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The role of ginseng extracts green nanoparticles as an antioxidant on physiological parameters and fertility in male rats exposed to potassium dichromate

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Abstract. *Hamza MA, Hassan MS, Mousa RF. 2024. The role of ginseng extract green nanoparticles as an antioxidant on physiological parameters and fertility in male rats exposed to potassium dichromate. Nusantara Bioscience 16: 219-227.* The toxicity of chrome ions is prevalent due to their commonly used in the industry. Some plants are useful for treating toxicity, and ginseng is one of the most known medicinal herbs worldwide and possesses numerous health benefits. The present study aims to use ginseng extract and nano ginseng particles to treat toxicity by potassium dichromate PDC in a rat's model. Therefore, the PDC-toxified rats were treated with ginseng extract and ginseng-NPs at different concentrations, and ginseng-NPs were prepared using green biosynthesis. ELISA technique was used for serum estimation of GSH, SOD, MDA, LH, FSH, and testosterone in the animals' groups. Ginseng extract and ginseng nanoparticles could alleviate the toxic effects of PDC, as indicated by lower MDA, higher levels of antioxidants (SOD and catalase), FSH, and LH-Ab compared to the PDC intoxication group. The results display the lower toxicity of MDA and Catalase parameters compared to groups 2 and 5, whereas the other parameters indicate an increase. By buffering the concentrations of the tested biomarkers in a concentration-dependent way, the nanoparticles added to the protective effects of ginseng. For PDC, ginseng extract has antioxidant and antitoxic properties. Using ginseng nanoparticles led to a concentration-dependent increase in the activity of ginseng extract.

Keywords: Extraction, ginseng, nanoparticles, potassium dichromate, toxicity

INTRODUCTION

Ginseng is a plant that is part of the family Araliaceae, and it has been for several centuries because of its numerous active ingredients (Liu et al. 2020); ginseng's multiple health benefits are noted. Investigations revealed the exceptional role of ginseng in decreasing the frequency of diabetes, high triglycerides, high blood pressure, tumors, pain, and other psychological problems (Majid 2019). Ginseng is not just any herb; it has multiple pharmacological effects, making it unique among its peers (Park et al. 2019). Ginseng has been found effective in many diseases, not specific to any particular organ but those affecting the entire system, including issues related to the cardiovascular system, hormonal imbalances, immunity weaknesses, menopausal discomforts, and reproductive anomalies (Park et al. 2017); research indicates that ginseng has a visible impact on skin health, showing how an organ-specific benefit is manifested due to its use (Ahn et al. 2021). The active components of ginseng contribute significantly to its benefits; for instance, reductase degradation is one pathway at the endoplasmic reticulum (Dong et al. 2021). Ginseng modulates several intracellular pathways by acting on cells' genomic and non-genomic signals through surface interactions with receptors like estrogen or growth factor-induced receptors. Structurally similar to 17-β-estradiol, ginseng attaches itself to different nuclear receptors, facilitating cellular functions like PCNA expression or estrous behavior regulation (Seghinsara et al. 2019; Saadi et al. 2024). Therefore, acting as an anti-stress agent along with other properties like anti-aging and antioxidant capabilities, ginseng also modulates follicular development while affecting sex hormone levels, thus controlling inflammation plus oxidative stress in this time frame (Chen et al. 2022; Mohammed et al. 2023). Prooxidants and antioxidants coexist peacefully and unharmed in a constant state (Fan et al. 2022). Numerous investigations have indicated that SOD significantly delays Nitric Oxide (NO) chemical inactivation. This results in endothelial and mitochondrial dysfunction and inhibits the production of nitrates (Gaur et al. 2021). Due to its many toxicities, chromium risks human and animal health (Fukai and Ushio-Fukai 2011). Hexavalent chromium undergoes an intracellular conversion to trivalent chromium, which results in reactive oxygen species and their deleterious effects on tissue and a range of cellular processes (Kawanish et al. 2002). Hexavalent chromium is professionally exposed to around 500,000 persons globally, and hexavalent chromium-contaminated water is a global issue (Patlolla et al. 2009). Potassium dichromate ($K_2Cr_2O_7$) is a chemical widely used in many sectors and is soluble in hexavalent chromium. PDC is categorized as hexavalent chromium, a type of environmental pollution that may be linked to lower male rat fertility. PDC can be harmful to reproduction by lowering blood levels of LH, testosterone, and sperm motility, as well as the quantity of epididymal sperm. Furthermore, spermatogonial tissue was damaged by the PDC treatment; this was demonstrated by a

marked increase in cell layer thickness, the presence of vacuoles, and bleeding in the stromal cells (Arivarasu et al. 2008).

