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A comparative study of the macro and microscopic anatomy of the liver and biliary system in pigeon (*Columba livia domestica*) and gull (*Larus canus*)

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Abstract

The aim of the study was to compare the anatomy and histology of the liver and biliary system in pigeons (*Columba livia domestica*) and gulls (*Larus canus*). A total of twenty adult birds (10 pigeons and 10 gulls) obtained from Tikrit and Mosul in Iraq were examined. Following euthanasia, the liver tissues were investigated both macroscopically and microscopically by using staining techniques such as Hematoxylin and Eosin, Masson's trichrome, and Best's carmine stains. both bird species exhibited bilobed livers positioned within the thoracic-abdominal cavity; however, in contrast to pigeons, gulls were found to have a gallbladder. The analysis of liver size and weight showed variations between gulls and pigeons, indicating that gulls have larger and heavier livers than pigeons do. The thickness of the liver capsules was greater in female gulls. This implies that there are species variations in liver protection mechanisms. Under the microscope, hepatocytes were found to be arranged in cords radiating around central veins. However, pigeons exhibited wider sinusoids compared to gulls. The liver structures of gulls show differences in thickness and size, with their bile duct system and blood vessels being particularly well-developed in comparison. Female gulls have had larger microscopic measurements of portal structures than male gulls. These findings highlight variations in liver anatomy and composition among bird species as well as between male and female birds.

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Introduction

Birds are among the most diverse creatures, living in groups and flocks in different environments and climatic conditions (1). The gull is one of the birds that live near the shores, where it relies on marine prey for its diet at various stages of its life (both young and adult), especially fish, in addition to waste (2). Pigeons live on all continents of the world except for Antarctica, Pigeons feed mainly on whole grains that are high in protein, such as corn and peas (3), the Pigeons have been used for many centuries as a source of food for humans (4). Birds of all kinds adapt their digestive systems to work according to the type of food (5). Liver is one of the main glands in the body, the liver serves many functions in birds, including metabolic role and internal balance, as it is a chemical factor for metabolism, synthesis, excretion, and detoxification. It is crucial for digestion and metabolism, as well as for control fat, protein, and carbohydrate production, storage, and secretion. The liver is producing blood proteins, enzymes, hormones, clotting factors, and immunity (6). The liver in birds is bilobed (right and left), The two lobes vary in size between bird species (7). The liver located in the cranial portion of the celomic cavity and positioned caudal and ventral to the heart and cranial to the gizzard and the shape of the liver adapts to the adjacent internal body wall and correlated organs like the proventriculus, gall bladder and gizzard (8). The histological structure of the liver varies between different species, but

there are common structures among most of these species. The liver is surrounded by capsule of connective tissue called the Clisson capsule, the functional and structural unit of the liver is represented by the presence of the hepatic lobule and the portal triad, Between the hepatic lobules is located the portal triad, which consists of a branch of the portal vein, more than one branch of the hepatic artery, and one or more bile ducts, in addition to the presence of a lymphatic vessel and nerves (9). The biliary tract generally consists of the gallbladder It is considered a major store of bile, intrahepatic bile ducts, and extrahepatic bile ducts for transports bile to the intestines. However, some birds and mammals have lost their gallbladder for unknown reasons, which may be related to the embryonic development of the biliary tract or the nutritional nature (10). The gallbladder is attached to the visceral surface of the right lobe of the live, while the extrahepatic bile ducts originate from the middle part of the liver, which lies between the two lobes of the liver, and extend posteriorly from the liver towards the duodenum (11). The bile ducts begin to form inside the liver as small ducts, then they combine to form the right bile duct and the left bile duct, and they continue their path to form the hepato-enteric duct, the cystic-enteric duct begins from the dorsal surface of the gallbladder (12). The gallbladder in birds is generally composed of three layers, which are: tunica mucosa, muscularis and the last layer is tunica serosa, cystic duct consists of three-layer, tunica mucosa, tunica muscularis and tunica adventitia, With the disappearance of the muscularis mucosa layer (13,14).

This study aimed to investigate the structural characteristics of the liver and biliary system in pigeons (*Columba livia domestica*) and gulls (*Larus canus*).

Materials and Methods

Ethical approval

International animal welfare guidelines were followed when conducting tests on birds, and approvals were obtained from the Animal Ethics Committee at the College of Veterinary Medicine, Tikrit University, dated 2024/12/24 and No Tu.Ve.80.

Animal selection

This study was conducted on a total of 20 healthy adult birds, comprising 10 pigeons (*Columba livia domestica*) and 10 gulls (*Larus canus*), The pigeon weighed 300-450 grams and the gull 1 kg, of both sexes. The birds were acquired from local markets in Tikrit and Mosul cities, Iraq. All birds were inspected for apparent signs of illness or injury prior to inclusion. Ethical guidelines for the humane treatment of animals were followed throughout the study.

Anesthesia and dissection procedure

Each bird was anesthetized using inhalation of 98% diethyl ether in a well-ventilated area to ensure minimal stress and pain. Following anesthesia, euthanasia was performed by cervical dislocation and subsequent exsanguination. Feathers and skin were removed carefully. The rib cage was bilaterally cut and raised to expose the thoraco-abdominal cavity, allowing clear visualization of the liver and biliary system.

Gross anatomical examination

After exposure, the liver and associated biliary tract were carefully isolated and excised from the body cavity. Gross anatomical parameters were assessed, including liver weight, color, surface appearance, and the number and shape of liver lobes. The presence or absence of the gallbladder was also documented. The length and width of each liver lobe were measured using a digital caliper to compare between species.

