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Microwave assisted production of silver nanoparticles using green tea extracts

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This study was designed to produce metallic silver nanoparticles (AgNPs) using green tea extract and microwave power. Two approaches were employed for AgNP production. Firstly, crude aqueous tea extract was filtrated and directly used in microwave assisted AgNP production system. Secondly, catechins were selectively extracted from crude extract and 2% (w/v) aqueous solutions of catechin extract has become available in the same process. A certain volume of extract (0.5 ml or 5 mL) was added to $AgNO_3$ solution (1–6 mM) and exposed to microwave radiation for 1, 5, 15 and 30 min in the presence and absence of capping agent polyethylene glycol (PEG). Plasmon resonance (SPR) absorption spectra were measured, thereby optimum conditions were determined. AgNPs were succesfully produced by both extracts only with 0.5 mL extract volume. Large volume of extract (5 mL) produced larger particles in all cases. Catechin extract was superior when compared with crude extract as the former produced high concentration of AgNPs at average 15 ± 6 nm particle size.

1. Introduction

Nobel metals have unique properties such as their resistance to harsh conditions. Silver has been used by various purposes for ages including antimicrobial protection, in particular. Traditionally Ag-based antiseptic formulations have been used in the control of bacterial growth in health care such as dentistry, burn healing and disinfection of medical equipment.

Obviously, nanotechnology has widened the horizon of medical applications for many metals including silver. It is well-known phenomenon that noble metals exhibit unique properties when they are produced at nanoscale. The major methods used in silver nanoparticles (AgNPs) synthesis are the physical and chemical methods that they have been recently reviewed [1,2]. On the other hand, green chemistry involves the production of materials using eco-friendly reagents. Recently, different methods have been introduced to produce AgNPs by means of biomaterials. In this sense, three major sources, e.g. bacteria, fungi, and plants have become ideal tools for synthesizing AgNPs. Biosynthesis of silver nanoparticles is a bottom-up approach that mostly involves reduction/oxidation reactions. Microorganisms have a unique metabolism, enabling metal ions to reduce, and leading to produce metal nanoparticles. They contain various reductase enzymes that serve as nanomachines for the production of nano structures. Synthesis of AgNPs by intra- and extracellular mechanism of bacteria, fungi and yeasts has been recently reviewed by Singh et al. [2].

Plant derived chemicals and, more precisely, plant extracts have been employed for ecofriendly, simple, rapid, stable and cost-effective production of AgNPs. Particularly water-mediated extraction of plant materials have been of great importance and value in terms of production strategy. The whole plant itself or its leaves, roots, flowers or fruits have selectively been used in the green synthesis of AgNPs and a number of reviews have become available in the current literature [2–7]. Plant extracts are reported to be able to reduce silver ions, faster than fungi or bacteria. Besides, plant-based AgNPs are more stable when compared to those produced by aforesaid organisms [6] and polyphenols as well as phenolic acids present in the extract provide extra protection on AgNPs due to surface interaction between nanoparticle and

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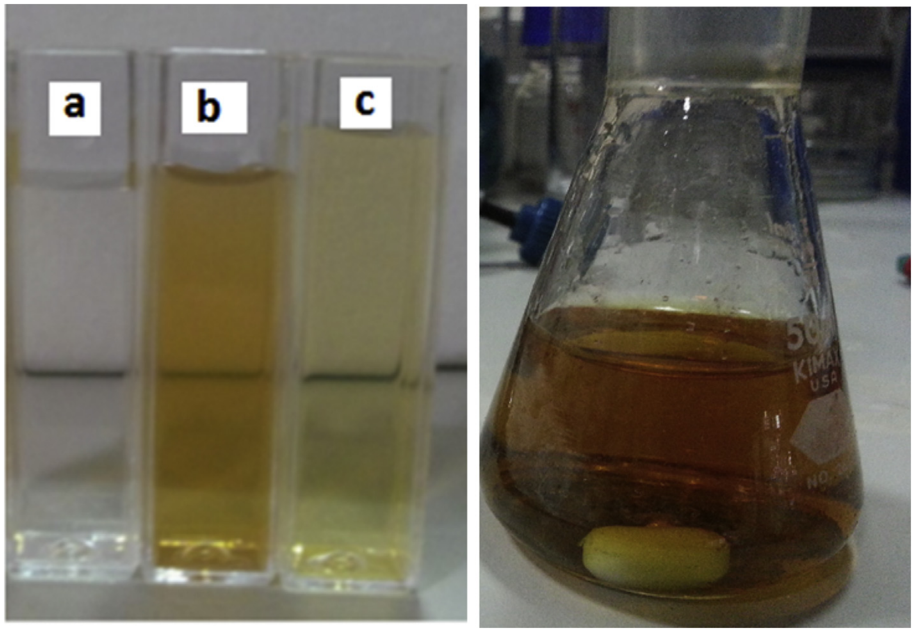

