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Controlling of oral pathogens using ginger oleoresin mediated silver nanoparticles

Karthikeyan Gayathri, Anitha Roy*, Thangavelu Lakshmi, Rajeshkumar S

Department of Pharmacology, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India

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ABSTRACT

Silver nanoparticles have become a substance of great interest among researches in the present time due to its low cost and its wide range of applications in various fields. Moreover, recently, green nanotechnology has been gaining popularity because of its exclusion of damaging reagents and cost-effectiveness. In this study, ginger oleoresin mediated silver nanoparticles were prepared and confirmed with UV-Vis spectroscopy. The ginger oleoresin mediated silver nanoparticles were then tested for its antibacterial activity using agar well diffusion method against *Staphylococcus aureus*, *Streptococcus mutans* and *Enterococcus faecalis*. The antimicrobial activity was found to be highest against *Streotococcus mutans* among the test organisms. Silver nanoparticle synthesised using natural substances can be used in control of oral pathogens.

*Corresponding Author

Name: Anitha Roy
Phone: 9840787458
Email: anitharoy2015@gmail.com

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INTRODUCTION

Silver nanoparticles have become a substance of great interest and focus in researches in recent years due to its low cost and its wide range of applications like such as catalysis, electrical batteries, biosensing and biotechnology. In recent times metal nanoparticles have been manufactured from eco-friendly sources such as fruits, fungi, plant extracts and microorganisms. Studies report that the reduction of metal ions using plants are much faster as compared to microorganisms (Rajeshkumar, 2016; Rajeshkumar and Bharath, 2017).

Recently green nanotechnology has been gaining popularity because of its exclusion of damaging reagents and cost-effectiveness. Several studies have shown that silver nanoparticles have antifungal and antibacterial activity (Rajeshkumar, 2016; Santhoshkumar and Kumar, 2017; Menon and Rajeshkumar, 2017). Green synthesis of silver nanoparticles using the various parts of the plant for example leaf extract, seed extract, plant latex, microorganisms and some biopolymers have been reported. Polymers such as polyethylene glycol, polyvinylpyrrolidone, polyacrylonitrile, poly(methyl methacrylate), polyaniline and poly(vinyl alcohol) were also used as reducing and stabilizing agents for the formation of well-dispersed AgNPs. (Agarwal and Menon, 2018; Ponnanikajamideenm and Priya, 2016). *Zingiber officinale is* an aromatic and pungent spice that has unique culinary, medicinal value. It is cultivated in tropical and subtropical countries. Ginger is effective against the growth of various microorganism, which cause many diseases (Mbaeyi-Nwaoha and Elizabeth, 2013). In this study, ginger oleoresin mediated silver nanoparticles were prepared and evaluated for its antimicrobial activity.

MATERIALS AND METHODS

Plant material

Ginger oleoresin was obtained from Synthite Industries Ltd, Kerala, India as a gift sample.

Synthesis of nanoparticles

90 mL of 1 mM silver nitrate solution was mixed with 10 mL of ginger oleoresin extract (1 mL of ginger oleoresin in 9 mL of 50 % ethanol) solution and was kept in magnetic stirrer for nanoparticle synthesis formation. The colour change was observed visually, and photographs were recorded.

Conformation of synthesis of NPs

The synthesised NP's solution was preliminary confirmed by UV-Vis-spectroscopy. 3 mL of the solution was taken in cuvette and scanned in double beam UV-Vis-spectrophotometer from 300 nm to 700 nm wavelengths. The results were recorded for graphical analysis.

Preparation of nanoparticles powder

The prepared nanoparticle solution was centrifuged using refrigerated lark centrifuge at 8000 rpm for 15 minutes, and the pellet were collected and washed twice with distilled water. The final purified pellets were collected and dried at 60^0C and stored in airtight Eppendorf tube (Jain and Roy, 2019).

