RESEARCH ARTICLE

GROSS ANATOMY AND HISTOLOGY OF THE URINARY SYSTEM OF THE SPUR-WINGED GOOSE (*PLECTROPTERUS GAMBENSIS*)

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Original Submission: 12 January 2024
Revised Submission: 28 March 2024
Accepted: 15 April 2024

How to cite this article: Majama YB, Wulgo AM, Malah MK, Kwabe ID. 2024. Gross anatomy and histology of the urinary system of the spur-winged goose (*Plectropterus Gambensis*). Veterinaria, 73(1), 53-61.

ABSTRACT

This research aimed to investigate the gross anatomy and histology of the urinary system of the Spur-winged goose. A total of 10 matured healthy Spur-winged goose, 5 males and 5 females were used for this study. These birds are collected from a commercial poultry farm in Damaturu, Yobe State, Nigeria and transported to the Gross and Histology Postgraduate Research Laboratory of the Department of Veterinary Anatomy, University of Maiduguri, Nigeria. The birds were acclimatized for 10 days, before euthanized. The abdominal cavity of the birds was exteriorized to grossly observe the kidneys, ureters and cloaca before harvested for microscopic study. Grossly, the kidney appeared brownish, dorso-laterally flattened with three distinct lobes. The ureter appears as a tubular vessel emanating from the kidneys and enters the cloaca at the dorsomedial aspect. The cloaca was observed as a common organ that connects the urinary, reproductive and digestive system. Histologically, the kidney parenchyma was divided into renal cortex and medulla, containing the central vein and renal corpuscles respectively. The lamina epithelia of the ureter were lined with a pseudostratified columnar epithelium containing loose connective tissues and lymphoid cells. The mucosa of the cloaca possesses a short and slender villi projection. Currently, there is no baseline information regarding the anatomic characteristics of the urinary system of the Spur-winged goose. Therefore, this present study serves as firsthand information on the anatomy of the urinary system of the Spur-winged goose.

Keywords: Avian, cloaca, kidney, ureter, waterfowl

doi.org/10.51607/22331360.2024.73.1.53

INTRODUCTION

Geese are among water birds of the family Anatidae. The Anatidae family is a biological family of birds that includes geese, swans and ducks (Makram, 2018). It has many subfamilies, those related to geese and swans are Plectropterinae, Anserinae, and Tadorninae respectively (Johnsgard, 2010). Geese are regarded as an important species economically due to their resistance to most avian diseases, ability to tolerate a wide range of adverse conditions, and large egg size (Jalaludeen et al., 2004; Patki et al., 2012). Generally, geese are herbivorous, and are monogamous breeders. There are more than 50 wild hybrids from wild species that undertake annual migrations (Makram, 2018). They are excellent producers of eggs and meat from very low-quality waste products, and therefore large expenses are not needed for their management (Dekaet al., 2015).

The Spur-winged goose (*Plectropterus gambensis*) is considered members of the aquatic bird family (Anatidae), which is classified as one of the 10 subfamilies (Plectropterinae). Africa is the native home of this species where it's found in a number of African countries like South Africa, Tanzania, and Algeria (Daniels, 2008), but reported to be extinct in Egypt (Makram, 2018). They are also among the groups of large African waterbirds (CRC, 2008). The characteristic features of the Spur-winged goose include a body covered with black feathers, white patches around the eyes, face and wings respectively. They have long pinkish legs adapted for swimming. The male can be easily distinguished from female, by the presence of a large red facial patch that extends back from the red bill and presence of a knob at the base of the upper mandible (Ogilvie and Young, 2004). Generally, Spur-winged goose prefer quiet stretches of riverbanks and wetlands for breeding, and are also among the migratory birds designated to be conserved by the Conservation of African-Eurasian Migratory Water birds (AEWA) (Warwik, 2002).

