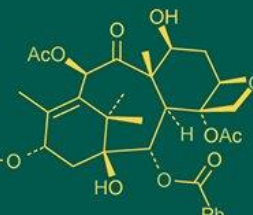
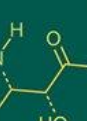
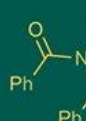


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; 10(7): 594-598
www.biochemjournal.com
Received: 16-05-2026
Accepted: 22-06-2026

Anil Kumar Safi
Department of Veterinary
Anatomy, Bihar Animal
Sciences University, Patna,
Bihar, India

Manoj Kumar Sinha
Department of Veterinary
Anatomy, Bihar Veterinary
College, Bihar Animal Sciences
University, Patna, Bihar,
India

Avnish Kumar Gautam
Department of Veterinary
Anatomy, Bihar Animal
Sciences University, Patna,
Bihar, India

Sanjay Kumar Bharti
Department of Veterinary
Anatomy, Bihar Animal
Sciences University, Patna,
Bihar, India

Sudhanshu Kumar
Department of Veterinary
Medicine, Bihar Animal
Sciences University, Patna,
Bihar, India

Corresponding Author:
Manoj Kumar Sinha
Department of Veterinary
Anatomy, Bihar Veterinary
College, Bihar Animal Sciences
University, Patna, Bihar,
India

Age-dependent microstructural and histochemical alterations in the pancreas of duck after hatching

Anil Kumar Safi, Manoj Kumar Sinha, Avnish Kumar Gautam, Sanjay Kumar Bharti and Sudhanshu Kumar

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i7h.9091>

Abstract

A total of forty ducks were procured from a certified duck farm and divided into four age-based groups, with ten birds in each group: post-hatched (Group I), one month (Group II), three months (Group III) and six months (Group IV). Histological examination revealed that the dorsal, ventral and splenic lobes of the pancreas exhibited a similar structural organization across all age groups. In all groups, the pancreatic parenchyma contained a relatively large proportion of exocrine tissue in which small distinct arrangements of islets were found. The sections stained with Hematoxylin and Eosin demonstrated that the exocrine component were made up of serous tubuloacinar glands with spherical to ovoid shapes whose epithelium layer was made up of a single layer of columnar to pyramidal cells. The nuclei of acinar cells were revealed to be spherical and oval in shape. In the pancreas of every experimental duck, darkly pigmented oval or spherical centroacinar cells were also observed in the lumen of acini. In all age groups of birds, fine strands of connective tissue were frequently seen surrounding the acinar units and appeared between the acini. The sections stained with Weigert's elastic stain, Van Gieson's stain and Masson's Trichrome revealed that the interacinar connective tissue strands and connective tissue septa were made of collagen and scanty of elastic fibres. The Periodic Acid-Schiff (PAS) staining showed mild to moderate reaction in pancreatic acini suggesting the existence of a small quantity of neutral mucopolysaccharides.

Keywords: Ducks, exocrine, pancreas, histochemistry

Introduction

Ducks (family Anatidae) represent a diverse group of waterfowl with a cosmopolitan distribution, thriving in varied ecological niches from wetlands to agricultural landscapes worldwide (del Hoyo *et al.*, 1992) [7]. The pancreas, a composite glandular organ strategically positioned in the limbs of the duodenum, is crucial to duck digestion, combining both exocrine and endocrine functions required for metabolic equilibrium (King & McLelland, 1984) [12]. The exocrine pancreas, made up of acinar cells and ductal systems, secretes a bicarbonate-rich pancreatic juice that neutralizes acidic chyme from the stomach entering the duodenum. This juice contains high concentrations of sodium bicarbonate (NaHCO_3) and digestive enzymes like amylase, lipase and proteases (Solomon, 2006; Rawles, 2015) [25, 21]. Duck pancreases undergo many alterations after hatching. Acinar tissue expands rapidly, zymogen granules mature and several kinds of endocrine cells arise. These changes occur as the ducks' diets shift from yolk sac reserves to solid food. These ontogenetic changes are pivotal for establishing digestive efficiency, yet even subtle histological variations such as alterations in lobular architecture, ductal proliferation, or endocrine cell distribution can impair exocrine secretion or endocrine signaling, leading to growth stunting, maldigestion, or metabolic disorders (Nitsan *et al.*, 1991) [20]. This paucity of knowledge hampers targeted interventions in duck health and production. Therefore, the present study aims to elucidate the microscopic architecture, histological organization and histochemical profile of the pancreatic lobes in post-hatched ducks, across key developmental stages.

