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Curcuma Amada (Mango Ginger) Roxb Catalysed Synthesis of Copper Oxide Nanoparticles

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ABSTRACT - Plant mediated synthesis of nanoparticles are an increasing economical demand due to the wide applications in various areas such as electronics, catalysis, chemistry, energy, cosmetics and medicine. In the current study, green synthesis of copper nanoparticles is carried out by using root derived callus extracts of Curcuma amada (Mango Ginger) Roxburgh. The synthesis of CuNPs was carried out at different conditions, including pH, temperature, concentration ratio and time. FTIR absorption spectra results concluded that the compounds attached with copper nanoparticles could be polyphenols with aromatic ring and bound amide region. SEM analysis results revealed that the synthesized copper nanoparticles were spherical but agglomerated in shape. XRD analysis results revealed that the size of the copper nanoparticles derived from Curcuma amada was found to be 42 nm. The approach used for the synthesis was eco-friendly, non-toxic, rapid and cost effective. This study provided an opportunity to synthesize CuNPs via biological method.

Keywords: CuNPs, , FTIR, Plants, Mango Ginger, SEM, XRD

I. INTRODUCTION

Curcuma amada commonly called as Mango ginger belongs to the family of Zingiberaceae is a unique spice having morphological resemblance with ginger but imparts raw mango flavour. It has huge importance in Ayurveda and oldest system of medicine in Indian medicinal systems and used as an alexiteric, antipyretic, aphrodisiac, diuretic, expectorant and laxative and cure itching, skin diseases, bronchitis, asthma, hiccough and inflammation due to injuries treating mamilities, jaundice and urinary disease. Curcuma Amada is mainly cultivated for its fresh edible rhizomes have the flavour and colour of mango and seeds which are rich in oil and proteins. C. amada rhizomes reported to have bioactive compounds including curcuminoids effective in skin allergies, it is also used in biliousness, itching, skin diseases, bronchitis, asthma, hiccough and inflammation due to injuries. According to the Unani system of medicine, it is a diuretic, maturing, emollient, expectorant, antipyretic and appetizer. It is useful against inflammation of the mouth, ear and gleet, ulcers on the male genitalia, scabies, lumbago and stomatitis [1].

Green synthesis of metallic nanoparticles is widely used because of its harmless obtaining method. It uses molecules in plants and microorganisms (bacteria, fungi) as a reducing agent. It has the advantage of using more eco-friendly materials, being cheaper than chemical synthesis, simpler, more rapid and sustainable. It is preferable to use plant extracts to obtain nanoparticles rather than using microorganisms because of increased difficulty in preserving cell cultures. Moreover, it reduces the complex process of maintaining cell cultures and it is also suitable for creating large scale synthesis of nanoparticles.

Considering the use of nanoparticles in medicine, there is an increased need to use an eco-friendly method of obtaining as they are regarded as the next step in battling diseases. As Thiruvengadam et al. present, the nanoparticles obtained with the help of plants have excellent antimicrobial, anticancer, antidiabetic, anti-inflammatory and antioxidant activities [2-8].

Nanoparticles exhibit completely new or improved properties based on specific characteristics such as size, distribution and morphology. Specific surface is relevant for catalytic reactivity and other related properties such as antimicrobial activity in copper nanoparticles. As specific surface area of nanoparticles is increased, their biological effectiveness can increase in surface energy [9-10]. Copper has long been recognized as having an inhibitory effect towards many bacterial strains and microorganisms commonly present in medical and industrial processes [11]. Procedure followed and schematic presentation of copper oxide nanoparticles is as shown in fig 1.

II. EXPERIMENTAL

Material and Method: -

Plant material and preparation of the extract

Fresh Curcuma amada plants with rhizome were collected from the vegetable market of Roha Taluka of Raigad district.

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was washed twice with sterile distilled water to remove medium components before grinding. Approximate 20 g of rhizome was crushed in 100 ml of sterile distilled water in mortar and pestle. The resulting extract was filtered through filter paper (Whatmann No.1) and used for the synthesis of copper nanoparticles.

