# Histomorphological and morphometrical comparative study of the kidney between Quail (*Conturnix coturni*) and Green-winged Teal (*Anas crecca*) according to their environment type

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## Abstract

The present work was designed to investigate the morphometrical and histological differences in kidneys of two species (Quail and Green-winged Teal) belong to different orders varied in their environments. The study was performed on ten healthy male (five birds for each species). After the kidneys were removed the samples were taken. Three stains were used (H&E, PAS, and Van-Gieson). The result revealed that the kidneys in both birds were coated by a thin capsule. The thickness of capsule was higher significant in Green-winged Teal than in Quail. There was no clear delineation of cortical and medullary regions as there was in the mammalian kidney. The result showed the high significant of number of glomerulus in Green-winged Teal than in Quail, also the height of epithelial cells and of proximal convoluted tubules diameters were high significantly in Green-winged Teal. The height of epithelium cells and distal convoluted tubules diameters were significantly high in Green-winged Teal than in Quail. The study was examined and compared the morphometric and histomorphologic of the kidney in the two species according to their environment which live in it.

**Key words: Kidney, Quail, Green-winged Teal, morphometrical, histomorphological.**

# دراسة مقارنة نسجيه شكلية وقياسية في الكلية بين طائر السمان (*Conturnix coturni*) وطائر الحذاف الشتوي(*Anas crecca*) اعتمادا على نوع البيئة

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**الخلاصة**

صمم هذا البحث لمعرفة الاختلافات القياسية و النسجية في كلى نوعين من الطيور (السمان والحذاف الشتوي) التي تقع تحت رتب منفصلة ومتنوعة في بيئتها . استخدمت عشر طيور من الذكور فقط خمسة من كل نوع بعد رفع الكلية واخذ العينات ، استخدمت ثلاث صبغات (هيموتوكسلين و ايوسين، كاشف شف الدوري ، وفان كيزين). اظهرت النتائج ان الكلية في كلا النوعين من الطيور تحاط بمحفظة رقيقة. سجل سمك القشرة في كلية الحذاف الشتوي فرقا معنويا اعلى مما هو علية في السمان. كما وجد انه ليس هنالك تحديد واضح بين طبقات القشرة واللب كما هو الحال في اللبائن. بينت النتائج فرقا معنويا اعلى في عدد الكبيبات في الحذاف الشتوي وأيضا ارتفاع الخلايا البطانية واقطار النبيبات الملتوية الدانية اعلى معنويا في الحذاف الشتوي . كما بينت النتائج هنالك فرق معنويا اعلى في ارتفاع الخلايا البطانية واقطار النبيبات الملتوية القاصية في الحذاف الشتوي مما هي علية في السمان . أن النتائج السابقة بينت أن كلية الحذاف الشتوي أعلى فعالية وذلك للحفاظ على التوازن الداخلي وكذلك كثرة أعادة امتصاص للماء والايونات.

**الكلمات المفتاحية: الكلية ، طائر السمان ، طائر الحذاف الشتوي ، قياسية ، نسجيه وشكلية.**

## Introduction

A Quail is a bird which belongs to the order of Galliforms which are considered to be rather primitive birds and most of these species in this order are medium sized birds. Their body form and behavioral characteristics are similar to domestic chickens (1). Common quail are terrestrial, temperate, topical birds and the grasslands are the general habitat of these birds (2) while Green-winged Teal, the smallest north American dabbling duck, which are inhabit inland lakes, marshes, ponds, pools, and shallow streams with dense emergent and aquatic vegetation (3). The kidneys in both mammals and birds are principle organ concert with maintaining the unchanging nature of the internal environment by providing a balance between glomerular filtration, renal tubular secretion volume, osmolality, ionic content and pH of the body fluids (4). The Kidney plays an important role in maintaining homeostasis. The urinary system of the birds consists of large paired kidney, lying symmetrically one on either side of the vertebral column, drained by ureters which open into the urodeum of the cloacae, no urinary bladder is present in birds (5). The surface of the kidney is covered by large number of small roughly structures with shallow depression between them, each of these structure is formed unite of cortical kidney (6). Eight or ten of these cortical units form group drain urine into a single medullary cone. This region of kidney tissue is known as lobules, which consist of a few elongated units of cortical tissue together with the single medullary cone into which their urine flows. Medullary lobules are essentially cones surrounded by a connective tissue sheath open to the cortex at the wide end and attached to a major urethral branch at the other (7). The avian kidney has two types of nephron, cortical types is reptilian in form devoid of a nephronal Henle loop confined to the cortical region of the lobule and medullary types, has nephronal loop which penetrates the conical medullary region of lobule similar to that in mammals (8, 9). In mammals, all nephrons contain a loop of Henle, but some of them are long (10). The ability to conserve ions and water may be correlated with the structure of nephron. The surface of the kidney is covered by a large number of small roughly structures with shallow depression between them, each of this structure are a unite of cortical kidney (6). The avian glomerulus similar to its mammalian counterpart but it is smaller and has simpler system of capillary loops arranged around core of mesangial cells. The distal convoluted tubule (DCT) is characteristically different from the proximal convoluted tubule (PCT) in that the cells of the lining epithelium possess no brush border and the epithelial cells are approximately cuboidal in shape (6, 7).

