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Green Synthesis of Copper Nanoparticles Using Ocimum Sanctum Leaf Extract

Vasudev D. Kulkarni [2], Pramod S. Kulkarni [1*]

1. Department of Chemistry, Hutatma Rajguru Mahavidyalaya, Rajgurunagar, Pune (MS) India 410505 [E-mail: pramodskulkarni3@gmail.com]
2. Department of Physics, Hutatma Rajguru Mahavidyalaya, Rajgurunagar, Pune (MS) India 410505 [E-mail: kulkarni_vd55@yahoo.co.in]

Development of green nanotechnology is generating interest of researchers toward ecofriendly biosynthesis of nanoparticles. In this study, biosynthesis of stable copper nanoparticles were done using *Ocimum sanctum* leaf extract. First we prepared leaf extract of Ocimum sanctum in deionised water. This extract added to 1mMol of copper sulfate solution and we observed the change in color of the solution from colorless to colored solution, this indicates that there is a formation of Cu nanoparticles. These biosynthesized Cu nanoparticles were characterized with the help of X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR). It was observed that the *Ocimum sanctum* leaf extract can reduce copper ions into copper nanoparticles within 8 to 10 min of reaction time. Thus, this method can be used for rapid and ecofriendly biosynthesis of stable copper nanoparticles.

Keyword: Cu nanoparticles, Tulsi, *Ocimum sanctum,* Copper sulfate, biosynthesis.

1. Introduction

In recent years, Nanotechnology has attracted many researchers from various fields like biotechnology, physics, chemistry, material sciences, engineering, medicine. Nanoparticles are synthesized by physical and chemical Methods, these are suffering from drawbacks like expensive reagent, hazardous reaction condition, longer time, tedious process to isolate nanoparticles[1,2]. Hence, there is scope to develop new methods for the synthesis of nanoparticles which should be required inexpensive reagent, less drastic reaction condition and eco-friendly.

In recent years, Cu nano particles have attracted much attention of researchers due to its application in wound dressings and biocidal properties [3-4], potential industrial use such as gas sensors, catalytic process, high temperature superconductors and solar cells [5-7].

In literature, the Cu nanoparticles are synthesized from (a) vapor deposition [8], (b) electrochemical reduction [9], (c) radiolysis reduction [10], (d) thermal decomposition [11], (e) chemical reduction of copper metal salt [12] and (f) room temperature synthesis using hydrazine hydrate and starch [13]. In recent, green synthesis of Cu nanoparticles was achieved by using microorganisms [14], plant extract [15]. *Ocimum sanctum* (local name Tulasi) is a traditional medicinal plant of India has a source of bio-reduction and stabilizers. The constituent of Tulsi are alkaloids, glycosides, tannins, saponins and aromatic compounds. It is used in the treatment of headaches, coughs, diarrhea, constipation, worts, worms and kidney malfunctions. Recent interest on Ocimum has resulted from its inhibitory activity against HIV-1 reverse transcriptase and platelet aggregation induced by collagen and ADP22 (adenosine 5-diphosphate) [16]. Recently *Ocimum sanctum* leaf extracts have been used in the synthesis of silver nanoparticles and gold nanoparticles [17].

