



## Macroscopic and histomorphometry investigation of pancreas in adult local partridge (*Francolinus francolinus*)

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### Abstract

The histological, histomorphometrical, and macroscopical properties of the pancreas in local partridge (*Francolinus francolinus*) were the objectives of this study. Twelve adult partridges were purchased from the market of Baquba city. The gland was examined in situ macroscopically, and multiple sections of pancreatic tissue underwent microscopic analysis after preparation and staining with different stains. Macroscopic findings of the partridge pancreas determined the presence of the gland between the ascending part and descending part of the duodenum arms, and it consists of four lobes, which were ventral, splenic, third, and dorsal lobes. Three pancreatic ducts were detected. Histologically, it was noted that a thin capsule of connective tissue was surrounding the partridge's pancreas, and many septa were sent to the parenchyma, forming several lobules. The average thickness of the capsule was  $12.54 \pm 0.65 \mu\text{m}$ . Two portions were identified within the gland's parenchyma: the endocrine and exocrine portions. The endocrine part occupies a smaller area in the gland when compared with an exocrine one. Islets of Langerhans in various sizes and forms were observed, which represented the endocrine part. Cells of beta, alpha, and delta were located in those islets. The mean diameter of islets was  $70.51 \pm 4.75$ ,  $65.75 \pm 4.1$ ,  $53.65 \pm 3.85$ , and  $45.22 \pm 3.20 \mu\text{m}$  in different lobes, respectively. The exocrine contained cells are arranged in acini, associated with the ductal system. In conclusion, the present research gives a window for histomorphometry and anatomical properties of the pancreas in local partridge. Nevertheless, more examinations as immunohistochemical and ultrastructure should be conducted on partridge's pancreas in future investigations.

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### Introduction

The Iraqi black partridge (*Francolinus francolinus*) is a granivore in feed and belongs to the order Galliformes and the family Phasianidae (1). In vertebrates, there are two generally defined regions in the pancreas. The area responsible for releasing somatostatin, glucagon, and insulin hormones represents the endocrine part, while the area that secretes enzymes to the gastrointestinal tract represents the exocrine region (2). In birds, the pancreas is situated between the limbs of the duodenum, the descending and ascending (3). This avian gland is often lobulated, which contains just ventral and dorsal lobes in some species (4,5) or more than

two lobes, as reported in another bird (6). Compared to those in vertebrates, the parenchyma of the bird pancreas comprises endocrine and exocrine parts that differ in their structures and size (7). Besides, two kinds of islets were detected in the endocrine area, including islets of beta and islets of alpha, which differ in their cells and function in early hatched geese (8). The third type of islets, called mixed, was located in chickens in addition to the other two types, and those three islets were found more often in the third and splenic lobe and rarely determined in the lobes of the dorsal and ventral one (9). Moreover, the necessary electrolytes and enzymes secreted from the exocrine mass that play an essential role in the digestive system and the hormones of

endocrine islets that regulate blood sugar levels were observed in long-legged buzzards (10). The exocrine region units that include acini of secretory cells and the ductal system were investigated in red jungle fowl and goose (6,11).

Because of the paucity of data about the pancreatic structures of partridges, especially histomorphometry and morphology, the current study was undertaken to describe those structures in the pancreas of Iraqi black Partridge macro and microscopically.

## Materials and methods

### Animals

Twelve adult local partridges were used in the current experiment regardless of sex. The local market in the city of Baquba was the source of the experimental birds.

### Experimental design

Six birds were separated for macroscopic examination, and the remaining six were subjected to microscopic investigation. The birds, after being anesthetized with 25 mg/kg of ketamine, intramuscular injection (12-16), were slaughtered, and a line of incision in the ventral side of the abdomen was performed to view the viscera and to detect the pancreas attachments, situation, and its shape. The pancreas and its ducts were removed and washed with saline solution. Then, all macroscopic studies were conducted. A buffered 10% neutral formalin was used to fix the gland for 48 hours. A routine process was employed for fixed specimens, and by using a rotary microtome, a 5 µm thickness of series sections was obtained, which were then stained with routine and special stains (H&E, Gomori, and Masson's trichrome stain) (17-23). All microscopic examinations were conducted using a light microscope and the findings were recorded. Diameters of various kinds of ducts, islets, and capsule thickness were the microscopic parameters. A digital camera (image scope 9) with image processing software was used to accomplish the microscopic measurements (24). All data were analyzed statistically by using the software of SPSS.