## Materials and methods

Ten healthy mature male birds (5 birds from each species) were obtained from Al-Kut birds market. The birds were anesthetized and sacrificed. From each bird, the kidneys were removed and dissection into three lobes cranial, middle and caudal, then these specimens was cut longitudinally to the left kidney and transversely to the right kidney. Fixation, clearing, embedding, dehydration and cutting were made. Three stains were used, these are H&E, PAS and Van-Gieson stains (11). Some morphometric measurements (Number of glomeruli in $mm^2$, and thickness of capsule and diameter of PCT and DCT) were done (12). Statistical analysis was obtained as standard deviation and standard error for many parameters in kidneys. Analysis of T-test for statistical differences of variables of two sets was done (13).

## Results

In the cross section of kidneys in the two type of the birds the microscopic examination were revealed that the kidney covered by very thin capsule. This capsule appeared consisting of smooth muscle with some of collagen fibers (Fig.1 and 2). The present study found that the thickness of capsule was significantly higher in Green-winged Teal than in Quail (table 1). The histological result of this study showed that

**Table (1): Show the number of Glomeruli in 1 mm$^2$ and thickness of capsule in the two species of birds.**

| Species | Green-winged Teal | Quail |
|---|---|---|
| No. of Glomeruli in mm$^2$ | 20.325 ± 1.21A | 16.432 ± 1.14B |
| Thickness of capsule ($\mu m$) | 8.22 ± 0.52A | 6.76 ± 0.64 B |

**The values represent the Mean ± Standard Error (SE). The different capital letters mean significant differences at p<0.05 level.**

**Table (2): Show diameter of PCT and DCT with the height of epithelial lining in the two species of birds.**

| Species | | Green-winged Teal | Quail |
|---|---|---|---|
| Diameter of tubule ($\mu m$) | PCT | 39.32 ± 1.441 A | 30.52 ± 1.511 B |
| | DCT | 24.33 ± 1.312 A | 19.52 ± 1.123 B |
| Height of epithelial ($\mu m$) | PCT | 10.22 ± 0.311 A | 8.11 ± 0.242 B |
| | DCT | 5.531 ± 0.234 A | 4.751 ± 0.412 B |

**The values represent the Mean ± Standard Error (SE). The different capital letters mean significant differences at p<0.05 level.**

these were many lobules in both kidneys of the two birds; each lobule has medullary tissue and cortical tissue. There was no cleared delineation of cortical and medullary layers as in mammalian kidney (Fig. 3, 4). The connective tissue covering of medullary lobules and the medullary interstitium in two birds was thin with reticular and collagen fibers (Fig. 1 and 2). There were two types of nephrons, cortical type (small cortical glomeruli) and medullary type (large cortical glomeruli) (Fig. 3, 4). The results of the present work were showed that the renal corpuscle of two species of birds consisted of an outer Bowman's capsule separated by Bowman's space from a centrally located glomerulus (Fig. 5, 6). The number of glomeruli in 1 mm$^2$ in Green-winged Teal kidney was more than that in the kidney of quail (Table 1). The microscopic measurements of the epithelial height of proximal convoluted tubule (PCT) were higher significantly in Green-winged Teal than in quail. The study revealed that the diameter of PCT was significantly high in Green-winged Teal than in quail (Table 2). The distal convoluted tubule (DCT) in two species were appeared different from the PCT with regard to epithelium lining which possessed no brush border and it was cells appear lighter in staining and approximately cuboidal in shape (Fig. 5, 6), the current result found that the diameter of DCT was significantly higher in Green-winged Teal than in quail. The result explained that the thick and thin limbs of Henle were separated by the collecting ducts. Thick limbs were restricted to the periphery of the medullary cone and surrounded a ring of collecting ducts, which in turn surrounded a few number of thin limbs. The thin and thick limbs consisted of simple cuboidal epithelium (Fig. 4, 5). The present study showed there were no clear differences between the basement membranes of renal corpuscles, proximal convoluted tubules (PCT) and distal convoluted tubules (DCT) in both birds (Fig. 7, 8). The present study noted the mesangial cells in the glomerulus of renal corpuscles in both birds (Fig 7, 8).

## Discussion

The present study was revealed that kidneys in the two types of the birds were showed covered by very thin capsule. This capsule appeared consisting of smooth muscle with some of collagen fibers. This finding was in agreement with that of (14) in coturnix quail who remind that the capsule have smooth muscle and some of collagen fibers. The present result revealed that the thickness of capsule was significantly higher in Green-winged Teal than in quail. The high thickness of capsule in Green-winged Teal may be due to the birds live in aquatic environment so can be resistance all deferent in nature of water which take it and live in it and related with renal functional role. The connective tissue covering of medullary lobules and the medullary interstitium in two birds was thin with reticular and collagen fibers. This was in agreement with the observations of (6) who reported that medullary interstitium in fowl has reticular

