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Research Article

GREEN SYNTHESIS OF SILVER NANOPARTICLES USING THE AQUEOUS EXTRACT OF *PORTULACA OLERACEA (L.)*

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ABSTRACT

In order to implement green chemistry techniques in the synthesis of silver nanoparticles and to focus on the importance of plant sources available world-wide, an eco-friendly method of synthesis of silver nanoparticles using aqueous extract of *Portulaca oleracea* was carried out. Rapid synthesis of silver nanoparticles was seen in sonication method comparing room temperature and higher temperature conditions. The completion of the formation of silver nanoparticles was monitored by UV-visible spectroscopy. The particle size of the synthesized silver nanoparticles was found to be less than 60 nm and confirmed by XRD, Scherrer's formula and SEM analysis.

Keywords: *Portulaca oleracea,* Nanoparticles, SEM, XRD, Scherrer's formula.

INTRODUCTION

Nanotechnology is a field that is making a mark in research day by day and making an impact in all spheres of human life. Biological methods of synthesis have paved way for the "greener synthesis" of nanoparticles and these have proven to be better methods due to slower kinetics, they offer better manipulation and control over crystal growth and their stabilization[1].

Many preparations of the building blocks of nanotechnology involve hazardous chemicals, low material conversions, high energy requirements, and difficult, wasteful purifications; thus, there are multiple opportunities to develop greener processes for the manufacture of these materials. Many of the green chemistry principles apply readily to the synthesis or production of nanoscale materials. A more efficient and less hazardous synthesis of metal nanoparticles has been developed, producing greater amounts of particles, in less time, under milder conditions, while using less hazardous reagents than the traditional preparation [2].

Synthesis of silver nanoparticles is of much interest to the scientific community because of their wide range of applications in catalysis, electronics, photonics, optoelectronics, sensing, and pharmaceuticals [3,4]. These nanoparticles could be successfully used in the cancer diagnosis and treatment [5]. In recent years, biosynthesis of silver nanoparticles using plant extracts [6-8] and microorganisms [9,10] have been reported. Due to the availability, low cost, eco-friendliness, non-toxic nature, the synthesis of silver nanoparticles using plant extracts has become dominant among the others.

Portulaca oleracea or Purslane (paruppu keerai), was one of the anti-magic herbs and contains large amounts of *l*-norepinephrine, a neurohormone that has vasopressor and antihypotensive activities and reduces haemorrhage at the tissue level. It also contains numerous common nutrients like vitamins, minerals (especially potassium); fatty acids, especially omega-3 acids, glutathione; glutamic acid; and aspartic acid [11]. It is eaten as a salad and vegetable all around the world and used medicinally for a variety of conditions that include headache, stomach ache, painful urination, enteritis and mastitis.

An aqueous extract of *Portulaca oleracea* was shown to have skeletal muscle relaxant effects both *in vitro* and *in vivo*; other studies include: antibacterial and antifungal; wound healing; anti-inflammatory; uterine stimulant and diuretic in rabbits [12].

In this paper, we reported the synthesis of silver nanoparticles using the aqueous extract of *Portulaca oleracea* employing different experimental conditions and thereby enhancing the importance of plant sources and implementing green chemistry for future research.

MATERIALS AND METHODS

Preparation of plant extract

The plant broth was prepared by taking 20 g of fresh leaves of *Portulaca oleracea*. The fresh leaves were washed thrice and boiled for 5 minutes with 100 ml of Millipore water in a 500 ml Erlenmeyer flask. The prepared plant broth was filtered through Whatmann filter paper to obtain clear solution.

Synthesis of silver nanoparticles

The silver nanoparticles was synthesized by the addition of 1 ml of aqueous extract of *Portulaca oleracea* to different volumes (6ml, 7ml, 8ml, 9ml and 10ml) of 3Mm of silver nitrate solution. The yellow coloured solution was changed into reddish brown after 1hr under room temperature. The same concentrations were heated in a water bath at a constant temperature of 70-75°C and also sonicated using an ultrasonic bath (PCI Ultrasonic 1(H)).

Separation of silver nanoparticles

The synthesized AgNP's was separated by means of centrifugation (Spectrofuge 7M) at 13,000 rpm for 15 mins. The pellets was redispersed and again centrifuged for 15 mins. The supernatant solution thus obtained was stored at -4°C.