Synthesis of copper nanoparticles

10 ml of extract of Curcuma Amada (Mango Ginger) Roxb was added to 90 ml aqueous solution of copper sulphate (1mM) solution separately for reduction in to Cu^{++} ions and stirred at room temperature (35° C) for about 4-5 hours. The primary detection of synthesized copper nanoparticles was carried out in the reaction mixture by observing the colour change of the medium from greenish to dark brown. After 5h of incubation the copper nanoparticles were isolated and concentrated by repeated (4-5 times) centrifugation of the reaction mixture at 10,000 ×g for 10 min. Procedure followed and schematic presentation of copper oxide nanoparticles is as shown in **fig 1**

Fig 1: - Procedure followed for synthesis of copper oxide nanoparticles

III. RESULTS AND DISCUSSION

FTIR Analysis: -

To record the molecular functional vibration of chemical groups, present in the sample, Perkin-Elmer FT-IR spectrum spectrophotometer (Shimadzu 8400) was used and operated at a resolution of 2 cm−1ranging from 4000 to 500 cm−1. **Fig 2**

O–H stretching vibrations, associated with the inter and intramolecular hydrogen bonding of polymeric compounds (macromolecular associations), such as alcohols, phenols, and carboxylic acids, as in pectin, cellulose groups on the adsorbent surface is shown by the broad absorption peak at 3421 cm−1.

The symmetric and asymmetric C–H stretching vibrations of aliphatic acids are represented by peaks at 2920 cm−1 and 2867 cm−1.

The stretching vibration band due to non-ionic carboxyl groups (–COOH, –COOCH3) is shown by the peak observed at 1471.70 cm−1, 1390 cm−1 may be attributed to carboxylic acids or their esters.

The stretching vibration of C–OH of alcoholic groups and carboxylic acids may give rise to the broad peak at 880–1126cm−1. All these absorption bands are matched with previous study (12-14)