Tissue fixation and processing

Liver specimens were gently rinsed with distilled water to remove blood and debris. Samples from each liver, including sections from different lobes and the biliary tract, were fixed in 10% neutral buffered formalin for 48-72 hours at room temperature. After fixation, the samples 1-1.5 cm^3 were dehydrated in ascending grades of ethanol, cleared in xylene, and embedded in paraffin wax (15).

Sectioning and staining

Paraffin blocks were sectioned at 5-6 µm thickness using a rotary microtome. The tissue sections were mounted on glass slides and subjected to the following histological stains [1] Hematoxylin and Eosin (H&E): for general tissue morphology (15). [2] Best's Carmine stain: for glycogen detection (16). [3] Masson's Trichrome stain: for differentiating connective tissue from muscle fibers (17). These stains were selected to highlight various histological features relevant to comparative hepatic anatomy.

Microscopic examination and imaging

Histological slides were examined under an Olympus CX21 light microscope. Digital images were captured using an OMAX 18MP microscope camera attached to the eyepiece. All objectives were calibrated using a stage micrometer and camera software to ensure the precision of morphometric measurements. Observations included hepatocyte arrangement, sinusoidal patterns, capsule thickness, and bile duct structures.

Data recording and comparative analysis

All data were systematically recorded, including quantitative and qualitative observations. Comparative analysis between pigeons and gulls was performed to identify anatomical and histological differences in liver structure and biliary system morphology. Micrographs were used to support findings and document histological variations.

Statistical analysis

Using software Sigma stat (V13.0/ SYSTAT) to attain statistical analysis. The input data tabled as means±standard error, for (t-test), (student t-test) use at $P<0.05$ (18).

Results

The liver is located in the thoracic-abdominal cavity, as the bird's body did not contain a diaphragm. The liver in both birds consisted of two lobes right and left, separate from each other except for the front area, where the two lobes were connected by a bridge called the pars interlobaris. The liver of the pigeon was reddish-brown in color, and the liver of the gull was dark brown (Figure 1). The biliary ductus system in the gull composed of the gallbladder, a muscular, membranous organ located on the visceral surface of the right lobe of the liver. It was look like a pumpkin and dark green in color, and is approximately 3-3.5 cm long. The extrahepatic bile consisted of hepato-enteric and cystic-enteric duct (Figure 1). In pigeons: gallbladder was absent. Two bile ducts have been observed outside the liver, which were (the right hepato-enteric duct and the left hepato-enteric duct) (Figure 1).

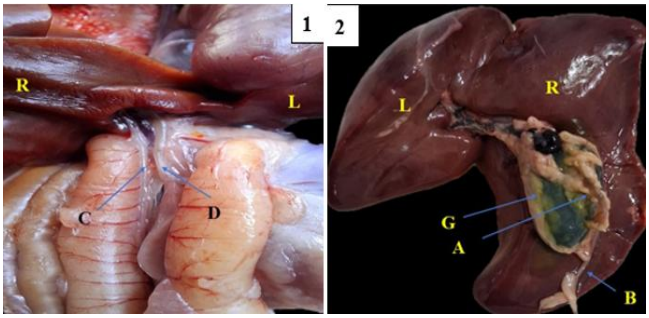


Figure 1: (1): Pigeon, (2): Gull, (R): Right lobe, (L): Left lobe, (G): Gall bladder, (A): Cystic- enteric duct, (B): Hepato-enteric, (C): The right hepato-enteric duct, (D): The left hepato-enteric duct.

Results of the histological study showed that the liver of the pigeon and the gull is surrounded by a capsule called the Clisson capsule, which is made up of dense connective tissue. These fibers, in turn, were covered by a row of flat cells(mesothelium) with an oval-shaped nucleus, also presence of lymphatic collections near the hepatic capsule in the gull and not noticing them in the pigeons (Figure 2). The liver parenchyma consisted of hepatocytes, which were distinguished in both birds and both sexes by their irregular shape, round nuclei, and clear nucleoli. The number of nuclei varies between hepatocytes, some having one nucleus, others two, and less often three nuclei. It was noted that the borders between hepatocytes are not clear, as the cells were clearly arranged side by side. Hepatocytes form hepatic cords, which are composed of one or two rows of hepatocytes. The sinusoids are lined by endothelial cells and filled with red blood cells, in addition to the Kupffer cells that are found in liver sinusoid attached to the epithelial cells, with a triangular shape containing a large nucleus (Figure 2). The study showed the presence of central veins randomly within the liver parenchyma of both birds and both sexes, but in pigeons they were more numerous, have a more regular lumen and smaller size than in the gull's liver. It was also noted that the arrangement of the liver cells around the central vein was radial and become in the form of groups the further away from it (Figure 3). In addition, there were lymphocyte clumps spread throughout the liver parenchyma and portal area of both birds, with their presence observed around the central vein in the gull's liver, while in the pigeons their presence was not observed around the central vein (Figure 3).

The portal area consisted of connective tissue containing a branch of the portal vein, branches of the hepatic artery and branches of bile ducts. When using Mason's trichrome stain, it was observed that the amount of collagen and elastic fibers in the liver and main bile ducts of the gull was greater than in the liver and main bile ducts of the pigeon which taken green color, in addition to the presence of a lymphatic vessel and bundles of nerve fibers (Figure 4). It was noted that the reaction of liver tissue with the best carmine dye to detect the amount of glycogen was strong in pigeons, while it was weak in gulls (Figure 5). The results of the study also showed the presence of binucleated hepatocytes near the portal triad region in both birds, but their number in the gull's liver was greater than in the pigeon's liver (Figure 6).

