GREEN SYNTHESIS OF COPPER NANOPARTICLES USING SALICORNIA EUROPAEA EXTRACT AND ITS CHARACTERIZATION

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Abstract : In this work, biosynthesis of stable copper Nano particles were done using *Salicornia europaea* leaf extract. The nanoparticles were synthesized through the chemical reduction of aqueous solutions of copper (II) sulfate with *Salicornia europaea* leaf extract. The biosynthesized Cu NPs were characterized with the help of ultraviolet visible spectroscopy, X-ray diffraction, Fourier transform infrared spectroscopy, scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The spectroscopic analysis of synthesized Cu NPs showed the maximum absorbance at 225 nm indicating the presence of biosynthesized Cu NPs in the reaction mixture. The analysis of the TEM images shows that the sizes of the nanoparticles are not spherical in shape with size around 100 nm.

IndexTerms* - Biosynthesis, *Salicornia europaea,* Copper nanoparticles, *Powder XRD, UV-Vis, FTIR.

I. INTRODUCTION

Nanotechnology is one of the most recent researches in the field of material science. It is rising as a quick developing field with its materials at the nano scale level. Nanotechnology has developed as a promising device in the field of drug by expanding utilization of Nano particles for the treatment of different diseases. Today, scientists and engineers are finding a wide variety of ways to make materials at the nano scale due to the advantage of their enhanced properties, such as higher strength, lighter weight, increased control of the light spectrum and greater chemical reactivity. Copper is a Block D, Period 4 element. It is a ductile metal with very high thermal and electrical conductivity. The morphology of copper nanoparticles is round, and they appear as a brown to black powder. Copper is found to be too soft for some applications, and hence it is often combined with other metals to form numerous alloys such as brass, which is a copper-zinc alloy. Copper nanoparticles are graded as highly flammable solids; therefore they must be stored away from sources of ignition.

Salicornia europaea is an annual succulent, with much-branched, fleshy stems, growing up to 1 foot. Its flowers are very small and hermaphrodite. The common name of salicornia europaea is glasswort. It is the ahalophytic annual dicot which grows in various zones of salt marshes. It is used as sleeping aids and helps to reduce obesity. Green methods for the synthesis of Copper Nanoparticles using L-ascorbic acid have already been investigated by Asim Umer, Shahid Naveed , Naveed Ramzan and Muhammad Shahid Rafique. The authors A. Tamilvanan, K. Balamurugan, K. Ponappa, and B. Madhan Kumar were done studies on Copper Nanoparticles Synthetic Strategies, Properties and Multifunctional Application. The studies showed that the Copper nanoparticles received much attention due to its high electrical conductivity, high melting point, low electrochemical migration behavior and low cost. Top Down (physical methods) and bottom up (chemical and biological) approaches adopted for the synthesis of copper nanoparticles are reported. Green Synthesis of Copper Nanoparticles Using Ocimum Sanctum Leaf Extract was investigated by Vasudev D Kulkarni and Pramod Kulkarni.

In this present work, the copper nano particles are obtained using salicornia Europaea extract by biosynthesis method and its characterization is studied. The copper nano particles were confirmed by various characterization techniques such as Powder X-Ray diffraction studies, Fourier transform infrared spectroscopy (FTIR), UV-Visible, SEM and TEM studies.

II. MATERIALS AND METHODOLOGY

2.1. Preparation of Leaf Extract

Salicornia europaea plant leaves are collected from the sea shore area of Manora in Tamil Nadu, India. To remove the dust particles of the leaves, they washed well several times in deionized water. Now, the leaves are allowed to dry in room temperature. After drying, the leaves are powdered finely. To get the leaf extract, 20 gm of powdered leaves is taken in 250 ml glass beaker along with 200 ml of sterile distilled water. The mixture was boiled for 20 minutes until the colour of the aqueous solution changes from watery colour to light brown. The extract was allowed to cool to room temperature and filtered utilizing a Whatman filter paper. At final the dust free Salicornia europaea plant leaf extract is obtained.

