Research article

Nephroprotective effect of black tea extract on cadmium induced male Wistar rats

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ABSTRACT

Introduction and Aim: Cadmium is an environmental pollutant and potential nephrotoxic to humans. Increase in industrialization is the major cause for heavy metal pollution and these heavy metals disrupts physiological homeostasis. Chelation therapy will be useful amelioration of heavy metal toxicity. This research was designed to understand the nephroprotective properties of black tea extract on cadmium induced renal toxicity in experimental rats.

Materials and Methods: Adult rats were kept into four groups (n=6/group). In that group 1: control group (normal saline), group 2: cadmium chloride ($CdCl_2$, 1.0 mg/kg, body weight; intraperitoneal), group 3: black tea extract and group 4: cadmium chloride plus black tea extract and processed for histopathology of kidney.

Results: Supplementation of black tea extract improves kidney architecture of rats exposed with cadmium chloride group.

Conclusion: Black tea extract seems to be nephroprotective against cadmium induced oxidative stress observed in experimental rats.

Keywords: Cadmium; kidney; black tea extract.

INTRODUCTION

Environmental pollution is a major global problem due to use of xenobiotic chemical such as heavy metal. Unrestrained industrialization has caused heavy metal contamination in the world (1). Organ functions are impaired by heavy metal compounds, which alter physiological equilibrium (2). Heavy metal contamination of environment an extra stress on metabolically active tissues and organs. Metals are steady, insistent environmental pollutants. Cadmium is a metal that is not required for life and has a variety of negative health consequences (3). The World Health Organization (WHO) has listed several chemical groups that are harmful to human health, including Cd and Pb (4).

In humans, a variety of metals are likely to trigger genetic changes in the target tissues (5). Every year a large amount of cadmium is released into the atmosphere as a result of industrialization, mining, agriculture and urbanization. Cadmium in water and food chain continually accumulating, this poses an increasing peril to human (6). People are exposed to cadmium chloride through various sources like water, food, cigarette smoking, consumer products, fertilizers etc. (7). Cadmium is one of the maximum dangerous and toxic occupational heavy metal in this earth. Chronic exposure to cadmium, it reacts with cellular biomolecules such as proteins, carbohydrate, lipids and it alters the gene expression and apoptosis (8).

Cadmium is mainly stored in the kidney and liver due to its lengthy half-life (about 12-30 years), and prolonged exposure to cadmium can affect multiple tissues and organs (9). Acute cadmium exposure has been shown to affect the liver and kidneys in Wister rats (10). Oxidative stress is the primary mechanism of cadmium toxicity (11). Cadmium causes oxidative stress by increasing the generation of free radicals, causing DNA damage, raising lipid levels, and lowering protein levels (12). Intracellular oxidative stress is promoted by reactive oxygen species (ROS), which can damage macromolecules and lead to a variety of illnesses, including cancer (12, 13).

Heavy metal detoxification from the liver, kidneys, and reproductive organs is challenging, and chelation

therapies have not proven successful in cases of cadmium toxicity. Tea is common beverage in Asian countries, and it is a popular brew next to water. Polyphenol content of tea is anti-mutagenic, anti-oxidative and anti-hypercholesteremic (14). Green and black teas both have a similar quantity of flavonoids, though their chemical structure differs. Green teas contain more simple flavonoids known as catechins, whereas black tea leaves undergo oxidation, which converts these simple flavonoids into more complex varieties known as theaflavins and thearubigins, which vary depending on the growing environment, leaf variety, manufacturing, and infusion preparation (15).

During the manufacturing of black tea, a polyphenol found in tea leaves (Camellia sinensis L.) that contains flavonoids, primarily catechins, epigallocatechin-3-gallate, epicatechin-3-gallate, epicatechin, epigallocatechin (C, EGCG, ECG, EGC, and EC) undergoes oxidation to form theaflavins and thearubigens (16). Theaflavin (TF1), theaflavin-3'gallate (TF2b), theaflavin-3 gallate (TF2a), and theaflavin-3, 3'-digallate (TF3) are the four primary chemicals found in theaflavines (17). Because of the gallic acid moiety and hydroxyl groups, theaflavin is a natural antioxidant and metal chelating polyphenol found in black tea (18). According to previous investigations, Black Tea Extract (BTE) reduced the cadmium-induced serum lipid profile and hepatocellular damage (19) in rats, therefore the goal of this study as to see if BTE could protect rats against cadmium-induced kidney histopathological changes.

