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Green Synthesis of Selenium Nanoparticles from Banana Stem Extracts and Evaluating their Cytotoxic Effect

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ABSTRACT

Background: Nanoparticles are made using a variety of traditional processes. To maintain stability, hazardous compounds are required as capping agents, resulting in environmental toxicity. As a result, we must switch to "green synthesis." As a result, the purpose of this research was to determine the cytotoxicity of selenium nanoparticles supplemented with banana stem cell extract. The banana was chosen for this investigation because of its inherent anticytotoxic characteristics.
Aim: Aim of the study was green preparation of selenium nanoparticles from banana stem and to check its cytotoxicity evaluation.
Material and methods: Cytotoxic effect of prepared selenium nanoparticles from banana stem was assessed using Brine Shrimp Assay respectively at 5 µL, 10 µL, 20 µL, 40 µL, 80 µL.
Results: The selenium nanoparticle is safe to be used in the dental materials till 20 µL concentration. Although at 40 µL, 80 µL concentrations cytotoxicity was observed.
Conclusion: Within the limits of the study it can be concluded that selenium nanoparticles can be safely used in concentrations upto 20 µL as periodontal dressing or incorporated as bone grafts in periodontal regeneration.

Key words: Selenium, Characterisation, Nanoparticles, Banana stem, Green synthesis, Nanoparticle, Cytotoxicity

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INTRODUCTION

Nanotechnology is a relatively new technology that has heralded a new age of scientific research. Nanoparticles have gotten a lot of coverage in the scientific community in recent years. This technology has also benefited optics, electronics, biomedical, and materials sciences [1]. Nanoparticles have recently been highlighted for their antimicrobial, anticancer, antioxidant, drug and gene delivery, and other advantages [1-3]. Nanoparticles, which are atomic or molecular aggregates with a size of less than 100 nanometres, are the focus of nanotechnology [4,5]. Chemical reduction [6], laser ablation [7] solvo thermal, inert gas condensation [8] and sol-gel technique are some of the traditional ways used to make selenium nanoparticles. Even though conventional physical and chemical processes take less time to synthesise vast quantities of nanoparticles, hazardous chemicals are necessary as capping agents to maintain stability, resulting in environmental toxicity [9,10]. Green synthesis, which avoids the use of harmful chemicals in the synthesis process, has a number of advantages in terms of environmental friendliness and compatibility for biological applications [9].

Because of their nontoxicity, biocompatibility, and pharmacological and antibacterial activities, selenium nanoparticles are excellent [11].

The contact killing property of selenium has been extensively researched in recent years. Increased bacterial intracellular oxidative stress in the bacterial cell wall due to ion release from the selenium surface results in bacterial cell lysis, according to studies [12].

Due to the high incidence of oxide layer development on the nanoparticle surface, synthesis of selenium nanoparticles is extremely technique sensitive, resulting in diminished antibacterial property [13].

The objective of this study was to use banana stem extract to synthesize selenium nanoparticles and to evaluate its cytotoxicity as its excellent potency against oral aerobes was already proven in the previous studies [11,13].

MATERIAL AND METHODS

Preparation of banana extract

Freshly selected organic banana fruits were washed many times in distilled water. The fruit was chopped into small pieces with a sterilised knife and pounded into fine particles with a mortar and pestle.

1 gram of banana pulp was combined with 100 ml distilled water to get a 1 molar solution of banana extract.

Synthesis of Se nanoparticle

Nano composite synthesis was done by combining 100 ml of 1M selenium nanoparticle solutions, as indicated in the preceding procedures. Before the colour change was discovered, an orbital shaker was used to mix the nanoparticle solution overnight, followed by a magnetic hot stirrer.

To trace the synthesis of selenium nano composites, hourly UV-vis spectrometric data were recorded. Selenium nanoparticles were obtained after centrifuging the resultant mixture [14].

UV-vis spectroscopy

As a result of integrated oscillations of conduction band electrons on the surface of metal nanoparticles in resonance with the light, the Surface Plasmon Resonance absorption band was identified.

A UV-vis spectrometer was used to examine the Nano composite's formation. At a wavelength of 320-350 nm, a colour change was noticed at 1.000 absorption.

Cytotoxic effect

Brine shrimp assay was used to test the cytotoxicity of selenium nanoparticle extract. 12 well ELISA plates were used, with 6-8 ml of seawater added to each plate before adding 10 nauplii to each well.

