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Orange fruit mediated synthesis and characterisation of silver nanoparticles

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Abstract: Development of environmental friendly procedures for the synthesis of nanoparticles through biological process is evolving into an important branch of nanobiotechnology. The present study deals with the synthesis of silver nanoparticles using the green synthesis method which is eco-friendy. On challenging, silver nanoparticles have been synthesized rapidly in green condition by using fruit extract of orange and aqueous $AgNO_3$ (1mM) solution. The entire reaction mixture turned to brown color after 5 hours of reaction. The reaction process is rapid, simple and easy to handle. The so-synthesized nanoparticles were characterized using UV-Vis absorption spectroscopy, X-ray diffraction (XRD) and FTIR Studies

Introduction

Recently, metal nanomaterials have attracted considerable attention because of their unique magnetic, optical, electrical, and catalytic properties and their potential applications in nanoelectronics [1].Because of the completely new or improved properties (size, distribution and morphology) new applications of nanoparticles and nanomaterials are emerging rapidly[2-4].

Nanocrystalline silver particles have found remarkable applications in the field of high sensitivity bimolecular detection and diagnostics[5],anti microbials and therapeutics[6-7], Catalysis[8] and micro-electronics[9].

However, there is still need for cost-effective, commercially feasible as well environmentally clean synthesis route to synthesize silver nanoaparticles. A number of approaches are available for the synthesis of silver nanoparticles and recently via green chemistry route[10-12]. The synthesis of silver nanoparticles by using environmentally benevolent materials like plant leaf extract[13], bacteria[14], fungi[15], soluble starch[16] and enzymes[17] offers numerous benefits of eco-friendliness and compatibility for pharmaceutical and other biomedical applications as they use non-toxic chemicals for the synthesis protocol.

Green synthesis provides progression over chemical and physical method as it is commercial, environment friendly, easily scaled up for large scale synthesis and in this method there is no need to use high pressure, energy, temperature and toxic chemicals[18] .

Today, nanometal particles, especially silver, have drawn the attention of scientists because of their extensive application in the development of new technologies in the areas of electronics, material sciences and medicine at the nanoscale[19-21]. Silver nanoparticles have many applications; for example, they might be used as spectrally selective for solar energy absorption and intercalation material for electrical batteries, as optical receptors, as catalysts in chemical reactions, for biolabelling, and as antimicrobials[22].

We report the synthesis of silver nanoparticles due to the reduction of aqueous Ag^+ (1mM) ions by the fruit extract of orange .The reduction of metal ions is fairly rapid, occurs readily in solution, and results in a high density of extremely stable silver nanoparticles.

2. Experimental Details

2.1. Preparation of the extract

Aqueous extract have been prepared by bringing fresh ripped Orange fruit. Orange fruit weighing 25g were soaked distilled water followed by drying, cut into fine pieces and were crushed into 100 ml sterile distilled water and filtered through Whatman No. 1 filter paper (pore size 25 μm). The filtrate was further filtered through 0.6 μm sized filters.

2.2. Synthesis of silver nanoparticles

Freshly prepared 1 mM aqueous solution of Silver nitrate ($AgNO_3$) was used for the synthesis of silver nanoparticles. 10 ml of orange fruit extract was added into 90 ml of aqueous solution of 1 mM aqueous solution of Silver nitrate for reduction into Ag^+ ions and kept at room temperature for 5 hours.

2.3. UV-vis spectra analysis

The reduction of pure Ag^+ ions was monitored by measuring the UV-Vis spectrum of the reaction medium at 5 hours after diluting a small aliquot of the sample into distilled water. UV-Vis spectral analysis was done by using UV-Vis spectrophotometer JASCO V-570.

2.4. XRD analysis

The silver nanoparticle solution thus obtained was purified by repeated centrifugation at 5000 rpm for 20 min followed by redispersion of the pellet of silver nanoparticles into 10 ml of deionized water. After freeze drying of the purified silver particles, the structure and composition were analyzed by XRD. The dried mixture of silver nanoparticles was collected for the determination of the formation of Ag nanoparticles by an X'Pert Pro x-ray diffractometer operated at a voltage of 40 kV and a current of 30 mA with Cu Kα radiation.

2.5. Observation of silver particle size

XRD patterns were analyzed to determine peak intensity, position and width. Fullwidth at half-maximum (FWHM) data was used with the Scherrer's formula to determine mean particle size. Scherrer's equation is given by

$$d = \frac{0.9\,\lambda}{\beta \cos\theta}$$

Where d is the mean diameter of the nanopartilces, λ is wavelength of X-ray

radiation source, β is the angular FWHM of the XRD peak at the diffraction angleθ [23].

2.6. FTIR analysis

To remove any free biomass residue or compound that is not the capping ligand of the nanoparticles, the residual solution of 100 ml after reaction was centrifuged at 5000rpm for 10 min and the resulting suspension was redispersed in 10 ml sterile distilled water. The centrifuging and redispersing process was repeated three times. Thereafter, the purified suspension was freeze dried to obtain dried powder. Finally, the dried nanopartiles were analyzed by FTIR Spectrometer – BRUKER Optik GmbH TENSOR 27.

3. Results and Discussions

The bio reduction of aqueous solution of silver nitrate is one of the most widely used methods for the synthesis of silver nanoparticles. In this study, the formation of silver nanoparticles by orange fruit extract was investigated. The appearance of a yellowish brown color reaction vessels suggested the formation of silver nanoparticles[24-25].

