SYNTHESIS AND CHARACTERIZATION OF COPPER NANOPARTICLES USING PLANT EXTRACT

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ABSTRACT: *Development of green nanotechnology is generating great research interest in order to develop ecofriendly nanoparticles. Nanoparticles is prepared using medicinal important plant Abrus precatorius extract and copper sulphate. The nanoparticles obtained have been characterized with various techniques like ultraviolet-visible spectrum, FTIR, EDX analysis. The smaller-size of Copper nanoparticals has many positive attributes for antibacterial activity against pathogenic microorganisms. Thus synthesized nanoparticles can be used for various applications due to its eco-friendly nontoxic and compatibility for pharmaceuticals applications.*

Key Words: *biosynthesis; Copper nanoparticles; FTIR; EDX; antibacterial activity*

Introduction:

Nanotechnology is the most auspicious technology which deals with understanding and control of matter at nano scale. Nanoparticles size lies between 1nm to 100nm(Karthik & Geetha, 2014). In the recent past, Nanoparticles are more important in the fields of biology, chemistry and medicine due to their unique physical, biological and chemical properties. It is very easy to synthesize nanoparticles from plant materials(Yugandhar & Savithramma, 2016). This procedure is efficient and ecofriendly in compair to chemical and microbe mediated synthesis(Alzahrani & Ahmed, 2016).

Recently different type of Nanoparticles are synthesized using plant materials like Indium oxide nanoparticles from aloe vera(Pirtarighat, Ghannadnia, & Baghshahi, 2018), Iron oxide nanoparticles from Medicago sativa, Copper nanoparticles (CuNPs) from Magnolia Kobus. ,Silver nanoparticles from *Abrus precatorious.*. Copper nanoparticles (CuNPs) has an important role in electronics, optics and antimicrobial fields. Colour change from colourless to brown indicates the formation of nanoparticles(Chandra, Kumar, & Tomar, 2014).

There are several methods to synthesize copper nanoparticles. The major techniques to prepare copper nanoparticles by chemical methods are chemical reduction, micro emulsion , sono chemical reduction , electrochemical , biological synthesis etc(Chandra et al., 2014). Biosynthesis of nanoparticles was developed to reduce the problems of physical and chemical synthesis as cost and hazardous chemicals. Copper nanoparticles have receieved significant attention because of their physiochemical properties like as high melting point temperature, magnetism, electrical and thermal conductivity, light absorption and high heat transfer(Carmona, Benito, Plaza, & Recio-Sánchez, 2017). Copper nanoparticles were used as an antimicrobial agent due to their high surface-to-volume ratio and easy interaction with other particles to enhance their antimicrobial eficiency. Copper nanoparticles are highly reactive compared to other metallic nanoparticles. Due to these special properties and small dimensions, copper nanoparticles finds important application in heat transfer systems, sensors, high strength materials, catalysts, antimicrobial materials, etc(Chandra et al., 2014).

Material and Method:

A. Preparation of plant extract :
   Samples of *Abrus precatorious* were taken from Saroli. The dried plants were powdered with a mortar and pestle. 10 ml of distilled water was poured to 0.2 g of plant powder. This combination was boiled for 5 min and then was cooled. The cooled solution was fltered with Whatman No. 1 flter paper (Chung et al., 2017).
B. Biosynthesis of silver nanoparticles
   Aqueous solution of Copper sulphate (1 mM) was prepared and mixed with fresh plant extract of *Abrus precatorious* at a ratio of 9:1. This solution was placed on a shaker with constant rotation in the room temperature at 50°C for 24 h. All stages of the experiment were implemented in three replicates(UMER, NAVEED, RAMZAN, & RAFIQUE, 2012).

