Indian Journal of Veterinary Anatomy 33 (2): 116-118, December 2021

Comparative Histochemical and Histoenzymological Studies on the Kidney of Domestic Animals

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Received: 05 October 2021; Accepted: 08 October 2021

ABSTRACT

The histochemical and histoenzymological aspects of kidney were studied in buffalo, sheep, pig and dog. The glomeruli, parietal and visceral layers of Bowman's capsule exhibited intense positive activity for PAS and moderate to intense activity for PAS-AB in buffalo, sheep, pig and dog. The basement membranes around the renal corpuscles and tubules of cortex and medulla showed intense activity for PAS in buffalo, sheep and pig and moderate activity in dog. The cortex showed intense alkaline phosphatase and acid phosphatase activity and fat deposition was observed in the tubules of cortical labyrinth in buffalo, sheep, pig and dog. The glomeruli of kidney showed more protein activity in buffalo and less activity in sheep, pig and dog. The strong activity for renin was observed at the vascular pole surrounding the afferent and efferent arterioles close to the macula densa in all domestic animals.

Key words: Kidney, Glomerulus, Mucopolysachharides, Protein, Fats

The kidney is a complex organ with myriad functions, including filtration of the blood, preservation of fluid, electrolyte and acid-base balance and regulation of blood pressure (Verlander, 1998). The study of general features of kidney in various domestic animals helps to identify the pathological conditions of kidney. Hence the present study was conducted to provide details on histochemical and histoenzymological aspects of kidney.

MATERIALS AND METHODS

The present study was conducted on kidney of buffalo, sheep, pig and dog with six in each species. The specimens from adult buffalo and sheep were collected from local slaughter houses located in and around Tirupati, whereas the specimens of pig were collected from AICRP on pigs, College of Veterinary Science, Tirupati and that of dogs were collected from the animals died during automobile accidents or from the cadaver of willed animal body programme at VCC, College of Veterinary Science, Tirupati.

Fresh tissue samples were collected from kidney and they were fixed in 10% Neutral Buffered Formalin. Later these samples were subjected to routine tissue processing for paraffin blocks (Singh and Sulochana, 1997). About 5-6 µm thick paraffin sections were obtained from the blocks and stained with Periodic acid Schiff method for neutral mucopolysaccharides (Bancroft and Gamble, 2008), Periodic Acid-Schiff-Alcian blue method for acid mucopolysaccarides (Bancroft and Gamble, 2008), mercury bromphenol blue method for proteins (Luna, 1968), Von-Kossa's method for calcium deposits (Luna 1968), weak periodic acid silver methenamine staining method for renin (Ren-1) (Yabuki et al., 2002). Frozen sections were cut from fresh kidney samples at 10 µ thickness on cryostat and subjected for Gomori's method for alkaline phosphatase activity (Singh and Sulochana, 1997), Gomori's method for acid phosphatase activity (Singh and Sulochana, 1997) and oil-red-O in propylene glycol method for fats (Singh and Sulochana, 1997).

RESULTS AND DISCUSSION

Mucopolysachharides: In the outer layer of renal capsule, PAS positive activity was moderate for neutral mucopolysaccharides in buffalo and mild in sheep, pig and dog, while in the inner layer of capsule it was intense in all the domestic animals (Fig. 1). Kumar (2006) observed moderate and mild activity of PAS in the outer and inner layers of capsule respectively in goat. The activity for PAS-AB in renal capsule was moderate in buffalo, pig and dog and mild in sheep. In the renal corpuscles, the glomeruli, parietal and visceral layers of Bowman's capsule exhibited intense positive activity for PAS (Fig. 2) and moderate to intense activity for PAS-AB in buffalo, sheep, pig and dog (Fig. 3). Similarly, several PAS positive deposits were observed in glomeruli of buffalo (Singh, 1966). Similar findings was also reported in glomeruli, while in Bowman's capsule the activity was reported to be mild to moderate reaction for acid mucoploysachharides in goat (Kumar, 2006). Further, PAS-AB reaction was noted as moderate in the parietal layer of Bowman capsule in goat (Reddy,

