Research Article

Leverage of Nano-Curcumin Phytosome in Nano-Silicon Dioxide Treated Female Rats

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Abstract | Silica nanoparticles (SiO2NPs) as one of the most productive nano-powder, SiO_2NPs cause cytotoxicity and genotoxicity in a variety of cell lines due to oxidative stress. Curcumin Phytosome has antioxidant effects. We aimed to determine how silicon dioxide nanoparticle (SiO2NPs) exposure to female rats affected the oxidative state. Ultraviolet-visible (UV-VIS), scanning electron microscopy (SEM), and Fourier transform infrared (FTIR) spectroscopy were used to investigate SiO2NPs and Curcumin Phytosome nanoparticles (CPNPs). Intense surface plasmon resonance at 1041 nm revealed the formation of silica nanoparticles. The two bands at 326 and 422 nm were ascribed to CPNPs, and SEM examination of SiO2NPs and CPNPs showed that SiO2NPs had an oval shape and a particle' average size of 64.45±1.18 nm whereas CPNPs had a particle' average size of 72.80.85 nm. The CCH and cis CH, benzoate trans -CH, the C-O, CH2 and CH3,(C=C),(C=O), CH2 and CH3 which operate as reducing and stabilizing agents were revealed by FTIR analysis of CPNPs. The SiO2NPs' FTIR spectrum shows two vibrations that can be attributed to SiO2's Si—O—Si and Si—O vibrations, respectively. Thirty-two Female rats that had reached adult were randomly split into four groups: Control; T1: received oral 200 mg/kg of SiO2 - NPs were gavaged orally to this group of rats. T2: received oral 100 mg/kg of CPNPs and Sio2NPs. T3: received oral 100 mg/kg of CPNPs. We analyzed blood samples of malondialdehyde (MDA), total antioxidant capacity(TAO-C), protein carbonyl(PC), reactive oxygen species (ROS), and gamma-glutamyl transferase concentration(GGT). The results indicated that 200 mg/kg of SiO2 - NPs orally for 4 weeks contributed to a substantial drop in serum TAC-O, an increase in MDA, GGT, PC, and ROS concentration, and attenuation of silica's oxidative stress status, CP NPs (T3) or SiO2 NPs (T2) administered orally to female rats for four weeks constitutes a case of oxidative stress. The study revealed the protective role of CP NPs against the negative impact of SiO2 NPs. The T3 group that got CP alone saw higher results; CP NPs can be thought of as an antioxidant component.

Keywords | Curcumin Phytosome Nanoparticles, Gamma-Glutamyl Transferase, Protein Carbonyl, Reactive Oxygen Specie, Silicon Dioxide Nanoparticle.

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INTRODUCTION

Nanoparticles (NPs) range in size from 1 to 100 nm, and is extremely small. According to their characteristics, forms, or sizes, they may be divided into many groups (Hasan and Raheem, 2021; Khan and Hossain, 2022). A surplus of silica dioxide (SiO2) was created in recent decades for use in the manufacture of industrial products such as lenses, bandages, catheters, dental fillings, consumer goods (Sharma et al., 2020), and food products (Peters et al., 2020). SiO_2NPs have lately been found to be hazardous *in-vivo* and *in-vitro*, although they have historically been thought to be less dangerous (Yazdimamaghani et al., 2019; Liu et al., 2020; Diao et al., 2021). Curcumin is a bioactive compound that shows promise as an antioxidant, an anti-inflammatory agent, an immunomodulatory agent, an anti-dyslipidemic agent, and an antithrombotic agent (Baradaran et al., 2020; Valizadeh et al., 2020; Momtazi-Borojeni et al., 2018; Keihanian et al., 2018) effects. However, the low bioavailability of curcumin can be ascribed to the poor absorption of curcumin in the gastrointestinal tract as well as the quick excretion caused by the fast hepatic metabolism. (Urosevic et al., 2022), phytosome was used to enhance the bioavailability of different plant active ingredients (Ghazi and AL-Bayati, 2020; Jaafar et al., 2020; AL-Yasiri and AL-Bayati, 2020) including curcumin (Hüsch et al., 2013), as well, it's used for drug delivery (Allawi and Al-bayati, 2020).

