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Weed Mediated Synthesis of Silver Nanoparticles

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ABSTRACT

The present study was conducted with an objective to study green synthesis of silver nanoparticles using plant leaves extract of Oxalis stricta and characterization of synthesized phyto silver nanoparticles. Nanotechnology refers broadly to a field of applied science and technology. Nanotechnology deals with the synthesis and stabilization of matters at the nanoscale level ranging from 1 to 100 nm. Green synthesis of silver nano-particles using plant extracts provides significant advantage over the chemical and physical methods. Cost effective, non-using toxic chemicals, low pressure, energy and temperature, environment friendly and easily scaled up for large scale applications are some of these benefits triggers by biological synthesized silver nanoparticles as compared to chemical synthesized nanoparticles. Various techniques used to characterize synthesized nanoparticles that include visual observation, FTIR and UV-Visible spectrophotometer. Among all the biological agents, plants provide a better platform for nano-particles synthesis as they are free from toxic chemicals and provide natural capping agents. Silver nanoparticles have found enormous applications in various fields such as antimicrobial agent, biolabelling, sensors, filters, microelectronics and catalysis, because of their specific physiochemical and biological properties.

Key words: *FTIR, Green synthesis, Oxalis stricta, Phyto silver nanoparticles.*

INTRODUCTION

Nanotechnology refers broadly to a field of applied science and technology whose unifying theme is the control of matter on the atomic and molecular scale[8]. Nanoparticles are characterized as fundamental building block of nanotechnology[7]. The word "nano" is used to indicate one billionth of a metal or 10^{-9}. "Nano" is a Greek word synonymous to a word meaning extremely small. Nanoparticles are cluster of atoms in the size range of 1 to 100 nm. Nanotechnology and nanoparticles exhibit astonishing optical, electronic, magnetic and catalytic properties than their respective bulk material. These key properties are owing to their high surface area to volume ratio[9]. Due to all these unique properties nano-structured metals are becoming key in applications as catalysts, sensors, electronics, biotechnology and biomedicine[2,10].

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Green synthesis of silver nano-particles using plant extracts and microorganisms provides significant benefit over the chemical and physical methods. Low pressure, energy and temperature, non-using toxic chemicals, cost effective, environment friendly and easily scaled up for large scale applications are some of these benefits[7]. In green synthesis, the use of plants as the production assembly of silver nanoparticles has drawn major attention, because of its fast, eco-friendly, non pathogenic, economical procedure and biosynthetic processes[1]. This synthesis method of silver nanoparticles involves the use of plant extract as reducing agent, capping agent or both[5].

Shamrock (*Oxalis stricta*) commonly considered as a weed of garden, field and lawns, it grows in full sun or shade. The alternate leaves of this plant are divided into three heart shaped leaflets that can grow upto 2 cm wide. These leaves are pale green to maroon heart shaped and curl up at night and open in the day to perform photosynthesis. All parts of the plant are edible with a distinct tangy flavor. The leaves and flowers of the plant are sometimes added to salads for decoration and flavoring. These can also be chewed raw as a thirst quencher. The leaves can be used to make a flavored drink that is similar in taste to lemonade and the whole plant can be brewed as herbal tea. An orange dye can be obtained by boiling the whole plant. It contain large amount of Vitamin C, an infusion of the plant has been used in the treatment of fevers, stomach cramp and nausea.

Phytosilver nanoparticles have found vast applications in diverse fields such as antimicrobial agent[11,12], amoebicidal activity[4], bio labelling, catalysis[3], filters, microelectronics and sensors, because of their specific physiochemical and biological properties[6,7]. Thus, keeping above views in consideration present investigation was undertaken with an objective of synthesis and characterization of biologically synthesized silver nanoparticles from *Oxalis stricta.*

MATERIAL AND METHODS

Sterilization of glassware

All the glasswares used during the experiments were sterilized by autoclaving at 121^{o}C for 15 minutes.

Plant material collection

Leaves of *Oxalis stricta* were collected from the fields of M.I.E.T., Meerut. The leaves were washed and then cleaned leaves were air dried for 15 days and ground to a fine powder.

