RESEARCH ARTICLE

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Enhanced Antibacterial Activity of Arrowroot Mediated Selenium Nanoparticles Against Streptococcus Mutans And Lactobacillus Species

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ABSTRACT

Biosynthesis of nanoparticles is an interdisciplinary application of metal science and technology through biology. SeNPs can be used for various applications especially in medicine, due to its medicinal properties such as low toxicity, better reactivity, low dosage, etc. Medical applications include drug targeting, drug discovery, diagnosis and regenerative medicines. When applying nanotechnology to medical uses, it is particularly important to ensure thorough safety evaluation of any new technologies and also to review the likely environmental impact. Due to the increasing number of antibiotics employment of SeNPs as antimicrobial agents has been widely investigated. The most common mechanism of action of SeNPs is the attachment of particles to the bacterial surface and release of the selenium ions into the bacterial cell, which generally causes the oxidation stress, inhibition of protein synthesis or DNA mutation. SeNPs were developed to treat S. aureus infections. Although there are previous reports on the biosynthesis of SeNPs using plant extract and microorganisms are available, the enhanced antibacterial activity of arrowroot mediated selenium nanoparticles is new to the field of nanotechnology. Arrowroot mediated Zinc oxide nanoparticles were initially synthesised and characterised by UV-Visible spectrophotometer and TEM. The enhanced antibacterial was studied by inoculating it in the culture media. The results showed that Arrowroot mediated selenium nanoparticles showed good antibacterial activity. An increased bacterial zone of inhibitions was observed against both Streptococcus mutans and Lactobacillus. Thus arrowroot mediated SeNPs can be used as an antibacterial agent.

ARTICLE HISTORY

Received October 16, 2020
Accepted November 03, 2020
Published December 14, 2020

KEYWORDS

Arrowroot, Selenium nanoparticles, Enhanced antibacterial activity, Streptococcus mutans, Lactobacillus

INTRODUCTION

Nanotechnology is one of the extremely useful fields in chemistry, biology, physics, materials science, and engineering. In the twenty-first century nanotechnology has become one of the promising approaches for innovations that lead to fulfilling the human requirements. Nanosized drug delivery systems have already entered routine clinical uses(1). Nanopharmaceuticals Can be developed either as drug delivery systems or biologically active drug products. The most pressing challenge is the application of nanotechnology to design of multi-functional, structured materials able to target specific diseases or containing functionalities to allow transport across biological barriers(2). The desired clinical benefits include focusing on the specific target disease like cancer, neurodegenerative and cardiovascular diseases. Biological applications include the definition of target and pathway and network analysis and mechanisms of signalling and signal transduction. Medical applications include drug targeting, drug discovery, diagnosis and regenerative medicines. When applying nanotechnology to medical uses, it is particularly important to ensure thorough safety evaluation of any new technologies and also to review the likely environmental impact.

Selenium nanoparticles can be prepared by physical, chemical and biological methods. Biological methods of preparation are much preferred since it is safe, eco friendly, inexpensive and non-toxic (3). The chemical and physical methods need high thermal conditions, hazardous chemicals and acidic pH, which is not safe for the biological application(4). The use of plant extracts for the synthesis of nanoparticles is much beneficial and easier over the microbial synthesis. Green synthesis of selenium nanoparticles (SeNPs) was achieved by a simple biological procedure using the reducing power of fenugreek seed extract(5). SeNPs have exceptional properties like catalytic, photoreactive, biocidal, anticancer, and antioxidant properties(6). Selenium nanoparticles can be used as a nutritional supplement due to its ability to release selenium after ingestion. Selenium acts as an essential trace element for the maintenance of health and growth and boosts our immunity if taken at the proper dosage and chemical forms(7). Daily supplementation of Selenium was recommended in diseases like HIV(8), Crohn's disease(9), Cardiovascular disease(10), Thyroid(11) and other diseases(12). Chronic selenium overdose causes garlic odour of the breath, metallic taste in the mouth and Selena's is which is manifested by hair and nail loss, brittleness, lesions of the skin and nervous system, nausea, diarrhoea, mottled teeth, fatigue, skin rashes and nervous system abnormalities(13). Investigators proved that SeNPs induced apoptosis of A375 cells with the involvement of oxidative stress and mitochondrial dysfunction(14). Thus acting as a novel chemopreventive and chemotherapeutic agent for human cancers(15). SeNPs present a wide range of possibilities for usage in the human diet and disease treatment.

