Green Synthesis of Silver Nanoparticles using Leaf Extract of Myrica esculenta

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Green Synthesis of Silver Nanoparticles using Leaf Extract of *Myrica esculenta*

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Abstract

The biosynthesis of metal nanoparticles is an expanding research area due to the potential applications for the ecofriendly development of novel technologies. Generally, nanoparticles are prepared by a variety of chemical methods which are not environmentally friendly. A green synthesis of silver nanoparticle was carried out using *Myrica esculenta* leaf extract. On treatment of aqueous solutions of 1mM silver nitrate ($AgNO_3$) with leaf extract, silver nanoparticles could be rapidly synthesised within 6 hours. These nanoparticles were characterized with UV-Vis spectroscopy, X-ray diffractometer (XRD) and transmission electron microscope (TEM).TEM analysis revealed that the silver nanoparticles were polydisperse and of different morphologies ranging from 45 to 80 nm in size. X-ray diffraction (XRD) results reveal that these nanostructures exhibit a face-centered cubic crystal structure.

Keywords: Green synthesis; *Myrica esculenta;* Silver nanoparticles; UV-Vis spectroscopy; TEM; XRD.

Introduction

The field of nanoscience has blossomed over the last twenty years and the need for nanotechnology will only increase as miniaturization becomes more important in areas such as computing, sensors, and biomedical applications. Advances in this field largely depend on the ability to synthesize nanoparticles of various materials, sizes, and shapes, as well as to efficiently assemble them into complex architectures. Nanoparticles exhibit completely new or improved properties based on specific characteristics such as size, distribution and morphology. New applications of nanoparticles and nanomaterials are emerging rapidly. Application of nanoscale material and structures are usually ranging from 1-100nm and is emerging area of nanoscience and nanotechnology. Metals nanoparticles have high specific surface area and high fraction of surface atoms.They have been studied extensively because of their unique physicochemical characteristics including catalytic activity, optical properties, electronic properties, antibacterial properties and magnetic properties [1-4]. Synthesis of noble nanoparticles for the applications such as catalysis, electronics, environmental and biotechnology is an area of constant interest [5-6]. Generally, metal nanoparticles are synthesized and stabilized by using chemical methods such as chemical reduction [7-8], electrochemical techniques [9], photochemical reactions in reverse micelles [10] and now days via green chemistry route [11]. Use of plants in synthesis of nanoparticles is quite novel leading to truly green chemistry which provide advancement over chemical and physical method as it is cost effective and environment friendly easily scaled up for large scale synthesis and in this method there is no need to use high pressure, energy, temperature and toxic chemicals. Now days we are using bacteria, fungi for the synthesis of nanoparticles [12-18] but use of leaf extract [19-20] reduce the cost as well as we do not require any special culture preparation and isolation techniques. There have been many reports on the synthesis of silver nanoparticles by using leaf extracts. Reports on the use of leaf extracts for synthesis of silver nanoparticles from *Helianthus annus, Basella alba, Oryza sativa,Saccharum officinarum, Sorghum bicolour, Zea mays* [21], *Azadirachta indica* (Neem)[22], *Medicago sativa* (Alfa alfa) [23,24], *Aloe vera* [25], *Emblica officinalis* (Amla) [26],*Capsicum annuum* [27], *Geranium* sp. [28,29], *Diopyros kaki* [30], *Magnolia kobus*[31], *Coriandrum* sp.[32].

However, here we report the synthesis of silver nanoparticles using *Myrica esculenta* leaf extract in the aqueous solution by introducing solution of silver nitrate(1mM) and the morphological characterizations are performed using transmission electron microscope (TEM) and X-ray diffractometer (XRD). The optical absorption properties was measured using UV-visible spectrophotometer and observed the absorption peak at 445 nm region, which was close to the characteristics surface plasmon resonance (SPR) wavelength of metallic silver.

Materials and Methods

Plant materials and preparation of the extract

Myrica esculenta extract was prepared by taking 20g of dry *Myrica* leaves, thoroughly washed and finely crushed mixed with 50ml of deionized water and boiling the mixture at 80ºC for 15 min. The extract was filtered by Watmann filter paper No.1(25µm pore size) before finally decanting it.

Synthesis of silver nanoparticles

Aqueous solution of silver nitrate of 1 mM was prepared and 30ml of the solution was added to 10ml of the *Myrica esculenta* leaf extract solution at the room temperature in dark for reduction of Ag^+ ions and was kept for 6 hours. The colour change in the colloidal solutions occurred indicating the formation of silver nanoparticles. The reduction of Ag^{+} ions was observed by measuring using UV-Visible spectrophotometer.

UV-Vis Spectra analysis of silver nanoparticles

Monitoring of the reduced silver particles was done by measuring the UV-Vis spectrum of the reaction medium after 6 hours. UV-Vis spectral analysis was done by using a double beam spectrophotometer (Hitachi, U-3010).

XRD measurement

The biosynthesized silver nanoparticles thus obtained were purified by repeated centrifugation at 10,000 rpm for 15 min followed by redispersion of the pellet of silver nanoparticles into 10 ml of deionised water. After freeze drying of the purified silver particles, the dried mixture of silver nanoparticles were analyzed by XRD(D8 ADVANCE,BRUKER) for the determination of the formation of Ag nanoparticles.

Transmission Electron Microscopy (TEM)

Samples for transmission electron microscopy (TEM) analysis were prepared by drop coating biologically synthesized silver nanoparticles solution (24 hours reaction of the silver nitrate solution with *Myrica esculenta* leaf broth) on to carbon-coated copper TEM grids. The films on the TEM grid were allowed to stand for 2 minutes, following which extra solution was removed using a blotting paper and grid allowed to dry prior to measurement. TEM measurements were performed on a JOEL JSM CX 100.

