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GREEN SYNTHESIS OF COPPER NANOPARTICLES USING MURRAYA KOENIGII LEAF EXTRACT AND THEIR CHARACTERIZATION

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Abstract: In this study, copper nanoparticles (Cu NPs) were synthesized using Murraya koenigii leaf extract as a natural solvent that was safe for the environment. Murraya koenigii leaf extract has been found to decrease copper ions without the need for a stabilizer or surfactant agent, making it an easy, economical, and environmentally friendly way to prepare Cu NPs. A color shift in the reaction mixture was noticed upon the combination of plant extract with the copper sulphate solution, indicating the creation of nanoparticles. Using UV-Vis spectra, FESEM images and XRD spectrum the particles were characterized. UV-vis data shows that Cu NPs generated using this green synthesis approach remain stable even after a month, confirming their stability. Metallic Cu nanoparticles are less expensive than conventional heterogeneous catalysts. The characterization results of biosynthesized Cu NPs show that the particles are crystalline and cubical in shape, with an average size of 11.3 nm, and are very stable. This study has the potential to have a significant impact in a few years on the industrial synthesis of metallic nanoparticles. Because of its outstanding qualities, we suspected that the use of green-produced Cu NPs will result in the biomedical applications. Cu NPs exhibit cytotoxicity and anticancer characteristics in numerous applications

***Index Terms* -** copper nanoparticles; Murraya koenigii leaf; FESEM; biosynthesized; characterization

I. Introduction

Green nanotechnology has received a lot of attention for its use in science and technology to create new materials at the nanoscale. The multidisciplinary field of nanotechnology encompasses physics, biology, chemistry, medicine, and material science. Nanoparticles (NPs) are the basic building blocks of nanotechnology. Many kinds NPs have been created, including those made of gold, silver, zinc, titanium, copper, and iron. Cu NPs are significant players in many nanoscience and nanomedicine domains [1]. The chemical compound copper has a nuclear number of 29 [2]. It is a naturally occurring, soft, pliable, and bendable substance. Furthermore, comparable to noble metal NPs such as platinum (Pt), silver (Ag), and gold (Au), the production of Cu NPs is less expensive. As proven biocidal actives, copper and copper-based composites are currently utilized in many applications related to health as well as pesticides. Copper nanoparticles (Cu NPs) can be made in various ways, including with costly and hazardous chemicals and abrasive-reducing components in organic solvents. While the consumption and discharge of poisonous solvents cause environmental problems, the existence of these hazardous and toxic compounds in any aspect of Cu NPs exacerbates the toxicity issue [3]. As the renowned physicist Richard Feynman introduced the concept of nanotechnology, an innovative synthetic approach known as the synthesis of nanomaterials using plant aqueous extract emerged [4]. On the other hand, the environmentally benign and economical green production of nanoparticles using different plants or gums eliminates the need for harsh chemicals. Since maintaining cell cultures is a complex process, using plant extracts instead of microorganisms is preferable for the creation of nanoparticles. In this paper, we propose a straightforward and environmentally friendly technique for the production of Cu NPs using an aqueous extract of Murraya koenigii leaf, as researchers are continuously interested in the green synthesis of metallic NPs. Green nanoparticle synthesis is a bottom-up approach that involves reduction and oxidation reactions.

A straightforward reaction setup, extremely mild conditions that cause mild reactions, the utilization of friendly solvents like water, the removal of hazardous chemicals, affordability, and integration for medical and pharmaceutical purposes are some of the other benefits of this secure and beneficial environment protocol [5]. Furthermore, this technique does not require the use of high temperatures, pressures or energies. Because of their easy manufacturing and possible physical and chemical features, nanoparticles made of metals and metal oxides NPs are very interesting for improving microbial operations. One of the best examples of prospective metal NPs for their many industrial and biological uses is copper. For their high electrical conductivity, low electrochemical movement, excellent solderability, high melting point, optical, and catalytic characteristics [4,6]. Cu NPs continue to pique the public's curiosity among metal NPs. These features are used in sensors, solar cells, information storage, heat transfer systems, textiles, water treatment, and as an antimicrobial coating material in surgical instruments [7]. The production of copper nanoparticles from Murraya koenigii leaf extract is reported in the results of this study. The optical and structural characterizations of green synthesized copper nanoparticles were investigated using UV-visible spectroscopy and XRD, respectively

II. Experimental details:

2.1 Materials required:

Copper sulphate pentahydrate ($CuSO_4.5H_2O$) was purchased from Merk India and used without further purification. Murraya Koenigii leaves were obtained from local market. Water used for this experiment was purified in Millipore Milli Q-manner. All the glass used was cleaned and then carefully rinsed with water.

