Evaluation of the antioxidant properties of ginseng green nanoparticles in protecting male rats against potassium dichromate toxicity

Mohammed A. Hamza[1], Mayada S. Hassan[1], Rana F. Mousa [1*], Marwa S. Majed [2]

[1] Physiology Department, Veterinary Medicine College, University of Kerbala, Kerbala, Iraq.
[2] AL-Zahraa University for Women, Kerbala, Iraq.
***Corresponding author e-mail: rana.f@uokerbala.edu.iq**
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Abstract

Potassium dichromate is a powerful oxidizing agent that is used in numerous industrial and laboratory procedures. It is known to cause cancer, but it can also exacerbate respiratory problems, burn skin, and even induce lung cancer. A popular herbal supplement, ginseng also has multiple medical applications. It could have anti-inflammatory and antioxidant properties in addition to increasing energy and cognitive performance and decreasing stress. to examine whether male rats may be protected from the harmful effects of potassium dichromate by using ginseng nanoparticles. Seven distinct animal species were included in the study. Every one of the 42 rates makes use of 6 male rats. The rats exposed to potassium dichromate had significantly higher levels of malondialdehyde (MDA) and lower levels of catalase and superoxide dismutase (SOD) compared to the other groups in the study, indicating that it had a deleterious impact on their health. The present results showed Ginseng green NPs enhance all of the above listed measures.

Keywords: Ginseng, potassium dichromate, and male rats.

Introduction

The industrialized chemical potassium dichromate was extensively used despite its toxicity [1]. Potassium dichromate has numerous negative effects on rat health, one of which is oxidative stress, which lowers sperm quality and quantity in male rates [2]. Traditional Chinese remedies make extensive use of ginseng. Technical studies have shown that ginseng's green extract can protect cells from free radical damage due to its potent antioxidant assets [3]. The several benefits of ginseng, especially its antioxidant properties, have been known to customary medicine practitioners for an extended time. Associated with progress in nanotechnology [4] and the potential for their request in biomedical research [5], there has been a growing fascination with green nanoparticles synthetic from ginseng. Finding out how efficient the antioxidant properties of ginseng green nanoparticles are in protecting male rats from the toxic effects of potassium dichromate is the main objective of this research. The bioactive components of ginseng, such as flavonoids, polysaccharides, and ginsenosides, possess antioxidant characteristics [6]. Converting green nanoparticles into ones with a higher outward area-to-

volume ratio improves their antioxidant capability [7]. The facility of these nanoparticles to scavenge free radicals, neutralize reactive oxygen species (ROS), and inhabit fat peroxidation makes them useful in the fight against oxidative damage to cells [8]. One of the numerous dangerous substances it could react with, leading to the production of free radicals in the body, is potassium dichromate [9]. Potassium dichromates (K2Cr2O7) are a very toxic biochemical that is used in a diversity of industrial operations [10]. in the redox reactions case, it makes ROS, which in turn causes DNA injury, oxidative stress, and cellular dysfunction [11]. PD (potassium dichromate) is an oxidizing agent reduced by different cellar metabolites to give chromium. Chromium generates oxidative stress during its reduction, and the reactive species produce cellular lipids, proteins and DNA injury. Chromium toxicity has also been reported to be associated with inflammation [9]. Exposure to potassium dichromate has been related to numerous harmful health effects, such as carcinogenicity, nephrotoxicity, hepatotoxicity, and propagative harmfulness [12].

Materials and Methods

Ethical approve

This study was conducted at the Kerbala University/ College of Veterinary Medicine's anatomical facility in Iraq under the reference number UOK. VET. PH. 2023.076.

Methodology for an experiment

This study's methodology and materials included potassium chloride (LC) supplied from an Indian media company and ginseng herb (GM) bought from a local Karbala marketplace.

The study's animals were split into seven categories. There are six male rats in each group, and they serve as group 1 (Negative Control): For six weeks, the animals were given regular saline orally. The second group of animals were given 2 mg/kg of body weight of Potassium Dichromate intraperitoneally once a day for two weeks. For four weeks, animals in Group 3 (Ginseng Positive Group) were given an oral dose of ginseng (200 mg/kg b.wt.). Group 4 Animals (Nano ginseng): For four weeks straight, these animals were given 200 mg/kg b.wt of Nano-ginseng orally. four weeks, animals in Group 5 took ginseng orally at a dosage of 200 mg/kg b.wt. in addition to 2 mg/kg of Potassium Dichromate. Group 6 animals were given 0.3 ml of a solution containing 200 mg/kg b.wt of potassium dichromate and ginseng nanoparticles once a day for four weeks.

