

Anatomy and Histological study of liver and Pancreas of Wild Owls (*Athene noctua*)

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Abstract:

Background: Raptors, including the wild owl, are ecologically important species that have been poorly studied anatomically and histologically, particularly the digestive accessory glands such as liver and pancreas.

Aims: The present study aimed to investigate the morphometrical and histological of the large glands in the body (liver and pancreas).

Results: Anatomically, the mean body weight of the owl was 102 ± 0.33 g and the weight of liver was 1.977 ± 1.22 g. The relative liver weight to body weight was 1.938, while the pancreatic weight was 0.453 ± 0.4 g and its relative weight was 0.442. Morphologically, the liver composed of two lobes (right and left), the right lobe was larger than left. Liver was dark brown in color, located cranially of coelomic cavity and associated with stomach, spleen, small intestine, and ovary or testis; while the pancreas was a lobulated organ situated in the space between duodenum limbs. Histologically, the liver is covered by thin capsule which surrounded the gland. The parenchyma of liver consists of laminae arranged radially around the portal area from the venules, arterioles, and portal vein (the central vein). Each lamina is composed of hepatocytes separated by a sinusoid; while the pancreas is composed of two external portions which form groups of acini that drain into a ductus system. Each acinus is made up of pyramid cells. The other part is the internal portion (endocrine portion) consisted of various shapes and sizes.

Conclusions: The wild owl displays anatomical and histological features in its liver and pancreas, reflecting its ecological and nutritional adaptations. These findings provide a primary scientific report that will contribute to enriching comparative studies among birds, particularly predatory carnivorous species.

Keyword: Anatomy, histology, wild owl, liver, pancreas



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Introduction:

The little owl (*Athene noctus*), has a short tail, a plump, compact body, and a flat-topped skull. The bird has a scowl because the facial disc is flattened over the eyes. Owls have been known by the Arabian culture as those wild birds with two horns on top of the large head, broad face, great fierce piercing eyes, curved beaks, and powerful legs equipped with sharp talons. Owls mostly inhabit ruins and caves in deserts and wadies, taking their prey at night with secretive behavior, noticed when heard with their heart-taking hoots rather than being visually seen. In Islamic belief, the owl came from the birds of prey characterized by their hooked beaks, rounded heads, and very short necks. The eyes are immobile and large surrounded by feathers attached to them. They fly slowly and have an accurate hearing sense Al-Sheikhly & Aidek (2023), Hussain & Akhtar (2021). The little owl is a small owl with a flat-topped head, a plump, compact body, and a short tail. The facial disc is flattened above the eyes giving the bird a frowning The undersides have darker streaks and are pallid, usually perched in a high spot (Holt et al., 2015). Its preys include insects, amphibians, reptiles, birds, mammals, and small invertebrates like earthworms (Johnson and associates, 2009). Much of the milder and more temperate regions are home to the small owl (*Athene noctua*). The bird's alimentary tract is different in comparison to that of mammals; it has many organs with essential inter-organ cooperation (Nasser and Khaleel, 2021; Khalid et al., 2023). The liver is regarded as the largest gland in the body because of its functions, which make it an essential organ for life. It receives blood from the intestines through the hepatic portal vein, where it metabolizes the byproducts of digestion. One significant gland connected to the digestive system is the pancreas (Beheiry et al., 2018). It functions as both an exocrine and an endocrine gland in vertebrates (Ibraheim, 2024). The endocrine part secretes hormones such insulin, glucagon, somatostatin, and pancreatic polypeptides from Islet Langerhans in owl pancreas composed of Alpha islet and Beta islet, in Golden Eagles (Al-Aggle and Mohammed, 2012), while the exocrine part secretes digestive enzymes (Kadhim et al., 2010). The pancreas in birds has multiple lobes depending on the type of feed, the pancreas in mammals is located retroperitoneally with head, body, and tail regions (Hiristov et al., 2017). The liver parenchyma of birds resembles the liver of mammals, but there are some differences in histological features, such as the absence of lobules and interlobular trabeculae; the principal cell of the liver is the hepatocyte (King and Melelland, 1984; Whitlow, 2000) This study aims to describe the morphological, and histological, features of the liver and pancreas. Also, it provides data for future studies to maximize the knowledge about this species of adult owl (*Athene noctus*), including: morphometrical and histological measurements of the accessory glands.

