Cumin Extract Alters The Histology of Kidney and Duodenum in Adult Rabbit

Hussein B. Mahmood [1*], Naseer A. Al-Arubaye [1], Walaa F. Obead [1]

Abstract

Background: The current study determined the histological alterations of the kidney and duodenum due to the administration of cumin plant. The objective of the study was how consuming cumin affects the histological structure of the kidney and duodenum. Methods: Ten healthy male rabbits were divided into two groups of five each. They were housed in the animal facility at the College of Veterinary Medicine, Kerbala University. The treatment group received an oral dose of cumin extract at 250 mg/kg body weight once daily for six weeks, while the control group was given a standard diet and water. Hematoxylin and eosin staining was used to examine tissue samples from the kidneys and duodenum. Results: The histological analysis revealed significant changes in the kidney and duodenum tissues of the rabbits treated with cumin extract. In the kidneys, there was an increase in the diameter of glomeruli and a narrower lumen of the proximal tubules, indicating increased activity. Similarly, the duodenum of the treated group exhibited taller villi and deeper crypts, suggesting enhanced absorption activity. Moreover, the arrangement of tall columnar epithelial cells in the duodenal villi was altered. Conclusion: In conclusion, high intake of cumin extract showed various histological alterations in the urinary and digestive systems, particularly in the kidney and duodenum. These findings provided insights into the potential effects of cumin consumption on organ structure and function, highlighting the need for further research to better understand its implications for human health.

Keywords: Cumin, Histological alteration, Kidney, Duodenum, Rabbit

Significance | This study showed the histological alterations of the kidney and duodenum due to excessive use of cumin.

*Correspondence. Hussein B. Mahmood, Department of Anatomy, College of Veterinary Medicine, University of Kerbala, Kerbala, Iraq
E-mail: hussein.mahmood@uokerbala.edu.iq

Editor Md Shamsuddin Sultan Khan And accepted by the Editorial Board Feb 20, 2024 (received for review Dec 15, 2023)

Introduction

Cumin, the second most frequently used type of pepper, is renowned for its medicinal and culinary benefits. Widely employed in various industries such as food, beverage, pharmaceuticals, cosmetics, and toiletries, cumin has garnered attention for its therapeutic properties (Bhatt et al., 2017). However, excessive consumption of cumin can potentially lead to hormonal abnormalities, prompting the need for research to investigate its histological effects (Obead et al., 2023). Kidneys, being urinary organs, are particularly vulnerable to the adverse effects of xenobiotics, contributing to the rise in renal diseases globally (Radi., 2019). Amidst this backdrop, alternative and complementary medicine, including the use of herbal remedies like cumin, has gained traction (Eisenberg et al., 1998).

Herbal medicine has been practiced for millennia across various cultures, yet the safety and efficacy of these remedies remain uncertain without robust experimental data (Eisenberg et al., 1998). Despite the lack of conclusive evidence, cumin seeds have been traditionally used to alleviate conditions such as chronic diarrhea, indigestion, gastritis, insulin resistance, and even certain malignancies (Langmead & Rampton, 2001). Animal studies have

Author Affiliation.
[1] Department of Anatomy, College of Veterinary Medicine, University of Kerbala, Kerbala, Iraq

Please cite this article.
Hussein B. Mahmood, Naseer A. Al-Arubaye , Walaa F. Obead. (2024). Cumin Extract Alters The Histology of Kidney and Duodenum in Adult Rabbit, Journal of Angiotherapy, 8(2), 1-6, 9509

explored the potential benefits of cumin seeds on digestive enzymes, shedding light on their impact on digestion (Porter & Crosby, 1998). However, excessive consumption of cumin has been linked to reproductive system damage and histopathological alterations (Hannan et al., 2021).

The kidneys play a crucial role in maintaining internal homeostasis, including the metabolism and elimination of xenobiotics (Claure & Espinosa, 2021; Hall et al., 2022). Their high metabolic activity and extensive vasculature make them susceptible to xenobiotic-induced damage (Radi, 2020). Moreover, the gastrointestinal tract, including the gut, pancreas, and liver, is integral to nutrient absorption and elimination processes (Huo et al., 2022; Hornbuckle et al., 2008).

This study aims to enhance understanding of the efficacy and safety of herbal therapies, particularly focusing on the bioactivity and histological effects of cumin powder. By investigating its impact on renal function and small intestine absorption, the study seeks to provide valuable insights into the potential benefits and risks associated with cumin consumption. Through rigorous experimentation and analysis, this research endeavors to contribute to the growing body of knowledge surrounding herbal medicine and its role in promoting health and well-being.