C. Characterization of silver nanoparticles

- Visible Characterization , UV-Visible Absorbance Spectroscopy : UV-Visible spectroscopy analysis was carried out on a UV Visible absorption spectrophotometer. Equal amounts of the suspension (0.5 mL) were taken and analysed at room temperature. The progress of the reaction between metal ions and the leaf extract was monitored by UV-Visible spectra of copper nanoparticles in aqueous solution with different wavelength in nanometers from 340 to 800 nm. The reduction of copper ions and formation of copper nanoparticles occurred within an 6 hour of reaction. Control was maintained by using $CuSO_4$.
- Fourier Transforms Infrared Spectroscopy (FTIR): For FTIR measurements, the synthesized copper nanoparticles solution was centrifuged at 10000 rpm for 30 minutes. The pellet was washed thrice with 5 mL of deionised water to get rid of the free proteins or enzymes that are not capping the copper nanoparticles. The pellet was dried by using vacuum drier. It was analysed by FTIR.
- SEM: The surface morphology and particle size of synthesized CuNPs was investigated by scanning electronic microscope
- EDAX : Percentage of copper ions of synthesized SNPs were done using a FEI Quanta 200 FEG HR-SEM machine equipped with EDAX instrument (Yugandhar & Savithramma, 2016).

Result:

CuNP synthesis At a wavelength of 565 nm, the optimum parameter required for CuNPs synthesis is 50˚C, 3 mM $CuSO_4$ (pH 6) and a 24 h incubation period. The formation of CuNPs was preliminarily confirmed by UV-Vis spectral analysis of coloured solutions, which exhibited SPR bands within 6 h; the bands were brown-like in colour (Fig. 1), indicating metallic copper. The characteristic absorption peak at 565 nm is due to the surface plasmon band of Cu colloids formation of non-oxidized CuNPs (Fig. 2).