The urinary system of birds comprises paired kidneys, ureters and a cloaca (Mobiniand Abdollahi, 2016). The kidneys are reddish brown, elongated and flattened (Singh et al., 2023). Consequently, each ureter opens into the urodeum of the cloaca, serving as the passage for urine to exit the body (Alabdallah, 2022). The cloaca is a common organ that connects the urinary, digestive, and reproductive system in birds, which consists of three compartments; coprodeum, urodeum and proctodeum respectively (Joshi and Meshram, 2018). The renal system of birds is considered very special among the vertebrate species (Echols, 2006), due to the presence of two types of nephrons (Bacha and Bacha, 2012), absence of renal pelvis (Dhyaa et al., 2014), and urinary bladder (PourhajiMotab and Rasuli, 2021) except in Ostrich and Rheas due to separate storage of urine and feces (Al-Ajeely and Mohammed, 2012). Presently, there are very few valuable reports peculiar to morphologic characteristics of the urinary tract of waterfowl species, despite the numerous existing literatures on the general anatomy of avian urinary systems. The present study was aimed at investigating the gross anatomy and histology of the urinary system of the Spur-winged goose with emphasis on the kidneys, ureters and cloaca respectively.

MATERIALS AND METHODS

Ethical consideration

This research work was approved by the University of Maiduguri Animal Use and Ethics Committee (AUEC). The research approval code (AUP-R004/2023) was received from the University of Maiduguri Animal Use and Ethics Committee (AUEC).

Animals

This study was conducted on 10 matured healthy Spur-winged goose, 5 males and 5 females. These birds were collected from a poultry commercial farm and transported to the Gross and Histology Postgraduate Research Laboratory of the Department of Veterinary Anatomy, University of Maiduguri, Nigeria. The birds were allowed to acclimatize for 10 days in a special wooden

cage. Commercial poultry diet and water was provided ad libitum. According to a technique previously described by Majama et al. (2016), the body weight of the geese was recorded using an electronic balance just prior to euthanasia. Euthanasia was achieved using ketamine (25mg/kg) and xylazine (5mg/kg) administered through the wing vein of matured geese, as described by Durrani et al. (2008).

Gross study

The birds were placed on a dorsal recumbency on an examination table. The abdomen was carefully dissected with a sterile scissors and scalpel blade. Blood, fat, and other tissues attached to the abdominal structures were gently removed to exteriorize the urinary tract of the bird. Photographs of the organs at different anatomical planes were taken using a Nikon D90 digital camera.

Histological study

According to Winsor (1994), about 0.5-centimeter square of each of the kidney, ureter and cloaca tissues were collected immediately after gross examination. These tissues were fixed in 10% formalin for 48 hours, dehydrated with graded levels of ethyl alcohol (70%, 90%, and 100%), and embedded in paraffin wax to form tissue blocks. The blocks were then sectioned at 4µm thickness, placed on glass slides and stained with hematoxylin and eosin (H&E). Thereafter the slides were viewed using DB2-180M digital biological microscope at different magnifications (×100, and ×400), and relevant photomicrographs of the sections were taken using Scope image version 9.0 (AD 2.0) software.

RESULTS

The gross study of the kidney of the Spur-winged goose showed the kidney appears as a brownish-flattened organ located intra-abdominally, occupying the synsacral fossa (Figure 1). The kidney is characterized by the presence of cranial, middle and caudal lobes, respectively. The ureter was observed as a tubular organ emanating from the kidneys and entering the cloaca at the dorsomedial aspect. The cloaca was observed as a common organ that connects the urinary, reproductive and digestive system (Figure 2).

