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Potato tuber extract based synthesis, characterisation and antibacterial activity of silver nanoparticles

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ABSTRACT

Nanotechnogy has played an important role in physical, chemical, biological and pharmaceutical sciences. The object consisted of the particles size 10-100 nm are usually known as nanomaterials. The important metal and metal oxide nanoparticles can be synthesised by using different physical and chemical methods. These methods are suffering with many disadvanges such as use of hazardous chemicals, low efficiency and high cost. Green synthesis of nanoparticles has been attracted for its efficiency, low cost and simplicity. In this study, silver nanoparticles (AgNPS) have been synthesised by using the extract of potato (*Solanumtuberosum*) tuber extract as reducing agent. The synthesised AgNPS were analysed by different analytical methods such as FTIR, powder XRD and FESEM. All these methods are indicating a sufficient formation of AgNPS. Biologically synthesised AgNPS have been tested for antibacterial activity. Remarkable zones of inhibition have been obtained for *Streptococcus mutons*, *Proteus vulgaris* and *Escherichia coli*.

Keywords:*Nanoparticles; Green synthesis; AgNPS; Characterisations; Antibacterial activity*

1. INTRODUCTION

The use of nanotechnology in the synthesis of nanoparticles by using plant derived extracts has been attracted great attentions since last 6 to 8 years. The biologically synthesised metal and metal oxide nanoparticles are used in physical, biological, pharmaceutical and chemical sciences (Gavamukulya et al., 2020). The conventional methods are used in the synthesis of such nanoparticles suffered with poor efficiency, high cost and use of hazardous chemicals. The green or biological synthetic approaches are good alternatives over these conventional methods and characterised by low cost, high efficiency and eco-friendly (Pirtarighat et al., 2019). The common green or biological synthesised nanoparticles are silver (Ag), gold (Au), copper (Cu), palladium (Pd), manganese oxide (MnO_2), zinc oxide (ZnO), cupric oxide (CuO), titanium oxide (TiO_2), calcium oxide (CaO), magnesium oxide (MgO) and iron oxides(Haberl et al., 2013; Durán et al., 2010; Salvioni et al., 2017; Joshi and Prakash, 2019). Siver nanoparticles (AgNPS) are greatly used in pharmaceuticals, air filtrations, water detoxification, catalysts, textiles diagnostics and optoelectronics and other clinical/pharmaceutical applications (Gavamukulya et al., 2020; Ouay and Stellacci, 2015; Chen et al., 2009; Sun et al., 2003; Haes and Duyne, 2002; Dankovich and Gray, 2011). Potato or *Solanumtuberosum* is very common cultivated tuber crop in the world. It is used as a food and in making processed foods; Potatos are also used in alcoholic and starch making industries (Zhang et al., 2016; Reddy et al., 2018).

2. MATERIALS AND METHODS

The materials such as silver nitrate ($AgNO_3$), sodium hydroxide (NaOH), double distilled water and plant leaves have been used in the synthesis of AgNPS.

Preparation of plant extract:

The collected parts of potato root (Tubers) have been washed with distilled water and cut into possible small pieces. 2 g of cut pieces were added into 100 ml of distilled water and boiled for 30 minutes. After boiling, the content was filtered and filtrate

i.e. tuber extract preserved at 4^0C for further studies (Pirtarighat et al., 2019).

Synthesis and characterisations of AgNPS:

5 ml of extract was treated with 100 ml of 0.1 M silver nitrate ($AgNO_3$) solution and stirred over a magnetic stirrer with a constant shake and at room temperature for 90 minutes. Now adjust the pH of this solution basic (10 to 10) by adding 0.1 M NaOH and digital pH meter. The precipitate of AgNPS has come out and separated from the solution by using centrifugation machine 10,000 rpm for 15 minutes. The collected AgNPS were washed three times with double distilled water and again centrifuged. After that, AgNPS have been completely dried in hot air oven and then calcined at 350^0C for 2 hours. Finally, AgNPS were preserved in air tight bottles for characterisations and other studies. The characterisation methods included FTIR, powder XRD and FESEM.

Antimicrobial activity:

The antimicrobial activity of AgNPS was done by using well diffusion method. The petri plates containing nutrient agar have been prepared by introducing 15 ml of liquid media on sterile plates and then solidified (Lorian, 1996). The AgNPS were loaded in the wells on plates and then incubated for 24 hours at 37°C.The bacterial cultures used for antibacterial activity of AgNPs were *Streptococcus mutons*, *Proteus vulgaris* and *Escherichia coli*.