Characterization of silver nanoparticles

The formation of silver nanoparticles was observed by the colour change and also monitored by UV- visible spectroscopy (Double beam spectrophotometer 2202- SYSTRONICS). The supernatant solution obtained after centrifugation was coated on a glass substrate and used for XRD (SHIMADZU Lab X XRD-6000) with a Cu Kα radiation monochromatic filter in the range 10–80°and SEM (TESCAN instrument provided with Vega TC software) analysis. The Debye-Scherrer's equation was used to calculate the particle size of synthesized nanoparticles from the 2θ values obtained from XRD analysis. The FTIR (BRUKER FTIR Tensor-27) analysis was also recorded with supernatant solutions.

RESULTS AND DISCUSSION

The green synthesis of silver nanoparticles using the aqueous extract of *Portulaca oleracea* was carried out under different experimental conditions viz.,

(i) Sonication method
(ii) Reaction at room temperature and
(iii) Reaction at 75°C.

On adding, aqueous extract of *Portulaca oleracea* (1ml) to different volumes (6ml, 7ml, 8ml, 9ml and 10ml) of silver nitrate solution, the yellow colour changed to reddish brown after 1 hr and is shown in fig 1. The sonication method was found to be efficient and results in easy synthesis of silver nanoparticles among the other conditions as given in table 1.

Fig 1:Synthesized silver nanoparticles using extract + silver nitrate solution (a) and aqueous extract of *Portulaca oleracea* (b)

Table 1: Comparative study on the synthesis of silver nanoparticles and its variation with time

Plant Extract + 3mM $AgNO_3$ (ml)	Time (minutes)		
	Room temperature	Higher temperature (75°C)	Sonication
1 + 6	60	35	27
1 + 7	50	30	24
1 + 8	40	25	20
1 + 9	35	20	20
1 + 10	30	20	18

The formation of the silver nanoparticles was confirmed by UV-visible spectroscopy. UV-visible spectra shows no evidence of absorption in the range of 400-800 nm for the plant extract (fig 2a.) and the plant extract solution exposed to $AgNO_3$ solution shows a distinct absorption at around 421 nm (fig 2b.) which corresponds to Surface Plasmon Resonance of silver nanoparticles established at 420 nm [13].

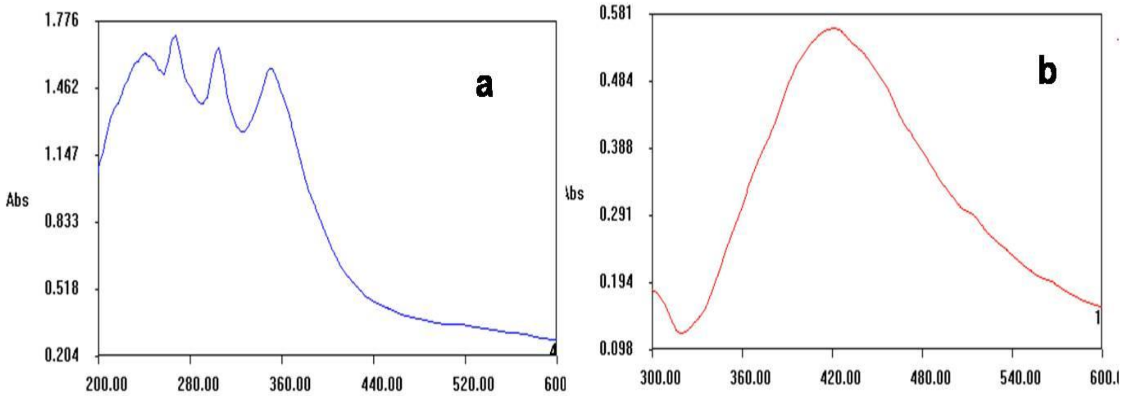

Fig 2:UV-visible spectra of aqueous extract of *Portulaca oleracea* (a) and synthesizedsilver nanoparticles using extract + silver nitrate solution.

Fig 3. shows the XRD pattern of drop coated silver nanoparticles synthesized from aqueous extract of *Portulaca oleracea.* The presence of sharp and intense peak at 2θ = 32.30° corresponding to the diffraction plane (101) of silver with fcc lattice [10]. According to Scherrer's formula, t = 0.9l/ β cosθ, an average crystal size (t) of the silver nanoparticles can be estimated from the X- ray wavelength of the Cu Ka radiation (l=1.54A°), the Bragg angle (θ), and the width of the peak at half height (maximum) (β) in radians. The particle size of the synthesized nanoparticles can be calculated using Debye-Scherrer's equation as given in table 2.

