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Accessment of the Kidney in Ginger Treated Wistar Rats

Patrick O. Ede; Kebe, E. Obeten; Victoria N. Isaac; Patricia P. Obasee
Department of Anatomy, University of Calabar, Calabar
Corresponding author: Kebe E. Obeten
Email: fredobeten@yahoo.com
Phone: 08035505856

ABSTRACT

Ginger, botanically known as *Zingerber offinale* is an underground stem or rhizome which is known to have originated from Asia and have been reported to have a number of medicinal properties which is used in the treatment of many ailments such as arthritis, painful menstrual periods, nausea etc. It is also used as a common specie in food and bakery industries. The effect of ethanolic extract of ginger on the kidney of male wistar rats was studied due to the availability and medicinal uses of ginger. Twenty five (25) adult Wistar rats weighing 125-200g were divided into five groups. Group A animals served as the control and were served with distilled water , B served as vehicle control groups and received olive oil. The animals in groups C, D and E served as experimental groups, and received 100mg/kg, 250mg/kg and 500mg/kg body weight of the ethanolic extract of *Zingiber officinale* respectively. The animals received the extract for 14 days and were sacrificed 24 hours after the last administration and the kidney was routinely processed histologically. The study shows enlargement of Bowman's space, disintegration of glomerular cells and dilation of the tubular lumen with shrinkage of tubular luminal cells when compared to the control group, which progressively increased as the duration of intake of *Zinger officinlae* increased. Therefore, *Zingerber officinale* should be used with caution because it may have deleterious effects on the liver cells at high doses.

Keywords: Assessment, Ginger, Treatment, Kidney, Wistar rat

INTRODUCTION

Ginger or **ginger root** is the rhizome of the plant Zingiber officinale, consumed as a delicacy, medicine, or spice. It lends its name to its genus and family (Zingiberaceae). Other notable members of this plant family are turmeric, cardamom, and galangal. The distantly related dicots in the Asarum genus have the common name wild ginger because of their similar taste. Ginger is indigenous to southern China, from whence it is spread to the Spice Islands and other parts of Asia, and subsequently to West Africa and to the Caribbean.[1] Ginger appeared in Europe, via India, in the 1st century CE as a result of the lucrative spice trade.[2]

Ginger produces clusters of white and pink flower buds that bloom into yellow flowers. Because of its aesthetic appeal and the adaptation of the plant to warm climates, ginger is often used as landscaping around subtropical homes. It is a perennial reed-like plant with annual leafy stems, about a meter (3 to 4 feet) tall. Traditionally, the rhizome is gathered when the stalk withers; it is immediately scalded, or washed and scraped, to kill it and prevent sprouting. The fragrant perisperm of Zingiberaceae is used as sweetmeats by Bantu, also as a condiment and sialogogue.[3]

According to the American Cancer Society, ginger has been promoted as a cancer treatment "to keep tumors from developing", but "available scientific evidence does not support this". They add: "Recent preliminary results in animals show some effect in slowing or preventing tumor growth. While these results are not well understood, they deserve further study. Still, it is too early in the research process to say whether ginger will have the same effect in humans."[4]

In limited studies, ginger was found to be more effective than placebo for treating nausea caused by seasickness, morning sickness and chemotherapy,[13][14][15][16] although ginger was not found superior to placebo for pre-emptively treating post-operative nausea. Some studies advise against taking ginger during pregnancy,[5] suggesting that ginger is mutagenic, though some other studies have reported antimutagenic effects.[5] Other preliminary studies showed that ginger may affect arthritis pain or have blood thinning and cholesterol lowering properties, but these effects remain unconfirmed.[6]

The kidneys are bean-shaped organs that serve several essential regulatory roles in vertebrate animals. They remove excess organic molecules (e.g., glucose) and it is by this action that their best-known function is performed: the removal of waste products of metabolism (e.g., urea, though 90% of this is reabsorbed along the nephron.) They are essential in the urinary system and also serve homeostatic functions such as the regulation of electrolytes, maintenance of acid–base balance, and regulation of blood pressure (via maintaining salt and water balance). They serve the body as a natural filter of the blood, and remove water soluble wastes, which are diverted to the urinary bladder. In producing urine, the kidneys excrete wastes such as urea and ammonium, and they are also responsible for the reabsorption of water, glucose, and amino acids. The kidneys also produce hormones including calcitriol, erythropoietin, and the enzyme renin, the latter of which indirectly acts on the kidney in negative feedback.