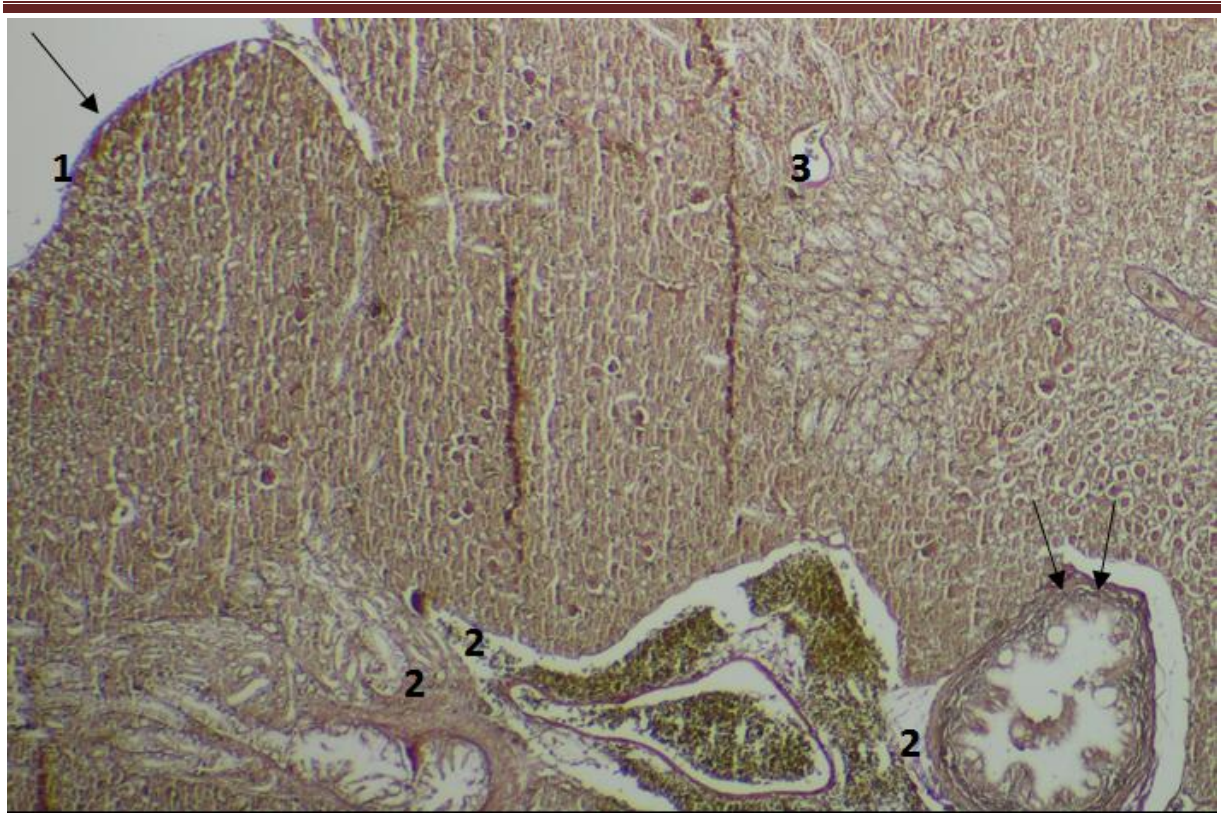


**Fig. (1): Histological section in Quail kidney show capsule (1), collagen fibers (arrow), connective tissue (2) and intra lobular vein (3) (Van-Gieson Stain 4 X).**