Materials and Methods:

Ten adult male birds, by the feather pattern and color of the owl, we know the adults were purchased from a local market in Baghdad Governorate. All birds were weighed. The average body weight of each owl was 102 ± 0.33 g. The birds were deeply anesthetized and euthanized by cervical dislocation, the body cavity was opened, and the liver and pancreas were removed. Detailed photographs were then taken using a 5-megapixel Canon digital camera. The weight of the pancreas and liver was measured (grams) using a sensitive balance

(Switzerl) to prepare liver and pancreas tissue samples for microscopic analysis, after removing and washing the samples with saline, they were preserved by immersion in 10% formalin solution for 48 hours. The samples were then dehydrated using a series of graded ethanol concentrations for 2 hours each, starting with 70%, 80%, 90%, and finally 100% ethanol. After drying, the samples were cleared with xylene for 1 hour. Finally, the samples were preserved in paraffin wax, which enabled the preparation of blocks, from which serial 5- μ m-thick sections were cut using a microtome. The strip sections were stained with hematoxylin and eosin (H & E) stain after being placed on glass slides to improve visualization under a light microscope. These prepared slides were then examined and photographed using a microscope equipped with a digital camera, ensuring high image quality (Khalaf, 2025).

Ethics approval:

The Scientific Ethical Committee of the College of Veterinary Medicine, University of Diyala, Iraq, approved this study (Approval no: Vet Medicine (214); August 2025, R, M, H, A and M).

Results:

Anatomical results of the liver

The owl liver was dark brown in color and was located in the cranial part of the celomic cavity (Fig. 1, A). It has two surfaces. The parietal surface was convex and the visceral surface was closely associated with the, proventriculus, gizzard, spleen, duodenum, jejunum and right testis or ovary in all the birds . It consisted of two lobes. The right lobe was larger than the left one and carried the gall bladder in its visceral surface. Fig. 1, B) Each lobe consists of three surfaces (dorsal, ventral, and medial) and four borders (dorsal, ventral, lateral, and medial). (Fig. 2, A). In the current study observed of a fissure in the caudal part of the left lobe of the liver (Fig. 2, B) meant the body weight of the owl was 102 ± 0.33 g, and the weight of the liver was 1.977 ± 1.22 ; the relative weight was 1.938 (Table1).

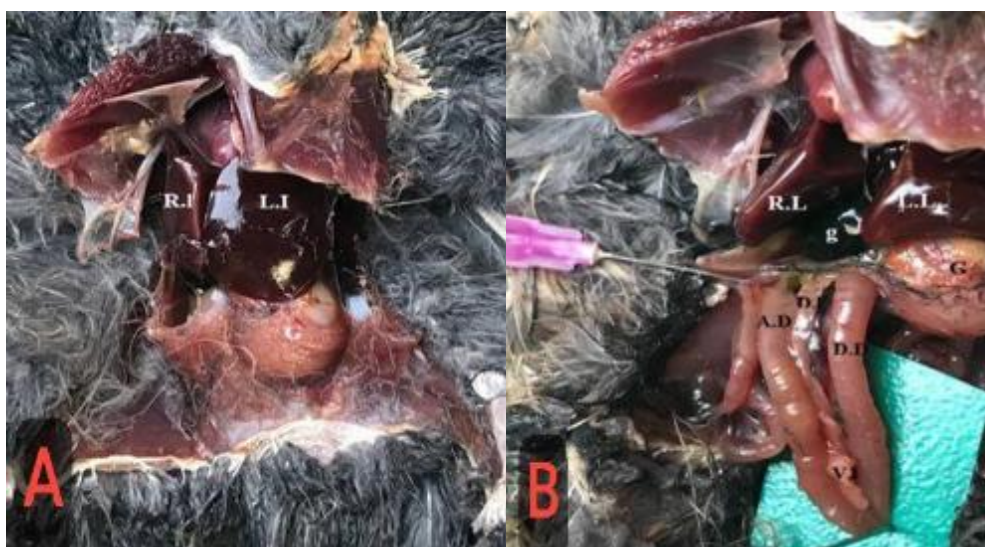


Figure 1: Photographs of anatomical dissection illustrating the position of the liver and pancreas in the coelomic cavity of a small wild owl (*Athene noctua*) show the descending & ascending duodenal limbs (D.D & A.D), the pancreas lobes (dorsal lobe (D.L) and ventral lobe (V.L)), and the lobes of the liver (R.L & L.L).



