The effect of potassium dichromate on convoluted tubules of the kidney of adult male albino rats and the possible protective role of ginseng: a histological and immunohistochemical study
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Introduction
The kidney is the most important organ of metabolism, detoxification, storage, and excretion of xenobiotics and their metabolites, and is especially vulnerable to damage by agents such as potassium dichromate [1,2].

Widespread pollution by heavy metals has important consequences on human health and on the quality of the environment. Among the toxic metals, chromium (Cr) is widely used in industries such as electroplating, alloy and steel manufacturing, leather tanning, metal finishing, pigmenting, and wood preservation. Chromium commonly enters the environment through the effluents from these industries. Once released into soil and water, it is a major cause of environmental pollution [3].

Background
Chromium is a heavy metal used in painting, dyes, and leather tanning industries. Potassium dichromate Cr6+ has demonstrated ability to induce nephrotoxicity associated with oxidative stress in humans and animals. Ginseng is one of the most popular herbal remedies, with a wide range of beneficial therapeutic effects.

Objective
The aim of the study was to evaluate the effect of potassium dichromate on the convoluted tubules of adult male albino rats and the possible protective role of ginseng.

Materials and methods
Forty adult male rats were divided equally into four groups (10 rats for each): Group I was the control group. In group II (the ginseng group), rats received a daily oral dose of ginseng at 100 mg/kg body weight/day by means of a gastric tube for 3 weeks. In group III (the potassium dichromate group), rats received a single subcutaneous injection of potassium dichromate at 15 mg/kg body weight. In group IV (the potassium dichromate and ginseng group), rats received potassium dichromate and ginseng for 3 weeks. Kidney specimens were prepared for light microscopic examination (stained with (H&E), Masson's trichrome, immunohistochemical detection of caspase-3). Semithin and ultrathin sections were prepared for electron microscopic examination.

Results
Group III showed degeneration and necrosis of cells of the renal tubules (proximal and distal) with tubular dilatation, an increase in collagen fibers around degenerated convoluted tubules, and cell apoptosis (highly expressed caspase-3). Electron microscopic results showed marked disrupted brush border of proximal convoluted tubules and disturbance of the basal infoldings of distal convoluted tubules. The cytoplasm had mitochondria that were irregular in shape and variable in size and large electron-dense particles. The smooth endoplasmic reticulum membrane revealed whorly appearance around the degenerated organelles. Group IV showed improvement in the light and electron microscopic changes described before.

Conclusion
Ginseng has a protective effect against potassium dichromate-induced nephrotoxicity as it has antioxidant, anti-inflammatory, and antiapoptotic activities. We advice the workers who deal with chromium to take enough doses of ginseng to protect themselves from its side effects.

Keywords:
ginseng, light and electron microscope, potassium dichromate, renal tubules
Cr\(^{3+}\) constitutes an essential nutrient, whereas Cr\(^{6+}\) is absorbed more easily, is highly toxic, and is a strong oxidizing agent compared with Cr\(^{3+}\) [4,5]. Chromium enters the body through the lungs, the gastrointestinal tract, and to a lesser extent through the skin [6].

Occupational exposure to Cr\(^{6+}\) compounds is associated with several adverse effects on health, such as lung toxicity and bronchial asthma, and it also causes nephrotoxicity and hepatotoxicity. Squamous cell carcinoma is the most frequent type of lung cancer among Cr\(^{6+}\)-exposed workers. Chromium is a Fenton metal and generates free radicals by itself. Fenton reactions are associated with membranous fractions including mitochondria, microsomes, and peroxisomes. Cr\(^{6+}\) enters cells rapidly, and once inside the cell it is reduced by intracellular reductants to short-lived chromium intermediates. This reduction process generates reactive oxygen species (ROS), such as superoxide (O\(^{2-}\)) and hydroxyl (OH\(^-\)), and (H\(_2\)O\(_2\)). Cr\(^{6+}\) exposure generates oxidative stress in many systems [7–9].