SiO 2NPs could result in inflammation and tissue damage (Al Faraj et al., 2015; Li et al., 2022). SiO_2 can hurt rats' T-cell immune systems but does not affect how severe an anaphylactic reaction is (Gmoshinski et al., 2020). According to Comelekoglu et al. (2019), exposure to SiO2NPs of 6, 20, and 50 nm diameters may have harmful effects on the hepatic, renal, and brain. Due to oxidative stress, SiO2NPs may cause cytotoxicity and genotoxicity in a range of cell types (Dong et al., 2020; Zhang et al., 2022).

Curcumin phytosome has been demonstrated to add several antioxidant plant active ingredients to nanoparticles decreasing their toxicity and increasing their bioavailability (Ali and Khudair, 2019; Sood and Khudair, 2018). The use of curcumin in the treatment of nonalcoholic fatty liver disease has been reported (Mirhafez et al., 2021) it possesses a hepatoprotective effect against methoxylated-induced hepatic injury (khudhair et al., 2022), in addition to its role in metabolic disease (Zheng et al., 2023). Curcumin plays a role in the treatment of osteoarthritis through its immunomodulatory effect (Atabaki et al., 2020), improvement of pulmonary function in Iraqi patients with chronic bronchial asthma (khdair et al., 2021), and modulation of inflammatory bowel disease (karthikeyan et al., 2021) and genotoxicity and cytotoxicity induced by heavy metals (Liu et al., 2023).

This study aimed to combine the active element of a plant extract (*Curcumin phytosmoe*) and investigate its ameliorative role in the removal of the destructive impact of SiO_2NPs in female rats.

MATERIALS AND METHODS

The institutional ethical approval number for the study (P.G 900 Data 27-4-3023). To characterize SiO2NPs and CPNPs we used:- Ultraviolet–visible spectroscopy(UV-VIS) (Shimadzu-Japan), Furthermore, the morphology and size of SiO2 NPs and CPNPs were analyzed using SEM (SEM-Tescan Vega III, Czech). The biological compound's functional groups in the nanoparticle process were identified using Fourier-transform infrared spectroscopy (Shemadzu-8400s, Japan). 32 adult female Animals were purchased from the Biotechnology Research Centre at AL-Nahrain University, and each rat had an average weight of 175 g and was around 4 months old. The animals were confined in wire-plastic enclosures with dimensions of 40 by 60 centimeters and raised under controlled conditions of approximately 12 hours of light and 12 hours of darkness at (23±2 C). Fed on standard laboratory food (Milk 20.0, Wheat particles 17.0, Wheat powder 17.0, Barley particles 20.0, Corn particles 25.0, Food salt 1.00) and drinking water. For four weeks, they were randomly assigned to one of four groups and received the following treatments: to determine the protective effect of CP- CPs on oxidative stress caused by SiO2 NPs. Control(C); T1: Oral 200 mg/kg of SiO2 nanoparticles dose obtained from effective dose experiment. T2: Oral 100mg/kg of curcumin phytosome (Sun et al., 2020) and 200 mg/kg of SiO2 nanoparticles. T3: Oral Curcumin phytosome at a rate of 100 mg/kg (Sun et al., 2020). Rats under anesthesia had their blood drawn using the heart puncture procedure. Eight samples were collected for each group so that the total number of samples was 32 blood samples and serum were then taken to measure the following: TAO-C using a rat total antioxidant capacity kit; MDA using rat ELISA MDA kit and PC using protein carponaly ELISA kit(MyBioSource/ USA), ROS using ROS ELISA kit(Sunlong biotech/ china) and GGT using GGT ELISA kit(Abbkine/ china)

Statistical Analysis

One-way analysis of variance (ANOVA) in SPSS Version 24 was used to statistically analyze the data, and a P value of less than 0.05 was deemed to indicate statistical significance. To find statistically significant differences between the groups, we used Least Significant Difference (LSD) tests (Zar,1984).

