



GREEN BIOGENIC APPROACH TO SYNTHESIS OF SILVER NANOPARTICLES USING *OPUNTIA FICUS INDICA* AND THEIR ANTIBACTERIAL ACTIVITY AGAINST WOUND CAUSING *S.AUREUS*

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ABSTRACT

Plant mediated synthesis of nanoparticles is a green chemistry approach that interconnects nanotechnology and plant biotechnology. In the present study the antibacterial activity of silver nanoparticles synthesized from *Opuntia ficus indica* were analysed against the wound causing *Staphylococcus aureus*. The formation and stability of the reduced silver nanoparticles in the colloidal solution were monitored by UV-Vis spectrophotometer analysis. It also possess very good antibacterial activity which makes them a potent source of antibacterial activity. The synthesized phytonanoparticles have exhibited a wide range of activities to the bacteria strains and reveals high efficacy of silver nanoparticle as a strong antibacterial activity against *S.aureus*. These finding could be useful in searching new clinically important antimicrobials and helpful the treatment of human and animal diseases and in replacing synthetic drugs as well.

KEYWORDS: *Opuntia ficus indica*, Silver nanoparticles, Antibacterial activity.

INTRODUCTION

Nanotechnology is one of the most active research areas in modern materials is gaining importance all over the world (Govindaraju *et al.*, 2010). Metal nanoparticles are more effective because of high surface to volume ratio. Among all metal nanoparticles, AgNPs have great importance due to their application in various fields such as nanomedicine, antimicrobial agent (Ganesh babu *et al.*, 2013). Silver nanoparticles have proved to be most effective against bacteria, viruses and other eukaryotic microorganisms. Silver nanoparticles used as Drug disinfectant have some risks as the exposure to Silver can cause argyrosis and argyria also, it is toxic to mammalian cells (Gong *et al.*, 2007). An eco friendly green mediated synthesis of inorganic nanoparticle is a fast growing research in the limb of nanotechnology (Sathya *et al.*, 2012). The biosynthesis method employing plant extracts have drawn attention as a simple and viable alternative to chemical procedures and physical methods. Bio reduction of silver ions to yield metal nanoparticles using living plants (Nagajyoti *et al.*, 2011). Various plant systems have been used for the biosynthesis of silver nanoparticles, Which includes *Langerstroemia speciosa* (Sundararajan *et al.*, 2014), *Manifera indica* (Vikas sursar *et al.*, 2013), *Abelmoschus moschatus* (Ruchita V Rane *et al.*, 2014), *Epiphyllum oxypetalum* (Priti paraikar, 2014), *Calotropis gigantean* (Sivakumar *et al.*, 2011), *Psidium guava* (Sriram *et al.*, 2014), *Acacia*

nilota (Usha *et al.*, 2014), *Lanтана camara* (Thirumurugan *et al.*, 2011), *Murraya koenigii* (Laura christensen *et al.*, 2011), *Azhadiraca indica* (Lalitha *et al.*, 2013), *Ocimum* (Mallikarjuna *et al.*, 2011) and *Tridax procumbens* (Himakshi Bhati *et al.*, 2013).



(*Opuntia ficus indica*) Cactus

Family : cactaceae
Order : caryophyllales
Kingdom : plantae
Binomial name : *Opuntia ficus indica*

Cactus (*Opuntia ficus-indica*) has been used in traditional folk medicine because of its role in treating a number of diseases and conditions, including diabetes,

hypertension, hypercholesterolemic, rheumatic pain, gastric mucosa diseases and asthma, in many countries over the world. Nowadays, the cactus, fruits and cladodes, is the focus of many studies because they contain bioactive (phytochemicals) compounds, well known for their health-related properties. It has been revealing a positive correlation between a diet rich in prickly pear cactus and a reduced risk of diseases associated with oxidative stress, such as diabetes, cancer, cardiovascular and neurodegenerative diseases. The *Opuntia ficus-indica* exhibits diverse pharmacological actions through its antioxidant activity: protects cells against oxidative damage, acts as radical scavengers, reduces lipid peroxidation and increases GSH levels. So far, there is no report about the adverse/toxic effects on humans (Ulises Osuna-Martínez *et al.*, 2014). Hence the aim of the present study is to develop a novel approach for the green synthesis of silver nanoparticles using herbal plant of *Opuntia ficus indica* which has been proven active against gram positive *S.aureus*.

MATERIALS AND METHODS

Collection of Plant material

Opuntia ficus indica pads were collected from Perumanallur of Tirupur district, Tamilnadu, India. The pads were washed with water, then surface sterilized with 10% sodium hypochloride solution, rinsed with sterile distilled water and air dried at room temperature. Fresh pads were used as a raw material (Mahendran sekar *et al.*, 2013).