Acute renal failure (ARF) is associated with high mortality, which reaches more than 50% even after adequate medical care. ARF is associated with several medical, surgical, and obstetric conditions, as well as with overexposure to heavy metals, such as lead, mercury, or chromium, which accumulate in the proximal tubules [4,10].

In rats, potassium dichromate administration has been established as a method to induce ARF with a single dose of 15 mg/kg body weight [4].

Several natural products have been used to protect the toxicities induced by drugs. Herbs are generally considered safe and have proven to be effective natural antioxidants that strengthen the endogenous antioxidant defenses and restore the optimal balance; their medicinal uses have been gradually increasing in developed countries [11].

Ginseng is one of the most highly valued natural dietary supplements [12]. The term ginseng refers to the dried root of several species in the genus Panax of the Araliaceae family, including two commonly used species – Panax ginseng C. A. Meyer (Asian ginseng) and Panax quinquefolius L (North American ginseng) [13]. Ginseng contains many physiologically important constituents, including saponins (ginsenosides), polysaccharides, peptides, polyacetylenes, alkaloids, nitrogen-containing compounds, fatty acids, and phenolic compounds [14].

It has a wide range of pharmacological and physiological properties, such as antiaging, antistress, antifatigue, antitumor, antiobesity, and anti-inflammatory properties. It also exerts antidiabetic effects by lowering the blood glucose level and stimulating sugar metabolism [15,16].

Ginseng has been reported to possess protective effects against drug-induced nephrotoxicity in experimental animals. Beneficial effects of ginseng are attributed to the presence of phenolic acids and flavonoids, which are responsible for increase in renal blood flow and elimination of free radicals [17].

The aim of this study was to evaluate the effect of potassium dichromate on the convoluted tubules of the kidney of adult male albino rats and the possible protective role of ginseng.

### Materials and methods

In this study, 40 adult male rats of average weight 150–250 g were used. The animals were housed under standard environmental conditions with free access to a standard basal diet and liberal supply of tap water.

#### Used drugs

Potassium dichromate (Cr\(^{6+}\)) was purchased from Sigma Chemical Company (St Louis, Missouri, USA).

Ginseng was purchased from Pharco Pharmaceuticals (Alexandria, Egypt).

It was available in the form of capsules containing the dried roots of Panax ginseng. Each capsule contained 100 mg of ginseng.

Rats were divided into four groups of 10 rats each.

#### Group I (the control group)

Rats in this group received 1 ml of distilled water orally through a gastric tube for 4 weeks.

#### Group II (the ginseng group)

Rats in this group received ginseng at 100 mg/kg body weight dissolved in distilled water daily orally by means of a gastric tube for 3 weeks [18].

#### Group III (the potassium dichromate group)

Rats in this group received a single subcutaneous injection of potassium dichromate (Cr\(^{6+}\)) at 15 mg/kg body weight dissolved in distilled water [19,20].

#### Group IV (the potassium dichromate and ginseng group)

Rats received potassium dichromate as in the previous group and ginseng at a dose of 100 mg/kg body weight dissolved in distilled water orally through a gastric tube daily for 3 weeks.

At the end of the experiment, the rats were killed by cervical decapitation, and specimens of kidney were taken. Paraffin sections were prepared for LM examination, H&E staining, and Masson’s trichrome staining [21]. Other paraffin sections were immunohistochemically stained following the standard avidin–biotin peroxidase method for detection of caspase-3 expression [22]. Briefly, sections were deparaffinized, hydrated, and then incubated overnight with the mouse monoclonal primary antibody to caspase-3 (Ab-7, Mouse Mab. MS.). Sections were rinsed in PBS and a few drops of biotinylated goat anti-mouse polyclonal secondary antibody were applied for 10 min. They were then rinsed and treated with two drops of the prepared diaminobenzidine.
tetra-hydrochloride substrate chromogen solution for 15 min until the desired brown color was obtained. This was followed by counterstaining with Mayer’s hematoxylin and mounting with aqueous mounting medium. Control sections were stained after omission of the primary antibody.