These reaction mixtures were further characterized by UV-visible spectroscopy to examine size- and shape-controlled nanoparticles in aqueous suspensions. The reaction of silver nitrate with extract of orange fruit resulted in the reduction as confirmed by UV spectroscopy (Figure 1). The increase in intensity over the time indicates the completion of the reaction.

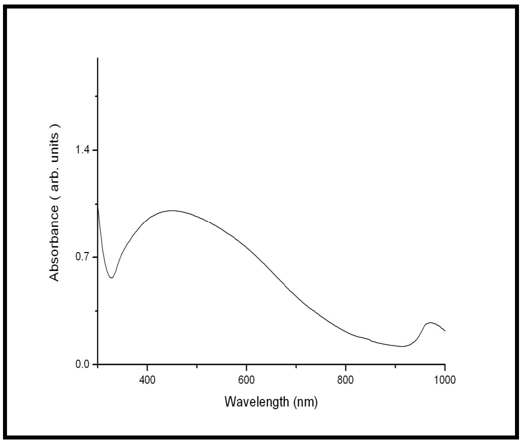

Fig.1. UV-Vis absorption spectrum of silver nanoparticles synthesized by treating 1mM aqueous AgNO3 solution with 10% Orange fruit

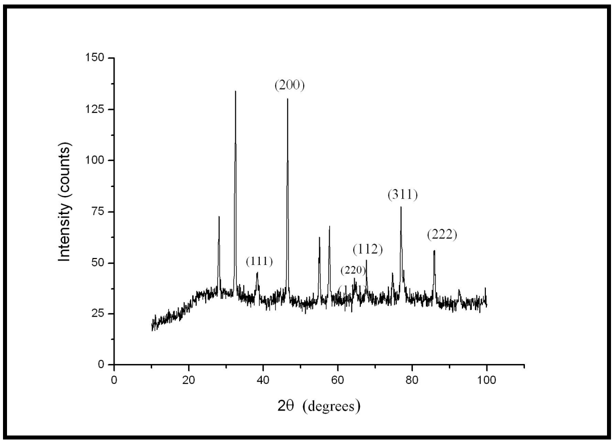

Fig.2 XRD pattern of silver nanoparticles synthesized by treating 10% Orange extract with 1 mM aqueous AgNO3 solution

Absorption spectra of silver nanoparticles formed in the reaction media has absorbance peak at about 450 nm might be assigned to the longitudinal plasmon resonance of spindle-shaped silver nanoparticles [18,25]. The biosynthesised silver nanostructure by employing orange fruit extract was further demonstrated and confirmed by the characteristic peaks observed in the XRD image (Figure 2).

The XRD pattern showed three intense peaks in the whole spectrum of 2θ value ranging from 10 to 80. Average size of the particles synthesized was 30 nm with size range 20 to 50 nm with cubic and hexagonal shape. The typical XRD pattern (Fig. 2) reveled that the sample contains a mixed phase (cubic and hexagonal) structures of silver nanoparticles. The average estimated particle size of this sample was 30 nm [26-27]derived from the FWHM of peak corresponding to 111 plane (Fig 2).

FTIR analysis was used for the characterization of the resulting nanoparticles (Figure 3). Absorbance bands in Fig. 3 are observed in the region of 500–2000 cm-1 are 1697, 1618, 1514, 1332, 1226 cm-1. These absorbance bands are known to be associated with the stretching vibrations for –C C–C O, –C C– [(in-ring) aromatic], –C–C– [(in-ring) aromatic], C–O (esters, ethers) and C–O (polyols), respectively. In particular, the 1226 cm-1 band arises most probably from the C–O group of polyols such as hydroxyflavones and catechins [25] leading to a broad peak at 1650cm-1 (for reduction of Ag).

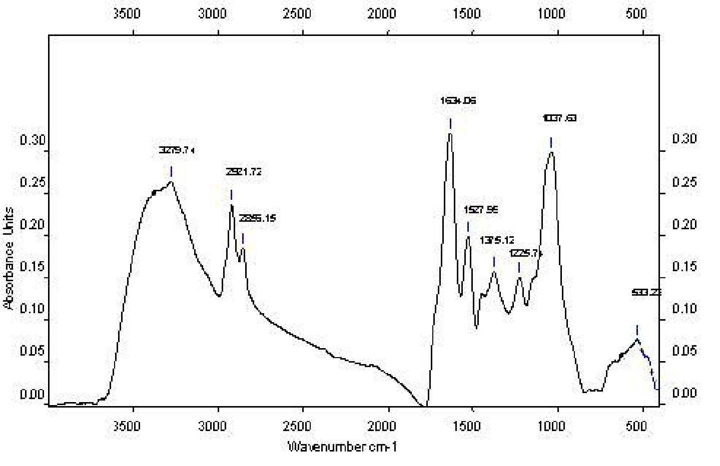

Fig.3. FTIR spectra of dried powder of silver nanoparticles synthesized by 10%fruit extract solution

4. Conclusions

In conclusion, the bio-reduction of aqueous Ag+ ions by the fruit extract of Orange has been demonstrated. The reduction of the metal ions through fruit extract leading to the formation of silver nanoparticles of fairly well-defined dimensions. This green chemistry approach toward the synthesis of silver nanoparticles has many advantages such as, ease with which the process can be scaled up, economic viability, etc. The use of Orange fruit extract has the added advantage can be used by nanotechnology processing industries. Applications of such eco-friendly nanoparticles in bactericidal, wound healing and other medical and electronic applications, makes this method potentially exciting for the large-scale synthesis of other inorganic materials (nanomaterials). Toxicity studies of Orange fruit extract mediated synthesized silver nanoparticles are under investigation.

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