The intrahepatic bile ducts (canaliculi) of both birds have a central lumen lined by simple cuboidal epithelial cells with centrally located rounded nuclei and surrounded by connective tissue. The duct of Hering had simple cuboidal epithelium in pigeons, with stratified cuboidal cells being noted on both edges of the duct in the gull. Then the small ducts begin to gather to form larger ducts, no matter how large the duct is, it remains a cuboidal epithelium, then the submucosal sheet follows, then a muscular layer composed of bundles of muscle cells (Figure 7). The ducts unite with each other to exit the liver. The histological structure of the gallbladder and extrahepatic (main) bile ducts in gulls and pigeons consistsed of several layers, the mucosal layer, including folds and invaginations. These folds are characterized by being unequal in length in the cystic-enteric duct and the common hepatic-enteric duct in the gull and the left hepatic-enteric duct in the pigeon, these folds were almost equal in length in the right hepatic-enteric duct of the pigeon. These folds were distinguished by their abundance in the gallbladder of the gull, and these folds have primary and secondary folds. The mucosal layer was lined by simple columnar epithelium in right and left hepatic-enteric duct of the pigeon and cystic-enteric and gallbladder in gull, but sometimes it was simple -pseudo-stratified columnar in right hepatic-enteric duct of the pigeon, but in the common

hepatic-enteric duct of the gull is simple cuboidal epithelium with spherical nucleus, in addition to the presence of glands in this layer.

The lamina propria- submucosa contains connective tissue collagen fibers that appeared green in color when Masson's trichrome stain is used and its fibers penetrate the muscular layer that follows it with the presence of lymphocyte clusters, the muscularis mucosal layer is missing in gull and pigeon. The muscular layer, composed of smooth muscle cells, which were arranged in a circular manner in the gallbladder, while it consisted of two layers in the main bile ducts of both birds, which were internally circular and externally longitudinal. The last layer was the serosal layer, which contains connective tissue fibers and blood vessels, in addition to the presence of fatty tissue, this layer covers the main bile ducts of both birds and the gallbladder (on the side not connected to the liver), it was called the adventitial layer in the gallbladder on the side connected to the liver (Figures 7-9).

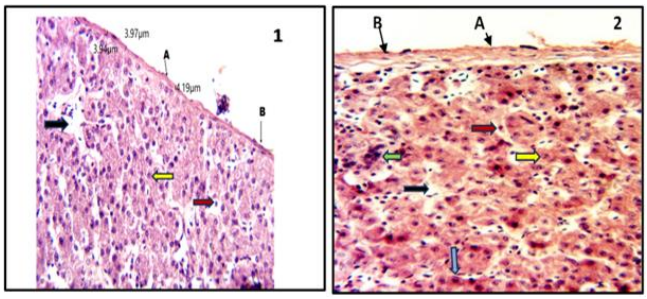


Figure 2: Note the histological section of the liver in (1) Pigeon, (2) Gull, (A) Capsule, (B) Flat cells, (yellow arrow) Nucleus of hepatocyte, (red arrow) Kupffer cell, (blue arrow) Endothelial cell, (black arrow) Irregular sinusoid, (green arrow) Lymphocyte clumps (H and E, 40X).

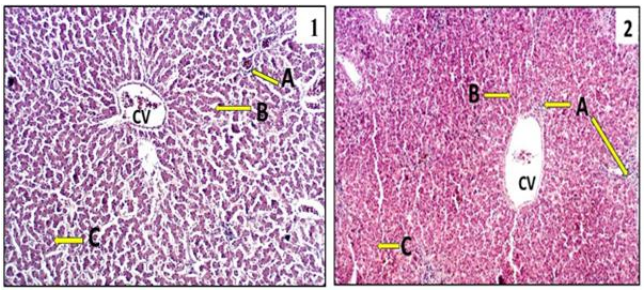


Figure 3: Note the histological section of the liver in (1) Pigeon, (2) Gull, (CV) Central vein, (A) Lymphocyte clumps, (B) Radial arrangement of hepatocyte, (C) Hepatocytes in groups, (H and E 10X).

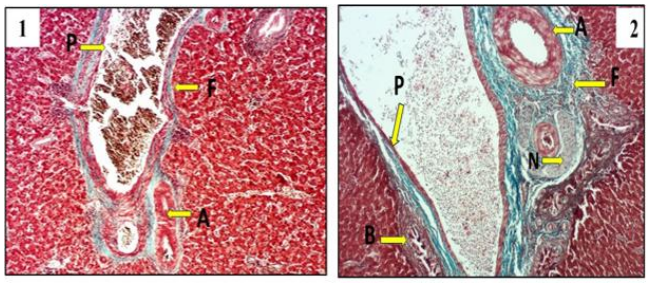
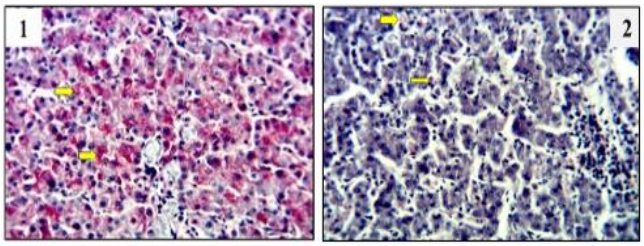


Figure 4: Note the histological section of the portal area, (1) Pigeon, (2) Gull, (P) Portal vein, (A) Hepatic artery, (B) Bile duct, (N) Nerve bundle, (F) Fibers of connective tissue, (Masson trichrome stain, 10X).



Figer 5: histological section showe the amount of glycogen of the liver in (1) Pigeon, (2) Gull, (yellow arrow) Glycogen, (Best carmine stain,40X).