For electron microscopic preparation, kidney specimens were processed and semithin sections (0.5–1 µm) were obtained, which were stained with toluidine blue and examined with a light microscope. Ultrathin sections were prepared and contrasted with uranyl acetate and lead citrate and then examined with a TEM JEOL 100CX, (Tokyo, Japan) as per Hayat [23].

Morphometric study
The mean area percentage (%) of collagen fibers and caspase-3 expression was quantified from 10 images in each group using Image-Pro Plus program version 6.0 (Media Cybernetics Inc., Bethesda, Maryland, USA). The mean area percentage of collagen fibers and caspase-3 expression was compared between group III (potassium dichromate group) and group I (control group) and between group IV (the potassium dichromate and ginseng group) and group III (the potassium dichromate group) using the t-test, with P less than 0.05 as the level of statistical significance. Statistical analyses were carried out using IBM SPSS Statistics software for Windows, Version 20 (IBM Corp., Armonk, New York, USA).

Results
Light microscopic results
H&E
Group I (the control group): the kidneys of control rats showed a normal histological appearance for renal corpuscles and for proximal and distal convoluted tubules (DCTs). The proximal convoluted tubules (PCTs) had a narrow lumen and were lined with pyramidal cells with acidophilic cytoplasm and rounded basally located nuclei. The DCTs were lined with cubical epithelium with light acidophilic cytoplasm and rounded apically situated basophilic nuclei. The lumen of the DCTs was wider than that of PCTs (Fig. 1).

Group II (the ginseng group): no histological changes were detected when compared with the control group.

Group III (the potassium dichromate group): this group showed various histological changes in the form of vacuolar degeneration of some tubules, such as epithelial flattening and cytoplasmic vacuolation. Some tubular cells had pyknotic and karyolytic nuclei. There was crowding of cells in some areas due to the mitotic activity of PCT cells. Dilated and congested peritubular capillaries and slight tubular dilation were seen (Fig. 2). Shedding of karyolytic nuclei of some tubular cells occurred and the lumen of some tubules contained cellular and hyaline casts. Epithelial vacuolation of some tubular cells was seen; other tubular cells showed deeply acidophilic cytoplasm and deeply stained nuclei (Fig. 3).

Group IV (the potassium dichromate and ginseng group): this group showed a picture nearly similar to that of the control group; most of the convoluted tubules had regenerated. Evidence of mitotic activity in the tubular cells (many binucleated cells) and cells in prophase were seen. Tubular cells had acidophilic cytoplasm (Fig. 4).

Masson’s trichrome stain
Group I (the control group): the kidney of the control rat showed a minimal amount of collagen fibers around the renal tubules (Fig. 5).

Group II (the ginseng group): no histological changes were observed in the distribution of collagen fibers in the kidney in this group as compared with the control group.

Group III (the potassium dichromate group): this group showed an increase in collagen fibers around the degenerated convoluted tubules (Fig. 6).

Group IV (the potassium dichromate and ginseng group): this group showed scanty collagen fibers around the regenerated convoluted tubules (Fig. 7).

Immunohistochemical result
Group I (the control group): the kidney of the control rat showed a negative immune reaction to caspase-3 (no brownish staining in the cytoplasm of tubular cells; no apoptosis) (Fig. 8).

Group II (the ginseng group): no detectable changes were observed to caspase-3 reaction in this group, compared with the control group.

Group III (the potassium dichromate group): this group showed highly expressed caspase-3 reaction in the cytoplasm of tubular cells. Positive immunohistochemical staining of caspase-3 demonstrated brown cytoplasmic staining (an index for the degree of nuclear apoptosis) (Fig. 9).

Group IV (the potassium dichromate and ginseng group): this group showed minimally expressed caspase-3 reaction in the cytoplasm of tubular cells (weak brownish staining in the cytoplasm) (Fig. 10).