Therefore, combining the fields of nanotechnology with biotechnology, nanobiotechnology focuses on using nanoparticles to solve biological problems in new and creative ways. Furthermore, drug delivery, cancer treatment, and other biological uses depend heavily on nanoparticles. Recent developments in the design and manufacturing of nanomaterials have created new opportunities to manipulate the size of molecules to alter their effect, particularly in immunity and anticancer activity. The current work intends to alleviate PDC toxicity in a rat model using ginseng extract and nano ginseng particles. This study aimed to reduce the toxicity of PDC in a rat by using ginseng extract and tiny ginseng particles.

MATERIALS AND METHODS

Alcoholic extraction of ginseng

This study used air-dried and ground ginseng material (100 g as a sample) using the method described by (Sultana et al. 2009). An entirely different experiment used 500 mL of liquid methanol (methanol: water, 80% v/v) to remove impurities for 8 hours using Soxhlet extraction on a water bath. The extract was also made stronger with a rotating evaporator, and the solvent was taken away at 45°C under lowered pressure. To figure out the output, the dried, pure, concentrated extract was weighed out and put in the fridge at 4°C until further needed (Bashandy et al. 2019).

Biosynthesis of Se NPs

The ginseng plant extract was used for the green biosynthesis of Se-NPs (Salem et al. 2022).

Characterization of the nanoparticles

Various techniques, including UV and FTIR, characterized the prepared nanoparticle composite.

Measuring the oxidative stress biomarkers and the sex hormones

The ready-for-use kits were used for estimating serum GSH, SOD, MDA, LH, FSH, and testosterone in the animals by using the ELISA technique purchased from Sunlong Biotech Company, China.

Experiments design

Six groups of animals were used in the study, and six male rats were used in each group as follows: 1-In Group 1, the control negative group, animals were given normal water orally daily for six weeks. 2-Animals in Group 2 (potassium dichromate group) were given 2 mg/kg of body weight of potassium dichromate intraperitoneally every day for two weeks. 3—Group 3 (Ginseng positive group): Animals were given 200 mg/kg of body weight of ginseng every day for 4 weeks. 4—Group 4 (Nano ginseng) Nano ginseng was given to animals orally once a day at a 200 mg/kg body weight dose for four weeks (Al-Mukhtar et al. 2016). Animals in Group 5 were given potassium dichromate 2 mg/kg plus one oral dose of ginseng (200 mg/kg). Six animals in group 6 were given 200 mg/kg of body weight of PDC + ginseng nanoparticles every day for four weeks (0.3 mL); seven animals in group 7 were given 200 mg/kg of body weight of potassium dichromate + ginseng nanoparticles every day for four weeks (0.1 mL).

RESULTS AND DISCUSSION

Serum biomarkers levels

Table 1 compares the amounts of blood biomarkers in rats exposed to dichromate (Group 2), ginseng extract (Group 3), and ginseng nanoparticles (Group 4). The levels in the control group (Group 1) are shown next to each other. This study found that MDA levels increased in Group 2 compared to the control group, Group 1. Along with Group 2, Groups 3 and 4 we observed less MDA and a drop in Group 2. These are the differences between the levels of blood biomarkers in rats that were exposed to dichromate (Group 2), ginseng extract (Group 3), and ginseng nanoparticles (Group 4). The first group is the reference group. The levels of serum SOD are much higher in Groups 3 and 4 than in Group 2. It is found that Group 2 has a lower amount of serum catalase than Groups 1, 3, and 4. The amount of LH-Ab is higher in Groups 3 and 4 than in Group 2. The amount of DHT in the blood is lower in Group 2 than in Groups 1, 3, and 4. Groups 3 and 4 have more serum FSH than Groups 1 and 2.

Table 1. The amounts of blood biomarkers in rats exposed to dichromate, ginseng extract, and ginseng nanoparticles

Parameter	Group1[A] Mean±SD	Group 2 [B] Mean±SD	Group 3 [C] Mean±SD	Group 4 [D] Mean±SD	F	p
MDA mmol/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 [B]	4.55±0.76 [A, C, D]	6.53±0.77 [B]	7±0.37 [B]	12.806	<0.001
LH-Ab Iu/l	4.14±0.56	2.88±0.67 [C, D]	5.78±1.51 [B]	5.91±1.17 [B]	9.487	0.001
DHT pg/mL	342±69.07 [B]	134.2±42.04 [A, C, D]	383±22.93 [B]	386.8±28.19 [B]	36.604	<0.001
FSH ng/mL	22.7±2.08 [B, C, D]	15.15±2.19 [A, C, D]	29.02±3.37 [A,B]	29±3.29 [A,B]	27.735	<0.001

Note: [A]: Comparison with control group, [B]: Comparison with the dichromate treated group, [C]: Comparison with ginseng treated group, [D]: Comparison with ginseng-nanoparticles treated group

The ginseng juice used to treat dichromate poisoning

Therefore, to evaluate how ginseng affects PDC's toxicity, the group that got PDC (Group 2) was compared to the group that got PDC and ginseng extract (Group 5), as shown in Table 2. The amount of SOD in the blood is higher in Group 5 than in Group 2. Also, there is a big difference between Group 5 and Group 2 in the levels of DHT. There are also significant differences between the groups in the levels of MDA, SOD, LH-Ab, and FSH.

