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Morphohistological study of kidney in local cow (*Bos taurus*) in Middle of Iraq

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Abstract
This study's objective was to investigate the kidney's anatomy and histology structure in healthy adults. cow in middle of Iraq. The study was performed on ten adult healthy cow (*Bos taurus*) about (392-485) kg where they were obtained from the local abattoirs of middle of Iraq in Babylon, Karbala and najaf provinces. The anatomical study included the study of the position of the kidney, its relation with the neighboring organs in the body, description of the morphology of the kidney, measurement of its size, weight, diameters which provide that kidney of adult healthy cow were large in size, hard, reddish-brown, bean-shaped retroperitoneal organ situated in the upper abdomen's posterior area and Compared to the left kidney. The right kidney weighed more and was larger.
According to in a capsule made of reticular fibers and a thin layer of fine collagen. The kidney is divided into two regions: the inner region, known as the medulla, is made. upofrenal corpuscles, convoluted tubules, and cortical loops of Henle, whereas the outer region, referre to as the cortex, is mostly made up of straight tubules, collecting ducts, and a special capillary network known as the vasa recta. Depending on where they are located in the renal cortex, renal corpuscles can be classified as cortical, mid-cortical, or juxtamedullary. According to the current study Cows have the longest proximal convoluted tubules, having tall cuboidal epithelial tissue. lining them and a brush border. The distal convoluted tubules in cow kidneys are shorter and less common in sections than the proximal tubules, while the Helene loop is made up of thick and thin limbs that have a relatively larger percentage of short Henley loops and are particularly pronounced in the medulla. From the terminal portion of The collecting duct system, which is encircled by cuboidal epithelium, is connected to the distal tubule by a short segment. tubules continue. Eventually, the collecting duct is separated into two sections: the cortical and medullary collecting ducts.

Keywords: Cow, kidney, microscopic, *Bos taurus*

Introduction
Inland fisheries, backyard chicken farming, and livestock (sheep, goats, cattle, camels, and b uffaloes) are vital sources of revenue and protein for the rural populace.
In the past, livestock production accounted for 30-40% of agricultural production value and made a substantial contribution to household nutrition (FWO, 2012). Commonly referred to as cows, cattle are domesticated herbivorous mammals belonging to the Bovidae family.
They have been tamed because to their gentle disposition, a comparatively basic diet, the ability to produce food (meat and milk), hides, and the potential to perform heavy labor (Hanotte *et al*., 2000) [25]. The kidney is a crucial component of the urinary system that maintains homeostasis through a multifaceted process that includes secretion, absorption and filtration. Additionally, it controls the body's fluid and electrolyte balance, as well as the location of erythropoietin production, which promotes the formation of erythrocytes, and renin, which controls blood pressure (Ganong, 2010) [3]. According to Kuehnel (2003) [5] mammalian kidney possessed the usual bean-shaped form that is typical of the kidneys of unipolar mammals. The inner medulla, outer cortex, and superficial capsule make up the unipapillary rabbit kidney. Compared to the outer medulla, the inner medulla is slightly thicker and less vascular, outer cortex (Kuehnel, 2003) [5]. According to Junqueira and Carneiro (2005) [6], the kidney's functional unit is the nephron, which is made up of renal corpuscles, collecting tubules, distal convoluted tubules, loop of Henle, and proxima l convoluted tubules.
The multilobar nature of the bovine kidney causes it to be lobulated, and the left kidney is m ovable to escape the pressure of the full rumen [1]. Nephrons are the kidney's functional urine filtration unit, and they are all located in the cortical region of the Bowman capsule [1].

Maintaining the components of bodily fluids within physiol ogical bounds is the kidney's main job.
Disease diagnosis may benefit from the kidney's morphomet ric characteristics [2, 3]. The health of the organs may be indicated by changes in a few morphometric markers [2, 3]. For instance, the kidney's weight is correlated with chemical alterations, and its overall volume is directly correlated with its functional reserve. (Barbai, 2004; Michael, 2007; König and Liebich, 2004) [27, 28, 26].

