Histological Study on the Kidney of Guinea Fowl (*Numida meleagris*)

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Abstract

The Guinea fowl bird possesses two reddish-brown coloured kidneys which were retroperitoneal placed on each side of the vertebral column in the depression of synsacrum. Kidney of the Guinea fowl was enclosed by a thin capsule and made-up of reticular, elastic and collagen fibers. Histological structure reveled that kidney was formed by larger cortical and smaller medullary region. The cortical component was consisted of all parts of nephron while the medullary area was comprised of medullary collecting duct, thin and thick segment of the loop of Henle & blood capillaries-vasa recta. The reptilian and mammalian type nephrons were seen while the intermediate type nephrons were not found. The mammalian nephron was relatively larger and juxtamedullary. The parietal layer and visceral layer of Bowman's capsule were simple squamous epithelium and cuboidal epithelium respectively. The epithelium of the proximal convoluted tubule (PCT) and distal convoluted tubule (DCT) was composed of the high columnar cell with an apical brush border present and cuboidal in shape without apical villi and the lumen was narrow but visible. The thin and thick segment of loop of Henle was comprised of simple squamous epithelium and cuboidal with visible lumen. The collecting tubule (CT) was cortical and medullary type and made-up of cuboidal and columnar epithelium respectively without apical villi. The lumen was visible and more substantial then PCT and DCT. The collagen, elastic and reticular fibers were also noticed in all parts of uriniferous tubules.

KEYWORDS:- Guinea fowl, Histology, Kidney and Nephrons.

INTRODUCTION

The Guinea fowl kidneys consist of three separated lobes characterized by the outer cortex formed major part and inner medulla or medullary lobules formed a minor part surrounded by a thin capsule. The Guinea fowl kidney has two types of nephrons: reptilian and mammalian types (Morild et al. 1985 a, Casotti and Braun 2000 and Mobini and Abdollahi 2016). The histological differences of nephrons indicate the functional adaptability of the bird's urinary system. The present study was aimed at a brief description of the histological characteristic of the Guinea fowl kidney.

MATERIALS AND METHODS

A total of 12 pairs of Guinea fowl kidneys samples were collected and fixed in 10% Neutral buffered formalin. Thereafter, these tissues were processed routinely and 5 µ thick paraffin sections were obtained. Sections were stained with Haematoxylin and Eosin for general tissue reaction (Singh and Sulochana 1996), Silver orecin and Aniline

blue method for elastic, reticular and collagen fibers (Singh and Sulochana 1996), Weigert's method for elastic and collagen fibers (Singh and Sulochana 1996). The aforesaid stained sections were examined under the Olympus light microscope and photomicrography was performed.

RESULT & DISCUSSION

Histologically, the kidneys of Guinea fowl bird consisted of two zones, the cortex and medulla. The cortex made up the vast area of the kidney with only a small portion being medulla. The cortex and the medulla were arranged in cones of different lengths, which were distributed randomly within the kidney. Kidney of Guinea fowl was covered with a very thin capsule, firmly in contact with parenchyma and composed of collagen, elastic and reticular fibers and no smooth muscle were found (Fig. 01). The present study was a similar observation to, Mohammed *et al.* (2009) in Steppe buzzard, Sreeranjini *et al.* (2010) in Japanese quails, Gahaffor and Mohammed (2012) in squab pigeon and Baragoth (2015) in Quail and Green-winged Teal. However, the elastic fibers not reported in the renal capsule of Siller and Hindle (1969) in the avian kidney, Fitzgersld (1969) in Japanese quail.

The capsule invented of dense connective tissue composed of reticular, elastic and collagenous fibers. Reticular fibers and collagen fibers observed in the capsule of the kidney in squab pigeons revealed by Gahaffor and Mohammed (2012) in Racing Pigeon and Sreeranjini *et al.* (2010) in Japanese quail (*Coturnix japonica*) reported collagen and reticular fibers were observed. These fibers provide support to the various histological structure of the kidney Mobini and Abdollahi (2016).

