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Antioxidant Effects of Selenium Nanoparticles Prepared from *Eruca Sativa* Extract on Ketoconazole –Induced Testicular Oxidative Damage in Male Rats

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Abstract:

Background: Recent studies have shown that the anti-fertility effects of Ketoconazole can be minimized by taking an antioxidant nanoparticles based-plant extract in combination with the medication or by taking it after medication. One of the effective methods to improve its medicinal properties and decrease the toxicities of Selenium is by formulating it as nanoparticles. However, this is still a challenging strategy.

Objectives: The aim of this study was to analyze the impact of nano selenium, which was prepared from *Eruca Sativa* extract, on testicular oxidative stress parameters in rats that were treated with ketoconazole. The study will focus on the evaluation of glutathione peroxidase, superoxide dismutase, and malondialdehyde as indicators of oxidative stress.

Methods: In this study, a 1% w/v solution of plant extract was added to a solution of 10mM sodium selenite in different ratios, and placed on a magnetic stirrer in the dark for 12 hours at a temperature 50C° and pH9. The solution was then left for 48 hours, and the optimal fabricated selenium nanoparticles were selected for further characterization. forty-eight rats were divided into six groups with eight animals in each. Group A was the negative control, while Group B was given oral Ketoconazole at a dose of 50mg/kg for fourteen days. Group BC, BD, BE1 and BE2 were given oral Ketoconazole at a dose of 50 mg/kg for fourteen days, followed by 200mg/kg Eruca Sativa, 0.5mg/kg oral sodium selenite, 0.25mg/kg oral nano selenium and 0.5mg/kg oral nano selenium for 28 days, respectively. Finally, the animals were euthanized and their testicle anti-oxidant parameters were evaluated.

Results: Significant increases in glutathione peroxidase and superoxide dismutase (p value < 0.001), and a decrease in malondialdehyde levels (p value < 0.001) were observed in groups treated with nanoparticles compared to control group.

Conclusion: Nano forms of prepared by *Eruca sativa* extract exhibit significant antioxidant effects on testicular tissues, while being available for several metabolic, biological, and physiological functions.

Keywords: Glutathione Peroxidase; Malondialdehyde; Nano Selenium; Oxidative Stress; Selenium; Superoxide Dismutase.

Introduction

Selenium is one of the most significant trace elements in medicine and biology. It is found as incorporated Selenoproteins rich in Selenocysteine. It acts as co-factor for various enzymes involved in oxidoreductase activities, such as glutathione peroxidase and thioredoxin reductase (1). These enzymes possess a cytoprotective effect, and their activation helps boost fertility, reduce inflammatory reactions, and provide a chemo- preventive effect against different types of cancers (2). In this regard, free radical-induced oxidative stress is thought to be the most important risk factor that threatens testicular functions; therefore, an antioxidants defense system which is represented by enzymes incorporated with selenoproteins can counteract these free radicals or prevent their formation in the testicular cells (3, 4).

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Nanotechnology is a novel growing field with important applications in science and technology. In the pharmaceutical industry, nanoparticles act as carrier platforms to transport drugs t their target sites of action. It is based on the creation of small particles at the submicroscopic level (<100 nm) (5), which serves to enhance the biological activity, minimizes toxicity, and allows for the regulated release of medications, especially in capsule form (6).

Metal nanoparticles can be prepared by using either chemical or biological reducing agents. Implementing plant extracts with prominent antioxidant effects may help achieve that target. Such formulations may achieve two targets using one stone, as the nanoparticle formulation will enhance the permeation of both Selenium and the plant extract into that target site, and this may help achieve a synergistic effect (7).

Ketoconazole is an antifungal drug that was reported to reduce epididymis sperm concentration, decrease

the weight of male reproductive organs, especially the testes, and decrease serum testosterone levels (8), in addition to other pathological changes characterized by atrophied seminiferous tubules, malformed germ cells, and degenerated Sertoli cells. Interestingly, co-administration or post-treatment with antioxidant phytochemicals of plant extract could prevent such testicular damages (9).

This study was designed to investigate changes in testicular oxidative stress parameters (Superoxide dismutase" SOD", Malondialdehyde "MDA" and Glutathione peroxidase "GPX") in response to antioxidant effects of nano selenium prepared from *Eruca Sativa* extract in male rats.