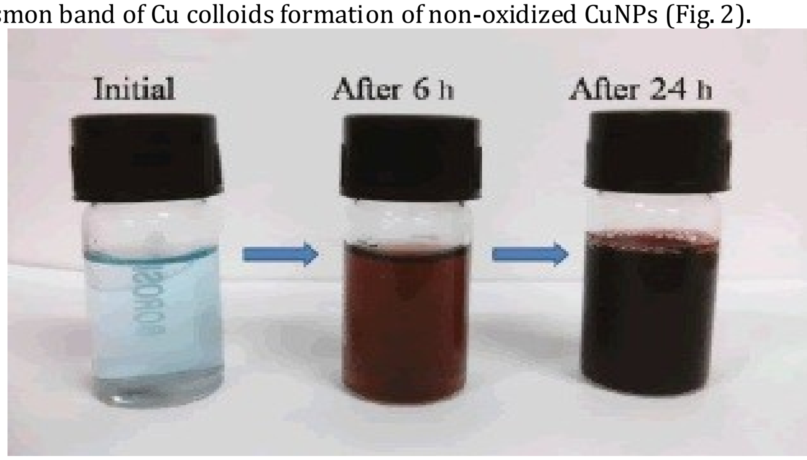

Figure 1 : Colour change from Colourless to Dark Brown

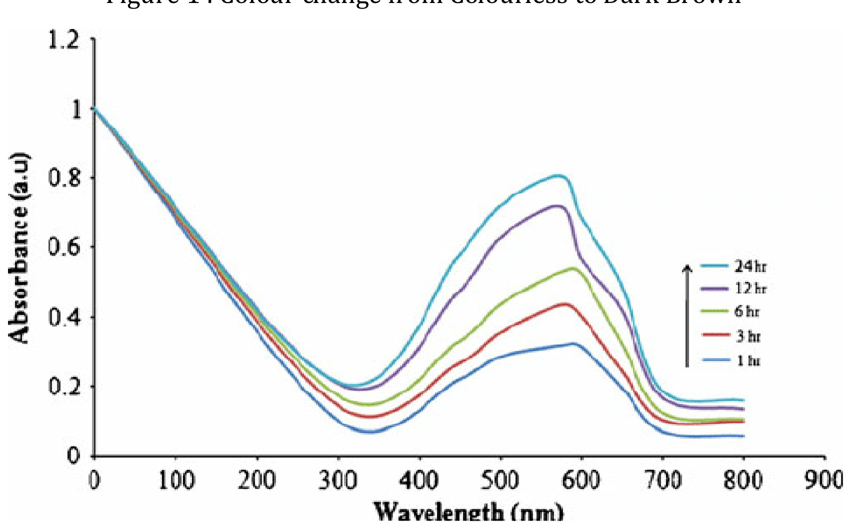

Figure 2: Result of UV- vis analysis showing SPR pear at 565 nm

FTIR analysis. In the present study, the FTIR spectrum was examined to identify the possible biomolecules responsible for capping and efficient stabilization of the CuNPs synthesized by *Abrus precatorious* leaf extract. Peaks were observed at 3424 cm-1 for the hydroxy group (H-bonded OH stretch); 2918 cm-1 for methylene C-H asym./sym. stretch; 1654 cm-1 for aromatic ring stretch; and 1106 cm-1 for aliphatic fluoro compounds (C-F stretch) (Fig. 3).

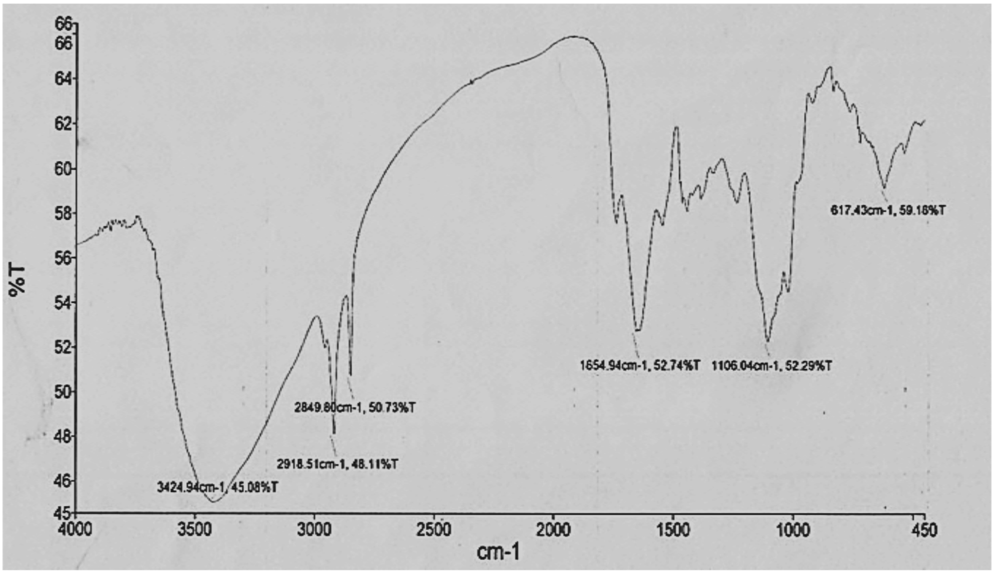

Figure 3: Fourier transform infrared (FTIR) spectra of CuNPs synthetized by using plant extracts of *Abrus precatorius*

SEM analysis. SEM micrographs of the CuNPs synthesized by the reduction of copper acetate revealed spherical, hexagonal and cubical NPs ranging from 14 to 68 nm, with an average size of 41±1 nm due to Cu ions. It was observed that they were approximately spherical in shape with a smooth surface (Fig. 4).