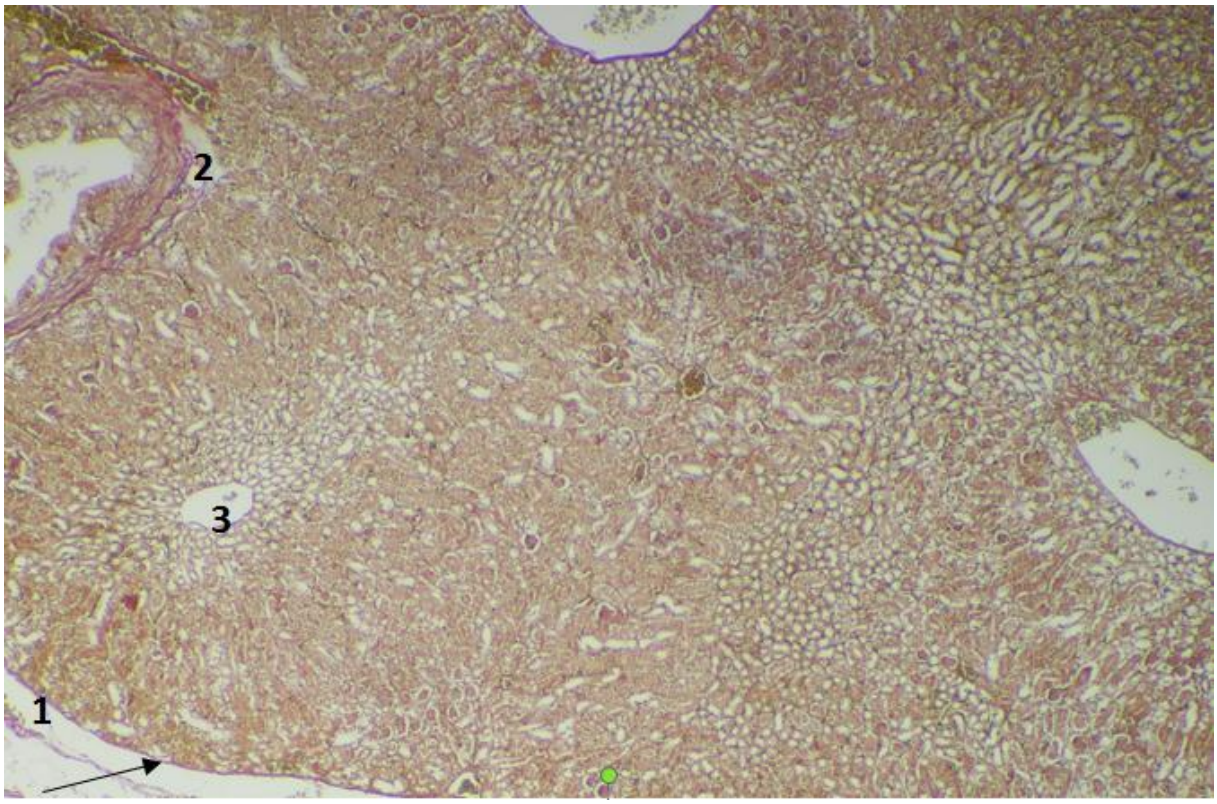


**Fig. (2): Histological section in Green-winged Teal kidney show capsule (1), collagen fibers (arrow), connective tissue (2) and intra lobular vein (3) (Van-Gieson Stain 4 X).**

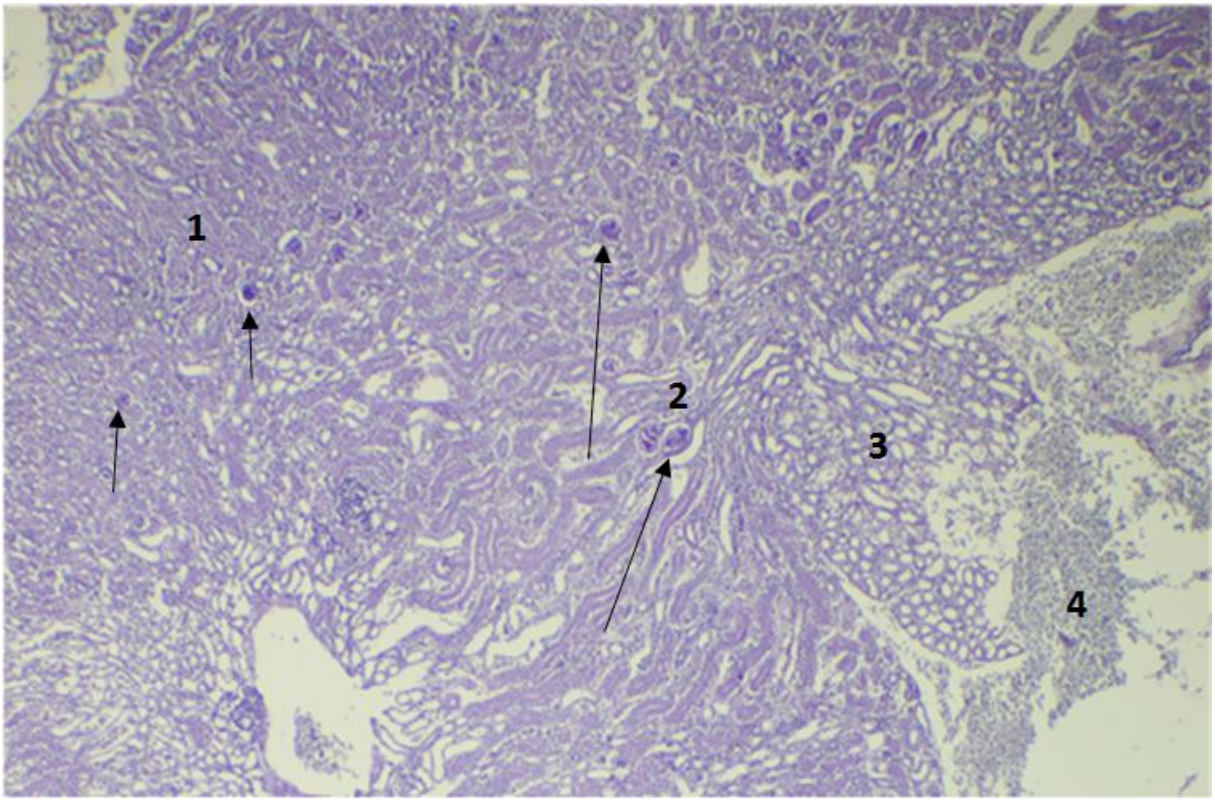


**Fig. (3): Histological section of kidney in Quail shows no cleared delineation of cortical and medullary layers. Cortex (1), medulla (2), island of medulla (3) connective tissue (4) cortical nephrons (small arrows) and medullary nephrons (large arrows)(H & E Stain 10 X).**