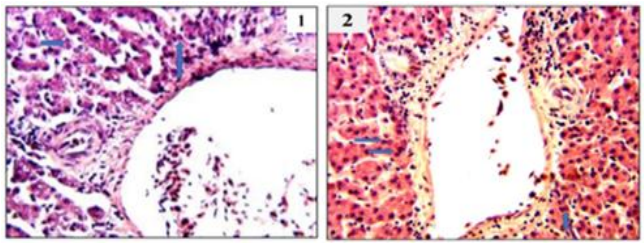


Figure 6: Note the histological section of the liver in, (1) Pigeon, (2) Gull, (blue arrow) binucleated hepatocytes, (H and E 40X).

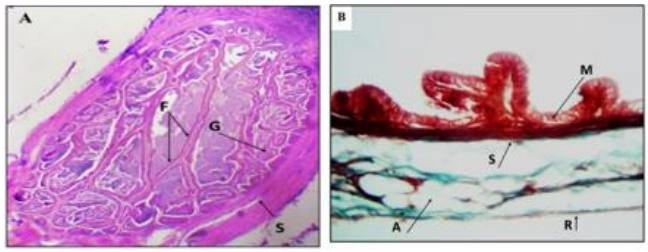


Figure 7: The gall bladder in gull Note:(M) The mucosal tunica, (F) The folds, (G) The glands, (S) The smooth muscles, (R) Serosa layer, (A) Adipose tissue. (A, H and E stain,4X), (B, Masson's trichrome stain,40X).

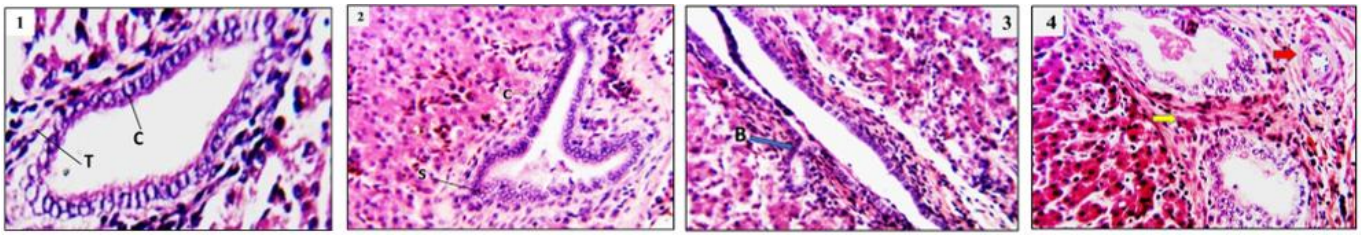


Figure 8: Note the bile ducts inside the liver. (1) Hering duct in the pigeon liver, (2) Hering duct in the gull liver, (3) Collection of bile ducts, (4) Hepatic artery adjacent to a bile duct, (C) Simple cuboidal epithelium, (T) Connective tissue layer, (S) Simple cuboidal- stratified cuboidal epithelium at one end in a gull, (B) Collection and union of bile ducts, (yellow arrow) Muscular layer common to the artery and bile duct, (red arrow) Hepatic artery, (H and E stained, 40X).

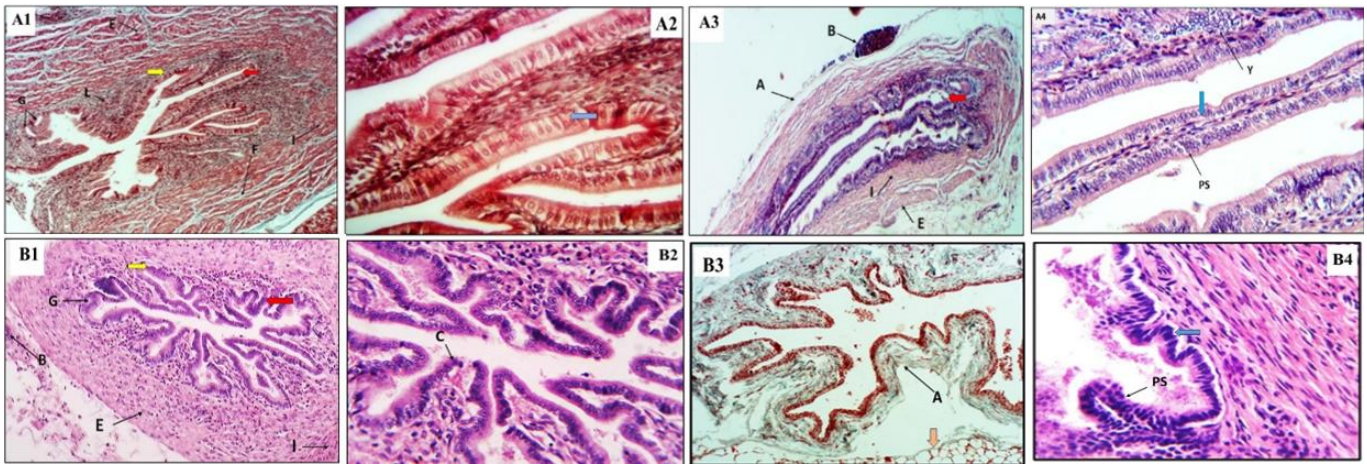


Figure 9:(A1,2) The left hepatic-enteric duct in pigeon, (A3,4) The right hepatic-enteric duct in pigeon, (B1,2) The hepatic-enteric duct in gull,(B3,4) Cystic-enteric duct in gull, (yellow arrow) The mucosal tunica, (red arrow) The folds, (G) The glands, (L) The submucosal lamina, (I) The internal smooth muscles, (E) External smooth muscles, (F) Connective tissue fibers that permeate the muscular layer, (A) Adventitia layer,(blue arrow) Simple columnar epithelium, (PS) Pseudo-stratified columnar epithelium, (C) Simple cuboidal epithelium, (B) Blood vessels, (Pink arrow) Adipose tissue, (Y) Lymphocyte clusters, (A3,A4,B1,B2,B4, H and E stain) (A1, A2, B3, Masson trichrome stain),(A1,A3,B1,B3,10X),(A2,A4,B2,B4,40X).

