-4429)
www.qu.edu.iq/journalvm

Table 2: Anatomical Measurements of two lobes of liver goose N =10

Anatomical Measurements of liver	Right lobe	Left lobe	T- test
	Mean ± SE	Mean ± SE	
Weight (g)	42.23 ± 0.05	20.99 ± 0.07	0.288*
Length (mm)	9.5 ± 0.17	6.9 ± 0.2	0.407*
Width (mm)	5.14 ± 0.13	3.82 ± 0.1	0.247*
Thickness (mm)	3.60 ± 0.11	3.67 ± 0.02	0.133NS
Volume (ml)	19.98 ± 0.04	18.7 ± 0.3	0.084*
*** (P<0.05) significant**			

Swan Goose livers lack lobules. It has two-cell hepatocyte plates between the hepatic sinosides. The hepatic capsule is a thin layer of connective tissue lined by mesothelium (Fig. 9).

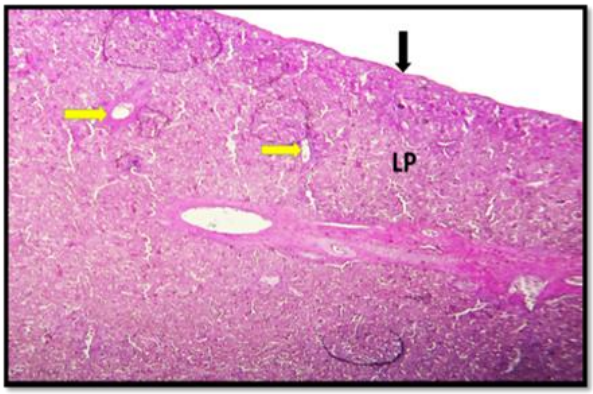

Figure 9: Histological section of liver parenchyma of Goose show: Capsule (black arrow), Central vein (yellow arrow) H&E 100X

Hepatocytes of the liver showed up as hepatic tubules in the longitudinal section and most probably were organized as cylinders, also we could notice Bile canaliculi between 4-6 hepatocytes as tubules in the transverse section; intra-lobular bile ducts and central veins (Fig.10), in birds. Hepatocytes have one or two big, spherical, eccentric nuclei with dark, oval, polyhedral nucleoli that vary in size. eosinophilic cytoplasm (Fig. 11). Liver sinusoids Goose are interspersed within hepatocytes, and flattened endothelial cells line sinusoids, which are called Kupffer cells due to the fact that they include erythrocytes and macrophages (Figs. 11 and 12). The hepatic portal had interlobular arteries, veins, and bile ducts. Smooth muscle fibers covered portal branches lined with endothelial cells. The interlobular bile duct was cuboidal epithelium. Abundant connective tissue supports the portal tracts (Fig. 13).

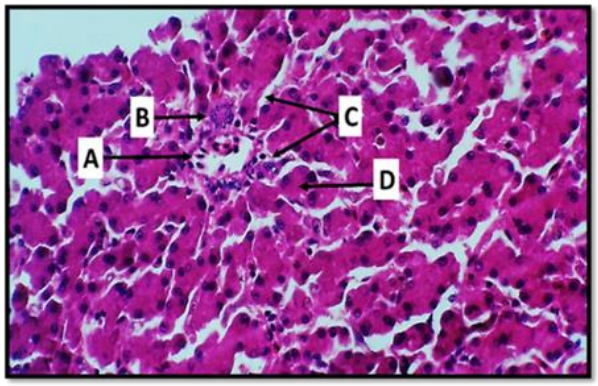

Figure 10: Histological section of liver of Goose show: Central vein (A), Intra lobular bile duct (B), Sinusoid (C), Hepatocytes arranged as 2 cell thickness (D) and H&E 400X