Located at the rear of the abdominal cavity in the retroperitoneum, the kidneys receive blood from the paired renal arteries, and drain into the paired renal veins. Each kidney excretes urine into a ureter, itself a paired structure that empties into the urinary bladder. Renal physiology is the study of kidney function, while nephrology is the medical specialty concerned with kidney diseases. Diseases of the kidney are diverse, but individuals with kidney disease frequently display characteristic clinical features. Common clinical conditions involving the kidney include the nephritic and nephrotic syndromes, renal cysts, acute kidney injury, chronic kidney disease, urinary tract infection, nephrolithiasis, and urinary tract obstruction [7]

The kidneys excrete a variety of waste products produced by metabolism. These include the nitrogenous wastes called "urea", from protein catabolism, as well as uric acid, from nucleic acid metabolism. Formation of urine is also the function of the kidney. The concentration of nitrogenous wastes, in the urine of mammals and some birds, is dependent on an elaborate counter current multiplication system. This requires several independent nephron characteristics to operate: a tight hair pin configuration of the tubules, water and ion permeability in the descending limb of the loop, water impermeability in the ascending loop and active ion transport out of most of the ascending loop. In addition, counter current exchange by the vessels carrying the blood supply to the nephron is essential for enabling this function.

Glucose at normal plasma levels is completely reabsorbed in the proximal tubule. The mechanism for this is the Na+/glucose co-transporter. A plasma level of 350 mg/dL will fully saturate the transporters and glucose will be lost in the urine. A plasma glucose level of approximately 160 is sufficient to allow glucosuria, which is an important clinical clue to diabetes mellitus.

Amino acids are reabsorbed by sodium dependent transporters in the proximal tubule. Hartnup's disease is a deficiency of the tryptophan amino acid transporter, which results in pellagra.[8]

MATERIALS AND METHOD

Preparation of ethanolic extract of *zingiber officinale* plant

A fresh ginger root was purchased from the Marian market in Calabar Muncipal Council, Cross River State, Nigeria. The roots were identified and authenticated by the botanist in the botany department, university of Calabar, Calabar.

2.5kg of fresh ginger rhizome was cleaned, washed under running tap water, cut into small pieces, air dried for two weeks and crushed into powdered form using an electric blender

2000g (2kg) of this powdered ginger was macerated completely in 5000ml of 99.9% ethanol and shaken vigorously. It was allowed to stand for 48 hours at room temperature and was stirred at intervals.

After 48 hours, the dissolved ginger in ethanol was filtered using at first a material with small pores after which it was filtered again using No1 whatmann paper (filter paper) and funnel. The filtrate was collected in a tray and was air dried for 5 days. This was to ensure the complete evaporation of the ethanol used.

The ginger paste obtained was collected from the tray with the aid of a spatula into a container and was measured using an electric weighing balance. 50g of ginger paste was extracted and was then dissolved in 100ml of extra virgin olive oil (which served as the vehicle). This extract was kept in a dry place at room temperature.

Breeding/grouping of animals

Twenty-five adult albino male wistar rats weighing between 125-200g were purchased from the department of pharmacology animal farm, university of Calabar, Calabar. These animals were housed in well ventilated animal cages and were kept in the animal house of the department of Human Anatomy, Faculty of Basic Medical Sciences, College of Medical Sciences, University of Calabar. The animal house was properly fitted with bright light and environmental temperature always kept at a range of 28^0C to 32^0C. The house was constantly kept clean and disinfected.

The animals were fed with growers mesh obtained from vital feed located in Calabar and Distilled water daily with the aid of water bottles and were allowed to acclimatize for a period of 14 days.

After the fourteenth day of acclimatization, the rats weighed between 125-200g, but the weight significantly changed after administration of extract in the treated animals. They were then randomly selected into five groups with each group containing five rats in well labelled cages.

Plant extract administration

The animals were divided into five groups with five rats each.

GROUP A: These animals were given distilled water and served as the control.

