



FREE RADICAL SCAVENGING ACTIVITY QUERCETIN MEDIATED SELENIUM NANOPARTICLES

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ABSTRACT

Aim: The absolute aim of the research is to find the free radical scavenging activity of Quercetin mediated selenium nanoparticles. **Materials and methods:** The plant extract is collected and dried up and powdered and mixed with water which is used to synthesize nanoparticles. The synthesized nanoparticles were tested for its antimicrobial activity against oral pathogens using agar well diffusion method. **Results and discussion:** From the synthesized nanoparticles antioxidant activity is done and the zone of inhibition is shown. **Conclusion:** The selenium nanoparticles has an effect on free radical scavenging activity.

Keywords: Selenium nanoparticles, Green synthesis, free radical scavenging.

INTRODUCTION:

The emergence of nanotechnology in the last three decades has changed the perception of drug discovery and development by opening many hidden doors in disease pathophysiology and treatment options. Nanotechnology deals with submicroscopic particles with at least one dimension less than 100 nm. The adage, “small is the new big”, rightly fits to describe the role played by nanotechnology based delivery systems in modern-day therapeutics. A variety of nanostructures, including polymers, dendrimers, liposomes, metal nanoparticles (Ag, Au, Ce, Cu, Eu, Fe, Se, Ti, Y, etc.), silicon and carbon based nanomaterials have been used as successful therapeutic agents and drug delivery carriers. The unique features of nanoparticles (NPs) like the small size, high surface area, surface charge, surface chemistry, solubility and multi-functionality make them remarkably unique. NPs have proven their case very strongly as drug carriers by



tremendous success in the delivery of the therapeutic molecules. Nanomedicine is the application of nanotechnology based techniques and methods in medical research and clinical practice for the treatment, diagnosis, monitoring and control of biological systems. The emergence of nanotechnology in the last three decades has changed the perception of drug. Quercetin is a plant pigment (flavonoid). It's found in many plants and foods, such as red wine, onions, green tea, apples, and berries. Quercetin has antioxidant and anti-inflammatory effects that might help reduce swelling, kill cancer cells, control blood sugar, and help prevent heart disease. Quercetin is most commonly used for conditions of the heart and blood vessels and to prevent cancer. It is also used for arthritis, bladder infections, and diabetes, but there is no strong scientific evidence to support most of these uses. There is also no good evidence to support using quercetin for COVID-19.

Quercetin is a polyphenolic flavonoid with potential chemopreventive activity. Quercetin, ubiquitous in plant food sources and a major bioflavonoid in the human diet, may produce antiproliferative effects resulting from the modulation of either EGFR or estrogen-receptor mediated signal transduction pathways(1). Although the mechanism of action of action is not fully known, the following effects have been described with this agent in vitro: decreased expression of mutant p53 protein and p21-ras oncogene, induction of cell cycle arrest at the G1 phase and inhibition of heat shock protein synthesis. This compound also demonstrates synergy and reversal of the multidrug resistance phenotype, when combined with chemotherapeutic drugs, in vitro. Quercetin also produces anti-inflammatory and anti-allergy effects mediated through the inhibition of the lipoxygenase and cyclooxygenase pathways, thereby preventing the production of pro-inflammatory mediators.(2)

Green nanoparticles synthesised using natural extracts is an interesting area in the field of nanotechnology, which has economic and eco friendly benefits over any other methods of synthesis.(3)Moreover nanoparticle synthesis using plant extracts are more of advantageous over biological process because, it exhibits the elaborate process of culturing and maintaining the cells(4). The antibacterial activity of the silver nanoparticles requires careful quantity of the silver ion concentration contributed by the nanoparticle, as well as the role that complex ligands present in the media could have on selenium ions and the particle bioavailability (5). The use of selenium nanoparticles has well thought of a range of medical applications, including, in the dental field, an antibacterial factor in resin composites in dentistry (6). Se is a semi solid-metal, usually observed as a red colored powder, black in vitreous form and metallic gray in crystalline form, resembling sulphur and tellurium(7). Se exists in different oxidation states like 2+, 4+, 6+, and 2-. Se has "zero" oxidation state, is colorless, non-toxic, biologically inert material. Some of the critical roles played by selenoproteins are immunomodulatory activity and orchestration of sperm motility(8) . There are 25 selenoprotein genes in the human genome. Se is incorporated as selenocysteine (SEC) in various antioxidant enzymes like glutathione peroxidase (GPX), thioredoxin reductase (TXNRD) and selenoprotein P (SELENOP). Se acts as the redox center of all these enzymes and



is essential for their biochemical activity. Some of the other important Se containing compounds are sodium selenite, selenomethionine and monomethylated Se which can act as anticancer agents (mainly chemopreventive) by different mechanisms.(9)

MATERIALS AND METHOD:

Preparation of plant extract:

The preparation of plant extract includes collection of plant extract in the form of powder. All glasswares were washed with distilled water and dried in a hot air oven before use. The powder which weighs about 1g was taken and mixed with 100 ml of distilled water in a conical flask (figure1). The solution is then boiled for 5 to 10 minutes and it is filtered through whatman number one filter paper. The extract thus obtained is filtered and used for further experiment.

