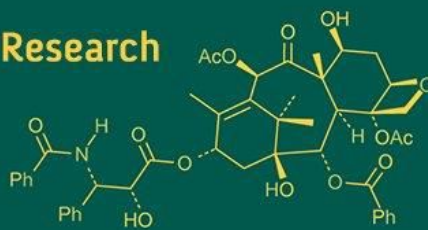


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; 9(10): 341-346
www.biochemjournal.com
Received: 16-08-2025
Accepted: 18-09-2025

Dr. S Dhilleswara Rao
Assistant Professor,
Department of Veterinary
Anatomy, College of
Veterinary Science, Sri
Venkateswara Veterinary
University, Garividi,
Vizianagaram, Andhra
Pradesh, India

P Jagapathi Ramayya
Associate Professor Dean,
College of Veterinary Science,
Sri Venkateswara Veterinary
University, Tirupati, Andhra
Pradesh, India

M Santhi Lakshmi
Professor, Department of
Veterinary Anatomy, College
of Veterinary Science, Sri
Venkateswara Veterinary
University, Tirupati, Andhra
Pradesh, India

RV Suresh Kumar
Professor, University Head,
Department of Veterinary
Radiology and Surgery, College
of Veterinary Science, Sri
Venkateswara Veterinary
University, Tirupati, Andhra
Pradesh, India

B Rambabu Naik
Professor, University Head,
Department of Veterinary
Physiology, College of
Veterinary Science, Sri
Venkateswara Veterinary
University, Tirupati, Andhra
Pradesh, India

Corresponding Author:
Dr. S Dhilleswara Rao
Assistant Professor,
Department of Veterinary
Anatomy, College of
Veterinary Science, Sri
Venkateswara Veterinary
University, Garividi,
Vizianagaram, Andhra
Pradesh, India

Comparative immunohistochemistry studies on pancreas of domestic animals

S Dhilleswara Rao, P Jagapathi Ramayya, M Santhi Lakshmi, RV Suresh Kumar and B Rambabu Naik

DOI: <https://www.doi.org/10.33545/26174693.2025.v9.i10e.6039>

Abstract

The present study was conducted on pancreas of domestic animals i.e 15 adult buffalo, 19 sheep, 18 goats 9 dogs and 17 pigs of either sex. The hormones were synthesized by the cells of islets of Langerhans. They include glucagon (α -cells), insulin (β -cells) and somatostatin (δ -cells) immunoreactive cells. The glucagon immunoreactive (IR) cells were predominantly located at the periphery of the islets of Langerhans in buffaloes, sheep, goat and pig while center of islets of Langerhans in dog. The insulin IR cells (β -cells) were distributed throughout the islets, with a higher frequency in the center, and were the most abundant cell type in all species. While, the somatostatin IR cells (δ -cells) were present at the periphery of the islets, often adjacent to glucagon and insulin IR cells, and were the least abundant cell type. Some endocrine cells were present as isolated individual cells or 2 or 3 cells in the parenchyma between the acini and epithelium of inter and intralobular ducts.

Keywords: Endocrine pancreas, insulin, glucagon, somatostatin, domestic animals

Introduction

The pancreas is an example for mixed gland and consists of exo and endocrine portions. It is a soft, encapsulated, lobulated gland. The function of exocrine portion is secretion of digestive enzymes and ions into the gastrointestinal tract i.e duodenum, which are necessary for digestion of food, whereas, the lightly stained endocrine part secretes hormones i.e glucagon, insulin and somatostatin by α , β and δ cells of islets of Langerhans and they are highly vascularised and key regulators of glucose homeostasis. The endocrine part of pancreas consisted of cellular aggregations interspersed irregularly between the acini i.e islets of Langerhans and they were organized into round or polygonal clumps of cells in between the exocrine part.

The acini contained a small lumen and were lined by pyramidal cells with basal, spherical nucleus. In pancreas, the exocrine component was far larger in domestic animals (Nickel *et al.* 1979) [20], Dellmann and Eurell, (1998) [4] and Konig and Leibich (2004) [15]. Gautam (2015) [7] noted that the 98% of pancreas consists of exocrine part, while only 2% of the tissue makes the endocrine portion in pancreas of humans. But literature is scanty in pancreas of domestic animals. Therefore present study was undertaken to see comparative immunohistochemistry on pancreas of domestic animals.