Toxicity of dichromate, ginseng, and ginseng-NP

Table 3 shows the effect of ginseng nanoparticles at two concentrations, 0.3 mL (Group 6) and 0.15 mL (Group 7) of nanoparticle solution, on the toxicity of PDC compared with Group 2, which applied only by PDC. The results show that ginseng-NP, at two concentrations, has no significant effect on the levels of MDA, catalase, and LH-Ab. Serum SOD level was increased after using ginseng-NPs at a concentration of 0.3 mL. While the level of DHT and FSH are increased after adding ginseng-NPs at concentrations of 0.15 and 0.3 mL.

Histopathologic results

A control rat's epididymis (testes), which showed normal histopathological traits under a microscope (Figure 1), revealed important information about the basic properties of healthy testicular tissue. This finding shows how important it is to keep the structure of seminiferous tubules and Leydig cells intact for healthy spermatogenesis and testicular function, which is in line with earlier research by Adamczewska et al. (2022). These researchers stressed how important these normal histological features are for men's reproductive health. The microscope study of testicular and epididymal tissue slices from animals given potassium dichromate (Figure 2) showed clear histopathological changes that showed the testicles and epididymis were toxic. This study observed many changes, including tubules getting smaller, tubules becoming empty, interstitial blood vessels getting clogged, germinal epithelia dying, areas of epithelium necrosis, changes in tubular epithelia, dying spermatogonia, pyknotic nuclei, low spermatic density, and interstitial spaces getting bigger. According to the current research, there is no compelling evidence to support a significant influence of ginseng on tubular epithelial changes and pyknotic nuclei. Consequently, it is reasonable to conclude that ginseng does not exhibit a clear and direct effect on these cellular processes. Based on these results, potassium dichromate may have damaged the male reproductive organs greatly. Researchers have already evaluated how hexavalent chromium, which includes potassium dichromate, affects the function of ovaries and, by extension, men's sexual health. Multiple studies have shown that chromium compounds can change the process of spermatogenesis, which can damage the testicles and cause changes in the cells of the testicles and epididymis (Aruldhas et al. 2005; Aitken and Roman 2008). Because of this, oxidative stress has been put ahead of other possible causes, such as mitochondrial damage and changes in the normal function of the testicles, as a likely pathophysiologic process adding to chromium-induced testicular toxicity. So, these results align with what other experts said about the changes in the testicular and epididymal tissues after potassium dichromate treatment.

After examining the changes in the shape of the testicles and epididymis of male rats, the study concludes that the potassium dichromate effect should not be taken lightly. It also shows that herb amounts of nano ginseng particles are needed to lower the chance of exposure to potassium dichromate (Marouani et al. 2012).

Table 2. Treatment of toxicity of dichromate by ginseng

Parameter	Group 2 Mean±SD	Group 5 Mean±SD	F	p
MDA			1.370	0.275
mmol/mL	14.52±1.12	10.3±0.96		
SOD u/mL	254.37±66.07	380.4±39.83	<0.001	0.993
Catalase u/mL	6.05±0.67	6.37±0.7	15.504	0.004
LH-Ab Iu/l	4.14±0.56	3.32±0.76	0.965	0.355
DHT pg/mL	342±69.07	237.4±52.99	11.637	0.009
FSH ng/mL	22.7±2.08	18.04±2.74	3.387	0.103

Note: Group 2: Comparison with the dichromate-treated group, Group 5: Animals received potassium dichromate +ginseng extract

Table 3. Treatment of toxicity of dichromate by ginseng-NP

Parameter	Group 2 [A] Mean±SD	Group 6 [B] Mean±SD	Group 7 [C] Mean±SD	F	p
MDA mmol/mL	14.52±1.12	11.89±5.63	13.28±0.76	0.774	0.483
SOD u/mL	254.77±67.46 [B]	342.4±21.64 [A]	303.6±20.67	5.310	0.022
Catalase u/mL	4.55±0.76	6.17±2.47	5.37±1.66	1.039	0.384
LH-Ab Iu/l	2.88±0.67	3.6±0.48	3.25±0.78	1.517	0.259
DHT pg/mL	134.2±42.04 [B,C]	313.4±25.98 [A]	269.4±42.97 [A]	30.503	<0.001
FSH ng/mL	15.15±2.19 [B,C]	22.08±2.6 [A]	19.56±1.5 [A]	13.376	0.001

Note: [A]: Comparison with the dichromate treated group, [B]: Comparison with ginseng treated group, [C]: Comparison with ginseng-nanoparticles treated group