Figure 2: Photographs illustrate the liver of an owl (*Athene noctua*) shows lobes of liver (right R.L and left L.L). (A) Parietal views and (B) Visceral view (fixed by 10 formalin).

Pancreas of owl

According to the anatomical assessment in this study, the pancreas of the owl was small, grayish-white organ with short, navicular-shaped lobes surrounded by duodenum loops (Figs.1, B). The third lobe, which was longer than the ventral lobe and very thin, resembling a triangle, extended on the dorsal surface of the ascending limb of the duodenum, with its base situated caudally and the apex extending cranially. The area between the duodenum's ascending and descending limbs was not entirely occupied by the third lobes, which is covered by mesentery (Figs. 3). There are three pancreatic ducts that drain the secretion into the duodenum (Fig.3). The mean body weight of the owl was 102 ± 0.33 g, and the weight of the pancreas was 0.453 ± 0.4 ; the relative weight was 0.442. The mean length of the owl was 12.32 ± 0.02 cm, the total length of the pancreas lobes was 1.99 ± 0.55 cm, and the relative length was 13.75 (Table.1).

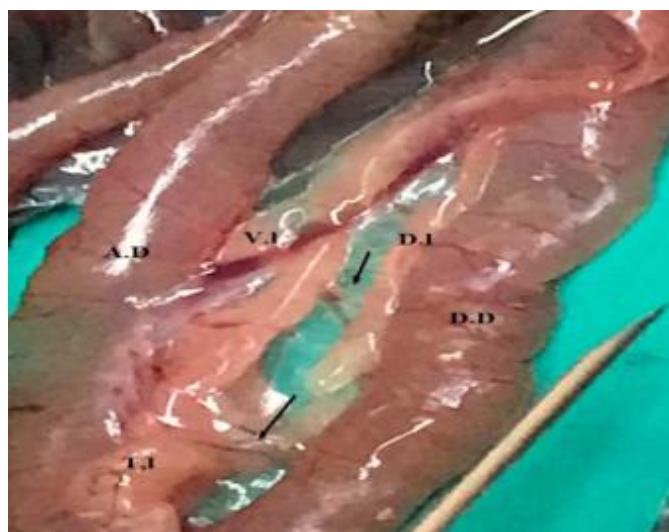


Figure 3: The photograph illustrates three pancreatic ducts (black arrow), Dorsal loop (D.L), Ventral loop (V.L), Tertiary loop (T.L), Descending (D.D) and Ascending (A.D).

Table 1: Morphometric data shows average weight of birds, weight of liver lobes and pancreas and relative weight of each gland of wild owl (*Athene noctua*).

| | Weight | Relative weight |
|-----------------------|---------------|-----------------|
| Right lobe of liver | 1.008 ± 0.01g | 1.938 |
| Left lobe of liver | 0.969 ± 0.05g | |
| Pancreas | 0.453±0.4g | 0.442 |
| Body of weight of owl | 102±0.33g | |

Histological analysis of the liver:

