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International Journal for Modern Trends in Science and Technology, 8(05):477-480, 2022

ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST0805072
Available online at: http://www.ijmtst.com/vol8issue05.html

Biomediated Synthesis of Silver Nanoparticles from *Coriandrum sativum* Leaf Extract: A Green Approach

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To Cite this Article
Nandini Phanse, K. Venkataraman, Vartika Mishra, Sanjay Shah and Shilpa Parikh. Biomediated Synthesis of Silver Nanoparticles from *Coriandrum sativum* Leaf Extract: A Green Approach. International Journal for Modern Trends in Science and Technology 2022, 8(05), pp. 477-480. https://doi.org/10.46501/IJMTST0805072

Article Info
Received: 22 April 2022; Accepted: 16 May 2022; Published: 22 May 2022.

ABSTRACT

Synthesizing metal nanoparticles by using biological resources has been extensively studied and has been recognized as a green and efficient approach. Among the various biological nanoparticles, green synthesis of nanoparticles from plants is an utmost emerging field in nanotechnology as it offers a single step and easy extracellular synthesis of nanoparticles. We have reported eco-friendly biosynthesis of silver nanoparticles using leaf extract of Coriandrum sativum from 1mM $AgNO_3$ without the use of toxic chemicals. Coriander leaves are known for their beneficial properties for health, which is ascribed to their strong antioxidant activity and can mediate the synthesis of metallic nanoparticles through oxidation/reduction reactions. The present study has reported the synthesis of silver nanoparticles using aqueous leaf extract of Coriandrum sativum from 1mM $AgNO_3$. Coriandrum sativum leaf extract acts as a reducing agent and reduces silver ions (Ag^+) to form a neutral Ag^0 atom. As the concentration of these neutral ions increases, the solution becomes supersaturated and the neutral Ag^0 atoms aggregate to form silver-nanoparticles. Visually, the formation of silver nanoparticles was confirmed by observing the colour change from pale yellow to dark brown colour. UV–Vis spectrum of the aqueous medium containing silver nanoparticles showed an absorption peak at 434 nm. These phyto-synthesised silver nanoparticles showed antibacterial activity against pathogens like Salmonella typhi, Pseudomonas aeruginosa and Staphylococcus aureus.

***KEYWORDS:** Green synthesis, Silver nanoparticles (SNPs), Coriandrum sativum leafextract, Antimicrobial activity*

1. INTRODUCTION

The field of nanotechnology is one of the most active areas of research in modern materials science and technology. In the era of nanotechnology, research on nano-materials is growing day-to-day with increasing demand. This is because metals in nanometer size will exhibit special properties that differs and is more superior from bulk metals.

The preparation of silver nanoparticles using various physical and chemical methods has been thoroughly studied. In the field of nanotechnology, the most important step is the fabrication of a study methodology to manufacture nanoparticles. Conventional methods to synthesize silver nanoparticles are mainly by different chemical, physical and biological approaches. The chemical and physical approaches are complicated, expensive and cause potential

environmental and biological hazards. The chemicals used in the production of nanoparticles are hazardous and cause acute complications. To reduce the toxic effects of these chemicals, there is an increasing demand for biological approaches because these are free of toxic chemicals. Thus, the interest in green nanotechnology is increasing day by day [1]. Recently, green synthesis of metallic nanoparticles is evolving as an important branch of nanotechnology due to its eco-friendliness, flexibility and more importantly due to evasion of toxic chemicals. Plants and microorganisms such as fungi and bacteria have been used for the green synthesis of silver nanoparticles [2, 3]. Nanoparticles prepared from plants are preferred because they are eco-friendly, produced using a one-step procedure, cost less, and protect personnel from health concerns [4]. Plant extracts contain reducing and
antioxidant properties that have been shown to cause the formation of the respective nanoparticles by reducing metal salts [5].

A variety of reducing agents, including biomass, plant extracts [6,7,8] and microorganisms [9] have been used in green synthesis research [10]. Among those reducing agents, biomass, especially flavonoids, was considered one of the most effective compounds to reduce Ag+ to AgNPs. More importantly, flavonoids are present widely in almost all plants, which indicates they are economically available and sustainable [11].