### Ethical approve

The scientific ethical committee in the College of Veterinary Medicine, University of Diyala was approved this study in ethical number VM.212.January2022.K&R, dated on 13/1/2022.

## Results

### Morphological outcomes

The macroscopic examination in the current work showed that the pancreas in the local partridge was a lobulated gland, pale pinkish, and found between ascending and descending parts of the duodenal limbs. It appeared ribbon-shaped, fixed in position with a ligament of pancreatic-duodenum. The gland is formed from four lobes: the ventral, splenic, dorsal, and third (Figure 1). The last one

(third) is considered a crossing segment between the dorsal and ventral portions of the pancreas. It was seen that the lobes of this organ filled the space between duodenal limbs. The lobes of the pancreas were connected with duodenal loops through 3 pancreatic ducts (Figure 2).



Figure 1: Photograph of gross morphology of pancreas in local partridge shows the lobes of the pancreas: third lobe (black arrow), dorsal lobe (DL), ventral lobe (VL), splenic lobe (SL), which found between the ascending limb of the duodenum (AD) and descending limb (DD).

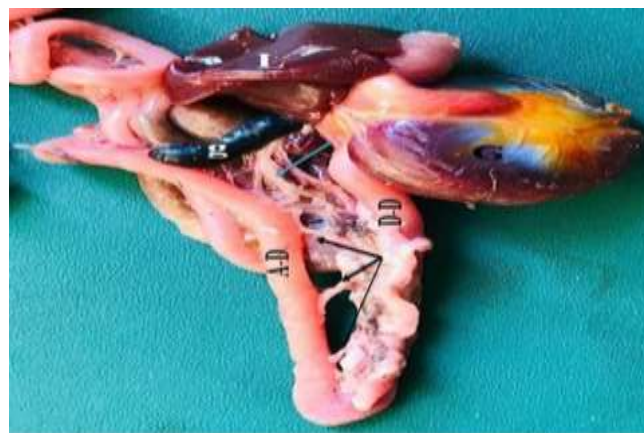


Figure 2: Photograph of gross morphology of pancreas in local partridge shows three ducts from the pancreas (black arrow), in addition to ascending limb (AD) and descending limb (DD) of the duodenum.

### Histological outcomes

Microscopic examination showed that the partridge's pancreas was surrounded by a capsule, which formed from cells of mesothelium resting on thin connective tissue. The average thickness of the capsule was  $12.54 \pm 0.65$  µm (Table 1). Several septa emerged from this capsule and directed toward the parenchyma to divide the pancreas into several lobules. The thin connective tissue septum often contained the excretory duct, nerves, lymph, and blood vessels (Figure

3). A basic structure of pancreatic parenchyma in partridge was the exocrine units (serous acini) (Figure 4). Specifically, cells with a pyramidal shape, contain acidic granules and a spherical nucleus found at the basis of serous acini. In addition, the cavity of those acini contained small cells called the centroacinar, which counts as a primary passage to the duct system. When liberated from the acini, the secretory materials could pass through the centroacinar to a series of ducts to reach the duodenum. The duct system comprised intralobular (intercalated), interlobular, and terminated by the main duct (Figure 5). The epithelial lining of those ducts was low cuboidal to flatted in the intercalated type, then converted gradually into simple cuboidal to columnar within the interlobular and main duct, respectively. The mean diameters of those ducts recorded  $605.40 \pm 15.38$ ,  $130.92 \pm 7.43$ , and  $83.84 \pm 4.63 \mu\text{m}$  in the main, interlobular, and intralobular ducts, respectively (Table 1). Significant differences in diameter were observed among various types of pancreatic ducts in partridge. Another composition, which was the least amount in the partridge pancreatic parenchyma, was the endocrine portion (Figures 3 and 4). The islets of Langerhans represent this part, which was scattered among the units of the glandular basic structure (Figure 3) and appeared in different shapes and sizes.

