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Isolation and Characterization of Silver Nanoparticles in *Cardiospermum halicacabum* l. Leaf Extract

Research Article

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Abstract

Cardiospermum halicacabum L. is a medicinal plant with enormous therapeutic properties. The synthesis and characterization of silver nanoparticles using *Cardiospermum halicacabum* extract was studied. The synthesis of silver nanoparticles was confirmed by a change in the colour within 10 to 15 min. Green synthesis of silver nanoparticles is an economically viable approach. The visual observations, EDAX and SEM spectroscopic techniques confirmed the formation of silver nanoparticles.

Keywords: *Cardiospermum*; EDAX; Green synthesis; Nano particles; SEM

Introduction

Nanotechnology is a field that is burgeoning day by day and making an impact in all spheres of human life. Nature and its products lead to the growth of advancements in the synthesis of nanoparticles. In the modern field of material science, Nanotechnology is one of the upcoming fields. This field is an interdisciplinary science that includes physics, chemistry, biology, material science and medicine. Nano particles are particles between 1 to 100 nm in size [1]. At molecular level, using engineered nanodevices and nanostructures, nanomedicine is being applied in monitoring, repair, construction and control of human biological systems. Nanotechnology applications are highly suitable for biological molecules, because of their exclusive properties [2]. Metal nano particles have a high specific surface area and a high fraction of surface atoms. A variety of techniques for silver nanoparticle synthesis have been reported by Iravani et al. [3].

The silver nanoparticles are usually synthesized by reducing silver salts with the help of reducing agents from biological sources [4]. The silver nanoparticles are synthesized by chemical, physical and biological methods. The chemical and physical methods for synthesis of nanoparticles are costly and release toxic by-products in nature. Due to these problems, biological method is an alternative source for the synthesis of silver nanoparticles [1]. Earlier, the use of biological methods of silver nanoparticle synthesis using biological entities like bacteria, fungi and plants has been reported.

The use of biological entities like bacteria, plant extracts or plant biomass for the production of nanoparticles could be an eco-friendly approach. Microorganisms trap metal ions from the environment that are converted into nanoparticles by an enzymatic process. Roy (2017) reported the synthesis of silver nanoparticles from medicinal plants.

Cardiospermum halicacabum L. (Sapindaceae), commonly called the balloon vine, is a weed found throughout the country. It finds its place in traditional systems of healing. It has enormous medicinal activities, such as diuretic, rubefacient, analgesic, anti-inflammatory activity, vasodepressant activity, antispasmodic, antirheumatism [5]. Medicinally important weeds can be used effectively in the production of nanoparticles . Hence, in this study, an attempt has been made to synthesize silver nanomaterial with Cardiospermum halicacabum.

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Material & Methods

In the present study, leaf extract of *Cardiospermum halicacabum L.* was taken for green synthesis and characterization of silver nanoparticles.

Collection of plant samples

The fresh and healthy leaves of *Cardiospermum halicacabum* were collected from an area near Kallakurichi, Tamil Nadu, India.

Morphology of the plant

Cardiospermum halicacabum L.

Systematic position

Kingdom : Plantae

Class : Angiosperms

Order : Sapindales

Family : Sapindaceae

Genus : *Cardiospermum*

Species : *C. halicacabum* L.

Common names: Karodiyo, Kagdodiyo, Balloon Vine and Heart-seed.

Botanical description

- Tropical and sub-tropical, annual and perennial, slender and beautifully delicate climber- with flower-peduncle tendrils.
- Cardiospermum halicacabum is a deciduous climbing shrub growing about 3 meters tall (Figure 1).
- The stems scramble over the ground, climbing into the surrounding vegetation. Leaves are twice ternate, segments lanceolate, serrate and acute. Umbellate cyme inflorescence.
- Sepals 4, imbricate, outer smaller, inner larger. Petals 4, rounded at apex. Ovary 3-celled, style very short, trifid.

Medicinal uses

- The entire balloon vine plant possesses several therapeutic properties.
- It is a good diuretic, diaphoretic, emmenagogue and laxative.
- Balloon vine is employed for treating stiffness of the limbs, rheumatism and snakebites.

Figure 1: *Cardiospermum halicacabum* L.

Preparation of Leaf Powder

The leaves of the medicinal plant taken for the present study were collected, cleaned and air dried, under shade for about three weeks. After drying, the leaves are blended using a household electric blender. This fine powder was analyzed for SNPs characterization study.

Green synthesis of silver nanoparticles using leaf extract

For the synthesis of silver nanoparticles, 1mM aqueous solution of silver nitrate was prepared and used. 10ml of plant extract was mixed with 90ml of aqueous 1mM AgNo3 solution in a 250 ml sterile Erlenmeyer flask. The solution was heated for a few seconds. Later, the reduction of silver ions was observed by a change in the colour of the solution from yellow to brown.

Characterization of Silver Nanoparticles

The characterization of silver nanoparticles was carried out by different techniques.

