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Anatomical and Histomorphological Study on the kidney of Awassi Sheep (*Ovis aries*)

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Abstract

THE PURPOSE of the present study was to explore the anatomical and histological features of sheep kidneys, focusing on their positioning, shape, and structural characteristics. Ten healthy adult male Awassi sheep (Ovis aries) were examined for histological study of the kidneys (left &right) using H&E stain, Masson trichrome, Periodic Acid Schiff (PAS)-Alcian blue, and Toluidine blue. The study found both kidneys to be retroperitoneal, with the right kidney located between the 12th thoracic vertebra and the 2nd lumbar vertebra, while the left kidney was beneath the first three lumbar vertebrae, and they having a smooth, bean-shaped appearance, with no significant differences in their weight, length, width, and circumference. Histologically, both kidneys showed no significant differences in capsule thickness, number and diameter of renal corpuscles, and diameter of Bowman's space in addition to their normal histological structure. The distribution of collagen fibers in the left and right kidneys did not differ as revealed by Masson's trichrome stain. Periodic Acid Schiff (PAS)-Alcian blue stain showed moderate activity in the right and left kidneys, but cortical renal tubules showed higher stain affinity compared to medullary tubules. The result of the Toluidine blue stain showed faint responses in the medulla and cortex, with no differences between right and left kidneys. This finding suggests that tissues contain acidic structures, especially glycosaminoglycans. In conclusion, this study reveals no differences between the right and left kidneys, enhancing the understanding of the anatomical and histological characteristics of sheep kidneys, which is crucial for physiological and pathological research.

Keywords: Awassi sheep, kidney, Histology, Anatomy, Special stain.

Introduction

Awassi sheep constitutes a major portion of the sheep population in Iraq. The domestication of sheep dates back to between 11,000 and 9,000 BC, making them one of the earliest animals domesticated by humans. Initially, sheep were raised for meat, milk, and wool production and can sustain the cold to hot climates [1]. In Iraq, sheep are the most significant livestock, with the annual income from meat, milk, and wool production contributing approximately 60%, 25%, and 15% respectively [2].

The kidneys are the main urinary system organ, being responsible for maintaining the body hydro electrolytic balance So, the principal function of urinary system is maintenance of water and electrolyte homeostasis and control of the blood pressure. The second major function of this system is the excretion of many toxic metabolic waste products particularly the nitrogenous compounds urea and creatinine from the body [3,4].

The kidneys also have endocrine function; they produce several hormones, such as: renin hormone, which converts the plasma protein angiotensinogen into angiotensin I. BradyKinin is another hormone produced by the kidney, it enhances renal blood flow through vasodilation and promotes natriuresis by preventing sodium reabsorption, bradykinin is broken down by peptidases. Erythropoietin produced by kidneys, enhances erythropoiesis. Selective reabsorption and conservation of useful substances, like glucose and sodium chloride occurs in the kidney [4,5].

Anatomically the kidneys of sheep are bean shaped located retroperitoneally, either against the lumbar muscles or suspended from the dorsal abdomen [6]. Typically, the right kidney sits slightly more cranial than the left. A single indentation, the

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hilus, accommodates the passage of the renal artery and vein, lymphatics, nerves, and the ureter. The surface of the kidney is enclosed in a fibrous capsule primarily composed of collagen fibers, along with smooth muscle and blood vessels [7].

Histologically, the kidney parenchyma is formed of peripherally located darker color, the cortex, and a centrally situated paler color, the medulla and renal pelvis. The kidney tissue is rich in nephrons which considered the functional unit of the kidney, and has a highly varied structure across various vertebrates; the nephron's development also exhibits a range of species-specific variations [8]. The nephron's consists of the renal corpuscles and its associated tubular system, the renal corpuscles and its convoluted part of tubular system located in the cortex, while the rest of urinary tubules extends into the medulla. The medulla has stripped appearance as it contains vertical nephron structures (tubules, collecting ducts) [3]. Network reticular fibers that ran from the capsule to the papilla apex were present in the interstitial tissue. Simple columnar epithelium that becomes transitional before emerging into the papilla lines the papillary duct [6,9,10].

The goal of the current investigation was to examine the placement, shape, and structural properties of the sheep kidneys in relation to their anatomical and histological features.

Material and Methods

Ethical approval

This cross-sectional study protocol and experimental dealing with animals was approved and performed according to the recommendations established by the Animal Welfare and Experimentation Ethics Committee College of Veterinary Medicine, University of Duhok, Kurdistan region, Iraq, with reference number (DR1996919CV approved on June 11, 2019).

Study area and Sample Collection.

The present study was conducted in the Department of Theriogenology, Physiology and Anatomy, College of Veterinary Medicine, University of Duhok. All kidney samples were collected at Duhok modern slaughterhouse at Khanke, Duhok City, Iraq.

A total of twenty kidneys were collected from healthy adult age of the local breed Awassi sheep (*Ovis aries*) ranging from (1-3) years old.