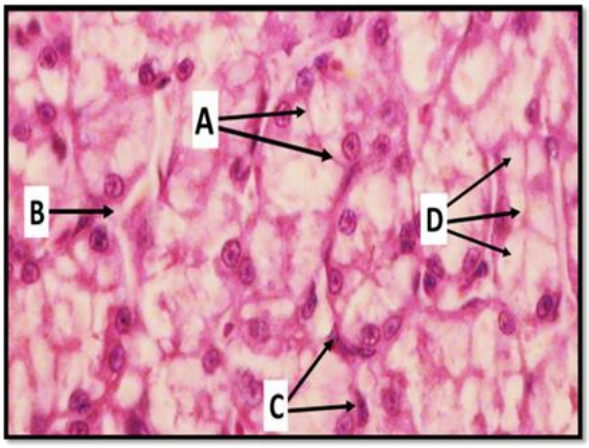

Figure 11: Histological section of liver of Goose show: Bile canaliculus which is surrounded by 4-

Al-Qadisiyah Journal of Veterinary Medicine Sciences
(P-ISSN 1818-5746/ E-ISSN 2313-4429)
www.qu.edu.iq/journalvm

6 hepatocytes (A), Sinusoids (B), endothelial cells (C) and Hepatocytes (D) H&E 1000X

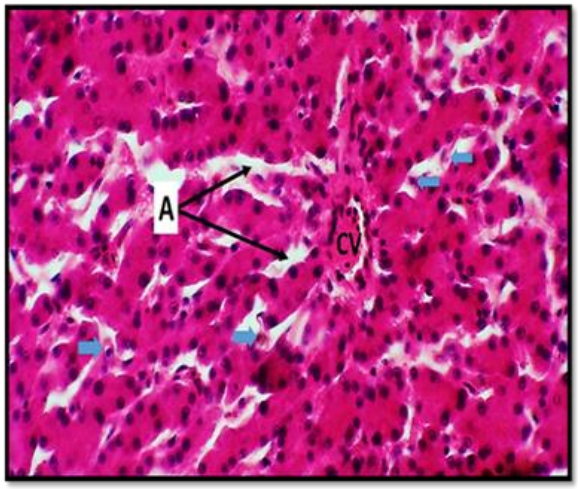

Figure 12: Histological section of liver of Goose show: Central vein (CV) Kuffer cells (blue arrow), Sinusoid (A) and Hepatocytes (yellow star) H&E 400X

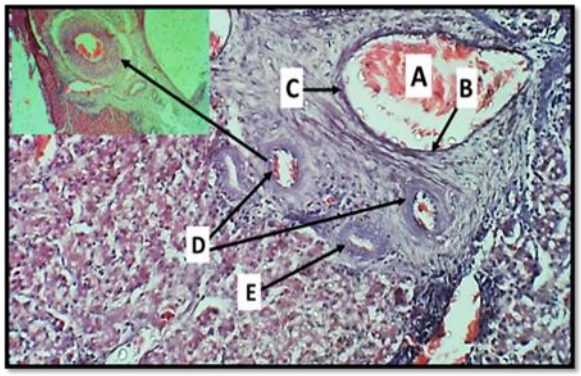

Figure 13: Histological section of liver of Goose show: Central vein (A), Endothelial cells (B), connective tissue (C) hepatic artery (D) and interlobular duct. (E) H&E 800X.

Discussion

The liver of the male and female swan goose is located in the right and left hepatoperitoneal cavities and occupies a large space in the abdomen. The heart is connected to the liver's dorsal border (Figs. 1 and 2). Because birds have air sacs, the abdominal cavity, which contains the intestinal tract, stomach, liver, and thoracic cavity, is not divided from the abdominal cavity. Due to blood saturation, the liver is reddish brown (Fig. 2). The nutritional state affects the natural color of the avian liver, according (10,11), however, (12) in Japanese (13) in male indigenous Turkey's liver, which ranges from reddish brown to dark brown.