Result and Discussion

The silver nanoparticles exhibit yellow brownish colour in aqueous solution due to excitation of surface plasmon vibrations in silver nanoparticles [33]. On mixing the extract *Myrica esculenta* with 1mM $AgNO_3$ solution, the colour of the solution changes from pale yellow to yellowish brown colour after 24 hours indicating the formation of silver nanoparticles which was determine by using UV-Vis spectroscopy [Figure 1]. The surface plasmon banding the silver nanoparticles solution remains close to 445nm region suggesting that the nanoparticles were well dispersed in the aqueous solution with no evidence for aggregation in UV-Vis absorption spectrum [Figure 2]. The biosynthesised silver nanostructure by using *Myrica esculenta* extract was further demonstrated and confirmed by the characteristic peaks observed in the XRD image [Figure 3]. The XRD pattern showed four intense peaks in the whole spectrum of 2 theta values of 38.16°, 44.54°, 64.58° and 77.61°, corresponds to 111,200, 220, and 311 planes for silver nanoparticles, respectively indicating crystalline in nature which was similarly reported earlier in case of *Coriandrum sativum* leaf extract synthesis [34]. The TEM image shown in [Figure 4] reveals that the silver nanoparticles obtained by the reduction of Ag^{+} by the *Myrica esculenta* leaf extract were predominantly spherical shaped and the size of the silver nanoparticles ranges between 45 nm to 80 nm. The average mean size of the silver nanoparticles was 55nm.

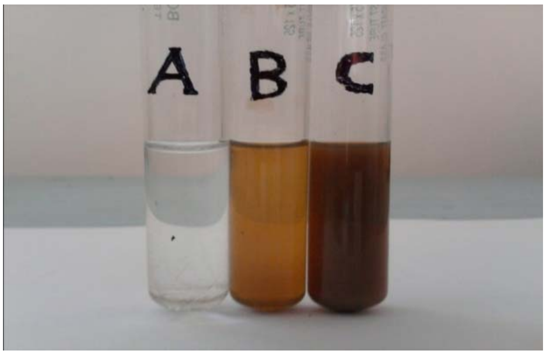

Figure 1: Digital photographs of (A) 1 mM $AgNO_3$ without *Myrica esculenta* extract (B) *Myrica esculenta* extract (C) 1 mM $AgNO_3$ with *Myrica esculenta* extract after 6 hrs of reaction.

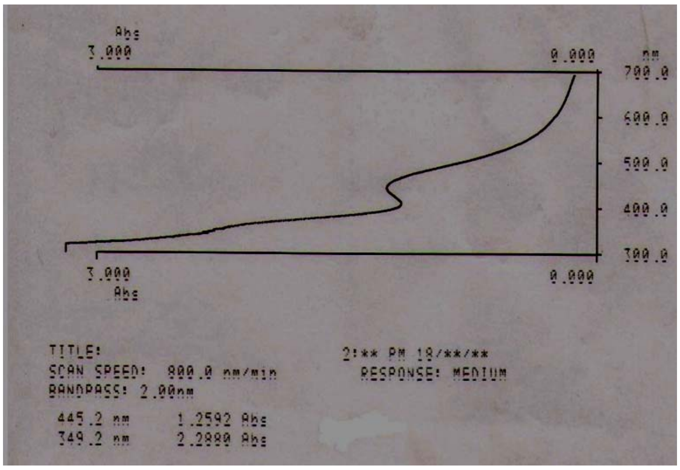

Figure 2: UV-Vis absorption spectrum of silver nanoparticles synthesized by treating 1mM aqueous $AgNO_3$ solution with *Myrica esculenta* extract (3:1) after 6 hrs. Absorption spectrum was at 445nm.

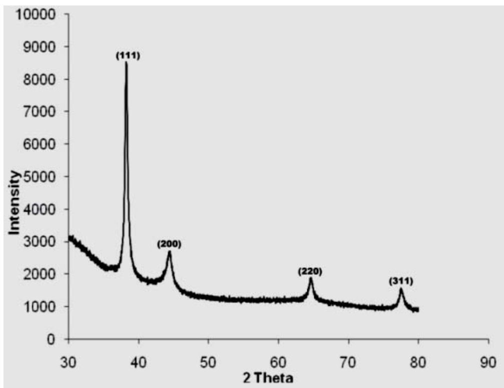

Figure 3: XRD pattern of silver nanoparticles synthesized by treating *Myrica esculenta* extract with 1 mM aqueous $AgNO_3$ solution.

Figure 4: TEM micrograph shows size and shape of silver nanoparticles. The silver nanoparticles were predominantly spherical shaped and the size ranges between 45 nm to 80 nm. The average mean size of the silver nanoparticles was 55nm.

Conclusion

The bio-reduction of aqueous Ag+ ion by the extract of the *Myrica esculenta* has been demonstrated. The reduction of the metal ions through leaf extracts leading to the formation of silver nanoparticles of fairly well-defined dimensions. Silver nanoparticles were synthesised by this method having 55 nm average mean size and an almost spherical shape. The preparation of nanoparticles by using *Myrica esculenta* extract has desired quality with low cost and convenient methods. Plant extract of *Myrica esculenta* is being ecofriendly, very cost effective which can be an effective alternative for the large scale synthesis of silver nanoparticles in nanotechnology processing industries.

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