Green Synthesis of Colloidal Silver Nanoparticles Reinforced PVA-Corn Starch Hydrogel Films

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Abstract. Hydrogels of poly (vinyl alcohol) (PVA) are versatile materials with great potential in biomedical and pharmaceutical applications. Reinforcement of silver nanoparticles into PVA matrix may offer excellent antibacterial properties. Among various physical and chemical methods (viz. chemical reduction, thermal decomposition etc.) for synthesizing silver nanoparticles, biological methods have been suggested as possible eco-friendly alternatives. In the present work a novel approach for the green synthesis of colloidal silver nanoparticles films has been achieved using environmentally acceptable plant extracts of *Catharanthus roseus* (*C. roseus*) Linn. G. Don. Following the proposed approach, in the present study PVA/corn starch based hybrid hydrogels have been designed and characterized. Due to the visco-elastic behavior, the corn starch is expected to impart mechanical strength to the synthesized films. The hydrogels were characterized by the techniques such as ultraviolet-visible (UV-Vis) spectrophotometry, scanning electron microscopy (SEM), and X-ray diffraction. SEM analysis showed the formation of silver nanoparticles having needle-like structures. The X-ray diffraction results clearly showed that the silver nanoparticles were formed by the reduction of Ag^+ ions by the *C. roseus* leaf extract and were crystalline in nature. Thus, it can be concluded that the leaves of *C. roseus* can be an environmentally and economically viable source for the synthesis of silver nanoparticles. The antibacterial nature of the synthesized green films warrants development of value added nanomaterials for various biomedical applications.

INTRODUCTION

Crosslinked polymeric networks, called hydrogels is a way to green synthesis as they possess ability to hold water within the spaces available among the polymeric chains. Hydrophilic PVA joined to other polymers opens a window of research for altering or tailoring the property of interest. PVA based materials have important biophysical properties, thus frequently used as biomaterials in various medical and pharmaceutical applications. Many techniques of synthesizing silver nanoparticles have been reported in the literature [1-4], few of which are either extremely expensive or a biological threat.

SYNTHESIS AND CHARACTERIZATION

The fresh leaf of *C. roseus* solution was prepared and the extract (filtrate) was treated with aqueous 1 mM $AgNO_3$ solution at room temperature. A brown-yellowish solution obtained indicated the formation of silver nanoparticles by reduction through aqueous extract of *C. roseus* leaves. PVA/corn starch based hybrid hydrogels were then synthesized by a redox system comprising of metabisulphite and persulphate in the immediate presence of a crosslinker *N,N′*□methylene bis acrylamide (MBA). colloidal silver nanoparticles were then evenly dispersed by in situ precipitation and the polymer nanocomposite matrix thus formed were characterized by techniques ultraviolet-visible (UV-Vis) spectrophotometry, scanning electron microscopy (SEM), and X-ray diffraction.

UV-Vis Spectroscopy Analysis

Small spherical nano particles (< 20nm) exhibit a single surface plasmon band[5]. The UV-Vis spectra show that an absorption peak, occurring due to Surface Plasmon Resonance (SPR), exists at 410 nm. The UV-Vis absorption spectra of the silver nano particles dispersed in the synthesized gel is shown in the Fig. 1. The broadening of peak indicated that the particles are poly dispersed.

