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Biosynthesis and kinetic studies of silver nanoparticles from *Semecarpus ancardium* Linn. F and their application

Sheikh Mohmad Vasim*[1], Devadiga Navin[2], Hate Manish[3]
Dept. of Chemistry, Ramnarain Ruia College, Mumbai, Maharashtra, India
*Corresponding author: Sheikh Mohmad Vasim

Abstract

Nowadays nanoparticles play an important role from biomedical to household. Nanotechnology has dynamically developed as an important field of modern research with potential effects in electronic and medicine [1].The present study reported a fast, green and simple method for reduction of silver nitrate to elemental silver from the *Semecarpus anacardium* Linn.F leaf aqueous extract. The confirmation of silver nanoparticles was done by uv-visible spectrophotometer. The structure of AgNps was confirmed by X Ray Diffraction (XRD) and Scanning Electron Microscopy (SEM) EDX techniques. A detailed study of kinetic aspect of silver nanoparticles with respect to temperature and time were investigated. The catalytic activity of AgNps was investigated by selecting the reduction of 4-nitrophenol to 4-aminophenol using aqueous $NaBH_4$ as reducing agent.

Keywords: XRD, SEM-EDX, UV, Silver nanoparticles (AgNps), Semecarpus anacardium, Catalytic activity, $NaBH_4$.

1. Introduction

Green synthesis of nanoparticle is an eco-friendly move towards to investigate the capability of different plants or herbs in order to synthesize nanoparticles. In recent years, much attention has been paid to the synthesis and study of nanoparticles because of wide range of potential applications [2]. A number of techniques to fabricate nanoparticles have been developed rapidly over the past decades. Among these, green synthesis of nanoparticles from plant material is a rapidly growing field because of its versatile applicability and eco friendly nature. Since the properties of these nanoparticles are basically determined by their mean size, size distribution, external shape, internal structure, and chemical composition, the characteristics of powders must be controlled during the production of the nanoparticles [3]. The modern material science nanotechnology finds an ample application from electronics to medicine, low energy consumption devices and so on. Due to the unique physical and chemical properties, the NPs have contributed a lot to use as a catalyst, an antibacterial agent and in magnetic and optical devices. Nanoparticles are prepared from noble metals like silver, gold, platinum and other transitions metals like copper to cadmium. The noble nature of silver metal leads to its used in biomedical fields. Silver nanoparticles are synthesized by various chemical and physical methods. In chemical method, the metal reduced by reducing agent like Sodium borohydride, citric acids etc were reported. The physical methods include synthesis by thermal, photochemical, sonication, microwave techniques etc. In this research paper a biosynthetic method for the synthesis of silver nanoparticles with the help of plant extracts is reported. The study also included the effect of temperature on the reaction rate and catalytic activity of AgNps.

2. Materials and methods:

2.1. Plant collection and authentication: The plant was collected from Keshav Shrusti near Mumbai, Maharashtra, India. The authentication of plant was done by Botanical survey of India, Pune, India. *Semecarpus anacardium* (SA) Linn.F belongs to family anacardeceae and has been known to show good reducing ability which for synthesis of silver nanoparticles [4].

2.2 Preparation of extract: The leaves of Semecarpus anacardium (SA) Linn.F were washed, air and shade dried at room temperature for two weeks and made into fine powder using electric grinder and sieved using a 100 mesh sieve and used for further studies. one grams of the plant powder was added to 25ml of double distilled water and boiled for five minutes, extract was then be suction-filtered and the process is to be repeated three times and all the extracts were collected in a 100ml volumetric flask and diluted up to volume. The Extracts were stored in an air tight container and protected from sunlight for further use.

2.3 Methods of testing for bioactive properties of Plant: The aqueous extract of semecarpus anacardium leaves were tested for the presence of some biological active phytoconstituents. 2.3.1 Tests for Alkaloids: The presence of alkaloids was tested by treating the 1ml aqueous extract with a few drops of mayer's reagent. Formation of cream coloured precipitate indicated the presence of alkaloids.

2.3.2 Tests for Saponins: Plant aqueous extract was shaken with water in a test tube. Frothing which persists on warming was taken as preliminary evidence for the presence of saponins. 2.3.3 Tests for Phenols: To the aqueous extract few drops of neutral 5% ferric chloride solution were added. A dark green colour indicated the presence of phenolic compounds. 2.3.4 Tests for Flavonoids: The presence of flavonoid was tested by Lead acetate test. The preliminary phytochemicals investigation of aqueous extracts of leaves of semecarpus anacardium showed the presence of flavonoids, phenols and alkaloids class of phyto compounds. These phytoconstituent may be responsible for the reduction of metallic silver to silver nanoparticles.