Toluidine blue stain
Group I (the control group): semithin kidney sections from the control group showed PCTs with basal rounded vesicular nuclei and apical brush border. DCTs appeared with apical rounded vesicular nuclei without an apical brush border. DCTs revealed a basal striated appearance (Fig. 11).

Group II (the ginseng group): no histological changes were observed in this group as compared with the control group.

Group III (the potassium dichromate group): semithin kidney sections from this group showed vacuolar degeneration of tubular cells and partial loss of the apical brush border of most PCTs. Absence of some tubular cell nuclei and congested peritubular capillaries were seen (Fig. 12).
Group IV (the potassium dichromate and ginseng group): semithin kidney sections from this group showed more or less normal appearance for most convoluted tubules, although some vacuoles continued to be seen in the cytoplasm of some tubules (Fig. 13).

**Electron microscopic results**

Group I (the control group): electron microscopic examination of the cells lining the proximal tubule showed numerous apical microvilli forming the brush border, many electron-dense tubules and vesicles, multiple mitochondria, and a part of a rounded euchromatic nucleus (Fig. 14). The cells lining the distal tubule showed prominent infoldings of basal membrane, which contained a basal elongated mitochondria. A part of two nuclei can be seen (Fig. 15).

Group II (the ginseng group): electron microscopic examination of the proximal and DCTs of this group showed no changes compared with the control group.

Group III (the potassium dichromate group): electron microscopic examination of a part of the PCT showed disrupted apical microvilli forming the brush border, coarse electron-dense bodies, and a shrunken condensed nucleus with chromatin margination. Mitochondria were variable in size, with loss of cristae (Fig. 16). A part of a DCT showed disorganization of basal infoldings with abnormal basal mitochondria, inclusion inside some mitochondria, and a part of a dark condensed nucleus (Fig. 17). Convoluted tubular cells showed apparent increase in thickness of the basal lamina with partial loss of basal infoldings. Degenerated mitochondria, large electron-dense particles, and a dark condensed nucleus were seen in the cytoplasm of tubular cells (Fig. 18).

Group IV (the potassium dichromate and ginseng group): electron microscopic examination of a part of the PCTs and DCTs of group IV showed marked improvement from the ultrastructural changes observed in group III. A part of the PCT showed restoration of the integrity of apical microvilli forming the brush border, with mitochondria more or less normal in shape and size, and a few vacuoles. Euchromatic nuclei were seen (Fig. 19). A part of the DCT showed restoration of basal infoldings, which contained multiple basal mitochondria. Electron-dense particles and euchromatic nucleus were seen (Fig. 20).

**Morphometric results**

The mean area% of collagen fibers and caspase-3 expression for all groups is presented in Tables 1 and 2. The mean area% of collagen fibers and caspase-3 expression was significantly increased in group III as compared with group I \((P < 0.05)\). The mean area% of collagen fibers and caspase-3 expression was significantly decreased in group IV as compared with group III \((P < 0.05)\).
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Figure 4. A photomicrograph of a section of a kidney from group IV showing evidence of mitotic activity of tubular cells (↑). Tubular cells have acidophilic cytoplasm.

H&E, × 630.

Figure 5. A photomicrograph of a section of a kidney from the control group showing minimal amount of collagen around the renal tubules (arrow).

Masson’s trichrome, × 630.

Figure 6. A photomicrograph of a section of a kidney from group III showing an increase in collagen fiber content around degenerated tubules (arrow).

Masson’s trichrome, × 630.

Figure 7. A photomicrograph of a section of a kidney from group IV showing scanty collagen fibers around regenerated convoluted tubules (arrows).

Masson’s trichrome, × 630.

Figure 8. A photomicrograph of a section of a kidney from the control group showing negative caspase-3 immunostaining of the tubular cell cytoplasm.

Caspase-3 immunostaining, × 630.

Figure 9. A photomicrograph of a kidney section from group III showing highly expressed caspase-3 reaction in the cytoplasm (C) of tubular cells.