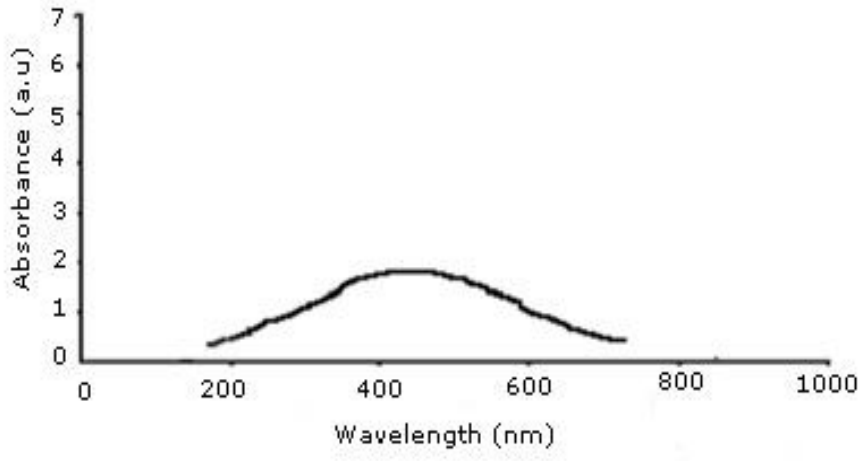

FIGURE 1. The UV/Vis absorption spectra of Ag nano particles

XRD ANALYSIS

The structure of prepared silver nanoparticles has been investigated by X-ray diffraction (XRD) analysis. Typical XRD pattern of the sample is shown in the Fig.2. The XRD study indicates the formation of silver (Ag) nano particles and clearly illustrated that the silver nanoparticles formed in this present synthesis are crystalline in nature.

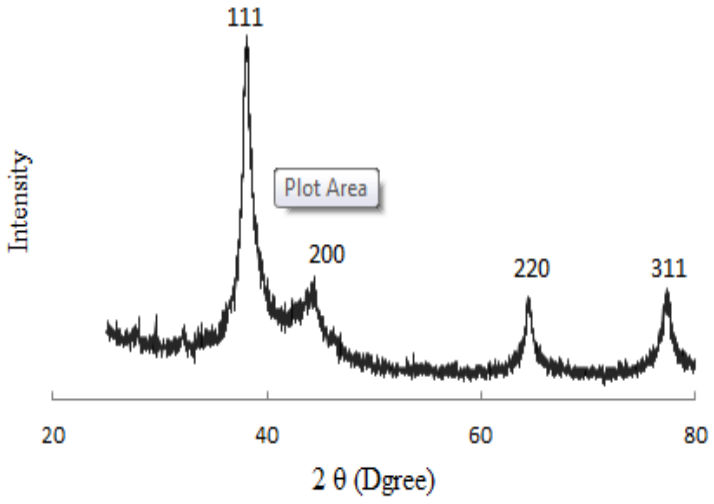

FIGURE 2. X-ray diffraction pattern of Ag nano particles

SEM ANALYSIS

SEM technique was employed to visualize the size and shape of silver nanoparticles. The shapes of the silver nanoparticles proved to be spherical and more or less uniform in size and shape. The formation of silver nanoparticles as well as their morphological dimensions in the SEM study demonstrated that the average size was from 20–35 nm (Fig 3).

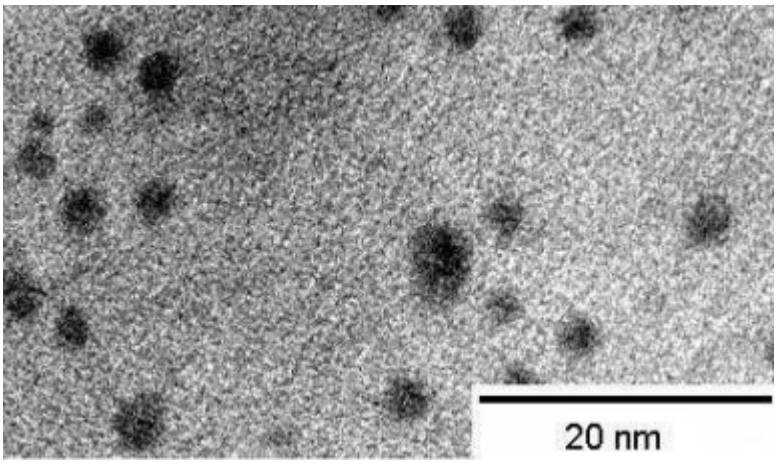

FIGURE 3 SEM image of *in-situ* Ag nano particles

CONCLUSION

The nanocomposites thus synthesized were primarily characterized by UV-Vis spectroscopy. The SEM image showed relatively spherical shape nanoparticle. The X-ray diffraction results clearly show that the silver nanoparticles formed by the reduction of Ag^+ ions by the *C. roseus* and *Cassia auriculata* leaf extract are crystalline in nature.

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