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GREEN SYNTHESIS OF SILVER NANOPARTICLES USING EXTRACT OF SARPAGANDHA (RAUWOLFIA SERPENTINA); SYNTHESIS AND CHARACTERIZATION

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Abstract :
Recently, biosynthesis of nanoparticles has attracted scientists' attention because of the necessity to develop new clean, cost-effective and efficient synthesis techniques. The present investigation deals with the rapid synthesis of Silver nanoparticles usin extract of Sarpagandha (rauwolfia serpentina).An ecofriendly, easy, one step, non-toxic and inexpensive approach is used, where aqueous plant extract acts as a reducing as well as stabilizing agent of AgNPs. The nanoparticles were characterized by UV-vis spectroscopy, transmission electron microscopy. Surface plasmon resonance of the nanoparticles was observed at near 450 nm in UV-vis spectroscopy. Transmission electron microscopy indicated that the synthesized nanoparticles are spherical in shape and approximately 20 to 30 nm in size.

Key Wards: *Green synthesis, Silver nanoparticles, Rauwolfia serpentina, TEM.*

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1. INTRODUCTION

In recent years, noble metals nanoparticles have been the subject of focused research due to their unique optical, electronic, mechanical, magnetic, and chemical properties that are significantly different from those of bulk materials (Mazur, 2004). These special and unique properties could be attributed to their small sizes and large surface areas. For these reasons, metallic nanoparticles have found uses in many applications in different fields, such as catalysis, photonics, and electronics etc. They have been extensively exploited for use in biomedical areas, such as targeted drug delivery (Jayanth P, 2003), imaging (Ji-Ho P, 2009) antimicrobial activity (Pallab SA, 2008) and antifungal (Yogeshwari Rout, 2012).

Silver is the one of the most commercialized nano-material with five hundred tons of silver nanoparticles production per year (Larue, 2014) and is estimated to increase in next few years. Including its profound role in field of high sensitivity biomolecular detection, catalysis, biosensors and medicine; it is been acknowledged to have strong inhibitory and bactericidal effects along with the anti-fungal, anti-inflammatory and anti-angiogenesis activities (El-Chaghaby, 2011).They also play an indispensable role in drug delivery, diagnostics, imaging sensing, gene delivery, artificial implants and tissue engineering. (P. Shanmuga, 2015)

Many techniques of synthesizing silver nanoparticles, such as chemical reduction of silver ions in aqueous solutions with or without stabilizing agents (Liz-Marzan, 1996) thermal decomposition in organic solvents (Esumi, 1990) chemical reduction and photo reduction in reverse micelles (Pileni, 2000) and radiation chemical reduction (Henglein, 2001) have been reported in the literature. Most of these physico-chemical methods are extremely expensive and also involve the use of toxic, hazardous chemicals, high temperature, pressure and production of hazardous by-products etc. Which may pose potential environmental and biological risks? Therefore; it becomes necessary to search for safer alternative methods of silver nanoparticles syntheses. Bio-inspired synthesis using microorganisms (Klaus, 1999) (Konishi, 2007), enzymes (Willner, 2006), fungus (Vigneshwaran, 2007) and plant extracts (Jae, 2009) for silver nanoparticles have been suggested as valuable alternative to chemical methods as it avoids use of toxic chemicals and use of high and temperature.

The plan

t biomass acts as both reducing agent and stabilizing agent and the solvent is an aqueous solution which is cost effective and eco-friendly. There are many examples of green synthesis of silver nanoparticles (AgNP) by using plant extract as reducing or capping agents such as Argemone mexicana leaf extract (Singh A, 2010), Mikania cordata leaf extract (Roy A, 2013), Pterocarpus santalinus leaf extract (Gopinath K G. S., 2013).

Rauwolfia Serpentina is commonly known as 'sarpagandha' or snakeroot. It belongs to the Apocynaceae family. It is an important Ayurvedic shrub about 30 to 90 cm in height with white and pinkish flower. The plant is available in tropical regions of the Indian subcontinent and East Asia. R.serpentinacontains many bioactive chemicals such as reserpine, ajmaline, yohimbine, serpentinine, deserpidine, rescinnamine, etc.