Caspase-3 immunostaining, × 630.
Figure 10. A photomicrograph of a kidney section from group IV showing minimally expressed caspase-3 reaction in the cytoplasm of tubular cells (C).
Caspase-3 immunostaining, × 630.

Figure 11. A semithin kidney section from the control group showing proximal convoluted tubules with basal rounded vesicular nuclei and apical brush border (B). Distal convoluted tubules (D) appeared with apical rounded vesicular nuclei and basal striated appearance. Toluidine blue, × 1000.

Figure 12. A semithin kidney section from group III showing vacuolar degeneration of tubular cells (V) and partial loss of apical brush membranes of most proximal convoluted tubules. Notice absence of nuclei in some tubular cells (↑) and congested peritubular capillaries (C). Toluidine blue, × 1000.

Figure 13. A semithin kidney section from group IV showing more or less normal appearance for most convoluted tubules (P), although some vacuoles continued to be present in the cytoplasm of some tubules (V). Toluidine blue, × 1000.

Figure 14. Electron micrograph of a part of a proximal convoluted tubule cell from the control group showing apical brush border (B), many electron-dense tubules and vesicles (↑), nucleus (N), and multiple mitochondria (M). × 4000.

Figure 15. Electron micrograph of a part of a distal convoluted tubule cell from the control group showing prominent infoldings of basal membrane (↑) with regular arrangement of elongated mitochondria (M) and a part of two nuclei (N). × 4000.
Figure 16. Electron micrograph of a part of a proximal convoluted tubule cell from group III showing disrupted brush border (B), coarse electron-dense bodies (D), and shrunken nucleus with chromatin margination (N). Mitochondria are variable in size, with loss of cristae (M). × 4000.

Figure 17. Electron micrograph of a part of a distal convoluted tubule cell from group III showing abnormal basal mitochondria (M), inclusion inside some mitochondria (★), and a part of a nucleus (N). × 4000.

Figure 18. Electron micrograph of a part of a convoluted tubular cell from group III showing apparent increase in thickness of the basal lamina (BL) with partial loss of basal infoldings (arrow). Mitochondria (M), large electron-dense particles (D), and condensed nucleus (N) were seen. × 4000.

Figure 19. Electron micrograph of a proximal convoluted tubule cell from group IV showing restoration of the integrity of the apical brush border (B), mitochondria more or less normal in shape and size (M), and a few vacuoles (V). × 3000.

Figure 20. Electron micrograph of a distal convoluted tubule cell from group IV showing multiple basal mitochondria (M) and restored basal infoldings (↑), electron-dense particles (D), and nucleus (N). × 4000.
degeneration and necrosis of tubular cells with slight lumen dilation. Exfoliation of tubular cells with formation of cellular and hyaline casts was seen, as well as significant increase in collagen fiber content around degenerated convoluted tubules. These results were in agreement with previous histopathological studies that stated that exposure to chromium leads to degeneration of tubular epithelial cells and to acute tubular necrosis, followed by fibrosis and ARF [5,25–30].

Electron microscopic examination of proximal and distal convoluted tubular cells of group III revealed a shrunken nucleus with chromatin margination (a sign of cell apoptosis). This was supported by a significant increase in caspase-3 reaction.

Discussion
The kidneys are dynamic organs and represent the major control system for maintaining body homeostasis. They are affected by many chemicals and drugs [24]. The kidney is the main route of chromium excretion. It has been reported that acute exposure to potassium dichromate in rats induces an increase in kidney chromium content [25].

Some investigators reported that exposure to Cr₆⁺ compounds could lead to nephrotoxicity in humans and experimental animals. They added that the PCT was the main site of toxicity because of accumulation of metal inside it [5].

The histological examination of kidney sections from group III revealed various changes, such as vacuolar degeneration and necrosis of tubular cells with slight lumen dilation. Exfoliation of tubular cells with formation of cellular and hyaline casts was seen, as well as significant increase in collagen fiber content around degenerated convoluted tubules.