2.2. Preparation of Cu Nano Particles

For the synthesis of Cu nano particles, about 5gm of $CuSO_4$ is mixed with 200ml of sterile deionized water is taken and then mixed with the prepared leaf extract. The mixture of aqueous solutions is kept for 12 hrs under room temperature. Now, the solution is poured into a test tube and it is centrifuged at 9000 rpm for 30 minutes. After centrifuging, the color of the solution changes from blue color to dark green color. The centrifuged solution is taken in the petri plate and kept in Owen at 900°C, until the solution dried. At final powdered sample is obtained. The dried powder is collected in the sample container and it is used for various characterizations. The figure 1 shows the graphical representation of preparation of Cu nanoparticles.

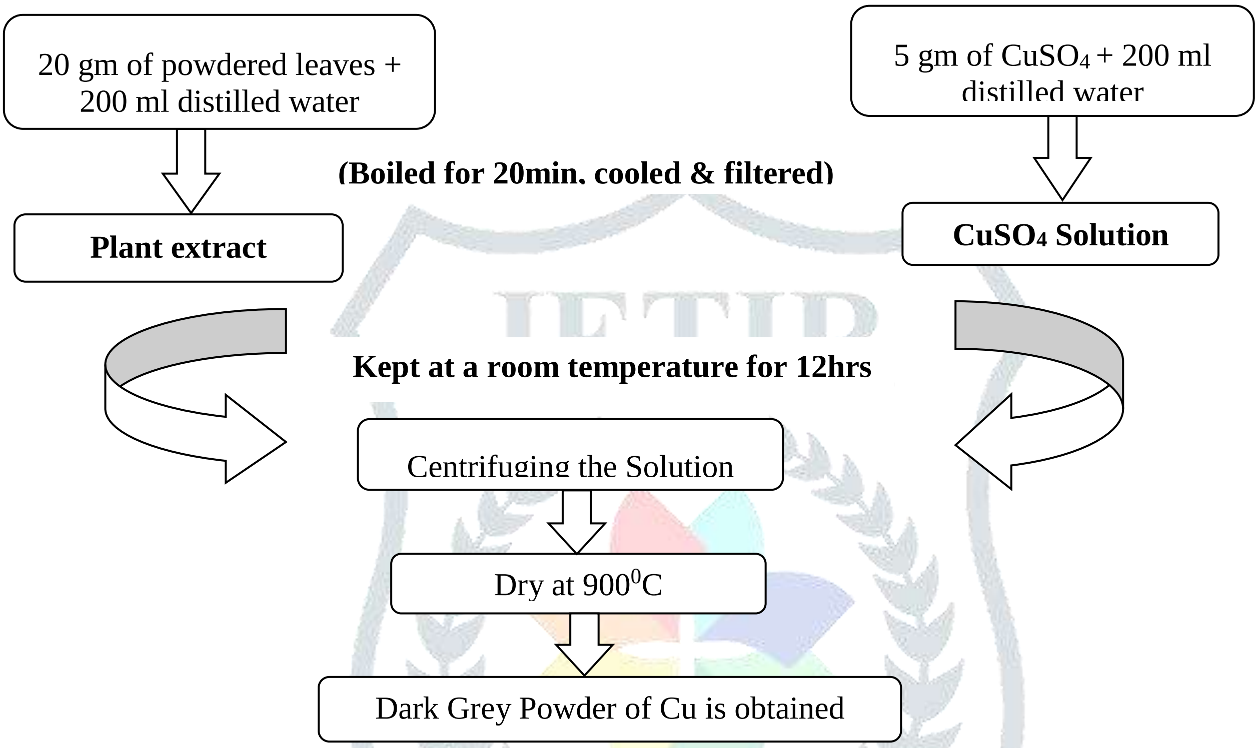


Fig -1. Graphical representation of preparation of Cu nanoparticles

III. RESULTS AND DISCUSSION

3.1 Powder XRD analysis

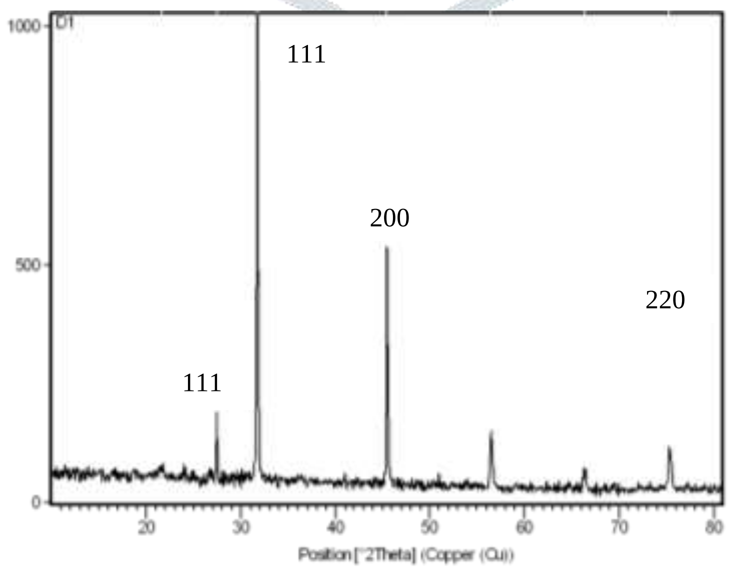


Fig – 2. Powder XRD of Cu Nano particles

The result of the XRD Spectra of Cu nanoparticles is shown in the figure 2. The diffraction peaks obtained at 2θ values are 27.4°, 32° and 47° which is corresponds to the crystallographic planes of the Face Centered Cubic Crystal (fcc). The Lattice parameter of Copper nanoparticles is calculated by using the formula,