Materials and Methods

The present study was conducted on pancreas of domestic animals i.e 15 adult buffalo, 19 sheep, 18 goats, 9 dogs and 17 pigs of either sex. The tissue samples of pancreas of buffalo, sheep and goat were collected immediately after their slaughter at municipal slaughter house, Proddatur and Tirupati, whereas tissue samples of pigs were collected from AICRP on pigs, Tirupati and tissue samples of dog were collected under willed animal body programme from Veterinary Clinical Complex, College of Veterinary Science, Proddatur and Tirupati. For immunohistochemical studies, the standard Avidin Biotin Complex (ABC) technique was adopted to study Insulin, Glucagon and Somatostatin cells in islets of Langerhans in pancreas in buffalo, sheep, goat, dog and pig (Bancroft and Gamble 2008) [1].

Table. 1: Different primary antibodies used for immunohistochemistry

S. No	Immunogen	Clone	Species	Target tissue	Source
1	Glucagon	Polyclonal	Rabbit	Pancreas	BioGenex
2	Insulin	HB125	Mouse	Pancreas	BioGenex
3	Somatostatin	BSB-113	Human	Pancreas	Bio SB

Results

In the present study, three types of immunoreactive cells i.e glucagon (A or α cells), insulin (B or β cells) and somatostatin (D or δ cells) were observed in the islets of Langerhans in the pancreas of buffalo sheep, goat, dog and pig. The immunoreactive cells were also noticed in parenchyma of exocrine portion of pancreas and epithelium of the inter and intralobular duct in some animals. The glucagon immunoreactive cells were present at the periphery of the islets of Langerhans in buffalo (Fig.1 & Table.2), sheep (Fig.2 & Table.3), goat (Table.4) and pig (Fig.3 & Table.5) while few were also noted in the center of the islets of Langerhans in sheep and goat (Fig.4 & Table.4) whereas glucagon immunoreactive cells predominantly at center of islets in dog (Fig.5 & Table.6), however moderate number were also present at peripheral zone. The glucagon immunoreactive cells were also observed in the epithelium of inter and intralobular ducts in dog (Table.6) and goat (Table.4) but do not observed in buffalo, sheep and pig. These IR cells scattered in small groups or isolated cells or individual cells were found in the exocrine portion of pancreas in buffalo and sheep.

The insulin immunoreactive cells were more in number within the islets of Langerhans (Table.2, 3, 4, 5 & 6) when compared to other types of islet cells and most of the insulin immunoreactive cells were scattered throughout the islet especially center of the islet in buffalo (Fig.6), dog and pig while, these insulin IR cells were distributed widely in most part of the islet of Langerhans in sheep (Fig.7). These IR cells showed strong immunoreactivity for insulin than the other islet cells in pig (Fig.8 & Table.5) and dog (Fig.9 & Table.6). Moderate number of insulin immunoreactive cells were also noted between the epithelial cells of the inter and intralobular ducts in buffalo (Fig.10 & Table.2) but absent in dog and pig. Some insulin IR cells were also observed between the exocrine portion as small islets or individual cells in buffalo, sheep and goat.

The somatostatin immunoreactive cells were observed at the periphery of the islet of Langerhans in pancreas of buffalo (Fig.11 & Table.2), sheep (Fig.12 & Table.3), pig (Fig.13 & Table.5), dog (Fig.14 & Table.6) and goat (Fig.15 & Table.4). Further, few IR cells were also noted in the center of the islet in sheep and goat. The somatostatin IR cells were very few in number and their number was least among the islet cells (Table.2, 3, 4, 5 & 6). These cells were scattered randomly between glucagon and insulin IR cells. They were distributed as isolated or individual cells between exocrine portion, but their presence was not observed in inter and intralobular ducts in buffalo, sheep, dog and pig while observed in goat.

Discussion

Immunohistochemical studies on endocrine part of pancreas of buffaloes, sheep, goat, dog and pig was studied. In the present study, the glucagon immunoreactive (IR) cells were placed at the periphery of islets of Langerhans in buffaloes, sheep, goat and pig. Similar findings were also reported by Hawkins *et al.* (1987) [11] in dog pancreas, Hiratsuka *et al.*

(1996) [13] in cows, Timurkaan *et al.* (2006) [23] and Budipitojo *et al.* (2016) [2] in pigs, Gustavsen *et al.* (2008) [9] in goats, Prakash *et al.* (2014) [21] in Madras red sheep, Hafez *et al.* (2015) [10] in bovines and camel, Tsuchitani *et al.* (2016) [24] in dogs, monkeys and minipigs. Contrary to the above findings, Karaca *et al.* (2014) [14] in cat, Helmstaedter *et al.* (1976) [12], Furoka *et al.* (1989) [5] and Hafez *et al.* (2015) [10] in horses reported glucagon IR cells in the centre of the islet of Langerhans.