These results were in agreement with previous histopathological studies that stated that exposure to chromium leads to degeneration of tubular epithelial cells and to acute tubular necrosis, followed by fibrosis and ARF [5,25–30].

Electron microscopic examination of proximal and distal convoluted tubular cells of group III revealed a shrunken nucleus with chromatin margination (a sign of cell apoptosis). This was supported by a significant increase in caspase-3 reaction. These

| Table 1. The mean area% and ±SD of collagen fibers in different experimental groups |
|-----------------------------------|---------|---------|---------|---------|
|                                   | Group I | Group II| Group III| Group V |
| Mean area%                        | 1.38    | 2.51    | 18.27    | 5.03    |
| ±SD                               | 0.3011  | 0.3859  | 0.6638   | 0.2928  |

Group III compared with group I (P<0.05).
Group IV compared with group III (P<0.05).

Histogram 1. The mean area% of collagen fibers in different experimental groups.

| Table 2. The mean area% of caspase-3 expression and ±SD in different experimental groups |
|-----------------------------------|---------|---------|---------|---------|
|                                   | Group I | Group II| Group III| Group IV |
| Mean area%                        | 0       | 0       | 22.91    | 1.61    |
| ±SD                               | 0       | 0       | 1.0856   | 0.5244  |

Group III compared with group I (P<0.05).
Group IV compared with group III (P<0.05).

Histogram 2. The mean area% of caspase-3 expression in different experimental groups.
findings were in accordance with those of previous studies [31–33].

Caspase-3 is a key factor in the apoptotic pathway, and caspase-3 expression is positively correlated with apoptosis [34]. Some studies reported that potassium dichromate and cadmium induced apoptosis in renal tubular cells [8,35,36].

Various types of DNA damage occur in response to exposure to chromium compounds, including DNA single-strand breaks, DNA–protein cross-links, Cr–DNA adducts, and DNA–DNA cross-links [37].

Group III revealed that the mitochondria were variable in size, with absent cristae. The mitochondria showed some inclusions indicating abnormal protein. Disruption of brush border and basal infoldings with accumulation of large electron-dense bodies was seen in the cytoplasm of tubular cells.

Mitochondria are the main intracellular source of ROS and they possess a very effective antioxidant system. Mitochondria are targets of metal toxicity. Oxidative stress leads to mitochondrial dysfunction and apoptosis [31,38].

Our results are in accordance with those of other researchers [39], who stated that the metals under study here, when administered in significant amounts, destroy the microvilli and membrane transport-associated enzymes. Potassium dichromate had potential to accumulate in the lysosomes, mitochondria, and other organelles, altering the functions of tubular segments, and later may lead to autolysis of such overburdened cells.

Some researchers demonstrated that the mechanism of action of Cr⁶⁺-induced cell injury was mediated through the production of free radicals and the oxidized products of oxidative stress such as ROS. These ROS of oxidative stress altered and damaged cell compounds, including protein and lipids, as well as membranes, and led to increased lipid peroxidation. Thus, DNA damage, apoptotic cell death, and neoplastic transformation occurred at the cellular level [3,8,29,40–42].

Further, potassium dichromate cytotoxicity could be caused by a combination of mechanisms, including DNA damage, caspase activation, mitochondrial dysfunction, and formation of ROS.

In the present study, group IV showed an improvement in the histological and ultrastructural changes induced by potassium dichromate. The presence of mitotic activity of tubular cells represented evidence of cellular regeneration. Moreover, there was restoration of the integrity of the brush border, mitochondria, and basal infoldings. A significant decrease in caspase and collagen fibers was also detected.

It has been reported that ginseng has a protective effect against many toxicants in humans and experimental animals. It increases the body’s resistance to many harmful factors and protects tissues from damage, as well as reduces the chromosomal aberrations induced by some chemicals. It has antitumor-promoting activity and can enhance the immunofunction of the human body [43].