$$\mathbf{a = d\,(h^2 + k^2 + l^2)^{1/2}}$$

By comparing the observed values with the theoretical values, it is clearly shown that, the Cu crystal is formed by the green synthesis of $CuSo_4$ with the salicornia europaea.

The average grain size of the Cu nano particles was calculated using the Scherer's equation,

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

Where, D is the average grain size and β is the full width half maximum. From the diffraction pattern of the grown crystal as shown in the figure 3, the values are θ = 32, β = 0.2 rad, and λ = 1.5406 A°, yielding a particle size D = 81.75 nm.

3.2. UV-Vis Studies

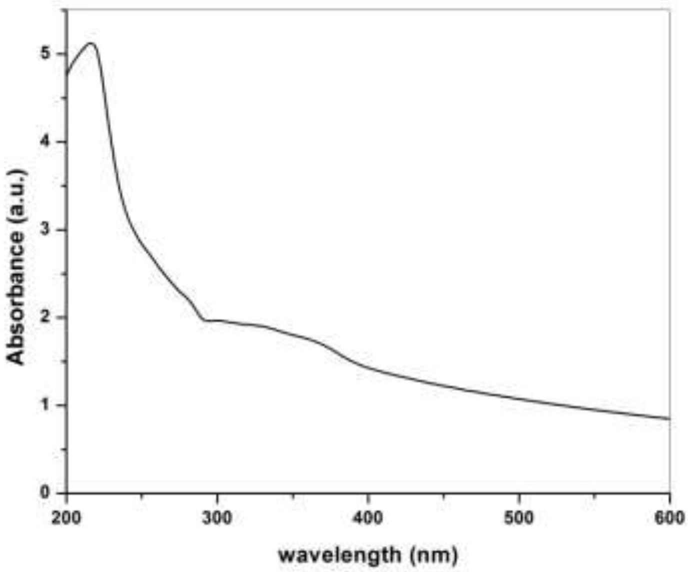


Fig – 3. UV-Vis Spectrum of Cu Nano particles

The optical properties of green synthesized copper nanoparticles are analyzed using UV–Visible absorption spectrum. The UV-Visible absorption spectrum of copper nanoparticles is shown in figure 3. From the analysis, at room temperature the spectra exhibited strong excitonic absorption peak at 225 nm. Then the band gap energy is found out by using relation, E = hc/λ. The band gap energy value of the cu nanoparticle is found to be $0.08835 X 10^{-17}$ joule.