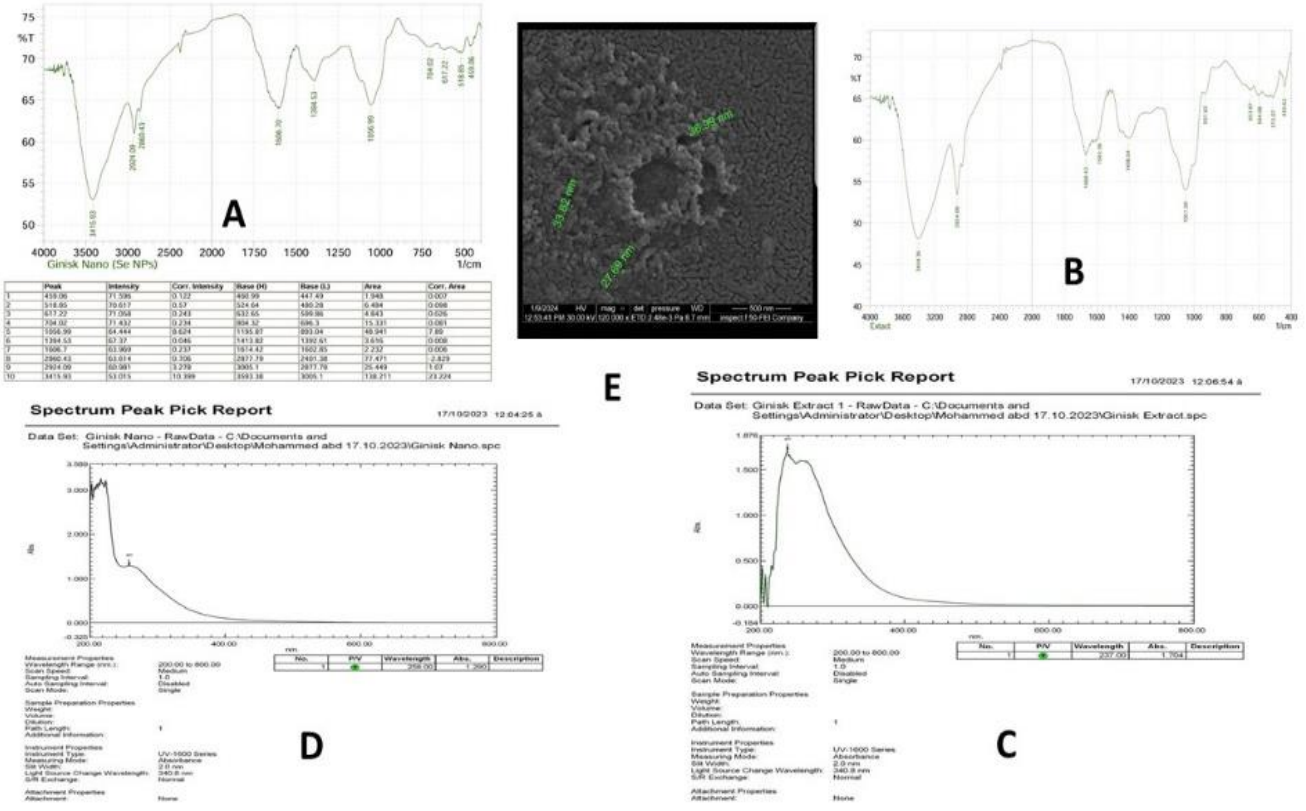


Figure 1. Characterization of ginseng nanoparticles (NPs). A. FT-IR spectrum showing functional groups of ginseng nanoparticles, B. FT-IR spectrum showing functional groups of ginseng extract, C. UV-visible spectroscope of ginseng extract, D. UV-visible spectroscope of ginseng nanoparticles, E. Scanning Electron Microscopy (SEM) shows the morphology and size of biogenic nanoparticles (NPs)