While cumin holds promise as a therapeutic agent, its excessive consumption may pose risks to hormonal balance and histological integrity. By elucidating its effects on renal function and small intestine absorption, this study aims to inform the safe and effective use of cumin in clinical practice and public health initiatives.

Materials &Methods

Srudy design

This study utilized ten mature male local rabbits to ensure the reliability and consistency of the data by minimizing hormonal fluctuations and variations inherent in females. The rabbits were divided into two groups, each comprising five individuals. The treatment group received cumin extract orally at a dosage of 250 mg/kg body weight via stomach tube feeding, while the control group was provided with standard food and water (Hmed et al., 2018). The experiment spanned a duration of six weeks for each group. At the conclusion of the study period, euthanasia was performed on all research rabbits using intramuscular injections of xylazine (0.5 ml) and ketamine (0.5 ml) (Mahmood et al., 2020). The research was carried out at the anatomical laboratory of the College of Veterinary Medicine, University of Kerbala, with the assigned reference number UOK.VET.AN.2022.052.

Extraction of cumin

Cumin powder was procured from the Kerbala city market for the study. An extract was prepared by combining 25 g of dried cumin powder with 10 ml of boiling distilled water for each batch. The extraction process took approximately half an hour to complete. To standardize the concentration, each extract was filtered and adjusted so that each 1 ml of sample contained 250 mg/ml of cumin extract. The resulting solutions were then stored in airtight containers to maintain their integrity (Al-Saaedi, 2021).

Histological preparing:

Histological samples were obtained from the duodenum and kidney, with tissue pieces approximately 0.5 cm wide. These pieces were then immersed in 10% formalin for a duration of 72 hours to preserve their structure. To distinguish between different tissue components, hematoxylin and eosin dyes were used in conjunction with standard histological techniques (Batah et al., 2020). Histological measurements were conducted on various tissue sections, including the intestinal villi, renal tubules, and renal corpuscles. The examination of histological properties was facilitated by a digital USB microscope camera (Canon 550 D, 18 Megapixel, Japan) mounted on an Olympus microscope. Objective lenses were calibrated using a stage micrometer to ensure accurate measurements (Sultan et al., 2023).

Results and discussion

Kidney of control group

Based on the histological examination conducted in the current study, the kidneys of the control group exhibited normal characteristics, including well-defined renal corpuscles with a thin connective tissue capsule enclosing urinary tubules. Additionally, the micro-vasculature within the renal corpuscles appeared significantly reduced. The glomeruli, which were observed to have a diameter of 130 µm, formed the structural framework of the renal corpuscles (Table 1). The Bowman capsule demonstrated a double-layered structure, with an outer parietal layer and an inner visceral layer closely associated with the renal tubule (Figure 1A). These findings are consistent with the observations of Al-Jammas & Al-Saraj (2019), who noted that the histological structure of kidney tissues in the control group appeared entirely normal, exhibiting the typical organization of renal components.

The current investigation revealed that the proximal convoluted tubule is distributed throughout the kidney tissue and is connected to the urine pole of the glomerulus. It is lined by a simple cuboidal epithelium resting on the basement membrane, with a diameter of approximately (m). The cells' free surface is characterized by small microvilli composing the brush border. These findings are consistent with the observations of Yousif & Rabee (2019), who noted the presence of Bowman's capsule surrounding the glomerulus with two distinct layers: an outer parietal layer and an inner visceral layer. The proximal convoluted tubules were observed to be lined with simple cuboidal epithelium.

Table 1. Comparative measurements kidney and villi (mean ± Std).

Measurements of kidneys			
Control Glomerulus	**lumen of proximal tubule (cont)**	**Treatment Glomerulus**	**lumen of proximal tubule (treat)**
130.28 ± 41.87 µm	22.16 ± 8.180 µm	188.68 ± 5.34 µm	7.62 ± 3.12 µm
Measurements of villi			
Villi (cont)		**Villi (treat)**	
214.23 ± 72.97 µm		405.10 ± 145.55 µm	

