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Phyto-assisted Synthesis and Assessment of Properties of Selenium Nanoparticles prepared Using Banana Stem Extracts and Incorporating them in a Mouthwash-A Patent

Divij Khullar*, S Rajeshkumar, Nabeel Ahmed

Department of Prosthodontics, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, (SIMATS), Saveetha University, Chennai, India

ABSTRACT

Traditional nanoparticle production procedures involve harmful chemicals, resulting in environmental toxicity. As a result, "green synthesis" will be required. Selenium nanoparticles supplemented with banana stem extract have demonstrated to have strong antibacterial capabilities in previous research. As a result, this study was conducted to investigate selenium's antibacterial characteristics. Selenium is an effective antibacterial agent because it stimulates cell wall breakage due to intracellular material leakage, and it was chosen to manufacture a nanoparticle.

Aim: Aim of the study was phyto assisted preparation of nano selenium from banana stem cell and evaluation of its anti-inflammatory and antioxidant properties.

Material and methods: Antimicrobial properties of the nanoparticle were assessed using Bovine Serum Albumin (BSA) and DPPH Assay respectively at 10 µL, 20 µL, 30 µL, 40µL, 50 µL.

Conclusion: Within the limits of the study it can be concluded that selenium nanoparticles have exceptional antimicrobial properties and further can be incorporated in dental materials or can be used to coat suture materials to improve their properties.

Key words: Selenium, Characterisation, Green synthesis, Nanoparticle, Antimicrobial properties

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Corresponding author: Divij Khular
E-mail✉:diving1625@gmail.com
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INTRODUCTION

In the era of antibiotic resistance, there has been growing concern as bacteria rapidly evolve adaptive countermeasures to traditional antibiotics [1]. Bacteria are potentially deadly pathogens that can spread infectious diseases. The use of bacteria as infection causative agents dates back to the 14th century. In 1910, Salvarsan was the first antimicrobial agent to be introduced. Other antimicrobial agents, such as chloramphenicol, nalidixic acid, and macrolides, are widely used soon after. Infectious bacterial infections were temporarily relieved in the twentieth century [2]. Nonetheless, antibiotic usage and the production of successful antimicrobials led to the production of antibiotic resistant bacteria [2].

Since then, significant efforts have been made to combat the emergence of these resistant strains by developing new antibiotic drugs with greater chemical diversity, identifying antibiotic-producing bacteria, and discovering additional antibiotics from natural, previously unknown sources. These advances, however, were insufficient to compensate for the rapidly growing number of resistant bacterial strains. The use of nanotechnology is widespread [3]. In the fields of biology and medicine, in the development of a wide range of goods. Nanotechnology has opened up many possibilities in biology, including tissue engineering, drug delivery, diagnosis, imaging, and protection against bacterial infections [4].

Nanoparticles have been proposed to treat infections as a new antimicrobial agent because they kill bacteria using different mechanisms than standard antibiotics [3,4] and have low toxicity in human cells. As a result, Nano materials could be a feasible alternative to antibiotics in the treatment of bacterial infections [5]. Selenium, a nutrient factor that plays an important role in biological processes, is one of the compounds that could be combined with antibacterial agents. Selenium is a trace element that is needed for proper body development and health [6]. The nano form of elemental Se has gotten a lot of attention because it is the least toxic form of Se.

MATERIALS 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.

RESULTS

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.

TEM scan analysis

The size and shape of the produced nano composite were examined by transition electron microscopy. The nano composite was 12-16 nm in size on average (Figure 1).