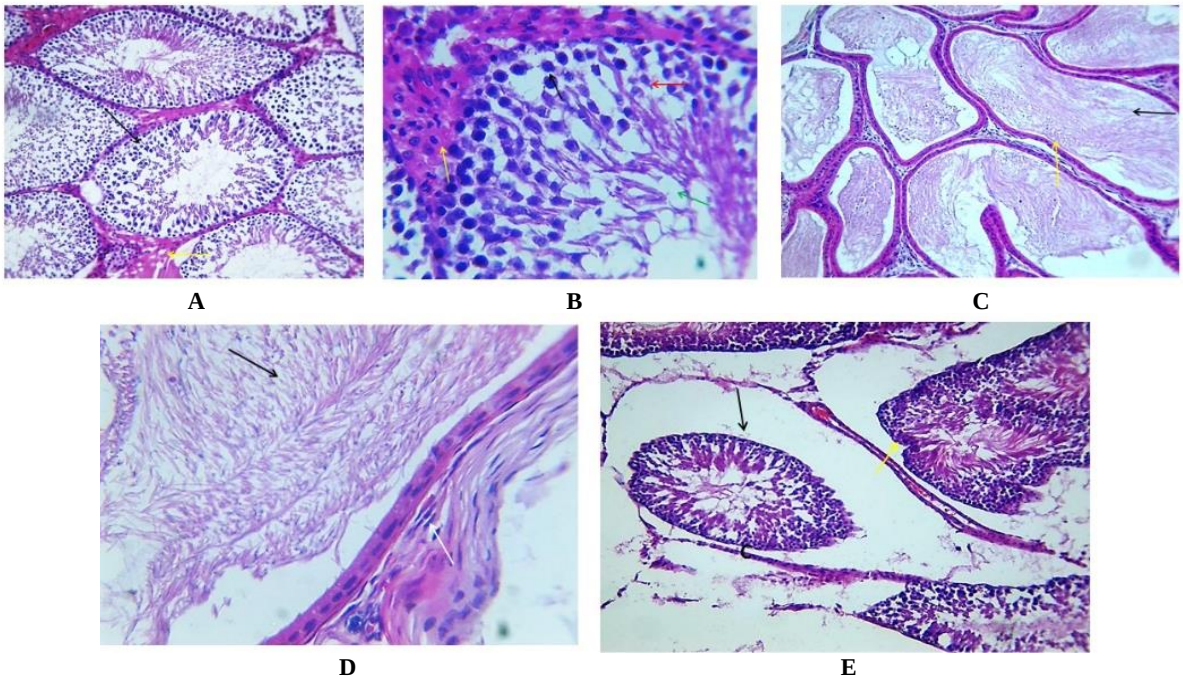


Figure 2. A-E Microscopical examination of a control rat testes and epididymis

Figure 3 shows that animals that were administered ginseng extract had good effects on the tissues in their testicles and epididymis. At 10X magnification, the testes showed normal testicular tissue shape with many blood vessels clustered between the cells. At 40X magnification, the seminiferous tubules looked normal, with wider interstitial areas and normal spermatogenesis. This shows that the ginseng extract treatment improved testicle health and the process of spermatogenesis. At 10X magnification, normal epididymal tubules with some lengthening were seen in the epididymis; there were also observed several sperms with good quality, and the spaces between the cells were getting bigger. The epididymal tubules looked normal at 40X magnification, with enough spermatic density and wider interstitial spaces. This suggests that treatment with ginseng extract may help keep the shape and quality of the epididymis normal. Previous research studies that supported the health benefits of ginseng extract on the testicles and epididymis have also been observed in this study. The study supports this result that animals' testes and epididymis looked better after treatment with ginseng (Jang et al. 2011).

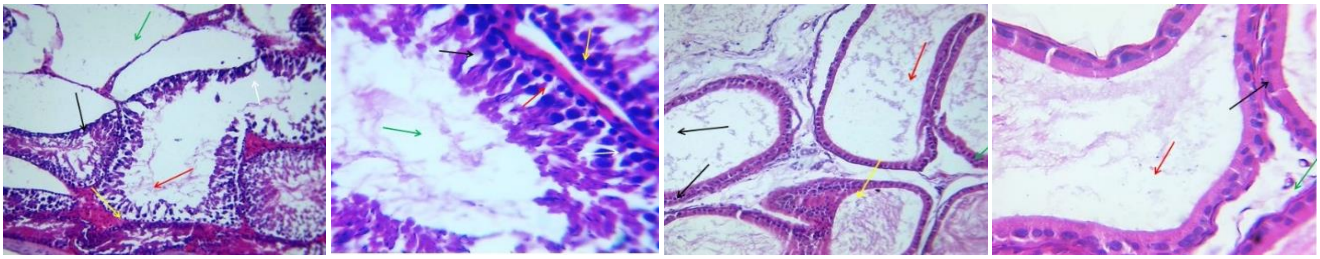
The structural changes were observed in testicular and epididymal tissue sections (Figure 4). At 10X magnification, the testicular tissue showed some degradation and plenty of crowded blood vessels in the interstitial space. At 40X magnification, mild disorganization in the tube germinal epithelia and Leydig cell degeneration were seen. At 10X magnification, the epididymis changes were not too different, with some showing degeneration in the germinal epithelium and marked dilation in the interstitial spaces. These changes led to hyperplastic cellular epithelia, whereas at 40X magnification, sperm density was seen to be moderate. Much research on ginseng and its products has shown that it can affect a man's ability to reproduce, especially by observing the effects on the testicles and the epididymis (Won et al. 2014)

Moreover, some studies have shown that ginseng and its products can improve the testicles and epididymis parameters (Sawiress et al. 2011). It might be like looking into a mist to see the changes when rat testicular and epididymal tissues were treated with ginseng nanoparticles. There seems to be a mysterious combination between ginseng's bioactive parts and reproductive tissues, and more research is needed to figure out how it all works.