Examination of the animal

Before slaughtering, all animals were routinely inspected physically by the veterinarian to check on body health condition of the animals, a case report was prepared to record all information related with the animals. Gender of animals were selected first. Then, these animals were numbered in their feet to avoid missing of animal after slaughtering, after that weighed using an electronic balance (Ingco electronic scale, HESA31003; China).

As soon as the animals were slaughtered, fresh kidney organs were taken, put in a labeled nylon bag then put in an ice-filled container, and shipped directly to the laboratory.

Exclusion Criteria

The following criteria were excluded from the study: Other breeds of sheep; small-aged animals; Unhealthy animals; animals that lost their numbers during slaughtering and skinning; Irregular kidneys (extra-large, too small); Damaged kidneys (kidneys that contain abnormal lesions, hematomas, trauma, cysts, or tumors).

Laboratory examinations

Anatomical and Histological study of the kidney:

Anatomical study

According to the [11], with some modification, the excess fat tissue, blood vessels, and ureter were removed from the kidneys' outer surfaces as soon as they were delivered to the laboratory. The kidneys were then grossly inspected and weighed using a sensitive electronic balance (Sartorius B154, ± 0.001 gm, China). Then, using electronic digital Vernier caliper, the length, width, and circumference of each kidney (left and right) were measured (Fig.1).

Following that, each of these kidneys was divided into two parts using a sharp knife in a sagittal plane. Each part was then further divided into numerous small pieces, and three pieces were randomly chosen (one from each of the cranial, middle, and caudal parts) with full thickness from the capsule up to the renal pelvis. These pieces were then preserved in a plastic container containing 10% neutral buffer formalin (Atom Scientific, UK) for 48 hours at room temperature, and they were subsequently processed using the standard paraffin tissue processing method [8].

Histological study

All the samples were processed at the laboratory of Duhok Research Center, College of Veterinary Medicine, University of Duhok, Iraq. After 48 hours fixation of kidney tissue samples in neutral buffered formalin, these samples were then cut into pieces of 4-5 mm thick and put into plastic tissue cassettes. The cassettes were then labeled with a lead pencil so as not to dissolve in water or chemical solvents. After that, the automated tissue processor (LEICA ASP 300S, Germany) was used to process the designated cassettes. The tissue processing method was carried out according to [12] instructions, which include dehydration with ascending grades of ethyl alcohol, then followed by clearing with Xylene until the tissue becomes transparent, after that the tissue

specimens were Impregnated by molten paraffin wax (melting point 56°C) inside an electric oven heated at (56-62°C), next embedded with molten paraffin wax (58-60 °C) and put on cold plate to make a blocks. After that, the blocks were trimmed and a 5µm thickness ribbons were prepared by rotary microtome (Leica RM 2235, Germany). Lastly stained with the following dyes [13]:

Haematoxylin and Eosin (H&E) method to study the detailed histological features; Masson's trichrome method for distinguishing the presence of collagen fibers and smooth muscles in the kidney; Periodic Acid-Shift Alcian Blue (PAS-Alcian blue) method for detection of the acidic and neutral mucins (the Alcian blue at a pH of 2.5 stained acid mucins with deep blue color (cell nuclei), whereas the PAS stained the neutral mucins bright magenta (cell cytoplasm) which provide examination of glomerular and tubular structures); and Toluidine blue: for highlighting cellular and extracellular structures through binding with nucleic acids and acidic polysaccharides (glycosaminoglycans) strongly, allowing clear visualization of cell nuclei and extracellular matrix components.

Then the examining slides were photographed using a light microscope (Olympus CX23) supplied with a digital camera.

Histological examination and Histomorphometric measurements of the kidney tissues

From H&E staining slides, five sections from each kidney sample (left and right) were randomly selected, then, from each section, ten typical fields were chosen to measure the followings [8]: thickness of capsule ; number of renal corpuscles; diameter of renal corpuscles; diameter of Bowman's (urinary) space.

Statistical analysis

All data were analyzed by one-way analysis of variance (ANOVA). Specific differences between the groups were determined using t-tests by using SPSS program version. The accepted level of significance was $p < 0.05$ [14].

Results

Animal Body weight

In the current study, the live body weight of the sheep (Rams) were ranged from 57 to 80 Kg with an average of 65.7 kg. (Table 1).

Morphometric analysis (position and shape) of the kidney

Both kidneys were retroperitoneal and located opposed to the dorsal body wall. The right kidney was situated between the 12th thoracic vertebra and the transverse process of the 2nd lumbar vertebra, while the left kidney was placed below the transverse process of first three lumbar vertebrae.

The kidneys exhibited a bean-shaped with a smooth surface and lacking an external lobulation, the color of the kidneys was dark red-brown, both kidneys were enveloped by a loosely attached capsule that could be easily detached from the kidney tissue and they were embedded in large amount of fatty tissue. The kidneys have anterior and posterior surfaces, separated by a minor concavity medially and significant laterally, with the hilum at its center, where the renal artery enters and the vein and ureter exit. (Fig. 2 A &B).