Antibacterial activity of nanoparticles against oral pathogens

Agar well diffusion method was used to determine the antibacterial activity of synthesised ginger oleoresin mediated silver nanoparticles. Different concentrations of AgNP's were tested against *Staphylococcus mutans*, *Enterococcus faecalis*, *Staphylococcus aureus*. The fresh bacterial culture was dispersed on the surface of Muller Hinton agar plates. Different concentrations of nanoparticles (20, 50, and 100 μL) were incorporated into the wells, and the plates were incubated at 37°C for 24 hours. Amoxycillin was used as positive control and the inhibition zone was recorded in each plate.

RESULTS AND DISCUSSION

Visual observation

It is a well-known fact that AgNPs exhibit dark brown colour depending on the intensity and size of nanoparticles. The colour change occurs due to the excitation of the surface plasmon resonance (SPR) of the silver nanoparticles. When Ginger oleoresin was added to the silver nitrate solution, the colour of the solution gradually changed from a turbid whitish-yellow colour to dark brown. This colour change has been shown in Figure 1 A and Figure 1 B. This colour change was indicative of the formation of silver nanoparticles which was further confirmed by UV – Vis spectrophotometry.

UV-Vis spectroscopy

The UV – Vis spectra was recorded for the prepared ginger oleoresin mediated silver nanoparticles (Figure 2). It was observed from the spectra that the AgNP's surface plasmon resonance peak occurs at 440 nm with high absorbance, which is indicative for silver nanoparticles. This confirms the formation of Ginger oleoresin mediated silver nanoparticles.

Antibacterial activity

The synthesised ginger oleoresin mediated AgNP's by green techniques were studied for antimicrobial activity against the pathogen such as*Staphylococcus aureus*, *Streptococcus mutans* and *Enterococcus faecalis*. The diameter of the zone of inhibition (ZOI) was recorded in millimetre against each concentration of bacterial species. (Figure 3). The results were tabulated, and the graph was plotted (Figure 3). The zone of inhibition for *Enterococcus faecalis* was noted as 9mm at 20 μL, 11mm at 50 μL and 13 mm at 100 μl. The zone of inhibition for *S.aureus* was noted as 10mm at 20 μL, 12mm at 50 μL and 13 mm at 100 μL. The zone of inhibition for *S.mutans* was noted as 10mm at 20 μL, 12mm at 50 μL, 16mm at 100 μL. The zone of inhibition was the highest for *S. mutans*. The results obtained were comparable to the study conducted by (Haripriyaa and Kumudinibelursatyan, 2014). In the present study, ginger oleoresin was used for the synthesis of silver nanoparticles. One of the main components of ginger oleoresin is ginger oil, which has numerous phytochemicals. The ginger oleoresin contains ginger essential oil and 6-gingerol and a structurally related vanilloid (Mbaeyi-Nwaoha and Elizabeth, 2013). This oil is shown to have a greater affinity towards the wall cell present in the gram-positive bacteria. The gram-positive bacteria have a cell wall composed of thick layers of peptidoglycans which the oil will attack and destroy. (Itzel and López, 2017). Green synthesised nanoparticles have numerous benefits of being eco-friendly and compatible with pharmaceutical and other biomedical applications (Sharma and Lin, 2009; Jain and Roy, 2019). In recent years, the number of infections connected with antibiotic-resistant bacteria has amplified, so the use of green synthesis of antimicrobials will be useful in combating this problem. The main reason for the use of nanoparticles is for good bioavailability, and it easily enter the cell membrane to improve the activity (Dutta and Dutta, 2004).