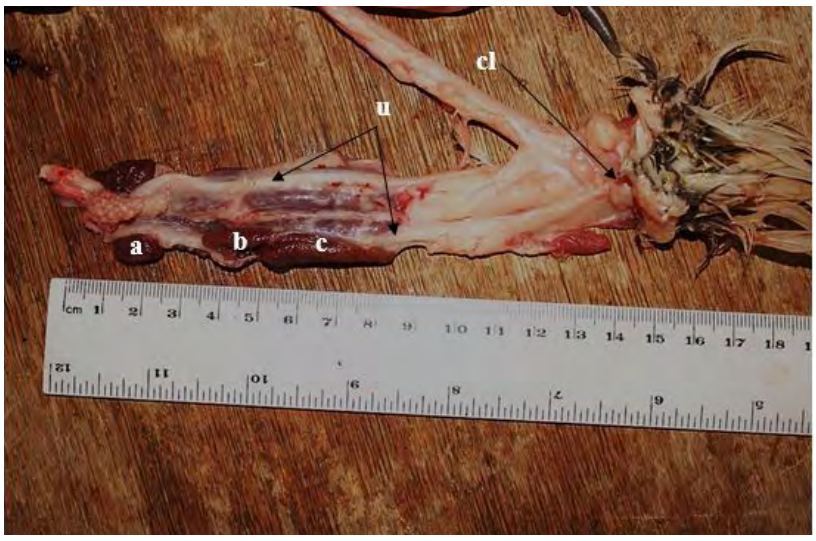

Figure 1 A Photograph showing the gross appearance of some organs related to the urinary system within the abdominal cavity of the Spur-winged goose. (a) Heart, (b) Lungs, (c) Ovary, (d) Kidney and (e) Intestine

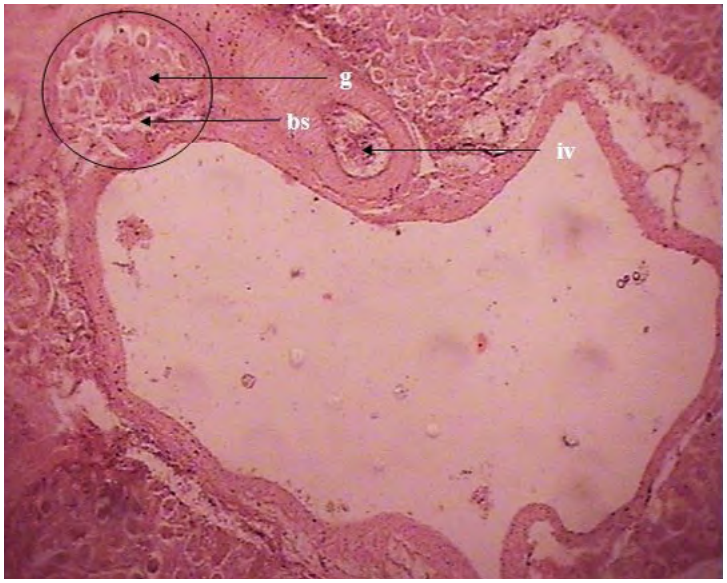

Figure 2 A Photograph showing the dorsal view of the kidney with distinct (a) cranial lobe, (b) middle lobe, (c) caudal lobes, (u) ureters, and (cl) cloaca

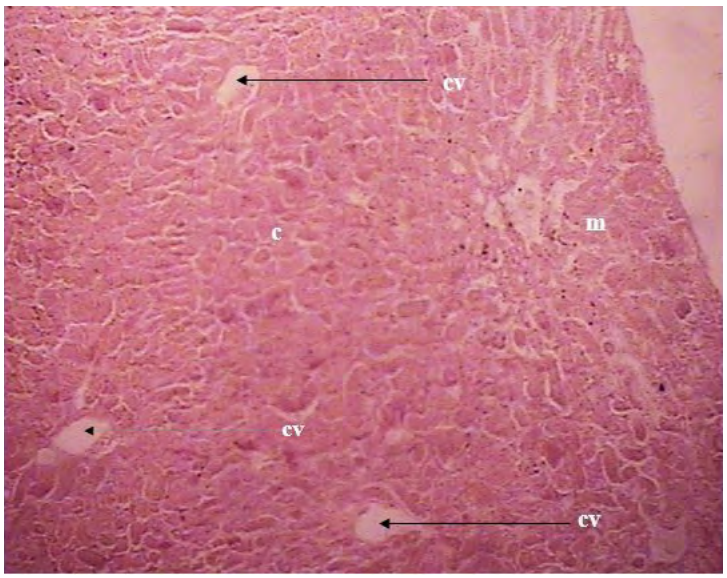

Figure 3 Photomicrograph of the kidney parenchyma: showing the (cv) central vein, (c) cortex, (m) medulla. H&E stain 100x