3.3. FTIR Studies

The figure 4 shows the Fourier transform infra-red spectra of salicornia europaea leaf mediated Copper nanoparticles. The Vibrational bands and functional groups are shown in the figure 5. The transmittance bands at 3405, 2928, 2848, 1727, 1639, 1383, 1321, 1074 and 1032 cm^{-1} are assigned to O–H stretching H bonded vibration of alcohol group of strong variable, C- H Stretching vibration of alkane group of strong intensity, C = C stretching vibration of alkyl halide of variable intensity and C – O stretching vibration of alcohol group of strong variable. The peak 613 cm^{-1} is exhibiting the C-Cl group. Thus the FTIR Spectrum of Cu nanoparticle suggested that Cu nanoparticles were surrounded by different organic molecules such as Alcohol, Alkane, Alkynes, and alkyl halide.

Table 1: Frequency assignments of Cu Nano particles.

S.No	Wavenumber	Assignments
1.	3405	O-H Stretching
2.	2928	C-H aldehydic
3.	2848	C-H Stretching
4.	1727	C=O Stretching
5.	1639	C=S Asymmetric Stretching
6.	1383	CH_3 Bending
7.	1074	C-O Stretching
8.	1032	C-OH Stretching
9.	613	C-Cl

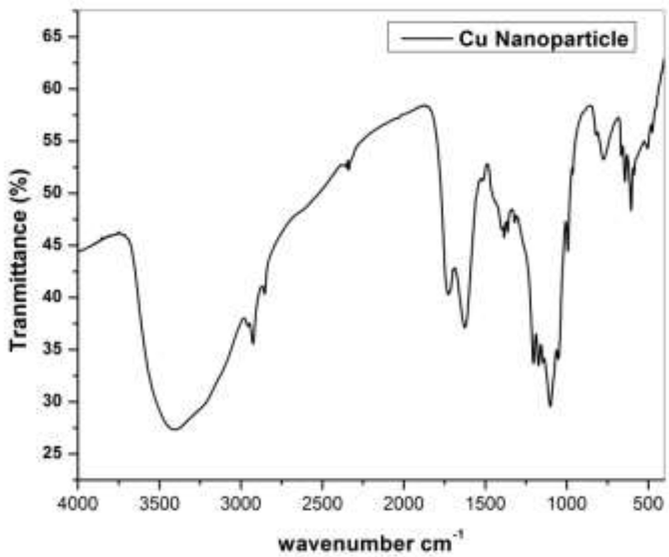
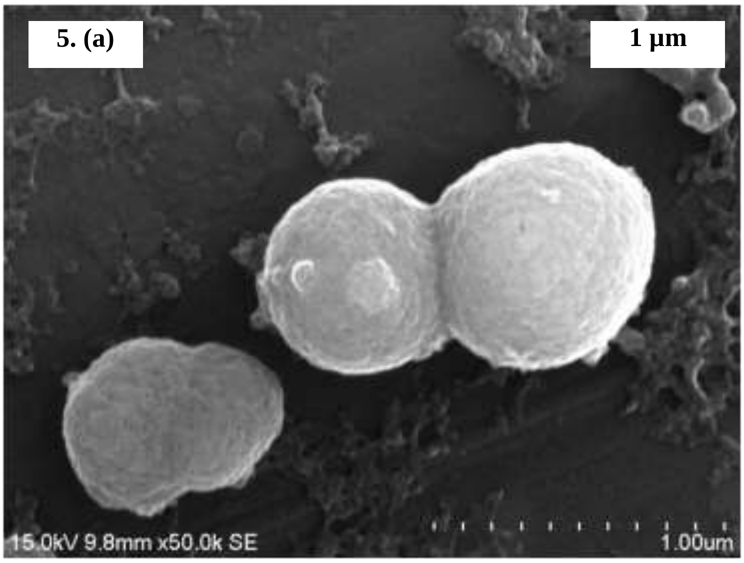