Bacterial strain isolation

A total of 5 wound samples were isolated from Perundurai Medical College and Hospital, Perundurai, Erode. Bacterial isolates were maintained at -20° C in nutrient broth. An aseptically collected wound sample was inoculated, with the help of standard inoculating loop, on the mannitol salt agar plate was incubated, the growth of bacterial colonies were observed and results were recorded (Akhilesh kushwaha *et al.*, 2015).

Opuntia ficus indica Extract Preparation

A 30 g portion of *Opuntia ficus indica* cladodes was rinsed with de-ionized water and finely cut. Afterwards, it was boiled in 100 ml of de-ionized water for five minutes. The mixture was cooled and vacuum filtered. The resulting extract was used for further experiments (Silva de hoyos *et al.*, 2012).

Synthesis of silver nanoparticles using *Opuntia ficus indica* extract

Different volumes of the extract were added to 5 mL of 10⁻³ mM AgNO₃ solutions, followed by the addition of 2.5 mL of 30% ammonia solution. Then, the volume was mixed with de-ionized water, to a final volume of 50 mL (Silva de hoyos *et al.*, 2012).

UV-Visible spectra Analysis

The reduction of pure Ag⁺ ions was monitored by measuring the UV-VIS spectrum of each reaction

mixtures at about 24 hours of reaction. A small aliquot was drawn from the reaction mixture and a spectrum was taken on a wave length from 300-540 nm on UV-VIS spectrophotometer (ELICO SL 159) UV-visible spectrophotometer (Jithesh Pooloth, 2013).

Antibacterial activity of silver Nanoparticles by Agar well diffusion technique

The silver nanoparticles synthesized using the cactus extract was tested for antibacterial activity by standard agar well-diffusion method against pathogenic bacteria *Staphylococcus aureus*. The pure cultures of bacterial pathogens were sub cultured on nutrient broth. 20ml of nutrient agar were poured into the Petri plates. Wells of 6 mm diameter were made on nutrient agar using gel puncture. Culture was swabbed uniformly using sterile cotton swabs, and then 50µl and 100 µl of 1mM AgNP (*Opuntia ficus indica*) solution was loaded into the wells. After incubation at 37°C for 24 hours, the different levels of zone of inhibition were measured (Perez, 1990).

RESULTS AND DISCUSSION

Identification of isolates

The isolated bacterial cultures were processed for identification. Based on morphological characterization and biochemical test the isolates were identified as *Staphylococcus aureus*.

Synthesis of silver nanoparticles

The biological synthesis of silver nanoparticles from aqueous extract of *Opuntia ficus indica* is confirmed by color change in reaction mixture from pale yellow to brown. The reaction mixture was analyzed by using UV-Vis Spectrophotometer. The absorbance was measured in the range of 300-600nm which includes the Plasmon absorbance peak of the silver nanoparticle centered at 420nm. UV-Visible spectrophotometric analysis has proved to be a very useful technique for the analysis of nanoparticles. In order to verify the synthesis of silver nanoparticles, the test samples were subjected to UV-Visible spectrophotometric analysis (Figure 1 and 3). Silva-de-Hoyos *et al.*, 2012 reported that the Plasmon peak for synthesized silver nanoparticle from *Opuntia ficus indica* was obtained at 398nm.

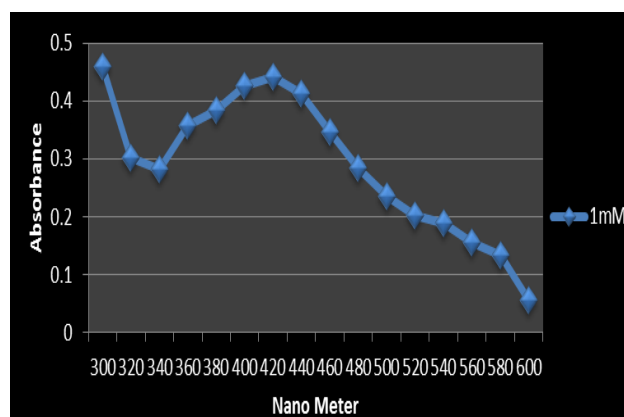


Figure 1: Synthesis of Silver Nanoparticles using *Opuntia ficus indica*

Antibacterial activity of Silver Nanoparticles against *S.aureus*

The antibacterial activity of silver nanoparticles synthesized from *Opuntia ficus indica* were studied against the *S. aureus*. (Figure 2 and 3) 1mM concentration of silver nanoparticles synthesized by *Opuntia ficus indica* in Aqueous extracts were found to have highest zone of inhibition in 16.35mm (50µl) & 18.25mm (100µl) for *S. aureus* 1. Minimum zone of inhibition was found in *S. aureus* 1 (10.45 (50µl) & 11.50mm (100µl)). Durgesh D Wasnik et al., 2016 stated the leaf pad of *Opuntia ficus indica* showed the least inhibitory activity against MDR strains isolated from clinical specimen.

