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Research Article

Green Synthesis of Silver Nanoparticles Using *Coriander sativum* Linn. Extract and Evaluating Its Antibacterial Properties

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ABSTRACT

Coriander (*Coriander sativum* Linn.) belongs to the family Apiaceae (Umbelliferae) and is commonly known as dhanya. It has potential source of high-value components for functional foods and nutraceuticals. For centuries, the coriander plants and their parts, primarily their leaves and ripe seeds, have been used in folk medicines in addition to culinary uses. This plant is herbaceous and aromatic and is cultivated in several countries, including India, Italy, the Netherlands, Europe, China, and Bangladesh. The present study aims that a simple, rapid and economical method to synthesize silver nanoparticles (AgNPs) from *Coriander sativum* Linn. extract. The topical formulation was prepared by incorporation of optimized AgNPs into the carbopol gel base. Further, the gel was evaluated in vitro antibacterial assay by agar well diffusion method. The antibacterial inhibitory efficiency of prepared AgNPs incorporated nano gel was found similar to the commercial product against the *Staphylococcus aureus*, E. coli and *Pseudomonas aeruginosa*.

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INTRODUCTION

Among herbs, coriander (locally known as “dhanya”) is known for its therapeutic properties in the Indo-Pak subcontinent. It is one of the widely cultivated herbs and native to North Africa, Southern Europe, and southwestern Asia. Scientifically, coriander (*Coriander sativum* Linn.) belongs to the Umbelliferae (Apiaceae) family. The herb portion consists of leaves and stems. The herbs and seeds of coriander are being excessively used in the traditional culinary owing to its pleasant color and flavor (Wei JN et al., 2019).Green silver nanoparticle synthesis has been achieved using environmentally acceptable plant extract and eco-friendly reducing and capping agents (Basu S. *et al*., 2018; Carabineiro, S. 2017; Roy, K. *et al*., 2013; Kaur, R. *et al.*, 2013). The use of plants for synthesis of nanoparticles is rapid, low cost, eco-friendly, and a single-step method for biosynthesis process. Silver nanoparticles incorporated into nano gel have shown a broad-spectrum microbicidal effect and have potential to use treatment of wounds (Abdal Dayem, A. et al., 2017; Bharathi, D. *et al*., 2018; Fathima, JB. *et al*., 2018).The goal of the research was to prepare silver nanoparticles by using plant extract then formulate and evaluate various polymers with varying concentrations for the preparation of a safe, effective and stable gel containing silver nanoparticles and to evaluate the in vitro evaluation and the antibacterial activity for prepared formulations.

MATERIAL AND METHODS

Preparation of Extract

The leaves of *Coriander sativum* Linn. were washed in water to remove the dust and foreign material from the surface then air dried under shade at room temperature. The air dried plant material was coarse powdered and subjected to methanol extraction using Soxhlet's apparatus by reflux for 24 h at 60°C. A grey colored semisolid mass was obtained, dried under vacuum and kept in desiccators until use.

Synthesis of Nanoparticles

In the single step green synthesis, 5 ml of leaf extract was added to 95 ml of 1 mM aqueous silver nitrate solution and kept in the dark place at room temperature for 24 h. Silver nanoparticle are formed by reduction of pure silver ions and it was monitored by measuring absorption of the reaction medium in the wavelength range of 300-700 nm using UV spectrophotometry. The synthesized silver nanoparticle (AgNP) was purified by centrifugation at 1000 rpm for 15 min. The supernatant was transferred to a clean dry beaker for further settlement of particles and repeated centrifugation was carried using cooling microfuge to get dried, purified and characterized the AgNPs.

UV-Visible Spectral Analysis

Silver nanoparticles were formed by reduction of silver ion; it was monitored by measuring the absorption spectra in the wavelength range of 300-700 nm using Shimadzu UV-1800 Spectrophotometer. The spectrum was recorded and
the maximum absorption wavelength was determined.

Preparation of Topical Formulation

Topical gel formulations were prepared by cold mechanical method with defined quantity of carbopol-934 and HPMC polymer. The specified quantity (1g) of polymers such as Carbopol 934 and HPMC were weighed separately and sprinkled slowly on surface of purified water. To this defined quality of double distilled water was added with vigorous stirring and left overnight for dissolving the polymer. To the polymer solution, drug silver nanoparticles were added to the gel with continuous stirring. Required quantity of glycerol was added and mixed well by using magnetic stirrer. After complete dispersion, the pH of the gel was adjusted to neutral pH 7 by using sodium hydroxide. Distilled water was added and made up to 100g.

