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Synthesis of silver nanoparticles (Ag NPs) for anticancer activities (MCF 7 breast and A549 lung cell lines) of the crude extract of *Syzygium aromaticum*

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Highlights

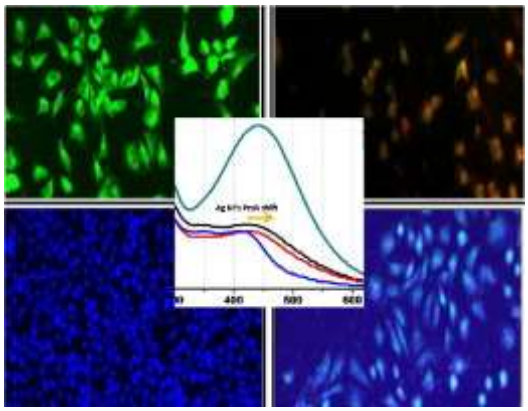
- Silver nanoparticles (Ag-NPs) synthesized by natural medicinal *Piper nigrum* extract
- Bioactivity test for in-vitro cytotoxicity efficacy against MCF-7 & HEP-2 cells
- Ag-NPs formed within 20 min and confirmed by UV–Visible spectroscopy
- UV–Vis showed surface Plasmon resonance (SPR) peak ~441 nm observed

- Ag-NPs surface HRTEM images shows spherical shape with particle-size 5 to 20nm.
- MTT assays for cytotoxicity carried-out different concentration of the plant extract.

Abstract

In the present report, silver nanoparticles were synthesized using Piper nigrum extract for *in vitro* cytotoxicity efficacy against MCF-7 and HEP-2 cells. The silver nanoparticles (AgNPs) were formed within 20min and after preliminarily confirmation by UV–Visible spectroscopy (strong peak observed at ~441nm), they were characterized by using FT-IR and HR-TEM. The TEM images show spherical shape of biosynthesized AgNPs with particle size in the range 5–40nm while as compositional analysis were observed by EDAX. MTT assays were carried out for cytotoxicity of various concentrations of biosynthesized silver nanoparticles and *Piper nigrum* extract ranging from 10 to 100μg. The biosynthesized silver nanoparticles showed a significant anticancer activity against both MCF-7 and Hep-2 cells compared to *Piper nigrum* extract which was dose dependent. Our study thus revealed an excellent application of greenly synthesized silver nanoparticles using *Piper nigrum*. The study further suggested the potential therapeutic use of these nanoparticles in cancer study.

Graphical Abstract



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Introduction

Nanoparticles, the rudiments for nanotechnology, are nowadays produced using noble metals like Ag, Pt, Au and Pd with the advancement of new materials with nanometer size including nanoparticles, nanotubes, nanowires, and so forth. In the recent times, silver nanoparticles (AgNPs) have attracted intensive research interest because of their advantageous applications in biomedical [1], [2], [3], drug delivery [4], food industries [5], agriculture [6], textile industries [7], water treatment [8], catalysis and surface-enhanced Raman scattering [9].

Diverse methods are used for the synthesis of silver nanoparticles. And the most commonly available known method is the chemical reduction of metal salt precursor using chemical reducing agents such as, citrate [10], polymer substances [11], [12], [13], borohydride, *N*,*N*-dimethyl formamide [14], sodium borohydride [15], trisodium citrate [16], sodium hydroxide [17], 2-mercaptobenzimidazole [18], sodium dodecyl sulfate [19], or other organic reagents [20], [21], [22], [23]. The physical methods include, laser ablation method [24], sono chemical deposition [25], [26], photochemical reduction [27], [28], gamma ray and solar irradiation [29], UV photo reduction [19], microwave-assisted [30], electrochemical method [31], [32], [33], thermal decomposition in organic solvents [34], and molecular beam epitaxy methods [35].

Although the commercial methodologies have proven as efficient tools for synthesizing AgNPs, but their continuous use may pose a great threat to human health and the environment because of the use of toxic and hazardous reagents and generation of toxic by-products in some instances. These products tend to bind to the AgNPs surface and may adversely affect their character and performance [36]. Hence, there is a great need to find alternative methods for AgNP synthesis, which are nontoxic and eco-friendly.

However, these methods suffer from disadvantages like low yield, high-energy supplies, and a need for complicated and inefficient purifications [37]. Some of the recently developed green methods utilizing biological materials show favorable routes for their synthesis. The use of plants for the synthesis of AgNPs is in the focus of intensive research because of its eco-friendly nature. The use of plants boasts of several advantages such as the elimination of elaborate processes of maintaining cell cultures, easy scale up for large-scale synthesis and cost-effectiveness. Moreover, plant extracts may act both as reducing agents and stabilizing agents in the synthesis of nanoparticles [38]. Typically, a plant-extract-mediated bio-reduction for photosynthesis of silver nanoparticles involves mixing the aqueous extract with an aqueous solution of the silver nitrate salt [39], [40], [41], [42], [43], [44].

The present study directs the advantageous of silver nanoparticles from silver nitrate through a simple green route utilizing the extract of Cloves (*Syzygium aromaticum*) as the reducing agent. Cloves (*Syzygium aromaticum*), are the aromatic flower buds of a tree in the family Myrtaceae and numerous restorative uses have been most broadly connected to a toothache, and for mouth and throat aggravation. Cloves show antiseptic, antibacterial, antifungal and antiviral properties. Thus, the study proceeds with the synthesis of silver nanoparticles utilizing *Syzygium aromaticum* and their cytotoxicity of biosynthesized silver nanoparticles was studied against MCF-7 and A549 cancer cell lines. However, the synthesis of silver nanoparticles utilizing cloves as biosource has not yet been studied.

Section snippets

Materials

Silver nitrate ($AgNO_3$) and MTT were purchased from Hi-Media Laboratories Pvt. Ltd. India. The MCF-7 cancer cell line was collected from King Institute of Preventive Medicine and Research, Chennai, India.

Preparation of Clove Extract

The *Syzygium aromaticum* (Cloves) were collected from the local market and authenticated. The *Syzygium aromaticum* were finely powdered using mortar and pestle. The plant powder (20g) was dissolved in 100ml of millipore water and the mixture was bubbled at 80°C for 10min followed by filtration

Formation of Silver Nanoparticles (AgNPs)

Silver nitrate solution (Fig. 1A) is colorless and extract of Cloves is dark red in color (Fig. 1B). After adding *Syzygium aromaticum* extract to Silver nitrate solution, the solution became grayish red in color (Fig. 1C). The color change confirms that the silver nitrate was reduced and transformed into silver nanoparticles.

UV–Vis Spectra Analysis

UV–Vis spectroscopy is one of the essential systems used to determine the primary existence of metal nanoparticles in a liquid medium. The color change demonstrating the

Conclusion

In the present study, different temperatures were used for silver nanoparticle biosynthesized by using *Syzygium aromaticum* clove extract. By fluctuating the temperature of the clove extract (Room temperature) RT to 80°C the plasmon resonance band raised slowly. Most extreme plasmon resonance band was achieved at 80°C, which demonstrates that the reduction of the silver particle was directly proportional to the concentration of clove extract. There was no development of the plasmon resonance

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References (57)

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Adv. Drug Deliv. Rev. (2011)

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Trends Food Sci. Technol. (2011)

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A. Bankar *et al.*
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Colloids Surf. A Physicochem. Eng. Asp. (2010)

H. Wang *et al.*
Preparation of silver nanoparticles by chemical reduction method
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X. Wei *et al.*
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