Selenium nanoparticles were introduced to each well at various quantities (5 litres, 10 litres, 20 litres, 40 litres, and 80 litres) and incubated for 24 hours.

The total number of live and dead nauplii was counted after 24 hours, and the mortality rate was determined (Figures 1 to Figure 3).

The current cytotoxicity concentrations were derived from research conducted by Kanagesan et al. and Rajeshkumar et al.[15,16].

Figure 1: Brine shrimp eggs.

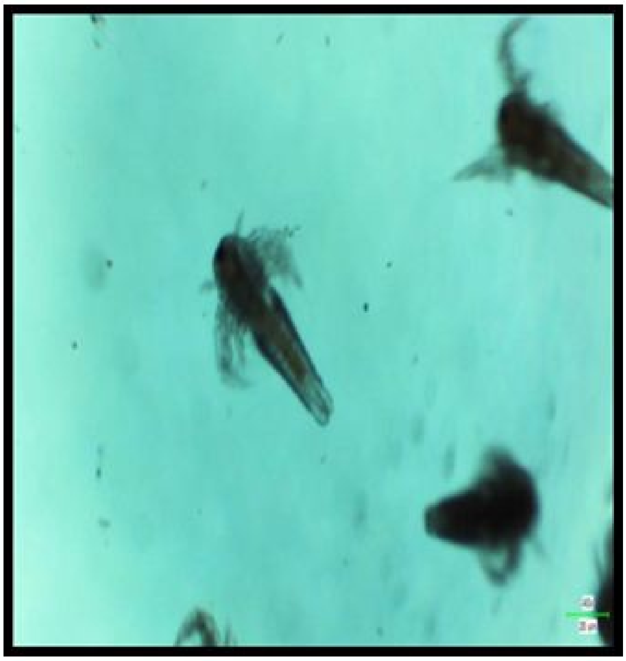

Figure 2: Hatched brine shrimp samplings (nauplii) under microscope.

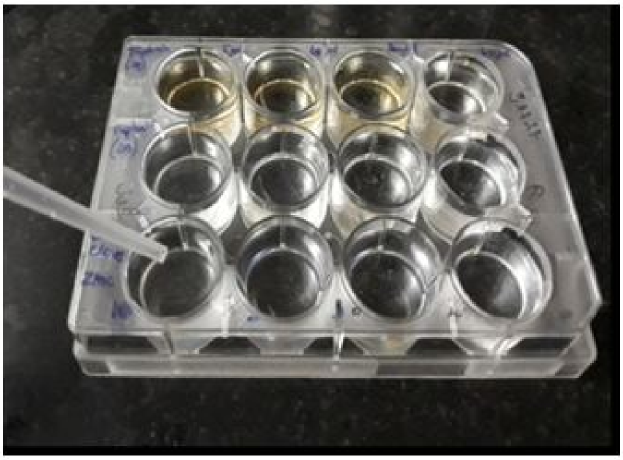

Figure 3: ELISA plate loaded with different concentrations (5μL, 10μL, 20μL, 40μL, 80μL and control 0μL) of CuGO Nano composite and 10 brine shrimp samples in each well.

RESULTS

Table 1 depicts the cytotoxicity of selenium nanoparticles reinforced with banana stem extract.

Upto 20 μL concentration there was a death of 100% of nauplii samplings that were alive at the end of the test period.

At 40 μL 20% death rate was seen and 30 % subsequently at 80 μL concentrations.

It was seen that as the concentration increased the cytotoxicity of the nanoparticles increased (Figure 4).

Table 1: Depicting the cytotoxicity of the copper and graphene oxide nano composite reinforced with amla extract.