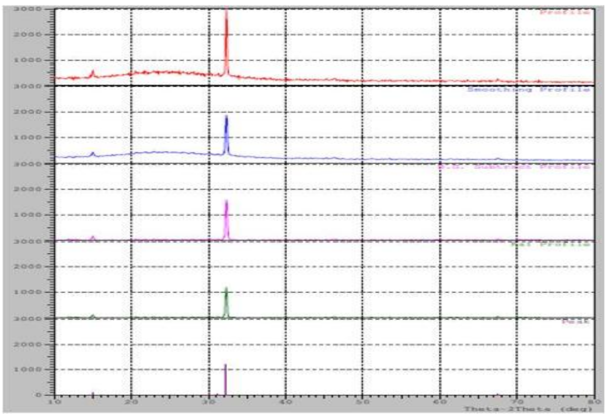

Fig 3: XRD pattern of silver nanoparticles synthesized from aqueous extract of *Portulaca oleracea.*

Table 2: Determination of crystalline size of AgNP's using Debye-Scherrer's equation

S.No	2θ (degrees)	β = π*FWHM/180 (radians)	θ	t = 0.9l / β. Cosθ (nm)
1.	32.3074	0.00447	16.15	32.24

SEM micrograph of synthesized silver nanoparticles using aqueous extract of *Portulaca oleracea* coated on a glass substrate is shown in fig 4. The silver nanoparticles were well separated with little agglomeration. The particle size of the synthesized silver nanoparticles was varied compared to that of the size obtained from XRD analysis.

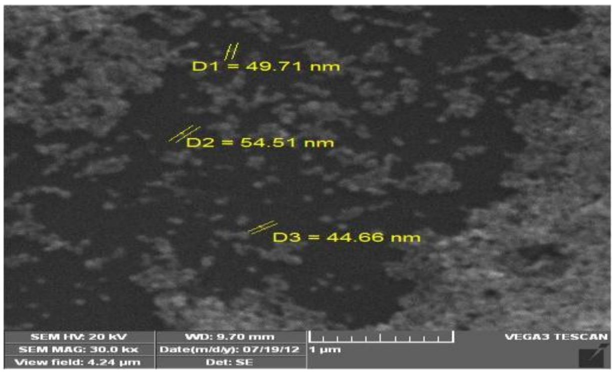

Fig 4: SEM micrograph of synthesized silver nanoparticles using aqueous extract of *Portulaca oleracea*

Fig 5. represents the FTIR spectra recorded for the silver nanoparticles synthesized from aqueous extract of *Portulaca oleracea.* The peaks located at 3277 cm^{-1} may be due to the presence of –NH or –OH group. The peaks at 1635 cm^{-1} and 2119 cm^{-1} revealed the presence of carbonyl and CN triple bond stretching in proteins respectively. The peaks at 543 cm^{-1} and 607 cm^{-1} shows significant changes upon reduction can be observed. Thus the presence of these functional groups is responsible for the stabilization of synthesized silver nanoparticles and also acts as reducing and capping agent.

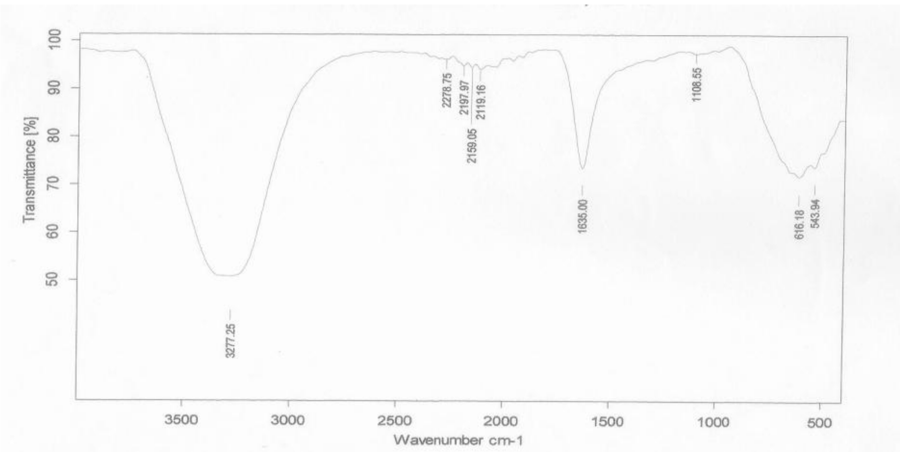

Fig 5:FTIR spectra of the silver nanoparticles synthesized from aqueous extract of *Portulaca oleracea.*

CONCLUSION

The biosynthesis of silver nanoparticles using the aqueous extract of *Portulaca oleracea* was explored under different conditions. The synthesized silver nanoparticle was monitored by UV-visible spectroscopy. The particle size of the nanoparticles was found to be less than 60 nm which was confirmed through XRD and SEM analysis. The FTIR spectra revealed the presence of functional groups which are responsible for the stabilization of the synthesized silver nanoparticles.

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