As shown in figure (2 C), the kidney's longitudinal section (macroscopic organization) reveals that the kidney's parenchyma is composed of an easily discernible inner striated appearance (medulla) and an outer dark layer (cortex) under the capsule. The renal pyramids were separate, the renal parenchyma is made up of fused pyramids, and there are renal columns in between the pyramids.

Gross Measurements

There were no statistically significance differences in gross measurements between right and left kidney of the sheep (table 1). The weight of the right kidney was 73.47 gm ± 2.65 and in left kidney was 73.01 gm ± 2.87. The length of the right kidney was 7.45 cm ± 0.12 while in left kidney was 7.58 cm ± 0.13. About the width of the right kidney, it was 4.54 cm ± 0.09 and the left kidney width was 4.75 cm ± 0.14. Regarding the circumference of the kidney, it measures 12.14 cm± 0.19 in right kidney and 12.05 cm ± 0.21 in left kidney.

Histological findings of the kidney

The statistical analysis showed that, there were no significance differences between, the thickness of capsule of right kidney was 107.36 µm ± 7.91 and for the left kidney it was 105.15 µm ± 7.11. The number of renal corpuscles for right kidney was 29.36 µm ± 1.57 and for the left kidney it was 28.7 µm ± 1.31. About the diameter of renal corpuscle, it was 153.89 µm ± 9.96 and 154.66 µm ± 8.59 for the right and left kidneys, respectively. Concerning the diameter of bowman's space, it measures 11.94 µm ± 1.18 in right kidney and 11.47 µm ± 0.87 in left kidney (Table 2).

Histological examination of kidney tissues

Hematoxalyin and eosin staining tissues

Histological study of the right and left kidney sections showed that the cortical and medullary regions had normal histological structure. These regions also showed normal architecture of the glomeruli, proximal, and distal convoluted renal tubules, as shown in Figures 3 (A, B, C, &D) and 4 (A, B, C, D, E, & F) respectively.

The sheep kidney's comprised cortex and medulla. Henle loops, renal corpuscles, and convoluted tubules make up the majority of the cortex. A

network of capillaries that ran parallel to the collecting tubules, collecting ducts, and straight tubules were visible in the cross section of the medulla. Bowman's capsule, a double-layered capsule, envelops the tuft of capillaries that make up the renal corpuscle. Bowman capsule consists of a parietal layer of simple epithelium and a visceral layer of modifies cells, tightly fitted over the glomerulus. The space between the layers is called Bowman space or renal space, leading to the proximal tubule. Other pole of renal corpuscle was vascular pole which containing afferent and efferent arterioles, mesangial cells, and a distal convoluted tube with macula densa, which was closely connected.The study reveals that proximal convoluted tubules were lined by tall cuboidal epithelium with spherical to oval nuclei, while distal convoluted ubules were lined by low cuboial epithelium with a spherical nucleus. The distal tubules lead to collecting tubules and then join the collecting ducts to reach the renal pelvis.

Special stain findings

Masson trichrome stain

The results of the Masson trichrome stain, revealed that the capsule of the left and right kidneys composed of an outer layer and an inner layer. The outer layer was consisted of large amount of collagen fibers which stained green in color and a fewer amount of smooth muscle fibers which stained red in color. While the inner layer of capsule was composed of large amount of smooth muscle fibers and little amount of collagen fibers and reticular fibers (Fig. 5A&C). Collagen fibers were scattered among the kidney parenchyma particularly in interstitial connective tissue between kidney tubules (Fig. 5B, D,E,&F) . The result indicated that there was no difference in the distribution of collagen fibers in the left and right kidneys.

(PAS)- Alcian blue stain

In present study, a stain of the PAS-Alcian blue was used in order to demonstrated the acid mucin from neutral mucin in the kidney tissues. As mentioned above in methodology, the Alcian blue at a pH of 2.5 stained acid mucins with deep blue color (cell nuclei), whereas the PAS stained the neutral mucins bright magenta (cell cytoplasm) which provide examination of glomerular and tubular structures. The result showed that the tissue sections from both left and right kidneys were moderately stained with this stain. As demonstrated in Figure (6), that the cortex renal tubules showed higher affinity to stain than in medullary tubules.

Toluidine blue stain

Staining kidney (Left and right) tissue sections with toluidine blue stain revealed that the renal cortex stained blue with the absence of magenta color (Fig. 7A, B, and C). While the medulla revealed both blue and slightly prominent magenta color in renal tubules and interstitial connective tissue between tubules, this result indicates the presence of acidic structures within tissues, particularly glycosaminoglycans (Fig. 7D).