GROUP B: These animals served as the vehicle control and received olive oil.

GROUP C: was the low dose group. They were administered 100mg/kg body weight of the ethanolic extract of Zingiber officinale.

GROUP D: was the medium dose group. The animals were administered 250mg/kg body weight of the ethanolic extract of Zingiber officinale.

GROUP E: was the high dose group. The animals were administered 500mg/kg body weight of the ethanolic extract of Zingiber officinale.

Each animal in the experimental groups was administered the plant extract based on its body weight and administration was done using the oral route throughout the period of the experiment (which lasted for 14 days) after which the animals were sacrificed, kidney harvested and processed for histological observation.

RESULT

Normal control (Group A): This group received no extract of *Zingiber officinale* but was given feed and distilled water. The slide shows noticeable glomeruli surrounded by a distinct bowman's space. The renal tubules are closely packed with a distinct lumen and epithelial linings made up of low columnar to cuboidal cells. The cells have round to oval basophilic nuclei and abundant eosinophilic cytoplasm. (Plate 1)

Vehicle control (Group B): This group received no extract of ginger but was given feed, olive oil and distilled water. The section of the kidney shows prominent glomeruli surrounded by a distinct Bowman's capsule. The renal tubules are closely packed with a distinct lumen and epithelial linings made up of low columnar to cuboidal cells. The cells have round to oval basophilic nuclei and abundant eosinophilic cytoplasm. (Plate 2)

Group C (Low dose): This group received low dose of 100g/kg body weight of the ethanolic extract of ginger for a period of 14 days. The section shows dilation of Bowman's space when compared with the control groups. The renal tubules have distinct lumen and intact epithelial linings consisting of round to oval basophilic nucle and abundant eosinophilic cytoplasm. (Plate 3)

Group D (Medium dose): This group received medium dose of 250g/kg of the body weight of the ethanolic extract of ginger for a period of 14 days. Section shows dilation of the Bowman's space and disintegration of the glomerular cells, the tubular cells are more cuboida. The renal tubules have distinct lumen and epithelial linings. (Plate 4).

Group E (High dose): This group received high dose of 500g/kg of the body weight of the ethanolic extract of ginger for 14 days. Section of the kidney shows enlargement of cells in the Bowman's space, disintegration of the glomerular cells and dilation of the tubular lumen with shrinkage of tubular luminal cells. The renal tubules are closely packed with intact epithelial lining. (Plate 5)

DISCUSSION

Ginger is a rhizome though referred as a root and had long been used for treating aliments like every other herb in the world for centuries such as diarrhea, common cold, heat condition, flu-like symptoms, headache and painful menstrual periods [9]. In 1982, Mowrey and Co-workers reported that ginger aid digestion, absorption and relieves flatulence in gastrointestinal tract by increasing the muscular activity.

A 2013 *in vivo* evaluation demonstrated ginger extract showed a hepatoprotective effect in rats.[10] A 2013 review found that ginger is a free radical scavenger, antioxidant; thus inhibits lipid peroxidation and that these attributes could be contributing to its known gastroprotective effects.[11] A 2012 review found ginger extract and ginger juice possess anti-emetic effects against chemotherapy-induced nausea and vomiting in experimental animals.[9] A 2012 review found the radioprotective properties of ginger extract might be effective to protect against gamma radiation-induced side effects from cancer treatment in mice.[12] A 2011 review found ginger displays chemopreventive and antineoplastic effects.[13] The same review found that ginger appears to be promising for cancer prevention, though further research is necessary to evaluate the efficacy and safety of ginger.[13] Advanced glycation end-products are possibly associated in the development of diabetic cataract for which ginger was effective in preliminary studies, apparently by acting through antiglycating mechanisms.[14][15] Zingerone may have activity against enterotoxigenic *Escherichia coli* in enterotoxin-induced diarrhea in mice.[16]