Further, in the present study, some alpha cells were scattered as small groups or isolated cells in the exocrine portion of pancreas in buffaloes, sheep, goat and pig. But in dogs the cells were also observed in between the lining epithelium of interlobular ducts. These findings were supported by Helmstaedter *et al.* (1976) [12] and Hafez *et al.* (2015) [10] in horses and Lucini *et al.* (1988) [17] in bovines, Ku and Lee (2005) [16] in mice. Contrary to the above findings Timurkaan *et al.* (2006) [23] and Budipitojo *et al.* (2016) [2] noted more number of alpha cells in the exocrine portion of pancreas of porcupine. In the present study, the small clusters of alpha cells were also noted within the connective tissue adjacent to the pancreatic duct in dog.

The percentage of α IR cells in large islets was 14.13% in buffalo, 20.86% in sheep, 16.88% in goat, 24.12 in dog% and 18.83% pigs, whereas, in medium islets their percentage was 14.98% in buffalo, 14.51% in sheep, 9.90% in goat, 13.69% in dog and 12.33% in pig. Hiratsuka *et al.* (1996) [13] noted 15 to 17% of α cells in cows, which is almost similar to the present findings in buffalo. But 20.40% of alpha cells were reported by Ku and Lee (2005) [16] in nude mice and 30% of α cells in humans pancreatic islets (Da and Xavier, 2018) [3].

The insulin IR cells (β cells) were more in number in islets of pancreas compared to other types of cells. Most of these cells were located centrally and few cells were scattered at the periphery of the islets in buffaloes. Similar findings were also reported by Nakajima *et al.* (1988) [19] in bovines, Hiratsuka *et al.* (1996) [13] in cows and Hafez *et al.* (2015) [10] in bovines. Further, some insulin IR cells were also observed between the exocrine portion as small islets or individual cells. The above results were in conformity with the findings of Forssmann *et al.* (1977) [12], Gersell *et al.* (1979) [8], Hawkins *et al.* (1987) [11] in dogs, Reddy and Elliott (1985a) [22] in goat foetus, Mahesh *et al.* (2017) [18] in goats, Prakash *et al.* (2014) [21] in sheep Helmstadter *et al.* (1976) [12], Furoka *et al.* (1989) [5] and Hafez *et al.* (2015) [10] in horses and Timurkaan *et al.* (2006) [23] and Budipitijo *et al.* (2016) [2] in pigs.

In the present study, the presence of β IR cells in large islets were 69.51% in buffalo, 65.36% in sheep, 71.81% in goat, 60.72% in dogs and 70.97% in pigs, whereas the medium islets consisted of 67.72% in buffalo, 67.92% in sheep, 67.62% in goat, 73.01% in dog and 73.04% in pig. Hiratsuka *et al.* (1996) [13] reported 72.8% beta cells in cow. Whereas, Da and Xavier (2018) [3] reported 60% of β cells in humans islets. In humans, β -cells were comparatively less in number when compared to domestic animals.

In the pancreas of buffalo, sheep, goat, dog and pig the somatostatin immunoreactive cells were very few in number and their number was least among the islet cells and observed at the periphery of the islet of Langerhans. Helmstaedter *et al.* (1976) ^[12] and Furuoka *et al.* (1989) ^[5] also noted somatostatin cells between glucagon and insulin cell groups and Hawkins *et al.* (1987) ^[11] reported delta cells randomly and less in number in pancreas of dogs similar to the present findings in domestic animals.

The somatostatin IR cells were present between glucagon and insulin IR cells peripherally in medium and large-sized islet of Langerhans. They were distributed as isolated or individual cells between exocrine portion, but their presence was not observed in inter and intralobular ducts. Further, in the pancreas of sheep and goat few somatostatin IR cells were also noted in the center of the islet. The few somatostatin IR cells showed cytoplasmic processes in the islets. Similarly, Prakash *et al.* (2014) ^[21] also noted the delta cells peripherally in the islets of Langerhans with cytoplasmic process in Madras red sheep. Whereas, Hafez *et al.* (2015) ^[10] reported the clumps of few numbers of δ cells throughout the islets in camel and a few δ cells in peripheral location in the bovine pancreas as noted in the present study. Further, Budipitojo *et al.* (2016) ^[2] observed somatostatin cells in mantle area and a few numbers in central and peripheral areas and also few cells were noticed between acinar cells of exocrine of pancreas in porcine.