Discussion

The result of the current study and other studies [4,5,6,10,15], showed that normally the kidney of Awassi sheep are bean shaped, smooth, lacking an external lobulation and a transparent capsule covering it. In 2018, Singh et al., [9], also reported that the kidneys (left and right) of Marwari sheep (*Ovis aries*) were both smooth, bean-shaped, and reddish brown in color. They were retroperitoneally located at the sublumbar region asymmetrically with the right kidney which located more cranial than the left one. The color of the kidneys were dark red-brown, they were embedded in large amount of fatty tissue, and as shown by [4,5,16], which states that the kidneys' high peri-renal fat content offers them greater location stability. Both kidneys have a thick fibrous capsule, consisting of two layers: an outer fibrous layer with collagen fibers and fibrocytes, and an inner layer with loose connective tissue, these finding was consistent with the results reported by Shang-Jian et al., [17]; Joana et al., (2013) [18]; and Salih, [4] in sheep; Singh et al., (2018) [9]; Gautam et al., (2022) [10] and (2024) [6] and Mohammed & Waheed, [19] in goats.

The study found no significant differences in kidney weight, length, width, or circumference between right and left kidneys, with slight differences in morphology. These results corroborated those of Jabbar et al., (2018) [5], who discovered that there is no discernible variation in the weight of a goat's left or right kidney. Singh et al., (2018) [9], also noted that the right kidney of Marwari sheep (*Ovis aries*) was somewhat longer than the left, and that the weight, width, thickness, circumference, and volume of the right and left kidneys did not differ significantly.

The thick fibrous capsule that protected the sheep's kidneys was composed of two layers: the inner layer, which had more smooth muscle fiber and blood vessels with varying thicknesses between the right and left kidney, and the outer layer, which was rich in collagenous fibrous tissue. This result was confirmed by the use of Masson trichrome stain. Though there were no statistically significant changes between the right and left kidneys, there were modest variations in the thickness of their capsules. These findings matched the knowledge obtained from [7,16,19].

The kidney's macroscopic organization reveals that its parenchyma is made up of an inner, paler medulla with striated appearance and an outer, dark cortex located beneath the capsule. The current study's findings on the sheep kidney's ability to

distinguish between its cortex and medulla are consistent with those of [5,9].

The number and diameter of renal corpuscles and the diameter of Bowman's space revealed no statistically significant differences between the right and left kidneys with a little variation between them; this, as mentioned by [7,8], was due to the close relationship between the structural morphology of the organ.

The findings of this investigation, together with those of [4,7,8,9,16,19], they demonstrated that the renal corpuscle is made up of a double-layered capsule (Bowman's capsule) enclosing a tuft of capillaries called the glomerulus that originated from afferent arterioles. Simple squamous epithelium made up the parietal layer of the Bowman capsule, which rested on a well-developed basement membrane. Modified cells that are present as global cells and are closely fitted over the glomerulus, which is represented by podocytes, make up the inner (visceral) layer. Bowman space, also known as renal space, is the area between the two layers of the Bowman capsule. The proximal tubule is located in the renal pole, which is one of the poles of the renal corpuscle. As demonstrated by [7], that the Mesangial cells, which had important roles like vasoconstrictor, phagocytic role and played key roles in the body, also macula densa were found near the vascular pole of the renal corpuscle.

In present study using the Masson's Trichrome stain in order to differentiated between collagen fibers and muscle fibers and amount of connective tissue in kidney capsule and interstitial connective tissue between kidney tubules. According to the results, the distribution of collagen fibers in the left and right kidneys did not differ. As mentioned by [18] that Masson's Trichrome stain is the best stain when used to stain sheep's kidney to identify peripolar cells (PPCs) in renal corpuscles. Kotob, et al., in (2021) [21] used Masson's Trichrome stain in aged rats and revealed accumulation of collagenous fibers around kidney glomeruli, around stromal blood vessels, around kidney tubules and in an interstitial area.

A combination of Periodic Acid-Schiff (PAS)-Alcian blue stain revealed moderate activity with no remarkable variation between the right and left kidneys. But compared to medullary tubules, the cortical renal tubules displayed a higher stain affinity. Same results obtained by [11] on renal collecting system of goat, revealed mild reaction to PAS. Mohammed & Waheed [19] and Ishiguro et al., (2001) [22] and demonstrated a markable changes in renal tubules and inner medulla by using PAS and Alcian blue staining in mice. Sujana et al., (2021) [23] documented PAS positive activity for the proximal convoluted tubules of kidney tissue and for the cytoplasmic granules in the lining cells of proximal tubules.

Tissue sections with Toluidine blue stain presented faint response to the stain in medulla and not clearly visible in the cortex with no remarkable differences between right and left kidneys. Same result has been documented by [24] and showed positive reaction to Toluidine blue stain on kidney tissue of rats. Joana et al., (2013) [18] and Mohammed & Waheed [19], also, showed moderate reaction to the Toluidine blue stain in kidney tissue of sheep.

Conclusion

This study explores the kidneys of Awassi sheep (*Ovis aries*), providing insights into their physiological adaptations and potential implications for veterinary medicine and animal husbandry. The study found a strong correlation between the right and left kidneys, providing valuable anatomcal knowledge for future comparative studies and guiding Awassi sheep health management practices.

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Conflict of interest: We declared that no conflict of interest.