RESULTS

The absorbance peak of silica nanoparticles was discovered at around 1041 nm from this analysis, as shown in Figure (1a). The two bands at 326 and 422 nm were assigned to phytosome curcumin as shown in Figure (1b)

The SEM pattern revealed in Figure (2a) that the silica particles were oval and varied sizes that vary between 42 to 105 nm. As shown in Figure 2b, phytosomal curcumin was found to have a spherical-like shape. The range of particle sizes was 52.5-115 nm, with a mean size of 72.8±0.85 nm.

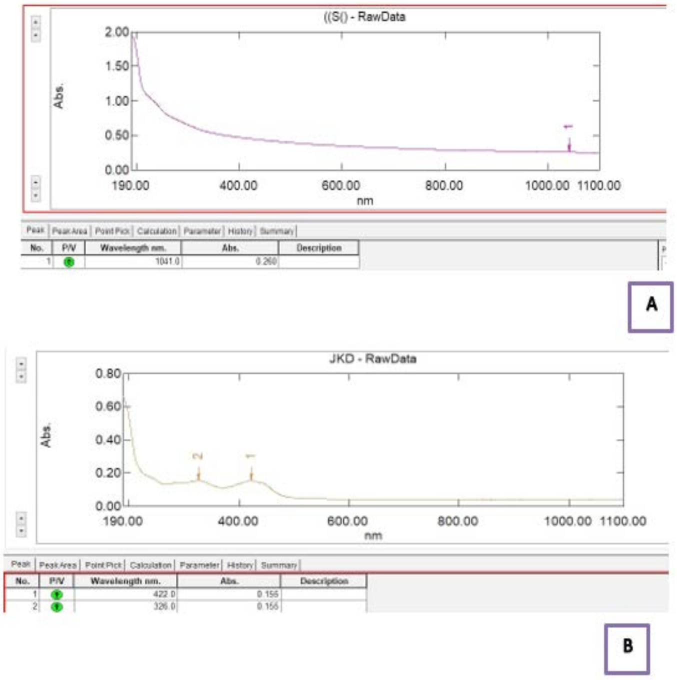

Figure 1: UV-VIS Absorbance Spectroscopy for(A) silica nanoparticles(B) curcumin phytosome

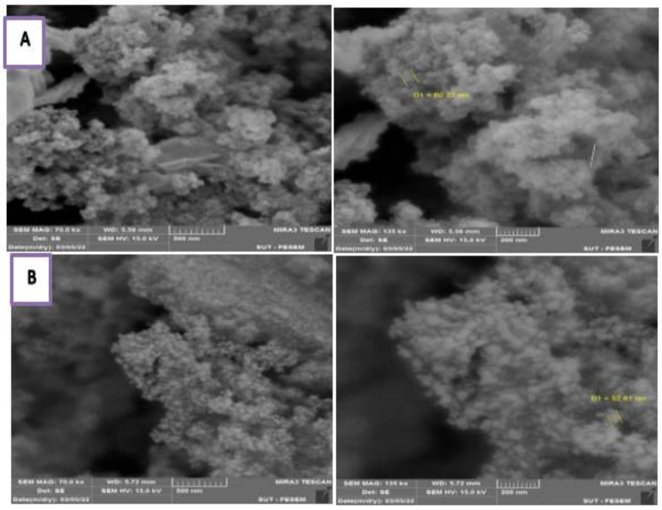

Figure 2: SEM image of for(a) Silica nanoparticles(b) curcumin Phytosom

The FTIR analysis of the curcumin phytosome is shown in Figure 3. The CCH and cis CH vibrations in the framework of the aromatic ring are what cause the peak at 567.07 cm-1. Benzoate has a trans-CH vibration frequency of 1022.27 cm-1. Peaks at 1107.14 cm-1 are credited with the C-O Phenolic band. Extending Carbonyl bond Vibration groups (C=O) are represented by the peaks at 1512.19 cm-1. The significant peak in both spectra in the 3200-3600 cm-1 range indicates the presence of -OH groups.

The silica (SiO2) FTIR spectrum It was demonstrated that the bands at 1635.64 and 3278.99 cm-1, which are assignable to the Si—O—Si and Si—O vibration modes of SiO2, respectively, are responsible for the OH bending and stretching vibrations.