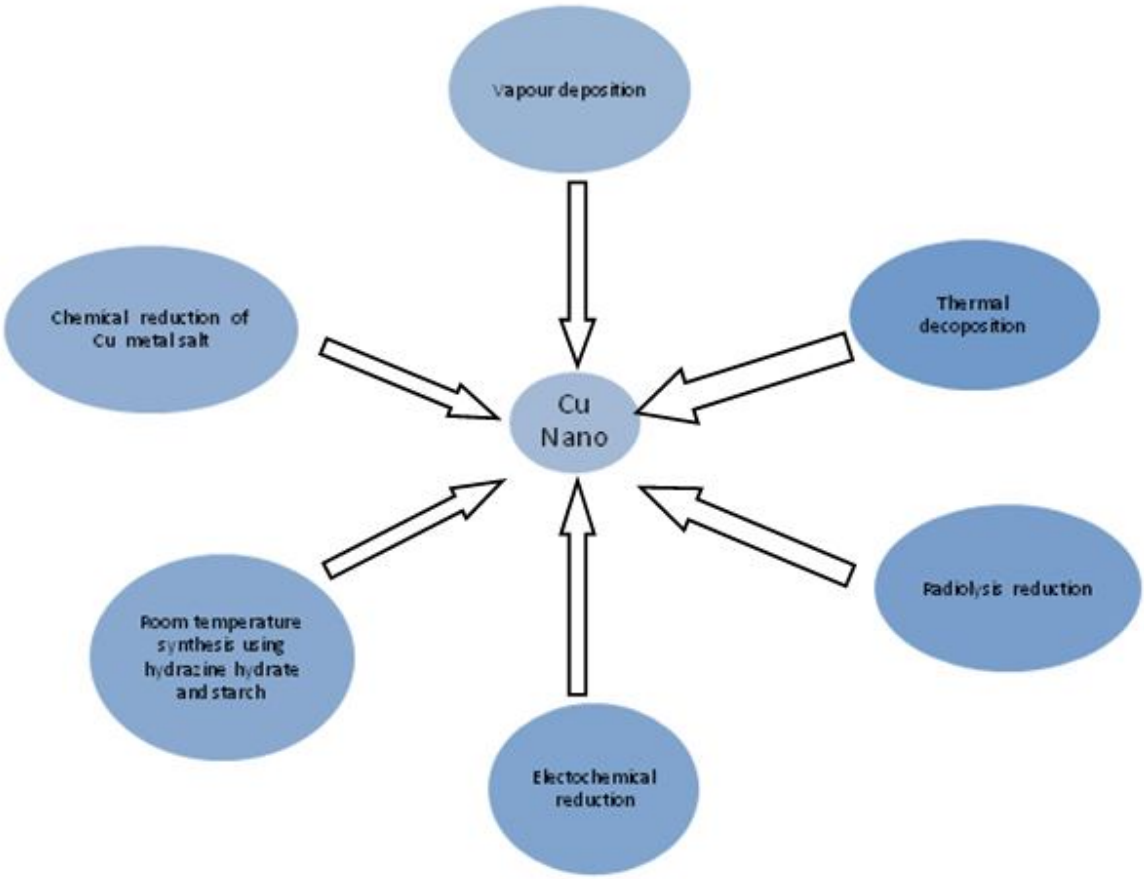

Fig 1: Different methods for synthesis of Cu nanoparticles

To the best of our knowledge, the use of *Ocimum sanctum* leaf extract at room temperature for greener synthesis of Cu nanoparticles has not been reported. Hence the present study was carried out to synthesize and characterize the copper nanoparticles using *Ocimum sanctum* leaf extract.

2. Experimental

2.1 Material

All the chemical reagents used in this experiment were of analytical grade purchased from Loba chemicals. The *Ocimum sanctum* leaves were collected from in and around Rajgurunagar, Pune Maharashtra, India. Thoroughly washed leaves (100 g) were cut and boiled with 100 ml of de-ionized water for 15 min in heating mental at temperature 80 ^{o}C. The resulting product was filtered and stored in refrigerator for further experiments.

2.2 Methods:

Synthesis of Cu Nanoparticles Using *Ocimum sanctum* leaf extracts

For the Cu nanoparticles synthesis, 1 ml of *Ocimum sanctum* leaf extract was added to 100 ml of 1mM aqueous $CuSO_4.5H_2O$ solution in a 250 ml Erlenmeyer flask. The flask was then kept overnight at room temperature. The Cu nanoparticles solution thus obtained was purified by repeated centrifugation at 12,000 RPM for 15 min followed by re-dispersion of the pellet in de-ionized water. Then the Cu nanoparticles were dried in oven at 80 ^{o}C.

3. Results and Discussion:

3.1 X-ray Diffractmeter

XRD pattern of synthesized Cu nanoparticles using a leaf extract of *Ocimum sanctum* is shown in Figure 3. The XRD pattern shows a high crystallinity of Cu sample level with diffraction angles of 22.3°, 25.9°, 28.3° and 44.8°, which correspond to the characteristic face centered cubic (FCC) of copper lines indexed at (111), (200), (210) and (222), respectively. The diffraction angle observed at 21.1° is related to the tulsi leaf extract medium. The size of the NPs obtained were estimated to be 77 nm using Debye-Scherrer Equation, which may indicate a high surface area, and surface area to volume ratio of the nano-crystals. The equation is written below:

$$d = \frac{K\,\lambda}{\beta\,Cos\,(\theta)}$$

Where K, known as Scherer's constant (shape factor), ranges from 0.9 to 1.0, λ is 1.5418 Å, which is the wavelength of the X-Ray radiation source, β1/2 is the width of the XRD peak at half height and θ is the Bragg angle.