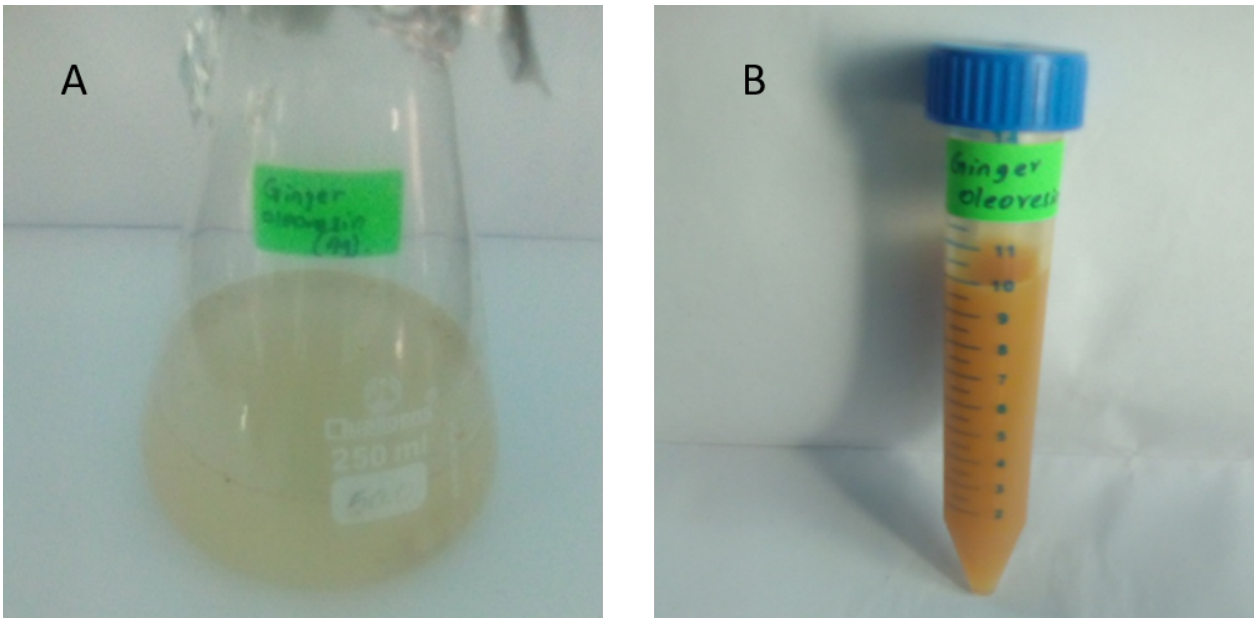

Figure 1: A & B Visual observation of Ginger oleoresin mediated silver nanoparticles before and after formation