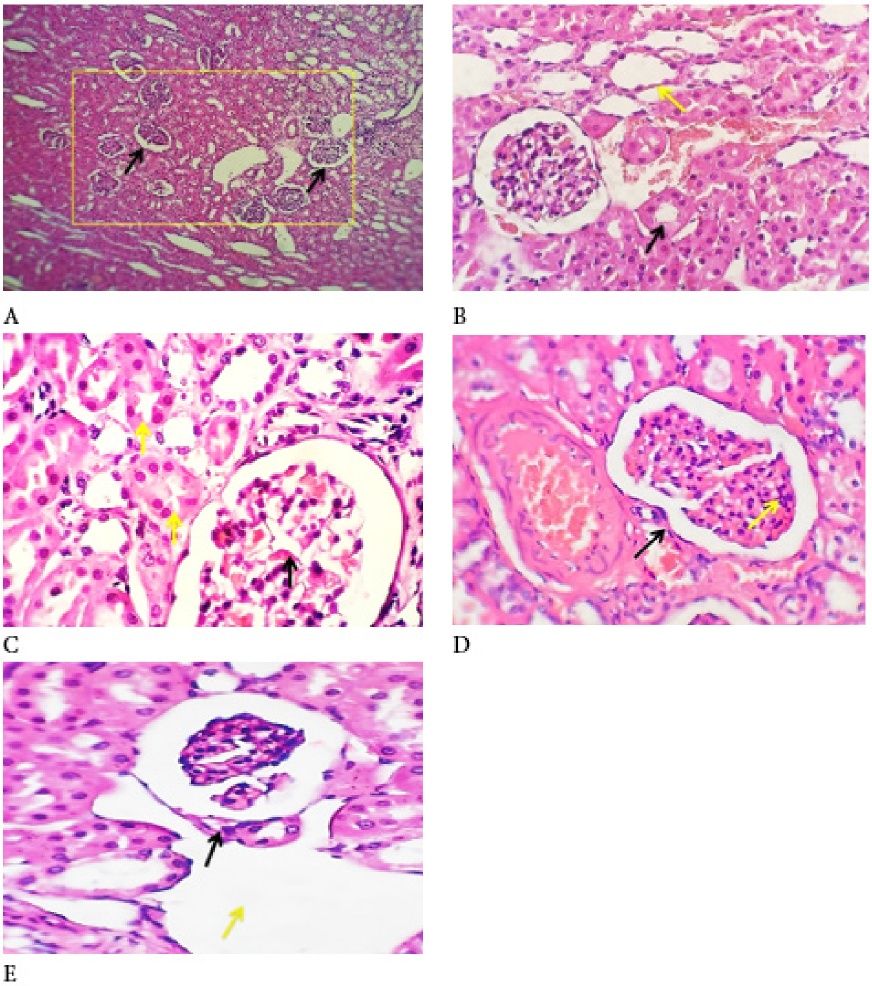

Figure 1. Photomicrograph of histological features of rabit with H&E stain 10x, A) control kidney - normal glomerulus and renal tubules (black arrows), B) control kidney - normal proximal tubules (black arrow) and apperence had wide lumen (yellow arrow), C) extract cumin – testis: the hypertrophy in glomerulus with density of microvascular network (black arrow) and the proximal tubules with high brush border with narrowing of lumen it (black arrows); D) extract cumin - density of mesangial cell in glomerulus (yellow arrow) with thickness of Bowman capsule (black arrows). E) extract cumin - the activity of juxtraglomerulus (black arrow) with expanded area in tubular pole (yellow arrows).