The main pharmacological actions of ginger and compounds isolated there from include immuno-modulatory, anti-tumorigenic, anti-inflammatory, anti-apoptotic, anti-hyperglycemic, anti-lipidemic and anti-emetic actions. Ginger is a strong anti-oxidant substance and may either mitigate or prevent generation of free radicals. It is considered a safe herbal medicine with only few and insignificant adverse/side effects(17).Oxidants and antioxidants have attracted widespread interest in nutrition research, biology and medicine. It has become clear that constant generation of pro-oxidants, including oxygen free radicals, is an essential attribute of aerobic life (18). A disturbance in the pro-oxidant/antioxidant system has been defined as oxidative stress. Reactive oxygen species (ROS) are very reactive molecules ranked as free radicals owing to the presence of one unpaired electron such as a superoxide ion (O─2), nitrogen oxide (NO) and hydroxyl radical (HO─). Even though naturally present in the organism, they are mainly confined to cell compartments and counterbalanced by natural antioxidant molecules, such as glutathione, glutathione peroxidase, superoxide dismutase, vitamin E and vitamin C, acting as free radical scavengers (19,20).

This study aimed to elucidate the effect of ethanolic extract of ginger on the histology of the kidney, using Wistar rats. Twenty five Wistar rats weighing 125-200g were used and divided into five groups, each group with five rats (A, B, C, D and E). Group and B were used as control and vehicle control respectively, while C, D and E served as experimental groups.

The study shows enlargement of Bowman's space, disintegration of glomerular cells and dilation of the tubular lumen with shrinkage of tubular luminal cells.

CONCLUSION

From the above result, it can be concluded that extract of ginger may have adverse effect on the integrity of Bowman's space, glomerular cells, tubular lumen with shrinkage of tubular luminal cells of the kidney

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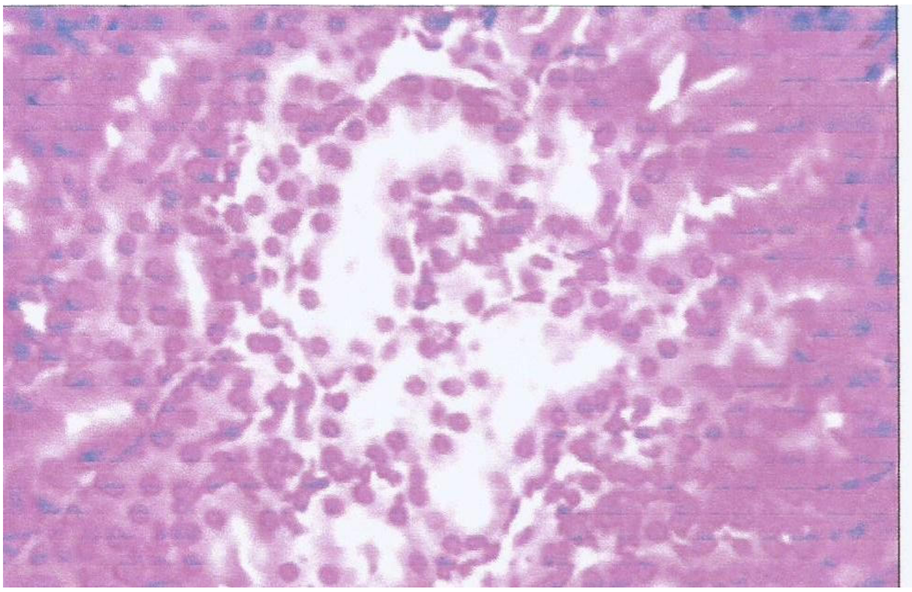

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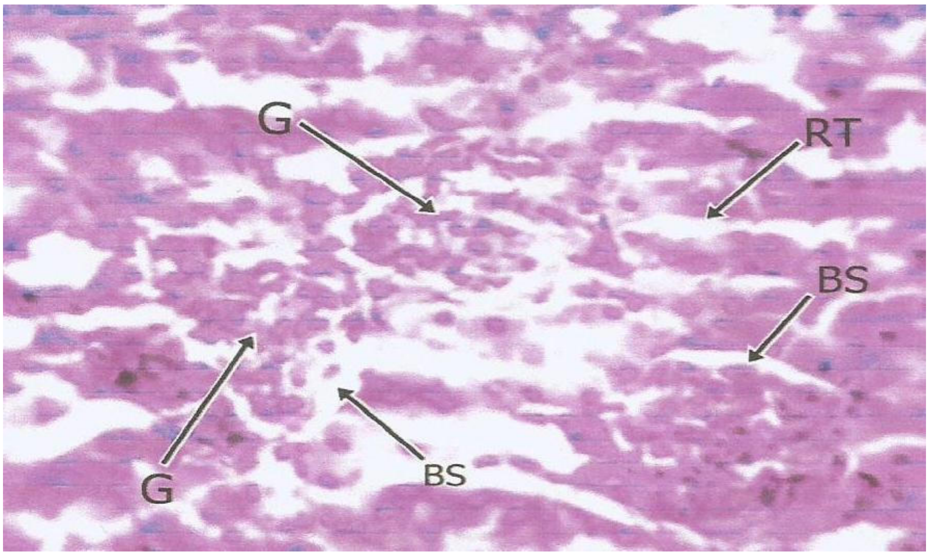