2. Collection of plant materials and preparation of plant :

Silver nitrate (AgNO3) was purchased from Sigma-Aldrich chemicals and the plant, *rauwolfia serpentine* was collected from western ghat regain in Raigad (MS)

2.1 Aqueous extract :

At first 25 g of plant leaves samples were collected washed with distilled water , dried with tissue paper and cut into fine pieces which is mixed with 100 ml deionized distilled water in 500 ml Erlenmeyer flask and then boiling mixture for 1 hr. A fefiltered through Whatman No. 1 Then the leaves were with 100 mL sterilized distilled water. After that the extract was filtered through Whitman No. 1. The extract was filtered and stored at room temperature in order to be used for further experiments.

2.2. Synthesis of silver nanoparticles :

An aqueous solution of silver nitrate was prepared by adding 1 mM of AgNO3 to 50 ml of distilled water at room temperature. The aqueous solution was mixed with 50 ml of leaf extracts at a temperature of 80 °C while stirring magnetically at 1000 rpm for 2 min. The bio-reduced aqueous component was used for the UV–vis spectroscopy characterization

2.3. UV–vis spectral analysis :

During the AgNPs synthesis in aqueous solution, the reduction of Ag^{+} to Ag^{0} and the formation of colloidal silver with particle diameter of several nanometers take place. Colloidal particles which are smaller than visible wavelengths show a band in the UV-vis range. The reduction of pure Ag^{+} ions was monitored by measuring the UV-Vis spectrum of the reaction medium at 5 hours after diluting a small aliquot of the sample into distilled water. The UV–vis analysis was performed by sampling the aqueous component at different time intervals and the absorption maxima was scanned over the 300–800 nm wavelength range on a PerkinElmer Lambda 25 spectrometer.

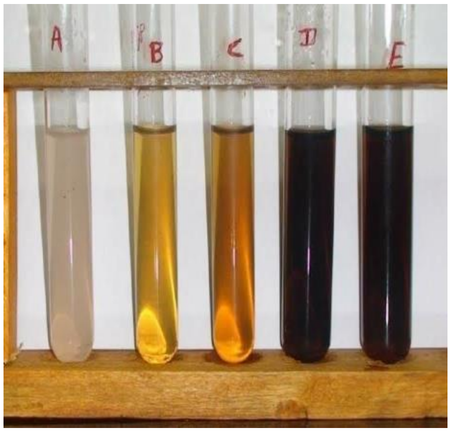

Fig. 1: Color changes during nanoparticles AgNP synthesis

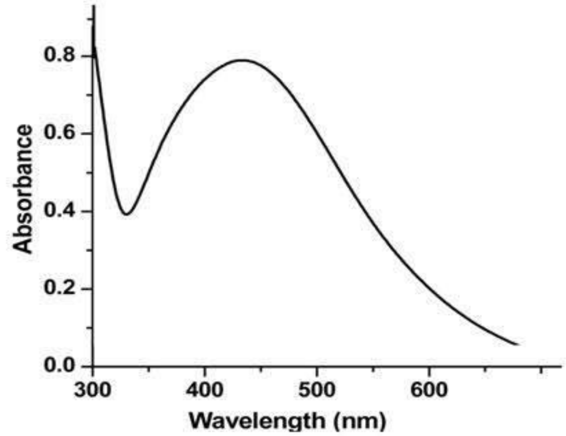

Fig.2: The UV-absorption spectra obtained for *extract of* Sarpagandha

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2.4. TEM analysis of silver nanoparticles

Transmission electron microscopy is used to study the shape and size of the biosynthesized AgNP Samples for electron microscopy observations were prepared by ultrasonically dissolving the aqueous solution in twice distilled water. A drop of the solution was subsequently deposited onto a lacey C film supported on a Cu grid and allowed to evaporate under ambience conditions. Electron microscopy experiments were carried out in a JEOL 2011 high resolution transmission electron microscope, operating at 200 kV, with a point resolution of 0.23 nm and Cs=1.0 mm. The microscope is also fitted with an Oxford Instruments INCAx-sight liquid nitrogen cooled energy-dispersive X-ray analysis (EDS) detector with an ultrathin window for detailed elemental analysis of the catalysts. Processing of the EDS spectra was accomplished using the INCA Microanalysis Suite software.