The animals in Group 7 were given a daily dose of 0.15 ml of a solution containing 200 mg/kg b.wt of Potassium Dichromate and ginseng nanoparticles for four weeks.

Ginseng root extraction

Following the protocol laid out previously [13], 100 g of air-dried ground plant material was extracted in two independent experiments using 500 ml of aqueous methanol

as a solvent (methanol: water, 80% v/v) under Soxhlet on a water bath for eight hours. The rotary evaporator was used to concentrate the extracts and remove the solvent at reduced pressure at 45°C. The yield was determined by weighing the dried crude concentrated extracts, which were then stored in a refrigerator at 4Co until needed.

Generating Selenium Nanoparticles (Se-NPs) through biosynthesis

Plant extracts were utilized to create Se-NPs using a green biosynthetic process. Ten milliliters of plant extract were combined with ninety milliliters of 2 mM Na2SeO3. The control sample consisted of 90 ml of 2 mM Na2SeO3 mixed with 10 ml of D.W [14].

Collecting blood samples

At the end of the experiment, the rats were put to sleep by being placed in a sealed container drenched with chloroform. A hot pierce was used to collect the blood (5ml). The tube containing the blood was spun at 300 revolutions per minute (RPM) for 15 minutes. Before analysis, the serum supernatant was removed and stored in Eppendorf tubes at -4 Cº.

Quantitative Evaluation

IBM-USA and SPSS Statistics version 26 were used to conduct all statistical analyses. Data would also be organized using Excel from Microsoft Office 2021.

Biochemical tests

In order to determine antioxidant indices, we used a spectrophotometer to measure malondialdehyde (MDA) levels (15), superoxide dismutase (SOD) levels (16), and catalase (CAT) levels (17).

Results and Discussion

Toxicity of Dichromate, Ginseng, and ginseng-NP

Table (1): Comparison in the serum biomarkers level in rat after exposure to dichromate (Group 2), ginseng extract (Group 3) and ginseng-nanoparticles (Group 4) with the control group (Group 1)

	Group 1 [A]	Group 2 [B]	Group 3 [C]	Group 4 [D]	F	P value
MDA nmol/ml	10.3 ±0.96 B, C, D	14.52 ±1.12 A, C, D	7.18 ±1.68 A,B	6.95 ±1.41 A,B	35.683	<0.001
SOD U/ml	380.4 ±39.83	254.77 ±67.46 C	436.4 ±134.39 B	447 ±47.24 B	5.890	0.007
Catalase U/ml	6.05 ±0.67	4.55 ±0.76	6.53 ±0.77	7 ±0.37	12.806	<0.001

	B	A, C, D	B	B		

[A]: Comparison with control group (Group 1), [B]: Comparison with the dichromate treated group (Group 2), [C]: Comparison with ginseng treated group (Group 3), [D]: Comparison with ginseng-nano-particles treated group (Group 4). MDA: malondialdehyde, SOD: Superoxide dismutase.

The making of oxidative stress through spermatogenesis has been found to be adversely affected by chromium, one of the most abundant elements in the Earth's crust [18]. Therefore, it may be helpful to consume antioxidants in instruction to keep spermatogenesis going [19]. According to reports, ginseng can protect against male reproductive failure and oxidative stress caused by doxorubicin, acetylsalicylic acid, and diabetes. research looked at how ginseng protected the testicles from oxidative stress, inflammation, and histopathological alterations brought on by potassium dichromate.