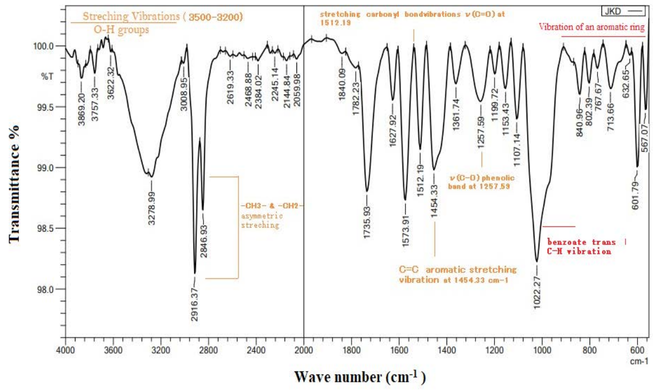

Figure 3: Fourier transform Infra-Red spectroscopy(FT-IR) for curcumin phytosome nanoparticle

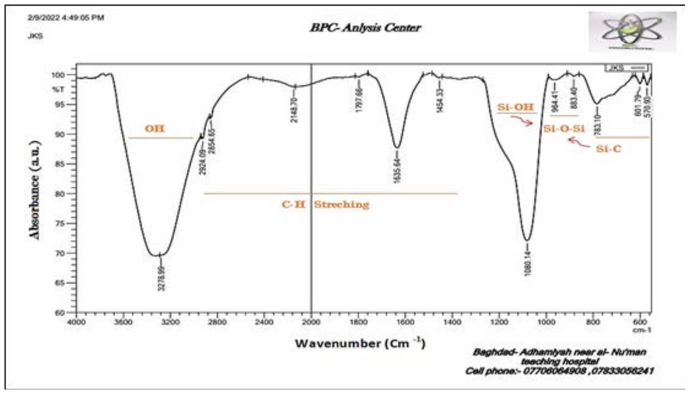

Figure 4: Fourier transform Infra-Red spectroscopy(FT-IR) for Sio2 nanoparticle

Effect of CP-NP on serum antioxidant statues of SiO2 npS Treated rats

In comparison to T1 groups, T2 and T3 groups treated with curcumin phytosome either on its own or in conjunction with SiO_2NPs had substantially higher ($P<0.05$) TAC-c levels. Additionally, the results demonstrated a statistically significant ($P<0.05$) rise in the amounts of ROS, MDA, and GGT in the serum in the SiO_2NPs(T1) in comparison to other experimental groups (Figures 5:B, C, and D, respectively). The T2 and T3 groups that received curcumin phytosome alone or in conjunction with SiO_2 respectively showed a significant ($P<0.05$) reduction in the previously indicated parameters.

The T1 group receiving therapy had a notable rise in ($P<0.05$) in this PC compared to the other experimental groups, following treatment with CP alone (T3) or in conjunction with SiO2 (T2), When compared to the T1 group, there was a statistically significant ($P<0.05$) reduction in PC level (Figure 5 E).

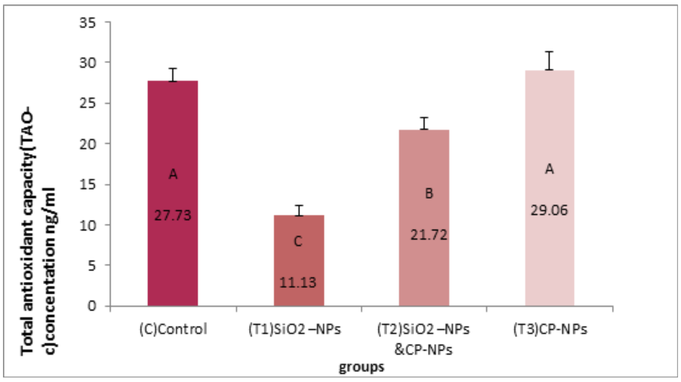

Figure 5A: Effect of curcumin phytosome on Serum Total antioxidant capacity(TAC-c) concentration ng/ml in Silica nanoparticles(SiO2 NPs) treated rats