Preparation of nanoparticles:

For the synthesis of selenium nanoparticles 20 mg of quercetin is dissolved in 10 ml of ethanol and mixed for 5-10 minutes. 0.346 grams of selenium (20 millimolar) is dissolved in 50ml of distilled water, then it is mixed and kept in a shaker to observe the colour change. One week later 1 gram of quercetin powder is mixed in 1 ml of distilled water and then activities are done.

RESULTS :

Biopotential Applications of Qr-SeNPs

Antioxidant Assay

Free radical scavenging activity of PF-SeNPs was determined by DPPH and ABTS radical scavenging assays as per earlier reported methods (Kumar et al., 2016; Sellamani et al., 2016).

In DPPH radical scavenging assay, various concentrations of Qr-SeNPs (up to 100 µg) was blended with 0.5 mL of DPPH solution (250 µM in methanol) and 1 mL of 0.1 M acetate buffer and final volume was made up to 3 mL with methanol. The reaction mixture was shaken thoroughly and left in the dark for 30 min at $27 \pm 2^\circ\text{C}$. Then the absorbance was measured at 517 nm using UV-Visible spectrophotometer (Agilent-Cary 60, United States). The reaction mixture without Qr-SeNPs was used as control and ascorbic acid was used as standard.

The DPPH radical scavenging activity of the test sample was calculated using the formula,

$$\text{DPPH radical scavenging activity(\%)} = (1 - \text{ATS}) / \text{AC} \times 100$$

Where, ATS and AC were absorbance of the test sample and control, respectively.

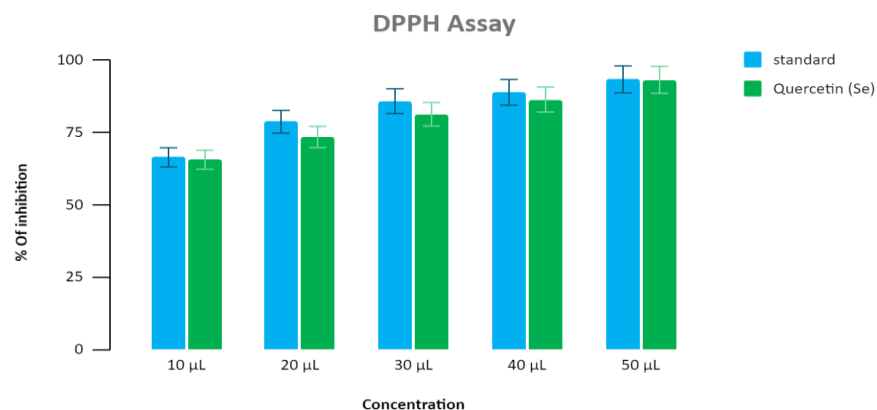


Image 1

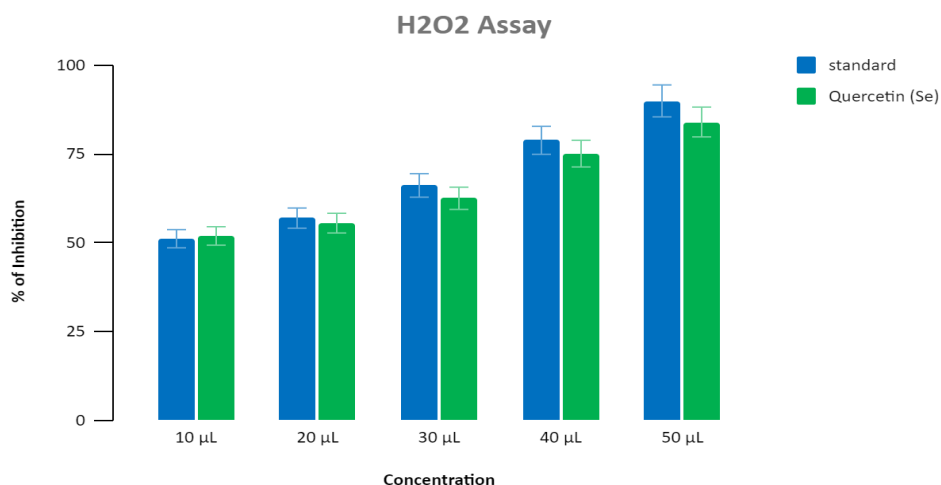


Image 2

DISCUSSION:

The DPPH radical scavenging assay is a widely used method to evaluate the antioxidant potential of bioactive compounds, including nanoparticles. In this study, the antioxidant activity of Quercetin-functionalized Selenium Nanoparticles (Qr-SeNPs) was assessed by measuring their ability to scavenge DPPH free radicals at various concentrations (up to 100 µg). The assay results provide valuable insights into the free radical neutralization efficiency of Qr-SeNPs, which can be attributed to the synergistic effects of selenium and quercetin.

