Turmeric Oil Mediated Green Synthesis of Silver Nanoparticles and their Antioxidant Activity

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BACKGROUND

The number of medical applications of silver nanoparticles is constantly increasing due to their high bactericidal properties coupled with low toxicity towards living cells. Because of this expanding use of silver nanoparticles, novel methods of synthesis have been developed in order to achieve nanoparticles preparation through inexpensive and environmentally friendly process.[1] Biogenic synthesis of silver nanoparticles is an approach that meets those requirements. Nanoparticles are an intermediate between bulk materials and individual atoms with unique properties. Nanoparticles have been employed in various fields such as catalysis, ceramics, drug delivery and diagnostics and therapies of oncology.[2] Several studies have described the controlled synthesis of metal nanoparticles of different sizes and shapes mediated by bio molecules, which is nontoxic and minimises environment damage.

Antioxidants have been widely used as additive to provide protection against oxidative degradation of foods.[3] Although many synthetic chemicals, such as phenolic compounds are found to be strong radical scavengers, they usually have serious side effects.[4] In view of this, antioxidant substances obtained from natural sources will be great interest.

Turmeric is extensively used as spice, as a colouring agent for textiles, pharmaceuticals, confectionary and cosmetics.[5] In Indian system of medicine, turmeric is used in stomach-ache, as a blood purifier, carminative, appetiser and tonic.[5,6] Turmeric is also used in drugs against cancer, dermatitis, AIDS (Acquired Immuno-Deficiency Syndrome) and high cholesterol level.[7] During the course of this study, we have synthesized silver nanoparticles using turmeric oil and characterised them using UV-vis spectroscopic analysis and checked for their antioxidant activity.

SYNTHESIS OF SILVER NANOPARTICLES

In this descriptive study, the synthesis of the silver nanoparticles is been done with green synthesis method. A fresh turmeric oil sample was collected, and added to 50 mL of 1 x 10-3 M silver nitrate and incubated in the room temperature. Formations of grey colour with turmeric oil mixture after 60 min indicates the silver nanoparticles synthesis. The silver nanoparticles thus obtained was spectrometrically recognised with UV-Vis spectrophotometer under the wavelength of 300 – 600 nm.

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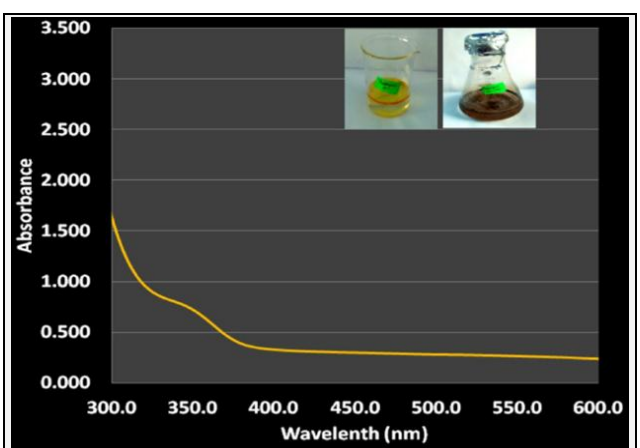
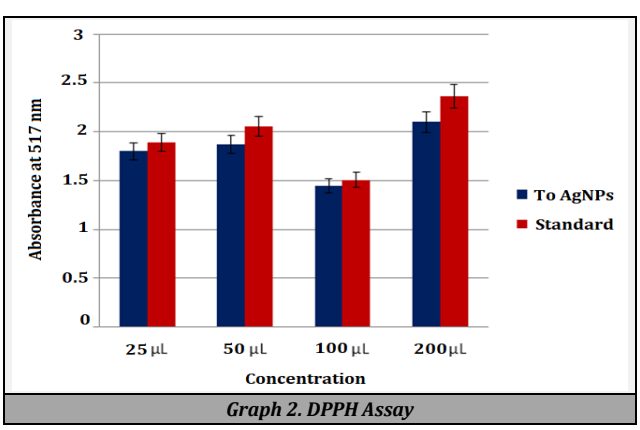
The Nitric Oxide free radical scavenging activity of nanoparticle was also determined by the method of Rajeshkumar 2017. Typically, different concentration (2 - 10 µg / mL) of plant extract was mixed with 1 mL of 0.1 mM DPPH in methanol solution and 450 µl of 50 mM Tris-HCl (Hydrochloric Acid) buffer (pH 7.4) and incubated for 30 min. After incubation, the reduction in the number of DPPH free radicals was measured based on the absorbance at 517 nm. BHT was used as controls. The percent inhibition was calculated from the following equation:

