Antibacterial Activity of White Pepper Oleoresin Mediated Silver Nanoparticles against Oral Pathogens

Rachel Preethi Paul¹, Anitha Roy², Maajida Aafreen M.³, Rajeshkumar Shanmugam⁴

¹Department of Pharmacology, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India. ²Department of Pharmacology, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India.

³Department of Pharmacology, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India. ⁴Department of Pharmacology, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India.

ABSTRACT

BACKGROUND

Plant mediated biological synthesis of silver nanoparticles is gaining importance due to its eco friendliness and simplicity. Different types of nanoparticles such as metal, metal oxide, metal sulphide and polymer nanoparticles are used in different types of applications in the fields of electronics, communications, electrical, mechanical, medical, dental etc. Aim of the present study was to evaluate the antibacterial activity of white pepper oleoresin mediated silver nanoparticles against oral pathogens.

METHODS

In the present investigation, white pepper mediated synthesis of silver nanoparticles was carried out by the addition of silver nitrate with prepared white pepper oleoresin solution. White pepper oleoresin mediated silver nanoparticles were initially confirmed by colour changes and confirmed by UV- Visible spectroscopy. Anti-bacterial activity of the synthesised silver nanoparticles was carried out using agar well diffusion method. Different concentrations of silver nanoparticles were tested against different oral pathogens such as *Staphylococcus aureus*, *Streptococcus mutans* and *Pseudomonas sp.*

RESULTS

The solution containing white pepper oleoresin and silver nitrate solution showed a brown colour confirming the formation silver nanoparticles and peak at 350 nm revealed the silver nanoparticles surface plasmon resonance. The white pepper oleoresin mediated silver nanoparticles showed good antibacterial activity against all tested microorganisms and the maximum activity was found with *Pseudomonas spp.* followed by *Staphylococcus aureus*, and *Streptococcus mutans*.

CONCLUSIONS

Green synthesis of silver nanoparticles using white pepper oleoresin was of low cost and was convenient to carry out. Hence, white pepper oleoresin mediated silver nanoparticles may be used for the control of oral pathogens.

KEY WORDS

White Pepper Oleoresin, Green Synthesis, Nanoparticles, Oral Pathogens, Silver Nanoparticles

Corresponding Author:

Dr. Anitha Roy,
Department of Pharmacology,
Saveetha Dental College,
Chennai, Tamil Nadu, India.
E-mail: anitharoy2015@gmail.com

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BACKGROUND

Nanotechnology is expected to be the basis of many main technology innovations in the 21st century. Research and development in this field is growing rapidly throughout the world. A major output of this activity is the development of new materials in the nanometer scale, particulate materials with at least one dimensions of less than 100 nanometres (nm).^(1,2,3) Nanotechnology occupies tremendous application in diverse fixed such as chemistry, cosmetics, catalyst, energy, plasmonic, onto-electronics and medicine. In the branch of nanotechnology, the synthesis of nanoparticles and their development play a significant role because of their applications. Size up to 100 nm is usually referred to as nanoparticles. In the recent years there, there are various noble metals such a silver (Ag), lead (Pb), platinum (Pt) and gold (Au).⁽⁴⁾ Among the above four, silver nanoparticles play a significant role in the file of biological systems, living organisms and medicine.^(5,6) Silver has long been recognised as having inhibitory effect towards many bacterial strains and micro-organisms commonly present in medicinal and industrial process.⁽⁷⁾ The most widely used and known applications of silver and silver nanoparticles include topical ointments and creams containing silver to prevent infections of burns and wounds.⁽⁸⁾ Many attempts have been made to use silver nanoparticles as an anti- cancer. The strong toxicity of silver against wide range of micro-organisms is well known and silver nanoparticles have been recently shown to have promising anti-microbial material.⁽⁹⁾ Sondi et al studied the antimicrobial activity of silver nanoparticles against *Escherichia coli* as a model of gram-negative bacteria.⁽⁷⁾

Piper nigrum family *Piperaceae* has got application in food industry as well as in pharmaceutical industry. The medicinal properties of the pepper are due to the presence of an active compound called piperine with a molecular formula of $C_{17}H_{19}NO_3$. The oleoresin extracts from white pepper is made up of 4.6-9% piperine, 6% pungent resin, 2.5% essential oil and starch. The oleoresin extracts from white pepper possesses a characteristic anti-inflammatory, antidepressant, anti-rheumatic and anti-diabetic properties.^(10,11) In this present study, white pepper oleoresin was used for the synthesis of silver nanoparticles and was characterised by UV visible spectroscopy. The synthesised nanoparticles is used for the analysis of anti-bacterial activity against oral pathogens.