MATERIALS AND METHODS

Breeding of animals and care were carried out in accordance with Government of India standards to use laboratory animals (20). Experiments were carried out after getting approval from the institutional animal ethical committee (1169/ac/08/CPCSEA). Adult male Wister rats (160±10g) were placed into four groups: group 1, control; group 2, cadmium (1 mg/kg, i.p.) (21); group 3, black tea extract (2.5g tea leaf/dl of water, equivalent to 2.5 percent black tea extract); and group 4, cadmium and BTE combined for 21 days.

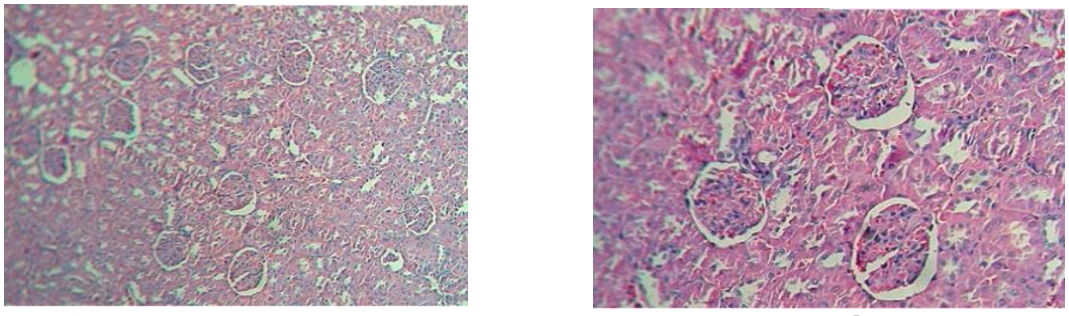
Preparation of 2.5 % Aqueous BTE

25 grams of black tea leaves were steeped for 15 minutes in 500mL of boiling water. After cooling to room temperature, the infusion was filtered. The residues of the same black tea leaves after a second extraction with 500mL boiling water. Combining both filtrates yielded a 2.5 percent aqueous black tea extract (2.5 g black tea leaf/100mL water) (22).

For the histopathology evaluation, each rat's kidney was stored in a 10 percent neutral buffered formalin solution. In addition, each rat kidney was processed and sectioned by typical histological techniques. Serial slices of 5 mm were obtained from tissue blocks after the samples were sunk in paraffin. Three slides were made for each rat and stained with hematoxylin and eosin. The preparations were photographed and assessed under a photomicroscope.

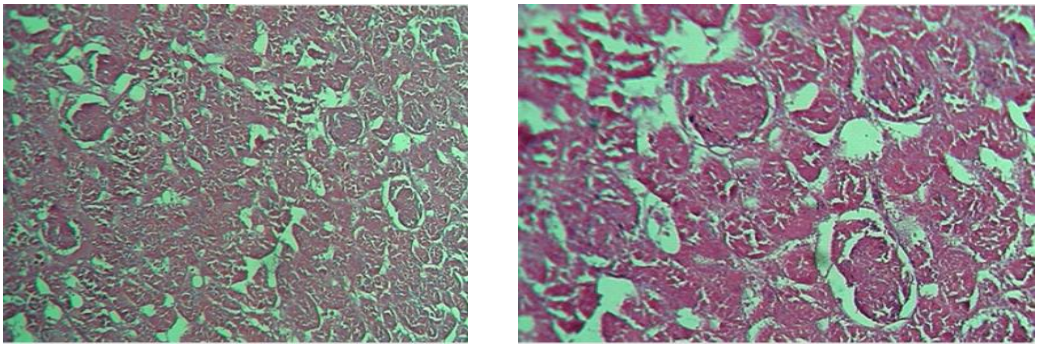
RESULTS

The histological structure of the untreated normal kidney (group 1) was normal as per Fig. 1 (a) and (b). Glomeruli are affected focally and segmentally in group 2 (cadmium), glomeruli are hypercellular with glomerular basement membrane thickening and mesangial proliferation, mesangial hyalinosis and sclerosis, tubular basement membrane mild thickening, cloudy swelling, degeneration, atrophy, coagulation, and interstitial necrosis focal with dilated and congested vessels in Fig. 2(a) and (b). In group 3 (BTE), the architecture was normal, and the kidney appeared normal Fig. 3 (a) and (b). In group 4 Glomeruli are mild-hypercellular and show mild glomerular basement membrane thickening, mild mesangial, focal tubular basement membrane mild thickening with increased cytoplasmic and interstitial focal inflammation as shown in Fig. 4 (a) and (b).
After hematoxylin and eosin staining, representative photomicrographs of rat kidney sections are shown.