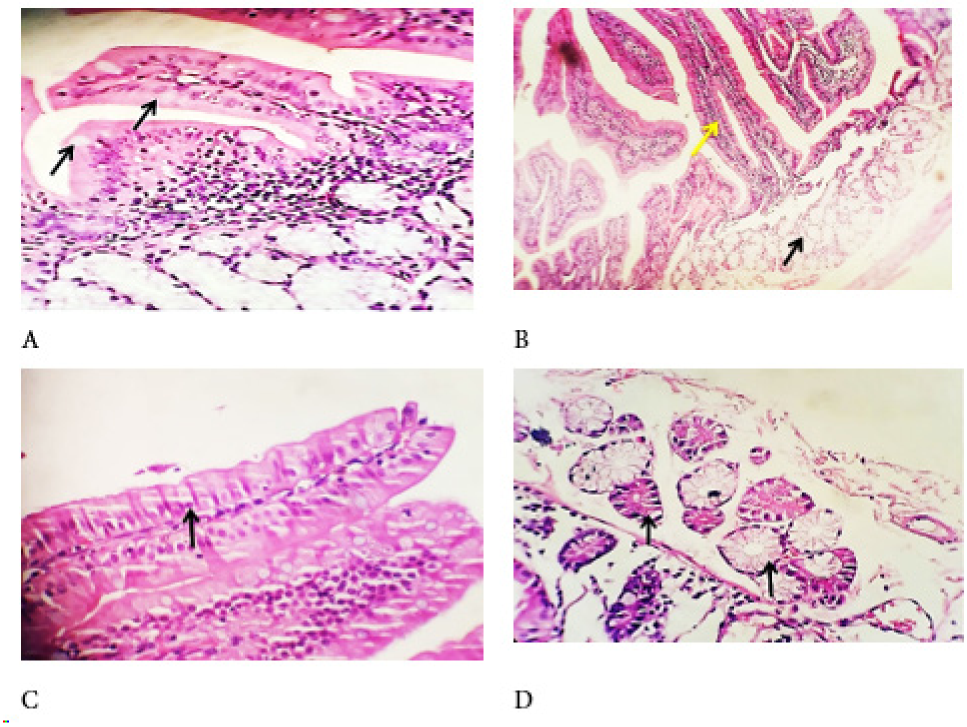

Figure 2. Photomicrograph of histological features of rabit with H&E stain 10x, A) control - small intestine with short villi & crypts (black arrows), B) extract cumin - small intestine with high villi & crypts (yellow arrows) with normal distributed of intestinal glands (black arrow), C) extract cumin - small intestine with tall columner epithelia & and high activity of villi (black arrow), D) extract cumin - small intestine with high activity of the intestinal glands and the high granule production in the cytoplasm (black arrow).

The histological evaluation results revealed that the basement membrane appeared less prominent in the tissue sections lined by a simple cuboidal epithelium. Additionally, it was observed that the distal convoluted tubule is short and closely associated with the epithelial cells. The absence of a brush border on the free surface of the cells and the wider lumen diameter (m) allowed for the distinction between the lining cells of the distal convoluted tubule and those of the proximal convoluted tubules, as illustrated in Figure 1B. These findings are in contrast to the earlier findings of Ajayi et al. (2010), which suggested that the proximal convoluted tubules are lined by columnar epithelium. However, they are consistent with the notion that the proximal tubule is narrower than the distal convoluted tubule.

Kidney of treatment group

The current investigation clarified histological changes in the treated group caused by renal corpuscle enlargement, activity, and increased proliferation in tubular epithelial cells. The diameter of glomerulus approximately (188) µm (Table,1). Additionally, the renal corpuscle's vascular pole revealed dilatation. These histological alterations may be caused by the ability of cumin to cause weight loss, the necessity to drain interstitial fluid created by metabolic processes, and the requirement of kidney activity in this process (Figure 1C). These investigations support the findings of (Petrosyan *et al.,* 2019), who claimed that fluid flow caused renal epithelial cells to express important renal transporters at higher levels.

The current analysis revealed that, as a result of the nephron's bioactivity, the proximal tubules have a limited lumen, enlargement of epithelial cells, and a well-developed brush border (Figure 1C). This outcome is comparable to renal tubular epithelial cells getting exposed to dietary supplements throughout the blood and glomerular filtrate (Eisenberg et al., 1998). Due to their vast transport systems and rapid metabolic rate, tubular cells. Mesangial expansion, which is demonstrated in this investigation in the cumin group, has been defined as an elevation in extracellular material in the mesangium so that the breadth of the interspace exceeds two glomerular mesangial cell nuclei. The Bowman capsule was thickened, glomeruli are active, and interstitial fibroblasts have been identified. In addition, showing activity of juxtaglomerular and expanded in tubular pole of renal corpuscle (Figure 1D, 1E). These findings correspond to consensus with (Pearson *et al.,* 2022), who claimed that the breakdown and excretion of xenobiotics result in the kidneys receiving an important proportion of the blood flow from the kidneys, which was carried by a vast microvascular network.

Histological examination of duodenum

In the control group, the short crypts and villi were visible through histological analysis; the villi were protected by short columnar enterocytes. Due to normal metabolism and the lack of any substance that would stimulate intestinal activity, the duodenal crypts were bordered with dormant pyramidal enterocytes (Figure 2A, 2B), the length of average villi about (214) µm (Table 1). The results reported here are similar to those of (Arévalo *et al.,* 2017), who claimed that the In the current investigation, the rat duodenal mucosa revealed short, finger-shaped villi and their width in the animal's healthy state.