The histological section of the kidney showed a cortical and medullary region, and a central vein seen at the cortical region (Figure 3). The renal corpuscle consists of an outer Bowman's capsule, separated from the glomerulus by a centrally located space (Bowman's space). Intralobular vein is also visible (Figure 4). The glomerulus consists of tightly packed mesangial cells, surrounded by glomerular capillaries and podocytes (Figure 6). The kidney parenchyma consists of the proximal and distal tubules with an intralobular vein (Figure 7). The histological sections of the ureter showed the mucosa distinct layers; stratified transitional epithelial cells at the lamina epithelialis, the lamina propria was seen containing loose connective and lymphoid tissues, and the tunica muscularis was also seen (Figure 8). The tunica musculari swas seen having smooth muscle fibers arranged in outer longitudinal, middle circular and inner longitudinal muscle fibers at the urodeum. The cloacal mucosa was characterized with pseudostratified epithelium possessing projecting villi. The lamina propria possesses loose connective tissues (Figure 9).

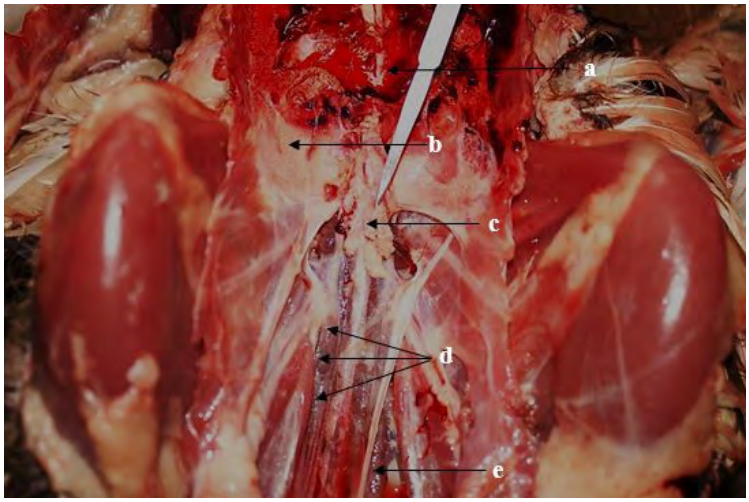

Figure 4 Photomicrograph of the kidney parenchyma showing: (circle) renal corpuscle, (g) glomerulus, (bs) Bowman's space and (iv) intralobular vein H&E stain 100x

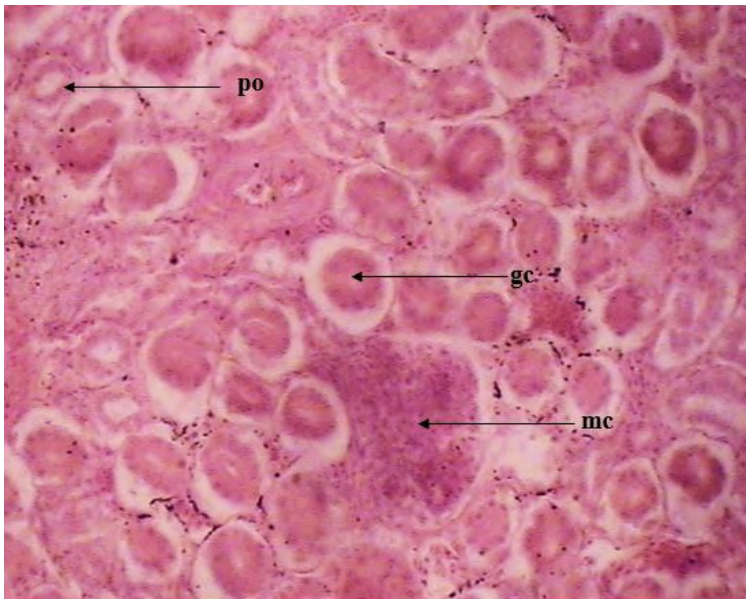

Figure 5 Photomicrograph of the glomerulus and Bowman's capsule showing: (gc) renal glomerular capillaries, (mc) mesangial cells, (bs) Bowman's space, and (pbs) parietal layer of Bowman's space. H&E stain 100x