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Author`s contributions:

The work distributed equally between the team

Fig.1. Photograph shows measuring the length of the kidney using electronic digital Vernier caliper.

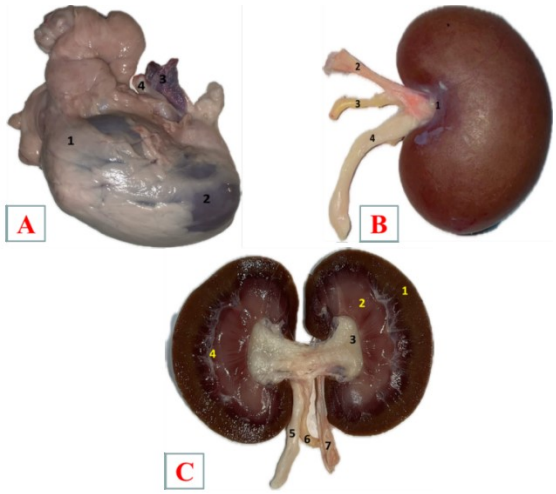

Fig. 2. (A): Photograph of the kidney after immediate removal from the slaughtered animal shows 1. Excessive fat tissue 2. Kidney capsule. (B): Photograph shows the surface anatomy of kidney illustrating, 1. Hilum, 2. Renal vein 3. Renal artery 4. Ureter. (C): Photograph of the kidney sagittal section showing 1. Cortex 2. Medulla 3. Renal pelvis. Renal crest 5. Ureter 6. Renal artery 7. Renal vein

TABLE 1. Body weight and gross measurements of the kidney

	Body weight (kg)	Kidney weight (gm)		Kidney length (cm)		Kidney Width (cm)		kidney circumference (cm)	
		R	L	R	L	R	L	R	L
Mean ± SE	65.7	73.47± 2.65	73.01± 2.87	7.45± 0.12	7.58± 0.13	4.54± 0.09	4.75± 0.14	12.14± 0.19	12.05± 0.21
SD	6.96	8.38	9.08	0.4	0.43	0.28	0.46	0.62	0.69
P value		0.63		0.24		0.15		0.6	

SD= standard deviation, SE= standard error, statistical significance was $P \leq 0.05$.

TABLE 2. Histological investigation of the kidney

	Thickness of Capsule (μm) 40X.		Number of Renal corpuscles (μm) 10X		Diameter of Renal corpuscles (μm) 10X		Diameter of Bowman's space(μm) 10X	
	R	L	R	L	R	L	R	L
Mean ± SE	107.36± 7.91	105.15± 7.11	29.36± 1.57	28.7± 1.31	153.89± 9.96	154.66± 8.59	11.94± 1.18	11.47± 0.87
SD	25.02	22.49	4.98	4.17	31.50	27.18	3.75	2.76
P value	0.46		0.64		0.86		0.77	

SD= standard deviation, SE= standard error, statistical significance was $P \leq 0.05$.

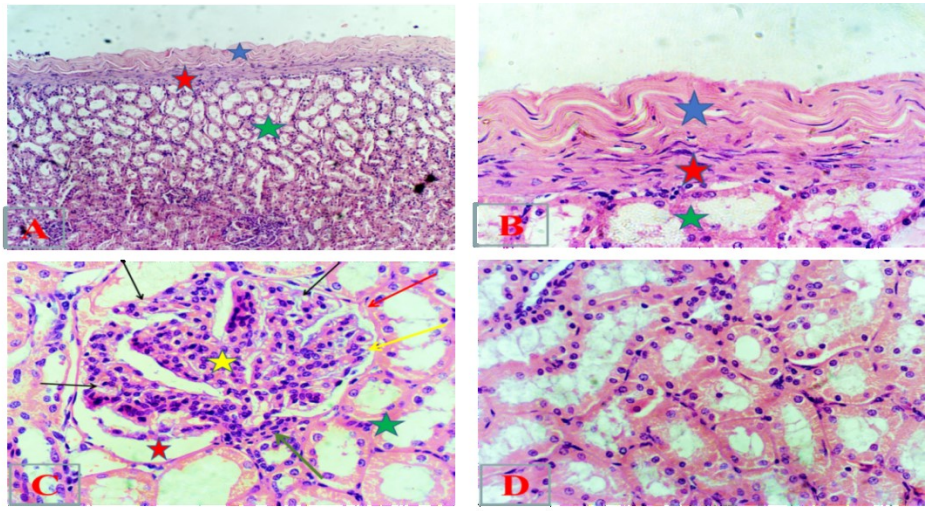

Fig.3. Transvers section through the right kidney of sheep showing normal histological structure of the kidney tissues. A&B: Photograph shows the capsule of kidney composed of an outer fibrous layer (blue star), and an inner smooth muscle layer (red star). Green star indicates the renal cortex which composed renal glomeruli and renal tubules. C: Bowman's capsule which consist of the parietal layer (red arrow); and visceral layer (yellow arrow); peri-glomerular space (Bowman's space) (red star); glomerulus (yellow star); Jaxta glomerula apparatus (green arrow), proximal tubule (green star); and Glomerulus capillaries (black arrows). D: Renal tubules. H&E stain (A: 100X; B, C & D: 400X).