Materials and Methods

The present investigation was conducted on pancreatic samples collected from forty ducks of both sexes, procured from a registered duck farm. The birds were divided into four age-based groups, with ten ducks in each group.

Group I comprised newly hatched ducklings, Group II included ducks aged one month, Group III consisted of ducks aged three months and Group IV comprised ducks aged six months. Immediately after collection, the pancreas along with its respective lobes (dorsal, ventral and splenic) was carefully excised, washed thoroughly in normal saline to remove blood and debris and fixed in 10% buffered neutral formalin for histological examination. After adequate fixation, tissue samples from each lobe were processed routinely through paraffin embedding. Serial sections of appropriate thickness were cut and stained with Haematoxylin and Eosin (H&E) for general histoarchitecture. In addition, special staining techniques were employed to demonstrate specific tissue components, including Van Gieson's stain, Gomori's stain, Weigert's elastic stain (Luna, 1968) ^[13], Maldonado's stain (Maldonado and Jose, 1967) ^[17], Johnson's stain, Masson's trichrome stain (Bancroft and Stevens, 1996) ^[4] and Periodic Acid-Schiff (PAS) stain (Singh and Sulochana, 1997) ^[23]. Micrometric measurements were performed wherever necessary using an ocular micrometer.

Results

In the present investigation, the pancreas of ducks in all experimental groups exhibited a well-organized parenchyma composed of both exocrine and endocrine components (Fig 1-2). The pancreatic lobes were distinctly demarcated by delicate connective tissue septa, which subdivided the gland into numerous lobules of variable sizes. Within the parenchyma, the exocrine portion constituted the predominant component, occupying the major volume of the glandular tissue. In contrast, the endocrine portion was comparatively sparse and appeared in the form of small, clearly defined islets scattered irregularly among the exocrine acini (Fig 3). These islets were separated from surrounding acinar tissue by a thin connective tissue boundary and were more lightly stained than the surrounding exocrine tissue.

Histological sections stained with Hematoxylin and Eosin revealed that the exocrine pancreas in all age groups consisted of serous tubuloacinar glands. The acini were predominantly spherical to ovoid in outline and closely packed with minimal interacinar space. Each acinus was lined by a single layer of tall columnar to pyramidal epithelial cells (Fig 4). The cytoplasm of these cells exhibited basophilia in the basal region and eosinophilia in the apical region, indicating the presence of abundant rough endoplasmic reticulum basally and zymogen granules apically.

In the experiment it was found that the nuclei of acinar cells mainly found towards the basal portion of the cells and appears in the form of spherical to oval in shape (Fig 4). The nuclear chromatin appeared moderately condensed with a distinct nucleolus in many cells. These acinar cells formed the major cellular population within the pancreas of the experimental ducks. Distinct centroacinar cells were also observed within the lumen of the acini in all examined samples (Fig 5). These cells appeared as darkly stained oval to spherical cells projecting into the acinar lumen and represented the initial portion of the intercalated ducts.

In all age groups, delicate strands of connective tissue were frequently observed surrounding individual acinar units and also extending between adjacent acini, thereby forming a supportive stromal framework. Special staining methods

further clarified the nature of this connective tissue. Sections stained with Weigert's elastic stain, Van Gieson's stain and Masson's Trichrome stain demonstrated that the interacinar connective tissue strands and septa were composed predominantly of collagen fibers with only scanty elastic fibers (Fig 6-7). In the experiment of all pancreas of ducks, the collagen fibers were found to be dense and arranged regularly mainly towards the interlobular septa. On other hand the elastic fibers were found to be sparse and discontinuous.

Overall, the pancreatic architecture remained constant throughout all experimental age groups, displaying typical avian pancreatic structure defined by a strong exocrine component, distributed endocrine islets, serous acinar layout and a collagen-rich supporting stroma.

Histochemistry

In the current study it was found that the Periodic Acid-Schiff (PAS) stained tissues showed mild to moderate reaction in pancreatic acini in all experimental duck that suggesting the existence of a small quantity of neutral mucopolysaccharides (Fig 8).