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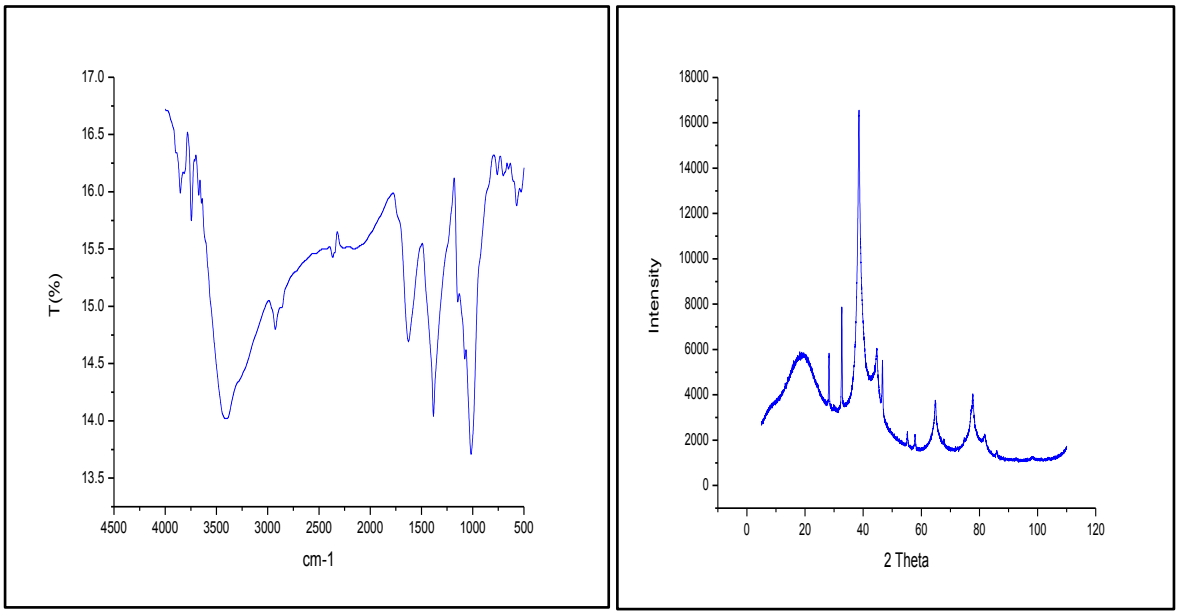
3. RESULTS AND DISCUSSION

Characterisations of AgNPS:

The AgNPS have been investigated by using FTIR, powder XRD and FESEM methods. Fourier Transform Infrared Spectroscopy is related to the absorption of light by atoms and molecules in infrared region by the molecules and used to detect the type of bonds present in the biologically synthesised nanomaterials (Pirtarighat et al., 2019). The characteristic peaks are obtained at 3728 cm^{-1}, 1637 cm^{-1}, 1384 cm^{-1}, 1027 cm^{-1} and 579 cm^{-1} and related to O-H, C=O, C-C, Ag-C, Ag-O etc (Fig. 1A). The powder X-ray diffraction method is generally used to determine the amorphous, semi-crystalline and crystalline nature of nanomaterials. The XRD pattern is represented in figure 1B and indicating the crystalline to some semi-crystalline nature of green synthesised AgNPS by using potato extract. The characteristic peaks are obtained at 18 Ɵ, 42 Ɵ, 64 Ɵ and 78 Ɵ for AgNPS(Gavamukulya et al., 2020; Joshi and Prakash, 2019). The morphological features are usually determined by using Field Emission Scanning Electron Microscope (FESEM) technique. FESEM image of AgNPS (Fig. 1C) indicates agglomerated and semi-sphere shaped nanoparticles.

Antibacterial activity:

The metal and metal oxide nanoparticles have been significantly utilised in the pharmaceutical and biological sciences due to their antibacterial behaviour. The AgNPS are most common antibacterial agents because of their small size and advanced properties. Such particles can easily enter into the bacterial cells and cause distortions inside the bacterial cells and destroy the cell membrane (Pirtarighat et al., 2019; Joshi and Prakash, 2020;Dankovich and Gray, 2011). This finally causes death of the bacterial cells. We have utilised the AgNPS for the inhibition of *Streptococcus mutons*, *Proteus vulgaris* and *Escherichia coli* by using well diffusion method. After incubation period, the zones of inhibitions are obtained as 16 mm, 12 mm and 16 mm for *E. coli*, *P. vulgaris* and *S. mutons*at 12.5 mg/ml dosage (Table 1).



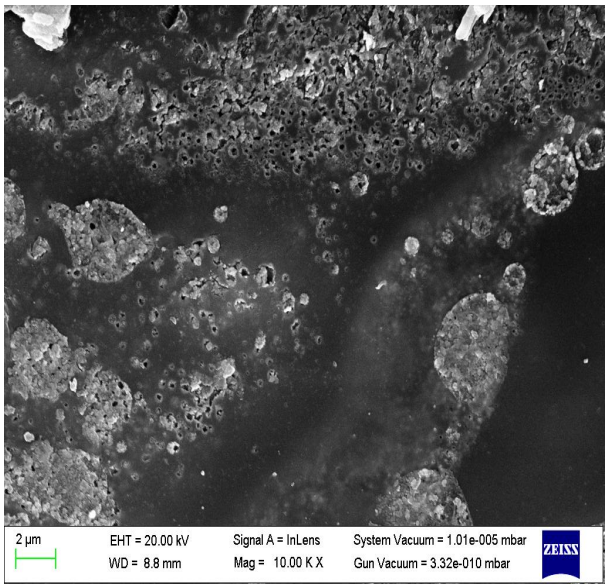


Figure 1 (A) FTIR (B) XRD and (C) FESEM image ofAgNPS

Table: 1 Antibacterial activity of NPS against different bacterial strain.

Bacterial strain	Zone of inhibition
Streptococcus mutons	16 mm
Proteus vulgaris	12 mm
Escherichia coli	16 mm

4. CONCLUSIONS

Potato tuber extract based synthesis of silver nanoparticles is found very low cost, simple and efficient. The synthesised nanoparticles were well investigated by using different analytical methods such as FTIR, XRD and FESEM. The biologically synthesised silver nanoparticles have been tested for different bacterial species and found effective for *E. coli* and *S. mutans*.

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