The renal parenchyma consisted of numerous large polyhedral peripheral cortical lobules and few cone-shaped medullary lobules in Guinea fowl (Fig.02). These observations were similar to the findings of Trautmann and Fiebiger (1957), Johnson and Mugaas (1970), king and McLelland (1975), and Morild *et al.* (1985). In the lobules, peritubular capillary sinuses with red blood cells were observed, and lymphoid aggregations were noticed as described by Trautmann and Fietiger (1957), which help in the defensive mechanism of the organ. The cortical lobules and cone-shaped medullary lobules formed the basic structural unit of guinea fowl kidney as reported by Hodges (1974) in fowl kidney. The medullary lobules were small and formed by numerous small tubular segments and large collecting ducts, similar to the findings of Johnson and Skadhauge (1975), King and McLelland (1975), Braun (1998), Dantzler and braun (1980) and Casotti and Richardson (1993) in the avian kidney.

The cortex consisted of all parts of nephron except the loop of Henle; similar findings were recorded by Siller and Hindle (1969), Hodges (1974) and Warui (1989). While the medullary part composed of medullary collecting tubule and loop of Henle. The cortex is about 71% while the medulla is about 29%. While, Warui (1989) reported cortex 71-81 %, and medulla 5-15%, in avian species and Casotti *et al.* (1998) reported 90% of the cortical tissue and medullary tissue 2% in the hummingbird. Each cortical lobule consisted of central vein as the main axis and interlobular vein at the periphery as reported by Siller (1971) and Hodge (1974) and in fowl kidney. In the present study several blood capillaries present, which may help in the reabsorption of water this is in agreement with Nickel *et al.* (1977) in the avian kidney.

The medullary lobules in the present study were enclosed by thin layers of fibers as observed by Jhonson and Mugaas (1970), Siller (1971), Braun and Dantzler (1972), Schmidt- Nielsen (1979), and Nicholson (1982). The medullary lobule was comprised of the medullary collecting duct, the thin, thick segment of the loop of Henle and blood capillaries-vasa recta (Fig.03), as studied by Braun (1998) in birds, Casotti *et al.* (1998) and Beuchat *et al.* (1999) in the hummingbird. This study was contrary to the findings of king and MeLelland (1975) mentioned that avian medulla contains the only loop of Henle and collecting duct. In this study, the medullary tract consisted of two or three medullary lobules demarcated by connective tissue observed by Emery *et al.* (1972). The medulla of Guinea fowl kidney consisted of elastic, collagen and reticular fibers. However, in the present study, the presence of smooth muscle and lymphatic infiltrations was not observed which was contrary to the findings of Hodges (1974) in fowl.

The Guinea fowl kidney was comprised of two types of nephron viz. Reptilian type nephron without loop of Henle and mammalian type nephron with the loop of Henle (Fig.04), these findings were by the observation of Braun and Dantzler (1972) in desert quail, Wideman *et al.* (1981), Morild *et al.* (1985a). Dyce *et al.* (2010) in domestic fowl and Gahaffor and Mohammed (2012) in squab pigeon, Sivakumar *et al.* (2012) in Guinea fowl and Dhyaa *et al.* (2014) in mallard species. However, the intermediate type nephron reported by Nicholsen (1982), Wideman and Nissley (1992). Islam *et al.* (2004), and Mobini and Abdollahi (2016) not observed in the present study.

The mammalian type of nephrons in the present study was relatively more extensive than the reptilian type and was situated close to the medullary lobules. They characterized by large glomerulus surrounded by the visceral layer of cells. Distal convoluted tubules were also present on the vascular pole of the glomerulus. A large amount of urinary space was present in Bowman's capsule (Fig.05).

The renal corpuscle composed of the Bowman's capsule as the parietal layer and capillary loops lined by endothelial cell and mesangial cells as the visceral layer (Fig.05). The parietal layer lined by simple squamous epithelium and visceral layer by cuboidal epithelium similar findings by Braun and Dantzler (1972) in desert quail, Hodges (1974) in fowl and Sreeranjini *et al.* (2010) in Japanese quail. The partial layer was composed of all three types of fibers viz. collagen, elastic and reticular fibers whereas more elastic fibers and few reticular fibers observed in the visceral layer of the renal corpuscle (Fig.06). Islam *et al.* (2004) and Sreeranjini *et al.* (2010) they were reported collagen and reticular fibers in the renal corpuscle.