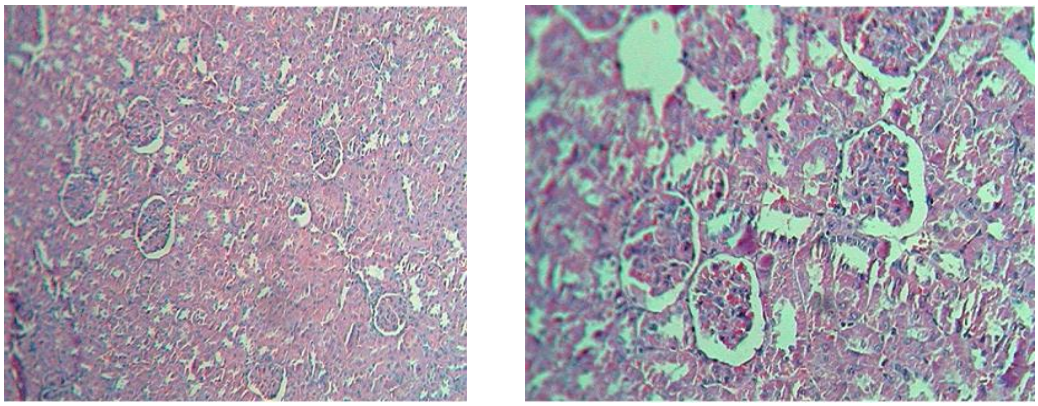
(a) **(b)**

Fig. 1: Histopathological section of control group1 (a) 10X and (b) 45X



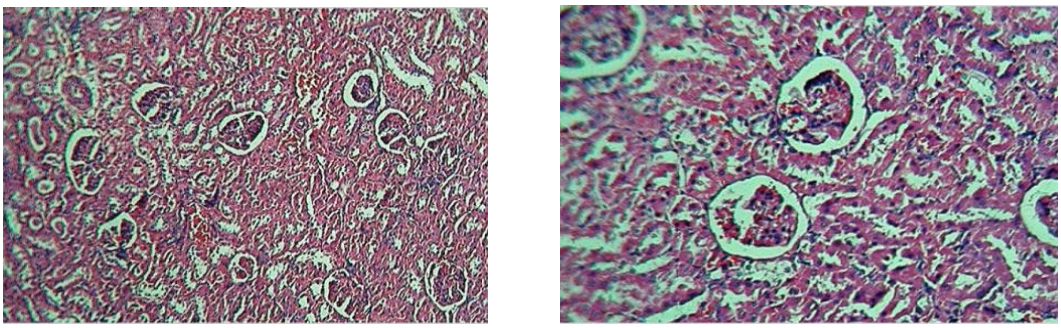
(a) **(b)**

Fig. 2: Histopathological section of cadmium group2 (a) 10X and (b) 45X



(a) **(b)**

Fig. 3: Histopathological section of black tea extract group 3(a) 10X and (b) 45X



(a) **(b)**

Fig. 4: Histopathological section of cadmium plus black tea extract group4 (a) 10X and (b) 45X

DISCUSSION

This study showed cadmium induced alteration of kidney histology and reflects a clear sign of cellular damage in glomerulus of the kidney. The kidney showed severe congestion, focal hemorrhage and hydropic degeneration of renal tubules epithelium, alternative areas of activation and depletion of hematopoietic element after cadmium exposed group 2. Toxicity induces the nitric oxide synthase (iNOS) level and affects the renal physiology (23). BTE is helpful in averting cadmium-induced lipid alterations (19)

Many studies have shown that low-dose cadmium exposure disrupts the redox equilibrium, induces apoptosis, and damages the kidneys. Cadmium limits Fe+ absorption from the intestine, which leads to decreased activity of Fe+-containing catalase and an increase in ROS generation and lipid peroxidation, all of which contribute to oxidative stress, mitochondrial damage, and kidney dysfunction (24). Some data showed that dietary cadmium intake is associated with chronic kidney diseases in cadmium polluted area (25).

Furthermore, cadmium is a dangerous heavy metal that induces degenerative histopathological alterations in the kidneys. According to this study, simultaneous BTE treatment may help to reduce renal degeneration.

CONCLUSION

In male Wister rats, black tea extract was found to be effective in reducing cadmium-induced impaired kidney cellular damage.

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CONFLICT OF INTEREST

There are no conflicts of interest declared by the authors.

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