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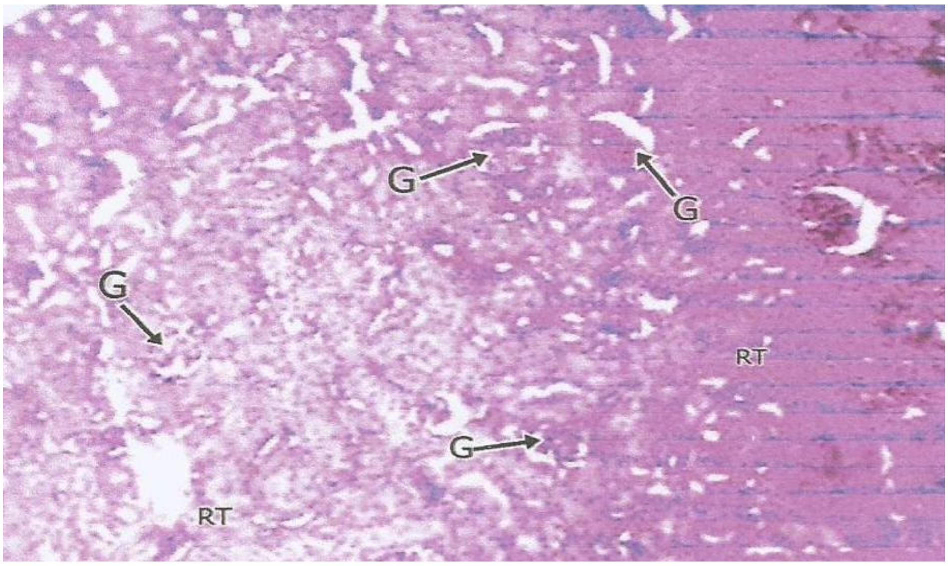
Plate 1: Photomicrograph of the control kidney showing noticeable glomeruli surrounded by a distinct bowman's space. The renal tubules are closely packed with a distinct lumen and epithelial linings made up of low columnar to cuboidal cells. The cells have round to oval basophilic nuclei and abundant eosinophilic cytoplasm



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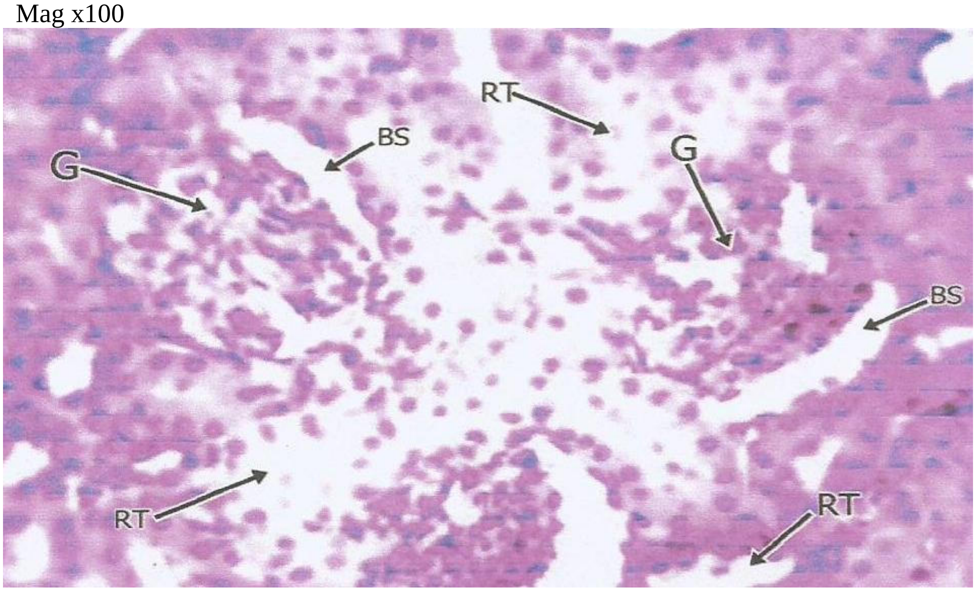