The liver was surrounded by a capsule of connective tissue, while the parenchyma was composed of hepatocytes arranged in laminae (Fig.4,A). The hepatic laminae were mostly two cells thick. They were separated from the adjacent laminae by the sinusoids, which open into the central veins (Fig. 4, A and B). The sinusoids were lined by thin endothelial cells and were wider in the layer group. The hepatocytes were polygonal cells with round to oval nuclei (Fig. 5). It was observed that the central vein is situated in the center of each hepatic lobule, which represents a branch of the vena cava and extends from the central vein (Fig. 5). The portal tract contains a venule with a very thin wall lined by endothelial cells, flattened and small, and composed of the thick-walled blood vessels (arterioles), the terminal branch of the hepatic artery, and the vein and lymphatic vessels (Fig. 6). The bile duct structure, which receives secretion from hepatocytes through bile canaliculi, is located between each plate of hepatocytes; these plates are lined by simple columnar epithelium, where capillaries can also be observed (Fig.6, B). The sinusoid is lined by three types of cells, including the first (mainly) endothelial cells (E), which are characterized by the dark-stained nucleus; the second, monocytes called Kupffer cells; and the third, hepatocytes (Fig. 5).

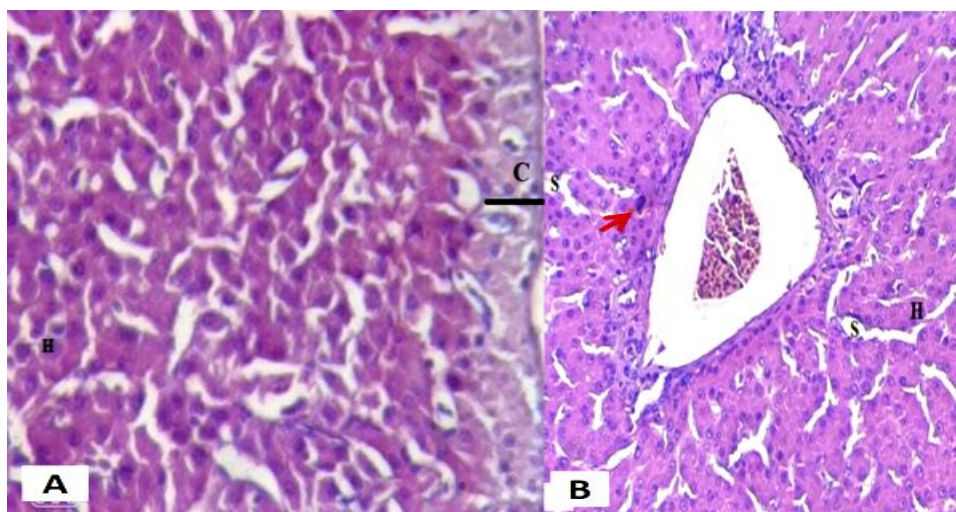


Figure 4: Microscopic images of liver of wild owl illustrates liver lobule surrounded by a thin capsule (C) (black line), liver lobule composed of central vein (v) and hepatocyte (H), arranged as the radiate, sinusoid (S), Kupffer cell (red arrow) (A: H & E Stain X 100, B: H & E Stain X 100).