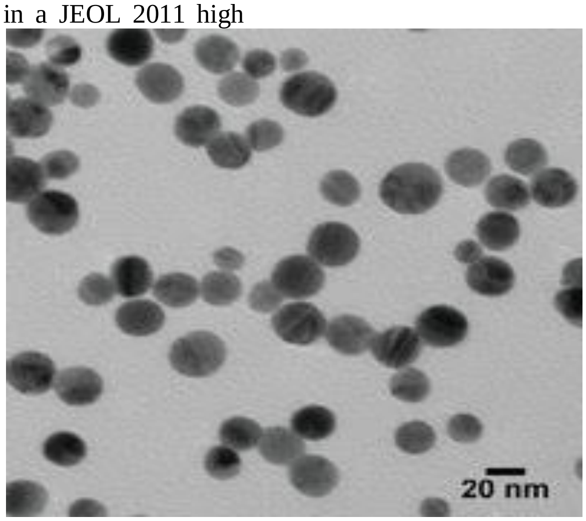

Fig. 3 TEM images of the synthesized AgNP

3. RESULTS AND DISCUSSION:

UV-vis spectroscopy analysis is the signature of AgNP synthesis from plant extract in presence of silver nitrate solution. Various reports show that the color changes from light yellow to brown (Figure 2) and resonance peak of AgNP appearing in the region 412 nm to 453 nm (Gopinath K G. S., 2013) (Umashankari J, 2012;) (Li G, 2012) is the signature of AgNP formation. The color changes during the formation of AgNP due to the excitation of surface plasmon vibrations. Fig.2 shows the UV–vis spectra of aqueous component as a function of time variation of plant extract with 1 mM aqueous $AgNO_3$ solution. Metal nanoparticles have free electrons, which give surface Plasmon resonance (SPR) absorption band, due to the combined vibration of electrons of metal nanoparticles in resonance with light wave. The sharp bands of silver colloids were observed at near 450 nm. The intensity of absorption band increases with increasing time period of aqueous component and consequent color changes were observed from colorless to reddish yellow. These characteristic color variations is due to the excitation of the of the surface plasmon resonance in the metal nanoparticles.

Transmission Electron Microscopy (TEM) experiments proved the formation of nanocrystalline silver particles, as shown in Fig. 3. The nanoparticles predominately adopt a spherical morphology and are often agglomerated into small aggregates, comprising of 5–6 particles each, as Fig. 3 illustrates. The obtained nanoparticles are quite uniform in size and up 20 to 30 nm. In rare occasions, particles with higher sizes were also observed in the sample, but their population was rather low. The TEM images revealed that the small particle aggregates are coated with a thin organic layer, which acts as a capping organic agent. This also may well explain that fact that the nanoparticles showed a very good dispersion inside the bio-reduced aqueous solution, even in the macroscopic scale.

The previous literature study shows that there are many examples of synthesized AgNPs from aqueous plant extract. The phytochemicals are rich in carbohydrate, tannin, alkaloids, flavonoids, steroids, for example 'Neem'. The phytochemicals are biodegradable, less toxic, eco-friendly and less costly. The presence of these groups is confirmed by the FTIR study. These groups are responsible for the reduction Ag (I) ion. The change of color during the synthesis of AgNPs from light yellow to yellowish brown confirms the synthesis of AgNPs from plant extract.The peaks of SPRdue to the collective oscillation of the electron of the synthesized AgNPs from phytochemicals has similarity with the chemically synthesized AgNPs

CONCLUSIONS:

In summary, AgNPs from R. serpentina leaf extract is synthesized in one step biological method which is eco-friendly, low cost, energy efficient and may be competitive alternative of the conventional physical or chemical methods. Different groups of the plant extract acting as both reducing and stabilizing agents. The color changes during the synthesis of AgNPs and SPRat near 450 nm confirm the synthesis of the AgNPs from the plant extract. We have synthesized spherical shaped AgNPs which is 20 to 30 nm in size and with crystalline nature. This green approach may find various medicinal as well as technological applications. The method is general and may be extended to other noble metals such as Au and Pt.

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