Fig.4. FTIR spectra of salicornia europaea mediated copper particles

3.4. SEM analysis



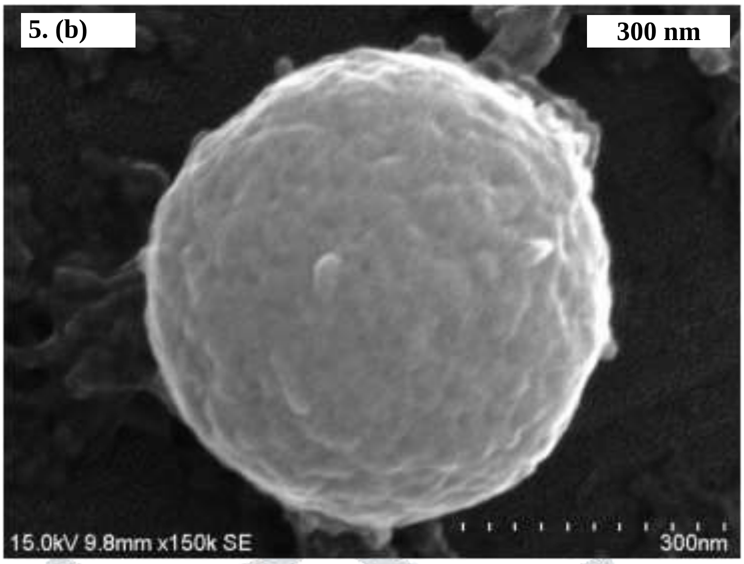


Fig. 5(a) & 5(b). SEM shows the presence of varying sized Copper particle formed during the reduction with salicornia europaea

The Fig. 5(a) and (b) are the SEM images of green synthesized copper nanoparticles. SEM is used for analysis of powdered sample of copper nanoparticles. It shows that the size of the Copper nanoparticles obtained in the range of 300 nm.

