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Coriander leaf extract is efficient biocatalyst for synthesis of copper nanoparticles

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Abstract : The use of biomaterials are considered a green method for the preparation of nanoparticles because it does not involve any hazardous chemical, simple reaction condition, easy isolation of nanoparticles therefore it is an alternative to physical, and chemical methods. In this paper, we report the synthesis of Cu nanoparticles using Coriander Leaf Extract. For synthesis of Cu nanoparticles copper sulfate was used as starting material and its reduction was carried by Coriander Leaf Extract from Cu^{2+} to Cu^{0} The synthesized Cu nanoparticles characterized by UV-Visible, FTIR and XRD methods. From XRD analysis size of Cu nanoparticles was found to be 13nm. **© Global Scientific Inc.**

Keywords : Cu nanoparticle; Coriander leaf; Biosynthesis; Green method.

INTRODUCTION

The discovery of nanotechnology has provided a broad research area in recent years by intersecting with various other branches of science and forming impact on all forms of life[1]. This small size materials are attracted many researchers due to their unique properties like electronic[2], optical, mechanical and rheological properties[3], sensors[4], medicinal properties[5], catalytic activity[6]. All these properties of nanoparticles are dependent on their size. Size of nanoparticles is 10^{-9}nm and has large surface area and a larger surface to small volume ratio due to this a higher concentration of partially coordinated surface sites than corresponding bulk materials[7]. In periodic table Copper, Silver and Gold are placed in group 11. These metals are not easily oxidized to form positive ions, therefore they react slowly with most of the reagents and this resistance increases from copper through silver to gold. On the other hand reduction of their compound to pure metal state is easiest for gold and diminishes through silver to copper. Due to this Ag and Au are most studied and Cu is less studied metal among this family. Copper nanoparticles has been successfully synthesized by γ-radiolysis[8],

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laser irradiation[9], thermal decomposition[10], thiol-induced reduction in supercritical water[11], reduction in microemulsions[12], reverse micelles[13], vapor deposition[14], sonoelectrochemical[15], flame spray[16], and chemical reduction[17]. However, these methods have demerits like hazardous condition, use of expensive chemicals and instruments, long reaction time. Besides from these methods green synthesis of copper nanoparticles is reported from curd, milk, herbal extract such as tamarind, lemon juice[18], Ocimum sanctum as capping agents[19], Magnolia kobus leaf extract[20], Syzygium aromaticum (Cloves) aqueous extract[21] and polyvinylpyrrolidone as a capping agent, L-ascorbic acid and isonicotinic acid hydrazide as reducing agent in presence of air[7], but this method uses very expensive chemicals, tedious process. Hence there is scope to develop new methods for the synthesis of Cu NP.

However the use of vegetable for synthesis of nanoparticles is very limited. Here, we use Coriander leaf extract for synthesis of Cu NP. Coriander (Coriandrum sativum L.) is spice crop which belongs to the family Apiaceae (Umbelliferae) is mainly cultivated from its seeds throughout the year[22]. Constituent of Coriander are phenolic acid including caffeic and chlorogenic acid. The flavonoids include quercetin, keampferol, rhamnetin, apigenine and most of these compounds are known to inhibit free radicals generated in the cell, when they are obtained through the diet[23]. Coriander has been reported to possess many pharmacological activities like antioxidant[24], antidiabetic[25], anti-mutagenic[26], antilipidemic[27], antispasmodic[28].

EXPERIMENTAL

Material

All the chemical and reagents used in this experiment were of analytical grade purchased from Loba chemicals. The Coriander leaves were purchased from Rajgurunagar vegetable markets Pune, Maharashtra, India 410505. The coriander leaves were thoroughly washed and dried in shade. For preparing the plant broth solution, 20gm dried leaves of coriander was cut into small pieces and washed with distilled water. This was taken in a 250ml beaker with 100ml of distilled water and then boiled the mixture for 20 minutes at 80°C. The extract was filtered through wahatman filter no. 1 and then was stored at 5°C and used within a week.