Materials and Procedures
Ethical permission: The Institutional Animal Ethics Committee gave its clearance for the experimental procedures, which were carried out *at the Veterinary Medicine Collage, Al-Qasim Green University, Iraq. This research was* intended to describe the kidneys' morphological and histological characteristics in adult local Iraqi cow. The, samples are collected from December 2022 to January 2023. The study is performed on six adult cows that are collected from healthy animals slaughtered in the abattoirs of Babylon and najaf. The approximate age of experimental animals was determined depending on the formula of milk teeth and eruption age of teeth using the following formula: [2(0\3 + 1\0 + 3\3)= 20],the information attainable from the owner are regarded to detect the exact age, Following that, anatomical parameters were noted and moved to the proper fixative for histology procedure. Anatomical analysis: The kidney was gently removed, and the Vernier Calliper was used to measure the kidneys' length, width, and thickness as well as their weight using a delicate balance. Histological analysis: Samples were collected as soon as the animals were killed and preserved for 72 hours in 10% formalin. Following fixation, the tissue was cut, the specimens were rinsed for three to four hours with tap water to get rid of the formalin solution, and they were then moved on to the next steps: After dehydration, clearing, and embedding, the rotary microtome is used for cutting and staining, and hematoxylin and eosin is regularly used for staining. The statistics were computed using a computer application known as version 15 of the Statistical Package for Social Sciences [SPSS] [9]. Lastly, morphometric measurements of various histological sections were performed using a light microscope and the S-EYE 2.0 digital eyepiece for information on how to install the microscope. Measurements of diameter of renal corpuscles in the juxamedullary, cortical, and subcapsular regions under (40 x) were the measures employed in this study. [10]

Findings and conversation
Anatomical findings kidney's form and location
There was abundant amount of perirenal fat surrounds both kidney. The capsule was opaque, thin and loosely attached to the kidney (Fig, 1). The kidney of bovine was large in size, firm, reddish brown in color, very grooved filled with fat tissue, showing clear lobulation into 25-30 lobes (Fig 2).
The current study, mid-longitudinal dissection of cow kidney comprised of two regions, the inner being reddish and the outer being darker and granular, representing the cortex and lighter from cortex its medulla and also present the subcortical region its line between the cortex and medulla – straight appearance with band nearer. the cortex being somewhat darker, this is the medulla. The medulla projects into the lumen of minor calices by apex of renal pyramid, this is the renal papillae, the structure was conical in shape where based toward the cortex and the apex embraces in lumen of minor calyx called the renal pyramid. The major & minor calices were embedded in adipose tissue. The ureter divides into two branches or major calices, each of which divides into several minor calices, each of these minor calices embraces on renal pyramid (Fig 3). The ratio of medulla to cortex ratio was 3: 1.
The right kidney (R.K.): The right kidney, which is located beneath the final rib and the first, second, and third lumber transvers processes, was bigger and more substantial than the left. It was oval in shape, long, uneven, and dorsoven trally flattened. The ventral surface was closer to the liver and more convex., pancreas, and caecum, while the dorsal surface was flattened and primarily in contact with the sublumbar muscles. The hilus is located close to the medial boundary on the cranial portion of the ventral surface. Compared to the left kidney, the right kidney has two equal ends with more lobulation and calices (figures 4 and 5).
L.K., the left kidney: The caudal ends of the left kidney are rounded, while the cranial end is pointed. It looks more like a pyramid. Due to interaction with the rumen's dorsal sac, the left surface was flat and motile. From the second or third lumbar vertebrae to the fifth caudally to the right kidney, the hilus was larger than usual. The left kidney was connected to the colon's side and the left side of the rumen. (figure, 4 & 5).

Kidney weight and size
the kidneys were found to differ slightly in the current investigation. The left kidney weighed around 970±20 grams, whereas the right kidney weighed approximately 995±25 grams. Age, breed, and environmental variations may be the cause of these value discrepancies. The findings suggest that the two kidneys' (left and right) diameters differed. The left kidney's length ranged about 148±4.56 mm, whereas the right kidney's ranged around 157±5.95 mm. The two kidneys' widths varied; the right kidney's width was approximately 58±2.76 mm at the crnail pole and 62±1.65 mm at the caudal pole, whereas the left kidney's width was around 38±1.67 mm at the crnail pole and 51± 2.02 mm at the caudal pole. Additionally, the current results demonstrated that the two kidneys' thicknesses differed, with the right kidney measuring roughly 72±1.95) mm and the left kidney measuring roughly 68±2.45) mm (table, 1). The right side of the abdomen contains critical organs., such as the liver and pancreas, as well as the right kidney's cranial placement, which is closer to the heart than the left, could be the cause of the right kidney's high weight.

Table 1: Showing Kidney parameters of local cow

Parameter organ	Weight (gm)	Lenhth (mm)	width at cranial pole (mm)	width at coudal pole (mm)
Right kidney	995±25 A	157±5.95 A	58±2.76 A	62±1.65 A
Left kidney	970±20 A	148±4.56 A	38±1.67 B	51±2.02 B

The values show the mean ±S.E.
Significant differences (P≤0.05) across various parameters are shown by distinct capital letters.