Materials and Methods

Eruca Sativa Extract: Preparation and Characterization

One hundred grams of dried leaves powder *of Eruca sativa* was macerated with 2 liters n-hexane (99.8%) for four days for defatting plant material, then 80% ethanol was added, and the solution was filtered and evaporated using a rotary evaporator (4 rpm at 40Cº). Finally, ethyl acetate and sodium Disulphate were added and the solution was then filtered, left to dry, and stored in a dark, sterile screw bottle at 4C° until used. The extract was characterized by measuring the total flavonoid content and its antioxidant power using a reducing power assay (10).

A. Measurement of Total Flavonoid Content

Flavonoids were estimated using a technique described by Ibraheem *et al*, 2014**,** where each mg of Gallic acid equivalent per gram of extract had its absorbance measured against a blank at 510 nm, and a calibration curve was analyzed (11).

B. Measurement of the Extract's Total Antioxidant Activity (Reducing Power Assay)

The extract's reducing power was measured according to the method prescribed by Ibraheem *et al,2012*; the absorbance of different concentrations of the extract was measured at 700 nm and compared with the control (DW) (12). The percentage of absorption increased was sketched with different concentrations of Vitamin C as a standard (13).

Preparation of Selenium Nano Composite Using *Eruca Sativa* Extract

Briefly, a solution of 1% w/v of the extract was loaded to a solution of 10 mM sodium selenite at the four proportions (1:2, 1:4, 1:10 and 1:20 sodium selenite/ extract). The former was prepared by dissolving 0.172 gm. of sodium selenite (Na_2SeO_3) in 100 ml deionized water. Then, the final mixture was mixed using a hot plate magnetic stirrer (temp. 50 C° & pH of around 9) in the dark for 12 hrs. It was then autoclaved (temp. 121C° & gas pressures of 1.5 bar) for 15 min (14)**.** Next, the autoclaved mixture was exposed to filter sterilization using a Millipore filter membrane (0.22µm) and ultra-sonic vibration (20 KHz by Q700 sonicator) to ensure an even dispersion of the nanoparticles in the liquid and to get micron-sized colloidal particles. Finally, the prepared colloid was sent for the characterization processes (15).

Characterization of the Nanocomposite

A. UV-Vis spectra analysis

B. Fourier transform infrared spectroscopy (FTIR).

C. Dynamic Light Scattering (DLS)

The samples were analyzed at the University of Technology's Nanotechnology Department.

Experimental design

A. Animals and ethical issues

This study was carried out on forty-eight healthy male adult albino rats (weighing 301± 24.28 grams and aged 10±2 weeks). They were gathered from the animal house at AL-Nahrin University/ College of Pharmacy and the Iraqi Center for Cancer and Genetic Research at AL-Mustansiriyah University. The study was approved by the Institutional Review Board (IRB)/College of Medicine /Baghdad University (Pharma Comed uvB 23.6) all the procedures and experiments were performed following the rules and legitimacy of the animal ethics committee /College of Pharmacy/ Al-Nahrin University.

Animals grouping: The experiment was implemented from the first of March 2022 to the end of August 2022. First, the animals were randomly divided into six groups with eight rats in each; Group A: -ve control, orally administered with 2 ml distilled water (DW) daily via gavage tube for 42 days. Group B: +ve control, orally received 2 ml of Ketoconazole (KET) solution (50mg/kg /day) via gavage tube (16) for 14 days, followed by 2 ml distilled water for 28 days. Group BC: received 2 ml of ketoconazole solution (50 mg/kg/day) orally for 14 days, followed by a therapeutic dose of *E. Sativa* extract (200mg/kg/day) orally (17) via gavage tube once daily for 28 days. Group BD: received 2 ml of ketoconazole solution (50mg/kg/day) orally for 14 days, followed by a therapeutic dose of sodium selenite solution (0.5 mg/kg/day) ^{orally} (18) via gavage tube once daily for 28 days.

Group BE: Nano Selenium group, which was subdivided into: Group BE_1 and BE_2: that received 2 ml of ketoconazole solution (50 mg/kg/day) orally for 14 days, followed by a therapeutic dose of 2ml Nano-Selenium solution 0.25 or 0.5 mg/kg/day, respectively, via gavage tube once daily for 28 days.

After forty-two days, the rats were ethically anesthetized by chloroform and euthanized. The right testes were excised, weighed, and homogenized in buffer phosphate saline (1:10 parts, pH 7.4) using Electrical Tissue Homogenizer (IKA, Germany); after that, the homogenate was centrifuged at 12,000 rpm at 4°C for1 min and store at -20℃ for antioxidant assays (19).