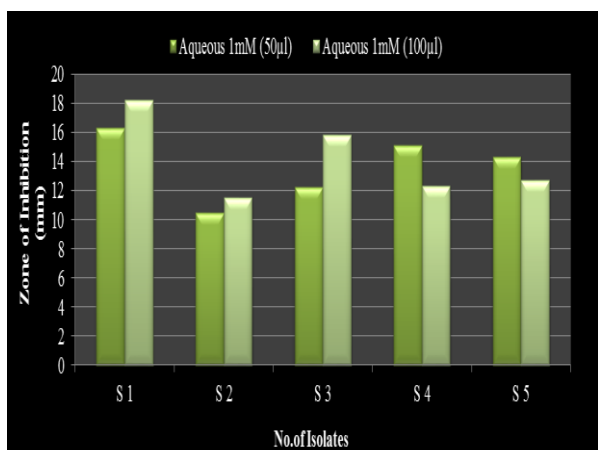


Figure 2: Antibacterial activity of Synthesized Silver Nanoparticles using *Opuntia ficus indica*

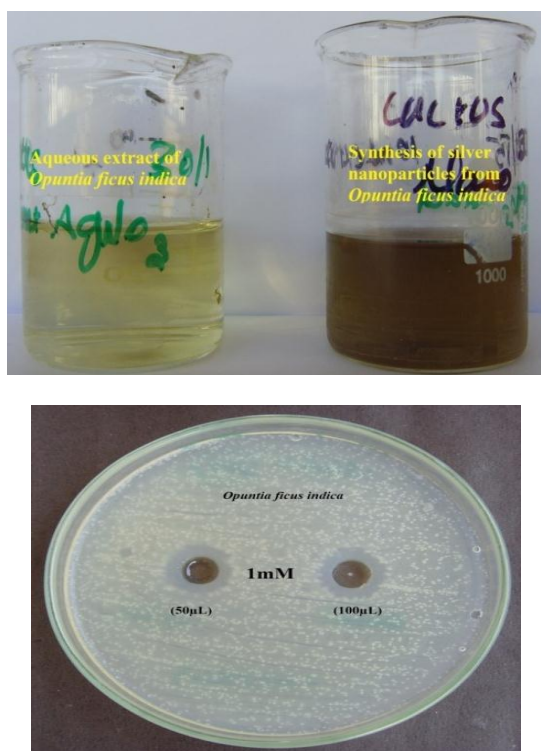


Figure 3: showing the synthesis of silver nanoparticles from *Opuntia ficus indica* and its antibacterial activity against *S.aureus*

CONCLUSION

The silver nanoparticles have been produced by *Opuntia ficus indica*, which is an economical, efficient and eco-friendly process. The zone of inhibition were formed in the antimicrobial screening test indicated, that the AgNps synthesized in this process has the efficient antimicrobial activity against pathogenic bacteria. The biologically synthesized silver nanoparticles could be of immense use in medical field for their efficient antibacterial function.

REFERENCES

1. Akhilesh kushwaha, Vishal kumar singh, Juhi bhartariya, Priya singh and Khadeja yasmeeen. Isolation and identification of *E.Coli* bacteria for the synthesis of silver nanoparticle: Characterization of the particles and study of antibacterial activity. Eur J Exp Bio, 2015; 5(1): 65-70.
2. Durgesh D Wasnik, Tumane P.M. In vitro Antibacterial activity of *Opuntia ficus indica* L. (Prickly pear) against multiple drug resistant (MDR) bacteria isolated from clinical samples. W J Pharmacy and Pharmaceutical sciences, 2016; 5(3): 996-1006.
3. Ganesh Babu MM, Gunasekaran P. Extracellular synthesis of crystalline silver nanoparticles and its characterization. Mater Lett, 2013; 90: 162-164.
4. Gong P, Li H, He X, Wang K, Hu J and Tan W. Preparation and antibacterial activity of Fe O @Ag nanoparticles. Nanotechnol, 2007; 18: 604-11.
5. Govindaraju K, Tamilselvan S, Kiruthiga V, Singaravelu G. J Biopest, 2010; 3: 394-399.
6. Jithesh pooloth. Biosynthesis of Silver Nanoparticles using *Trigonella Foenum Graceum* and the Determination of their Antimicrobial Activity. Int J of Sci and Res, 2013; 2319-7064.
7. Lalitha A, Subbaiya R and Ponmurugan P. Green synthesis of silver nanoparticles From leaf extract of *Azhadira Indica* and to study its antibacterial and antioxidant activity. Int J Curr Microbiol App Sci, 2013; 2(6): 228-235.
8. Laura Christensen, Singaravelu Vivekanandhan, Manjusri Misra, Amar Kumar Mohanty. Biosynthesis of silver nanoparticles using murraya koenigii (curry leaf): An investigation on the effect of broth concentration in reduction mechanism and particle size. Adv Mat Lett, 2011; 2(6): 429-434.
9. Mallikarjuna K, Narasimha G, Dillip GR, Praveen B, Shreedhar B, Sree lakshmi C, Reddy BVS, Deva prasad raju B. Green synthesis of silver nanoparticles using *ocimum* leaf extract and their characterization. D J of Nanomat Biostruct, 2011; 6(1): 181 – 186.
10. Mahendran sekar, Nor safwakhodi, Bin nor afendi, Puteri nurul, Fatiah datu bandria, Zakiah syahirah binti mohd hasim, Ezza izzaty binti mohd nor, Nalina krishnaswamy, Mohd sydfiq bin Abdullah. Int J Current Pharm Res, 2013; 5(4): 32-35.
11. Himakshi Bhati, Kushwaha C P Malik. Biosynthesis of Silver Nanoparticles using Fresh extracts of