Histological description of kidneys

Kidney capsule

The current study discovered that the kidney capsule of cows was thin and had two distinct layers, in contrast to the thick capsules of other animals, like camels. The deep layer contained smooth muscle fibers, while the superficial layer was composed of dense irregular connective tissue, primarily collagenous fibers with a small amount of elastic fiber (figure 6). In contrast to camels (al-salami, 1992) [17], this is in line with the findings of (Dellmann and Brown, 1987 and Bacha, 2000) [15, 16] in cows, sheep, and goats. Depending on certain life circumstances, such as food type, ambient temperature, and water availability, this broad range of thickness may have an impact on the renal system and animal species.

Cortex of the kidney

Mostly made up of cortical loops of Henle, convoluted tubules, and renal corpuscles. The sections that run to the medulla from the capsule. demonstrate variations in renal corpuscle distribution, with the superficial region having fewer than the mid-cortical region, and the juxtamedullary region having fewer than the mid-cortical region (figure 7).

Medulla of the kidney

In cross section, the medullary area is made up of collecting ducts, straight tubules, and the the vasa recta, a special capillary network. The collecting ducts and the straight tubules of the nephrons proceed from the cortex into the medulla. They are accompanied by the vasa recta, a capillary network that runs parallel to the various tubules. (figure, 8). Due to their arrangement and variations in length, The medulla's tubules create many conical. structures k nown as renal. pyramids, These pyramids are made up of renal papillae, which are the apex and broad base toward the cortex. The calyx is a cup-shaped structure that extends from the renal pelvis, is where the calyx projects. The region cribrosa, or tip of the papilla, is punctured by the collecting duct apertures (figure 8).

Nephron

The renal corpuscle

Bowmann's capsule is a double-layered cup-shaped structure that encloses the glomerulus, a tuft of capillaries that makes up the renal corpuscle. The capillary loops originate from the afferent arteriole, and the basal lamina supports the simple squamous epithelium that makes up the outer or partial layer of Bowmann's capsule. Podocyte nuclei served as a representation of the inner or visceral layer, also there was the mesangial cells which associated with glomerular capillaries. The Bowman space, which at the urinary pole leads into the proximal tubule, was located between the two layers of Bowmann's capsule. According to their position in the renal cortex, three different types of renal corpuscles were found in this study: Cortical, midcortical, and juxtamedullary renal corpuscles (Fig. 4). Thes observations align with the research conducted by [19] on a number of mammalian species. The cortical renal corpuscles' diameter is about (32±1.5um) while mid-cortical about (29±1.1) and juxtamedullary about (25±1um) (Figure, 9,10).

Convoluted tubule at the proximal end: According to the current investigation, the proximal convoluted tubules in cow-is longer and larger in length than the distal convoluted tubule lined by high simple cuboidal epithelium with cells had acidophilic stain and brush border was prominent (Figure,10).

Loops of Henle

According to recent research on rabbit kidneys, the medulla is where the Helene loop's thick and thin limbs are most noticeable. While the thick segment of the Henle loop was lined by cuboidal epithelium, the thin segment was lined by simple squamous epithelium tissue with cells reset on visible basement membrane. The cells in the cross-section were composed of two cells, each spindle-shaped with prominent oval nuclei that bulged to the inside of the tubule, forming a narrow lumen and diameter about half of a thick segment. Cells with oval nuclei in the center reset on the exposed basement membrane. These results differ with discoveries that confirmed the absence of the Henle loop in fish, and they are consistent with those described in domestic animal by Dyce *et al*. (2010) [4] and Bacha (2000) [16]. This variance results from these species' aquatic habitat. In contrast to desert species like camels, lizards, and spiny mice, whose excrement contains concentrated pee, cows did not require substantial re-absorption of water, which is why their kidneys have a comparatively higher ratio of short Henle loops. This is because camels can stand for long periods of time without drinking, water and can produce urine that is extremely concentrated (Abdalla and Abdalla, 1979) [22]. In the scorching weather that can reach 50 °C, high levels of dryness, arid desert, and rocky environments that these animals naturally occupy, the camel's higher level of development in comparison to other mammal species is probably favorable. Distal convoluted tubules Simple cuboidal epithelium lined the distal convoluted tubules. The cells were less acidophilic and smaller than those of P.C.T. (Fig 9, 10). This study's description of the proximal convoluted tubule is consistent with findings from buffaloes by Al-Kinanny (2006) [24]. They lack the brush border and have luminal widths that are narrower than collecting tubules and larger than proximal tubules. The pervious description in agreement with [15] and [16] in domestic animals.