Comparative liver morphometry

The data presented in table 1 reveal statistically significant differences between male pigeons and gulls across all measured hepatic morphometric parameters. Liver lobe length and weight, gulls exhibited significantly larger right and left liver lobes compared to pigeons left lobe: 6.2±0.39 cm vs. 2.95±0.12 cm; right lobe: 7.1±0.4 cm vs. 4.65±0.34 cm. Similarly, liver weight was substantially greater in gulls 20.5±0.8 g than in pigeons 8.74±1.21 g. Capsule thickness, interestingly, capsule thickness was significantly higher in pigeons 8.99±0.41 µm compared to gulls 7.02±0.64 µm. Sinusoid diameter, pigeons demonstrated a notably larger sinusoid diameter 18.09±1.6 µm than gulls 3.86±0.36 µm. Hepatic cord thickness and hepatocyte diameter, gulls showed a significantly greater hepatic cord thickness 23.5±1.24 µm and hepatocyte diameter 12.2±0.7 µm compared to pigeons 14.5±0.67 µm and 7.1±0.41 µm, respectively. Portal triad structures, the bile duct, portal venules, and hepatic arterioles were all significantly larger in gulls compared to pigeons; bile duct 19.84±1.38 µm (gull) vs. 10.28±0.47 µm (pigeon), portal venules 30.98±2.26 µm vs. 16.34±0.75 µm, hepatic arterioles 38.08±4.8 µm vs. 33.25±2.4 µm.

The results of the study showed that the weights of the livers and the lengths of their lobes varied for pigeons and gulls, also some histological measurements of the liver of both birds. The similar letters between male and female means there was no significant difference, the different letters between male and female means there was a significant difference. The liver sinusoids separate rows of hepatocytes, which were characterized by being wide in the pigeon but narrow in the gull, with an irregular shape in both birds. It was noted that the thickness of the capsule in the female's gull was thicker than that in the pigeon (Tables 1 and 2). The data presented in Table 2 show statistically significant differences ($P<0.05$) between female pigeons and

gulls in several morphometric liver parameters. The gulls had significantly larger left and right liver lobes and heavier livers compared to pigeons, as indicated by different letters (a vs. b). Notably, the capsule thickness, portal venules, bile ducts, and hepatic arterioles were also significantly greater in gulls, suggesting a more robust and vascularized liver architecture. Though, some parameters-sinusoid diameter, hepatic cord thickness, and hepatocyte diameter-did not show significant differences between the two species, as evidenced by the shared letter "a". This suggests that while gross anatomical features differ significantly, some microstructural components remain relatively conserved between the species.

Table 1: Measurement in male pigeons and gulls' livers

Parameters	Pigeons	Gull
LLL (cm)	2.95±0.12a	6.2±0.39b
RLL (cm)	4.65±0.34a	7.1±0.4b
W (g)	8.74±1.21a	20.5±0.8b
CT (µm)	8.99±0.41a	7.02±0.64b
SD (µm)	18.09±1.6a	3.86±0.36b
HCT (µm)	14.5±0.67a	23.5±1.24b
HD (µm)	7.1±0.41a	12.2±0.7b
BD (µm)	10.28±0.47a	19.84±1.38b
PV (v)	16.34±0.75a	30.98±2.26b
HA (µm)	33.25±2.4a	38.08±4.8b

Left lobe length (LLL), Right lobe length (RLL), Weight (W), Capsule thickness (CT), Sinusoid diameter (SD), Hepatic cord thickness (HCT), Hepatocyte diameter (HD), Bile duct (BD), Portal venules (PV), Hepatic arteriole (HA). M±SE: Mean±Standard Error, the similar letters mean there is no significant difference at P< 0.05. The different letters mean there is a significant difference at P<0.05.

Table 2: Measurement in female pigeons and gulls' livers

Parameters	Pigeons	Gull
LLL (cm)	2.65±0.18a	6.4±0.36 b
RLL (cm)	4.65±0.19a	7.25±0.37b
W (g)	6.06±0.35a	22.95±0.73b
CT (µm)	8.58±0.6a	18.1±1.2b
SD (µm)	5.88±0.56a	5.38±0.18a
HCT (µm)	19.2±1.2a	19.54±0.55a
HD (µm)	9.04±0.47a	9.5±0.48a
BD (µm)	9.64±0.38a	34.16±1.6b
PV (v)	18.26±1.04a	33.66±5.4b
HA (µm)	36.1±0.94a	45.16±2.8b

Left lobe length (LLL), Right lobe length (RLL), Weight (W), Capsule thickness (CT), Sinusoid diameter (SD), Hepatic cord thickness (HCT), Hepatocyte diameter (HD), Bile duct (BD), Portal venules (PV), Hepatic arteriole (HA). M±SE: Mean ± Standard Error, the similar letters mean there is no significant difference at P< 0.05. The different letters mean there is a significant difference at P<0.05.