Coriandrum sativum L, also called as coriander, is a culinary plant from the family of *Umbelliferae /Apiaceae*is widely cultivated from India, Russia, Asia and Middle East countries. Coriander leaves may be used to increase the content of antioxidants [12]. The coriander seeds have potential medicinal use in the drugs for rheumatism and pain in the joints, indigestion, against worms, so that they can be used as gastrointestinal complaints. *Coriandrum sativum* root is used in traditional medicine and contribute to health and protection against the onset of disease [13]. *Coriandrum sativum* contains various phytochemicals such as flavonoids, phenols, carbohydrates, protein, gardiac glycosidase, tannins, terpenoids, alkaloids, minerals and vitamin contents including calcium, phosphorus, iron, carotene, and niacin . Various parts of *Coriandrum sattivum*can be used for bio-medical applications like anti-bacterial and anti-cancer activities [14]. Thus, biological synthesis of silver nanoparticles using plants has been considered as a suitable alternative to chemical procedures and physical methods. Coriander leaves are known for their inhibitory activity on food degradation and their beneficial properties for health, both ascribed to their strong antioxidant activity. Studies have shown that coriander leaf extracts can mediate the synthesis of metallic nanoparticles through oxidation/reduction reactions.

2. MATERIALS AND METHODS

A. Preparation of Leaf Extracts:

Fresh leaves of *Coriander sativum* were washed thoroughly with deionized water. 20 g of leaves were dried, cut into fine pieces added to 100 ml deionized water in 250 ml beaker and boiled for 10 minutes. The mixture was then filtered with Whatman filter paper [15]. The filtrate was used as a reducing agent and stabilising agent for $AgNO_3$. The extract was stored at 4 °C for further experiments.

B. Synthesis of silver nanoparticles

1 mM solution of silver nitrate (80 ml) was added to 20 ml of the leaf extract and stirred on a stirring water bath (Remi Water bath shaker, RSB-12) at 75ºC for 25 min. A change in colour from yellow to brown specified the production of silver nanoparticles. The solution was sonicated using Ultrasonic processor (Schottky Rivotek) and then the synthesized nanoparticles were collected through centrifugation performed in a cooling centrifuge (Remi C-24) [16].

C. UV-Visible spectra analysis

The bio-reduction of Ag ions into Ag^0 was monitored by measuring UV-Vis spectrum of the reaction mixture after 1 hour by diluting an aliquot of 0.1 ml of sample into 2 ml of deionised water within the range of 300-600 nm using UV-Vis spectrophotometer (Model UV 1800 Shimadzu, Japan).

D. Antibacterial study of silver nanoparticles

The antibacterial studies were performed on pathogens, *Salmonella typhi, Pseudomonas aeruginosa* and *Staphylococcus aureus* by agar well diffusion method on Mueller Hinton agar medium. Silver nanoparticles along with leaf extract, $AgNO_3$ and distilled water as control

were added into the 6 mm diameter well and incubated for 24 hours at 37 ºC. The diameter of the inhibition zone formed was measured in mm.

3. RESULTS AND DISCUSSION

A. Synthesis of silver nanoparticles

When the aqueous leaf extract of *Coriander sativum* was mixed with 1mM $AgNO_3$ solution, the colour changed from pale yellow to dark brown because of the apparent excitation of the plasmon resonance. This is the primary method to confirm that the synthesised nanoparticles are silver (Fig 1). The colour change is due to the reduction of silver ions. Bio-molecules present in the sample donate electrons to Ag^+ions& they are reduced to form silvernanoparticles. The appearance of yellowish-brown colour in the reaction vessels suggest the formation of silver nanoparticles [17]. Silver nitrate is used as reducing agent as silver has distinctive properties such as good conductivity, catalytic and chemical stability. The time duration of change in colour varies from plant to plant. The present study has reported the synthesis of silver nanoparticles using aqueous leaf extract of *Coriandrum sativum* from 1 mM $AgNO_3$,without the use of toxic chemicals. *Coriandrum sativum* leaf extract acts as a reducing agent and reduces silver ions (Ag^+) to form a neutral Ag^0 atom. As the concentration of these neutral ions increases, the solution becomes supersaturated and the neutral Ag^0 atoms aggregate to form silver-nanoparticles.

B. UV-Visible spectra analysis

The synthesis of silver-nanoparticles had been confirmed by measuring the UV-Vis spectrum of the reaction media. The UV-Vis spectrum of colloidal solutions of silver-nanoparticles synthesized from, *Coriandrum sativum* have absorbance peaks at 400 to 450 nm [18]. Visually, the formation of silver nanoparticles was confirmed by observing the colour change from pale yellow to dark brown colour. Reduction of silver ions was monitored by using UV–Vis spectroscopy from 300 to 600 nm scan range. The peak obtained at 434 nm is a typical absorption peak for metallic nanoparticles which further confirms the reduced nanoparticles are silver. The nanoparticles in reaction mixture absorb light at different wavelengths & get excited due to charge density at the interface between conductor & insulator of UV–Vis spectroscope to give a respective peak.