3.5. TEM analysis

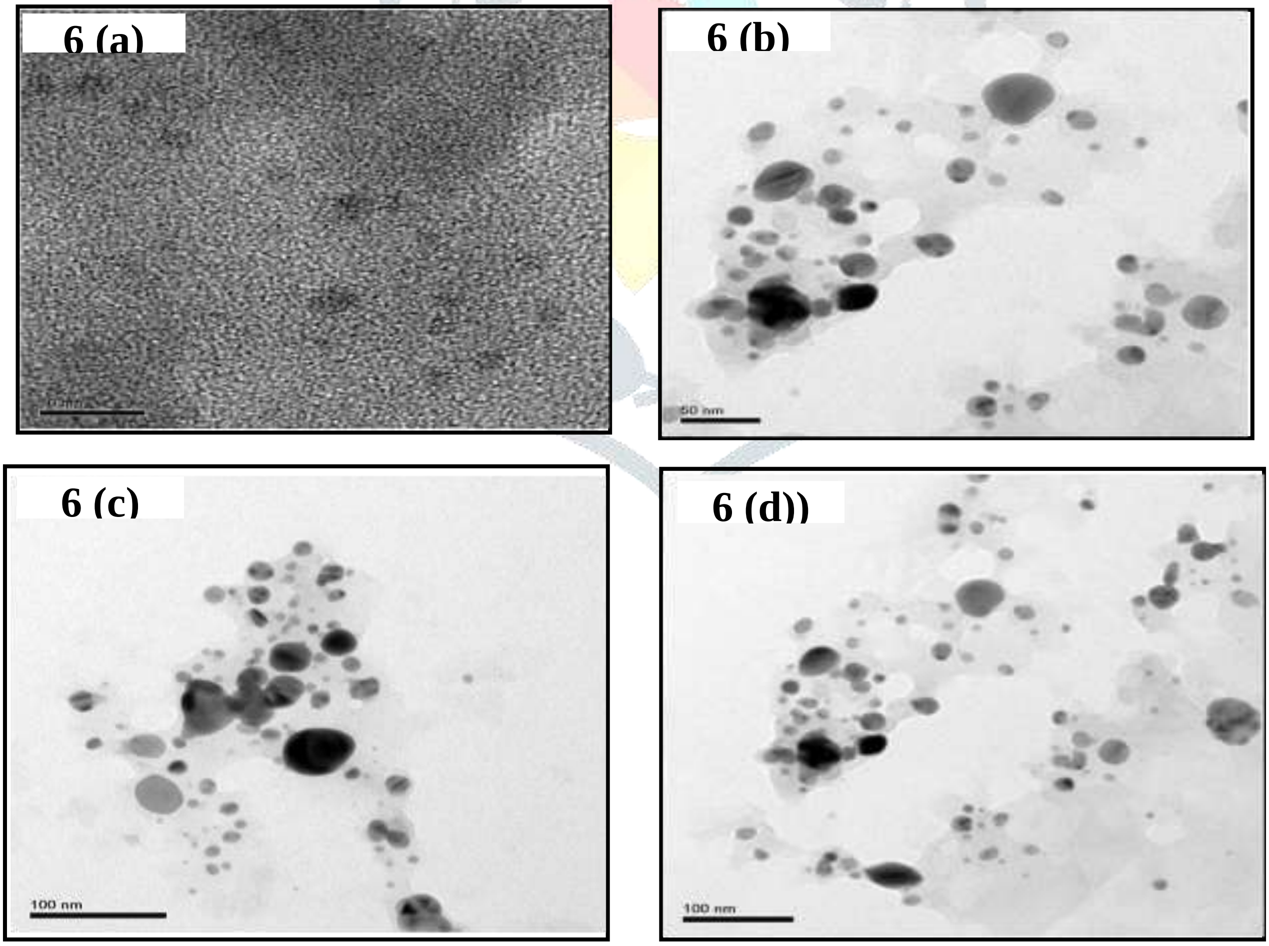


Fig. 6. High resolution transmission electron microscopic image of Cu nanoparticles shows the presence of *salicornia europaea*. (a) and (b) High resolution image of Cu nanoparticles with clear lattice fringes and (c) and (d) Individual nanoparticles

The figures 6(a), (b), (c) and (d) represents the TEM images of green synthesized copper nanoparticles. SEM and TEM analysis are used to determine the size and shape of nanoparticles. From the analysis, the prepared copper nanoparticles are obtained in non-spherical structure. The TEM image reveals that nanoparticles are not in physical contact but are separated by uniform inter particle distance, which was confirmed by microscopy visualizing under higher resolution. The TEM image reveals that the morphology of copper nanoparticles is nearly non-spherical in shape with range of 100 nm.

V. CONCLUSION

The copper nano particles are obtained using salicornia europaea by biosynthesis method. The synthesized nanoparticle was analyzed by UV-Vis spectroscopy and the peak of the spectra was found to be at 225 nm. The morphological study of Cu NPs using TEM suggests that the nanoparticles are non-spherical in shape with size around 100 nm. The physiochemical properties of copper nanoparticles using FTIR, powder XRD concludes that the nanoparticle form in the process is crystalline with miller indices of (111). The particle grain size is also calculated using the Scherer's equation and found to be 81.75 nm. The synthesis of copper nanoparticles, from the leaf of salicornia europaea was confirmed by the color change from yellow to dark brown, which indicated the formation of copper nanoparticles. Therefore, the growing need of developing an eco-friendly nanoparticles synthesis is possible and it can be used for various biomedical applications to avoid the adverse effects chemically synthesized nanoparticle in the field of medical application.

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