Collecting tubules and duct: The cuboidal epithelium lining the collecting tubules changes to columnar toward the pyramid's apex; it stains faintly, giving the tubules a light look. The intercellular limits between these tubules were not distinct. Minor calices lined by thin layer of transitional epithelium which may reach to 2-3 cell thickness. Major calices lined by transitional epithelium and consist of 3-4 cell thickness (Figure, 10).

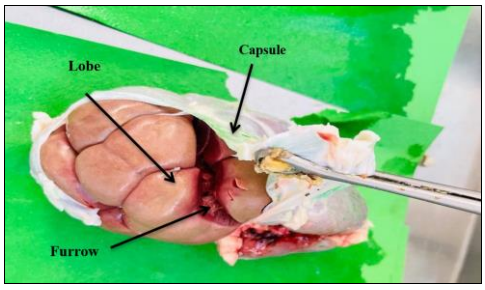

Fig 1: Anatomical view showing: Capsule of kidneys in local Iraqi cow

Fig 2: Anatomical view showing: External surface of kidneys and grooved in cow showing lobes

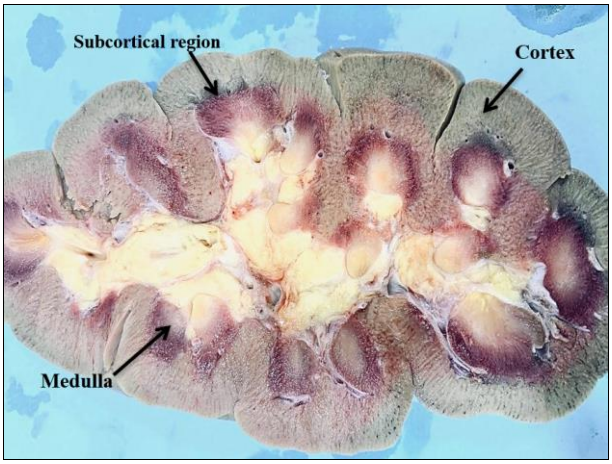

Fig 3: Anatomical view showing: cross section of kidneys in local Iraqi cow

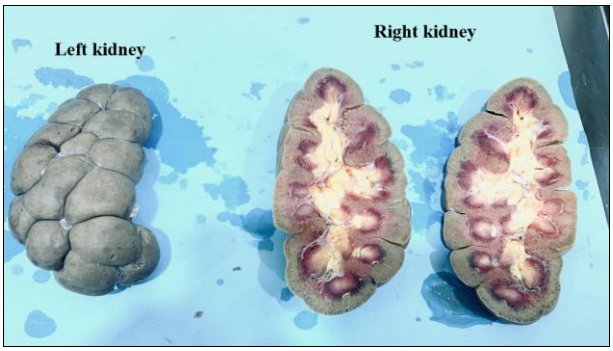

Fig 4: Anatomical view showing: the right and left kidneys in local Iraqi cow

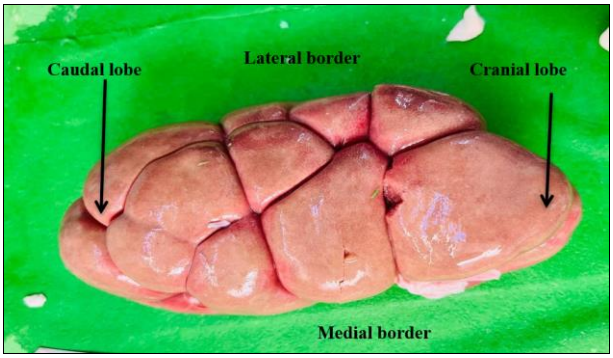

Fig 5: Anatomical view showing: external surface of kidneys in local Iraqi cow

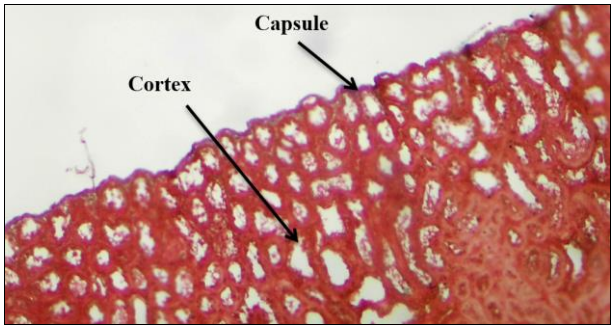

Fig 6: Cross section in kidneys showing: the capsule and cortex (Masson trichrome stain) X10