Discussion

In the current study it was found that parenchyma of all experimental ducks were composed of exocrine and endocrine tissue in which exocrine tissue was mostly composed of serous tubuloacinar arranged somewhat concentrically around the islets of Langerhans and considered as major portion of parenchyma. Similar observation was also made by Das *et al.* (2003) ^[8] in ducks, Mobini (2011) ^[18] in geese, Faris (2012) ^[9] and Mobini (2013) ^[19] in pigeons, Hamodi *et al.* (2013) ^[10] in common gulls and guinea fowls, Basir and Abdi (2015) ^[5] in caspian gulls, Al-Sharoot (2016) ^[3] in early-hatched geese, Kadhim *et al.* (2010) ^[11] in red jungle fowls and Al-Agele and Mohammed (2012) ^[1] in golden eagles. In contrast Madhavi *et al.* (2000) ^[14] domestic duck (*Anas boschas domesticlls*) found tubuloalveolar acini around the islets.

The nuclei of acinar cells were revealed to be spherical and oval in shape and were found close to the basal region of acinar cells darkly pigmented oval or spherical centroacinar cells were also observed in the lumen of acini. Similar results on the location and appearance of acinar cells may be found in adult ducks by Das *et al.* (2003) ^[8], in domestic ducks by Madhavi *et al.* (2000) ^[14] and in chabro chickens by Yadav *et al.* (2018) ^[26]. Yadav *et al.* (2018) ^[26] in chabro chickens observed elongated or spherical tiny centroacinar cells, while Madhavi *et al.* (2000) ^[14] in domestic duck observed elongated centroacinar cells. In contrast centroacinar cell were absent in the result of Saadatfar *et al.* (2009) ^[22] in Mynah (*Acridotheres tristis*), Basir and Abdi (2015) ^[5] in Caspian Gull and Mahdi *et al.* (2023) ^[15] in Guinea fowl (*Numida meleagris*).

Fine strands of connective tissue were frequently seen surrounding the acinar units and appeared between the acini which were mostly composed of collagen and scanty of elastic fibres in all experimental ducks. According to Beheiry *et al.* (2018) ^[6] in geese and Mobini (2013) ^[19] in pigeons, connective tissue fibers were found between interacinar gaps and septa separated the pancreas into lobes and lobules, which is consistent with the findings of the current study on connective tissue septa. Septa separated the gland into lobules and continued to spread across acinar

cells, according to Agele and Mohammed (2012) ^[1] in Golden Eagle. Similar results were found in red jungle fowl by Khadim *et al.* (2010) ^[11] and in geese by Al-Sharoot (2016) ^[3]. According to Sivakumar *et al.* (2000) ^[24], acinar units and smaller ducts are connected to small connective tissue strands. Mobini (2011) ^[18] reported that collagen and reticular fibres were found in both the interlobular and interacinar connective tissue of the goose pancreas, which was consistent with the results of the current study concerning the components of connective tissue septa.

The exocrine parenchyma of pancrease showed a small quantity of neutral mucopolysaccharides which were in accordance with Al-Khakani *et al.* (2019) ^[2] in white-eared bulbuls and Mahmood *et al.* (2022) ^[16] in native ducks for pancreatic acini.

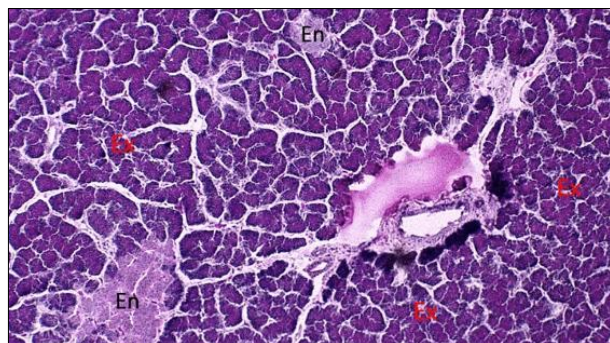


Fig 1: Photomicrograph showing endocrine (En) and exocrine (Ex) portion of pancreas of group II. (Gomori's method 100X)

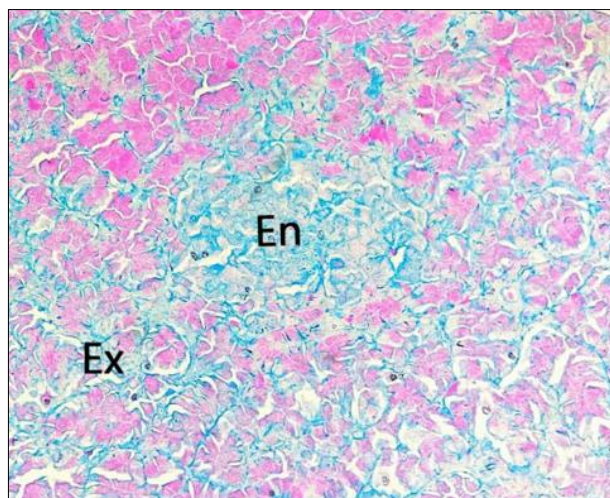


Fig 2: Photomicrograph showing endocrine (En) and exocrine (Ex) portion of pancreas of group IV. (Maldonado's method 100X)