Phytocomponent	**Test/Reagents**	**Results**
Alkaloids	Mayer's Reagent	+++
Phenolic compounds	Ferric Chloride	+++
Saponins	Foam's	+++
Flavonoids	Lead Acetate	+++
Alkaline Reagent	+++	

2.4 Synthesis of Silver nanoparticles: The various ranges from 1mM to 5mM silver nitrate solution were prepared and were treated with plant extract. Based on trial and error final concentration of silver nitrate was selected. 4mL of 3mM silver nitrate solution was taken in 10mL standard flask to which 1mL plant extract is added. The solution was then allowed to react at room temperature. The change in colour from colourless to yellow-brown indicates the reduction of silver nitrate to elemental silver [fig.4].

2.4.1. Separation of silver nanoparticles The synthesized silver nanoparticles were separated by centrifuging (Spectrofuge 7M) at 13,000 rpm for 15 minutes. The process was repeated by dispersion of pellets in water, to obtain coloured supernatant solutions. The sample was then stored at -4°C for further use.

2.4.2. Mechanism of reduction of silver to AgNP's Formation of AgNP's was noted over a time period of 30 minutes to three hours for the various concentrations. The actual mechanism involve for the reduction is based on the presence of different phytocompounds like flavonoids, steroids etc. HPLC analysis of semecarpus anacardium methanolic leaves extract showed the presence of Quercetin a flavonoid and Amentoflavone biflavonoid [8] and some phenolic compounds. These compounds have potent antioxidant properties [9] therefore they easily undergo the redox reaction.

2.5 Characterization of silver nanoparticles

2.5.1 UV Analysis: The bio reduction of $AgNO_3$ was monitored using Shimadzu UV 1800 spectrophotometer with scanning wavelength range of 300-800 at different time intervals.

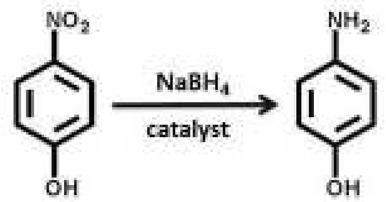
2.5.2 X-Ray Diffractometry: XRD measurements were recorded on Shimadzu Analytical, Japan X-ray diffractometer equipped with Cu k alpha radiation (λ= 0.1549 nm). For XRD analysis, the AgNPs were dried in an oven for their phase structure and identification [fig.1].

2.5.3 SEM Analysis: Scanning Electron Microscopic (SEM) analysis was done using FEI Quanta-200 SEM machine. The appeared precipitated powder was coated on the carbon coated copper grid and allowed to magnify the grid to know the shape and size of the particles [fig.2].

2.5.4 EDAX measurements: EDAX is an analytical technique used for the elemental analysis or chemical characterization of a sample [fig.3].

3. Catalytic reduction of 4-nitrophenol (4-NP) to 4-aminophenol (4-AP):

In a typical reaction, the reduction of 4-nitrophenol to 4-amino phenol was carried out by $NaBH_4$ using AgNP as a catalyst. To study this reaction, 2 mL of 4-nitrophenol (8 mM) was taken in a quartz cuvette of 1 cm path length and to this 0.5 mL freshly prepared $NaBH_4$ solution (0.06 M) was added. Then 0.5 mL of AgNP hydrosol was added to start the reaction. The reaction was monitored by analyzing the absorption peak at 400 nm using Shimadzu UV-Vis 1800 spectrophotometer. The absorption spectra were recorded at regular interval of time [5]. Schematic diagram of catalytic reduction of 4-nitrophenol to 4-aminophenol by NaBH4 over metallic surface



4. Effect of Temperature:

The effect of temperature on reaction rate was systematically investigated by carrying silver synthesis at different temperatures. It was observed that the reaction is relatively slow at lower temperature and there was no formation and growth of the silver nanoparticles. At room temperature the reaction is fast and particle formation and growth is complete with respect to time. While, for higher temperatures, the reaction is relatively fast and but as time increases particle formation distribution is less. In order to confirm this hypothesis, the synthesis was carried at room temperature and UV spectrum recorded at every 5 minutes for complete growth of silver nanoparticles. The decreased particle size and narrower size distribution with increasing temperature is a well known phenomenon [7]. As the temperature increases, reaction rate increases and the fast consumption of silver ions results in smaller particles and narrower size distributions at higher temperatures [fig.5 and 6].