Figure 5 shows the changes seen under a light microscope in rats' seminiferous tubules and epididymis administered with potassium dichromate and ginseng extract. Some rats' had normal germinal epithelium, while the other tubules showed signs of degeneration and clogged interstitial blood vessels at both ends; therefore, other people had completely different situations. There were normal spermatogonia and normal spermatocytes found only in places where there was no sign of these cells' future development because they were between two areas of congestion. This information indicated an ongoing spermatogenesis process in the studied tissue sections, even though some parts did not support this activity. These results show that ginseng extract might protect testicular and epididymal cells, even with potassium dichromate. As a known poison, the fact that ginseng has positive effects when combined with other drugs (despite the negative effects of the individual drugs) may help us understand how ginseng might protect the male reproductive system.

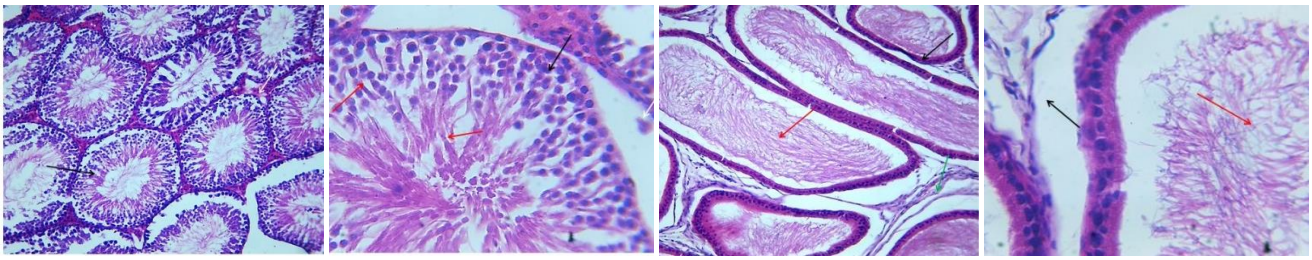
Histological analysis of rat testes and epididymis following treatment with potassium dichromate and ginseng nanoparticles 0.3 mL (as used in Group 6) depicted marked enhancements and reversible changes in tissue morphology (Figure 6). At a magnification of 10X, the seminiferous tubules exhibited a typical structure characterized by normal interstitial spaces and Leydig cells. In comparison, at 40X magnification, the germinal epithelium appeared healthy, with spermatogonia, spermatocytes, and spermatids being normal. The findings in the epididymis also showed improvements; at 10X magnification, tubule morphology was near normalcy with a healthy spermatic population and spaces that were slightly dilated; observations with a higher magnification of 40X revealed that the epididymal tubules were indeed normal with appropriate spermatic population and orderly arrangement of tubular epithelium. These collective results point towards a positive impact of combining potassium dichromate and ginseng nanoparticles 0.3 on testicular and epididymal health, an effect which fosters development through enhancement of tissue morphology; thus, spermatogenesis occurred. Literature has previously highlighted ginseng's protective and therapeutic effects on testicular health, including protection against toxicants inducing testicular atrophy, such as TCDD (Elgharabawy and Emara 2014), corroborating our findings.

Histological examination reveals the testicular composition of potassium dichromate and ginseng nanoparticles 0.15 mL treated rat (see Figure 7), showing some tubular sloughing elements within a congested interstitial space, semi-normal. The findings from the seminiferous tubule indicate degeneration of germinal epithelia and necrosis of spermatids. At the same time, those in epididymis show significant alterations with moderate to normal populations of spermatic disarrangements plus epithelial cells' distribution along the tubules. These observations suggest that potassium dichromate and ginseng nanoparticles of 0.15 mL have a moderate protective effect on testicular and epididymal health, improving tissue morphology and spermatogenesis indices. Studies have previously demonstrated ginseng's protective and therapeutic effects on testicular health, including protection against atrophy induced by TCDD; thus, this study will evaluate WA's ameliorative effects on DM-induced male reproductive dysfunction in mice based on these positive outcomes. Results indicated WA treatment improved sperm population and motility among diabetic mice, implying potential protective roles toward testicular components, especially when considered alongside other related findings concerning alterations seen following the use of potassium dichromate coupled with ginseng nanoparticles 0.15 mL as it used in Group 7, indicating potency via protection against toxicant-induced damage: supportive literature notes high prospects for ginseng also (Al-Saadi 2017).