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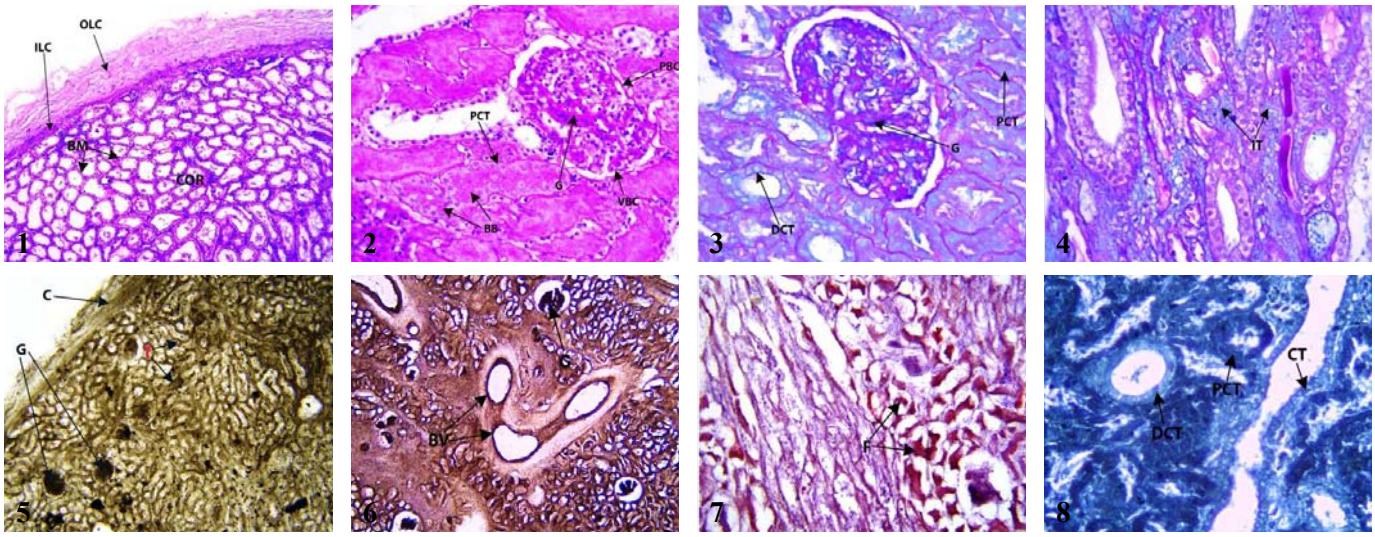

Figs. 1-8. **1.** Photomicrograph showing PAS activity in outer (OLC) and inner layers of capsule (ILC) and in basement membrane (BM) of tubules of cortex (COR) of buffalo kidney. Periodic Acid Schiff method x 100; **2.** Photomicrograph showing PAS activity in glomeruli(G), parietal (PBC) and visceral (VBC) layers of Bowman's capsule and brush border (BB) of proximal convoluted tubules (PCT) of pig kidney. Periodic Acid Schiff method x 400; **3.** Photomicrograph showing PAS-AB activity in glomeruli(G), proximal convoluted tubules (PCT) and distal convoluted tubules (DCT) of buffalo kidney. Periodic Acid Schiff-Alcian blue method x 400; **4.** Photomicrograph showing PAS-AB activity in interstitial tissue (IT) of medulla of pig kidney. Periodic Acid Schiff-Alcian blue method x 400; **5.** Photomicrograph showing alkaline phosphatase activity in capsule (C), glomeruli(G) and in tubules of cortex (T) of buffalo kidney. Gomori's method ×40; **6.** Photomicrograph showing acid phosphatase activity in glomeruli (G) and blood vessels (BV) of sheep kidney. Gomori's method ×40; **7.** Photomicrograph showing fats (F) in cortical tubules of pig kidney. Oil red O method x 100; **8.** Photomicrograph showing protein activity in proximal convoluted tubules (PCT), distal convoluted tubules (DCT) and collecting tubules (CT) of buffalo kidney. Mercury Bromophenol blue method x 400.

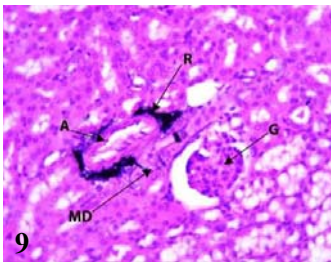

Fig. 9. Photomicrograph showing renin (R) activity in dog kidney in afferent arteriole (A), near macula densa (MD) and glomerulus (G). W- Periodic acid silver methenamine×400.

2018). The basement membranes around the renal corpuscles and tubules of cortex and medulla showed intense activity for PAS in buffalo, sheep and pig and moderate activity in dog (Fig.1). Similarly, glomerular basement membrane showed PAS positive activity in domestic animals (Eurell and Frappier, 2006), goat and pig (Reddy, 2018). The basement membrane of the tubules was PAS positive in goat (Kumar, 2006) as observed in the present study.