Animals monitoring

Measurement of oxidative stress parameters

In this study, the levels of three enzymes; Superoxide Dismutase (SOD), Glutathione peroxidase (GPX) and Malondialdehyde (MDA) were tested using ELISA Kits provided by SunLong Biotech Co., LTD to assay enzymes levels in the testicular tissues based on the interaction of pre-coated specific antibody on micrelisa strip plate wells with standards or samples.

Statistical analysis

The statistical package for social science (SPSS) (IBM SPSS Statistics for Windows, Version 23) was used for the analyses. One-way analysis of variance (ANOVA) was performed to summarize the results, and significant differences of $P \leq 0.05$ were applied.

Results

Characterization of *Eruca Sativa* extract

A. Total Flavonoid Content (TFC)

According to the experiment applied to estimate TFC, 0.9 g of the extract was found to be equivalent to 1 mg of Gallic acid.

B. Reducing Power Assay

A plot of log concentrations versus absorbance at 700 nm showed the right and downward shifting curve of E. sativa extract, compared to vitamin C curve as a standard, which indicated that the extract's reducing activity is less than that of vitamin C within these selected concentrations, as shown in Figure (1).

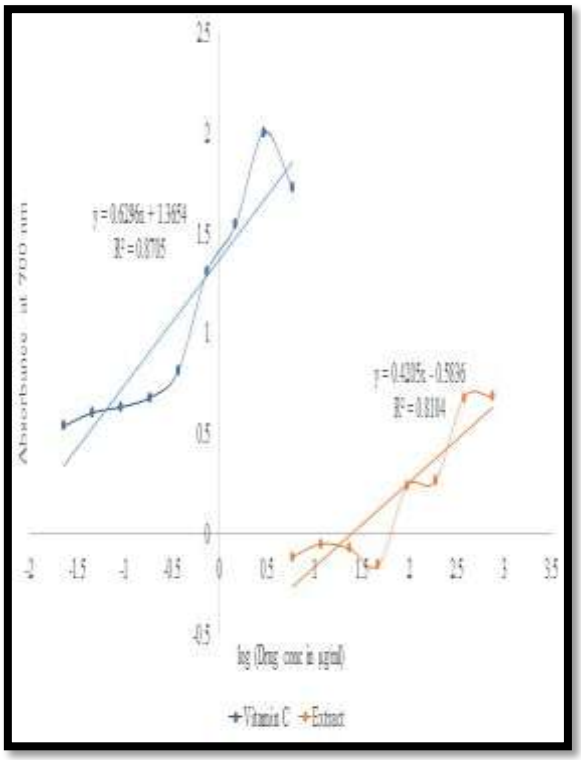

Figure 1: Reducing power assay of *E. sativa* compared to vitamin C as a standard.

Characterization of Nano-Selenium

- **Visual observation**

Synthesis of SeNPs was indicated from the gradual conversion of the color of the extract from dark brown to light yellow and then reddish orange after about 12 hours of adding the acidic sodium selenite solution to the *Eruca Sativa* extract. This change can be ascribed to the aptitude of the extract to reduce selenium ions into SeNPs (Figure 2).

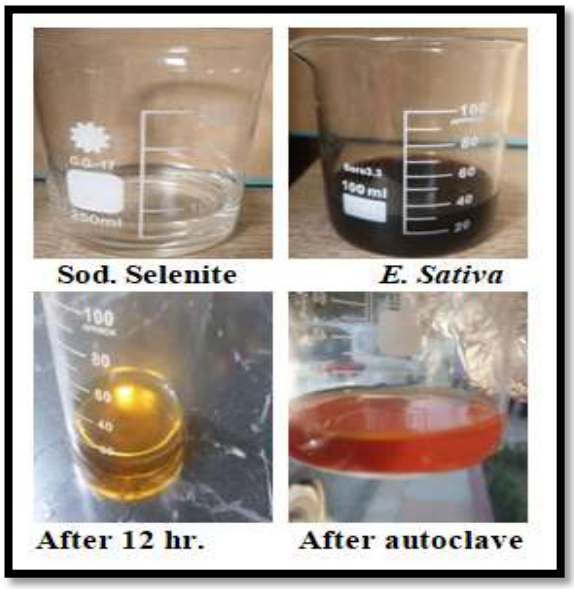

Figure 2:-Visual observation for Nano-selenium formation

A. UV-Vis Spectrum Analysis

Figure (3) shows the UV-Vis spectrum of SeNPs biosynthesized from Eruca Sativa extract. The spectrum of absorbance was measured from 220-1000 nm. A prominent absorption peak between 268 and 964 nm, with a maximum at 268 nm, is a conclusive evidence of Nano selenium's production