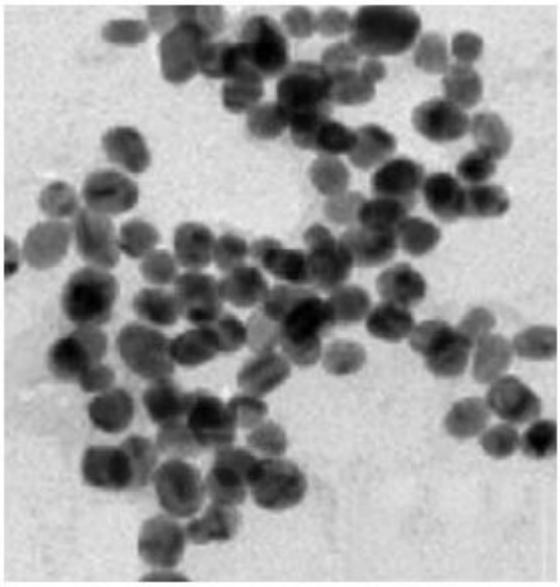

Figure 1: TEM scan image for selenium nanoparticle.

Antimicrobial activity of the nano composite

As indicated in result table number 1, nano composite at 150L concentration exhibited promising results. At 150L concentration, the zone of inhibition for all three spices, *Enterococcus faecalis*, *Streptococcus mutans*, and *Candida albicans*, was 15, whereas the control group had 14, 27, and 30 (Figure 2-6).

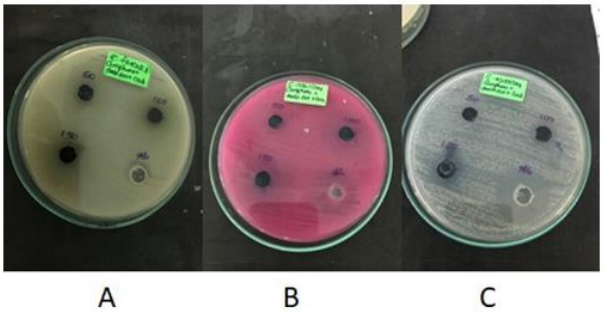

Figure 2: Showing the zone of inhibitions for A. *Enterococcus faecalis* B. *Candida* albicans and C. *Streptococcus mutans* at 50µL, 100µL, 150µL concentration and the control antibiotic group.

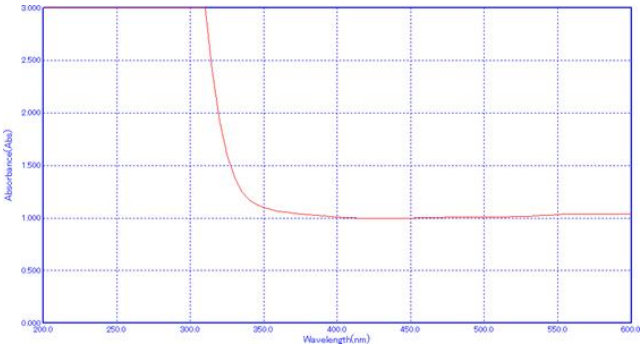

Figure 3: Representing the colour change at the 48 hour mark in the solution. UV-Vis spectrometer readings of the nanoparticle.

Figure 4: Showing the process of magnetic (auto heated) stirring of selenium nanoparticle extract solution.

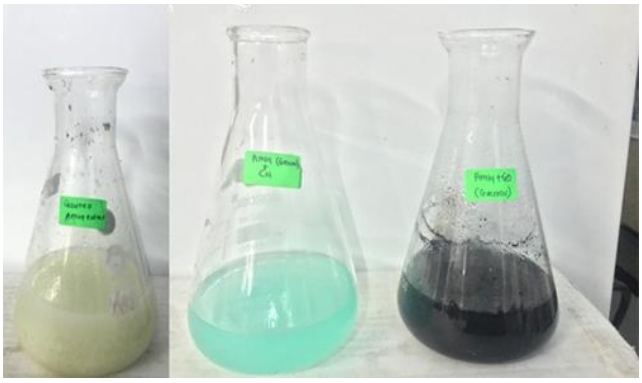

Figure 5: Showing the three beakers containing 1M solution of amla fruit extract , copper sulphate and graphene oxide respectively.

Figure 6: Showing the amla fruit extract used for the green preparation of the copper and graphene oxide nano composite.