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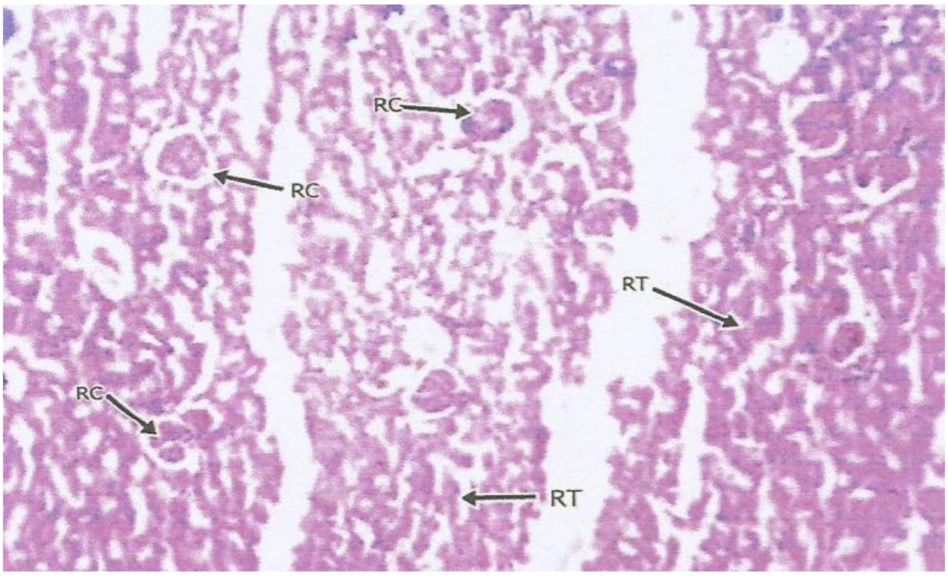
Plate 2: Photomicrograph of kidney shows prominent glomeruli surrounded by a distinct Bowman's capsule. The renal tubules are closely packed with a distinct lumen and epithelial linings made up of low columnar to cuboidal cells. The cells have round to oval basophilic nuclei and abundant eosinophilic cytoplasm



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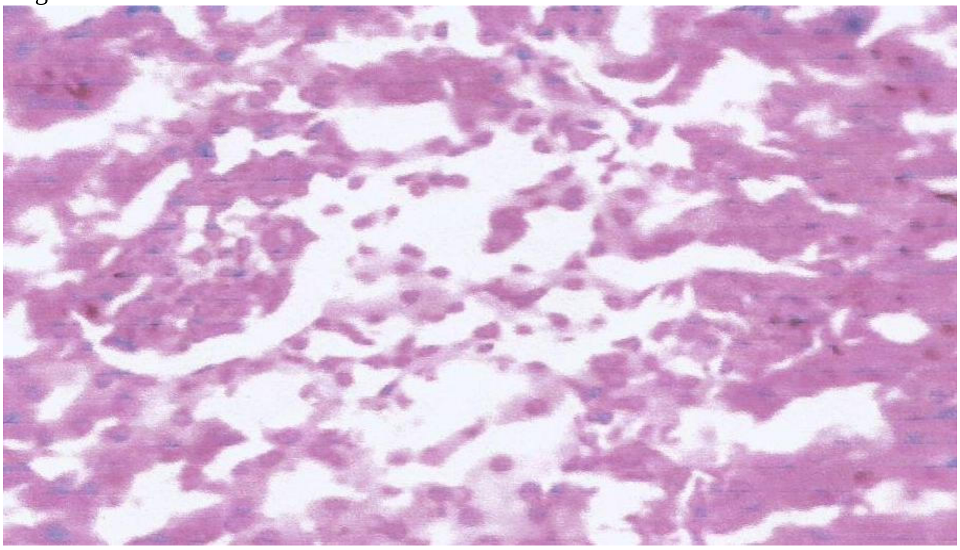