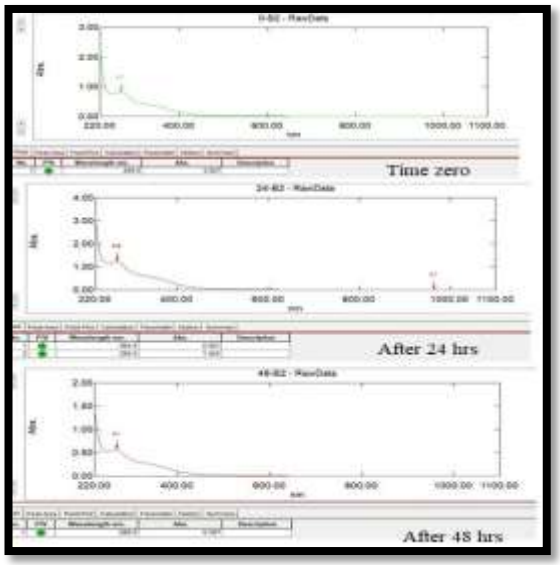

Figure 3:- UV-visible spectrum of selenium nanoparticle

B. Dynamic Light Scattering (DLS)

Particle size measurement

Table (1) shows that the average particle size of the synthesized Se-NPs varies from 39.4 to 124.6 nm. It also shows that the smallest particle size of the NPs is 39.4 nm, with PDI= 0.242, which was achieved using 1:2 of (Na_2SeO_3**:** *Eruca Sativa*) solution.

Zeta Potential

The produced Se-NPs had a zeta potential value of -56.57 mV. as shown in Figure (4), under optimal synthesis circumstances (1:2).

Table 1:- Poly disparity of nanoparticles and mean particle size

Sample Sod. selenite: *E.sativa*	Mean Particle size	Polydispersity
1:2	39.4nm (minimum)	0.242
1:4	48.2nm	0.198
1:10	57.9nm	0.005
1:20	124.6nm (maximum)	0.304

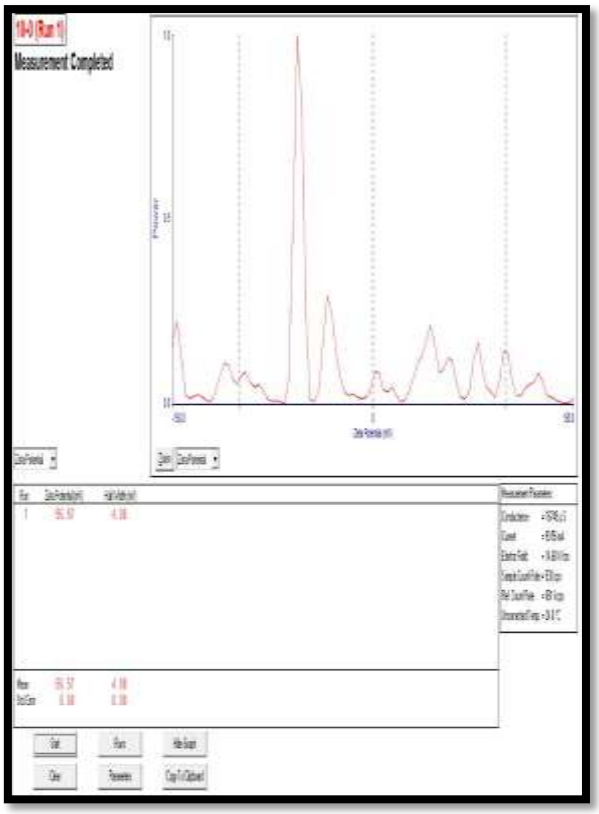

Figure 4: Zeta potential of the synthesized Se-NPs made from sodium selenite with *Eruca Sativa* extract in the percentage of 1:2 (v/v).

C. Fourier transform infrared spectroscopy (FTIR)

To find out what biomolecules and plant extracts could be interacting with metal ions to create and stabilize selenium nanoparticles, FTIR spectroscopy was used. Figure 5A, B, and C shows the FTIR analysis results of Eruca Sativa extract. The spectral appearance of Eruca Sativa extract devoid of metal selenium is shown in (A). (B) is a representation of the sodium selenite spectrum, whereas the spectrum in (C) depicts the sample that includes selenium metal in Eruca Sativa extract, hence displaying the peaks of both the control and test samples, as do the transmission peaks depicted in (B) and (A).