Physicochemical Evaluation of Formulations

Spreadability

Glass slides with standard dimension (length of 6.0 cm) were taken. Topical gel formulation was placed on the one side of the glass slide and sandwiched with the help of another slide. Remove the adhering gel on the outer surface of the glass slides by wiping. Slides are fixed in a stand that only upper slide to slip off freely without any disturbance by force of weight (20g) tied to it. Time taken for the movement of upper slide to the distance of 6.0 cm was measured. Measurement of spreadability was done in triplicate and calculated by using the following formula:

Spreadability = (Weight×Length) / Time

Where, S=Spreadability; m=Weight tied to the upper slide (20 g); l=Length of the glass (6.0 cm); t=Time taken in seconds

Determination of zone of inhibition

Antibacterial activity was checked by agar well diffusion method. In this method a previously liquefied medium. In each of these plate extract, silver nanoparticle medium was inoculated with 0.1 mL Bacterial suspension having a uniform turbidity at temperature of 40°C. In a sterile petri dish having an internal diameter of 8.5 cm was taken, 20 mL of culture medium was poured into it. Care was taken to form a uniform thickness of the medium in different plates. Wells were made aseptically with cork borer having 6 mm diameter after complete solidification of liquefied inoculated and topical gel formulation were placed carefully. Plates were kept for pre diffusion for 30 min at room temperature; then the plates were incubated at 37°C for 24 h and the zones of inhibition were measured.

RESULTS AND DISCUSSION

Green Synthesis of AgNPs

Green synthesis of AgNPs was prepared from plant extract and shown in Fig.1. On mixing plant extract with the silver nitrate solution, a change in the solution color from pale yellow to dark brown was observed which indicates the reduction of silver ions and formation of silver nanoparticle.

Characterization of Silver Nanoparticles

UV-Visible Spectral Analysis

The UV absorption spectrum of *Coriander sativum* Linn. has shown a peak specific in the range between 400 and 450 nm. Peak specific in this region might be due to Mie scattering effect24. The UV spectrum of silver nanoparticle is shown in Fig.2.

Fig.1: Silver Nanoparticles Preparation

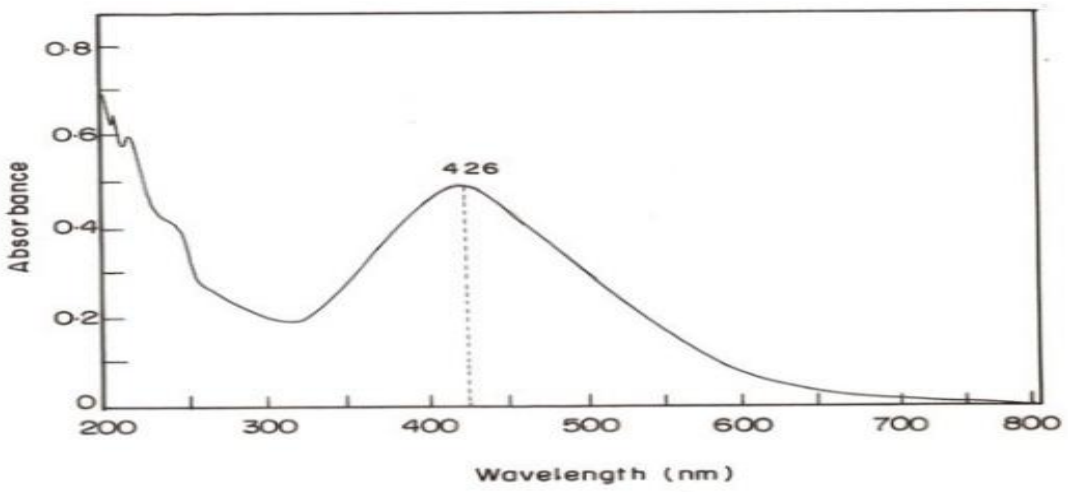

Fig.2: UV-Visible spectra of Silver Nitrate Nanoparticles

Spreadability

Bioavailability and therapeutic property of the topical formulation depends upon the spreadability. The spreadability is expressed of time in seconds based on the slip off from the gel by upper slide under certain load. Time taken for the separation of the two slides is less which indicates the topical formulation has better spreadability. The spreadability value was found to be 6.9 ± 0.1 (g.cm/sec) for gel prepared by Carbopol.

Antibacterial Activity of the Formulation

The antibacterial activity study results of the formulated herbal gel showed antibacterial activity against Staphylococcus aureus (S. aureus) bacteria was depicted in Fig.3. The antibacterial study reveals that the silver nanoparticle of *Coriander sativum* Linn. showed higher activity than the extract against all the pathogens.

Fig.3: In vitro Antimicrobial Activity of Silver Nitrate Nanoparticles incorporated Hydrogel, Plain Silver Nanoparticles, Marketed Silver Nitrate gel.

CONCLUSION

Concerning the environmental protection, green synthesis of nanoparticle has gained friendly and growing demand. Among the different metal nanoparticle, AgNPs has an excellent antibacterial agent due to its non-toxic effect on the human cells. Medicinal plants have been used as a home remedy from ancient time due to its variety of metabolites and its phytoconstituents. AgNP of *Coriander sativum* Linn. have potential to improve antibacterial effects of silver nitrate.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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