Table 1: Microscopic parameters of the pancreas in Iraqi black partridge

Parameter	Mean $\pm$ SE ( $\mu\text{m}$ )
Thickness of capsule	$12.54 \pm 0.65$
The diameter of main duct	$605.40 \pm 15.38^*$
Diameter of interlobular duct	$130.92 \pm 7.43^*$
Diameter of intralobular duct	$83.84 \pm 4.63^*$

\*Indicate significant difference ( $P < 0.05$ ) among types of pancreatic ducts.

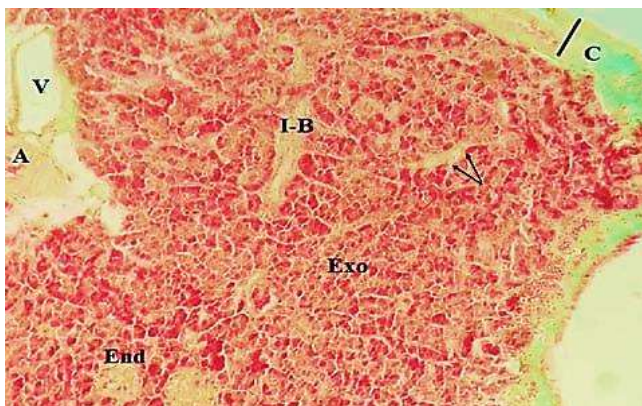


Figure 3: Microphotograph of the pancreas in local partridge shows the capsule (C), a portion of exocrine (Exo), a portion of endocrine (End), intralobular duct (black arrow), interlobular duct (I-B), artery (A), Vein (V): Masson's Trichrome, 100 X.

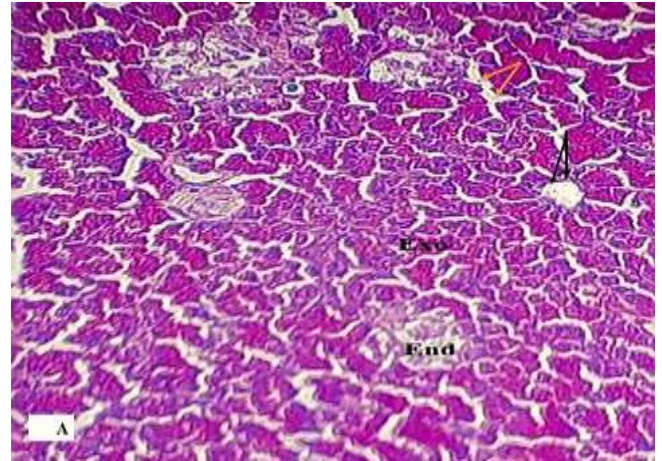


Figure 4: Microphotograph of the pancreas in local partridge shows exocrine (Exo), endocrine (End), intralobular (brown arrow), interlobar duct (black arrow), H&E, 100 X.

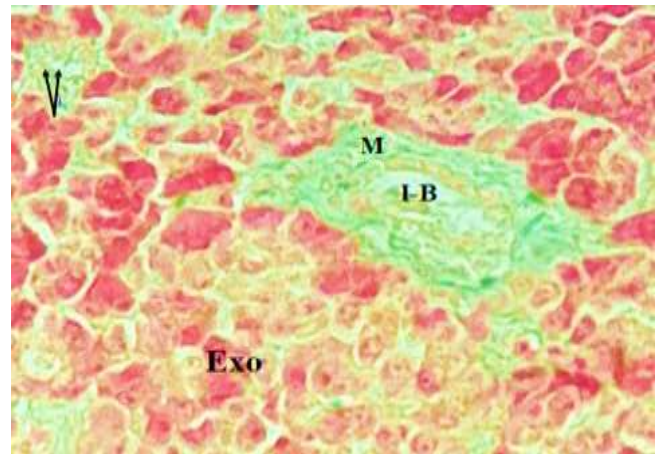


Figure 5: Microphotograph of pancreas in local partridge shows exocrine (Exo), intralobular duct (black arrow), and interlobular duct (IB) lined with epithelium resting on connective tissue (M): Masson's Trichrome stain, 200 X.