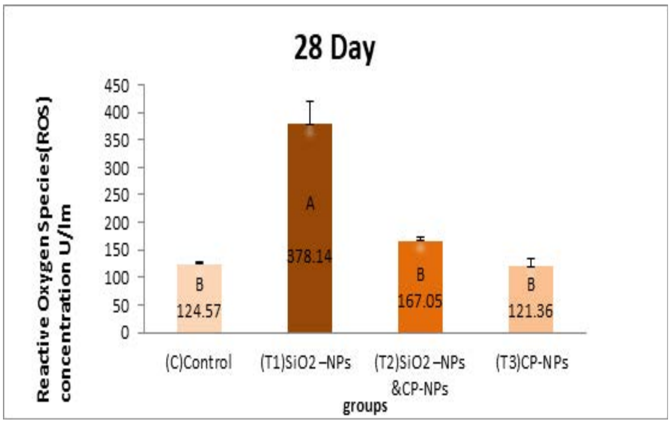

Figure 5B: Effect of curcumin phytosome on Serum Reactive Oxygen Species(ROS) concentration U/lm in Silica nanoparticles(SiO2 NPs) treated rats

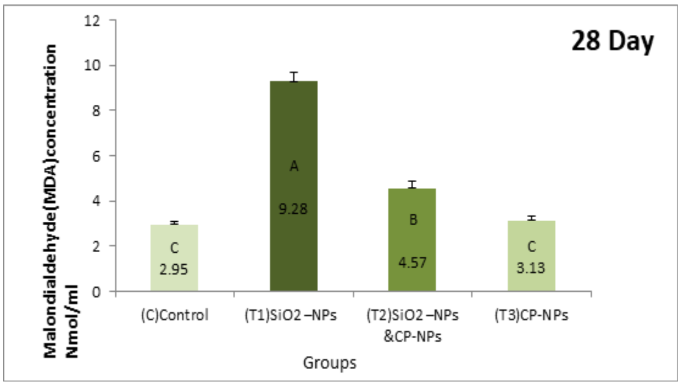

Figure 5C: Effect of curcumin phytosome on Serum Malondialdehyde(MDA)concentration Nmol/ml in Silica nanoparticles(SiO2NPs) treated rats

values reported as mean, SE, with n=8 Significant differences across groups are shown by different capital letters ($P<0.05$). T1 team:- 200 mg/kg of SiO2 was given orally to the rats in this group. - NP, T2 group:- Rats in this group received oral gavage doses of 100 mg/kg of curcumin phytosome and 200 mg/kg of SiO2-NP. 100mg/kg of curcumin phytosome was given orally to the rats in this group. The 28-day course of treatment.

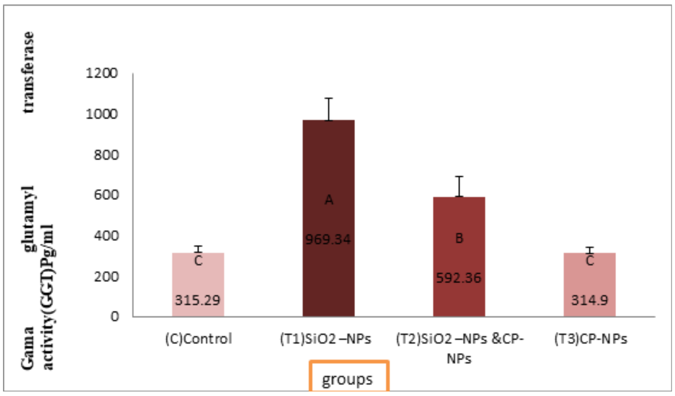

Figure 5D: Effect of curcumin phytosome on Serum Gama glutamyl transferase concentration(GGT)Pg/ml in Silica nanoparticles(SiO2 NPs) treated rats