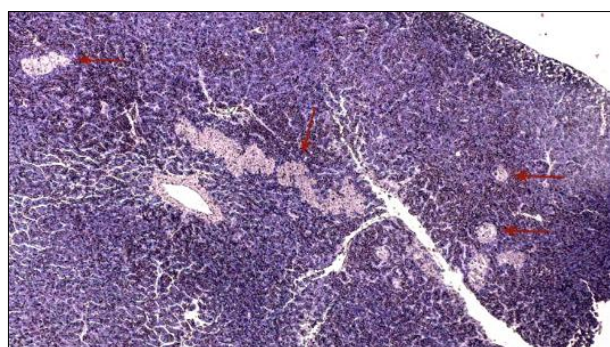


Fig 3: Photomicrograph showing endocrine portion (arrow) dispersed in exocrine portion of pancreas of group IV in ducks. (Toluidine Blue 100X)

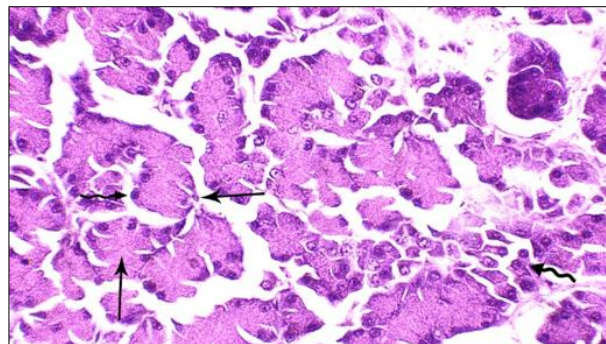


Fig 4: Photomicrograph showing columnar acinar cells (arrow) and spherical to oval shaped nuclei (zigzag arrow) at base of acinar cells of exocrine portion of pancreas in group II of ducks. (Hematoxylin & Eosin 400X)

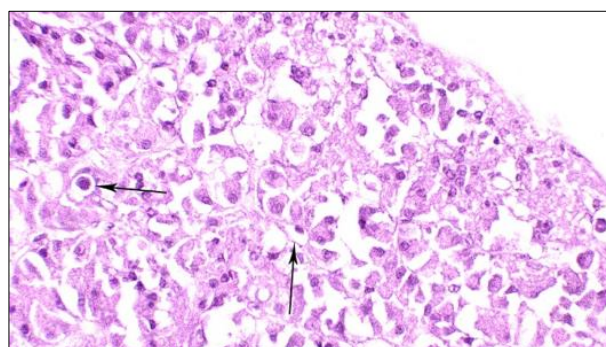


Fig 5: Photomicrograph showing centroacinar cells (arrow) of pancreas in ducks. (Hematoxylin & Eosin 400X)

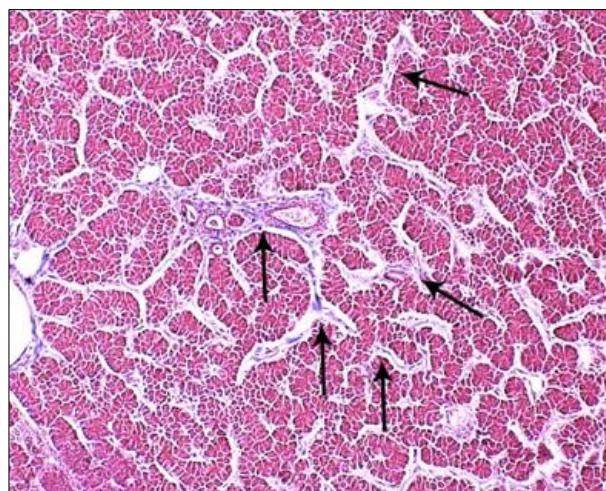


Fig 6: Photomicrograph showing the collagen fiber (arrow) around acinar cells of pancreas. (Masson's Trichrome method 100X)