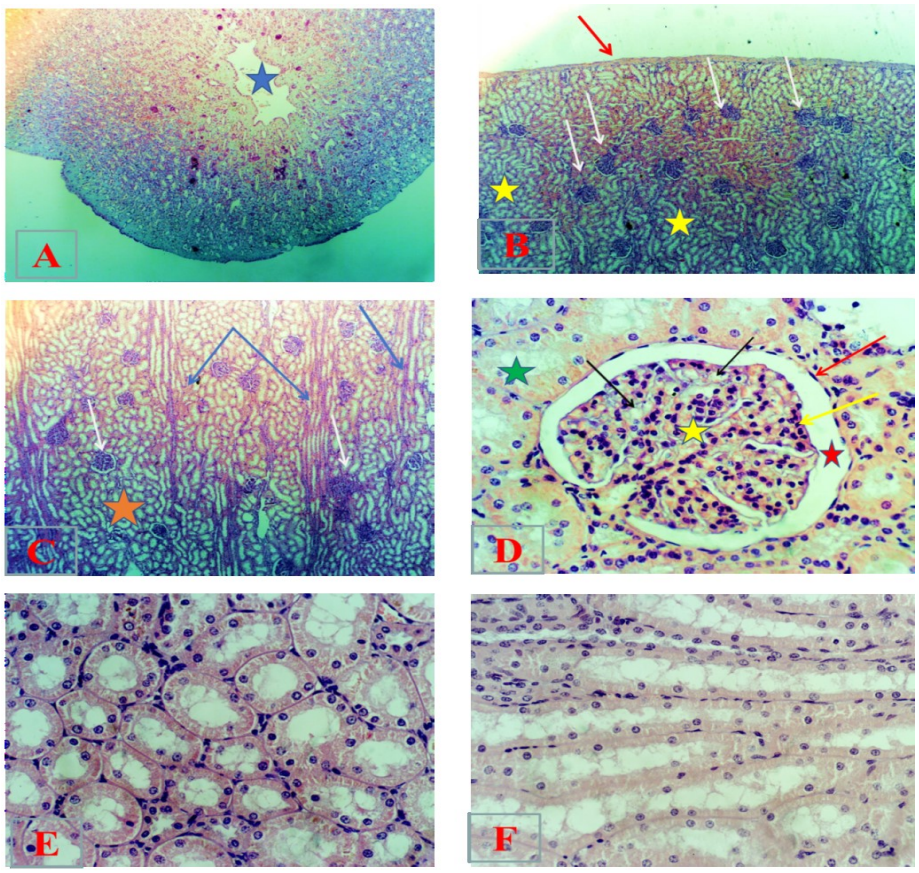

Fig.4. Transfer section through the left kidney of sheep showing normal histological structure of the kidney tissues. A: Photograph shows the renal papilla. B: Photograph of the kidney cortex showing the capsule (red arrow), renal tubules (yellow stars), and glomeruli (white arrows). C: Showing medullary rays (blue arrows), renal tubules (orang star), and glomeruli (white arrow). D: Bowman's capsule which consist of the parietal layer (red arrow); and visceral layer (yellow arrow); periglomerular space (Bowman's space) (red star); glomerulus (yellow star); Glomerulus capillaries (black arrows) and proximal tubule (green star). E: Distal tubules. F: Collecting tubules. H&E stain (A,B, & C: 40X; & D, E & F: 400X).