Concentration of Nano composite (μL)	Viable napulii (24 hrs.)	Death%
Control (0 μL)	10	0
5 μL	10	0
10 μL	10	0
20 μL	10	0
40 μL	8	20
80 μL	7	30

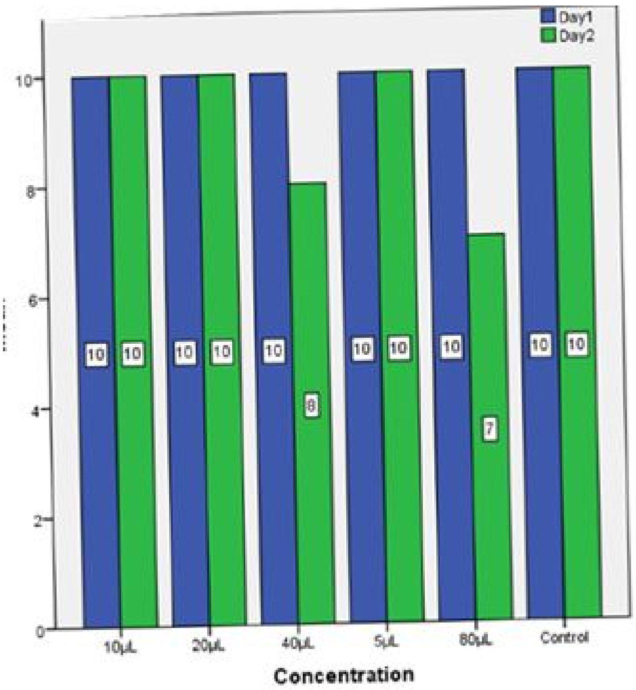

Figure 4 : Bar diagram showing the number of alive brine shrimp sampling at 24 and 48 hours at given concentrations. Where x-axis represents concentrations and y-axis represents the number of alive brine shrimp samplings.

DISCUSSION

The rising usage of nanoparticles, mostly in commercially available items, has given rise to Nano toxicity, a burgeoning research field. Nanomaterials' danger factors are currently unknown [2]. Extensive procedures are being carried out to assess the hazardous effects of these Nanomaterials for this aim.

The ability of some substances or mediator cells to kill living cells is referred to as cell cytotoxicity. Healthy live cells can be induced to undergo necrosis (accidental cell death) or apoptosis (planned cell death) by using a cytotoxic chemical (programmed cell death). Given this knowledge, the ability to precisely assess cytotoxicity can be a highly useful technique for finding substances that may pose health hazards to humans [2,17].

This is especially important during the research phase of generating new pharmaceutical medicines to assure end-user safety. Because of their low cost, ease, optimum life span, and quick screening technique, many researchers have recently concentrated on brine shrimp lethality assays. Artemia salina, a type of brine shrimp, is widely employed in medication development to test the toxicity of various components. Brine shrimp assay was first proposed by [18] which was then developed (Figure 5) [18].

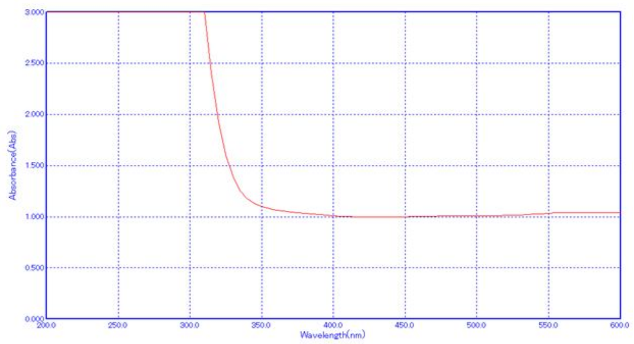

Figure 5: Representing the colour change at the 48 hour mark in the solution. UV-Vis spectrometer readings of the nanoparticle.

In comparison to the early part of the century, nanoparticle synthesis has progressed quickly recently [19]. The nanoparticles were previously synthesised using traditional procedures. Even while traditional physical and chemical processes take less time to synthesise vast quantities of nanoparticles, hazardous chemicals are necessary as capping agents to guarantee stability. Because harmful substances were used, these procedures resulted in environmental toxicity. The Green Synthesis process was proposed to prevent the usage of toxic chemicals, and it is now widely employed all over the world. It is both an environmentally friendly and cost-effective method [19,20]. As a result, we conducted this research to assess the cytotoxicity of selenium nanoparticles derived from banana stem extract. In previous research, the antibacterial activities of the same were proven to be excellent against oral microorganisms [9,10].

CONCLUSION

Within the limits of the study it can be concluded that selenium nanoparticles extracted from banana stem demonstrated promising cytotoxic activity against live shrimp eggs. Further cytotoxicity studies and antibacterial activity against periodontal pathogens has to be done.

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CONFLICT OF INTEREST

The authors have nothing to disclose or any conflicts of interest.

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