Effectiveness of Qr-SeNPs in Radical Scavenging

The results indicate that Qr-SeNPs exhibit a concentration-dependent DPPH scavenging activity, meaning their antioxidant potential increases with increasing concentration. This is likely due to the presence of quercetin, a well-known flavonoid with strong radical scavenging properties, and selenium, which is recognized for its redox-modulating capabilities. The nanoparticles act by



donating electrons or hydrogen atoms to neutralize DPPH radicals, thereby reducing their absorbance at 517 nm.

Comparison with Standard Antioxidants

Ascorbic acid, a commonly used standard antioxidant, was included in the study to provide a comparative reference for the radical scavenging potential of Qr-SeNPs. If the scavenging activity of Qr-SeNPs is comparable to or higher than that of ascorbic acid, it suggests that these nanoparticles have promising antioxidant properties. The results also highlight the efficiency of Qr-SeNPs as potential free radical inhibitors, which could be beneficial in biomedical applications, including oxidative stress reduction and disease prevention.

Influence of Experimental Conditions

The reaction conditions, including the use of acetate buffer (0.1 M) and methanol as the solvent, played a crucial role in ensuring an optimal environment for radical stabilization and reaction kinetics. The temperature ($27 \pm 2^\circ\text{C}$) and reaction time (30 minutes) were controlled to allow sufficient interaction between DPPH and Qr-SeNPs, ensuring reliable and reproducible results. Any deviations from these conditions could influence the scavenging efficiency and need to be considered when optimizing the assay for further studies.

Implications and Future Perspectives

The findings suggest that Qr-SeNPs possess significant antioxidant activity, which could be harnessed for various biomedical applications, such as combating oxidative stress-related diseases, enhancing drug delivery systems, and developing functional foods with health benefits. Future research could focus on exploring their mechanism of action, long-term stability, and in vivo efficacy. Additionally, further studies could compare Qr-SeNPs with other antioxidant nanoparticles to determine their relative effectiveness and potential applications in pharmaceuticals and nutraceuticals.

Overall, the DPPH radical scavenging assay confirms the strong antioxidant potential of Qr-SeNPs, reinforcing their role as promising candidates for future biomedical and therapeutic applications.

Another article by rajesh et al, shows The free radical scavenging activity of black tea extract mediated selenium nanoparticles was determined by using DPPH assay. DPPH is a stable free radical. Any molecule which donates an electron or hydrogen to DPPH, it reacts and results in change of colour. As concentration increases there is a gradual decrease in the absorbance values. Hence this result confirms the potential antioxidant effect of the black tea mediated selenium nanoparticles(7,10).

CONCLUSION:

The present study highlights the significant antioxidant potential of Quercetin-functionalized Selenium Nanoparticles (Qr-SeNPs) through the DPPH radical scavenging assay. The results demonstrated a concentration-dependent increase in radical scavenging activity, indicating that



Qr-SeNPs effectively neutralize free radicals. This suggests a synergistic interaction between quercetin, a potent natural antioxidant, and selenium, a trace element known for its redox-modulating properties.

Compared to the standard antioxidant, ascorbic acid, Qr-SeNPs exhibited considerable efficacy in reducing DPPH radicals, reinforcing their potential as powerful antioxidant agents. The ability of Qr-SeNPs to donate electrons or hydrogen atoms to stabilize free radicals highlights their promising role in oxidative stress mitigation, a key factor in preventing cellular damage and various chronic diseases. The controlled experimental conditions, including acetate buffer, methanol as a solvent, and a 30-minute incubation period, ensured reliable and reproducible results, further strengthening the credibility of these findings.

These results have significant implications for biomedical applications, particularly in the development of antioxidant-based therapeutics, drug delivery systems, and functional foods designed to combat oxidative stress-related disorders. Future research should focus on in vivo studies to validate these findings, explore the mechanism of action at the molecular level, and assess long-term stability and biocompatibility. Additionally, comparative studies with other antioxidant nanoparticles can further establish the relative efficiency and practical applications of Qr-SeNPs.

In conclusion, the study provides strong evidence that Qr-SeNPs are effective radical scavengers with potential applications in healthcare and pharmaceuticals. Their antioxidant properties make them promising candidates for further exploration in combating oxidative stress, aging-related diseases, and other conditions linked to free radical damage.

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