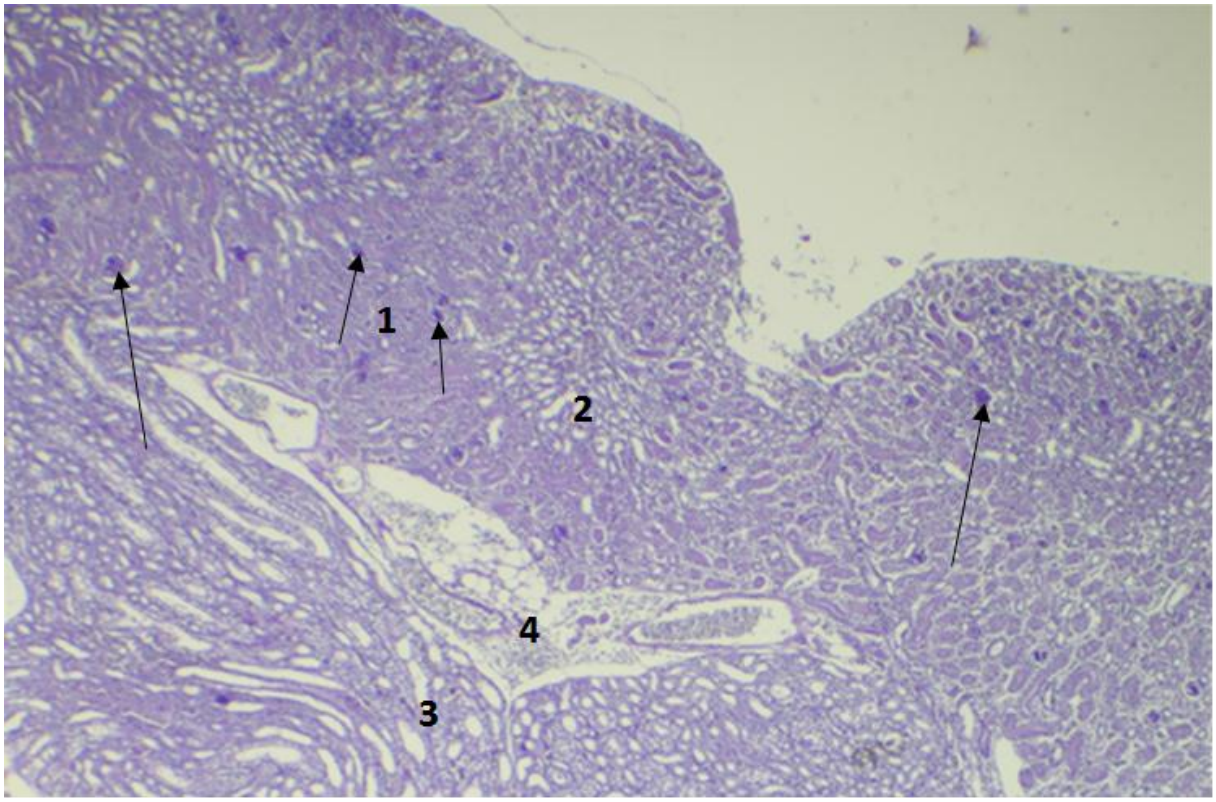


**Fig. (4): Histological section of kidney in Green-winged Teal shows no cleared delineation of cortical and medullary layers. Cortex (1), medulla (2), island of medulla (3) and connective tissue (4) cortical nephrons (small arrows) and medullary nephrons (large arrows) (H & E Stain 10 X).**