Fig. 1. Color change of $AgNO_3$ and tea extract mixture before (a) and after microwave treatment (b and c). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

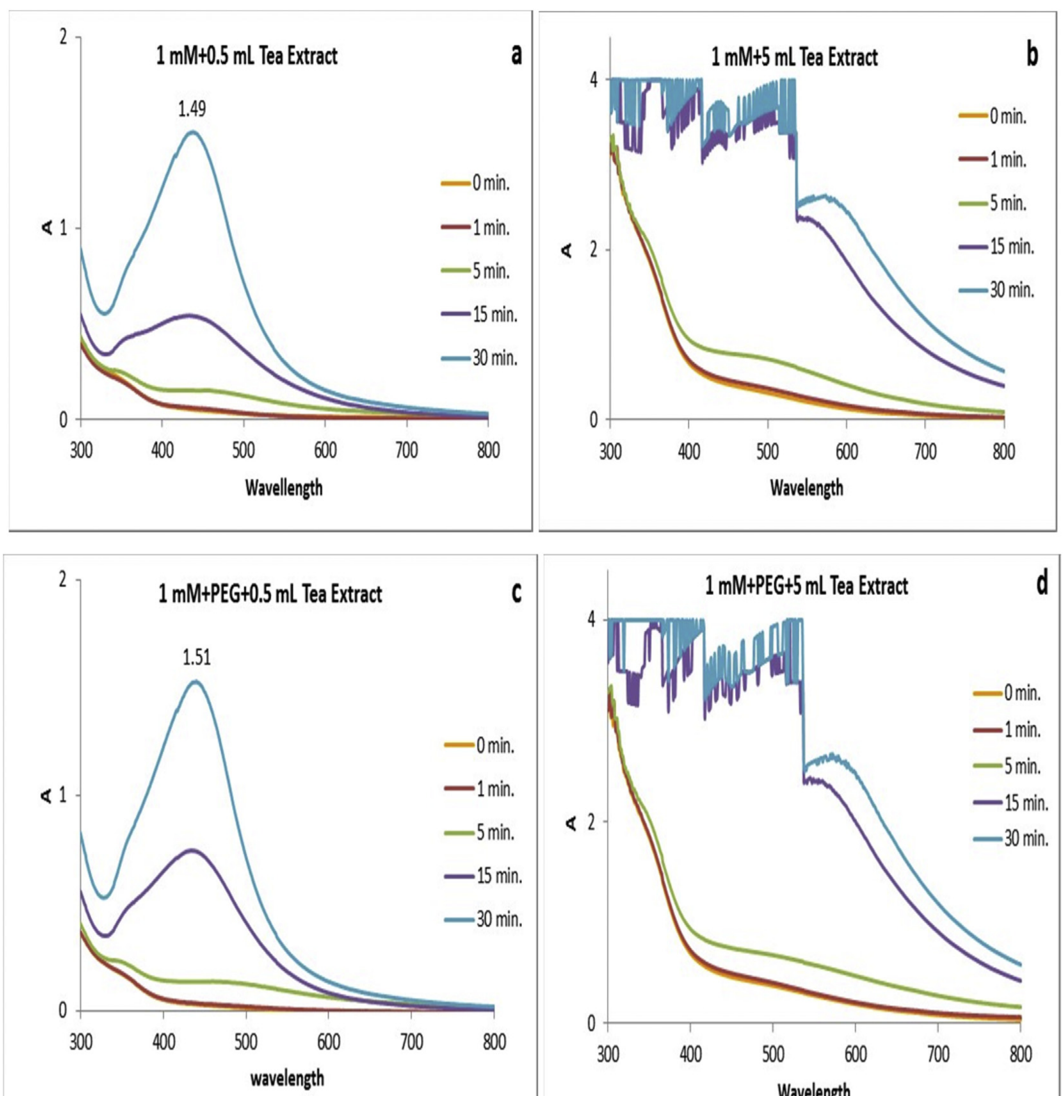

Fig. 2. Surface plasmon resonance (SPR) absorption spectra of silver nanoparticles in the presence of crude tea extract.