This mechanism is known as surface plasmon resonance (SPR).

C. Antibacterial study of silver nanoparticles

The phyto-synthesised silver nanoparticles showed antibacterial activity against pathogens like *Salmonella typhi*, *Pseudomonas aeruginosa* &*Staphylococcus aureus* (Fig.2).

4. CONCLUSION

The present study included the bio-reduction of silver ions through medicinal plants extracts and testing for their antimicrobial activity. The aqueous silver ions exposed to the extracts, the synthesis of silver nanoparticles were confirmed by the change of colour of plant extracts. These environmentally benign silver nanoparticles were further confirmed by using UV-Vis spectroscopy The present investigation revealed that the *C.sativum* leaf extract would be a good source for green synthesis of silver nanoparticles. This method of green synthesis of silver nanoparticles is simple, ecofriendly and economic. Bactericidal activity of these silver nanoparticles against *S. aureus*, *S.typhi* and *P.aeruginosa* confirmed that the silver nanoparticles are capable of rendering antibacterial activity . The bactericidal study of these nanoparticles may play a vital role in the treatment and invention of new drugs against infections caused by *S. aureus, P. aeruginosa and S.typhi.*

ACKNOWLEDGMENT

The authors express their thanks to the Management and Principal of PMB Gujarati Science College, Indore, for providing instrumental and technical support.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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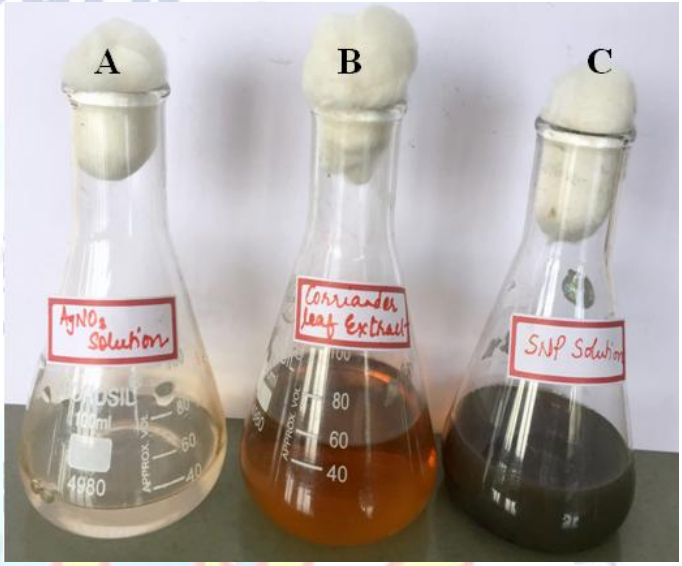

Fig.1- Colour change in reaction mixture: A) 3mM $AgNO_3$ B) Coriander leaf extract C) Silver nitrate + Leaf extract after 25 minutes of incubation

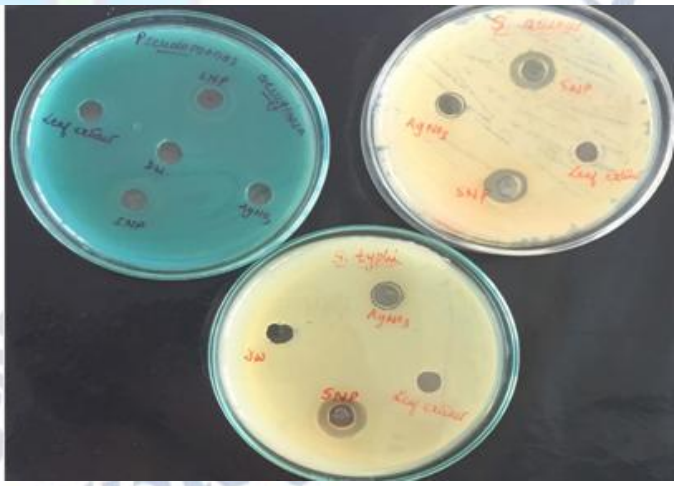

Fig.2: Antibacterial study of SNPs

Zone of inhibition of silver nano-particles on pathogenic bacteria. The phyto-synthesised silver nanoparticles showed antibacterial activity against pathogens like *Salmonella typhi*, *Pseudomonas aeruginosa & Staphylococcus aureus*