It has four borders: dorsal, ventral, right, and left, as well as two surfaces: parietal and visceral. Additionally, it has two undivided lobes: the right and left lobes. It is possible to discern both the right ventral processes and the left dorsal processes on the surface of the parietal bone. A cardiac notch can also be found along the dorsal border of both lobes of the liver, and this notch can be observed on the parietal surface of the liver (Fig. 3). The visceral surface of the liver has cranial processes, right dorsal processes, and left ventral processes (Fig. 4). However, the caudal vena cava pierces the dorsal border of the right lobe, and in the middle of the visceral surface there is a portal fissure that extends along the two lobes. The portal fissure was connective tissue septa from where the portal vein and hepatic arteries enter the liver (Fig.5). This result agreed with (14) in captive bustards, (15) in avian, and (16), who pointed out that the liver of domestic poultry has two lobes, the left of which is divided into the dorsal and ventral parts, and the liver lacks any additional lobular subdivisions. These researchers studied the livers of captive bustards, avians, and domestic poultry. with (14) in captive bustards, and in contrast with (17), who observed that the left lobe of the ostrich is divided into three parts: a tiny caudodorsal component, a big caudoventral part, and a small left intermediate region.

There is also many impressions on the visceral surface of liver like duodenal impression on the lateral margin of the right lobe dorsally, proventriculus impression on the left lobe dorsolaterally and the gizzard impression on both lobes caudodorsally. While the cardiac notch at the dorsal border of both lobes of the liver that can be seen at its parietal surface (Fig.6). These results are in agree with the results described by (5) in avian & (18) in birds.

This change in parameters was explained by (14) in the article that they published (captive bustards). who went on to state that there is a considerable association

Al-Qadisiyah Journal of Veterinary Medicine Sciences
(P-ISSN 1818-5746/ E-ISSN 2313-4429)
www.qu.edu.iq/journalvm

between the type of food eaten and the size of the liver in proportion to the size of the body. Also (20), the weight of the liver changes in relation to the amount of food consumed by snow geese and is responsive to changes in diet. This suggests that the metabolism of proteins, fats, and carbohydrates is high in the liver of these birds. In this regard, we agree with the researchers, particularly with regard to the amount of food consumed by the bird.
Swan Goose livers lack lobules. It has two-cell hepatocyte plats between the hepatic sinosides. In chicken liver (19) and hen liver (16), the hepatic capsule is a thin layer of connective tissue lined by mesothelium (Fig. 9) .

Hepatocytes of the liver showed up as hepatic tubules in the longitudinal section and most probably were organized as cylinders, also we could notice Bile canaliculi between 4-6 hepatocytes as tubules in the transverse section; intra-lobular bile ducts and central veins (Fig.10), this agree with (18) in birds.Hepatocytes have one or two big, spherical, eccentric nuclei with dark oval, polyhedral nucleoli that vary in size. Eosinophilic cytoplasm (Fig.11). Our results concur with (21) in wood pecker (Larus canus), parrot (Agaporins fischeri), and turkey (Numida meleagris) that hepatocytes were distributed in cords or plates around sinusoids. and L. canus had larger hepatocytes than N. Meleagris and A. Fischer consecutively.

Swan goose liver histology differed from that of many birds (22), who found that tiny birds possessed one or two cells dependent on hepatocyte cord thickness. Although it matched research that showed hepatocyte cords with one to two cell thickness in numerous animals (17,23,24,25). (8) found that teleost hepatocyte cords (bony fish) Liver has three categories: Cord-like, tubular, and solid forms exist (multiple cell-thick plate type), the big hepatocytes could be attributable to the metabolic relevance of these cells in the animal and their more effective metabolic activities, as well as genetic differences between species. Liver sinusoids Goose are interspersed within hepatocytes and flattened endothelial cells line sinusoids, which are called Kupffer cells due to they include erythrocytes and macrophages (Fig.11,12).