The proximal tubules showed PAS positive activity for cytoplasmic granules in their lining cells. Similar findings were observed in buffalo (Singh, 1966). The PAS positive cytoplasmic granules were numerous in pig, but very few in buffalo, sheep and dog. The brush border of the lining cells in the proximal tubules exhibited intense reaction for PAS in all the domestic animals studied (Fig. 2). Similar finding was observed in goat by Kumar (2006). The lining cells of proximal convoluted and straight tubules showed moderate PAS-AB positive activity in all domestic animals. The PAS positive activity in the lining epithelial cells of distal convoluted tubules, collecting tubules in cortex and outer medulla was moderate in buffalo and mild in sheep, pig and dog. Mild PAS positive activity was also observed in the lining cells of thick and thin segments of loops of Henle, collecting tubules of inner medulla and papillary ducts of all the domestic animals. The lining cells of distal convoluted tubules, thick and thin segments of loops of Henle and collecting tubules showed mild to moderate activity for PAS-AB. In contrary to this, distinct reaction for acid mucopolysachharides was observed in luminal surface of cells of arched collecting tubule in goat (Kumar, 2006). The renal papillary epithelium showed moderate to intense PAS positive activity and moderate PAS-AB activity. Similar findings were reported in goat by Venumadhav *et al*., (2019).

In all the domestic animals, the juxtaglomerular cells and extraglomerular mesangial cells showed moderate to intense positive reaction for PAS and mild activity for PAS-AB. The lining cells of macula densa showed mild PAS positive activity. Similarly, PAS positive reaction was observed in the juxtaglomerular cells of buffalo (Singh, 1966), goat (Kumar, 2006) and sheep (Singh, 2018). In contrary to this juxtaglomerular cells were reported to be PAS negative in porcine by Oguri, (1980). The PAS activity in interstitial connective tissue of cortex and medulla was intense in buffalo and sheep, moderate in pig and mild in dog. But the activity for PAS-AB in interstitial connective tissue of medulla was mild in buffalo and sheep, moderate

in pig (Fig.4) and intense in dog. The walls of the blood vessels of kidney showed intense PAS and PAS-AB positive activity of all domestic animals.

Alkaline and acid phosphatase: In the renal capsules of all domestic animals, exhibited mild to moderate activity for alkaline phosphatase (Fig.5) and very mild activity for acid phosphatase. In all domestic animals, the cortex showed intense alkaline phosphatase and acid phosphatase activity than medulla. Similar finding was reported in goat by Iyyangar (1986). Intense reaction of alkaline phosphatase and acid phosphatase activity was observed in the renal corpuscles (Figs. 5, 6). The alkaline phosphatase activity was moderate to intense in the lining cells of tubules of renal cortex, whereas in tubules of medulla it was observed mild to moderate. The alkaline phosphatase activity was observed in the cells of cortical tubules in goat (Iyyangar, 1986).

The acid phosphatase activity in the tubules of the cortical labyrinth was moderate to intense in buffalo, sheep and pig, but mild to moderate in dog. In all the domestic animals, mild to moderate acid phosphatase activity was observed in the tubules of the medullary rays of the cortex and in tubules of medulla. Iyyangar (1986) observed acid phosphatase activity in proximal convoluted tubule, distal convoluted tubule and macula densa of goat. Intense alkaline phosphatase and acid phosphatase activity (Fig.6) was observed around the blood vessels in kidney of all the domestic animals.

Fats: Fat deposition was observed in the tubules of cortical labyrinth of kidney of buffalo, sheep, pig and dog (Fig.7). Fat deposition was more in the renal cortex of dog when compared to other domestic animals of this study. Fat deposition was observed only in some tubules of medulla of kidney. However, Iyyangar (1986) reported that fat droplets were present in the cytoplasm of distal convoluted tubule of goat kidney. But Kumar (2006) reported that lipids were located in an abundant amount in the proximal convoluted tubule of goat kidney.

Calcium: Calcium deposition was not observed in the kidney of buffalo, sheep, pig and dog in the present study. In contrary to the present study, calcification was reported in the tubules of the inner zone of medulla of domestic cat by Lucke and Hunt (1967) and blood vessels of goat kidney by Kumar, (2006).

Protein: The glomeruli of kidney showed more protein activity in buffalo and less activity in sheep, pig and dog. However, Zaghloul (2011) reported moderate protein activity in renal gomeruli of rat. In the present study, the cells of proximal convoluted and straight tubules showed more activity while cells of thick and thin segments of loop of Henle, distal convoluted tubules, collecting tubules showed less activity in buffalo, sheep, pig and dog (Fig. 8). The activity for proteins was more in buffalo and less in dog when compared to other domestic animals. Zaghloul (2011) also reported proteinic particles in renal tubules of rat.

Renin: The activity for renin was observed at the vascular pole surrounding the afferent and efferent arterioles close to the macula densa in all domestic animals (Fig.9). In sheep, renin activity was also noticed in the walls of the blood vessels lying in their course in cortical region. The activity for renin was more in sheep followed by dog, buffalo and pig. However, Yabuki *et al*. (2002) noticed that renin was particularly specific only for juxtaglomerular cells of kidney of mouse.

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