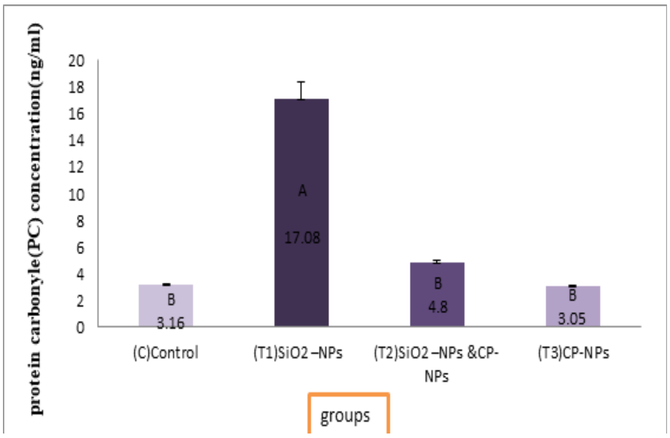

Figure 5E: Effect of curcumin phytosome on Serum protein carbonyle(PC) concentration(ng/ml) in Silica nanoparticles(SiO2 NPs) treated rats

DISCUSSION

Serum MDA and ROS levels significantly($P<0.05$) increased in the SiO2-treated group (T1) whereas TAO-C concentration decreased, indicating oxidative stress brought on by SiO2 NPs. The findings of this investigation agreed with the results of previous research (Mahmoud et al., 2019; Damiano et al., 2020 and 2021).

According to Cheraghi et al. (2019), products of lipid peroxidation and protein oxidation have been generated as a result of this damage, which may affect cellular function. The oxidative stress caused by SiO2NPs is determined by the reduced antioxidant defense systems as well as the increased creation of harmful ROS. An increase in GGT in the T1 group implies an oxidative state. GGT enzymes are released into the blood and their levels increase in response to hepatic injury and impairment (Mohammadpour et al., 2019; Aouey et al., 2021). The study team created nano-curcumin (Nano-CUR) to control oxidative stress and shield cells from ROS-mediated oxidative damage (El-Desoky et al., 2020a). The enhanced oral bioavailability of Nano-CUR is encouraging more usage. Curcumin was shown to be an antioxidant in some studies, including Motaghinejad et al. (2017), Boarescu et al. (2019), Heshmati et al. (2020), Baqer et al. (2020), and Baradaran et al. (2020). Curcumin can also reduce the oxidation of lipids by enhancing the antioxidant enzymes glutathione peroxidase, catalase, glutathione-S-transferase, and superoxide dismutase, as well as by raising levels of the natural free radical scavenger GSH (Aggarwal and Harikumar, 2009; Aggarwal et al., 2013). Curcumin also stimulates GSH biosynthesis by elevating the expression of glutamylcysteine ligase, the enzyme that regulates the rate of GSH biosynthesis. This increased production of glutamylcysteine ligase causes its activity to increase (Dickinson et al., 2003) and a subsequent rise in TAO-c level (Edwards et al., 2017). Curcumin therapy has the potential to significantly reduce MDA because it can reduce hydrogen peroxide (H2O2)-induced lipid peroxidation and limit nitric oxide synthase activity by reducing NO synthesis (Mehta et al., 2018; Boarescu et al., 2019). Additionally, boosting the expression of the protein sequence for peroxisome proliferator-activated receptor gamma co-activator 1 alpha (PGC1) increased glutathione peroxidase activity and decreased the expression of oxidative stress (Heshmati et al., 2020). And diseases associated with mitochondrial dysfunction may explain how curcumin acts (Sathyabhama et al., 2022). Shahmoradi et al. (2018) claim that the H-atom donation in the phenolic group is what gives curcumin its antioxidant properties. Because of its 1,3-diketone and other chemicals, it can inhibit LPO (Priyadarsini et al., 2003).

CONCLUSION

We documented the ameliorative role of CP NPs against the damaging effect of the SiO2 NPs. Besides, better results were obtained in the T3 group that received CP alone, where CP NPs can be considered as an antioxidant factor.

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The College of Veterinary Medicine at the University of Baghdad and the Scientific Committee of the Department of Physiology, Biochemistry, and Pharmacology both gave their stamp of approval to the experiment's concept.

NOVELTY STATEMENT

The present research has highlighted the role of Curcumin Phytosome Nanoparticle on the oxidative status of Silicon Dioxide Nanoparticle Treated Female Rats.

AUTHORS CONTRIBUTIONS

The authors of the current experiment contributed equally.

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