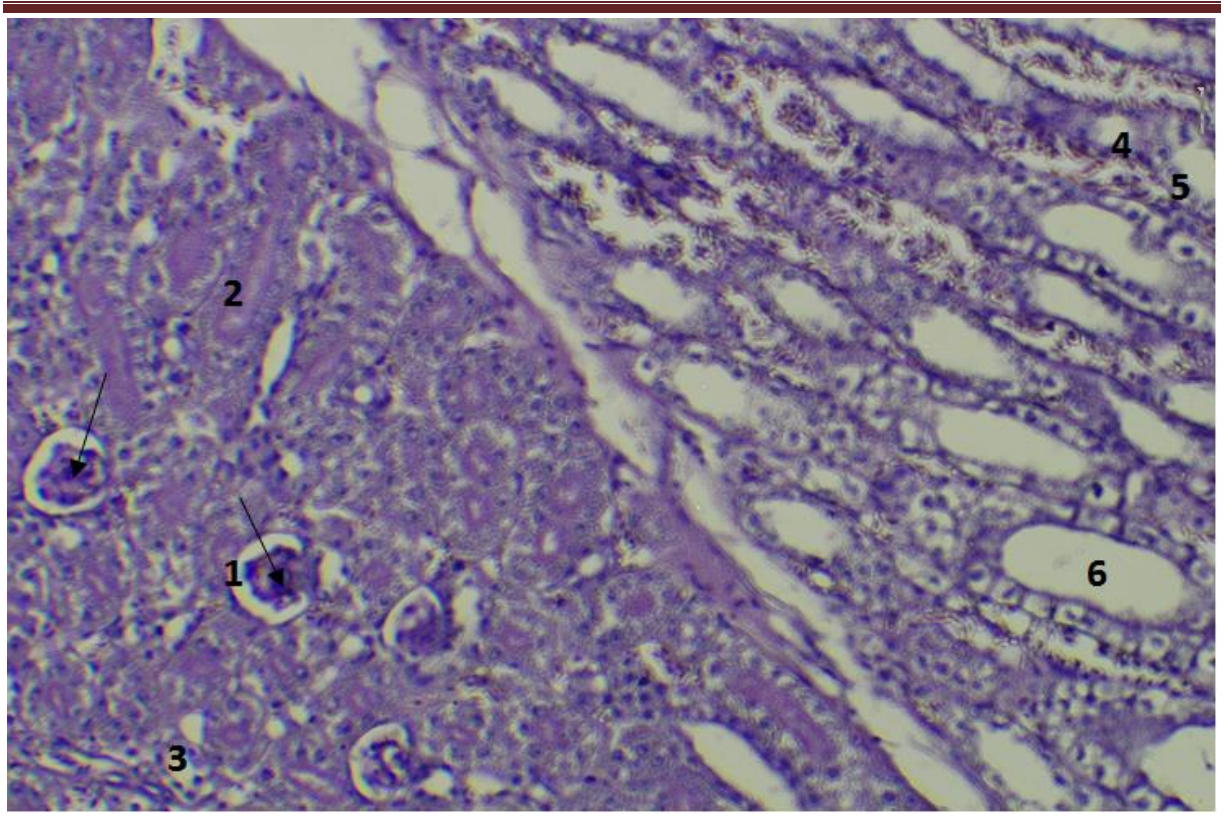


**Fig. (5): Cortex and medulla in the kidney of Quail. Renal corpuscle (1), glomerulus (arrows), proximal convoluted tubule (2), distal convoluted tubule (3), thin segment (4), thick segment (5), collecting duct (6) (H & E Stain 20 X).**

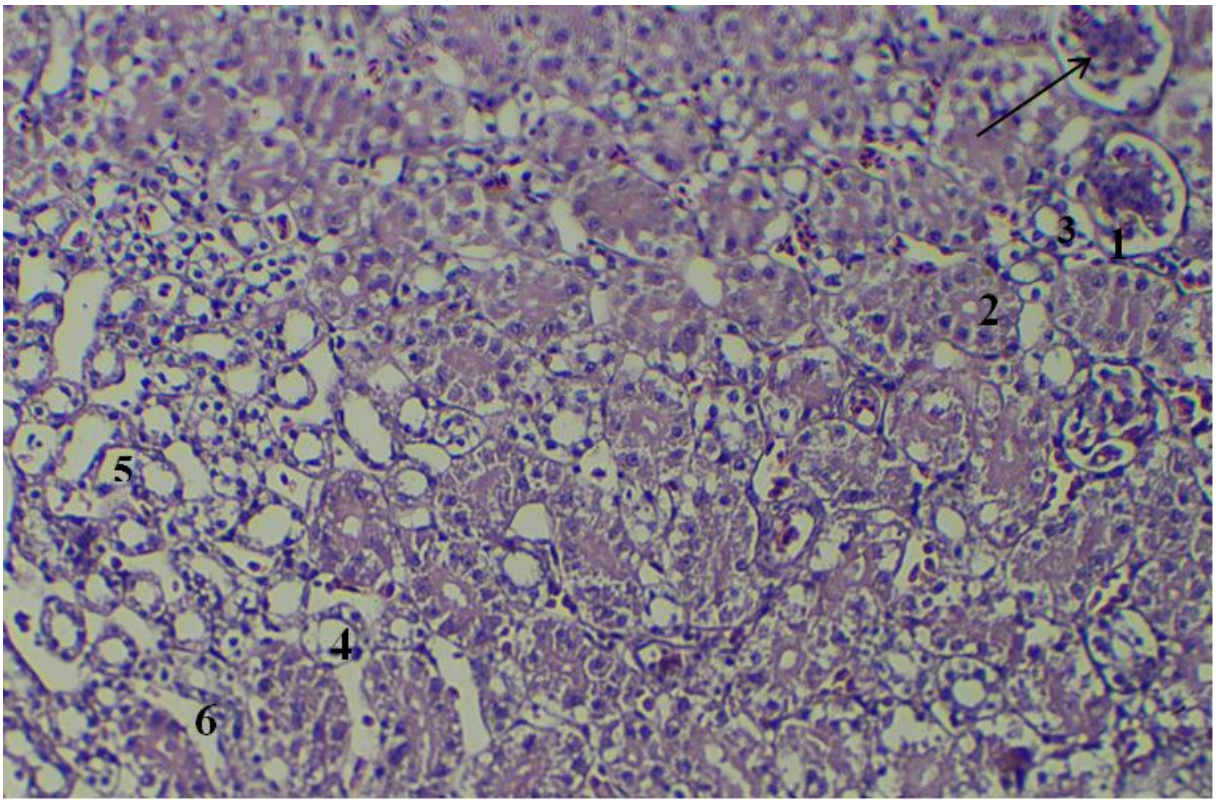


**Fig. (6): Cortex and medulla in the kidney of Green-winged Teal. Renal corpuscle (1), glomerulus (arrows), proximal convoluted tubule (2), distal convoluted tubule (3), thin segment (4), thick segment (5), collecting duct (6) (H & E Stain 20 X).**