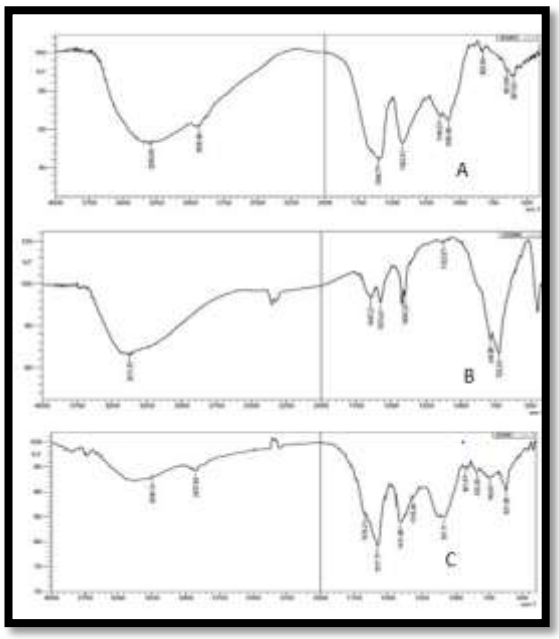

Figure 5: FTIR spectrum of (A) Eruca Sativa extract, (B) sod. selenite sol. and (C) selenium nanoparticles based- *Eruca Sativa* extract.

The plasma level of Malondialdehyde

The study showed a significant increase in the plasma level of MDA after exposing the animal to ketoconazole toxicity (P<0.001). MDA level was significantly higher in Gr B (P<0.001) compared to Gr A and this level stayed high even after treating the animal with *Eruca sativa* extract and sodium selenite (Gr BC and BD).

On the other hand, a prominent decline was noticed in Gr BE1 and Gr BE2. The levels were statistically insignificantly different compared to Gr A and stayed significantly lower than Gr B (P<0.001). Notably, the decline in MDA was prominently noticed after treating the animals with the Nano composite of selenium in the doses of 0.25 and 0.5mg/kg (BE1 and BE2), respectively. MDA level of BE2 was significantly lower than that of groups B, BC and BD (P<0.001) and was insignificantly different as compared to the negative control (Gr A) (P<0.001). At the same time, for BE1 there was a significant decrease compared to Gr B (P<0.001) but a non-significant differences in comparing to Gr A, also, BC and BD.

The plasma levels of antioxidant enzymes

The study showed a prominent and statistically significant decline in the plasma levels of the antioxidant enzymes (Glutathione peroxidase and Superoxide dismutase) as measured in I.U/ml and pg/ml respectively, after having the animals exposed to ketoconazole toxicity (P<0.01) (Table 2). This decline persisted even after treating the ketoconazole-exposed rats with each of *Eruca sativa* extract and sodium selenite (Gr. BC and Gr.BD); the

plasma level stayed significantly lower than that of the negative control, with P<0.01 and P<0.001, respectively. Nevertheless, Gr. BD showed a statistically significant higher levels of plasma SOD and GPx as compared to Gr. B P<0.001, and high significant decrease compared to Gr. A P<0.001, with a significant increase P<0.01, relative to Gr BC. Treatment with all forms of selenium nano composite produced a statistically significantly higher level of these two enzymes than that of Gr. B, BC and BD, indicating the extract's potential to augment the body's antioxidant power (P<0.001). At the same time, SOD and GPx in Gr BC and BD showed statistically lower levels than those in the negative control and higher levels than those in the positive control (Table 2).

Table 2: Levels of Malondialdehyde, superoxide dismutase and glutathione peroxidase in the homogenate of the testicular tissues of different treatment groups in rats

Group	MDA ng/g (tissue)			SOD I.U / g (tissue)			GPx pg/ g (tissue)		
gr A	45.57 ± 3.01			7.80 ± 0.52			664.67 ± 23.05		
gr B	71.38 ± 4.66	***		4.42 ± 0.49	***		338.67 ± 24.65	***	
gr BC	65.71 ± 5.17	***		5.20 ± 0.45	***		403.33 ± 37.43	***	
gr BD	63.43 ± 5.55	***		5.83 ± 0.62	***,♦♦		497.33 ± 33.85	***,♦♦♦,##	
gr BE1	55.48 ± 5.68	♦♦♦		7.52 ± 0.55	♦♦♦,###,☼☼☼		654.33 ± 29.21	♦♦♦,###,☼☼☼	
gr BE2	43.33 ± 3.51	♦♦♦,###,☼☼☼		8.00 ± 0.44	♦♦♦,###,☼☼☼		662.67 ± 39.99	♦♦♦,###,☼☼☼	