The heights, activity, and frequency of the villi and crypts were found in the treatment group of the current study. discovering the depths of crypts is another thing. Tall columnar enterocytes with a distinct brush border coated the villi. Pyramidal enterocytes with the cytoplasm being basophilic and spherical basal nuclei lined the duodenal crypts of this population (Figure 2C, 2D), the length of average villi about (405) µm (Table 1). In the lower portions of the crypts, paneth cells might have been seen. This outcome may be due to an increase in energy metabolism brought on by the treatment group's lower energy intake nutrient intake (Yang *et al.,* 2016). Similarities between these findings and (Shaw *et al.,* 2012) a combination of nutrition and age, the rat's small intestine mucosa experiences a number of architectural and physiological adaptation change. In current study observed the activity in small intestine specifically in Brunner's gland these finding akin with (Obead *et al.,* 2023) who stated these findings could have been caused on by overindulging in cumin extract, which is frequently used as a body-slimming agent and might have contributed to weight loss.

Conclusion

It is evident that excessive consumption of intolerable cumin causes an assortment of histological changes in the duodenum and kidney. The research revealed that the 250 g/kg b.w. cumin extract utilized generated high renal activation and enhanced small intestine permeability.

Author contribution

H.B.M. wrote the manuscript, N.A.A. designed the study, W.F.O., H.B.M. analyzed data and wrote the manuscript.

Acknowledgment

The authors were grateful to The University of Kerbala's College of Veterinary Medicine.

Competing financial interests

The authors have no conflict of interest.

References

Ajayi, I. E., Ojo, S. A., Ayo, J. O., & Ibe, C. S.(2010). Histomorphometric Studies of the Urinary Tubules of the African Grasscutter (Thryonomys swinderianus). J. Vet. Anat. 3(1): 17 – 23. DOI: 10.21608/jva.2010.44903.

Al-Jammas, S., & Al-Saraj, A. (2019). The histological changes induced by cytarabine on rabbits kidneys (with and without vitamin E administration). Iraqi Journal of Veterinary Sciences, 33(2).

Al-Saaedi, A. M. (2021). Antipyretic Activity of The Aqueous Extract of Cumin (Cuminum cyminum L.) with Yeast Induced Pyrexia in Female Rats. University of Thi-Qar Journal of Science, 8(1), 33-35.DOI: 10.32792

Angell, M., & Kassirer, J. P. (1998). Alternative medicine—the risks of untested and unregulated remedies. New England Journal of Medicine, 339(12), 839-841. DOI: 10.1056/

Arévalo Sureda, E., Weström, B., Pierzynowski, S. G., & Prykhodko, O. (2017). Correction: Maturation of the Intestinal Epithelial Barrier in Neonatal Rats Coincides with Decreased FcRn Expression, Replacement of Vacuolated Enterocytes and Changed Blimp-1 Expression. Plos one, 12(1), e0169724. DOI:10.1371/journal.pone.0164775.

Batah, A. L., Mahmood, H. B., & Obead, W. F. (2020). Anatomical, histological and histochemical investigation of soft palate in cat (Felis catus Domesticus. L). Indian Journal of Forensic Medicine & Toxicology, 14(3), 957-961.

Bhatt, J., Kumar, S., Patel, S., & Solanki, R. (2017). Sequence-related amplified polymorphism (SRAP) markers based genetic diversity analysis of cumin genotypes. Annals of Agrarian Science, 15(4), 434-438. DOI: 10.1016/j.aasci.2017.09.001.

Claure-Del Granado, R., & Espinosa-Cuevas, M. (2021). Herbal Nephropathy. Nephrology and Public Health Worldwide, 199, 143-154. https://doi.org/10.1159/000517693.

Eisenberg, D. M., Davis, R. B., Ettner, S. L., Appel, S., Wilkey, S., Van Rompay, M., & Kessler, R. C. (1998). Trends in alternative medicine use in the United States, 1990-1997: results of a follow-up national survey. Jama, 280(18), 1569-1575. doi:10.1001/jama.280.18.1569.

Hall, A. M., Trepiccione, F., & Unwin, R. J. (2022). Drug toxicity in the proximal tubule: new models, methods and mechanisms. Pediatric Nephrology, 37(5), 973-982. https://doi.org/10.1007/s00467-021-05121-9.