Aqueous plant extract preparation

200 mg of powdered leaves was dispensed in 100 ml of sterile distilled water and boiled for one hour at 80^{o}C. Then the leaves extract was collected in separate conical flasks by standard filtration method. The same method was applied for all the three samples of plant material.

Preparation of 1 M silver nitrate

Crystals of 1M silver nitrate was dissolved in the 100 ml of sterile distilled water and solubilized to make a clear solution. The solution was kept in dark bottles for future use.

Green synthesis of silver nano-particles

0.001M silver nitrate (10^{-3} M) and aqueous plant leaves extract were mixed in a ratio 95:5 ml. The time of addition of leaves extract into the aqueous silver nitrate solution was considered as the start of the reaction. Then the solution was kept at 80^{o}C at shaking condition for 24 hrs and colour change was observed. This reaction mixture was used for further study.

Detection and characterization of phyto-silver nanoparticles

Visual observation

The reaction mixture containing 95 ml of 0.001 M silver nitrate and 5 ml of aqueous plant leaves extract was examined after every 1 hour upto 24 hours and the change in colour was observed with respect to time for the detection of silver nanoparticles.

UV-Visible spectroscopy analysis

For the UV-visible spectrum analysis the aliquots of reaction mixture were subjected to the measurement of the absorbance by UV-Visible Spectrophotometer (239/Gen/01) at the wavelength 300 to 550 nm for the detection of silver nanoparticles and the baseline was always set with a relevant blank.

Fourier transform infrared spectroscopy analysis

Fourier transform infrared measurement was recorded by FT-IR instrument **(**Shimadzu FTIR-840S) in a range of 400 to 4000 cm^{-1}. For FT-IR analysis of silver nanoparticles, the solution of silver nanoparticles was converted to powdered form by lyophilizer (Macflow FD3C) to determine the variation of the functional groups present in the synthesized silver nanoparticles.

RESULTS AND DISCUSSION

Plant mediated synthesis of silver nanoparticles

On treatment of plant leaves extract of *Oxalis stricta* with 0.001M silver nitrate and incubation in dark at room temperature, the colour changes from transparent to pale yellow and further to dark orange show the synthesis of silver nanoparticles. It is an efficient and rapid synthesis which corroborate with the result obtained by other researchers who had worked with different plant systems[12,2,1]. Colour change was due to excitation of surface plasmon vibrations in the synthesized phyto silver nanoparticles[7].

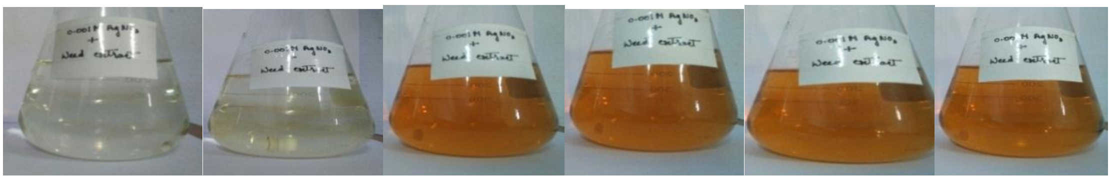
Table 1: Indication of colour change in phyto silver nanoparticles solution

S. No.	Plant Extract	Colour of silver nitrate solution observed after 24 hours	Time (hours)					
			0	1	2	3	4	24
1	*Oxalis stricta*	Orange	-	-	+	++	+++	+++

Detection and characterization of phyto-silver nanoparticles

Visual observation

Fig. 1 shows the change in colour of 0.001M silver nitrate solution after the addition of aqueous plant leaves extract of *Oxalis stricta* from transparent to pale yellow within one hour and then to dark orange within three hours was observed and with time the intensity of the colour was enhanced and became stable after four hours which concludes that silver nitrate solution was reduced by the organic moiety present in the plant extract to silver ions and silver nanoparticles was formed.



At 0 hour After 1 hour After 2 hours After 3 hours After 4 hour After 24 hours

Figure 1: Synthesis of silver nanoparticles by *Oxalis stricta*

UV-Visible spectroscopy

The absorption band in visible light region of 300-550 nm is typical for silver nanoparticles. Fig. 2 shows the absorbance peak due to the excitation of surface plasmon vibrations at 431 nm for the synthesized silver nanoparticles that confirmed the synthesis of silver nanoparticles using plant leaves extract of *Oxalis stricta*.