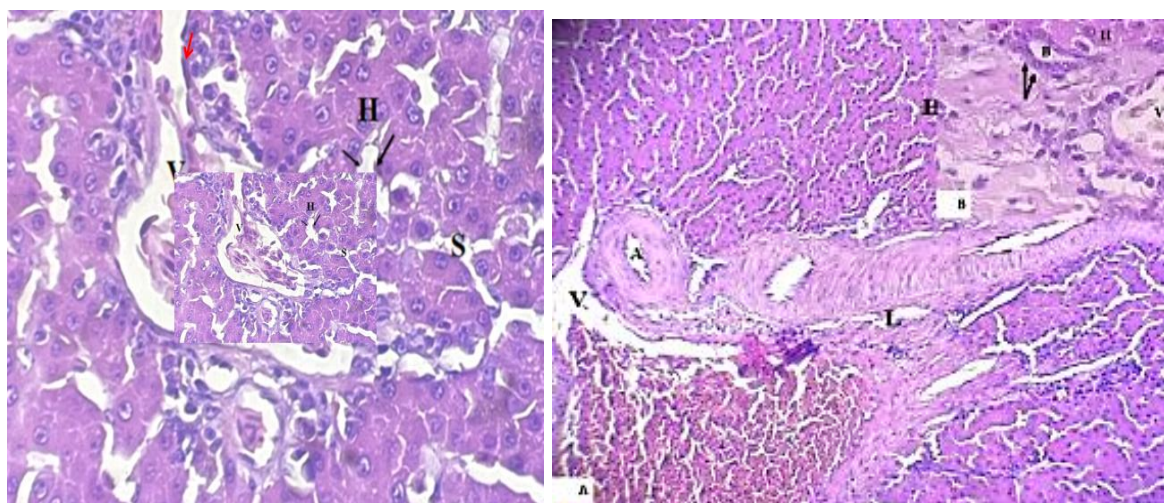


Figure (5): Photomicroscope of the liver in wild owl illustrates the hepatocytes were polygonal cells (H), with round to oval nuclei, sinusoid (S) lined by endothelial cells (black arrow) (H & E Stain X 400).

Figure (6): Photomicroscope of wild owl pancreas illustrated. The portal tract includes branches of the hepatic portal vein (V), hepatic artery (A), bile ductile (B), lymphatic vessel (L), and hepatocyte (H) (A: H&E stain 200X B: H&F stain 400X)

Histological study of the pancreas

In wild owls, the pancreas is dense irregular connective tissue surrounds the pancreas, extending it into a barrier that separates the stroma into several lobules (Fig.7, A). Each lobule was composed of acini that drain into the developed duct system of the duct. Each acinus was made up of pyramidal cells that form an irregular cluster of secretory cells that are pyramid-shaped. These cells released their secretion in an intercalated duct (Fig. 7, B), an acinus lined with pyramidal, acinar cells known as centroacinar

cells (Fig. 8), which were lined with flat epithelial cells, and a related intercalated duct with centroacinar cells (Fig. 9.A). The interlobular duct lined by simple cuboidal epithelial cells was replaced by a simple columnar epithelial interlobular duct (Fig. 9.B) of each of the lobes. The islets of Langerhans, which were observed, were irregular in shape. The islets of Langerhans in the owl pancreas, composed of secretory cells, include alpha and beta cells. while the beta cells were spherical or oval and irregular in shape, located in the margin of the islet (Fig. 7B).

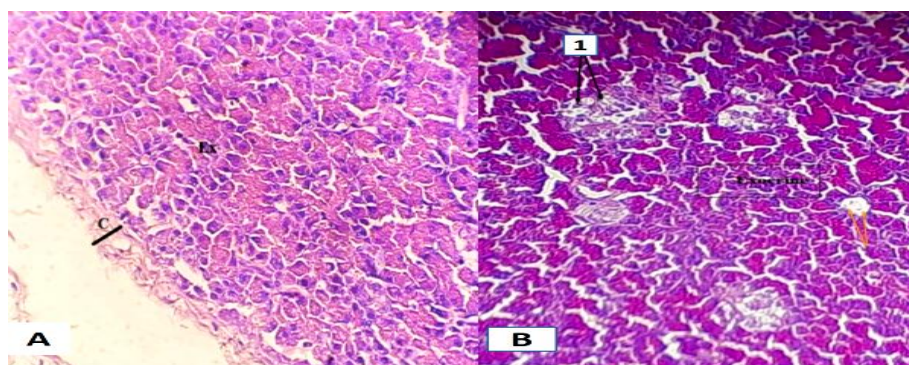


Figure 7: Representative images of pancreas illustrate: The capsule (C), Exocrine portion (Ex), and islet of Langerhans (1), Intercalated duct (brown arrow), A: (H&E 10X.B: :(H&E 200X).

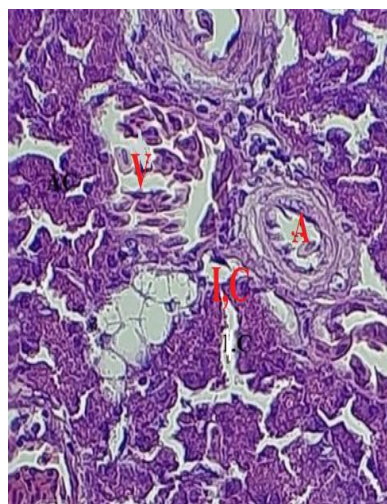


Figure (8): Photomicroscope of pancreas illustrate. The blood vessels a (A,V) , intercalated duct (I.C) and Fat. Among the pancreatic acini (H&E, X400).