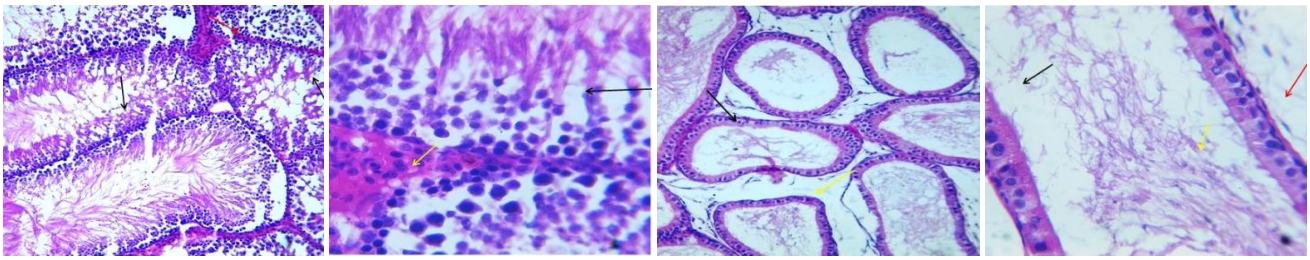
A B C D

Figure 3. A-D Microscopical examination of rat testes and epididymis after animals received potassium dichromate



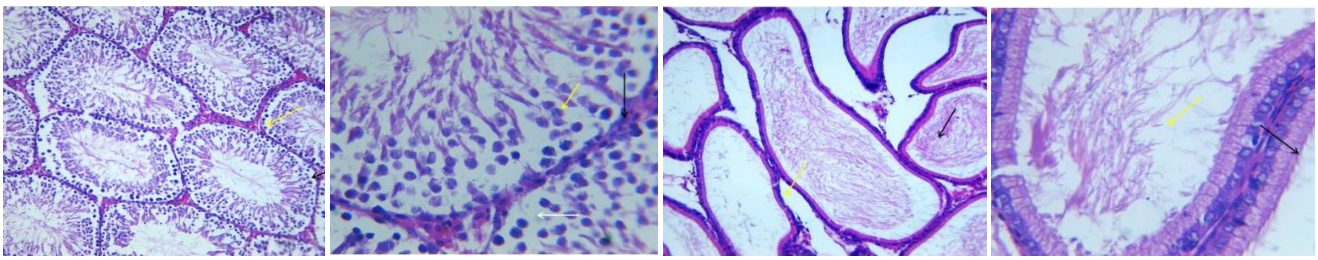
A B C D

Figure 4. A-D D Microscopical examination of rat testes and epididymis after Animals received ginseng orally.



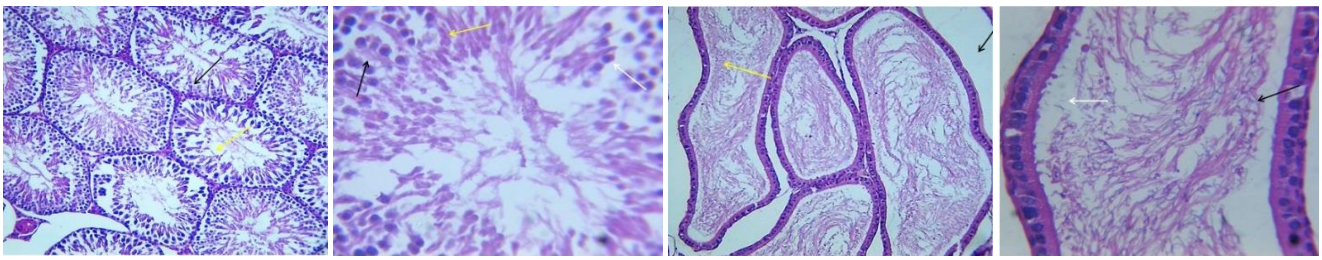
A B C D

Figure 5. A-D Microscopical examination of rat testes and epididymis after animals received nano-ginseng orally



A B C D

Figure 6. A-D Microscopical examination of rat testes and epididymis after animals were administered a mixture of potassium dichromate and ginseng



A B C D

Figure 7. A-D Microscopical examination of rat testes and epididymis after Animals received Potassium Dichromate + ginseng -NPs

Discussion

The first important result of this study is that the MDA level lowered after rats were exposed to PDC and remained low after being treated with ginseng extract and ginseng nanoparticles. This shows that these ginseng products protected the rats from the harmful effects of PDC. Some other parameters of ginseng preparation were raised amounts of LH-Ab, FSH, and DTH hormones, and SOD and catalase enzymes, which are antioxidants. These results are important for animal tests that use ginseng to protect against poisoning.