The Proximal convoluted tubules were seen in cortex and lined with high columnar cells. The cell boundaries were indistinct, and the nucleus was large, centrally placed. These observations were similar to Fitzgerald (1969), Nishimura *et al.* (1989) in quail, Patil and Janbandhu (2012) in Indian false vampire bat, However, the cuboidal type of cell reported by Kurihara and Yasuda (1978), Batah (2012), Khadim and Dauod (2014), Mobini and Abdollahi (2016) and Michalek *et al.* (2016) not observed in the present study. In this study the presence of brush border at the apical surface of cuboidal cells were seen (Fig.07), similar to Casotti and Richardson (1993), AL-Agele (2012), Abdulla *et al.* (2014), Khadim and Dauod (2014), Michalek *et al.* (2016) and Mobini and Abdollahi (2016), At the basement membrane of Proximal convoluted tubules were investigated of all three types of fibers viz, collagen, elastic and reticular fibers present findings were in line with Islam *et al.* (2004) and Sreeranjini *et al.* (2010).

The mammalian type nephron possesses the loop of Henle in the medullary cone. In medullary cone, there was numerous thick and thin limb of the loop of Henle combine with medullary collecting duct (Fig.03). Similar findings with Wideman *et al.* (1981), Casotti and Richardson (1993), Nabipour *et al.* (2009), Baragoth (2015). In the present study at the periphery of the medullary cone, there was numerous thick limb of the loop of Henle observed while the thin limb located in the center of the medullary cone. Similar findings have given by Baragoth (2015). Loop of Henle was composed of all three types of fibers viz. collagen, elastic and reticular fibers whereas Islam *et al.* (2004) and Sreeranjini *et al.* (2010) reported collagen and reticular fibers. Casotti and Richardson (1993) in honeyeater (*parvorder corvi*) and Baragoth (2015) in Quail and Green-winged teal who have reported the simple cuboidal epithelium found in both thin and thick limb of the loop of Henle however in the present investigation the thick limb and thin limb of the loop of Henle were observed simple cuboidal epithelium with the wider lumen and simple squamous epithelium with narrow lumen respectively. The nucleus of the thin and thick loop of Henle was identified as spherical and centrally placed (Fig.08).

Distal convoluted tubule (DCT) was observed to continue within cortex from ascending limb of Henle although mostly found near the collecting tubule and PCT. These tubules were easily distinguished from the proximal tubules due to a wide lumen, darkly stained cytoplasm, and dense centrally placed nucleus (Fig.09). This tubule was lined by the simple cuboidal epithelium with devoided of brush border which was observed in the proximal convoluted tubule. This outcome of the present examination was in accordance with to close consent of Batah (2012) in coot bird, Patil and Janbandhu (2012) in Indian false vampire bat and Abdulla *et al.* (2014) in the house sparrow.

The lumen of the distal convoluted tubule was showing wider than compared with proximal convoluted tubule and visible. Islam *et al.* (2004) and Sreeranjini *et al.* (2010) reported that the distal convoluted tubules were composed of all three types of fibers viz. collagen, elastic and reticular fibers similar with the current investigation.

Macula densa (MD) and Juxta Glomerular Apparatus was observed in both Mammalian and Reptilian types of the nephron in Guinea fowl kidney with all components (Fig.10). These findings were by similar reports in avian kidneys given by Dantzler and Braun (1980) Morild *et al.* (1985 b), Casotti and Richardson (1993), Sreeranjini (2010) and Islam *et al.* (2004). Dark stained cells statement by Ogawa and Sokabe (1971) and tall cells found by Morild *et al.* (1985 b) in macula densa of the avian kidney was observed only in the mammalian type of nephrons. However, in the present investigation, dark-stained cells and tall cells were found in both mammalian and reptilian types of nephrons.

Collecting tubule (CT) was observed in both the cortex and medullary regions. The lining epithelium of collecting tubules cuboidal epithelium in the cortical region and columnar epithelium in the medullary region (Fig.11). this agrees with those similar findings of Sreeranjini (2010) in quail, Casotti and Richardson (1993) in Honeyeater birds and Archana *et al.* (2017) in Emu and Duck Mobini and Abdollahi (2016) in Japanese quail who has reported that distinctive brush border of interdigitations microvilli which projected into the terminal web was observed on luminal surfaces of the epithelial cells of the renal collecting ducts however those findings which were not seen in the present findings. All three types of fibers like collagen, elastic and reticular fibers

were also noticed in collecting tubule. Present findings were analogous with Islam *et al.* (2004) and Sreeranjini *et al*. (2010).