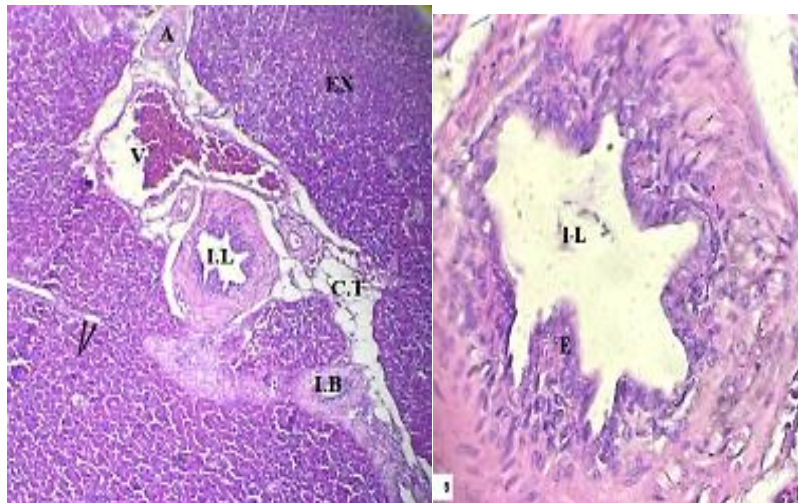


Figure (9): Photomicroscope of pancreas illustrated. The duct system, shows rich blood supply (A,V) , interlobular (I,L) , intralobular duct (I.B) , intercalated duct (black arrow) A: H&E stain , X200. B: intralobular duct (I.B), Epithelial cells (E), lining the large pancreatic duct (H&E, X400).

DISCUSSION

The findings of the current study demonstrated that the livers of owls and fowls are closely related. The findings are similar to those reported by Al-Araji (2015) in native male turkeys and Al-AI-in local ducks; however, they were different from those of Hamdi et al. 2013 who described the liver color of three bird species as light to dark red (Alshamy et al., 2019). Claimed that an owl's liver might be either brown or reddish brown, depending on its age, As a result, the liver was pale-brown on the first day of hatching due to the rich yolk pigment, but by the end of the first week, it had darkened to a light brown. According to Sadiq and Hussein (2019), the color of the avian liver varies depending on the nutritional status of the adult bird; it is typically dark red to reddish-brown, but if the bird consumes a high-fat diet, it may turn yellow-tan. It features a distinct transverse groove on the visceral surface of both lobes that reveals the entrance of the gallbladder, bile ducts, portal veins, and hepatic arteries (similar findings previously reported by Al-hamadawi et al.). (2009)) in Iraqi wild birds (common kestrel, laughing dove, and white-throated kingfisher). by McLeland, (1990), the gall bladder is located on the dorsal surface of the right lobe, which is absent in a number of other species, including parrots, pigeons, and ostriches. Additionally, the current study showed that the liver of Wild owls split into two lobes, with the right lobe being larger than the left, which also splits into two secondary portions to present the large sac (gall bladder) in left side This result was in agreement with Hamdi et al. (2013) and Al-A´Aaraji (2015) in poultry that described the liver of birds involved double lobes, with the left lobe being smaller and divided into dorsal and ventral parts. This result also agreed with Selman (2013) in local coots and Muscovy ducks, which claimed that the liver lobes of bustards do not contain any additional subdivisions. The present study also contradicts the findings of Stornelli et al. 2006 in ostriches and Nickel et al. (1977) in pigeons, which state that the liver's left lobe is composed of three parts: The liver parenchyma was covered by capsule, which was composed of hepatocytes arranged in laminae. The current findings are supported by Hamdi et al. (2013) and Al-A´Aaraji (2015), which was separated from the adjacent laminae by the sinusoids that opened into the central veins, as reported by Al-hamadawi et al. (2009). The hepatocytes were polygonal cells with round to oval nuclei, as reported by Selman (2013) in local coot birds and Vaish (2005). There was no separation between the adjacent hepatic lobules; this confirmed the reports of Hodges (1974) and Bacha and Bacha (2000), who stated indistinct lobulations in the liver of birds. The area resembles a portal triad surrounding the branches of the hepatic duct, which consists of the portal vein, hepatic artery, and bile ductules, as stated by Al-A´Aaraji (2015) in turkey birds. Thick connective tissue setae were observed in the parenchyma. Lymphocytic aggregation was seen in the course of septa at some places. Kupffer cells were also observed in the lining of the (space of Disse); it was under the findings of Vaish (2005).