2.2 Synthesis procedure:

For the preparation of Copper nanoparticles (Cu NPs), were prepared by green synthesis method. At first, M.koenigii leaf extract was prepared by reflux method. Briefly cleaned the Murrya Koenigii leaf in hot air oven for one day and 30g of the dried leaves was refluxed at 100°C for 8 hours in 100ml double distilled water, filtered and centrifuged the above solution to obtain this leaf extract. 30ml of these leaf extract is taken in a 100ml beaker. After that, 7mmol of $CuSO_4.5H_2O$ was taken in a 500ml beaker and added 100ml distilled water heated at 70°C for 2 hours to obtain the supersaturated solution of copper sulphate. Then the pre prepared leaf extract was added in the solution and stirred continuously. The pH was maintained as 11 by adding NaOH. The colour change was observed from light blue to dark green. This indicates the formation of reduction of copper ions. The reaction mixture kept for 5 hours in an undisturbed manner and it was centrifuged 1500 rpm for 10min, washed several times using distilled water and dried in a hot air oven hence to obtain Cu NPs. Various stages of synthesis process are shown in Fig.1.

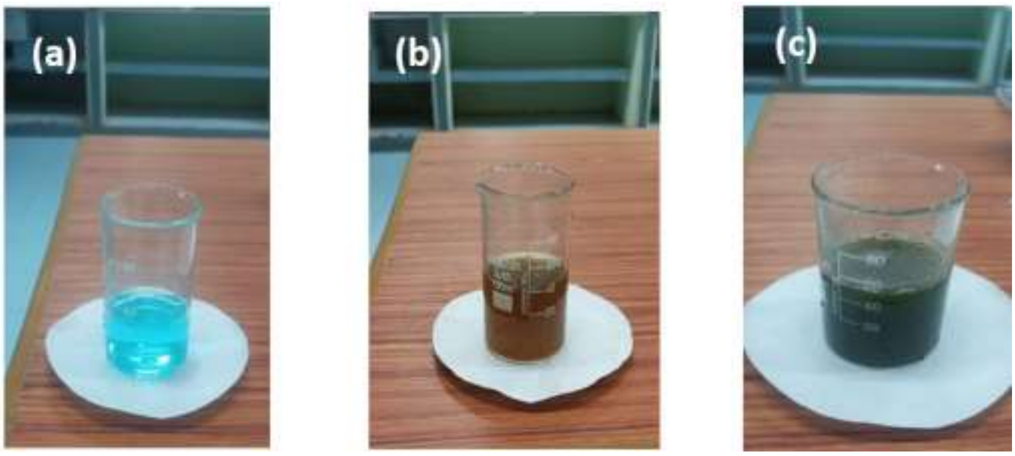

Fig.1: (a) Copper sulphate solution, (b) M.koenigii leaf extract and (c) reaction mixture for the formation of copper nanoparticles

2.3 Characterization:

Bruker D8 Advance X-ray diffraction spectrometer with Cu-Kα (1.54Å), current 30mA, Time/Step 0.3s, voltage 40kV Increment 0.02°source over the range of 10° to 80°was used for X-ray diffraction studies. Morphological analysis of was done by using Field emission scanning electron microscopy (FE-SEM, Zeiss Supra 55VP). The Shimadzu UV3600+ spectrophotometer is used for recording the UV – Vis spectra.

III. Results and Discussion

Powder XRD pattern of Cu NPs is shown in Fig.1. The three major peaks at 2ϴ values of 43.63°, 49.91° and 73.26° corresponding to (111), (200), (220) planes of copper [8] which is in a very good accordance with Face Cantered Cubic (FCC) structure of Cu NPs with JCPDS (Joint Committee on Powder Diffraction Standers) card no. 04-0836 [6]. The corresponding peak (111) plane is most intense compared to other peaks in the spectrum. All the peaks are sharp and strong, it indicates the crystalline nature of the synthesized nanoparticles. There is an unassigned peaks appears at 52.82°, this may be due to the residues impurities present on the Murraya Koeinigii leaves.

The mean size of copper nanoparticle was calculated using Debye-scherrer's equation [9] (($D = 0.91\lambda/\beta\cos\theta$), Where D- Is the average crystallite domain size perpendicular to the reflection plane, λ- Is the X-ray wavelength, β is the full width at half maximum. And ϴ is the diffraction angle). From this, the crystalline size of the synthesized Cu NPs is calculated to be 11.3 nm**.**

The FESEM images (Fig.3(a) and (b)) further confirm the formation of the nano-sized particles with spherical morphology.