Gr. A & Gr B represent the negative and positive controls, respectively. Meanwhile, each of Gr BC and Gr.BD Represent the extract and pure sodium selenite, respectively. (Gr BE1 and BE2) were treated with selenium nanocomposite at 0.25 & 0.5 mg/kg, respectively. ($^{*, ** \&***}$), ($^{♦, ♦♦ \&♦♦♦}$), ($^{\#, \#\# \&\###}$) and ($^{☼, ☼☼\&☼☼☼}$) signify a statistically significant difference as compared to groups A, B, BC and BD, with P values of P<0.05, P<0.01 and P<0.001, respectively.

Discussion

In the reducing power assay test, Perlis Prussian stain's blue color appeared due to ferric ion reduction to ferrous ion in ferric ferrocyanide form. This test gives an idea about the potential of *Eruca. Sativa* extract to donate electrons to free radicals (13).

According to the experiment that was performed to estimate total flavonoids content, 0.9 g of 1% *Eruca Sativa* extract is equivalent to 1 mg Gallic acid, which is compatible with Isra, 2022 results in which alcoholic extract and fresh rocket leaf contained high phenolic compounds and nearly equal amounts of total flavonoids content (0.81mg and 0.80 mg QE/g, respectively) (20).

The reddish brown color is the most significant property of nanoparticle formation. Many researchers have previously obtained this result using different types of green plants (21) (Figure 2).

Nanoparticle properties were characterized to confirm the formation of targeted Nano Selenium, using different techniques, including UV-Spectroscopy, Dynamic Light Scattering (DLS), and Fourier Transform Infrared Spectroscopy (FT-IR) (22).

The sample peak optical density, or absorbance, correlates linearly and directly to the concentration of nanoparticles in solution (23). According to Cittrarasu et al (2021) this SeNPs peak was created by the Surface Plasmon Resonance (SPR), which is induced when the electrons of metal nanoparticles interact with incoming photons (24), This result is compatible with many previous researches associated with various ranges of UV-visible maximum absorption peaks. Ramamurthy *et al.* found an absorbance peak ranging from 200–400 nm, with the maxima peak at 390 nm, when using fenugreek extract for SeNPs synthesis (25). Other SeNPs were synthesized by (26) using garlic cloves which reported an absorption peak at 260 nm. *Withania somnifera* was used to synthesize spherical SeNPs with a maximum absorbance of 310 nm, using Dynamic Light Scattering (DLS) (26). From the current study, it can be analyzed that there were uniformly dispersed particles, mostly in spherical Nano size, and no other peak was observed in the whole spectrum, meaning that Se^0 has been successfully formed (27).

DLS was performed to assess the particle size of different Nano solutions. The current study shows that, when increasing extract concentration in relation to sodium selenite; there was an increase in particle size diameter; the largest size 124.6 nm was related to the largest ratio of extract sample. This can be ascribed to the double quantity of extract solution available for reducing Na_2SeO_3 to Se^0, resulting in more abrupt nucleation and faster growth of the nanoparticles. In some cases, small agglomerates were produced simultaneously (28).The least concentrated Nano sample has a much smaller mean size of approximately 39.4nm. However, it is characterized by a narrow size scatter compared to the sample with the largest extract ratio. The results were in line with the findings of Skandalis *et al.*, in which Nano silver was synthesized using Arbutus unedo extract, which gained a small particle size with the lowest concentrated extract sample.(29).

Polydispersity index (PDI) is a scaled and dimensionless index; when the value is higher than 0.7 it indicates that the sample has a very wide particle size distribution and that the DLS technique probably not suitable to analyze it , while

monodisperse standard are mainly seen with the value smaller than 0.05 (30).

In general, zeta potential is the most important method to investigate the dispersion characteristics of nanoparticles and Nano fluids (31). It measures the potential differences between the charged ions on the nanoparticle surface that is opposite to the bulk fluid in which a particle is dispersed (32). The higher magnitude of potential differences around ± 60 mV exhibits higher electrostatic repulsion force and therefore increased stability, while agglomeration of particles may typically begin with the value lower than -15 mV. At the same time, zeta potential equals zero could represent the precipitation of the colloid into a solid (32). Zeta potential value of the fabricated Se NPs was -56.57 mV, which indicated that the formed NPs were highly stable due to negatively charged groups that surrounded them. The poly dispersity index (PDI) value of the fabricated Se NPs was 0.242. This low value indicated that the formed Se NPs were mono dispersed (33) .