Discussion

The weight of the liver varies from one bird to another depending on the body size, metabolic activities, and type of food. This is what the researcher (6) discussed in his research on the gull. The present study found that the pigeon and gull was bilobed and situated in the mid-coelomic cavity. Our findings are consistent with what researchers have formerly reported for pigeons and gull (19,20). The results of the current study showed that the pigeon liver was reddish brown in color and the gull liver was dark brown in color, similar to what was found by (21) in chicken and (22) Male geese. The nutritional status, breed, and age of the birds affect the weight, size, and color of the liver (23).

The morphometric analysis revealed variations in various liver parameters, between pigeons and gulls. The right and left lobes of the gull liver were notably longer and heavier compared to those of pigeons. Furthermore, there was a greater capsule thickness in gulls implying stronger structural integrity. Nonetheless no significant distinctions were noted in sinusoid diameter, hepatic cord thickness and hepatocyte diameter indicating a cellular architecture at the microstructural level. In gulls the portal venules and bile duct measures appeared notably larger possibly due, to their intricate biliary drainage system and higher circulatory needs. The researchers (24,25) mentioned the gull has a gall bladder while the pigeon does not, and the results of our study were consistent with that.

The gallbladder located on the visceral surface of the right lobe; the result is consistent with what was reported by (14) in adult domestic chickens. We noticed that the gall bladder in the gull was look like a pumpkin and was dark green in color because it contained the biliverdin substance, the morphological description did not match some birds, as the researcher described them (26) in white - eared bulbul is oval in shape and (27) Balloon-like in mallard. The researcher stated (12) Pigeons do not have a gall bladder and have two bile ducts outside their liver, our results were similar to that. The researcher found (28) The bile ducts in the goose consist of a cystic and a hepatic-enteric duct, our observations in the gull were similar.

The results in this research showed that the liver parenchyma in both birds consistes mainly of hepatocytes with an irregular shape, round nuclei, which are similar to what the researchers described for the hepatocyte (23,29) in lovebird, while the description contradicts (30). In African ostriches, it is multifaceted. The researchers agreed unanimously (31) In their studies of different bird species, the partitions between the lobules in the liver parenchyma were not clear, this is due to the lack of connective tissue in the septa extending between the lobules and the results of the study were similar to that. The results of the study showed the presence of hepatic sinusoids, which lined by endothelial cells with a flat nucleus, irregular shape, among these sinusoids are spread defensive cells to eliminate foreign

bodies, irregular in shape, called Kupffer cells, our results are similar to each of (24) in gull, (32) in pigeon, we noticed that the sinusoids of the gull are narrower than those of the pigeon, which makes the gull's liver more robust than the pigeon's liver. Our results were consistent with what the researcher stated (21) in broiler chickens noted that the arrangement of the hepatocyte around the central vein is radial. The hepatic cords are composed of one or two rows of cells, but the majority are two rows, the results agreed with the researcher (8) in Muscovy Duck and (25) in domestic pigeons. The portal area consists of a branch of each of the hepatic vein, artery and bile duct, a cluster of lymphocytes was observed around this area, and this result was similar to what the researcher had reached (32) in pigeon.

The research revealed the presence of binucleated liver cells near the portal area in both birds, this is not common in birds (33). The researcher (34) explained through his study of the liver of vertebrates that there is a difference in the composition between the species in the fibers, this result confirms our research results, the amount of liver fiber in gulls is greater than in pigeons, which makes the liver of the pigeon more flexible than the liver of the gull.

The researchers stated (23,35) that the glycogen stores in the liver of birds depend primarily on the bird's physical activity. The amount of glycogen in pigeon liver cells is greater than in gulls, the reason may be that the gull is a migratory bird and covers long distances during the journey, which leads to the consumption of glycogen stores, which is the source of energy, unlike the pigeon, which is a domesticated bird. Mallard and Broiler fowl that the gallbladder consists of several layers (mucosa, submucosa, muscularis, and adventitia), This supports what we have reached in our research (27). The researcher (14) described the mucosa layer of the gallbladder in local adult chicken is lined by simple columnar epithelium and has folds, some folds long and some short, this study was consistent with our results. the submucosal layer consists of connective tissue fibers and the muscular layer consists of a single layer of smooth muscle cells arranged in a circular manner; this description is similar to what the researcher reached (26) in white - eared bulbul.

The last layer of the gallbladder is composed of connective tissue fibers that contain blood vessels in addition to the presence of fatty tissue (36,37). This result in line with the researchers (33) reported that the smaller bile duct and Hering duct are lined with cuboidal cells and surrounded by dense connective tissue, this result confirmed our results. The bile ducts located within the portal area are lined with cuboidal cells and surrounded by connective tissue, as the researchers mentioned (7,24) in their research on the gull. Gradually, the amount of connective tissue of the intrahepatic bile ducts increases, forming the submucosal layer. Then, the muscle layers begin to appear in sequence to support the extrahepatic bile ducts as they exit the liver parenchyma, where they lose support from the hepatic cells.

The extrahepatic bile ducts, they are also distinguished by having several wall layers, the right and left hepato-enteric ducts in pigeons have folds extending along the duct lined with simple columnar epithelium, this result was confirmed by the researcher (38) in quail, The results in (39,40) for hepatic intestinal tract is lined with simple columnar epithelium. However, this study did not match what we found in the gull, where the common hepato-enteric duct was lined with simple cuboidal epithelium, this result is consistent with what the researcher (38) reached through his study on Japanese quail. The fibers of the submucosal lamina send their fibers to the muscular layer to spread between the smooth muscle cells, The muscular layer (inner longitudinal and outer circular), this result was confirmed by the researcher (22) in male geese. These fibers make the muscular layer very cohesive, which supports the ability of the bile ducts to expand and return to their normal size.