In the present study, the δ IR cells in large islets were 11.25% in buffalo, 9.61% in sheep, 8.14% in goat, 10.19% in dogs and 6.57% in pigs whereas, medium islets consisted of 10.83% in buffalo, 11.59% in sheep, 14.89% in goat, 8.62% in dog and 10.28% in pig. Ku and Lee (2005) ^[16] also noted somatostatin immunoreactive cells on peripheral parts of islets similar to glucagon secreting alpha cells with 2.10 ± 1.66 and $15.60 \pm 2.95/100$ cell frequencies in the central and peripheral regions and in the splenic lobe respectively. Similarly, in the duodenal lobe noticed 0.69 ± 0.70 and $8.90 \pm 7.65/100$ frequencies of cells in the central and peripheral regions respectively in mice. Timurkaan *et al.* (2006) ^[23] noted that the somatostatin cells were mainly present in the mantle zones and at a lesser extent in the peripheral regions. Few were also scattered in the central regions of the pancreatic islets and in the exocrine portions in porcupine as observed in the present study.

In buffalo, sheep, goat, dog and pig the α cells were distributed peripherally and insulin secreting β cells in the center of the islets. According to Tsuchitani *et al.* (2016) ^[24] the β cells were occupied the large central part of the rat islet, α cells and few δ cells were located peripherally as observed in the present study. In monkey, few δ cells were located in the periphery and occasionally at the center of islet, whereas in minipig islets showed an irregular outline and α and β cells and few δ cells were scattered in all parts of the islet.

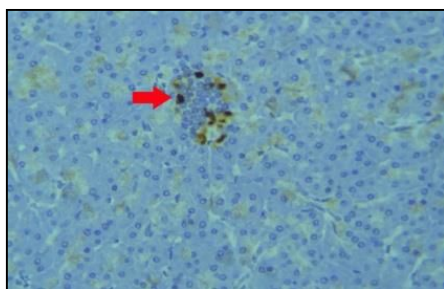


Fig 1

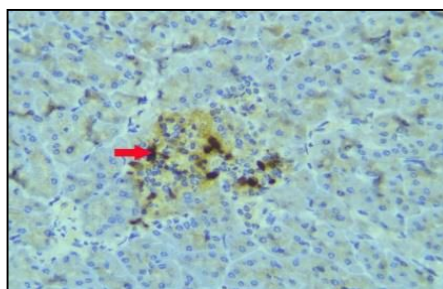


Fig 2

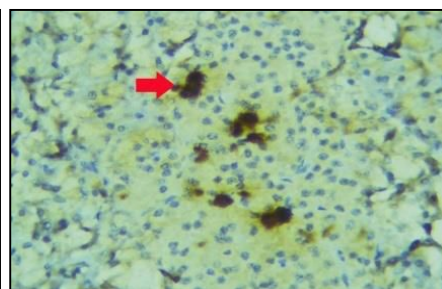


Fig 3

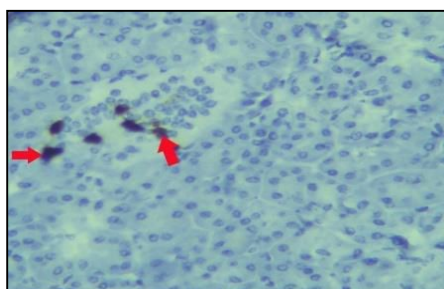


Fig 4

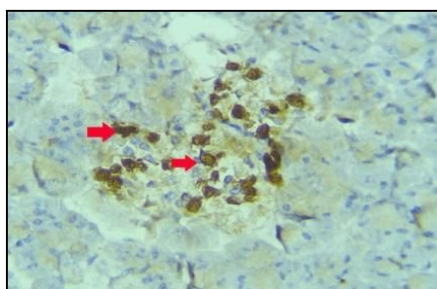


Fig 5

Fig 1-5: Photomicrograph showing glucagon immunoreactive cells (Red arrow) in islets of Langerhans in pancreas of buffalo (Fig.1), sheep (Fig.2), pig (Fig .3), goat (Fig .4) and dog (Fig.5) ABC method x 400