The UV-vis absorption spectrum of Cu NP_S is shown in Fig 4. The UV-visible spectroscopy was considered to measure the optical effects of the produced Cu NP_s . It has been proved to be a very useful technique for the detection of synthesized metallic NP_s, because the peak position and shape of the spectra are sensitive to the particle size [10]. The UV-vis absorbance spectrum was drawn for (200-800nm). The maximum absorption peak for Cu NP_s was observed to be found at around 290-330 nm confirms the formation. Cu NP_s. This absorption peak can be ascribed to the Surface Plasmon Resonance (SPR) of Cu $NP_{s.}$ The formation of the copper nanoparticle was considered successful by change in colour of the solution. The change in SPR band may shift based on the individual particle properties such as size, shape, etc.

The reflectance curve was measured with the UV-visible spectroscopy. Fig 5 displays the UV-vis reflectance spectrum of the green mediated copper nanoparticles. An extract of Murraya Koeinigii leaves was used to manufacture copper nanoparticles in the wavelength range of 200-800 nm. This should be attributed to the quantum size effect because of the so small particle size of the as-prepared copper nanoparticles. The peak is obtained at 561nm represents the Cu NP_s from this reflection spectrum. The reflectance value obtained from this spectrum of the prepared copper nanoparticle is used to make suitable materials for antireflection coating.