DISCUSSION

Nanotechnology is gaining popularity among researchers because of the following benefits in the medicinal and medical fields: less invasive, reduced risk and adverse effects, faster action with reduced dosage due to increased bioavailability, increased beneficial effects, and unsolved medical problems such as cancer have been one of the most important researches in the field of nano medicine. Nano medicines are now being used in local drug delivery in dental disciplines, and not just for fatal systemic disorders like cancer [7]. Incorporating nanoparticles in dental dressings, suture materials, mouthwashes, and local drug delivery media has been a focus of dental nano research [8].

The discovery of effective drug delivery methods that can improve the therapeutic profile and efficacy of therapeutic agents is one of the most pressing concerns in modern medicine. Advances in nanoscience and nanotechnology, which have permitted the creation of novel nanomaterials, have facilitated the development of a number of innovative drug delivery systems [9].

In comparison to the early half of the century, nanoparticle synthesis has improved fast in recent years [5]. Traditional methods were previously used to create the nanoparticles, and even though these traditional physical and chemical methods for synthesising vast amounts of nanoparticles take less time, hazardous substances are used as capping agents for stability [10].

These methods resulted in environmental toxicity due to the use of hazardous compounds. The Green Synthesis process was devised to avoid the use of such harmful chemicals, and it is now widely employed all over the world. It is a method that is both ecologically friendly and cost-effective [11]. As a result, we did this study to see how harmful selenium nanoparticles containing banana extract were. Antibacterial activities of the same were proven to be excellent against oral microorganisms in previous studies [12,13].

Banana extract has been proved in studies to be an excellent antibacterial [5], and as a result, Selenium, which is the main contributor to this feature, was employed in this investigation, with encouraging findings.

When certain bacteria come into touch with an unprotected selenium surface, the release of ions from the copper surface causes intracellular oxidative stress in the bacterial cell wall, resulting in bacterial cell lysis. This phenomenon has been known since ancient times, but experts have recently revived their interest in it. For the aforementioned phenomenon, the term "contact killing" was coined. In the year 2008, the United States Environmental Protection Agency (US EPA) designated copper as the first antimicrobial metal [14].

Low levels of resistance in bacteria are one of the most prominent advantages of selenium as an antibacterial agent. Because of their large surface area and high charge density, NPs can interact extensively with the negatively charged surface of bacterial cells, resulting in increased antibacterial action [15]. The Surface Plasmon Method of green synthesis was chosen for the nanoparticle production because it is cost-effective and does not require the use of harmful chemicals [16].

Numerous plant extracts have been accounted for in numerous studies, to synthesize selenium nanoparticles. Also, as seen in the results of the current study nano selenium showed promising antimicrobial properties. Further cytotoxicity tests have to be performed to move the nanoparticle into the clinical trial phase and be incorporated in mouthwash and other dental materials to increase the beneficial effects of the materials [17,18].

CONCLUSION

Within the limits of the study it can be concluded that selenium nanoparticles extracted from banana stem demonstrated promising antibacterial properties against Enterococcus faecalis, *Streptococcus mutans* and *Candida Albicans* at 150µL. It can be clearly seen that synthesized nanoparticles showed wider zone of inhibition against Enterococcus faecalis than that of the control antibiotic

used (Table 1). Further cytotoxicity studies and antibacterial activity against periodontal pathogens has to be done.

Table 1: showing the results of the antimicrobial activity of the selenium nanoparticle from bananastem extract against *Enterococcus faecalis*, *Streptococcus mutans* and *Candida albicans* at 50µL, 100µL ,150µL concentration with the help of zone of inhibition.

Microorganism/ Concentration	Zone of inhibition			50µl	100µl	150µl	Control (Antibiotic)	
Enterococcus faecalis	9	12	15					14
Streptococcus mutans	9	12	15	27				
Candida albicans	9	9	15	30				

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CONFLICT OF INTEREST

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

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