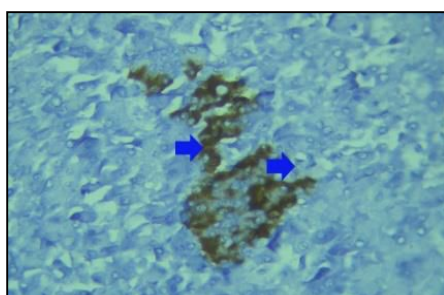


Fig 6

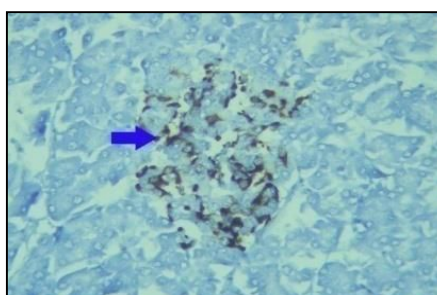


Fig 7

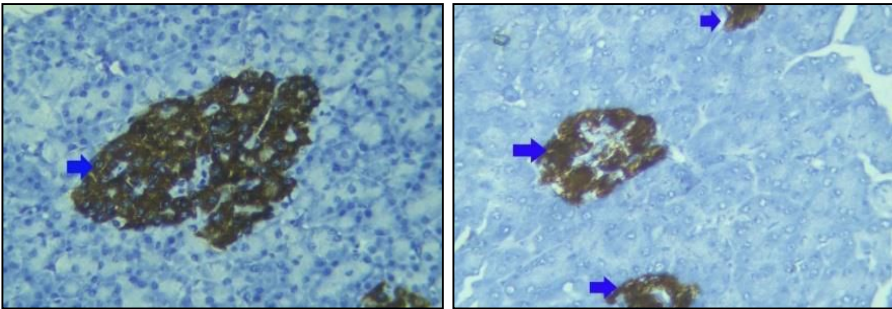


Fig 8

Fig 9

Fig 6-9: Photomicrograph showing insulin immunoreactive cells (Blue arrow) in islets of Langerhans in pancreas of buffalo (Fig.6), sheep (Fig.7), pig (Fig .8) and dog (Fig.9). ABC method x 400

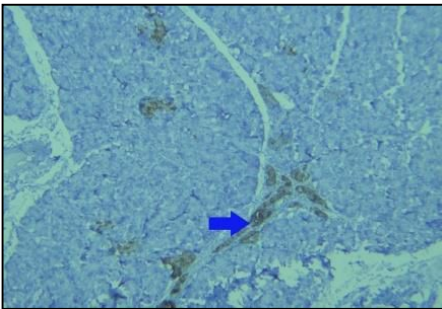


Fig 10: Photomicrograph showing insulin immunoreactive cells (Blue arrow) in islets of Langerhans in pancreas of buffalo. ABC method x 100