Fig 2: Photos of Tulsi leaves, extract and $CuSO_4$ solution, Cu NP

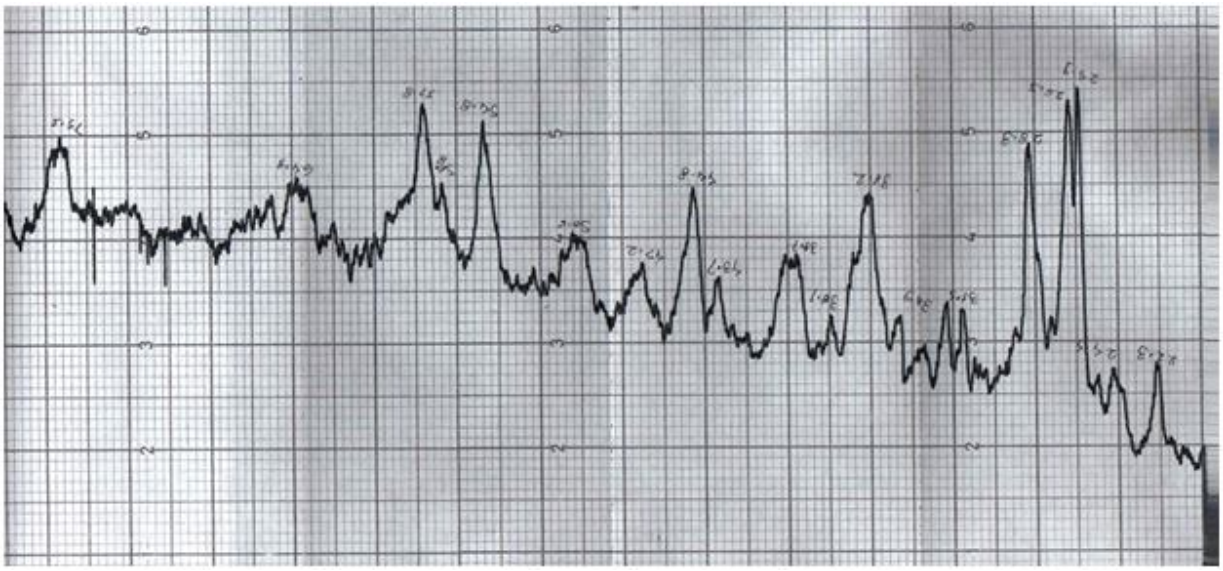

Fig 3: XRD of Cu nanoparticles using Tulsi leaf Extract

3.2 FTIR

The FTIR spectrum of Cu nanoparticles is shown in Fig. 4. The IR spectrum of Cu nanoparticles shows band at 3373 cm^{-1}, 1635 cm^{-1}, 1516 cm^{-1}, 1376 cm^{-1} , 1198 cm^{-1} corresponds to O-H Stretching H-bonded alcohols and phenols, carbonyl stretching, N-H bend primary amines, corresponds to C-N stretching of the aromatic amino group and C-O stretching alcohols, ethers respectively. FTIR spectrum of Cu nanoparticles suggested that Cu nanoparticles were surrounded by different organic molecules such as terpenoids, alcohols, ketones, aldehydes and carboxylic acid.

4. Conclusion

In conclusion, here we report eco-friendly synthesis of Cu nanoparticles using leaf borth extract of *Ocimum sanctum*. This method has merits over other reported methods are easily available starting materials, inexpensive and procedure is easy to carry out any laboratory, use of toxic reagent is avoided and pollution free.

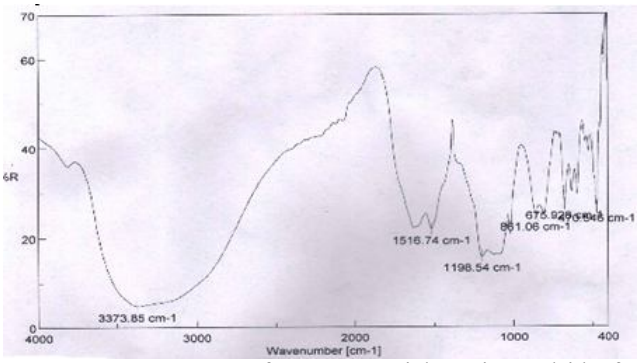

Fig 4: FTIR spectrum of Cu nanoparticles using Tulsi leaf extract

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