Due to the increasing number of antibiotics employment of SeNPs as antimicrobial agents has been widely investigated. The most common mechanism of action of SeNPs is the attachment of particles to the bacterial surface and release of the selenium ions into the bacterial cell, which generally causes the oxidation stress, inhibition of protein synthesis or DNA mutation. SeNPs were developed to treat S. aureus infections(16). Staphylococcus aureus, which is the reason for most of the infections, is difficult to treat due to the biofilm formation and documented antibiotic resistance. SeNPs were developed to treat S. aureus infections(17),(18). The flexibility of SeNPs for modifications by natural polymers such as chitosan makes it a candidate for use as an antimicrobial or anticancer agent. SeNPs present a wide range of possibilities for usage in the human diet and disease treatment.(34)

MATERIALS AND METHODS

Preparation of Arrowroot Extract

Fresh arrowroot powder extract is collected from the market, Chennai. 1g of this freshly prepared arrowroot powder extract is mixed with 100 mL of distilled water and boiled for 3-5 minutes in the heating mantle. Then the extract was filtered using filter paper into a conical flask.

Preparation of Selenium Nanoparticles

0.173 gms of sodium selenite is added to 40ml of distilled water. To this 40ml of freshly prepared arrowroot extract is added and the solution is placed in the shaker and the observation was made every two hours for analysing the synthesis of nanoparticles under UV visual spectroscopy. Then the solution was kept in the magnetic stirrer and the readings were measured every two hours. The mixture was then centrifuged at 8000 rpm for 10 minutes and then the nanoparticles were collected.

Enhanced Antibacterial Activity

The standard Antibiotic powder novamoxin was mixed in distilled water and the solution was inoculated in the culture media containing Streptococcus mutans and Lactobacillus species. Arrowroot mediated selenium nanoparticles was inoculated at a variant concentration of 30µg, 60µg and 90µg in the agar medium. Three concentrations of selenium nanoparticles were tested against Streptococcus mutans and Lactobacillus species growth. Selenium nanoparticles were mixed with bacterial solutions and cultured for 3, 4, and 5 hours in an incubator (37°C, humidified, 5% CO_2), shaking at 250 pm.

Figure 1: Preparation of Arrowroot extract

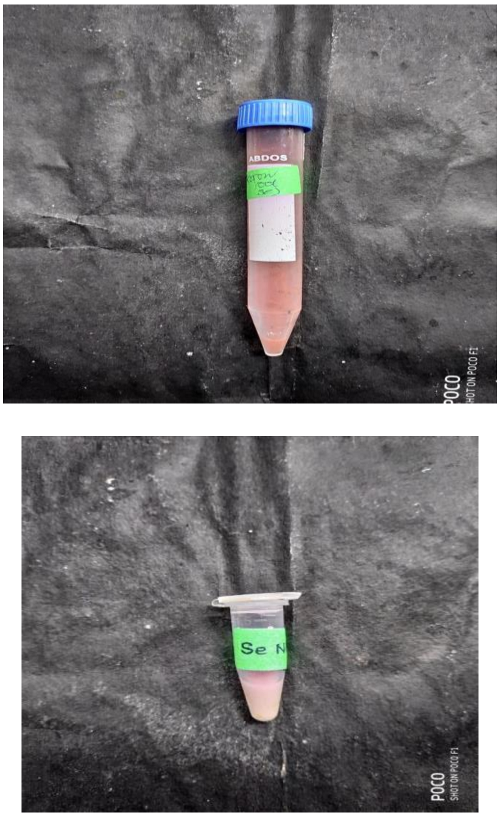

Figure 2: Preparation of Arrowroot mediated selenium nanoparticles

RESULTS AND DISCUSSION

Nanoparticles have been increasingly studied for a wide range of medical applications. The advantages of nanoparticles include their high surface-to-volume ratios and their nanoscale sizes. The high surface areas of nanoparticles increase the more active sites for interacting with biological entities such as cells. The higher surface areas of nanoparticles compared with conventional micron-size particles also offer more sites for functionalization with other bioactive molecules, such as anticancer and antibacterial drug molecules. From the results it is observed that arrowroot mediated SeNPs shows an enhanced antibacterial against Streptococcus mutans lactobacillus species in a concentration-dependent increase, Nanomedicinesy conducted studies SeNPs showed strong inhibitory effects with the conventional antibiotics like amoxicillin, oxacillin, and penicillin. The synergic effects of quercetin and gallic acid in combination with SeNPs were studied previously and the findings possess biosynthesized therapeutic efficacy in terms of antioxidant, antimicrobial against Escherichia coli and Bacillus subtilis(20). The results of this study also showed a very good antibacterial effect against Streptococcus mutans and Lactobacillus. According to figure 3, the SeNPs showed a greater antibacterial effect against lactobacillus species than Streptococcus mutans. In comparison with the standard novamoxin, SeNPs showed a greater antibacterial effect. The inhibitory potential continued as time increased. The growth profile of bacteria in the presence of selenium nanoparticles is presented more clearly in Figure 4 and 5. Further research can be implemented to understand the working mechanisms of such antibacterial selenium properties to further develop these promising antibacterial nanoparticles.