Three types of cells were detected in those islets, including beta, alpha, and delta cells (Figure 6). The most abundant cell in the islet was beta, distinguished by its small size and its nucleus large and dark with acidophilic cytoplasm. It was shown that the alpha cells presented in the least number, more significant than beta, and have nuclei as small pale (basophilic cells). The cells appeared irregular in shape with a large nucleus named delta. The diameters of Langerhans islets were recorded as a mean of  $70.51 \pm 4.75$ ,  $65.75 \pm 4.1$ ,  $53.65 \pm 3.85$ , and  $45.22 \pm 3.20 \mu\text{m}$  in the splenic, third, dorsal, and ventral lobes respectively (Table 2). Based on these measurements, a significant variation was detected in islet diameters among different pancreatic lobes.

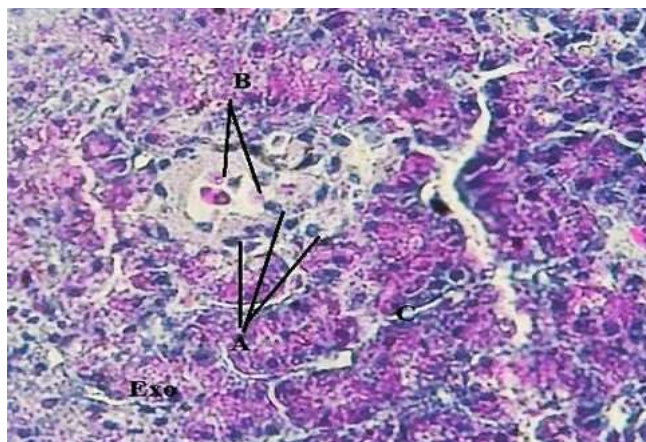


Figure 6: Microphotograph of the pancreas in local partridge shows Langerhans islet in which beta cells (B) and alpha cells (A), in addition to exocrine part (Exo), intercalated (C) ducts. Gomori stain, X400.

Table 2: A mean diameter of pancreatic islets in different lobes of the pancreas in Iraqi black partridge

Pancreatic lobe	Diameter of Langerhans islets ( $\mu\text{m}$ )
Ventral	45.22 $\pm$ 3.20*
Dorsal	53.65 $\pm$ 3.85*
Third	65.75 $\pm$ 4.1*
Splenic	70.51 $\pm$ 4.75*

\*Indicate significant difference in ( $P < 0.05$ ) among types of pancreatic Langerhans islets in different lobes.

## Discussion

In the current experiment, the pancreas of the Iraqi black partridge appeared as a lobulated gland comprising four lobes: splenic, third, ventral, and dorsal. These results are consistent with a report of Kadhim *et al.* (6), who showed that the pancreas of red jungle fowl has four lobes, and with observations of Al-Sharoot (8) in the geese (*Anser anser*), but they do not correspond with those demonstrated in the native duck's study Mahmood *et al.* (25) and mynah's (*Acridotheres tristis*) pancreas (26). On the other hand, in our work, the gap between two duodenal arms was occupied with pancreatic lobes. These findings disagree with previous research of Beheiry *et al.* (27) in goose and in golden eagle (8) but were in line with the investigation of Kadhim *et al.* (6) in jungle fowl. It was found that the connective tissue of the pancreatic capsule in the current study was thin and sent septa to split the parenchyma into lobules. These observations are unlike the description of the thick capsule by Mobini and Aghaabedi (28) in turkeys, but they follow the findings of Mobini (11) in geese.

Microscopic inspection of the partridge's pancreas showed that two parts make up this gland: endocrine and exocrine areas. The serous acini are the main components of

the primary exocrine segment, while Langerhans islets are distributed among the glandular regions and represent the part of endocrine, these results are in line in pigeon (29) and in Kestrel (3). Our study revealed that the tubule-acinar gland in partridge's pancreas has pyramidal cells called centroacinar in the center cells. These findings are similar to reports of Tarakci *et al.* (2) in Ostrich (*Struthio camelus*). It detected a set of ducts in the partridge, including intercalated, intralobular, and main duct. The epithelial lining of those ducts was low cuboidal to flattened in the intercalated type, then converted gradually into simple cuboidal to columnar within the interlobular and main duct, respectively. These results agree with numerous previous investigations in ducks (30), in golden eagles (5), and in jungle fowl pancreas (6).