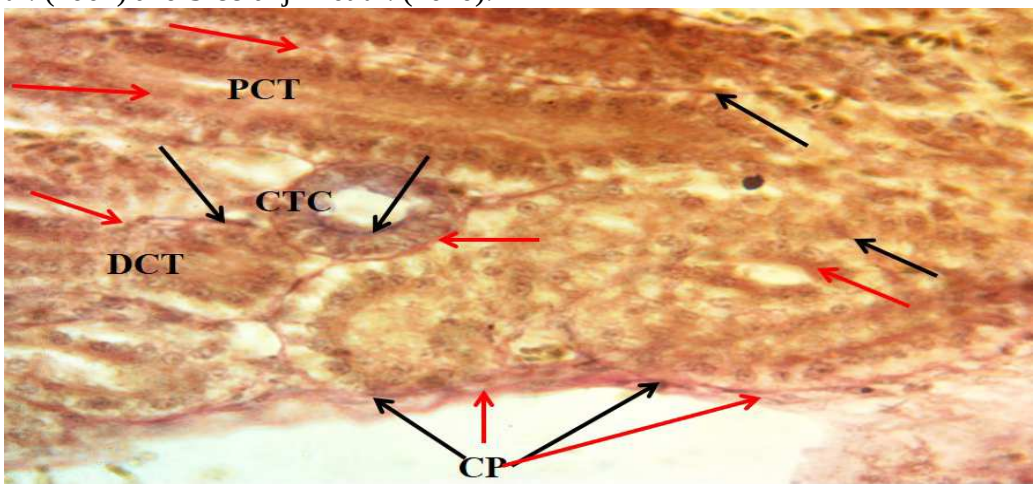

Fig.01. Photomicrograph Showing the capsule, elastic and collagen fibers of Guinea fowl kidney. CP- Capsule, PCT-Proximal convoluted tubule, DCT- Distal Convoluted Tubule, CTC- Cortical Collecting tubule, Red Arrow- Collagen Fibers, Black Arrow- Elastic Fibers. **Weigart's Stain- 400x**

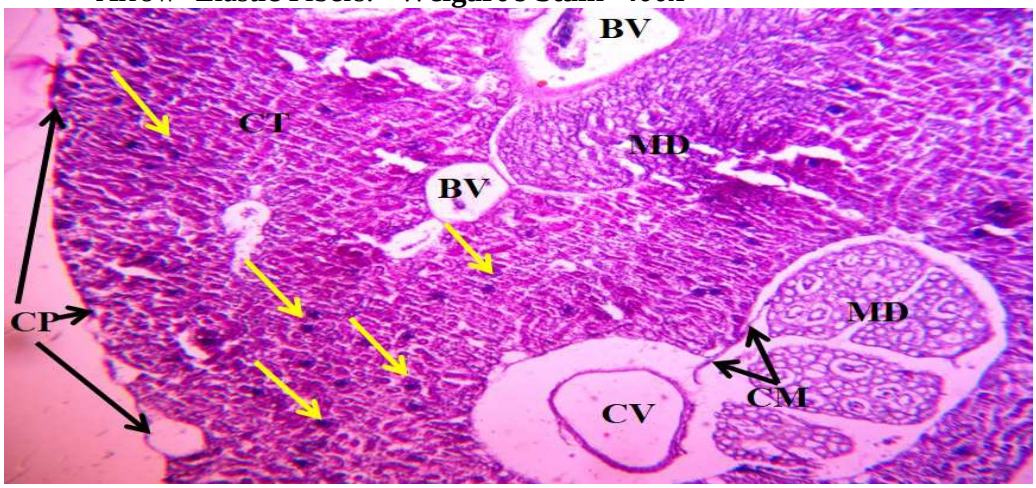

Fig.02. Photomicrograph Showing the histological details of Guinea fowl kidney. CP- Capsule, CT- Cortex, MD- Medulla, Yellow Arrow- Reptilian type Nephron and Black Arrow- Mammalian type Nephron. **Haematoxylin and Eosin- 40x**