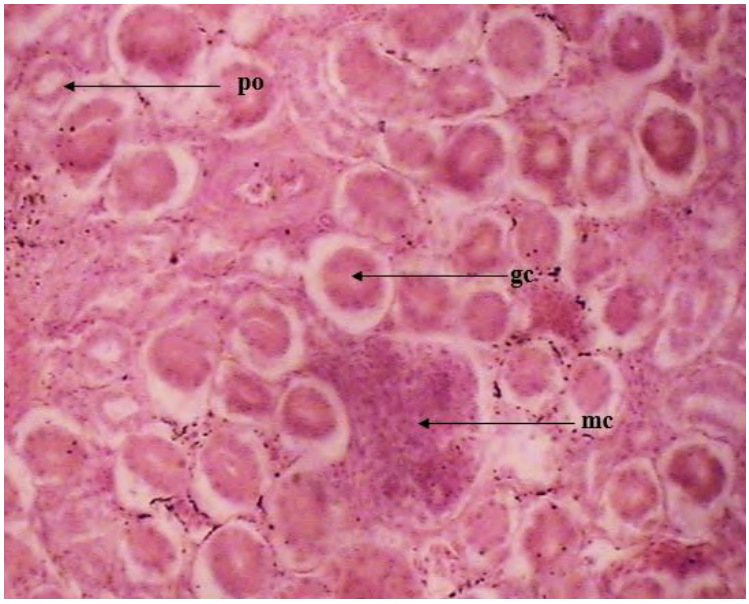

Figure 6 Photomicrograph of the glomerulus showing: (gc) glomerular capillaries, (mc) mesangial cells and (po) podocytes H&E stain 400x

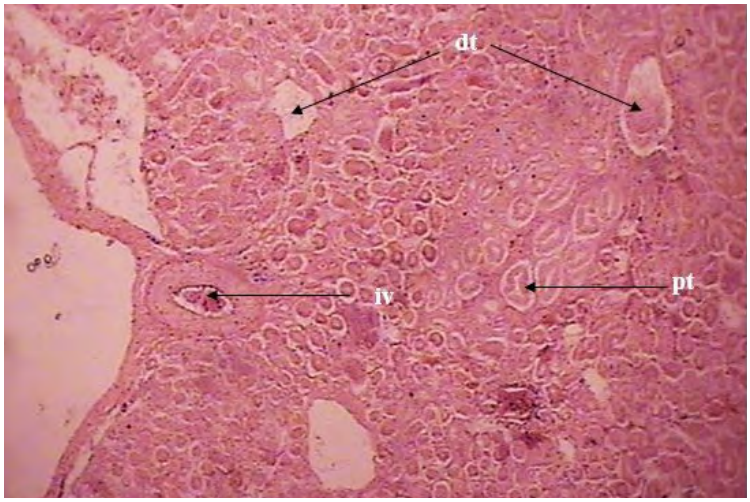

Figure 7 Photomicrograph of kidney parenchyma showing: (dt) distal tubules, (pt) proximal tubule, and (iv) intralobular vein H&E stain 100x**.**

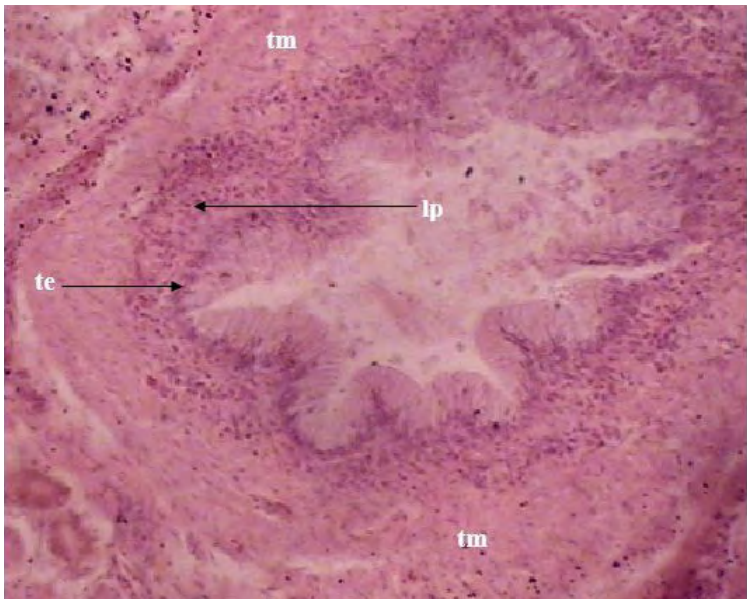

Figure 8 Photomicrograph of the ureter showing: (te) transitional epithelium, (lp) lamina propria, and (tm) tunica muscularis. H&E stain 400x