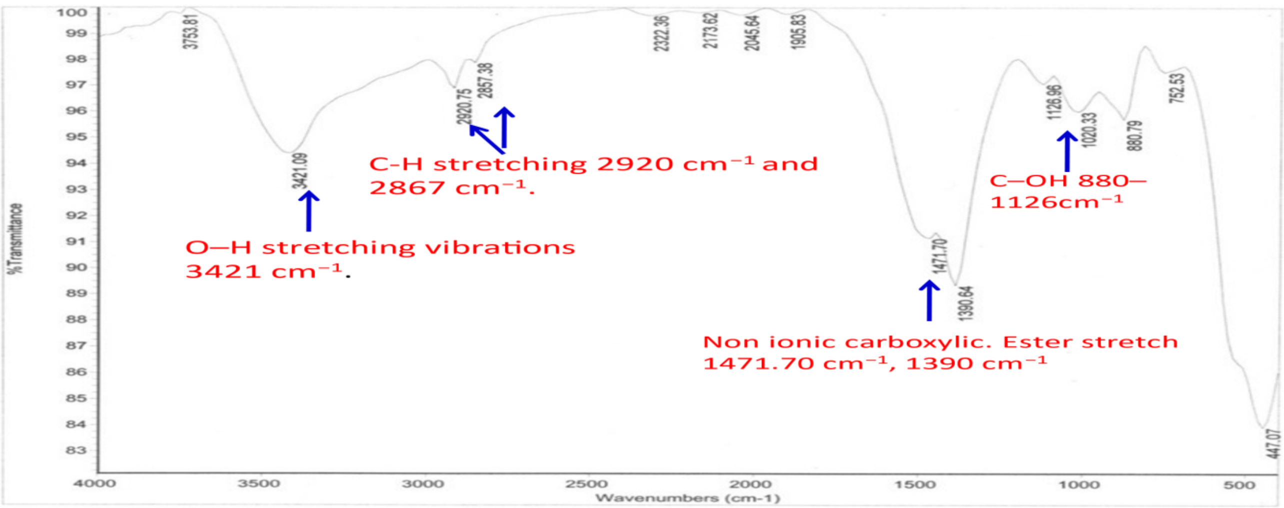

Fig. 2: FTIR Spectra of CuO nanoparticles

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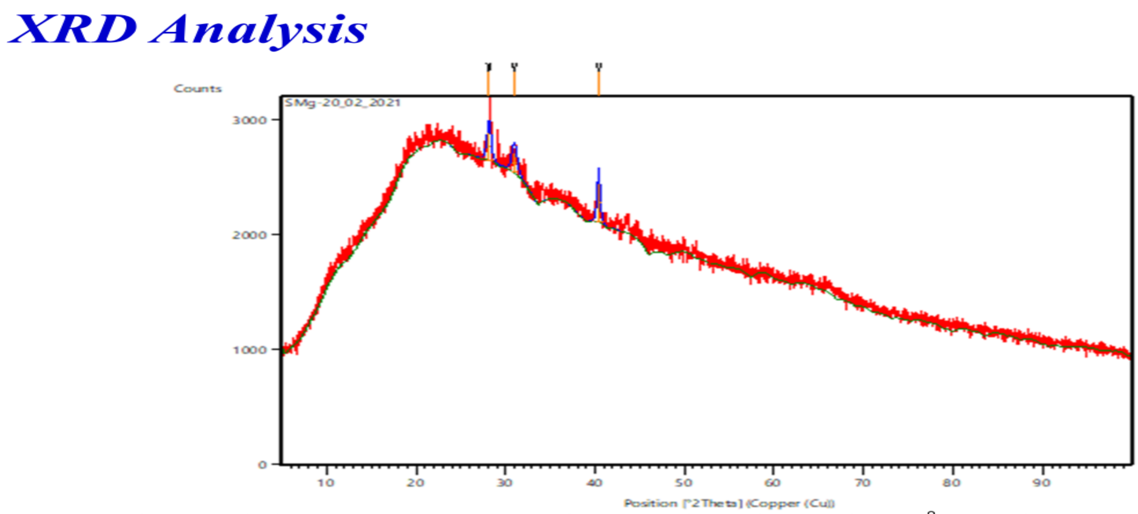
XRD Analysis: - XRD characterization was conducted to determine the crystallinity of CuONPs. X-ray diffraction data (XRD) was recorded in the 2Θ range of 30-80 using XRD 6000, (Shimadzu) of Cu-Ka radiation, the energy of which was 8.04 keV and wavelength was 1.54 **Fig 3.**

The applied voltage was 40 kV and current was 25 mA. The crystallite size was estimated using the Scherer equation and was found 41.17 nm. From the results, there are Prominent peaks of 2Θ: 28.13, 30.97 and 40.38



Pos.[°2Th.]	Height [cts]	FWHMLeft [°2Th.]	d-spacing [Å]	Rel. Int. [%]
28.1388	237.16	0.5196	3.17131	69.69
30.9738	178.54	0.6927	2.88721	52.46
40.3812	340.32	0.3464	2.23367	100.00

Fig 3: XRD spectra of synthesised CuO nanoparticles

SEM and EDX Profile: -

The CuNPs shape and size was determined by scanning electron microscopy SEM-EDS-JEOL-JSM 6390 model). SEM analysis revealed the presence of cluster of aggregated nanoparticles with irregular shapes with some agglomeration due to sampling preparation (fig 4). The size of the particles was calculated by SEM analysis and was found to be with an average particle diameter of 42 nm as displayed in the size distribution histogram. The studies are matched with previous work. (15-16)

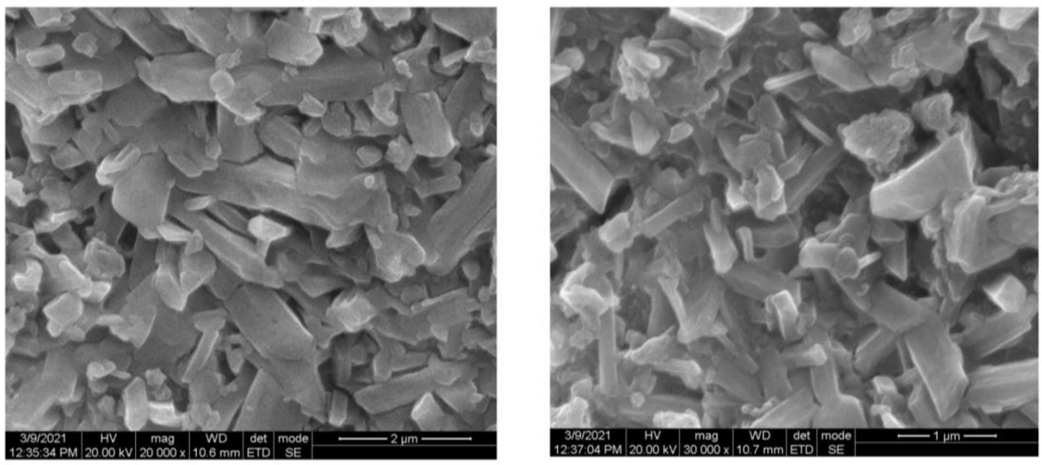


Fig 4. SEM analysis of synthesised nanoparticle

IV. CONCLUSION

This study presents green synthesis of non-toxic and economically viable CuONPs by using aqueous extract of Curcuma Amada (Mango Ginger) Roxb. This material was characterized by FTIR, XRD and SEM analysis. The biosynthesized CuONPs are cluster of aggregated nanoparticles with irregular shapes with a size of 42 nm.

The approach used for the synthesis was eco-friendly, non-toxic, rapid and cost effective. This study provided an opportunity to synthesize CuNPs via biological method. CuONPs synthesis through this green method can contribute

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to the other fields such as green photo catalyst, drug delivery, adsorbent, detector, and green separation science and technology

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