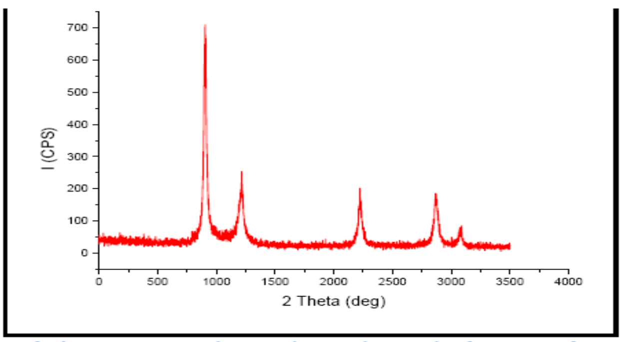


Figure 1: Typical XRD pattern of silver nanoparticles synthesized using leaf extract of Semecrapus anacardium Linn.F.

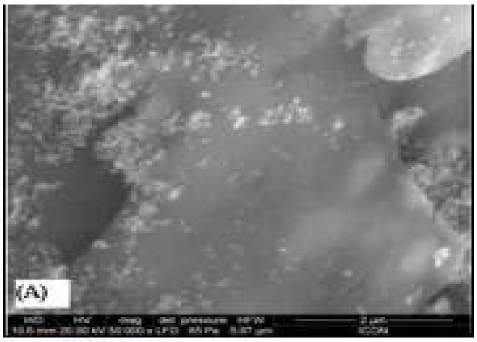


Figure 2: SEM

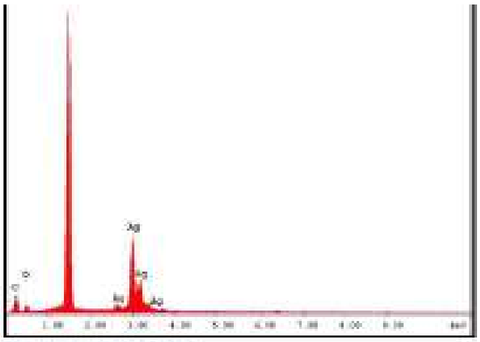


Figure 3: EDX of NPs

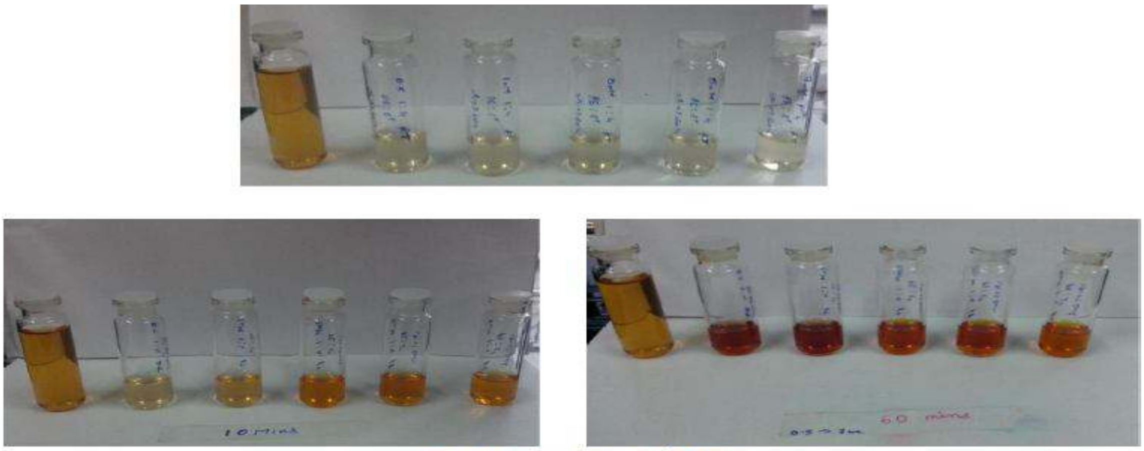
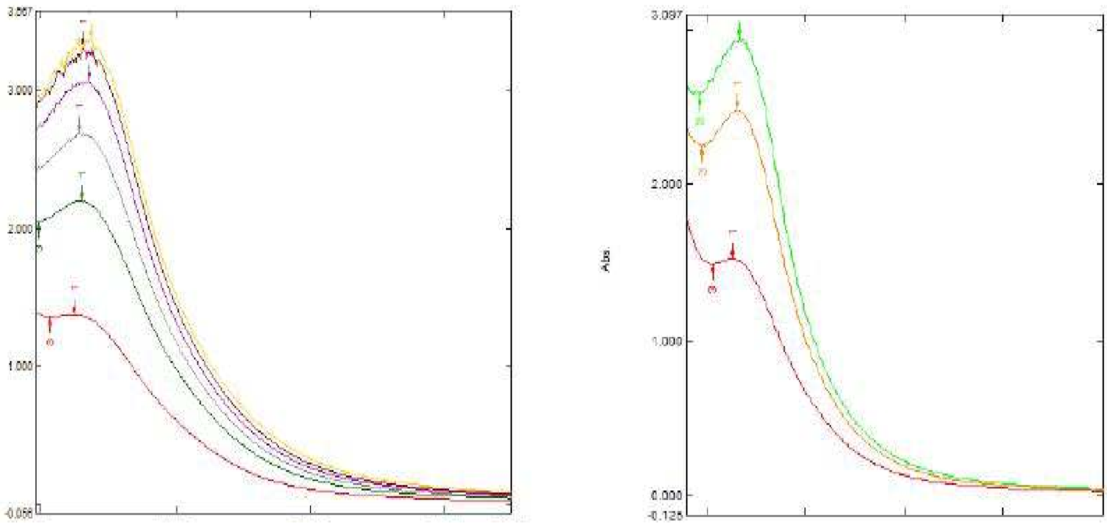