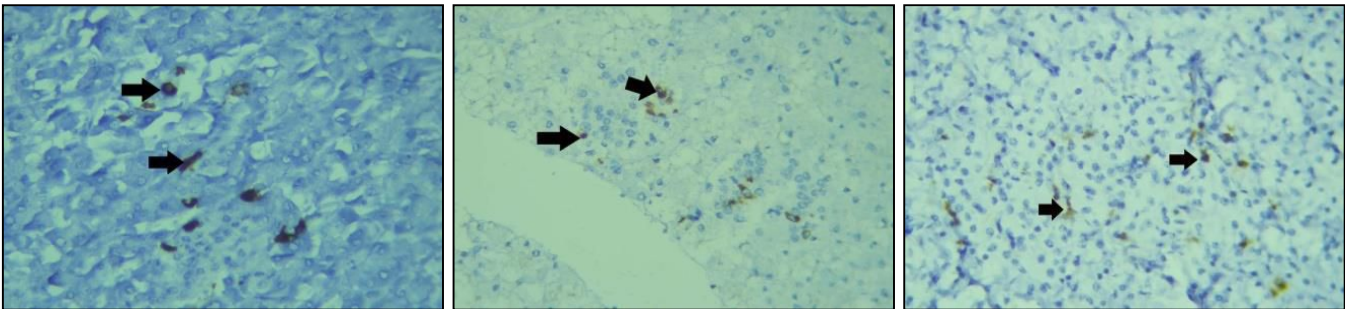


Fig 11

Fig 12

Fig 13

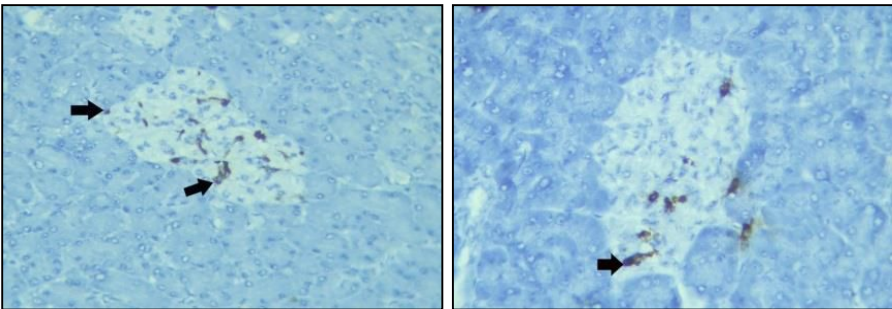


Fig 14

Fig 15

Fig 11-15: Photomicrograph showing somatostatin immunoreactive cells (Black arrow) in islets of Langerhans in pancreas of buffalo (Fig.11), sheep (Fig.12), pig (Fig .13), dog (Fig.14) and goat (Fig .15). ABC method x 400

Table. 2: Distribution of immunoreactive endocrine cells in islets of pancreas of buffalo.

S. No	Antibodies	Islet of Langerhans		Exocrine portion	Epithelium of duct
		Periphery	Central		
1	Glucagon	++	-	+	-
2	Insulin	++	++++	+	++
3	Somatostatin	+	-	++	-

Table 3: Distribution of immunoreactive endocrine cells in islets of pancreas of sheep.

S. No	Antibodies	Islet of Langerhans		Exocrine portion	Epithelium of duct
		Periphery	Central		
1	Glucagon	+	+	+	-
2	Insulin	+++	+++++	+	-
3	Somatostatin	++	+	+	-

Table 4: Distribution of immunoreactive endocrine cells in islets of pancreas of goat.

S. No	Antibodies	Islet of Langerhans		Exocrine portion	Epithelium of duct
		Periphery	Central		
1	Glucagon	++	+	+	-
2	Insulin	+	++++	+	-
3	Somatostatin	++	+	+	-

Table 5: Distribution of immunoreactive endocrine cells in islets of pancreas of pig.

S. No	Antibodies	Islet of Langerhans		Exocrine portion	Epithelium of duct
		Periphery	Central		
1	Glucagon	++	++	+	-
2	Insulin	++++	+++++	++	-
3	Somatostatin	+	+	+	-

Table 6: Distribution of immunoreactive endocrine cells in islets of pancreas of dog.

S. No	Antibodies	Islet of Langerhans		Exocrine portion	Epithelium of duct
		Periphery	Central		
1	Glucagon	++	++	++	+
2	Insulin	++++	+++++	++	-
3	Somatostatin	+	+	+	-

+ Few number, ++ Moderate number, +++More number, ++++Maximum number and-not detected,

Conclusion

This study provides a comprehensive overview of the distribution and frequency of glucagon, insulin, and somatostatin IR cells in the pancreas of domestic animals, highlighting species-specific differences and similarities. These findings contribute to our understanding of the morphology and function of the endocrine pancreas in these species.