These results were in agreement with the findings of other researchers who reported that ginseng has protective effects against nephrotoxicity as it contains ginsenosides, phenolic acids, flavonoids, and saponins. These were thought to provide many beneficial preventive effects against organ damage [17,43–46].

Some researchers reported that the protective effect of ginseng was due to its antioxidant property, as it acts as a free-radical scavenger and lipid peroxidation inhibitor. It also increases the intracellular concentration of glutathione and superoxide anions, thereby inactivating nitric oxide, and increases antioxidant enzymes [47–49]. Ginseng has been shown to ameliorate renal interstitial fibrosis [50].

Ginseng has a potent antiapoptotic effect as it decreases the expression of the proapoptotic gene and proinflammatory genes such as caspase-3 and COX2, whereas it increases the expression of the antiapoptotic gene Bcl-2 [51–53].

**Conclusion**

Potassium dichromate exposure resulted in pronounced oxidative stress and degenerative changes of renal tubules. Ginseng has a protective effect against potassium dichromate-induced nephrotoxicity as it has antioxidant, anti-inflammatory, and antiapoptotic activities. We advice workers who deal with chromium to take enough doses of ginseng to protect themselves from its side effects.

**Acknowledgements**

**Conflicts of interest**

There are no conflicts of interest.

**References**


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تأثير ثنائي كرومات البوتاسيوم علي الأنابيب الملتوية في كلي ذكور الجرذان البيضاء البالغة والدور الوقائي المحتمل للجينسج: دراسة هستولوجية و هستوكيميائية

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المقدمة: الكروم هو معدن ثقيل ويستخدم علي نطاق واسع في كثير من الصناعات مثل الدهانات والأصباغ ودباعة الجلد. كرومات البوتاسيوم(السداسي) عرف أنه ذو تأثير سام على بعض أجزاء الكلية في الحيوانات والبشر. إن الجينسج من أكثر الأدوية العشبية شائعة الاستخدام وله نطاق واسع من الاستخدامات العلاجية الدافعة.

الهدف: فقد استهدفت البحث معرفة وتقييم تأثير ثنائي كرومات البوتاسيوم علي الأنابيب الملتوية في كلي ذكور الجرذان البيضاء البالغة والدور الوقائي المحتمل للجينسج.

الطريقة وخطة العمل: تضمنت الدراسة عدد أربعون من ذكور الجرذان البيضاء، وقد قسمت إلي أربع مجموعات.

المجموعة الأولى استخدمت كمجموعة سليمة (ضابطة)، والمجموعة الثانية كانت مجموعة (الجينسج) وقد أعطيت أسباب (3 مجم لكل كيلو جرام من وزن الجسم) باستخدام أنبوب المعدة لمدة 100 (جرعات يومية من الجينسج) والجمعة الثالثة كانت مجموعة (كرومات البوتاسيوم) وقد حققت تحت الجلد مرة واحدة بكرومات البوتاسيوم (السداسي) وجرعته (15 مجم لكل كيلو جرام من وزن الجسم) لمدة 3 أسابيع، وأما المجموعة الرابعة كانت مجموعة (كرومات البوتاسيوم والجينسج) وقد حققت بكرومات البوتاسيوم بالإضافة إلى الجينسج بنفس الطريقة والجرعات السابقة. وفي نهاية التجربة تم تشريح الجرذان وأخذت عينات من كل جرذ وقد جهزت العينات للدراسة الهستولوجية وصبغت بالهيماتوكسلين والأيوسين وأيضا بصبغة الماسون تراي كروم وأيضا للدراسة الهستوكيميائية المناعية (باستخدام مادة كاسباس)

النتائج: هذه النتائج تثبت أن الجينسج له دور وقائي ضد تأثير الكلوي السام لكرومات البوتاسيوم لأنه يعتبر مادة مضادة للأكسدة ومضادة للالتهاب ومضادة للموت الخلوي المبرمج. ولذلك ننصح باستعمال الجينسج للعملين الذين يتعرضون من خلال عملهم إلي الكرومات لوقاية لهم من هذه الآثار الجانبية.