GREEN SYNTHESIS AND CHARACTERIZATION OF KNO_3 NANOPARTICLES USING C-ROSEUS PLANT EXTRACT

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ABSTRACT

A green rapid biogenic synthesis of silver nanoparticles (KNO_3NPs) using Catharanthus roseus flower extract was performed. Synthesized nanoparticles were characterized using UV-Visible, Fourier transform infra-red (FTIR) and X-ray diffraction (XRD). The reduction of silver ions to KNO_3NPs using C. Roseus extract was completed within 240 mins. The formation of KNO_3NPs was confirmed by Surface Plasmon Resonance (SPR) at 442 nm using UV-Vis Spectrophotometer and it is characterized by XRD, Transmission electron microscope (TEM) and Scanning electron microscope (SEM). The morphological studies revealed the spherical shape of the particles with sizes ranging from 16-35 nm and Energy dispersive X-ray (EDX) spectrum confirmed the presence of silver along with other elements in the plant's metabolite. The extracellular KNO_3NPs synthesis by aqueous leaf extract demonstrates ultra-fast, simple and inexpensive method comparable to other methods. The antioxidant assay of the synthesized KNO_3NPs indicated that they have a strong antioxidant property as compared to the control. Since these compounds are also safe to use and discharged into the environment, the green KNO_3NPs could be considered as an innovative alternative approach for biomedical and nanoscience-based industries.

Keywords: XRD; SPR; UV; TEM; SEM and EDX.

1. INTRODUCTION

Nanotechnology is very diverse, ranging from extensions of conventional device physics to completely new approaches based upon molecular self-assembly, from developing new materials with dimensions on the nanoscale to direct control of matter on the atomic scale. Nanotechnology entails the application of fields of science as diverse as surface science, organic chemistry, molecular biology, semiconductor physics, micro fabrication. The thought of nanotechnology to engineering by means of the idea of molecular manufacturing was for the 1st time applied by Eric Drexler. Drexler had ultimately envisioned that these nano bots would be utilized as assemblers for the objective of placing together atoms into any shape. Drexler claimed that coal can modify into diamond and laptop or computer chips can be created from sand. By reorganizing the atoms that make these supplies, the process will be significantly shortened and their useful goods would be made at a quicker speed. This was the cause nanotechnology was presented by Drexler as a scientific field that exclusively revolved about molecule manufacturing [1]. Nanoparticles have extremely small size which having at least one dimension 100 nm or less. Nanoparticles can be nanoscale in one dimension e.g. surface films, two dimensions e.g. strands or fibres, or three dimensions e.g. particles. They can exist in single, fused, aggregated or agglomerated forms with spherical, tubular, and irregular shapes. Common types of nanoparticles include nanotubes, dendrimers, quantum dots and fullerenes. According to Siegel, Nanostructured materials are classified as Zero dimensional, one dimensional, two dimensional, three dimensional nanostructures. Nanoparticles are structures created by nanotechnology research that range from 1 to 100 nanometers in size. Common examples of nanoparticles found in scientific literature are,Fullerenes, Nanotubes, Bucky balls, Quantum dots [2]. Free nanoparticles in the environment quickly tend to agglomerate and thus leave the nano-regime and nature itself presents many nanoparticles to which organisms on earth may have evolved immunity, such as trepans from plants or dust from volcanic eruptions [3, 4].

The synthesis and study of nanoparticles has become a major interdisciplinary area of research over the past 10 years. General methods for synthesis of nanoparticles are ability to control the particle size, shape, composition and size distribution. Methods to produce nanoparticles from atoms are chemical processes based on transformation in solution e.g. sol-gel processing, chemical vapor deposition (CVD).Plasma or flame spraying synthesis, laser pyrolysis, atomic or molecular condensation. These chemical processes rely on the availability of appropriate “metal-organic” molecules as precursors [5-9]. Sol-gel processing differs from other chemical processes due to its relatively low processing temperature. This makes the sol-gel process cost-effective and versatile. In spraying processes the flow of reactants (gas, liquid in form of aerosols or mixtures of both) is introduced to high-energy flame produced for example by; plasma spraying equipment or carbon dioxide laser. Rapid cooling results in formation of nanoscale particles. Nanotechnology is anticipated to open novel opportunities to prevent and fight against diseases using atomic scale tailoring of materials [1]. In the field of nanotechnology, the synthesis of nanoparticles of different sizes, chemical compositions, and controlled monodispersity is essential because they exhibit unique properties, which are not observed in bulk materials [2-3]. Nanoparticles play crucial roles in drug delivery, diagnostics, imaging, sensing, gene delivery, artificial implants and tissue engineering [4] and which has considerable attention because of their various applications. The novel green synthesis of silver nanoparticles (PnNPs) is evolving an important branch of nanotechnology. Recently, researchers have focused on biologically synthesized PnNPs, because of its extensive applications in the development of new technology in the field of electronics, material science and medicine at the nanoscale [5]. Catharanthus roseus (L.) G. Don (Vinca rosea) (Local Name in Tamil: Nithyakalyani), an important medicinal plant, belongs to family Apocynaceae and it is a perennial herb grown commercially for its alkaloids [6-7]. There are more than 70 alkaloids (mostly of indole type) that have been reported from different parts of C. roseus [8] and the major alkaloids are Vincristine and Vinblastine, which has anticancer property and used as a drug in the treatment of different cancers [9]. In India as well as other countries, tea made from the fresh leaf juice of C.roseus has been used by Ayurvedic physicians for the treatment of certain skin problems such as dermatitis, eczema and acne [10]. PnNPs also show evidence of potent cytoprotective activity towards HIV-infected cells [11]. The main aim of this study is to green synthesize PnNPs by reducing silver ions present in the fresh aqueous leaf extract of the herbal plant C.roseus and analyzeits antibacterial activity against gram negative and gram positive bacteria.