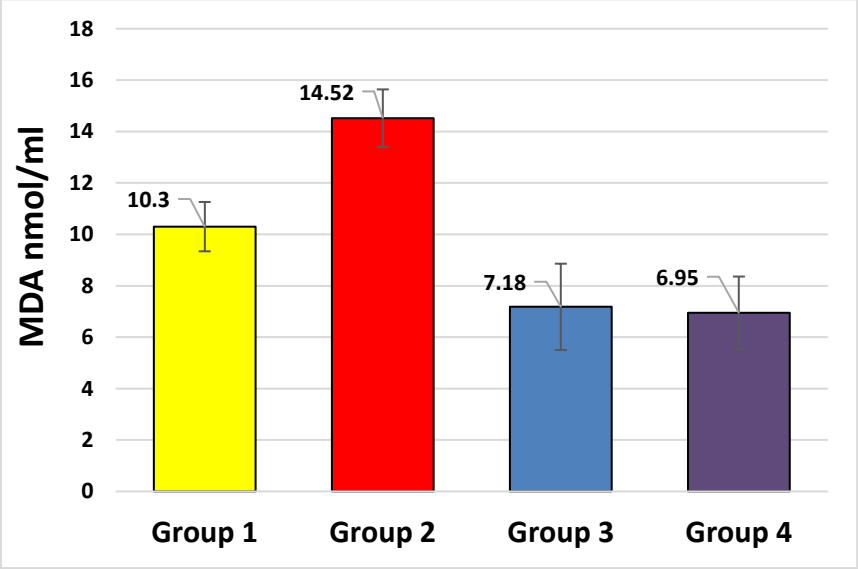

Figure (1): Comparison of serum malondialdehyde (MDA) level in rats after exposure to dichromate (Group 2), ginseng extract (Group 3) and ginseng-nanoparticles (Group 4) with the control group (Group 1).

This study displayed those rats exposed to oral potassium dichromate every day for 2 weeks developed testicular oxidative stress. The study found that the considerable increase in MDA was evidence of oxidative stress caused by potassium dichromate.

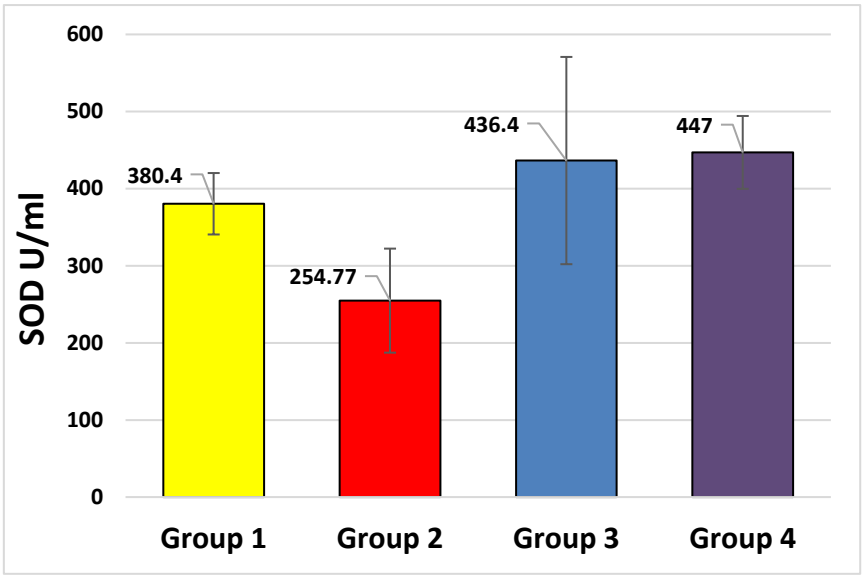

Figure (2): Comparison of serum superoxide dismutase (SOD) activity in rat after exposure to dichromate (Group 2), ginseng extract (Group 3) and ginseng-nanoparticles (Group 4) with the control group (Group 1)

The potassium dichromate group presented a clear decline in SOD level when contrasted with the control group. Consistent with other research, which found that potassium dichromate therapy causes testicular dysfunction due to oxidative stress [20, 21], our outcomes support this theory.