The functional groups present on the surface of the nanoparticles can be assessed by FTIR through measuring the chemical bond vibrational rates (34). Fig. (5) shows two absorption peaks located around 3248.13 & 3290.56 cm-1 that can be assigned as the absorption band of (O-H carboxylic acid), and one peak at 3371.57 cm-1 assigned as the absorption peak of (N-H) group. Also, FTIR spectrums depicted that IR bands in the regions 2935.66 & 2927.94 cm-1 are assigned for (C-H) asymmetric bending, in addition to three peaks at 1674.21, 1647.21 & 1604.77 cm-1 that may be due to (C=C) group (35). Similarly, two peaks at 1577.77 & 1573.91 cm-1 confirmed the presence of (C=N) group. The absorption peaks at 1423.47, 1411.89 & 1400.32 cm-1 referred to the presence of (O-H) group Two peaks at 1149.57 & 1122.57 cm-1 referred to (C-O-C) group, two peaks at 1083.99 & 1091.71 cm-1 to (C-N) group, and one peak at 829.35 cm-1 to (C-H) group (35).

In the present study, KET-induced testicular damage was associated with the reduction in both of SOD and GPx peaks with the elevation in MDA level. These results are in harmony with previous studies that tested the ability of azoles to induce damages in different cellular models. In one study, Sertoli cells were exposed to different types of azoles and their combinations for 30min and 3h of incubation, azoles where elicited prooxidant properties associated with cells death, apoptosis, and necrosis (36). Also, marked changes of natural antioxidants (SOD and CAT) with oxidative damage to testicular lipids were associated with ketoconazole toxicity (36).

Although *Eruca Sativa* possesses powerful anti-oxidant properties as confirmed previously by total flavonoid content and reducing power assay, this effect was not powerful, as shown by the activities of the phyto-component conjugated selenium nanoparticles in reducing MDA and enhancing GPX and SOD level in the current study. This confirmed the results of synergistic effects exerted by the bio-conjugation of Se-nanomaterial with plant extract in reducing their toxicities to biological systems and improving their therapeutic effectiveness (11)

The current results showed a significant decrease in MDA level in both BE1 and BE2 groups compared to Group B, in contrast to groups BC and BD which showed non-significant changes as compared to group B. These results confirmed the novel properties of the prepared nano solution-based *Eruca sativa* extract in reducing MDA, which can be considered as a diagnostic tool in male infertility (37). A previous study that tested the effects of nano selenium administration on ram sperm, previously exposed to freeze/thawing process, showed a significantly increased quality of sperm by enhancing viability, motility and membrane integrity, in addition to significant reduction in the amount of MDA and damaged acrosome membrane (38).

The antioxidant enzymes, GPx, and SOD work together to scavenge the formed reactive oxygen species. Therefore, minor changes in normal constituents of these enzymes may disturb the body defense systems with increasing the susceptibility to oxidative damages (39). Treatment with the Nano composite (Gr. BE1 and BE2) has elevated the level of GPX and SOD to be significantly higher than that obtained after treating the animals with sodium selenite or the extract alone (Gr. BD and BC) ($P<0.001$) ; these results proved the novel characteristics of nano particles in crossing blood testes barrier (BTB) and maintaining the cellular redox, antioxidant capacity, and neutralizing ROS(40). The current results were compatible with other studies that have been previously published. Saber and Khalid, 2014, showed that Nano-selenium prepared by glutathione containing either 2 mg or 20 mg bovine serum albumin, when administered in a dose 0.5 mg/kg to male albino rat, would increase the defense mechanism and testicular antioxidant activity through enhancing the testicular GSH concentration, with reducing MDA concentration, with increasing catalase and SOD activity, as compared to controls and selenium groups (41). Furthermore, it has been reported that in addition to Se role in forming selenoproteins, which helps synthesize GPx enzymes, Se nanoparticles have the ability to up-regulate the expression of these enzymes through the formation of selenophosphate (41).

Conclusion

Nanotechnology is a revolutionary technology that has been gaining an increased attention worldwide because of its potential role in medication delivery systems. Although selenium would be available for several metabolic, biological, and physiological functions, its nano forms prepared by *Eruca sativa* extract are unique in targeting the male reproductive system, by improving the antioxidant defense

mechanism through its novel stability and small particle size characteristics, suggesting a role against oxidative stress-related infertility induced by ketoconazole.