2. EXPERIMENTAL PROCEDURE

2.1. Materials

The fresh, fully matured leaves of C. roseus were collected from Bharathidasan University campus Tiruchirappalli, India and leaves were cut and shade dried which is used for the biosynthesis of PNNPs. Plant leaf extracts were prepared by boiling10g of dried leaves in 90 ml of deionized water for 30 minutes at 60° C and filtered through a Whatmann no.1 filter paper. C. roseus leaf extracts was treated with 90 Mole aqueous 1mM KNO3 solution with constant stirring for reduction of Water molecule and then periodically (10, 30, 60, 120 and 180 mins) color change was observed.

3.2. Synthesis of KNO3 nanoparticles

The dried leaf, stem, root and flower (1.0 kg) were powdered by electrical blender. Three litres of methanol, acetone and ethyl acetate separately were used for the extraction of 1.0 kg in the soxhlet apparatus followed by the standard procedure. The plant material was loaded in the inner tube of the soxhlet apparatus and then fitted into a round bottomed flash containing methanol, acetone and ethyl acetate separately. The solvents were boiled gently (40°C) over a heating mantle using the adjustable rheostat. The extraction was continued for 8 h and the solvent was removed at the reduced pressure with the help of rotary vacuum evaporator to yield a viscous dark green residue (12.5g) of each of methanol, acetone and ethyl acetate.

Fig.1. synthesization of KNO_3 nanoparticle

3. RESULTS AND DISCUSSION

3.1. XRD Analysis

X-ray diffraction (XRD) patterns of KNO_3NPs indicate that the structure of KNO_3NPs is the face centered cubic (fcc) structure of metallic silver (Fig. 2). In addition, the diffraction peaks at 2q values of 38.1, 44.3, 64.4, and 74.3 could be attributed to (111), (200), (220), (311) respectively, planes of pure silver ions indicating the biosynthesis of KNO_3NPs.Accordance with the standard metallic silver XRD pattern JCPDS No. 89-3722. The Scherrer equation the aver KNO_3e crystallite size of KNO_3NPs found to be lower than 24 nm in size. These peaks are due to the organic compounds which are present the extract and responsible for silver ions reduction and stabilization of resultant nanoparticles

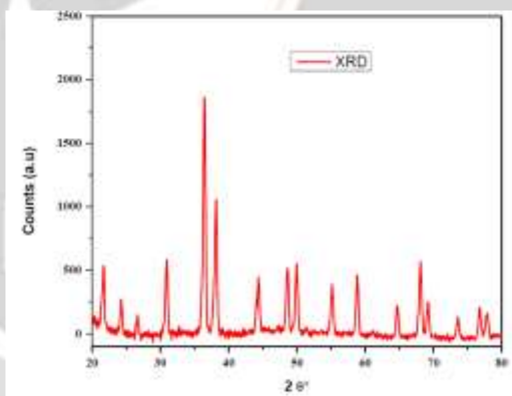

Figure 2. XRD spectra representing the crystalline KNO_3 nanoparticles

The observation indicates that the reduction of Ag+ ions took place extracellular. This result confirmed that the formation of Ag NPs using leaf extract of M. uniflorum. Therefore, the present study is highly co–related and supported with the previous study, the optical absorption spectrum of Ag NPs in the region of 320–620 nm (Jegatha 2012).

3.2. FT-IR Analysis

The FT-IR spectra were recorded to identify the possible bio molecules responsible fort he reduction of the KNO3þ ions and capping of the bio-reduced KNO_3NPs synthesized by the croseus leaf extract. Fig. 3 shows the spectra of PNO3NPs the transmission peaks at 3365.48, 2980.21, 2393.80, 1791.57, 1608.63, 1134.57, 808.79, and at 587.82 cm-1. The band at 2917 cm^{-1} indicated the formation of O-H stretching corresponding to carboxylic acid, 1656.9 cm-1 stretching for -C=C- corresponding to alkenes and 1540.4 cm-1 stretching for N-O corresponding to nitro compound This result finds similarity with the results obtained by Senthilkumar et al27 whose FTIR spectra had maximum peaks at 885.16 cm-1 and 3002.99 cm- 1 indicating the presence of C-O stretch bond, C=C group.