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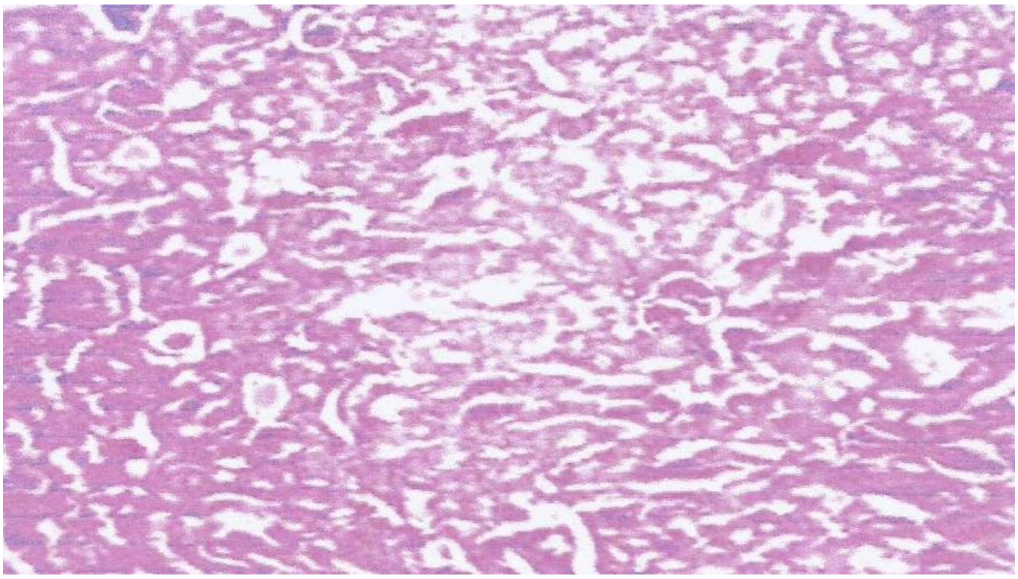
Plate 3: Photomicrograph of the low dose kidney shows dilation of Bowman's space when compared with the control groups. The renal tubules have distinct lumen and intact epithelial linings consisting of round to oval basophilic nucle and abundant eosinophilic cytoplasm



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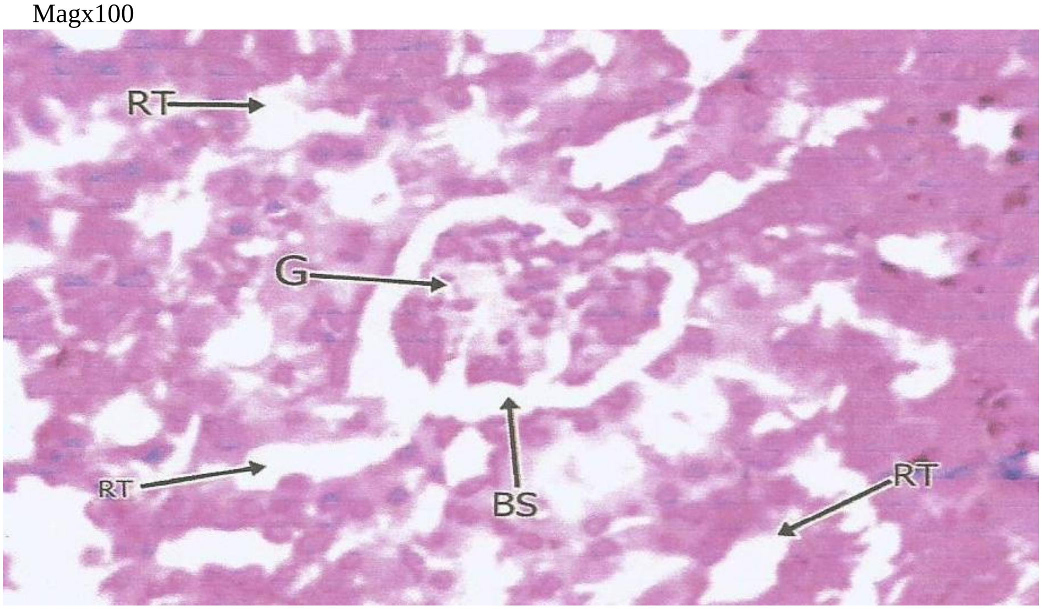