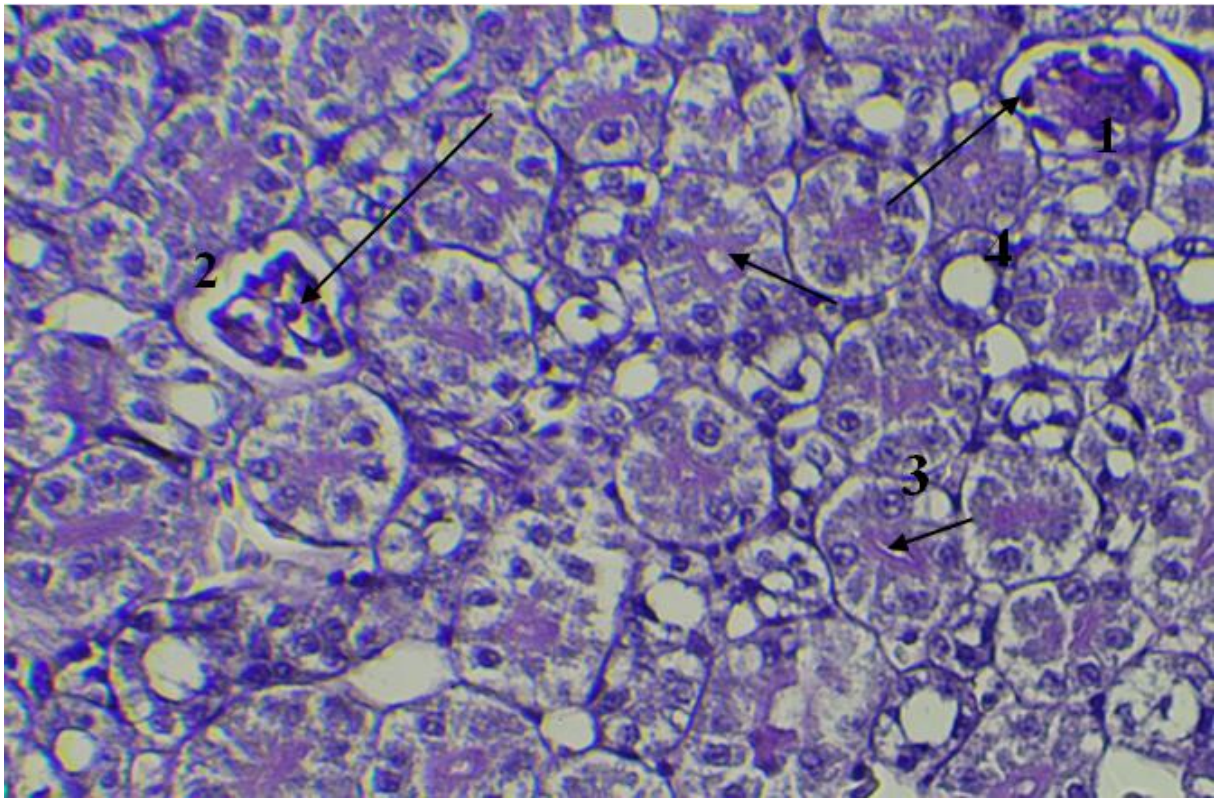


**Fig. (7): Showing cortex of kidney in Quail, glomeruli (1), mesengeal cells (large arrows), basement membrane of renal corpuscle (2), basement membrane of (PCT) (3), basement membrane of ( DCT) (4) brush border of PCT (small arrows) (PAS Stain 40 X).**