SEM Analysis

Scanning Electron Microscopy is a commonly used method for characterization of silver nanoparticles. A thin film of sample was prepared on a carbon coated grid by placing a very small amount of sample on the grid, and then it was allowed to dry and examined under SEM.

EDAX analysis

The sputtering of the sample was done using a SC7620 Sputter Coater unit under the nitrogen atmosphere. A small strip of carbon tape was stuck on an aluminium stub and a pinch of sample was placed on the carbon tape. The elemental analysis and distribution of the particles were carried out using EDAX with a SUTW-SAPHIRE model detector.

Results & Discussion

The results of the green synthesis and characterization studies on silver nanoparticles showed the following results.

Scanning Electron Microscope

In Scanning Electron Microscope (SEM) analysis, high resolution images are generated by focusing a high energy beam of electrons on the surface of the specimen. These electrons interact with the specimen to produce signals that provide information about the sample such as

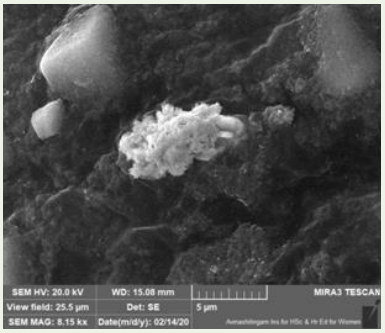

Figure 2: SEM image of silver nanoparticles formed by *C. halicacabum* L. using aqueous extract.

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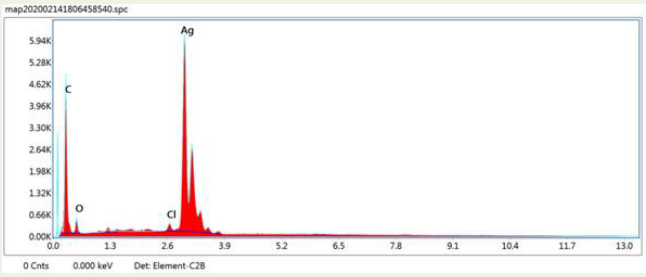

Figure 3: EDAX spectrum recorded showing sharp peak between 2.8 and 3.9 keV confirming the presence of silver in the sample of *C. halicacabum* L.

Table 1: Elements present in *Cardiospermum halicacabum* L.

Element	Weight%	Atomic%	Elements present in percentage
C	62.45	72.26	74%
O	30.6	26.58	17%
Mg	0.44	0.25	2%
Ag	1.78	0.23	3%
K	1.2	0.43	4%
Au	3.53	0.25	1%

the surface morphology, elements or chemical composition, crystal structure and position of atoms that make up the sample

The SEM image of silver nanomaterial synthesized using *C. halicacabum* L. showed the presence of high conductivity of AgNP's in the view field of 25.5 µm (Figure 2). The SEM HV showed a 20.0kV nanoparticle, but it was unstable. Khan et al. (2018) have shown spherical shaped NPs in *Coriandrum sativum* leaf extract [7]. Concentration of the plant extract, concentration of metal salt, pH, temperature and contact time can have an effect on the time, yield and other properties of nanoparticles [8,9].

EDAX

Energy Dispersive X-ray (EDX) spectrometer analysis confirmed the presence of an elemental silver signal of the silver nanoparticles. The number of X-ray counts are displayed on the vertical axis and energy in KeV displayed on the horizontal axis. The silver (Ag) peak is observed in the spectrum as well as in the elemental composition showing its presence in the leaf extract (Table 1, Figure 3). Earlier, Kumar et al. (2014) studied the characterization of AgNPs using XRD and TEM analysis which showed a spherical shaped structure with an average particle size of 25nm [10].

Nanoparticles act as 'magic bullets' that can target the desired part of the plant to achieve their potential as herbicides, fungicides, nutrients, fertilizers or nucleic acids [6]. Earlier, Farghaly and Nafady (2015) used the leaf extract of Rosemary for the biosynthesis of silver nanoparticles (AgNPs) and showed their eco-friendly and cost effective nature. They have also studied the effect of AgNPs on the growth of wheat and tomato plants [11-13]. Ashlesha et al. (2021) have studied the green synthesis of nanoparticles and their antimicrobial properties from ex-situ grown bryophytes. It uses agricultural inputs more effectively and reduces the by-products that could harm the environment as well as human health [14-17]. Logeswari et al. (2015) studied the synthesis of nanoparticles from commercially available plant powders. Applications of Nanotechnology in agriculture can prove to be a boon to mankind [18,19].

Conclusion

Silver nanoparticles find a large application in Industries and medicine. Hazardous organic solvents and surfactants which are often employed in chemical synthesis of nanoparticles can be avoided through green synthesis techniques. The present study demonstrates the bio-reduction of aqueous Ag+ ions by the leaf extract of *Cardiospermum halicacabum L.* The present protocol is an eco-friendly and cost-effective method for the synthesis of silver nanoparticles. Further studies are to be carried out to analyze the biological activities of the synthesized nanoparticles.

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