The researcher (22) indicated through his research on male geese that the cystic-enteric duct is lined with simple columnar cells and that the mucosal layer contains lymphatic aggregates in the lamina propria - submucosa and that the adventitial layer is composed of connective tissue fibers with the presence of blood vessels. This result was similar to what we mentioned in our research.

Conclusion

The histological and morphometric results on the liver and biliary system exhibited variations between pigeons and gulls. This difference might be due to the different environmental and nutritional habitats of the two birds.

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Conflicted interest

None.

References

1. Miller CV, Pittman M. The diet of early birds based on modern and fossil evidence and a new framework for its reconstruction. Biol Rev. 2021;96(5):2058-2112. DOI: 10.1111/brv.12743
2. de Faria JP, Vaz PT, Lopes CS, Calado JG, Pereira JM, Veríssimo SN, Paiva VH, Gonçalves AM, Ramos JA. The importance of marine resources in the diet of urban gulls. Mar Ecol Prog Ser. 2021;660:189-201. DOI: 10.3354/meps13611
3. Sales J, Janssens GP. Nutrition of the domestic pigeon (*Columba livia domestica*). Worlds Poult Sci J. 2003;59(2):221-32. DOI: 10.1079/WPS20030016
4. Kuraz Abebe B. The dietary use of pigeon pea for human and animal diets. Sci World J. 2022;2022:4873008. DOI: 10.1155/2022/4873008
5. Hollwarth A, Prieto LG. Avian gastroenterology: anatomy and assessment. Vet Clin Exot Anim Pract. 2025;28(2):413-24. DOI: 10.1016/j.cvex.2024.11.009

6. Zaefarian F, Abdollahi MR, Cowieson A, Ravindran V. Avian liver: the forgotten organ. Animals. 2019;9(2):63. DOI: 10.3390/ani9020063
7. Abd Al-Khazraji KI. Morpho-histological comparative study of the liver in white-eared bulbul (*Pycnonotus leucotis*), mallard duck (*Anas platyrhynchos*), and gull (*Larus canus*). Iraqi J Vet Med. 2017;41(2):94-9. DOI: 10.30539/iraqijvm.v41i2.56
8. Alshammary A, Kareem H. Histomorphological study of the liver in Muscovy duck (*Cairina moschata domestica*). Tikrit J Agric Sci. 2021;21(3):112-8. DOI: 10.25130/tjas.21.3.14
9. Mohsin AR, Hameed ZH. Morphological and histological structure of the liver in budgerigar (*Melopsittacus undulatus*). Ibn Al-Haitham J Pure Appl Sci. 2016;29(1). [available at]
10. Higashiyama H, Kanai Y. Biliary system; anatomy and development. Encycl Gastroenterol. 2020:314-24. DOI: 10.1016/B978-0-12-801238-3.65863-4
11. Higashiyama H, Uemura M, Igarashi H, Kurohmaru M, Kanai-Azuma M, Kanai Y. Anatomy and development of the extrahepatic biliary system in mouse and rat: a perspective on the evolutionary loss of the gallbladder. J Anat. 2018;232(1):134-45. DOI: 10.1111/joa.12707
12. Higashiyama H, Kanai Y. Comparative anatomy of the hepatobiliary systems in quail and pigeon, with a perspective for the gallbladder-loss. J Vet Med Sci. 2021;83(5):855-62. DOI: 10.1292/jvms.21-0009
13. Purushottam MB, Kumari A, Kamble M. Histomorphological studies on the gallbladder in guinea fowl (*Numida meleagris*). Indian J Vet Anat. 2021;33(2):130-1. [available at]
14. Al-Bakri NA, Al-Hamawandy DH. Morphological description and histological structure of gallbladder in local adult chicken *Gallus gallus domesticus*. Al-Qadisiyah Agric J. 2020;1(1):6-11. [available at]
15. Suvarna SK, Layton C, Bancroft JD. Theory and practice of histological techniques. 3rd ed. UK: Churchill Livingstone; 2013. 109-21 p.
16. Smith YU. Special stains and techniques: dermatopathology. USA: CRC Press; 2001. 347-52 p. DOI: 10.1201/9781498713665-30
17. Kiernan JA. Graduate training and education in histotechnology and histochemistry. J Histotechnol. 2009;32(3):115-8. [available at]
18. Petrie A, Watson P. Hypothesis tests: the F-test. In: Petrie A, Watson P, editors. Statistics for veterinary and animal science. 3rd ed. USA: Wiley-Blackwell; 2013. 105-11 p.
19. Kausar R, Noor S, Hameed N, Jan S. Histometerical and morphological studies of digestive tract and associated glands in domestic pigeon (*Columba livia*) with regard to age. Pak Vet J. 2019;39(4):573-7. DOI: 10.29261/pakvetj/2019.040
20. Alabdallah ZA. Morphological and histological comparison of the internal organs of birds. Clin Rev Case Rep. 2024;3(1). DOI: 10.31579/2835-7957/051
21. Tarek K, Amine B, Eddine RD, Abdelhafidh M, Hanane A. Morpho-histological comparisons of liver between broiler chickens and wild boar in Algeria. Adv Anim Vet Sci. 2019;7(1):24-9. DOI: 10.17582/journal.aavs/2019/7.1.24.29
22. Subhan SN. Anatomical, histological and radiological study of the liver, gallbladder and biliary duct system of male local breed geese, *Anser anser* (Greylag goose) [master's thesis]. Iraq: University of Sulaimani; 2009. 66-79 p.
23. Hamodi HM, Abed AA, Taha AM. Comparative anatomical, histological and histochemical study of the liver in three species of birds. Raf J Sci. 2013;24(5):12-23. [available at]
24. Khaleel IM, Al-Khazraji KI, Al-Aameli MH. A comparative evaluation of morphological and histological features of gull (*Larus canus*) and mallard duck (*Anas platyrhynchos*) lungs. Adv Anim Vet Sci. 2017;5(7):307-11. DOI: 10.17582/journal.aavs/2017/5.7.307.311
25. Alkhazarji KIA, Naser RAA, Zghair FS. Histological changes in the kidney and liver associated with administration of ethylene glycol in domestic pigeons (*Columba livia domestica*). Tikrit J Agric Sci. 2021;21(3):106-11. DOI: 10.25130/tjas.21.3.13
26. Al-Shaheen NA, Hussein AJ. Morpho-histological and histochemical study of the gallbladder of white-eared bulbul (*Pycnonotus leucotis*). Basrah J Vet Res. 2020;19(1):121-33. DOI: 10.23975/bjvetr.2020.170617
27. Abdulqader SA, Huwait AR. Comparative anatomical and histological study of gallbladder in mallard (*Anas platyrhynchos*) and broiler fowl (*Gallus gallus*). Univ Thi-Qar J Agric Res. 2023;12(2):15-25. DOI: 10.54174/utjagr.v12i2.254
28. El Karmoty AF, Tolba AR. Angioarchitectural study on the intrahepatic blood supply of geese (*Anser anser domesticus*) with special reference to its biliary system. Appro Poult Dairy Vet Sci. 2019;6(1). DOI: 10.31031/apdv.2019.06.000630
29. Ismaeil SA, Emam H. 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. 2023;10(3):607-20. DOI: 10.17582/journal.aavs/2022/10.3.607.620
30. Moslem D. Histological study of the African ostrich liver and anatomical comparison with poultry liver. Biol Forum Int J. 2015;7(1):1185-8. [available at]
31. Saddam S. The morphological description and histological structure of the liver in marsh harrier bird in Iraq (*Circus aeruginosus*). Int J Sci Res. 2018;7(1). DOI: 10.21275/ART20179407
32. Alnassiri SH. Macro and micro anatomical comparative study for liver, kidney and testis between the albino rat and pigeon. Stallion J Multidiscip Assoc Res Stud. 2024;3(1):1-17. DOI: 10.55544/sjmars.3.1.1
33. Jennings R, Premanandan C. Veterinary histology. United States: The Ohio State University; 2017.
34. Petcoff GM, Díaz AO, Escalante AH, Goldemberg AL. Histology of the liver of *Oligosarcus jenynsii* (Ostariophysi, Characidae) from Los Padres Lake, Argentina. Iheringia Ser Zool. 2006;96(2):205-8. DOI: 10.1590/S0073-47212006000200010
35. Bingöl SA, Deprem T, Koral Taşçı S, Kocamış H. Immunohistochemical localization of catalase in geese (*Anser anser*) liver. Kafkas Univ Vet Fak Derg. 2011;17(1):77-81. DOI: 10.9775/kvfd.2010.2423
36. Muthukrishnan S, Rajathi S. Histological studies on the gallbladder of drongo. Indian J Vet Anat. 2017;29(2). [available at]
37. Mobini B. Histological study of the gallbladder of the common quail (*Coturnix coturnix*). Vet Med. 2014;59(5):261-4. [available at]
38. Mobini B. Histological study of hepatic bile ducts in the common quail (*Coturnix coturnix*). Res J Appl Basic Sci. 2013;4(5):1067-70. [available at]
39. Stornelli MR, Ricciardi MP, Giannessi E, Coli A. Morphological and histological study of the ostrich (*Struthio camelus* L.) liver and biliary system. Ital J Anat Embryol. 2006;111(1):1. [available at]
40. Schmidt RE, Struthers JD, Phalen DN, editors. Pathology of pet and aviary birds. USA: Wiley-Blackwell; 2024. [available at]