Figure 9 Photomicrograph of the cloaca showing: (pc) pseudostratified columnar epithelium, (lp) lamina propria and (ln) lymphoid nodules. H&E stain 400x

DISCUSSION AND CONCLUSION

The avian kidney is considered a vital organ of excretion involved in the removal of excess water and metabolic waste from the system (Mobini and Abdollahi, 2016). This present study reveals that the kidneys of Spur-winged goose were positioned retroperitoneally, located between the synsacrum and the iliac fossa as observed by Singh et al. (2023) in Pratapdhan bird, Pourhaji Motab and Rasuli (2021) in Pheasant, and Dhyaa et al. (2012) in harrier, chicken, and Mallared. In most species of birds, the kidneys were reported as dorso-laterally flattened and reddish brown in colour. This report was similar to the present study and that of Khadim and Daoud (2014) in barn owls, Reshag et al. (2016) in Great flamingo and Singh et al. (2021) in Guinea fowl. In contrast, Dhyaa et al. (2014) reported grayish colouration of the kidneys in Mallard ducks, brownish red to dark red in adult pigeon (Al-Ajeely and Mohammed, 2012), pink to brownish in canary (McLelland, 1990). This could be attributed to the amount of blood supply to the kidneys and ecological variation among avian species. The kidney was incompletely divided into cranial, middle and caudal lobes, with the caudal lobe being the largest, which concur to that of other avian species reported by Abdul-Gahaffor et al. (2012) in racing pigeon, Batah (2012) in coot bird, and Singh et al. (2021) in Guinea fowl.

The ureter connects the kidney to the cloaca, serving as the passage for metabolic waste and urine to exit the body (Alabdallah, 2022). The ureter was seen grossly as a tubular organ running from the medial aspect of the kidney to the dorso-medial aspect of the cloaca where it enters as the urodeum. This finding is similar to most avian ureters as reported by Al-Ageely and Mohammed, (2012) in racing pigeon, Sreeranjini et al. (2010) in Japanese quails, Kumar et al. (2018) in the Aseel and Rhode breed of poultry.

The cloaca is considered a significant region as outer opening to the urinary, digestive and genital organs that functions as a site for thermoregulation in birds (Hoffman et al., 2007). The three compartments, namely, the coprodeum, urodeum and proctodeum are found fused and positioned cranially to caudally, which are similar to most avian species as reported by Mohammed (2017) in Turkey and Joshi and Meshram (2018) in White leghorn fowl. The coprodeum appears as the largest of the three compartments of the cloaca, as reported by Gumus et al. (2004) and Oliveria (1996) in domestic fowl, and Mohammed (2017) in turkey.

Histologically, the kidney parenchyma is simply divided into the renal medulla and renal cortex which are not markedly divided. The cortex makes up a vast section of the kidney, enclosing the central vein and the medulla, making up a small portion similar to most avian kidneys hence coincides with the report of Nabipour et al. (2009). This finding also agrees with that of Al-Ajeely and Mohammed (2012) in racing pigeons, and Guo et al. (2014) in Ningdu yellow chicken. The proximal and distal convoluted tubules are lined with a simple columnar epithelium (Bacha and Bacha, 2012), except for the presence of brush border lining the surface of the epithelium in the proximal tubule, which is similar in other avian species, as reported by Nabipour et al. (2009) and Dhyaa et al. (2014). In contrast, a simple cuboidal epithelium was reported in racing pigeon (Al-Ajeely and Mohammed, 2012), and in coot bird (Batah, 2012). The renal corpuscles comprised of the Bowman's capsule, which is separated from a centrally located glomerulus by a space (Bowman's space). The glomeruli are lined externally with the parietal cells containing mesangial cells, podocytes, and capillaries. This agrees with the findings of Batah (2012), who reported that the renal cortex of coot bird was composed of large and small renal corpuscles, each containing a Bowman's capsule and glomerulus.