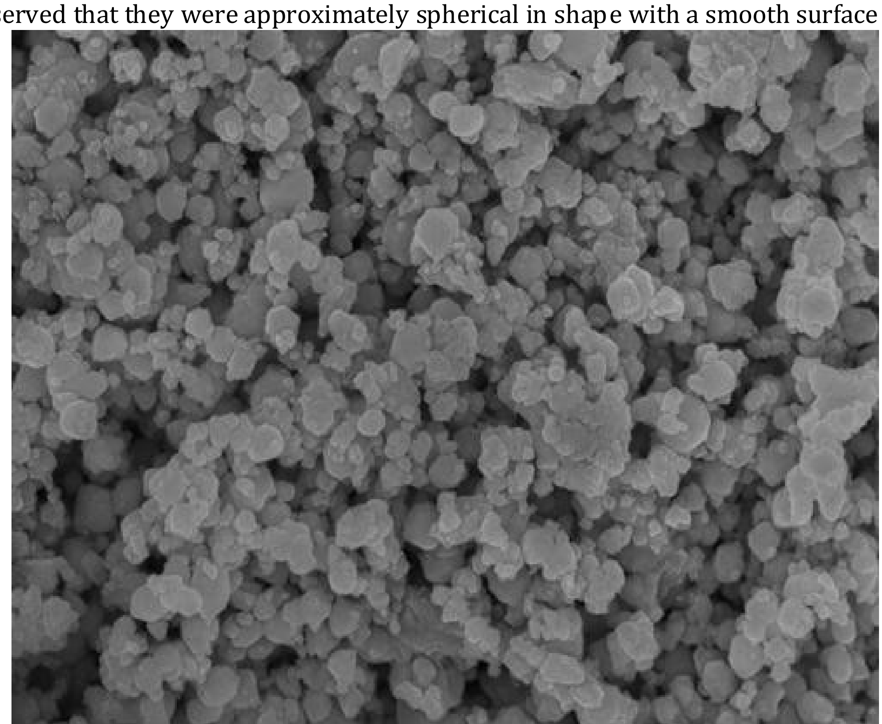

Figure 4: SEM images of CuNPs synthetized by using plant extracts of *Abrus precatorius*

The EDX of the synthesized CuNPs showed strong copper signals along with Cu and C peaks, which may originate from the biomolecules that were bound to the surface of the CuNPs (Fig. 5).

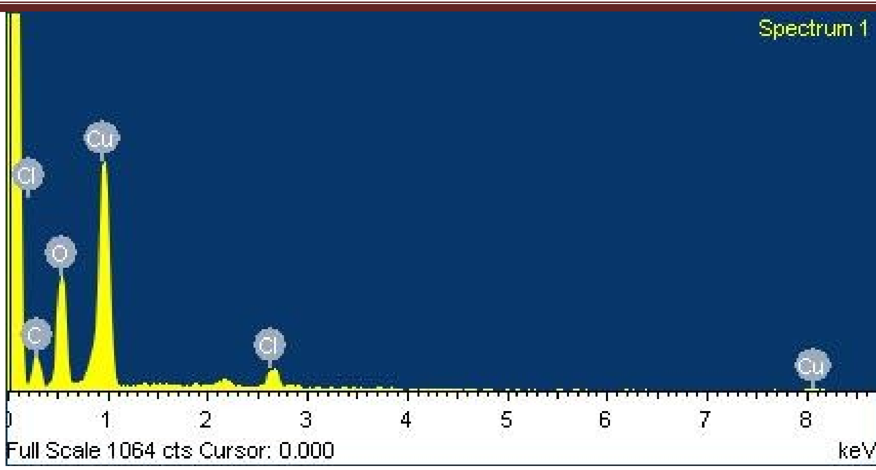

Figure 5: Energy dispersive X-ray analysis image of CuNPs synthetized by using plant extracts of *Abrus precatorius*

Conclusion:

- Copper nanoparticles are synthesized by using plant extracts of *Abrus precatorius*. This is a biological, economical, efficient, eco-friendly and simple process. The medium contributing to the maximum synthesis was concentration of 3mM $CuSO_4$ was optimized for CuNPs synthesis. Silver nanoparticles are known to exhibit a characteristic surface plasmon resonance band at 565 nm that can be measured using UV-vis spectroscopy for Copper nanoparticles. We have also achieved smaller-size CuNPs (14 to 68 nm) along with faster synthesis (within 6 hr) of particles when compared to those under unoptimized conditions.

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