References

- Bancroft JD, Gamble M. Theory and practice of histological techniques. 6th ed. Churchill Livingstone Elsevier; 2008. p. 248-250.
- Budipitojo T, Fibrianto YH, Mulyani GT. The types of endocrine cells in the pancreas of Sunda porcupine (*Hystrix javanica*). Veterinary World. 2016;9(6):563-567.
- Da G, Xavier S. The cells of the islets of Langerhans. Journal of Clinical Medicine. 2018;7(54):1-17.
- Dellmann HD, Eurell JA. Textbook of veterinary histology. 5th ed. Philadelphia: Lippincott Williams and Wilkins; 1998. p. 199-200.
- Furuoka H, Ito H, Hamada H, Suwa T, Satoh H, Itakura AC. Immunocytochemical component of endocrine cells in pancreatic islets of horses. Japanese Journal of Veterinary Sciences. 1989;51(1):35-43.
- Forssmann WG, Helmstaedter V, Metz J, Greenberg J, Chance RE. The identification of the F-cell in the dog pancreas as the pancreatic polypeptide-producing cell. Histochemistry. 1977;50(4):281-290.
- Gautam A. Islet cell transplantation for patients with chronic pancreatitis. Indian Journal of Surgery. 2015;77(5):470-471.
- Gersell DJ, Gingerich RL, Greider MH. Regional distribution and concentration of pancreatic polypeptide in the human and canine pancreas. Diabetes. 1979;28(1):11-15.
- Gustavsen CR, Pillay N, Heller RS. An immunohistochemical study of the endocrine pancreas of the African ice rat, *Otomys sloggetti robertsi*. Acta Histochemica. 2008;110(4):294-304.
- Hafez SA, Zaghloul DM, Caceci T. Immunohistochemical identification of the endocrine cells in the pancreatic islets of the camel, horse, and cattle. European Journal of Anatomy. 2015;19(1):27-35.
- Hawkins KL, Summers BA, Kuhajda FP, Smith CA. Immunocytochemistry of normal pancreatic islets and spontaneous islet cell tumors in dogs. Veterinary Pathology. 1987;24:170-179.
- Helmstaedter V, Feurle GE, Forssmann WG. Insulin, glucagon, and somatostatin immunoreactive endocrine cells in the equine pancreas. Cell and Tissue Research. 1976;172(4):447-454.
- Hiratsuka T, Abe M, Takehana K, Iwasa K, Takeo Hiraga T, Kobayashi A. Immunohistochemical analysis of the endocrine cells in the pancreatic islets of cattle. Okajimas Folia Anatomica Japonica. 1996;72(6):285-296.
- Karaca T, Kara A, Simsek N, Uslu S, Tekiner D, Yoruk M. Immunohistochemical distribution of glucagon, insulin, somatostatin, gastrin, and serotonin-containing cells in the pancreas of the Van cat. Turkish Journal of Veterinary and Animal Sciences. 2014;38:304-311.
- Konig HE, Liebich HG. Veterinary anatomy of domestic mammals. 3rd ed. New York: Schattauer; 2004. p. 340-342.
- Ku SK, Lee HS. An immunohistochemical study of the pancreatic endocrine cells of the nude mouse, *Balb/c-nu/nu*. European Journal of Histochemistry. 2005;50(1):61-68.
- Lucini C, Castaldo L, Lai O, De Vico G. Ontogeny, postnatal development, and ageing of endocrine pancreas in *Bubalus bubalis*. Journal of Anatomy. 1988;192(3):417-424.
- Mahesh, Gadre KM, Ashok P, Girish HM, Sharanagouda, Annapurana A. Comparative histomorphology of endocrine pancreas in Deccani sheep and Bidri goat. MOJ Anatomy & Physiology. 2017;3(1):1-3.
- Nakajima S, Kitamura N, Yamada J, Yamashita T, Watanabe T. Immunohistochemical study on the endocrine pancreas of cattle with special reference to coexistence of serotonin and glucagon or bovine pancreatic polypeptide. Acta Anatomica (Basel). 1988;131(3):235-240.
- Nickel R, Schummer A, Seiferle E. The viscera of the domestic mammals. 2nd ed. Translation and revision by WO Sack. Verlag Paul Parey: Berlin and Hamburg; 1979. p. 119-122, 136, 146, 179-180.
- Prakash P, Kumary SU, Kannan TA, Ramesh G, Basha SH. Microanatomy of the islets of Langerhans in the pancreas of Madras Red sheep (*Ovis aries*). Indian Journal of Veterinary Anatomy. 2014;26(1):40-42.
- Reddy SN, Bibby NJ, Elliott RB. Cellular distribution of insulin, glucagon, pancreatic polypeptide hormone, and somatostatin in the fetal and adult pancreas of the guinea pig: a comparative immunohistochemical study. European Journal of Cellular Biology. 1985;38(2):301-305.

23. Timurkaan S, Girgin A, Karan M. Immunohistochemical study of the pancreatic endocrine cells of the *Hystrix cristata* (porcupine). *Revue de Médecine Vétérinaire*. 2006;157(7):357-360.
24. Tsuchitani M, Sato J, Kokoshima H. A comparison of the anatomical structure of the pancreas in experimental animals. *Journal of Toxicologic Pathology*. 2016;29(3):147-154.