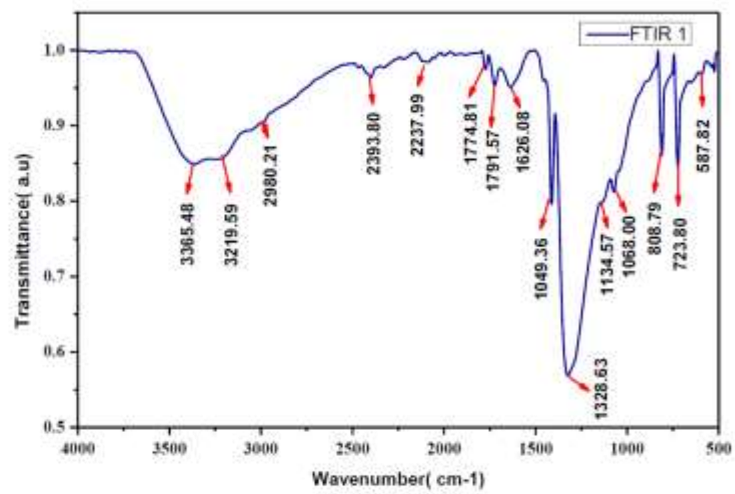

Figure 3. FT-IR Spectrum of KNO_3NPs

3.3. UV-Vis-NIR Spectroscopy Analyses

The optical property of KNO_3NPs was determined by UV-Vis spectrophotometer (Perkin-Elmer, Lambda 35, Germany).After the addition of KNO_3 to the plant extract, the spectra were taken in different time intervals up to 24hrs between 250 nm to 500 nm. Then the spectrum was taken after 24hrs of KNO_3 addition.

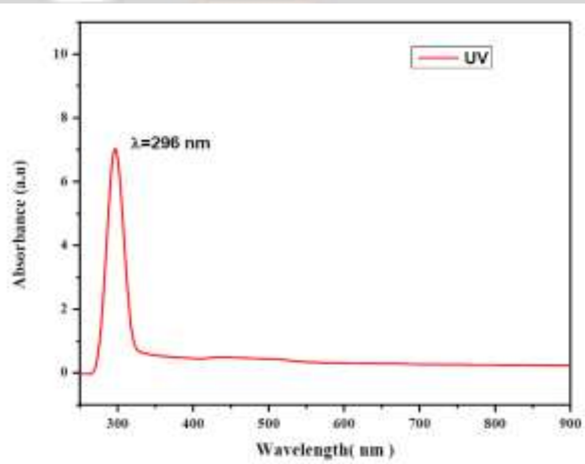

Figure 4. UV-VIS-NIR spectrum of synthesized sample

3.4. SEM Analysis

The morphological analysis of KNO3NPs was studied through SEM that revealed their spherical shape and variable size ranging from 16-35 nm with most of them coming in the size of 24 nm. However, the studies earlier performed by Ponarulselvum et al24 showed that the nanoparticles formed were in the range of 35-55nm.

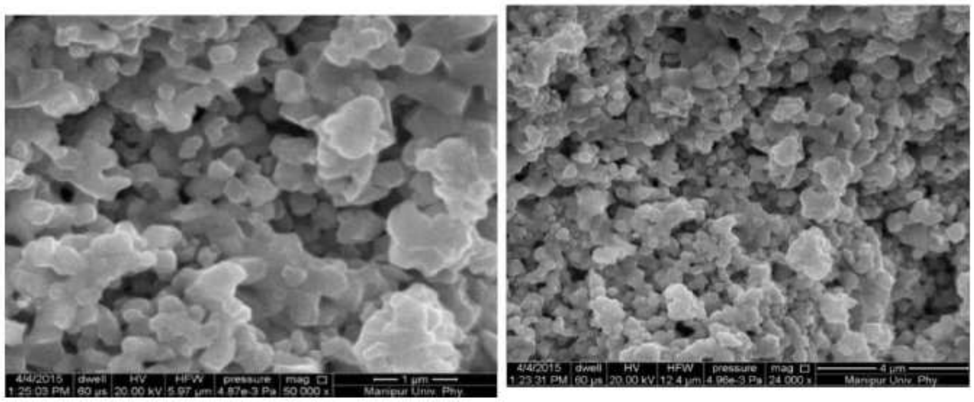

Fig. 5. SEM Analysis of KNO_3NPs.

4.CONCLUSION

In conclusion, the leaf extract of *C. roseus* is an excellent source for synthesizing KNO_3NPs demonstrating strong potential by rapid reduction of potassium ions (KNO_3+ to P0).Variable sized potassium nanoparticles were synthesized using *Catharanthus roseus* ranging from 16- 35 nm spherical shaped nanoparticles. The synthesized potassium nanoparticles were characterized using UV-Vis spectrophotometer, SEM, FTIR, XRD etc. Through these techniques, it was proved that the concentration of plant extract to metal ion ratio plays an important role in the shape determination of the nanoparticles. As these nanoparticles possessed significant antioxidant efficacy, it may also have potential applications in the field of biomedicine. Finally, it can be extended to large scale production of KNO_3NPs for commercial use of value-added products for biomedical/nanotechnology-based industries.

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