- Tridax Procumbens* Linn. Int J of Experimental Biology, 2013; (52): 359-368.
12. Nagajyoti PC, Prasad TNVKV, Sreekanth TVM and KapDuk Lee. Bio fabrication of silver nanoparticles using leaf extract of *Saururus chinensis*. Digest J Nanomat Biostruct, 2011; 6(1): 121-133.
 13. Perez C, Paul M and Bazerque P. Antibiotic assay by agar well diffusion method. Acta Biol Med Exp, 1990; 15: 113-115.
 14. Priti Paralikar. Biogenic Synthesis of Silver Nanoparticles Using Leaves Extract of *Epiphyllum Oxypetalum* and its Antibacterial Activity. Austin J Biotechnol Bioeng, 2014; 1(7).
 15. Ruchita V Rane, Meenakshi K, Mansi Shah and indu A George. Biological synthesis of Silver Nano particles using *Abelmoschus moschatus*. Indian J Biotechnoogy J Microbiol Biotech, 2014; 13: 342-346.
 16. Sathya A and Ambikapathy V. Studies on the Phytochemistry, Antimicrobial activity and green synthesis of nanoparticles using *Cassi tora* L. Drug invent Today, 2012; 4(8): 408-410.
 17. Silva-de-Hoyos LE, Sanchez-Mendieta V, Rico-Moctezuma A, Vilchis- Nestor AR, Camacho-Lopez MA, Avalos-Borja M. Silver nanoparticles biosynthesized using *Opuntia ficus* aqueous extract. Superficies Vacio marzo de, 2012; 25(1): 31-35.
 18. Sivakumar J, Premkumar C, Santhanam P and Saraswathi N. Biosynthesis of Silver Nanoparticles Using *Calotropis gigantean* Leaf. African J Basic Appl Sci, 2011; 3(6): 265-270.
 19. Sriram T, Pandidurai V. Synthesis of silver nanoparticles from leaf extract of *Psidium guajava* and its antibacterial activity against pathogens. Int J Curr Microbiol App Sci, 2014; 3(3): 146-152.
 20. Sundararajan B and Ranjitha kumara BD. Biosynthesis of silver nanoparticles in *lagerstroemia speciosa* (L.) pers and their antimicrobial activities. Int J Pharm Pharm Sci, 2014; 6(3): 30-34.
 21. Thirumurugan A, Neethu Anns Tomy, Hema Priyanka Kumar, Prakash P. Biological synthesis of silver nanoparticles by *Lantana camara* leaf extracts. Int J of Nanomat Biostruct, 2011; 2: 22-24.
 22. Ulises Osuna-Martínez¹, Jorge Reyes-Esparza, Lourdes Rodríguez-Fragoso. Cactus (*Opuntia ficus-indica*): A Review on its Antioxidants Properties and Potential Pharmacological Use in Chronic Diseases. Nat Prod Chem Res, 2014; 2:6.
 23. Usha C, Gladys Angelin Rachel D. Biogenic Synthesis of Silver Nanoparticles by *Acacia nilotica* and their Antibacterial Activity, 2014; 3(6).
 24. Vikas Sarsar, Krishan K. Selwal, Manjit K, Selwal. Green synthesis of silver nanoparticles using leaf extract of *Mangifera indica* and evaluation of their antimicrobial activity. J Microbiol Biotech Res, 2013; 3(5): 27-32.