دراسة مقارنة للتشريح العياني والمجهري للكبد والجهاز الصفراوي في الحمام والنورس

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الخلاصة

هدفت هذه الدراسة للمقارنة بين التراكيب التشريحية والنسجية للكبد والجهاز الصفراوي في الحمام والنورس فحص عشرين طائراً بالغاً (١٠ حمام و١٠ نورس) تم الحصول عليهم من مدينتي تكريت والموصل في العراق. بعد القتل الرحيم تم فحص أنسجة الكبد عيانيا ونسيجياً باستخدام صبغات مثل الهيماتوكسيلين والايوسين، وصبغة ثلاثية الألوان لماسون، وصبغة الكارمين لبست. أظهرت الطيور في كلا النوعين وجود كبد ثنائي الفصوص يقع داخل التجويف الصدري-البطني، ولكن النورس كان يمتلك مرارة بينما لا يمتلكها الحمام. أظهرت نتائج قياسات حجم ووزن الكبد فروقات بين النورس والحمام، حيث كان كبد النورس أكبر وأثقل. كانت سماكة المحفظة الكبدية أكبر في إناث النورس، مما يشير إلى وجود اختلافات بين الأنواع في آليات الحماية الكبدية. تحت المجهر، وُجد أن الخلايا الكبدية مرتبة في حبال تُشع من الأوردة المركزية، ولكن الحمام أظهر جيوب دموية أوسع من النورس. أظهرت تراكيب الكبد في النورس اختلافاً في السماكة والحجم، وكان الجهاز الصفراوي أكثر تطوراً مقارنةً بالحمام. كما أن إناث النورس امتلكن قياسات مجهرية أكبر لتراكيب الباحة البوابية من الذكور. تسلط هذه النتائج الضوء على الاختلافات في تشريح الكبد وتركيبه بين أنواع الطيور وكذلك بين ذكور وإناث الطيور.