Studies in the past have shown that adding ginseng can help lower the harmful effects of tobacco. The amounts of FSH and LH were much higher after being treated with tobacco and ginseng (Faghani et al. 2022). In addition, the tissues of the group that received both nicotine and ginseng had lower levels of MDA and higher levels of SOD compared to the nicotine group; this is what Faghani et al. (2022) stated. Mekhoukhe et al. (2019) explain how carob's ability to raise testosterone levels affects Leydig cells and testosterone production. Many know PDC has a detrimental effect on testicles (Morsy et al. 2023). Researchers in a previous study found that administering rats PDC orally every day for 8 weeks caused oxidative stress in their testicles, as shown by a noticeable rise in MDA, NO, and GSSG levels. It was also seen that the PDC group had significantly lower amounts of SOD, CAT, GSH, and Car in their testicles compared to the control group. These results align with earlier research that showed how PDC-induced oxidative stress causes testes not to work properly (Marouani et al. 2017).

This study revealed that higher antioxidant levels will help eliminate free radicals that could be harmful due to potassium dichromate. These results follow the researcher found in 2018 (Ighodaro and Akinloye 2018). MDA is a steady byproduct of lipid peroxidation pathways and is generally known as an indirect sign of higher ROS production inside cells (Cherian et al. 2019). Therefore, ginseng protects folliculogenesis by changing several hormone levels in the body, encouraging cell growth, and hindering cell death through anti-oxidative effects in the ovary, such as by lowering apoptotic markers (Salem et al. 2022). Additionally, Ibrahima et al. (2018) say that ginseng keeps other endocrine glands, like the thyroid glands, from detrimental effects by PDC model rats. Previous research shows that administering ginseng to animals with benign prostatic hyperplasia lowers DHT levels in the prostate significantly. It also helps keep the balance between cell death and proliferation, which means that proliferation takes over and apoptosis is stopped (Shin et al. 2012).

The second important result was that ginseng extract made PDC less harmful. Its health benefits derive from the many useful chemicals in the plant juice. A new study shows ginseng has many useful parts, like ginsenosides, polypeptides, and carbohydrates. Ginsenosides are one of ginseng's most important active ingredients that affect the immune, circulatory, and nervous systems (Zheng et al. 2018). Furthermore, K substance derived from Panax ginseng can stop cell death, reduce inflammation, and fight free radicals. It can also protect the meiotic maturation of pig eggs from damage caused by benzo(a)pyrene (Luo et al. 2020). Additionally, ginsenoside Rb1 is another chemical found in ginseng, which has been shown to help keratinocytes move and speed up the healing of skin wounds (Shin et al. 2018).

Rb3 can also boost the antioxidant power of diabetic mice, raising the level of superoxide dismutase (SOD) in their blood and lowering the level of malondialdehyde (MDA), which is a lipid peroxidation product. This is very important to lower possible illness (Ridha and Al-Shawi 2017). Ginseng stops oxidative damage, boosts the benefits of antioxidants, and lowers the number of free radicals in rats administered by alloxan (Kim et al. 2011). Another ginseng substance, ginsenoside Rf, can help with intestinal conditions by stopping the MAPK/NF-κB signaling pathway (Ahn et al. 2016).

Table 3 shows the third important result: ginseng-NP can treat PDC poisoning by being antitoxic. The amount of ginseng-NPs has a direct relationship with this effect. NPs are very small, less than 100 nm, but have many interesting physical and chemical features. These nanoparticles are crucial because of their surface energy, that have a lot of surface atoms, few flaws, and are confined in space, which makes them nanostructures. Nanotechnology can be used in many biology studies because nanoparticles are very small and have great physicochemical qualities (Chaudhary et al. 2015). In the past few years, NPs have become very useful and hopefully promising tools in biology (McNamara and Tofail 2017). NPs merge biology, chemistry, physics, and materials science, which leads to new therapeutic materials based on nano-sized materials used in various biological settings. Because they are small, they can easily get into cells and do many useful things in biology and antioxidants without being put into other carrier systems. Since NPs are also good at transport systems, they can be used as anti-inflammatory drugs or for imaging-based diagnostics (Farhan et al. 2023) with drug carriers or bioconjugates administered using biological treatments. Additionally, NPs were widely used in drug compounds as bio-conjugate materials where they were needed for treatment.

ROS are said to be made when hexavalent chromium changes to trivalent chromium inside cells (Stohs et al. 2001). According to (El-Sakhawy et al. 2017), vasoconstriction could be caused by the breakdown of lipids. Potassium dichromate raises the amount of Nitric Oxide (NO) inside cells. This turns on nuclear factor kappa B (NF-KB), "a key activator of genes involved in inflammation, immunity, and apoptosis" that causes more apoptosis by damaging DNA and turning on p53 (Kawanishi et al. 2002). This study's oxidative stress biomarkers went down because ginseng did the same phenomenon as Jadhav and Saudagar (2014) observed. The current study demonstrated that ginseng significantly reduced MDA levels and enhanced the levels of both catalase and SOD in the treated rat groups, whether administered as an extract or a nanoformulation.

In conclusion, the activity of Ginseng extracts as an antitoxic agent for PDC combined with the antioxidant factor; when ginseng nanoparticles were used, ginseng extract increased concentration-dependent.

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