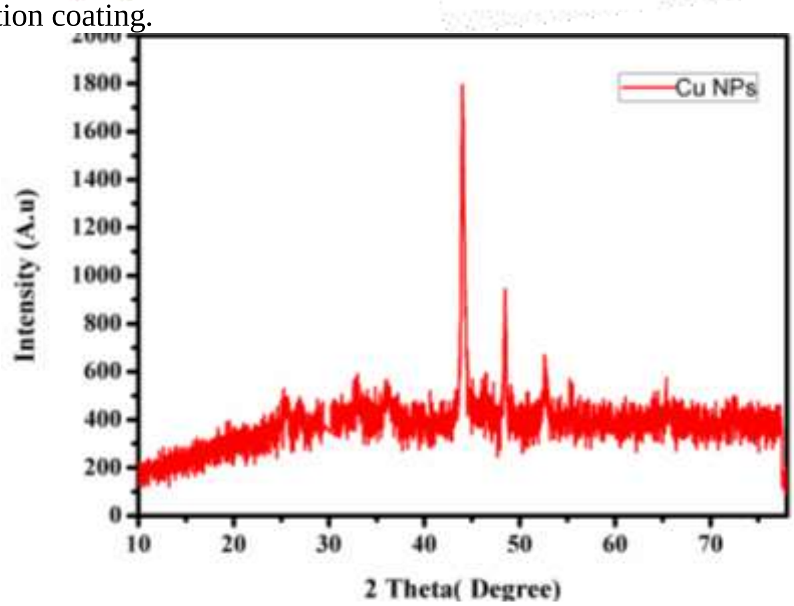

Fig.2: XRD pattern of copper nanoparticles

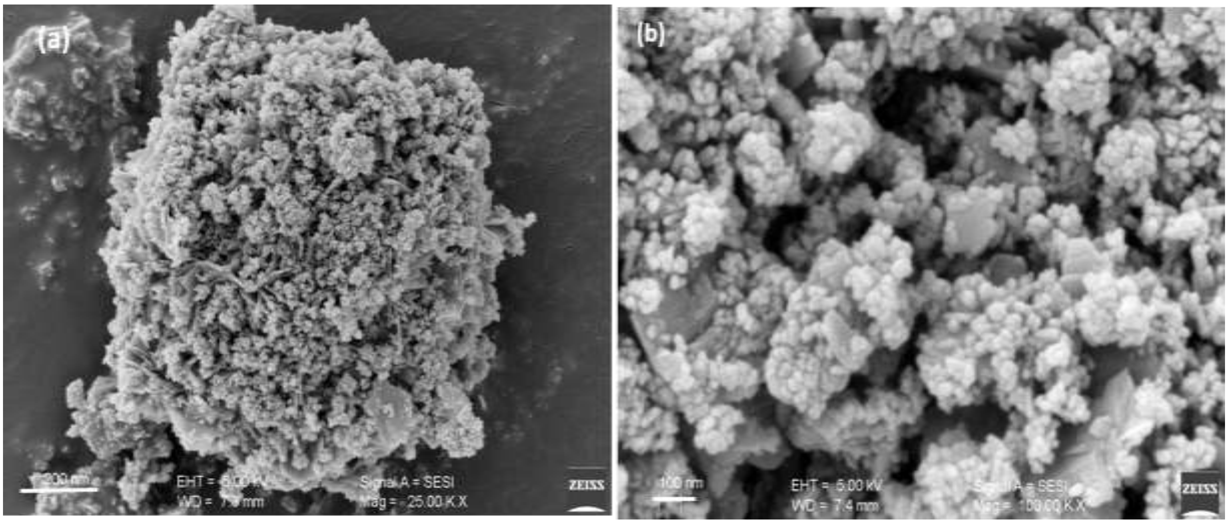

Fig.3: FESEM image of copper nanoparticles at different magnifications

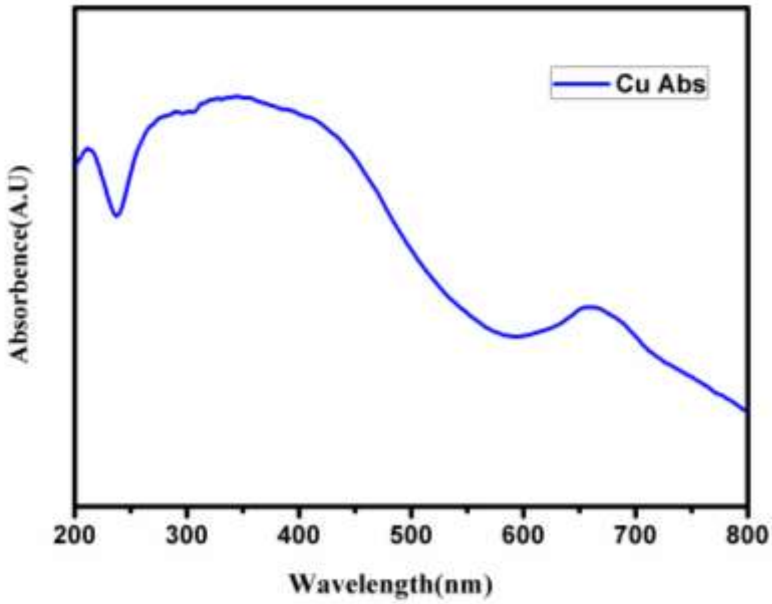

Fig 4: UV-vis absorption spectrum of copper nanoparticle

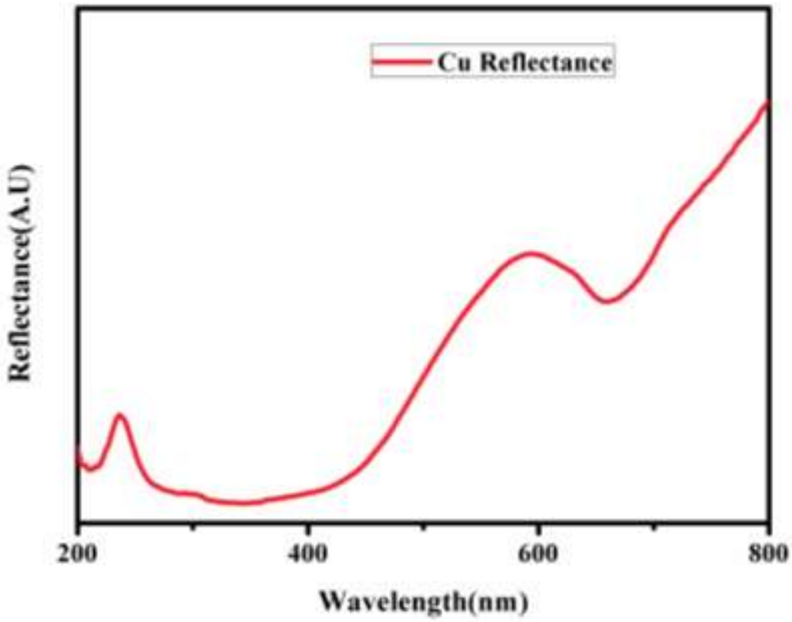

Fig 5: UV-vis reflectance spectrum of Copper Nano particle

IV. Conclusion:

In conclusion, Copper Nanoparticles were prepared by the Green synthesis method by using Murraya Koeinigii leaf extract as a reducing and stabilizing agent. This green synthesis method has many advantages such as high yields, easy to process which can be scaled up, no toxic reagents, an economic and environmental friendly. The proteins present in the Murraya .Koeinigii leaf extract were considered to be responsible biomolecules for the synthesis of copper nanoparticles. The formation of Nano-sized particles was evident from XRD analysis. Synthesized Cu NP_s are highly crystalline, cubical in shape with an average size 11.3 nm. The formation of particles was supported from the UV-visible spectroscopy. The absorption peak around 290-330 nm was confirming the formation of stable Cu NP_s in the reaction mixture. The UV-vis spectra reveal that the number and position of SPR peaks, the effective spectra range, and the band position are strongly dependent on the particle shape, size, symmetry and the morphology.

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Conflict of Interest

Authors declare no conflict of interest

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