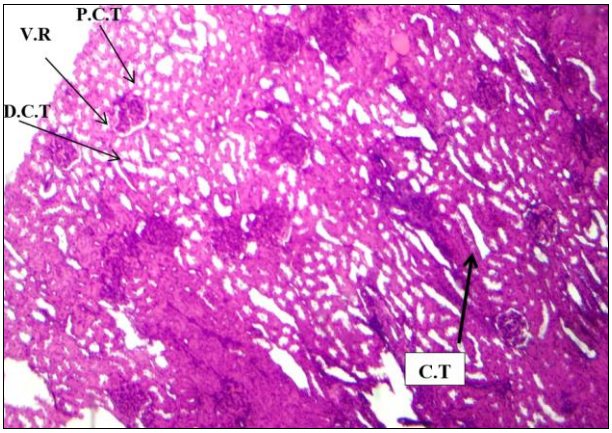

Fig 7: Cross section in kidneys cortex showing: Proximal convoluted tube (P.C.T) Versa recta (V.r) Distal convoluted tube. (D.c.t) (H &E Stain) X10

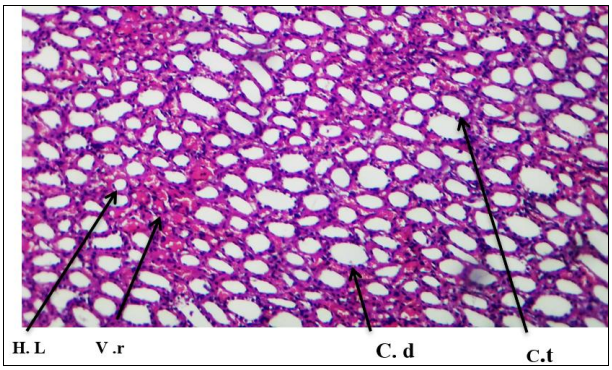

Fig 8: Histological section in kidneys medulla showing: Henle lope (H.l).Versa recta(V.r) Convoluted duct (C.d).Convoluted tubule(C.t) (H &E Stain)X10

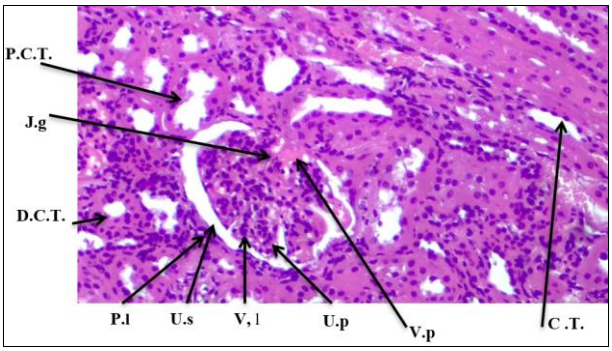

Fig 9: Histological cross-section in kidneys cortex showing: Proximal convoluted tube (P. C.T), Versa recta (V.r), Distal convoluted tube (D.C.T), Juxtamedullary (J.m), parietal layer (P.l), Urinary space (U.s), Visceral layer (V.l), Urinary pole (U.p), Visceral pole (V.p), Collecting tube (C.T.) (H &E Stain) X 20

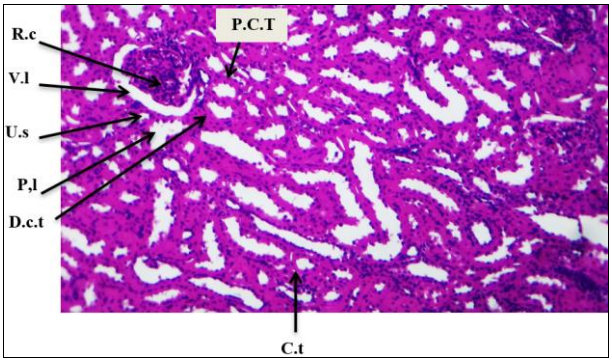

Fig 10: Histological section in kidneys medulla showing showing: Proximal convoluted tube (P. c.t). Renal corpuscle (R.c). Distal convoluted tube. (D.c.t). partial layer (P.l).Urinary space (U.s). Visceral layer (Collecting tube (C.t (H &E Stain) X10

Conclusion

The present study showed that adult kidney cow has large size with high number of lobules about 25-30 and high numbers of short loops nephrons (71 %) and less numbers of long loops nephrons (29 %). Cattle's kidneys have a medulla with many collecting ducts and few convoluted tubules, unlike camels' Compared to cattle, camel kidneys can adapt to desert conditions by preserving more water since they have many convoluted tubules and few collecting ducts, as well as a lengthy, two-part medulla.

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