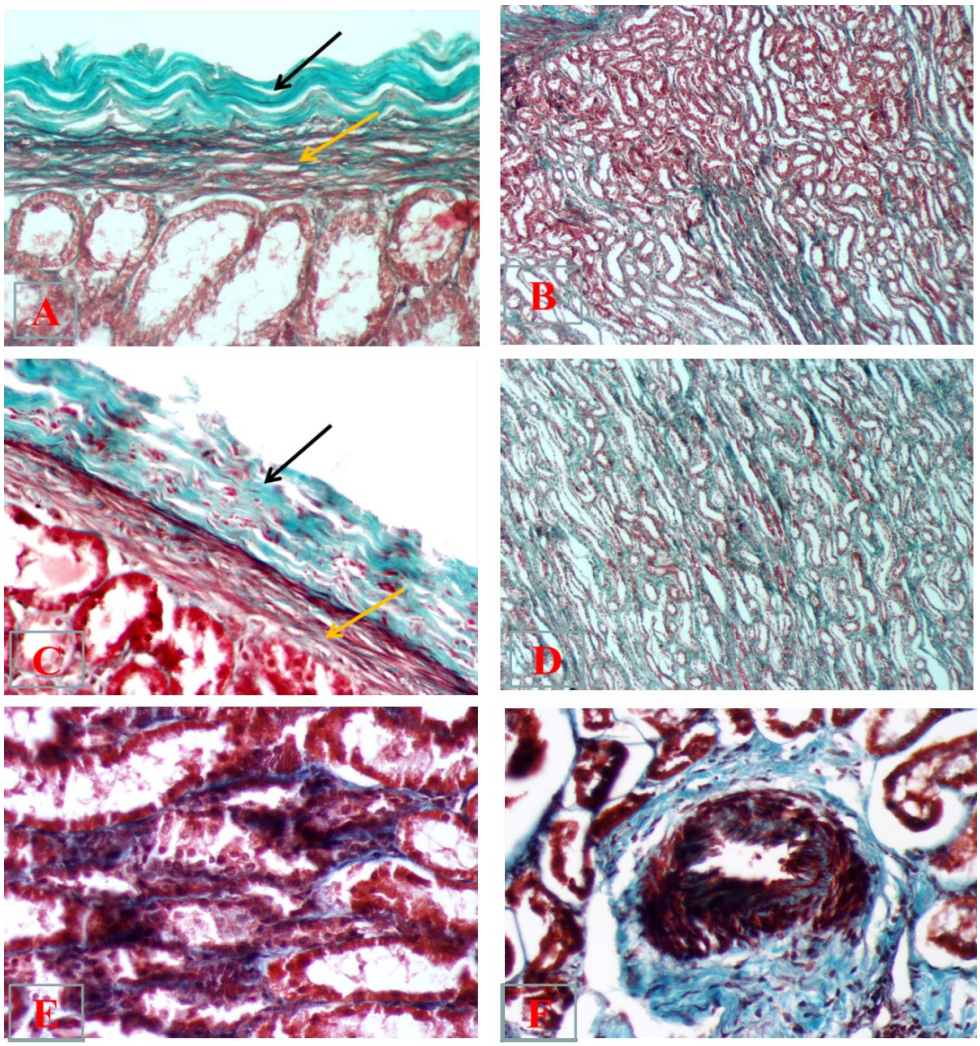

Fig. 5. Photomicrograph of the left (A&B) and right (C,D,E&F) kidneys stained with Masson trichrome. (A & C): showing that the capsule of the kidney composed of an outer fibrous layer (black arrow), and an inner smooth muscle layer yellow arrow). (B, D, E, &F): showing collagen fibers scattered among interstitial connective tissue particularly between urinary tubules in medulla. A, C,E,F::400X, B&D:100X.

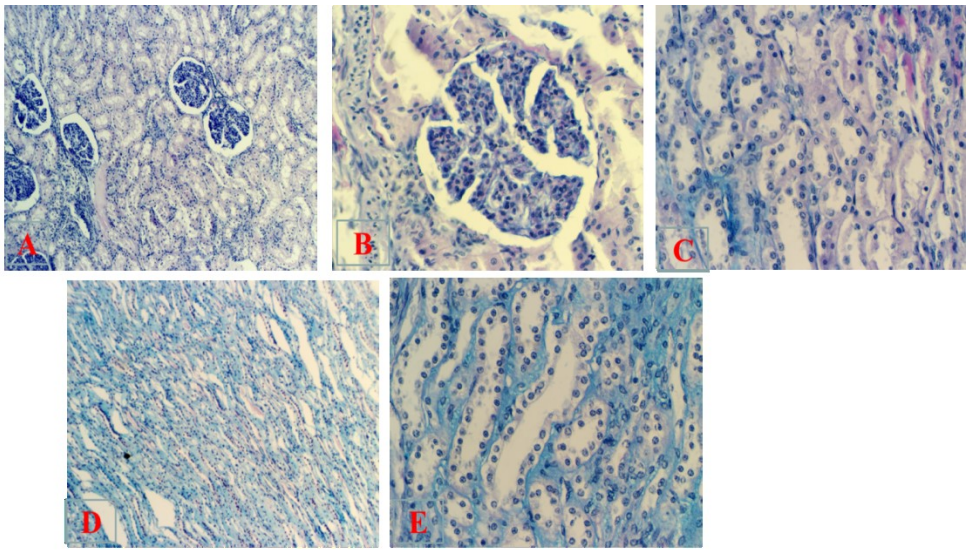

Fig. 6. Photomicrographs showing the dark blue color of cellular nuclei and magenta color of cytoplasm of glomerular mesangial cells and tubular cells with reddish pick color of cytoplasm. PAS-Alcian blue stain. A&D: 100X, B C&F: 400X.