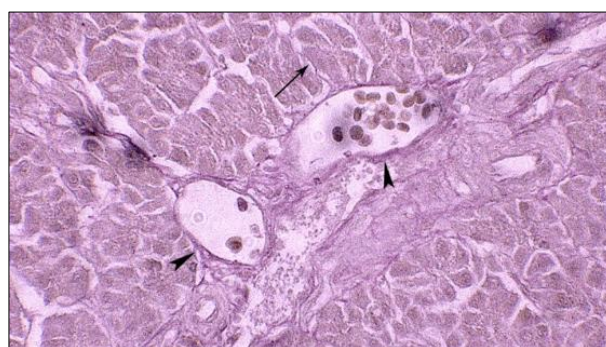


Fig 7: Photomicrograph showing the elastic fiber around acinar cells (arrow) and blood capillary (arrow head) of pancreas. (Weigert's elastic method 400X)

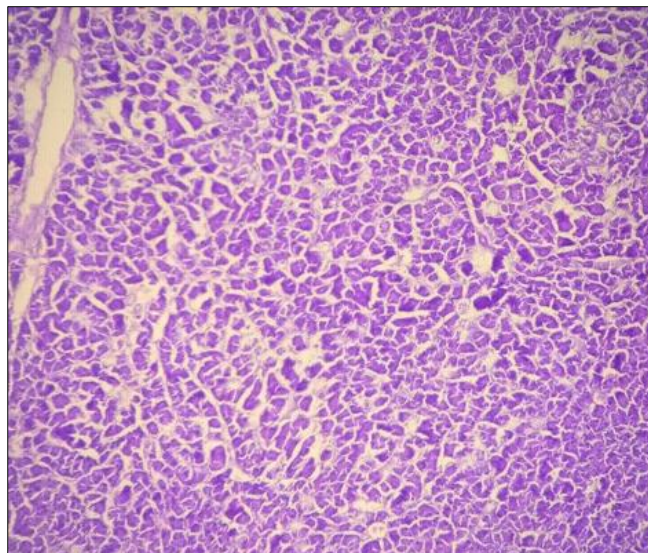


Fig 8: Photomicrograph showing mild to moderate PAS activity in the exocrine portion of pancreas. (PAS 100X)

Conclusion

The exocrine portion made up the majority of the parenchyma under which discrete units of endocrine portion can be identified. Serous tubuloacinar glands with spherical to ovoid forms comprised the exocrine parts. It was made up of a single layer of pyramidal to columnar cells. Acinar cell nuclei were found to be oval and spherical in form. These cells were mostly located around the basal part of acinar cells in the experimental ducks' pancreas. The lumen of acini also included oval or round centroacinar cells with dark pigmentation. In between the acini and around the acinar units, fine strands of connective tissue were commonly seen. Periodic acid-Schiff (PAS) staining showed mild to moderate reaction in pancreatic acini in all experimental duck that suggesting the existence of a small quantity of neutral mucopolysaccharides.

Conflict of Interest

All authors declare that there were no conflicts of interest regarding the publication of this manuscript.

Author's Contribution

All authors were involved in the conception and design of the study. Material preparation, data collection, and analysis were carried out by Dr. Anil Kumar Safi, Dr. Manoj Kumar Sinha, Dr. Avnish Kumar Gautam, and Dr. Sudhanshu Kumar. The initial draft of the manuscript was prepared by Dr. Anil Kumar Safi, and all authors reviewed and provided feedback on earlier versions. All authors read and approved the final version of the manuscript.

Ethical Approval

For the proposed experiment, ethical approval was taken from the Institutional Animal Ethics Committee, Faculty of Bihar Veterinary College, BASU Patna. Via protocol No. IAEC/BVC/2024/04.

Acknowledgment

The authors are grateful to Sanghars Farm and Hatchery, Bihar for providing ducks for the research work. we also thanks to Department of Veterinary Physiology and Biochemistry for time to time support.