The pancreas is an important gland accessory to the digestive system. In an owl, it is similar to the other avian pancreas and it is located on the right side of the coelomic cavity. It is tightly bound by mesentery and blood vessels positioned between two limbs of the duodenum in adult Kestrel ((Simsek et al., 2008; Hamdi et al., 2013; Al-Haaik, 2018) and in geese (Beheiry et al., 2018). Another study observed that the owl pancreas has four lobes in Japanese quail (*coturnix japonica*) (Simsek et al.,

2008) and in geese (Beheiry et al., 2018), which disagree with Khalid et al. (2010) in red jungle (gallus gallus), in pigeon (Faris ,2012), and in golden eagle (Mohamed, 2012). In partridge, it has three lobes and it is different from white-eared bulbul has two lobes (Al-Khakaniet et al., 2019). The owl pancreatic duct has three branches and it was proposed that pancreas secretion is drained in ascending duodenum this result finding in red jungle fowl (Kadhim et al., 2010) this result disagreed with those in turkey bird (*Meleagris gallopavo*) which has two pancreatic ducts opened into ascending loop of the duodenum near to the two biliary ducts; whereas, the two bile ducts were drained near the pancreatic ducts into the duodenum (Naser &Khaleel, 2020). Similar observations were reported in pied crow (*Coryus albus*) by Igwebuik and Eze (2010) and in guinea fowls by Zaghair and Khaleel (2019).

In the current study, it has been observed that pancreas was covered by thin capsule of connective tissue. This finding in Japanese quail (*coturnix japonica*) (Simsek et al.,2008) in duck (*Ansa platyrhuchos* Mallard) (Al-shaeli ,2010); in pigeon (Faris ,2012; Mobini ,2013). And disagreement in the common gull has a thick capsule that lacks septa (Hamdi et al.,2013). The stroma of each lobe in the owl pancreas consists of exocrine and endocrine portions. The exocrine part is composed of many acini that drain into a high duct system, each acinus made up of pyramid cells, these cells release the secretion in intercalated duct. This agreed with what was reported in chicken (Mutoh et al., 1997), in columbidae (AL-Hathry, 2006), and in local partridge (*Francolinus francolinus*) (Alkhazraji & Naser, 2024), and in white-eared bulbul (Al-Khakaniet et al., 2019). The excretory ducts that show pale-stained centroacinar cells that drained in intercalated ducts, resulting in findings in most avian species, such as ducks (Al-shaei, 2010; Japanese quails (Simeek et al.,2008). The digestive enzyme that drains into intercalated ducts for the digestion of the carbohydrate portion and fat, and is different from Guinea fowl and is absent from the center of acinias (Hamdi et al., 2013). And in the study, Islet Langerhans in an owl pancreas composed of Alpha islet and Beta islet, this resulted in acceptable in local partridge (*Francolinus francolinus*) and disagreement in the ducks (Al-Shaeli,2020; Alkhazraji & Naser,2024).

Conclusions:

The wild owl displays unique anatomical and histological features in its liver and pancreas, reflecting its ecological and nutritional adaptations. These findings provide a primary scientific reference that will enrich comparative studies among birds, particularly among predatory species (carnivorous).

Recommendations:

It is recommended to conduct comparative study of liver and pancreas with another bird species that is nourished on plants using histochemical study to distinguish the fibers in livers and the hepatocytes.

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Conflict of Interest: The authors declare no conflicts of interest.

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Authors Contributions: This research was conducted entirely by the authors, who were responsible for study design, data collection, data analysis, and writing of the draft and final versions of this manuscript.

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