Hannan, M. A., Rahman, M. A., Sohag, A. A. M., Uddin, M. J., Dash, R., Sikder, M. H., ... & Kim, B. (2021). Black cumin (Nigella sativa L.): A comprehensive review on phytochemistry, health benefits, molecular pharmacology, and safety. Nutrients, 13(6), 1784. https://doi.org/10.3390/nu13061784.

hmed Aljanabi, M. S. A., Alfahdawi, O. A. S., & Ismail, T. F. (2018). Physiological and histological study of the effect of Cumin Cyminum watery extract and vitamin E on the male reproductive system in rats exposed to oxidative stress. Tikrit Journal of Pure Science, 23(3), 23-32. DOI: http://dx.doi.org/10.25130/tjps.23.2018.044.

Hornbuckle W. E., Simpson K. W., & Tennant B. C. (2008). Gastrointestinal function. Clin. Biochem. Domest. Animals, 413–457. https://doi.org/10.3389/fphar.2022.962095.

Huo, Y., Zhou, Y., Zheng, J., Jin, G., Tao, L., Yao, H., ... & Hu, L. P. (2022). GJB3 promotes pancreatic cancer liver metastasis by enhancing the polarization and survival of neutrophil. Frontiers in Immunology, 13, 983116. https://doi.org/10.3389/fimmu.2022.983116.

Langmead, L., & Rampton, D. S. (2001). Review article: herbal treatment in gastrointestinal and liver disease. Aliment Pharmacol Ther, 15(9), 1239-52. https://doi.org/10.1046/j.1365-2036.2001.01053.

Mahmood, H. B., Dawood, G. A., & Bargooth, A. F. (2020). Histological Investigations for Cordia Myxa During the Treatment of Gastritis in Local Rabbits. Medico-legal Update, 20(3), 453.

Obead, W. F., Khalaf, H. H., & Mahmood, H. B. (2023). Histological changes of extract cumin cyminum on the leydig cells, seminiferous tubules and epididymis in adult rabbits (Oryctolagus cuniculus). Iraqi Journal of Veterinary Sciences, 37(Supplement I-IV), 177-182. DOI: 10.33899/ijvs.2023.138536.2811

Ojeda, J. L., Icardo, J. M., & Domezain, A. (2003). Renal corpuscle of the sturgeon kidney: An ultrastructural, chemical dissection, and lectin-binding study. The Anatomical Record Part A: Discoveries in Molecular, Cellular, and Evolutionary Biology, 272(2), 563-573. https://doi.org/10.1002/ar.a.10068

Pearson, A., Gafner, S., Rider, C. V., Embry, M., Ferguson, S. S., & Mitchell, C. A. (2022). Plant vs. Kidney: Evaluating Nephrotoxicity of Botanicals with the Latest Toxicological Tools. Current Opinion in Toxicology, 100371. DOI: 10.1016/j.cotox.2022.100371.

Petrosyan, A., Cravedi, P., Villani, V., Angeletti, A., Manrique, J., Renieri, A., & Da Sacco, S. (2019). A glomerulus-on-a-chip to recapitulate the human glomerular filtration barrier. Nature communications, 10(1), 3656. https://doi.org/10.1038/s41467-019-11577-z.

Porter, R., & Crosby, A. W. (1998). The Greatest Benefit to Mankind: A Medical History of Humanity from Antiquity to the Present. Nature, 391(6664), 241-241.

Radi, Z. A. (2020). Kidney transporters and drug-induced injury in drug development. Toxicologic Pathology, 48(6), 721-724.

Shaw, D., Gohil, K., & Basson, M. D. (2012). Intestinal mucosal atrophy and adaptation. World journal of gastroenterology: WJG, 18(44), 6357. doi: 10.3748/wjg.v18.i44.6357,

Sultan, G. A., Al-Haaik, A. G., & Alhasso, A. A. (2023). Morphometrical and Histochemical study of glandular stomach (Proventriculus) in local domestic male ducks (Anase Platyrhchos). Iraqi Journal of Veterinary Sciences, 37(1), 65-71.DOI: 10.33899/IJVS.2022.133451.2233.

Yang, H., Xiong, X., Wang, X., Tan, B., Li, T., & Yin, Y. (2016). Effects of weaning on intestinal upper villus epithelial cells of piglets. PloS one, 11(3), e0150216. https://doi.org/10.1371/journal.pone.0150216.

Yousif, R. R., & Rabee, F. O. (2019). Anatomical and histological study of kidney, ureter and urinary bladder in male guinea pig (Cavia porcellus). The Iraqi Journal of Veterinary Medicine, 43(1), 75-84. https://doi.org/10.30539/iraqijvm.v43i1.476.