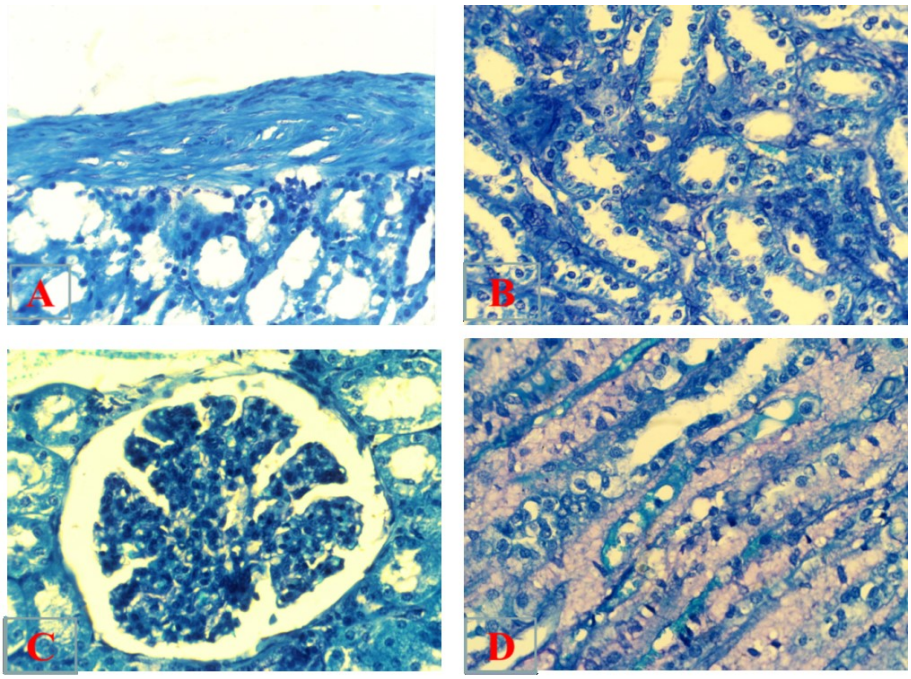

Fig. 7. Photograph shows the sheep kidney tissues staining with Toluidine blue . A, B. & C. the cortical layer reveal the absence of magenta color in renal corpuscle and renal tubules. D: showing the medullary layer which appeared bluish and purple color in an interstitial connective tissue among renal tubules indicating the presence of glycosaminoglycans (GAGs) and proteoglycans within the tissue. stain. 40X. A,B,C,&D:400X.

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دراسة تشريحية ونسيجية لكلى الاغنام العواسية (*Ovis aries*)

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الملخص

الهدف من الدراسة الحالية هو دراسة الصفات التشريحية والنسيجية لكلى الأغنام، وذلك من خلال التركيز على مكان تواجدها في الجسم وشكلها وخصائصها التركيبية. تم الفحص النسيجي للكليتين اليمنى واليسرى لعشرة ذكور بالغين من ذكور الأغنام العواسية (*Ovis aries*) وذلك بأستخدام ملون الهيماتوكسالين والايوسن و ملون ماسون ثلاثي الكروم Masson trichrome وكاشف شيف- حامض البريوديك- زرقة ألأليسان -Periodic Acid Schiff (PAS) Alcian blue و صبغة التولويدين الزرقاء وToluidine blue. بينت نتائج هذه الدراسة تواجد كلتا الكليتين خلف الصفاق، حيث تقع الكلية اليمنى بين الفقرة الصدرية الثانية عشرة والفقرة القطنية الثانية، بينما تقع الكلية اليسرى أسفل الفقرات القطنية الثلاثة الأولى، وتتمتع كلتا الكليتين بمظهر ناعم، وذا شكل يشبه شكل حبة الفول، مع عدم وجود فرق معنوي في وزن وطول وعرض ومحيط الكلى. نسيجيا، أظهرت النتائج بعدم وجود أي فروقات معنوية في كل من سمك الكبسولة ، وعدد وقطر الكبيبات الكلوية، وقطر فسحة بومان في الكليتين اضافة الى إظهارها التركيب النسيجي الطبيعي. وأظهرت نتائج صبغة ماسون ثلاثي الكروم بعدم وجود أي اختلاف في انتشار وتواجد ألياف الكولاجين في الكليتين اليسرى واليمنى. وكذلك اظهر استخدام حمض الدوري شيف- صبغة ألأسيان الزرقاء تفاعلا معتدلًا في الكليتين اليمنى واليسرى لهذا الكاشف، لكن الأنابيب الكلوية القشرية أظهرت استجابة أعلى لهذا الكاشف مقارنة بالأنابيب الكلوية للمنطقة اللبية. وايضا أظهرت المنطقة القشرية واللبية استجابة ضعيفة لصبغة التولويدين الزرقاء ، مع عدم وجود اي فرق بين الكليتين اليمنى واليسرى. تشير هذه النتيجة إلى أن الأنسجة تحتوي على تراكيب حمضية، وخاصة الجليكوزامينوجليكان. الاستنتاج، بينت نتائج هذه الدراسة الى عدم وجود فروقات معنوية بين الكليتين اليمنى واليسرى، مما يعزز فهم الخصائص التشريحية والنسيجية لكلى الأغنام، وهو أمر بالغ الأهمية للبحث الفسيولوجي والمرضي.

الكلمات المفتاحية: الأغنام العواسية، كلى، علم الانسجة، تشريح، صبغات خاصة.