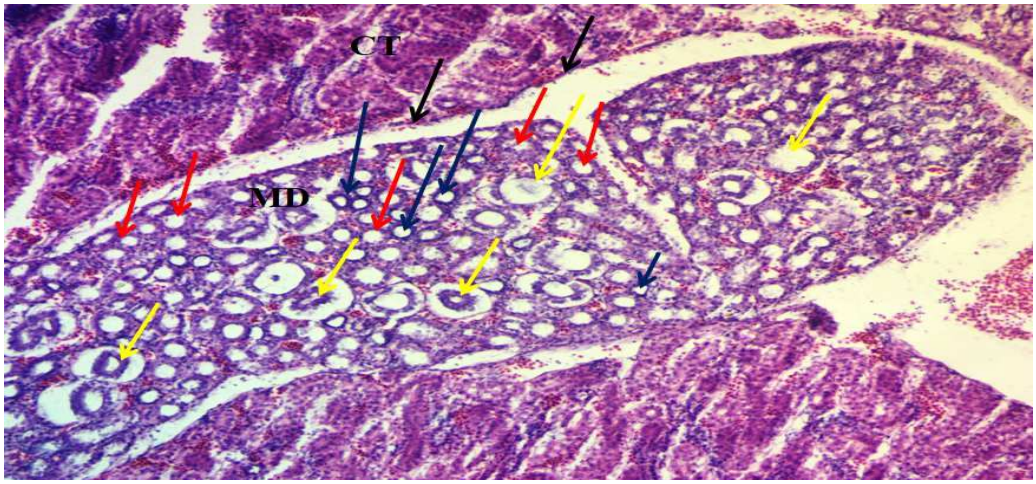

Fig.03. Photomicrograph Showing the histological details of Guinea fowl kidney. CT- Cortex, MD- Medulla, Black arrow- Medullary capsule, Yellow arrow- Medullary collecting Tubule, Red arrow-Thick limb of loop of Henle and Blue arrow- Thin limb of loop of Henle. **Haematoxylin and Eosin- 100x**

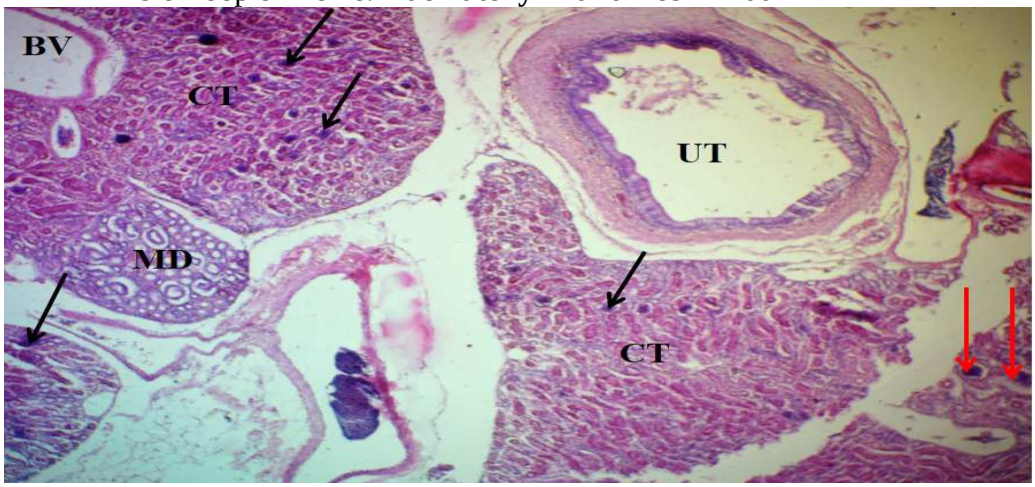

Fig.04. Photomicrograph Showing the histological details of Guinea fowl kidney. CT- Cortex, MD- Medulla, UT- Ureter, BV- Blood Vessels, Black Arrow- Reptilian Renal Corpuscle and Red Arrow- Mammalian Renal Corpuscle. **Haematoxylin and Eosin- 40x**