Authors' Declaration:
Conflicts of Interest: None
We hereby confirm that all the Figures and Tables in the manuscript are ours. Besides, the Figures and images, which are not ours, have been given permission for re-publication attached with the manuscript. -Authors sign on ethical consideration's approval-Ethical Clearance: The project was approved by the local ethical committee in (***College of Pharmacy /Al Nahrain University)*** according to the code number (Nah.Co. Pha.14).

Author contributions:
Study conception: (Basman and Shayma'a) **Study design:** (Basman and Huda). Literature search: (**Study conception:** Basman and Shayma'a) Data acquisition: (Basman). Data analysis & interpretation: (Basman, Huda and Shayma'a). Manuscript preparation: (Basman, Huda and Shayma'a). Manuscript editing & review: (Basman, Huda and Shayma'a).

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التأثيرات المضادة للأكسدة لجزيئات السيلينيوم النانوية المحضرة من مستخلص الجرجير على الكيتوكونازول – المسبب للأضرار التأكسدية في ذكور الجرذان

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الخلاصة

خلفية البحث: أظهرت الدراسات الحديثة أن التأثيرات المضادة للخصوبة للكيتوكونازول يمكن التقليل منها عن طريق تناول مستخلصات نباتية تحتوي على جزيئات نانوية مضادة للأكسدة مع الدواء أو عن طريق تناوله بعد الدواء. إحدى الطرق الفعالة لتحسين خصائصه الطبية وتقليل سمية السيلينيوم هي صياغته على شكل جسيمات نانوية. ومع ذلك، لا تزال هذه استراتيجية صعبة.

هدف **الدراسة**: الهدف من هذه الدراسة هو تحليل تأثير السيلينيوم النانوي المحضر من مستخلص نبات الجرجير (Eruca Sativa) على معايير الإجهاد التأكسدي الخصوي في الجرذان المعالجة بالكيتوكونازول. ستركز الدراسة على تقييم إنزيم الجلوتاثيون بيروكسيديز، وفوق أكسيد ديسموتاز، والمالونديالدهيد كمؤشرات للإجهاد التأكسدي..

المواد والطرق: في هذه الدراسة، تمت إضافة محلول 1% وزن/حجم من المستخلص النباتي إلى محلول 10 ملي مولار سيلينيت الصوديوم بنسب مختلفة، ووضعه على محرك مغناطيسي في الظلام لمدة 12 ساعة عند درجة حرارة 50 درجة مئوية ودرجة الحموضة 9. تم بعد ذلك ترك المحلول لمدة 48 ساعة، وتم اختيار جزيئات السيلينيوم النانوية المثالية لمزيد من التوصيف. تم تقسيم ثمانية وأربعين فأرًا إلى ست مجموعات تضم كل مجموعة ثماني حيوانات. كانت المجموعة (أ) هي المجموعة الضابطة السلبية، في حين أعطيت المجموعة (ب) الكيتوكونازول عن طريق الفم بجرعة 50 ملغم / كغم لمدة أربعة عشر يومًا. المجموعة BC، BD، BE1 وBE2 أعطيت الكيتوكونازول عن طريق الفم بجرعة 50 ملغم/كغم لمدة أربعة عشر يومًا، يليها: 200 ملغم/كغم من إيروكا ساتيفا، 0.5 ملغم/كغم من سيلينيت الصوديوم عن طريق الفم، 0.25 ملغم/كغم من السيلينيوم النانوي عن طريق الفم و0.5 ملغم / كغم من السيلينيوم النانوي عن طريق الفم لمدة 28 يومًا على التوالي. وأخيرا، تم الموت الرحيم للحيوانات وتم تقييم المعلمات المضادة للأكسدة في الخصية.

النتائج: وقد لوحظت زيادات كبيرة في بيروكسيداز الجلوتاثيون وديسموتاز الفائق أكسيد (قيمة $p < 0.001$)، وانخفاض في مستويات المالونديالدهيد (قيمة $p < 0.001$) في المجموعات المعالجة بالجسيمات النانوية مقارنة بالمجموعة الضابطة.

الخلاصة: : تظهر الأشكال النانوية المحضرة من مستخلص نبات الجرجير تأثيرات كبيرة مضادة للأكسدة على أنسجة الخصية، في حين أنها متاحة للعديد من الوظائف الأيضية والبيولوجية والفسيولوجية.

مفتاح الكلمات: السيلينيوم, نانو سيلينيوم ، سوبر اوكساید دسميوتيز ، الجلوتاثيون بيروكسيديز ، مالونديالديهايد