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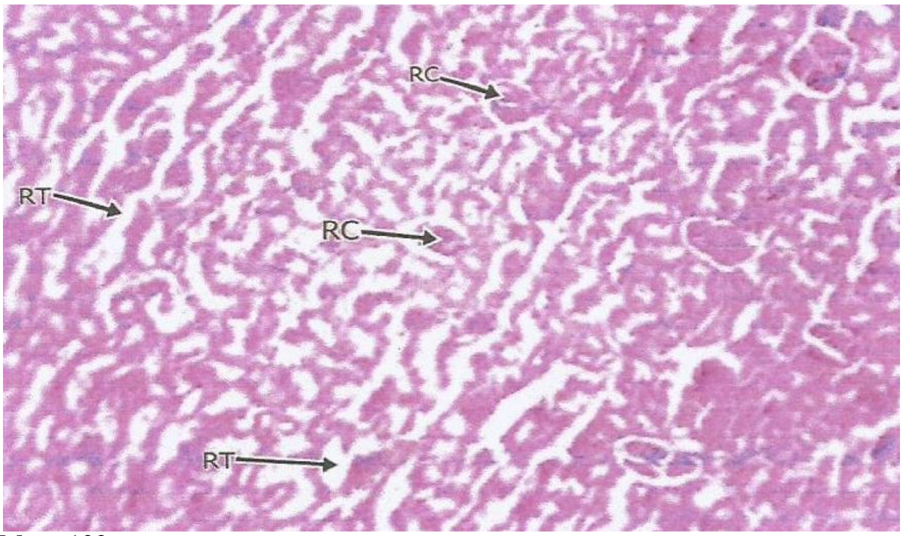
Plate 4: Photomicrograph of medium dose kidney shows dilation of the Bowman's space and disintegration of the glomerular cells, the tubular cells are more cuboida. The renal tubules have distinct lumen and epithelial linings



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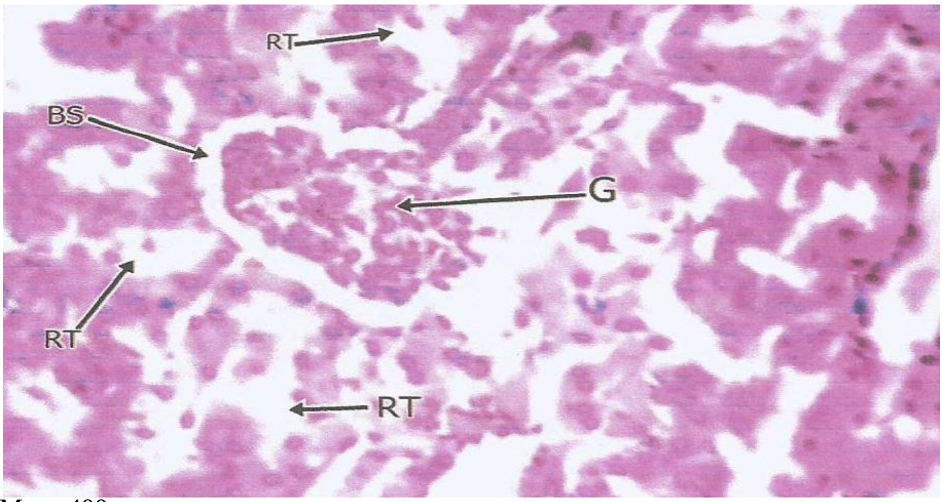

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Plate 5: Photomicrograph of High dose kidney shows enlargement of cells in the Bowman's space, disintegration of the glomerular cells and dilation of the tubular lumen with shrinkage of tubular luminal cells. The renal tubules are closely packed with intact epithelial lining