In fish and mammals, sinusoidal capillaries create a thick network around cord-like hepatocytes (24). Sinusoids had erythrocytes and macrophages. Adult avian livers first mentioned additional sinusoidal macrophages (26,27). Kuffer cells were also discovered in N. Meleagris sinusoids, which were larger than those of the wood pecker and parrot.(21)

The hepatic portal had interlobular arteries, veins, and bile ducts. Smooth muscle fibers covered portal branches lined with endothelial cells. The interlobular bile duct was cuboidal epithelium. Abundant connective tissue supports the portal tracts (Fig.13).Other vertebrates have this arrangement (24,25,28,29,30).Turkey (N. meleagris) and woodpecker L. canus had small and medium-sized bile ducts, while parrots did not (A. fischeri).

Conclusion

The morphological and histological analyses of the liver, with a few notable exceptions, are very similar to those performed on other domesticated birds' livers. The gallbladder lacks a neck and does not reach the ventral boundary of the liver; rather, it is situated on the visceral surface of right lobe of liver. Size of right lobe of liver is significantly greater than that of the left. There are no significant gender differences in the morphological or histological features of the liver and pancreas of swan geese, which indicates that the bird's genus has no effect on the function of these organs. This was determined by the fact that there were no gender differences in the characteristics of the liver and pancreas. The hepatic parenchyma of swan geese looks as two-cell-thick hepatocytes when viewed in longitudinal section, but when viewed transversely, it appears as tubules containing hepatocytes that are surrounded by bile canaliculi.

Al-Qadisiyah Journal of Veterinary Medicine Sciences
(P-ISSN 1818-5746/ E-ISSN 2313-4429)
www.qu.edu.iq/journalvm

References

1 .Wang W, Zheng S, Sharshov K, Cao J, Sun H, Yang F, et al. Distinctive gut microbial community structure in both the wild and farmed Swan goose (Anser cygnoides). J Basic Microbiol. 2016;56(11):1299-1307.https://doi.org/10.1002/jobm.201600155

2 .Denbow DM. Gastrointestinal anatomy and physiology. In: Whittow GC, editor. Sturkie's Avian Physiology. 5th ed. New York, NY: Academic Press; 2000. p. 299-325.https://doi.org/10.1016/B978-012747605-6/50013-4

3 .Genten F, Terwinghe E, Danguy A. Atlas of Fish Histology. Enfield, NH: Science Publishers; 2009. p. 92.https://doi.org/10.1201/9780367803599

4 .Reavill D. A Review of the Avian Liver. Lecture given at the MASAAV 1997 Conference. 2005.

5 .Getty R. Sisson and Grossman's the Anatomy of the Domestic Animals. 5th ed. Vol. 2. London: W. B. Saunders Company; 1975. p. 1879-1880.

6 .Dyce KM, Sack WO, Wensing CJG. Textbook of Veterinary Anatomy. 4th ed. Saunders Elsevier; 2010. p. 135-138.

7 .Motta PM. The three-dimensional microanatomy of the liver. Arch Histol Jpn. 1984;47:1-30.https://doi.org/10.1679/aohc.47.1

8 .Akiyoshi H, Inoue A. Comparative histological study of teleost livers in relation to phylogeny. Zool Sci. 2004;21(8):841-850.https://doi.org/10.2108/zsj.21.841

9 .Underwood W, Anthony R, Cartner S, Corey D, Grandin T, Greenacre C, et al. AVMA guidelines for the euthanasia of animals: 2013 edition. Schaumburg, IL: American Veterinary Medical Association; 2013.

10 .Carmen S, Mishil FS, Solcan IC. Histological Aspects of liver in domestic Fowl. Int J Physiol Life Sci. 2008;8(4):215-224.

11 .Guyton AC, Hall JE. Medical Physiology. Gökhan N, Çavuşoğlu H, editors. 2006.

12 .Ahmed E. Long-term p-nitrophenol exposure can disturb liver metabolic cytochrome P450 genes together with aryl hydrocarbon receptor in Japanese quail. Jpn J Vet Res. 2015;63(3):115-127.

13 .Al-A'Aaraji AS. Study of some anatomical and histological characteristics in liver of male indigenous turkey (Meleagris gallopava). Bas J Vet Res. 2015;14(2):150-157.