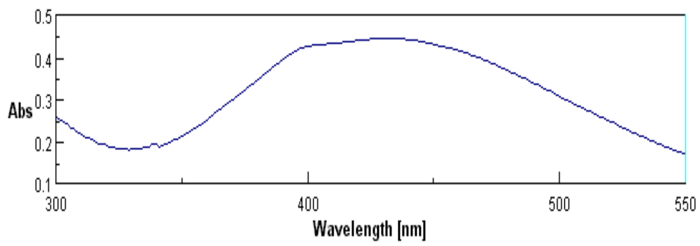


Figure 2: UV-Visible spectra of silver nanoparticles synthesized by plant leaf extract of *Oxalis stricta*

Fourier transform infrared spectroscopy

FT-IR is a unique quantitative analysis technique used for the characterization of the synthesized silver nanoparticles that identifies the types of chemical bonds in a molecule by producing an infrared absorption spectrum. Fig. 3 shows the characteristic absorption in the range of 400-4000 cm^{-1} and the type of vibrations shown by the functional groups present in the prepared complex and Table 2 indicates the different functional groups to identify the possible biomolecules responsible for reducing, capping and efficient stabilization of the synthesized phyto-silver nanoparticles.

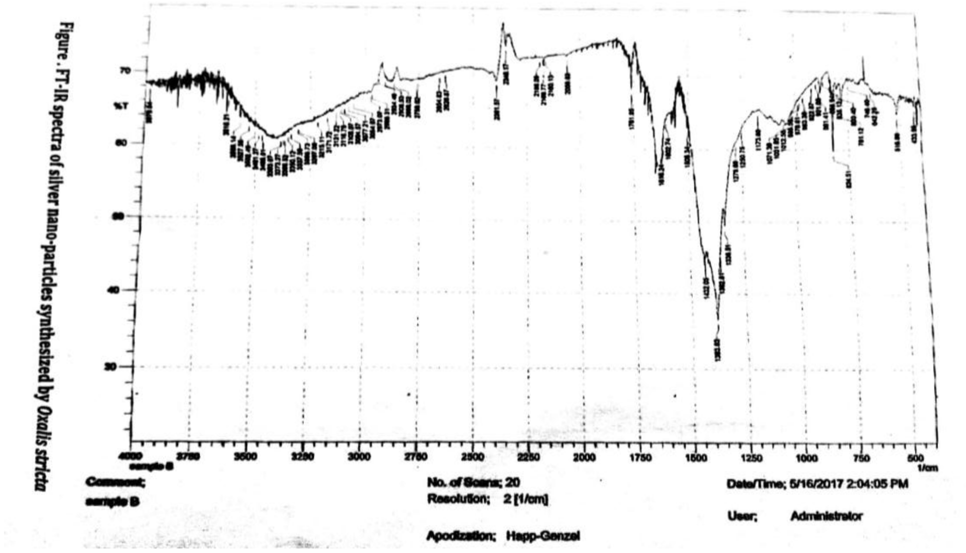


Figure 3: FT-IR analysis of silver nanoparticles synthesized by *Oxalis strict*

Table 2: FT-IR analysis of silver nanoparticles synthesized by *Oxalis stricta*

S.No.	**Characteristic absorption (cm^{-1})**	**Functional group**	**Type of vibrations**
1	1616.24	N-H	Bending
2	1432.05	C-H	Bending
3	1383.83	C-H, NO2	Bending, Stretch
4	1338.51	C-F, C-N	Stretch
5	824.51	C-H	Bending
6	781.12	C-Cl	Stretch
7	516.89	C-Br	Stretch

CONCLUSIONS

Hence the results conclude that the weed used is efficient in synthesizing the useful silver nanoparticles and hence weed mediated synthesis of silver nanoparticles are simple, rapid, cost efficient and eco-friendly method could be a competitive alternative to the conventional physical/chemical methods used for synthesis of silver nanoparticle, therefore, these synthesized silver nanoparticles could have potential use in industries for various commercial applications.

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