Reference

1. Al-Agele RAA, Mohammed FS. Architecture Morphology and Histological Investigations of Pancreas in Golden Eagles (*Aquila chrysaetos*). Al-Anbar Journal of Veterinary Science. 2012;5(2):149-155.
2. Al-Khakani SSA, Zabiba IMJ, Al-zubaidi KH, Al-alwany EAH. Morphometrical and histochemical foundation of pancreas and ductal system in white-eared bulbul (*Pycnonotus leucotis*). Iraqi Journal of Veterinary Sciences. 2019;33(1):99-104.
3. Al-Sharoot HA. Anatomical, histological and histochemical architecture of pancreases in early hatched goose (*Anser anser*). Kufa Journal of Veterinary Medical Sciences. 2016;7(1):147-153.
4. Bancroft JD, Stevens A. Theory and Practice of Histological Techniques. New York: Churchill Livingstone; 1996.
5. Basir Z, Abdi R. Histomorphometric studies of pancreas in Caspian gull. Cibtech Journal of Zoology. 2015;4(3):83-87.
6. Beheiry RR, Abdel-Raheem WAA, Balah AM, Salem HF, Karkit MW. Morphological, histological and ultrastructural studies on the exocrine pancreas of goose. Beni-Suef University Journal of Basic and Applied Sciences. 2018;7(3):353-358.
7. Del Hoyo J, Elliott A, Sargatal J. Handbook of the Birds of the World. Vol. 1, Ostrich to Ducks. Barcelona: Lynx Edicions; 1992.
8. Das A, Das RK, Parida S, Mishra UK, Solank D. Histomorphological study on pancreas of duck (*Anas boschas*). Indian Journal of Animal Sciences. 2003;73:598-599.
9. Faris SA. Anatomical and Histological study of the Pancreas of Pigeon. Journal of College of Education. 2012;2(4):64-72.
10. Hamodi HM, Abed AA, Ameer MT. Comparative anatomical, histological and histochemical study of the pancreas in two species of birds. Research and Reviews in BioSciences. 2013;8(1):26-34.
11. Kadhim KK, Zuki ABZ, Noordin MM, Babjee SMA, Zamri-Saad M. Morphological study of pancreatic duct in red jungle fowl. African Journal of Biotechnology. 2010;9(42):7209-7215.
12. King AS, McLelland J. Birds: Their Structure and Function. 2nd ed. London: Baillière Tindall; 1984.
13. Luna LG. Manual of histological staining methods of Armed Forces Institute of Pathology. 3rd ed. New York: McGraw-Hill Book Company; 1968.
14. Madhavi G, Rao TSC, Kumar PD, Nagmalleswari Y, Sreenu M. Histological studies on the exocrine portion of pancreas of the domestic duck (*Anas boschas domesticus*). Indian Journal of Animal Sciences. 2000;70(2):126-128.
15. Mahdi RT, Bargooth AF. Histological Study of Exocrine Portion of Pancreas in Guinea fowl (*Numida meleagris*). Wasit Journal for Pure Sciences. 2023;2(3):235-247.
16. Mahmood SK, Ahmed NS, Sultan GA, Yousif MJ. Histomorphological and carbohydrate histochemical study of the pancreas in native ducks (*Anas platyrhynchos*). Iraqi Journal of Veterinary Sciences. 2022;36(4):1103-1110.

17. Maldonoda R, Jose HS. A phloxin-azure-hematoxylin sequence for differential staining of cells in pancreatic islets. *Stain Technology*. 1967;42(1):11-13.
18. Mobini B. Histological studies on pancreas of Goose (*Anser albifrons*). *Veterinary Research Forum*. 2011;2(1):25-29.
19. Mobini B. Histochemical and histological studies on the pancreas in mature pigeon (*Columba livia*). *European Journal of Experimental Biology*. 2013;3:148-152.
20. Nitsan Z, Dunnington EA, Siegel PB. Organ growth and digestive enzyme levels to fifteen days of age in lines of chickens differing in body weight. *Poultry Science*. 1991;70(10):2040-2048.
21. Rawles DO. Avian digestive physiology. In: Whittow GC, editor. *Sturkie's Avian Physiology*. 6th ed. San Diego: Academic Press; 2015. p. 241-267.
22. Saadatfar Z, Asadian M. Anatomy of pancreas in mynah (*Acridotheres tristis*). *Journal of Applied Animal Research*. 2009;36(2):191-193. <https://doi.org/10.1080/09712119.2009.9707057>
23. Singh UB, Sulochana S. *A Practical Manual of Histological and Histochemical Techniques*. Bombay: Kothari Publications; 1997. p. 12-101.
24. Sivakumar M, Kannan TA, Parida SN, Sathyamoorthy OR, Vijayaragavan C. Histology and Histochemistry of the ductular and stromal components of the post hatch exocrine pancreas of japanese quail (*Coturnix coturnix japonica*). *Journal of Veterinary and Animal Sciences*. 2000;31(2):44-46.
25. Solomon SE. The avian pancreas. In: *Gut Function in Poultry*. Wallingford: Centre for Agriculture and Biosciences International; 2006. p. 145-160.
26. Yadav R, Prakash A, Farooq MM, Verma A, Pathak A, Singh SP, *et al.* Gross anatomy of the pancreas of Chabro chicken. *Indian Journal of Veterinary Anatomy*. 2018;30(2):100-103.