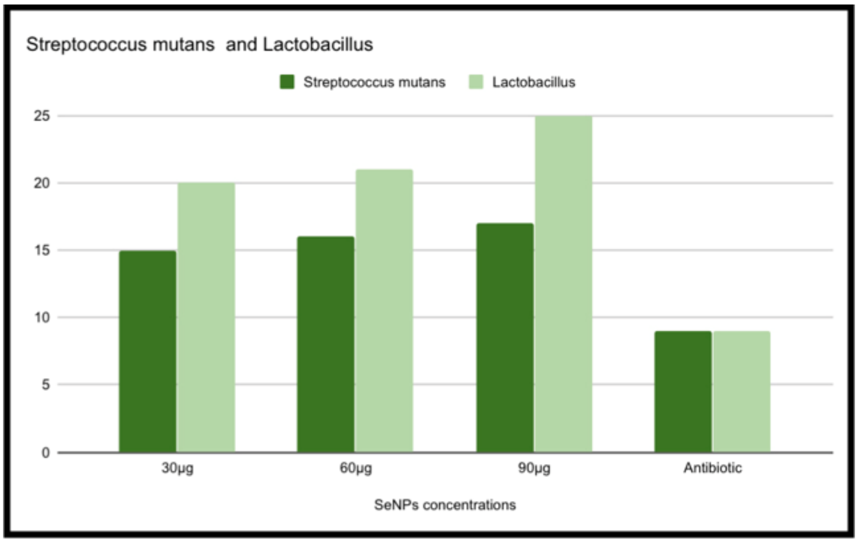

Figure 3: Enhanced antibacterial activity of Arrowroot mediated selenium nanoparticles against Streptococcus mutans and Lactobacillus species

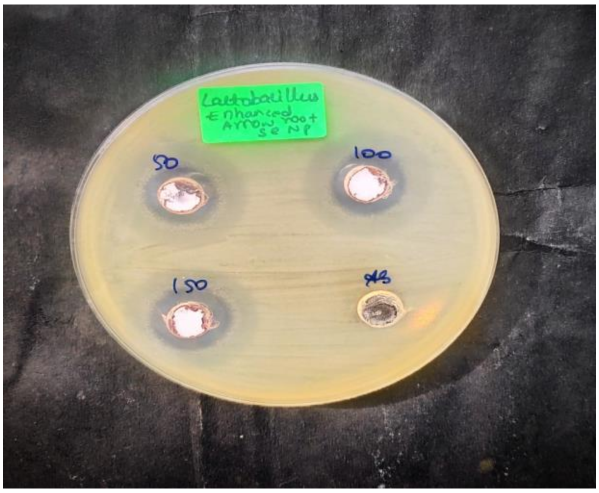

Figure 4: SeNPs against lactobacillus species

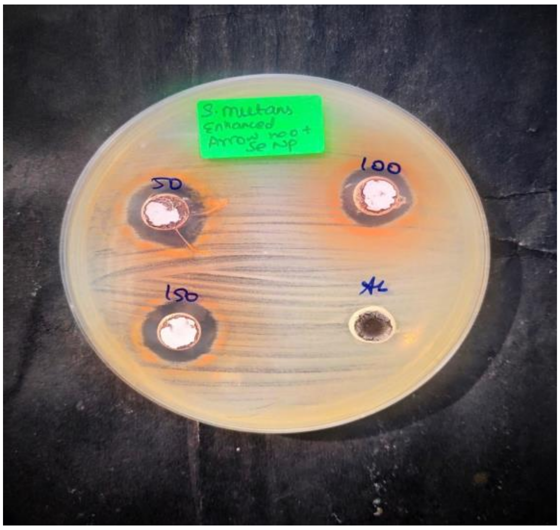

Figure 5: SeNPs against Streptococcus mutans

CONCLUSION

Nanotechnology has a tremendous application in pharmacotherapeutics. Nowadays Nanomedicines have been recognised and transferred into practice. Universities should be given much more entrepreneurial freedom and spirit to increase the inventiveness that will promote future technology pipelines. Nanomedicine should be discussed in terms of pharmacoeconomic value at an early stage with regulatory authorities, policymakers and health- care stakeholders. The potential of Nanomedicine to create not only new products but also new jobs (socioeconomic value) needs to be appreciated. Public awareness should be made and realistic risks of nanomedicine can be brought about by educational programmes. National support for Nanomedicine would be enhanced when action groups and patient-support groups are more aware of the benefits of these technologies.

ACKNOWLEDGEMENT

The authors would like to thank the editors and authors of the journal, which was the source of the scientific compilation of this review article.

CONFLICT OF INTEREST

Nil

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