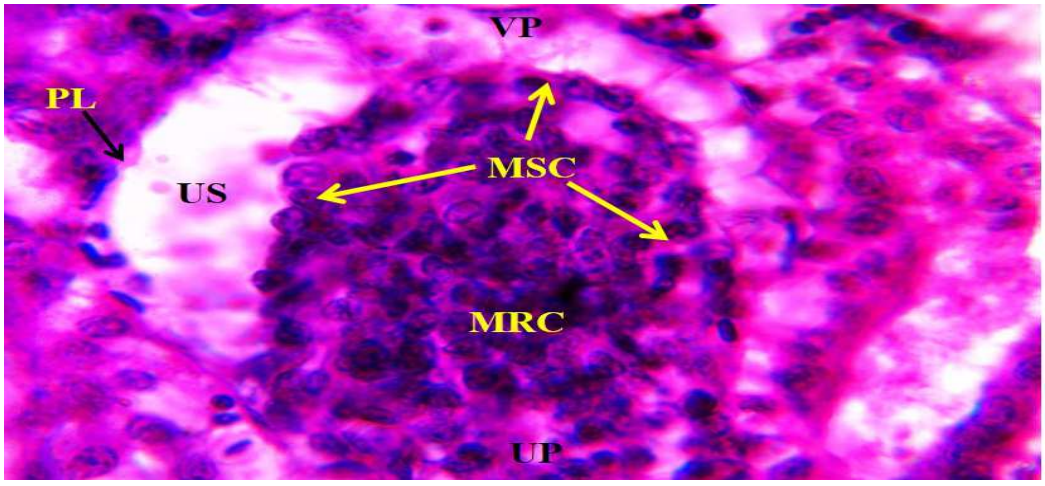

Fig.05. Photomicrograph Showing the histological details of Mammalian Renal Corpuscle of Guinea fowl kidney. MRC- Mammalian Renal Corpuscle, MSC- Mesangial cells, US- Urinary Space, PL- Parietal Layer, VP- Vascular Pole and UP- Urinary Pole.
Haematoxylin and Eosin- 1000x

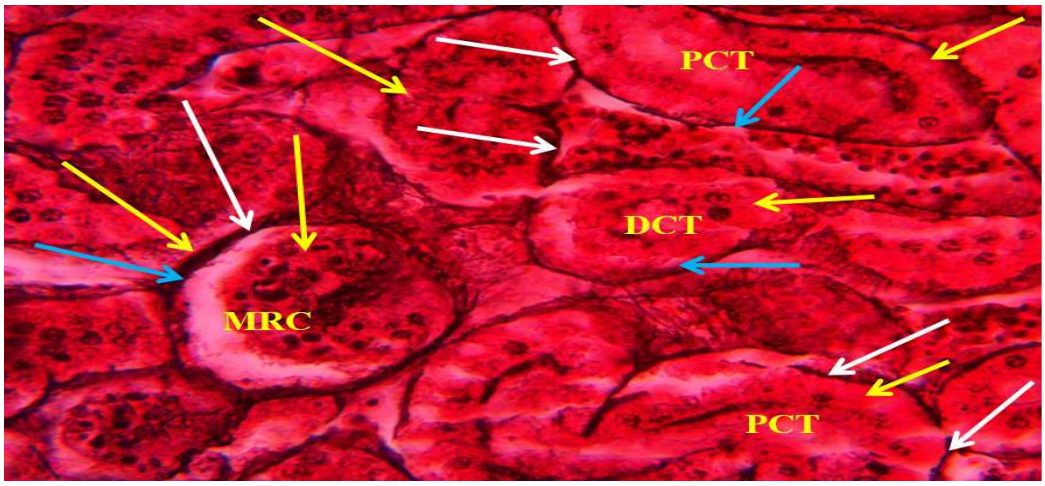

Fig.06. Photomicrograph Showing the elastic, collagen and reticular fibers of Mammalian Renal Corpuscle. MRC Mammalian Renal Corpuscle, PCT- Proximal Convoluted Tubule, DCT- Distal Convoluted Tubule, Yellow Arrow- Elastic Fibers, Blue Arrow- Collagen Fibers and White Arrow- Reticular Fibers.
Silver Orcein and Aniline Blue Stain- 1000x