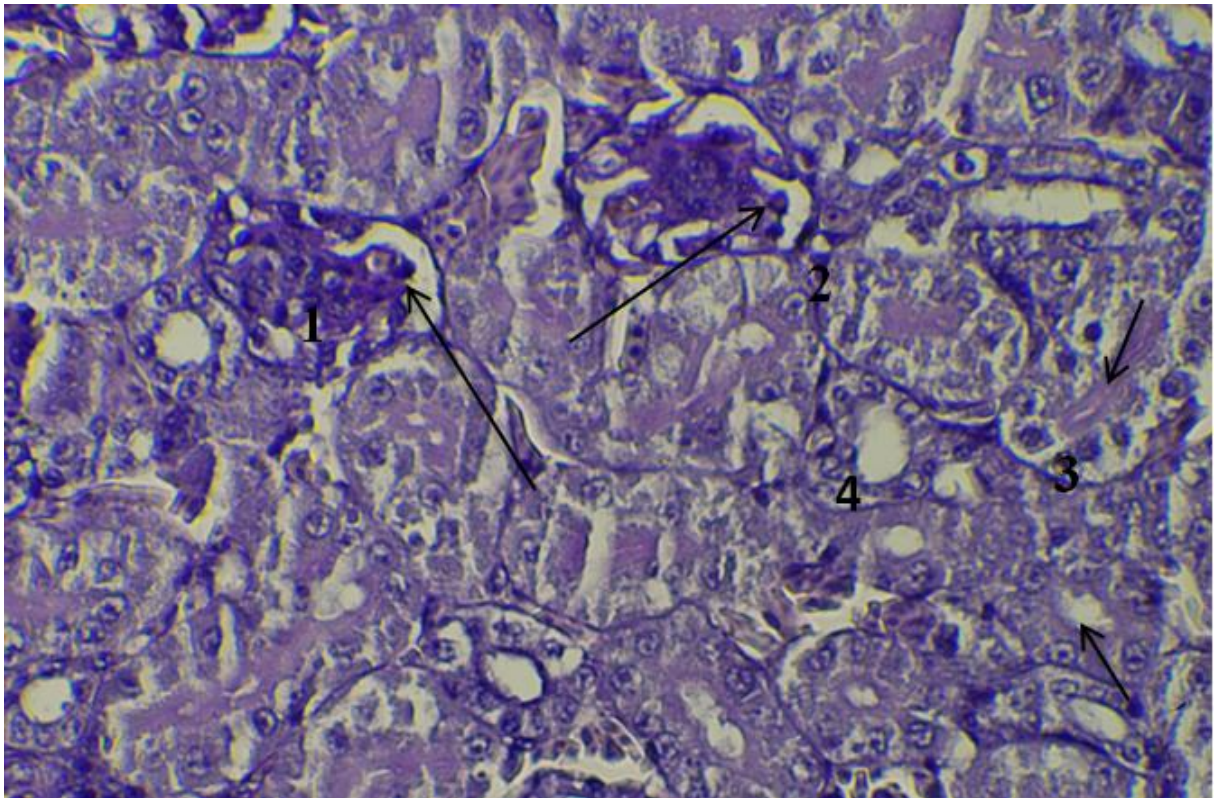


**Fig. (8): Showing cortex of kidney in Green-winged Teal; glomeruli (1), mesengeal cells (large arrows), basement membrane of renal corpuscle (2), basement membrane of (PCT) (3), basement membrane of (DCT) (4) brush border of PCT(small arrows) (PAS Stain 40 X).**

and collagen fibers. There was no cleared delineation of cortical and medullary layers as in mammalian kidney. The similar findings were previously reported by (15, 16).The results of the present work were revealed that the renal corpuscle of two species of birds consisted of an outer Bowman's capsule separated by Bowman's space from a centrally located glomerulus. The same findings were reported by (6, 17, 18, and 19).The presence of two types of glomeruli in studied birds, the small cortical type and larger medullary type. This was demonstrated by (17) about birds in general and (20) who study about domestic fowl and (18) who study the Gamble's quail. The number of glomeruli in 1 $mm^2$ in Green-winged Teal kidney was more than that in the kidney of quail. This difference in glomeruli number could be due to the difference in the environment in which birds are living and so the Green-winged Teal kidney is more functional for homeostasis than quail. last fact was supported by the microscopic measurements of the epithelial height of proximal convoluted tubule (PCT). This was higher significantly in Green-winged Teal than in quail. The study revealed that the diameter of PCT is significantly high in Green-winged Teal than in quail. The discussion of this results, that the avian proximal tubule absorbs about 70 of the filtered volume of water, which depends on active reabsorption (21), there for this results are may be mean greater capacity of kidneys in Green-winged Teal to absorb both water and ions, thus presence the kidney of Green-winged Teal becomes an important homeostatic mechanism, by which the internal environment is maintained at a fairly constant level. The distal convoluted tubule (DCT) in two species were appeared different from the PCT with regard to epithelium lining which possessed no brush border and it is cells appear lighter in staining and approximately cuboidal in shape, this result correspond with the report of (6) in the fowl, (7) which describe the histology of kidney in bird in general. The current result found that the diameter of DCT was significantly higher in Green-winged Teal than in quail. This result slightly mean that the DCT in Green-winged Teal has more absorption of water and in organic ions will be occur along this part of nephron according to (15). The result explained that the thick and thin limbs of Henle were separated by the collecting ducts. Thick limbs were restricted to the periphery of the medullary cone and surrounded a ring of collecting ducts, which in turn surrounded a few number of thin limbs. The thin and thick limbs consisted of simple cuboidal epithelium. The countercurrent multiplier mechanism operates between the descending and ascending limbs of Henle via recycling of a single solute (NaC) with no water accompaniment, forming an osmotic gradient along the medullary cone (23). The present study showed, there were no clear differences between the basement membranes of renal corpuscles, proximal convoluted tubules and distal convoluted tubules in both birds. This result explains the high function of segments of nephron in filtration in both birds (10). The present study noted the mesangial cells in the glomerulus of renal corpuscles in both birds. This agrees with (7) which he stated about fowl.

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