Figure 4: Formation of AgNPs



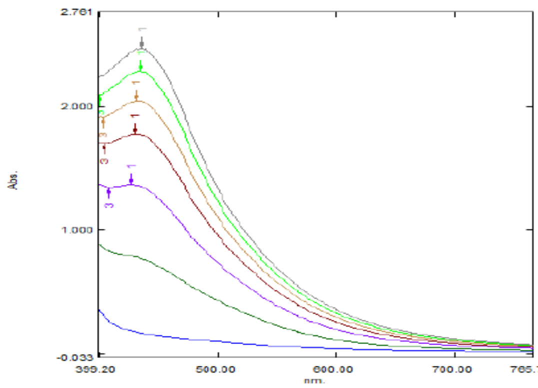


Figure 6: UV Spectrum showing formation of AgNPs at Room

5. Conclusion

An eco-friendly method of silver nanoparticles synthesis using leaf extract of a medicinal plant was carried out. The synthesis is found to be efficient in terms of reaction time as well as stability. This study has revealed catalytic activity of Semecarpus anacardium leaves extract. It has been observed that strong interaction between the catalyst surface and the substrate is essential for an effective catalytic process [6]. Thus the use of silver nanoparticles as a catalyst to convert nitro compound to amino compound might have possible application in industries. The effects of temperature on synthesis also reveal that at higher temperature though the rates of formation of silver nanaoparticles were fast but the particle sizes were not stable. This green chemistry approach toward the synthesis of silver nanoparticles finds many advantages such as, simplicity, economic viability, etc.

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References:

1. Glomm 2005, Chan 2006, Boisselier and Astruc 2009.

2. L. Hu, M. Chen. Preparation of Ultrafine Powder: the Frontier of Chemical Engineering (review) // Materials Chemistry and Physics. V.43. P.212– 219; 1996.

3. T. Sugimoto (Ed.), Fine Particles—Synthesis, Characterization and Mechanism of Growth, Marcel Dekker, New York, 1996.

4. Paras Jain* and HP. Sharma. ―A Potential Ethnomedicinal Plant: Semecarpus anacrdium Linn. – A Review‖. IJRPC, 3(3), 2013.

5. Siby.Joseph and Beena. Mathew, Synthesis of Silver Nanoparticles by Microwave irradiation and investigation of their Catalytic activity, Research Journal of Recent Sciences, Vol. 3(ISC-2013), 185-191 (2014).

6. N.Pradhan et al. / Colloids and Surfaces A: Physicochem. Eng. Aspects 196; 247–257; 2002.

7. Park J, Joo J, Kwon G S, Jang Y and Hyeon T Angew. Chem. Int. Ed. 46 4630; 2007.

8. Simultaneous determination of Quercetin and Amentoflavone in nethanolic leaf extract of Semecarpus anacrdium Linn. F. by reverse phase liquid chromatography. International Journal of Pharmacy and Pharmaceutical Sciences. ISSN- 0975-1491 Vol 6, Issue 6, 2014.

9. Burda S, Oleszek W. Antioxidant and antiradical activities of flavonoids. Journal of agricultural and food chemistry. 49(6):2774-9; 2001.