% Inhibition =
[Absorbance of control – Absorbance of test sample / Absorbance of control] × 100

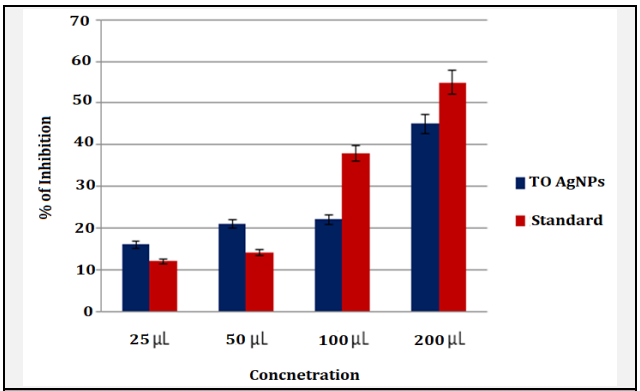
The addition of turmeric oil extract to $AgNO_3$ (Silver Nitrate) solution resulted visual colour change from colourless to yellow within 5 min because of Surface Plasmon Resonance (SPR) excitation due to the collective oscillation of free conduction electrons induced by an interacting electromagnetic field which is absent in bulk material indicating the reduction of Ag + to Ag0 [Graph 1]. Formation of Ag NPs was further confirmed by UV–Visible spectra by recording the absorption spectrum of the colloidal solution [Graph 1] with a characteristic SPR band at 360 nm with increasing time. The antioxidant activity of biosynthesized Ag NPs was evaluated by DPPH assay with BHT as the standard [Graph 2]. In the present study, the synthesized Ag NPs showed comparable Nitric Oxide free radical scavenging activity to that of the standard [Graph 3].



Graph 1. UV-Vis Spectroscopy



Graph 2. DPPH Assay



Graph 3. Nitric Oxide Scavenging Assay

DISCUSSION

Former studies reported that AgNPs can be synthesised by plants such as *Cymbopogon citrates,*[8] *Garcinia mangostana* bark extract,[9] *Mucuna pruriens* seed,[10] *Kalanchoe pinnata* leaf,[11] *Acorus calamus* root,[12] *Chrysanthemum indicum.*[13] In the current study, aqueous silver ions were reduced to AgNPs after mixing with cumin oil extract followed by incubation. The colour turned yellow to reddish brown and this change in colour has been previously observed by several investigators.[14-16] These authors suggested that the colour change appeared the study showed dose dependent antioxidant activity by DPPH and Nitric Oxide assay techniques. due to the surface plasmon-resonance of deposited AgNPs.

In the current study, the mechanism by which the turmeric oil could mediate AgNPs may be explained by the higher total phenolics content in it. These plant phenolics are strong antioxidants with high reducing capacity[17] which can be used for AgNPs synthesis.[18] The higher content of total phenolic content in turmeric oil extract facilitates the reduction of silver ions to nano-sized silver particles due to the electron donating ability of these phenolic compounds. Furthermore, the quinoid compound produced due to the oxidation of the phenol group in phenolics can be adsorbed on the surface of nanoparticles, accounting for their suspension stabilization.[19] It is well documented that the phenolic compounds may contribute directly to anti-oxidative action.[20] This antioxidant activity is attributed to the phenolic contents in plants probably due to their redox properties, which allow them to act as reducing agents, hydrogen donors, and singlet oxygen quenchers.[21-25]

Nanoparticles have application in vascular alteration, especially in endothelial dysfunction related to oxidative stress.[26-31] This condition can lead to a reduction in nitric oxide (NO) bioavailability, consequently affecting vascular tone regulation and endothelial dysfunction, which is the first phase in the development of cardiovascular diseases. Hence, nanoparticles with antioxidant properties synthesised in the present study may be employed to improve the treatment of cancer, dermatitis, AIDS and high cholesterol level.

CONCLUSIONS

The present study revealed that silver nanoparticles can be synthesized in a simple, eco-friendly method using turmeric

oil. These turmeric oil mediated nanoparticles have the potential to be used as an effective antioxidant. Hence, it can be employed in large scale production and may be used for targeted drug delivery in cancer, dermatitis, AIDS and high cholesterol level.

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