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

15 .Caceci T. Avian digestive system. Academic Press, Itheca, New York; 2006. p. 1-94.

16 .Al-hacham EI. Histological study of the native hens (Gallus Gallus). Qad J Vet Med Sci. 2008;7(1):26-30.

17 .Stornelli MR, Ricciardi MP, Giannessi E, Coli A. Morphological and histological study of the ostrich (Struthio camelus L.) liver and biliary system. It J Anat Embryol. 2006;111(1):1-7.

18 .McLelland J. Color atlas of avian anatomy. 1st ed. Aylesbury: Wolfe Publishing Ltd; 1990. p. 57-122.

19 .Hodges RD. The Histology of the Fowl. London: Academic Press, Inc. LTD; 1974. p. 55-101.

20 .Ankney CD. The use of nutrient reserves by breeding male lesser snow geese Chen caerulescens caerulescens. Can J Zool. 1977;55(12):1984-1987.https://doi.org/10.1139/z77-256

21 .Hamodi HM, Abed AA, Taha AM. Comparative Anatomical, Histological and Histochemical Study of the Liver in Three Species of Birds. Rafidain J Sci. 2013;24:12-23.https://doi.org/10.33899/rjs.2013.78754

22 .Hickey JJ, Elias H. The structure of the liver of birds. Auk. 1954;71(4):458-462.https://doi.org/10.2307/4081541

23 .Bertolucci C. Evidence for an overlapping role of CLOCK and NPAS2 transcription factors in liver circadian oscillators. Mol Cell Biol. 2008;28(9):3070-3075.https://doi.org/10.1128/MCB.01931-07

24 .El-Bakary NER, El-Gammal HL. Comparative histological, histochemical and ultrastructural studies on the liver of flathead grey mullet (Mugil cephalus) and sea bream (Sparus aurata). Glob Vet. 2010;4(6):548-553 .

25 .Sayrafi R, Najafi G, Rahmati-Holasoo H, Aref H, Ramin A, Shokrpoor S, et al. Histological study of hepatopancreas in Hi Fin Pangasius (Pangasius sanitwongsei). Afr J Biotechnol. 2011;10(17):3463-3466.https://doi.org/10.5897/AJB10.1054

26 .Ohata M, Tanuma Y, Ito T. Electron microscopic study on avian livers with special remarks on the fine structure of sinusoidal

Al-Qadisiyah Journal of Veterinary Medicine Sciences
(P-ISSN 1818-5746/ E-ISSN 2313-4429)
www.qu.edu.iq/journalvm

cells. Okajimas Folia Anat Jpn. 1982;58:325-368.https://doi.org/10.2535/ofaj1936.58.4-6_325

27 .Kanai M, Murata Y, Herbert DC, Soji T. Uptake behavior of embryonic chick liver cells. Anat Rec Adv Integr Anat Evol Biol. 2007;290(7):862-874.https://doi.org/10.1002/ar.20557

28 .Petcoff GM, Diaz AO, Escalante AH, Goldemberg AL. Histology of the liver Oligosarcus jenynsii (ostariophsi, characidae) from Los Pades Lake, Argentina. Ser Zool. 2006;96(2):205-208.https://doi.org/10.1590/S0073-47212006000200010

29 .Alshamarry HA. Histological and histometric study on the spleen of Iraqi camel (Camelus dromedarius). Emir J Food Agric. 2010;22(1):65-70.https://doi.org/10.9755/ejfa.v22i1.4908

30 .Monsefi M, Gholami Z, Esmaeili H. Histological and Morphological Studies of digestive tube and liver of the Persian tooth-carp, Aphanius persicus (Actinopterygii: Cyprinodontidae). IUFS J Biol. 2010;69(1):57-64.

31. Luna LG. Manual of histologic staining methods of the Armed Forces Institute of Pathology. 3rd ed. New York: McGraw-Hill; 1968.