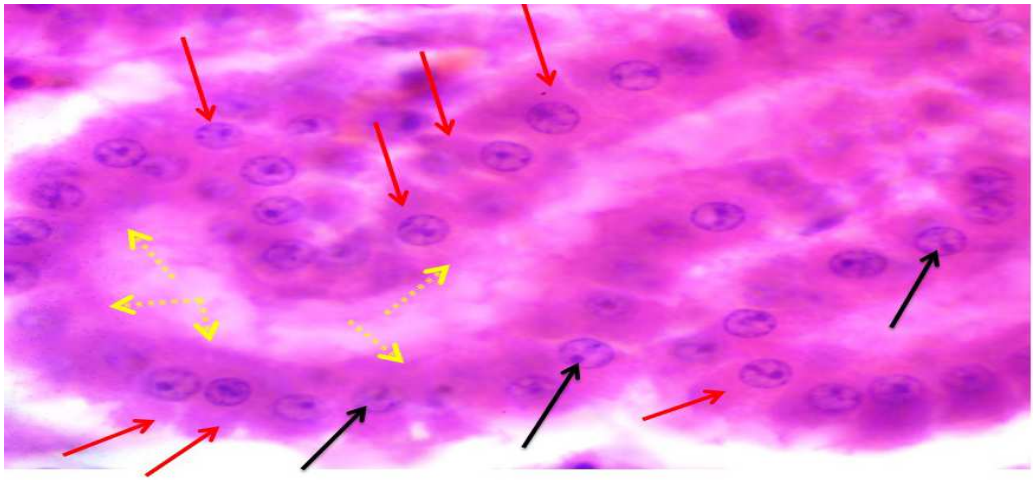

Fig.07. Photomicrograph Showing the histological details of Proximal Convoluted Tubule of Guinea fowl kidney. Red Arrow- Columnar cells, Black Arrow- Cell Nucleus and Yellow Arrow -Brush border. **Haematoxylin and Eosin- 1000x**

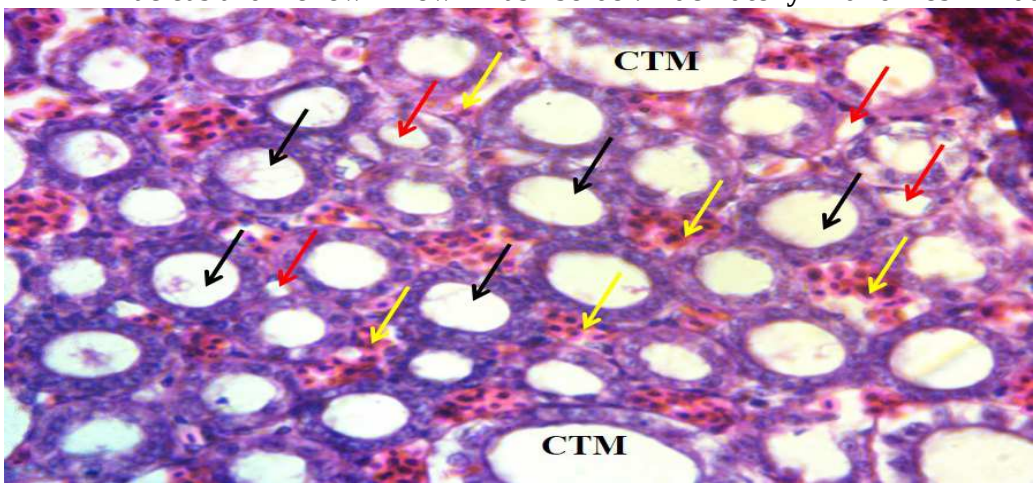

Fig.08. Photomicrograph Showing the histological detail of medulla of Guinea fowl kidney. CTM- Medullary Collecting Tubule, Black Arrow-Thick Limb of Loop of Henle, Red Arrow- Thin Limb of Loop of Henle and Yellow Arrow-Vasa recta. **Haematoxylin and Eosin- 400x**

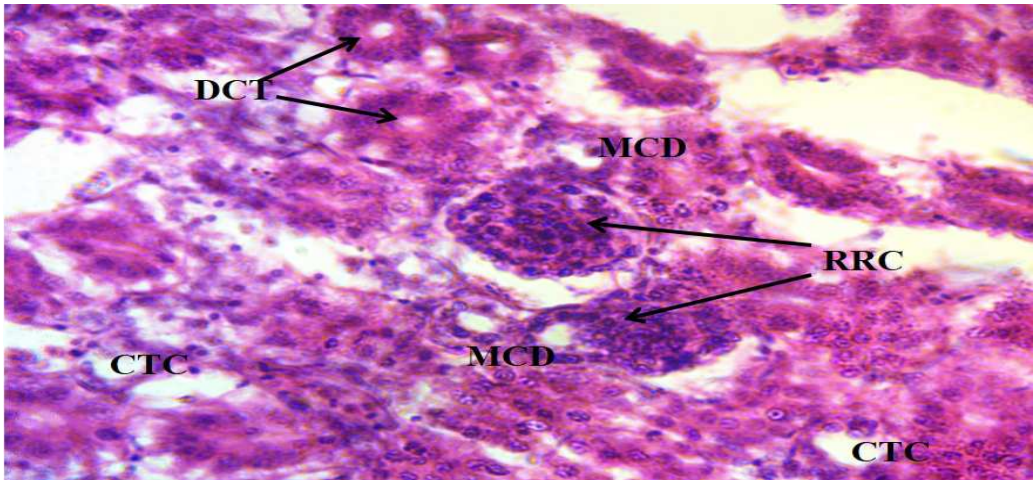

Fig.09.Photomicrograph Showing the histological details of Guinea fowl kidney. RRC- Reptilian Renal Corpuscle, MCD- Macula densa, DCT- Distal Convoluted Tubule and CTC- Cortical Collecting Tubule.
Haematoxylin and Eosin- 100x