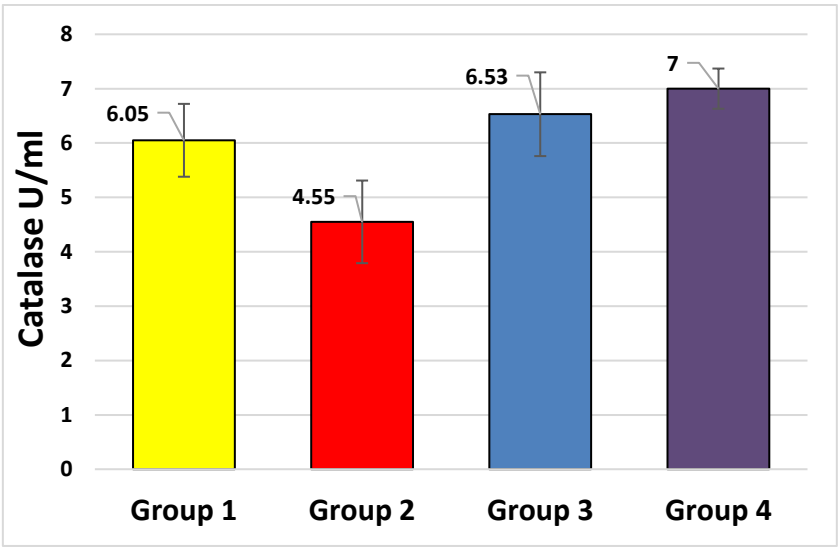

Figure (3): Comparison of serum catalase activity in rat after exposure to dichromate (Group 2), ginseng extract (Group 3) and ginseng-nanoparticles (Group 4) with the control group (Group 1)

The potassium dichromate group showed a marked decline in CAT when contrasted with the control group. Consistent with other research, which found that potassium

dichromate remedy causes testicular dysfunction due to oxidative stress [22, 23], our findings support this idea.

It is well-known that SOD and CAT have significant functions in lowering free radicals and preserving tissue antioxidant homeostasis [24 , 25]. This study found that rats exposed to potassium dichromate had increased levels of malondialdehyde (MDA) in their testes, suggesting oxidative damage. This could be because antioxidant enzymes are unable to remove the oxidants produced in this tissue. Lipidomic acid dehydrogenase (MDA) is a steady-state byproduct of lipid peroxidation and an indirect marker of elevated intracellular ROS generation [26]. Cell mortality and damage to membrane integrity can result from free radical reactions set off by lipid oxidation [27].

This study found that the oxidation of lipids can cause sterility and sperm malfunction [28]. Reduced levels of antioxidant enzymes in the testis may make sperm more vulnerable to free radical damage, which in turn reduces their concentration and motility [29]. Sperm are rich in poly fatty acids. By interfering with the phosphorylation of core axis proteins, which are crucial for sperm motility, reactive oxygen species produced during the chromium reaction can decrease sperm motility [30, 31]. The movement of sperm is also impaired when reactive.

The outcomes of the study are in line with those of earlier studies [32] that found that treating male rats with potassium dichromate significantly increased their MDA levels compared to the control group, signifying oxidative stress. Potassium dichromate inhibited the catalase and superoxide dismutase (SOD) enzymes, twofold significant antioxidants [33].

Researchers found that both ginseng nanoparticles and ginseng extract protected cells from potassium dichromate-induced oxidative stress [34]. Ginseng nanoparticles demonstrated a protective effect that was on par with, or straight better than, ginseng extract in terms of reducing MDA levels and enhancing SOD and catalase activity [35].

Their helpful effects are due to ginseng's and ginseng nanoparticles' antioxidant and anti-inflammatory capabilities [36]. The bioactive mechanisms of ginseng, such as flavonoids, polysaccharides, and ginsenosides, possess antioxidant activities. These components can mitigate free radical damage, neutralize reactive oxygen species (ROS), and moderate the expression of antioxidant enzymes [37].

Also, because of their smaller size and larger surface area, nanoparticles may be more effective antioxidants than the majority extract [38].

This study's findings that ginseng shielded participants from oxidative stress—a condition brought on by coverage to heavy metals and other contaminants in the environment—are in line with those of previous research. In line with previous research, this one highlights the antioxidant activity of ginseng nanoparticles [39, 40, 41].

Further investigation is needed to address a few limitations, though. The results need to be confirmed by additional research with large groups, as the study used a fairly small sample size [42].

Furthermore, ginseng nanoparticles' potential interactions with other drugs and supplements, as well as their long-term properties, require more study [43. 44].

Lastly, the data demonstrate that the ginseng extract and nanoparticles guarded male rats against oxidative stress caused by potassium dichromate. Ginseng nanoparticles seem to be as efficient as, if not more so than, the whole plant extract.

The findings suggest that ginseng green nanoparticles possess significant antioxidant properties, which aid in protecting against the oxidative stress induced by potassium dichromate. These results underscore the importance of exploring natural antioxidant sources, such as ginseng, and their nano formulations as potential therapeutic interventions against toxic metal-induced oxidative stress.

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