The least amount in the partridge pancreatic parenchyma is the endocrine portion. The islets of Langerhans represent this part, which was scattered among the units of the basic structure and appeared in different shapes and sizes. Three types of cells were detected in those islets, including delta, alpha, and beta. These findings align with a description of Palmieri and Shivaprasad (31) in raptor bird's pancreas and in jungle fowl (6), who mentioned that the pancreatic islets in their studies contained three cell that led to different island types. The beta and alpha islets contained delta cells in mynah's pancreas (*Acridotheres tristis*) (26). On the contrary, the researcher Mobini (32) noticed that the pancreas in pigeons lacked mixed islets, while the small and large islets represented beta and alpha islets, respectively. The previous study conducted by Helmy and Soliman (33) showed the presence of mixed islets and alpha and beta islets in the pancreas of ostriches (*Struthio camelus*).

## Conclusions

The present research gave a window on the histomorphometry and gross anatomy of the pancreas in local partridge and showed significant differences in the diameter of islets of Langerhans in various pancreatic lobes and pancreatic ducts measurements. Nevertheless, future investigations should conduct more examinations such as immunohistochemical and ultrastructure on partridge pancreas.

## Acknowledgments

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## Conflict of interest

The authors declare no quarrel of interest.

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عشر، وكانت مكونة من أربعة فصوص وهي الفص البطني والطحالي والثالث والظهري. وتم الكشف عن وجود ثلاثة قنوات بنكرياسية. نسيجياً، لوحظ أن بنكرياس الحجل محاط بمحفظة رقيقة من النسيج الضام، وامتدت العديد من الحويصلات من المحفظة الى المتن مكونة فصيصات متعددة. بلغ متوسط سمك المحفظة  $12,5 \pm 0,65$  مايكرومتر. متن الغدة تكون من جزئين وهي منطقتي الجزء الصماوي وجزء الإفراز الخارجي. شغل الجزء الصماوي مساحة اقل بالغدة عند مقارنته بمنطقة الإفراز الخارجي. ولوحظ أن جزر لانجرهانز والتي مثلت الجزء الصماوي تكون بأحجام وأشكال مختلفة. وجدت ثلاثة أنواع من الخلايا الصماوية في الجزر وهي خلايا بيتا والفا ودلتا. بلغ متوسط قطر جزر لانجرهانز  $3,85 \pm 0,65$ ،  $4,1 \pm 0,75$ ،  $4,75 \pm 0,51$  مايكرومتر في مختلف فصوص البنكرياس. احتوت منطقة الإفراز الخارجي على خلايا مرتبة بشكل وحدات إفرازية. ختاماً، نستنتج أن العمل الحالي اعطى نافذة على الصفات النسيجية الشكلية القياسية والتشريحية لبنكرياس الحجل المحلي، ومع ذلك ينبغي إجراء المزيد من الفحوصات كالمناعة النسيجية الكيميائية والتركييب الدقيق على بنكرياس الحجل في الدراسات المستقبلية.

## الفحص العياني والشكلي النسيجي القياسي للبنكرياس في الحجل المحلي البالغ

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### الخلاصة

هدفت الدراسة الى التحري عن الصفات النسيجية والنسيجية الشكلية القياسية والعيانية للبنكرياس في الحجل المحلي. تم استخدام اثني عشر طائر حجل بالغ من سوق مدينة بعقوبة. وفحصت الغدة عياناً في موقعها، وخضعت مقاطع متعددة من نسيج البنكرياس للفحص المجهرى بعد أعدادها وصبغها بصبغات مختلفة. النتائج العيانية لبنكرياس الحجل، حددت وجود الغدة بين الجزء الصاعد والجزء النازل من ذراعي الاثني