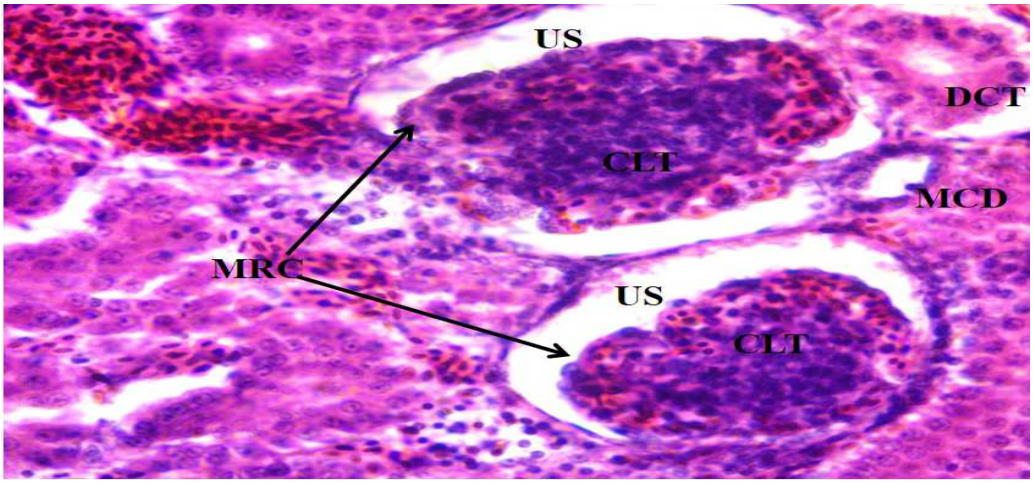

Fig.10. Photomicrograph Showing the histological details of Mammalian Renal Corpuscle of Guinea fowl kidney. MRC- Mammalian Renal Corpuscle, MCD- Macula densa, DCT- Distal Convoluted Tubule, US-Urinary space and CLT- Capillary tuft. **Haematoxylin and Eosin- 400x**

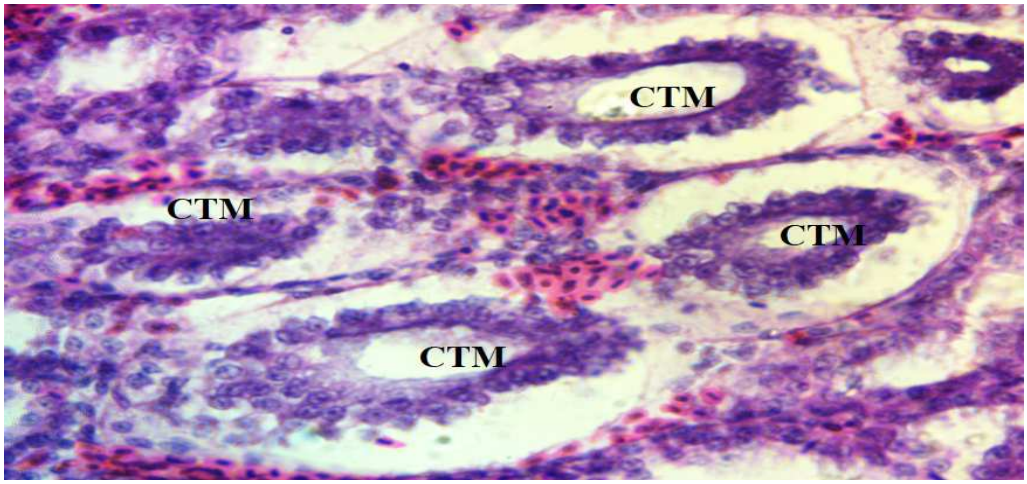

Fig.11. Photomicrograph Showing the histological detail of Medullary collecting tubules of Guinea fowl kidney. CTM- Medullary Collecting Tubules. **Haematoxylin and Eosin- 400x**

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