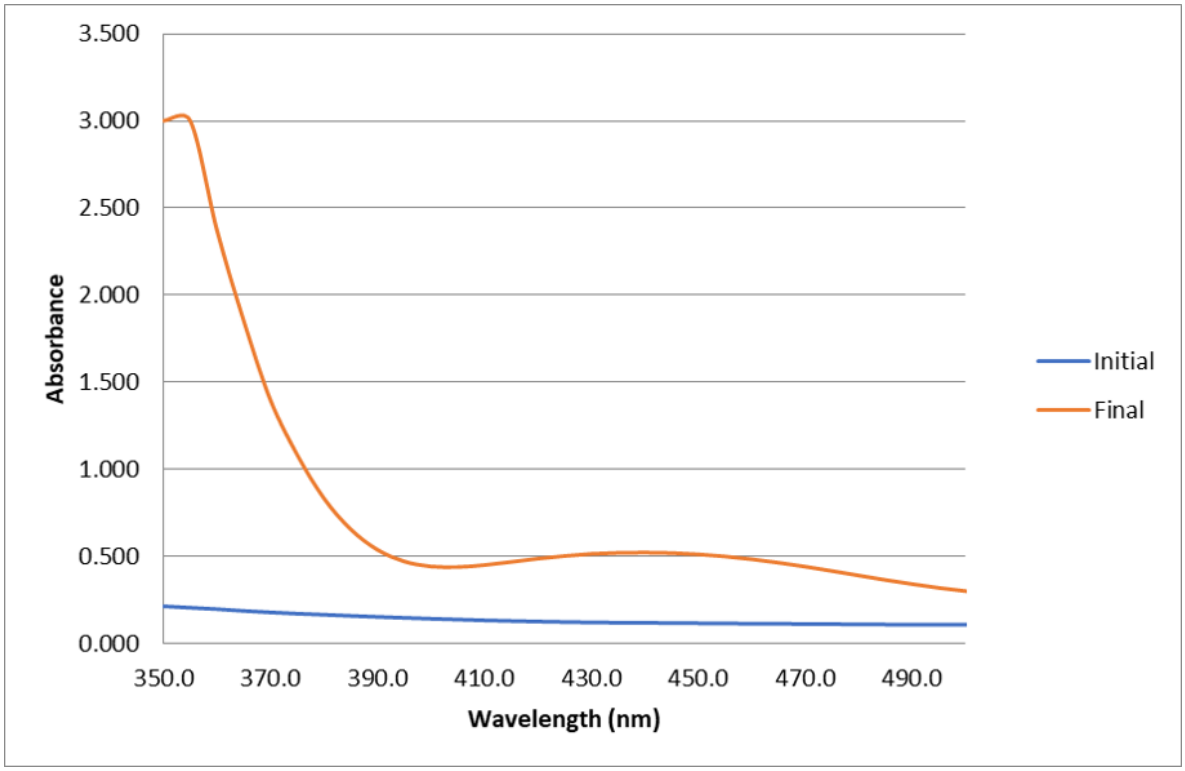

Figure 2: UV –Vis Spectroscopy of Ginger oil mediated silver nanoparticles

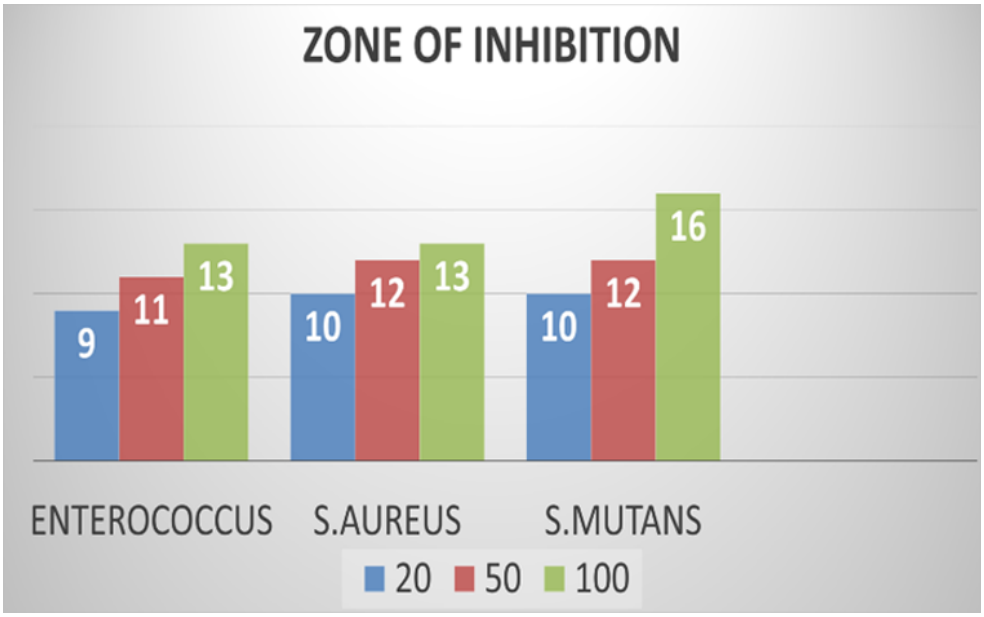

Figure 3: Antibacterial activity of Ginger oleoresin mediated AgNPs against test microorganism

CONCLUSION

The present study concludes that ginger oleoresin is an effective means to produce silver nanoparticles in an ecofriendly manner and that oral pathogens can be controlled by using ginger oleoresin mediated silver nanoparticles. Ginger oleoresin mediated silver nanoparticles was showing maximum activity against *Streptococcus mutans*. Hence, it may be used to control infections caused by *Streptococcus mutans*.

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