Histologically, the mucosa of the ureter is lined with stratified transitional epithelium, similarly agreeing with the findings of Al-Ajeely and Mohammed (2012) in racing pigeon. The muscularis layer consisted of inner circular and outer longitudinal muscle fibers and the adventitia as the last layer seen in most avian ureters, as reported by Mirabella et al. (2007) in duck, and Oliaii and Mobini (2017) in Japanese quails.

Histologically, the cloacal mucosa of the urodeum possesses tall villi lining the surface of the epithelium. These findings tally with Oliveira et al. (2004), who reported the same in ratite birds,except that there are abundant mucosal glands and the villi are thicker and pyramidal in nature. In contrast, Joshi and Meshram (2018), reported that the tunica mucosa of white leghorn fowl containeds short and flat villi. This could be as a result of species variation. The villi were lined with columnar cells, the lamina propria possessed a loose connective tissues and lymphoid cells which agrees with similar features reported by Verma (2000) and Joshi and Meshram (2018) in chicken and white leghorn fowl, respectively.

The Spur-winged goose has particular anatomical characteristics that contribute to its distinguishing look and functioning. The urinary system lacks a bladder, therefore, urine is eliminated via the urodeum of the cloaca. Currently, not much information has been documented on anatomical characteristics of urinary system of Spur-winged goose. Therefore, this present study serves as resourceful information on the gross anatomy and histology of the urinary system of the Spur-winged goose.

ACKNOWLEDGEMENTS

The authors appreciate the technical support received from the Staff of Gross Anatomy and Histology Laboratory, Department of Veterinary Anatomy, University of Maiduguri, Nigeria.

CONFLICT OF INTEREST

The authors declared that there is no conflict of interest.

CONTRIBUTION

Concept and Design–YBM; Supervision and Fundings–YBM; Materials and Data collection and/or processing–IDK; Literature review and Analysis and/or interpretation of the data–MMK; Writing and Critical review–AMW.

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ANATOMIJA I HISTOLOGIJA URINARNOG SISTEMA OSTRUGASTE GUSKE (PLECTROPTERUS GAMBENSIS)

SAŽETAK

Cilj istraživanja je ispitati anatomiju i histologiju urinarnog sistema Ostrugaste guske. U istraživanje je uključeno ukupno 10 zrelih zdravih jedinki Ostrugaste guske, od čega 5 mužjaka i 5 ženki. Ptice su nabavljene sa komercijalne peradarske farme u Damaturu, u državi Yobe u Nigeriji i prevezene u Postdiplomski istraživački laboratorij za anatomiju u histologiju Katedre za veterinarsku anatomiju Sveučilišta Maiduguri u Nigeriji. Ptice su aklimatizirane u trajanju od 10 dana prije nego što su eutanizirane. Potom je izvršena eksteriorizacija abdominalne šupljine gusaka zbog makroskopskog pregleda bubrega, uretera i kloake, prije pripreme za mikroskopski pregled. Bubrezi su makroskopski izgledali smeđkasti, dorzolateralno spljošteni sa tri jasno uočljiva lobusa. Ureteri su izgledali poput cjevastih šupljina koje se odvajaju od bubrega i ulaze u kloaku sa dorzomedijalne strane. Kloaka se doimala kao zajednički organ koji povezuje urinarni, reproduktivni i digestivni sistem. Histološki, bubrežni parenhim je podijeljen na bubrežnu koru i srž koje sadrže i centralnu venu i renalne kosrpuskule. Ureteralna Lamina epithelialis je obložena sa pseudostratificiranim cilindričnim epitelom koji sadrži rijetko vezivno tkivo i limfoidne stanice. Kloakalna sluznica posjeduje kratke i tanke vile. Trenutno ne postoje osnovne informacije o anatomskoj građi urinarnog sistema Ostrugaste guske. Stoga naše istraživanje služi kao osnova za poznavanje anatomije urinarnog sistema ove vrste.

Ključne riječi: Bubreg, ptičija, kloaka, ureter, vodene ptice