METHODS

Preparation of White Pepper Oleoresin

1 milli molar of silver nitrate solution was prepared initially by dissolving it in double distilled water. 90 ml of this 1 milli molar solution was mixed with 10 ml of white pepper oleoresin solution. The solution was kept in magnetic stirrer/ orbital shaker for the formation of nanoparticles. The colour change was observed visually and photographs were taken. (Graph 1).

Preparation of Nanoparticles

The nanoparticles solution was centrifuged using Lark refrigerator centrifuge. The solution was centrifuged at 8000 rpm for 10 minutes and the pellets were collected and washed with distilled water. The final purified pellets were collected and dried at 60 degree Celsius for 2 hours and stored in airtight Eppendorf tube.

UV-Visible Spectroscopic Analysis of Silver Nanoparticles

The synthesised white pepper oleoresin mediated nanoparticles were confirmed by UV visible spectroscopy. 3 ml of the solution was taken in cuvette and scanned in double beam UV visible Spectrophotometer from 300 nm to 650 nm. The results were recorded for the graphical analysis. (Graph 1)

Antibacterial Activity of Nanoparticles against Oral Pathogens

The agar well diffused method was used to determine the antibacterial activity of silver nanoparticles. Different concentration of silver nanoparticles was tested against *Staphylococcus aureus*, *Streptococcus mutans* and *Pseudomonas*. The fresh bacterial suspension was dispersed on the surface of Muller Hinton agar plates. Different concentration of nanoparticles (20 μ L, 40 μ L and 60 μ L) was incorporated into the wells and the plates were incubated at 37 degrees Celsius for 24 hours. The amoxicillin was used as positive control. Zone of inhibition was recorded in each plate.^(12,13)

RESULTS

Graph 1. UV Visible Spectrophotometric Analysis of Synthesised White Pepper Oleoresin Mediated Silver Nanoparticles.

It was well known that silver nanoparticles exhibit yellowish discolouration colour in aqueous solutions due to excitation of surface plasmon vibrations in silver nanoparticles. The peak was observed at 350 nm showing the steady intensity as a function of reaction time. (Graph 1).⁽⁸⁾

The green synthesised silver nanoparticles were studied for its anti-microbial activity against oral pathogens bacteria by using agar well diffusion assay. The silver nanoparticles synthesised showed antibacterial activity against all the tested organisms especially against *S. mutans* and *P. aeruginosa*. Maximum zone of inhibition was found to be with *Pseudomonas aeruginosa*.

DISCUSSION

Anti-Bacterial Activity of Silver Nanoparticles

Silver nanoparticles have the ability to attach to the bacterial cell and eventually penetrate into it thus causing structural changes in the cell membrane like the permeability of the cell membrane and death of the cell. The effect of silver nanoparticles were tested for the anti-microbial activity against oral pathogens namely *Staphylococcus aureus*, *Streptococcus mutans* and *Pseudomonas aeruginosa*. The extract obtained from white pepper oleoresin showed a zone of inhibition for the three pathogens. The zone of inhibition for *Pseudomonas aeruginosa* was comparatively larger than the other two showing increased effect of white pepper oleoresin mediated silver nanoparticles against the same. (Graph 2).^(9,14)

The synthesis of nanoparticles is in the lime light of the modern technology. Biosynthesis of nanoparticles by plant extracts is currently under exploitation.⁽¹⁵⁻²³⁾ The development of biologically inspired experimental process for the synthesis of nanoparticles is evolved into an important branch of nanotechnology.⁽²⁴⁻³³⁾ Silver nanoparticles find its use in many industries and the major applications include electronics, in optics and most importantly in the medical field as a bacterial and therapeutic agent.^(34,35)

CONCLUSIONS

Biosynthesised silver nanoparticles using white pepper oleoresin have excellent anti-microbial property. The biological approach seems to be a very cost efficient alternative to the conventional physical and chemical methods of silver nanoparticles synthesis and would be suitable for developing a biological process for large scale products. This study demonstrated the possibility of using green synthesised silver nanoparticles. The study reveals that the silver nanoparticles from white pepper show a good activity on the oral pathogens. Hence this technology can be applied in therapeutics in the near future.

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