Synthesis of Cu nanoparticles using Coriander leaf extract: 10 ml of coriander leaf extract was added to 100ml 0f 1mM aqueous copper sulphate solution in a 250ml Erlenmeyer flask. The colour of the solution changes from blue to pale yellow and stirred the solution of coriander leaf extract and copper sulphate solution for homogeneous mixing. Kept this flask at room temperature for overnight and Cu nanoparticles were separate out and settle at the bottom of this solution. The Cu nanoparticle thus obtained was purified by repeated centrifugation method at 5000 RPM for 15 minute followed by redispersion of the pellet in deionized water. Then the Cu nanoparticles were dried in oven at 80°C.

RESULTS AND DISCUSSION

The synthesized Cu nanoparticles were characterized by pH of solution, UV-Visible, FTIR, and XRD.

pH of solution

pH of copper sulphate solution was 2.16, when we added coriander leaf extract to this solution, pH changes from 2.16 to 2.64. pH of coriander leaf extract was 6.78. From this we confirmed that the capping between Cu and coriander leaf extract was taken place.

UV-Visible

The reduction of copper sulphate to pure Cu nanoparticle was monitored by using ultraviolet visible spectrophotometer. UV-Vis spectral analysis was done by using a double beam spectrophotometer 2203 Systronics range of 400-700. The absorption spectrum of pale yellow nanoparticle solution prepared with the proposed method showed a palsmon absorption band with a maximum of 560nm.

FTIR

FTIR spectra of biosynthesized copper

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Figure 1 : a. Coriander leaves, b: Coriander Leaves extract, c: 0.1molar copper sulphate solution, d: Copper sulphate solution + Coriander leaves, e: Cu NP settle at bottom.

nanoparticles were recorded to identify the capping and efficient stabilization of the metal nanoparticles by biomolecules present in coriander leaf extract. The FTIR spectrum of synthesized Cu nanoparticles using coriander leaf extract was shown in Figure 3. The band at 3500 cm^{-1} corresponds to O-H stretching of alcohols and phenols. The band at 1575 cm^{-1} corresponds to N-H bend of primary amines. The peak at 1418 cm^{-1} corresponds to C-N stretching of aromatic amino group. The band corresponds to 1670 cm^{-1} corresponds to carbonyl group of flavonoids, phenolic acids etc. The band at 1225 cm^{-1}corresponds to C-O linkages of phenol, acid, flavonoids. The band below 600 cm^{-1} corresponds to copper. Therefore, the synthesized copper nanoparticles were surrounded by proteins and metabolites such as phenolic acid, carboxylic acid, flavonoids. From the analysis of FTIR studies we confirmed that phenolic compounds has the stronger ability to bind metal indicating that the phenols could possibly form the metal nanoparticles to prevent agglomeration and thereby stabilized the medium. This suggests that the biological molecules could possibly perform dual functions of forma-

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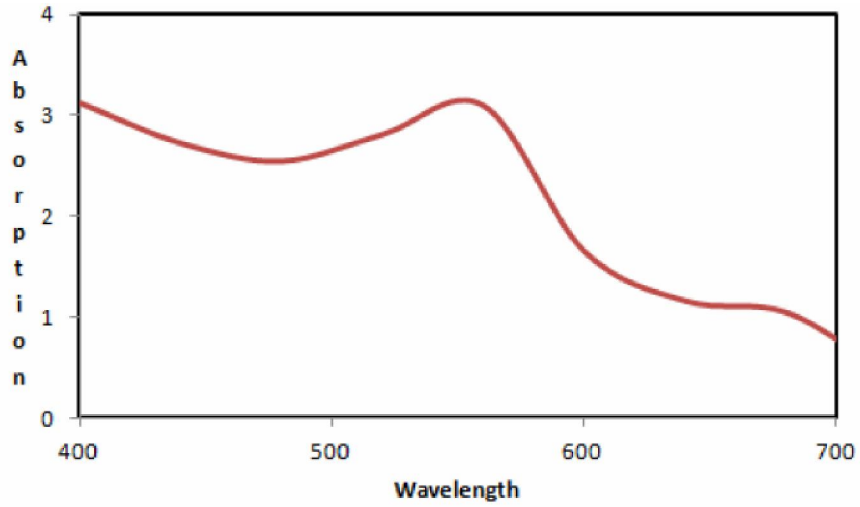

Figure 2 : UV-Vis spectrum of copper nanoparticles dispersed in deionized water at room temperature exhibiting peak at 560nm

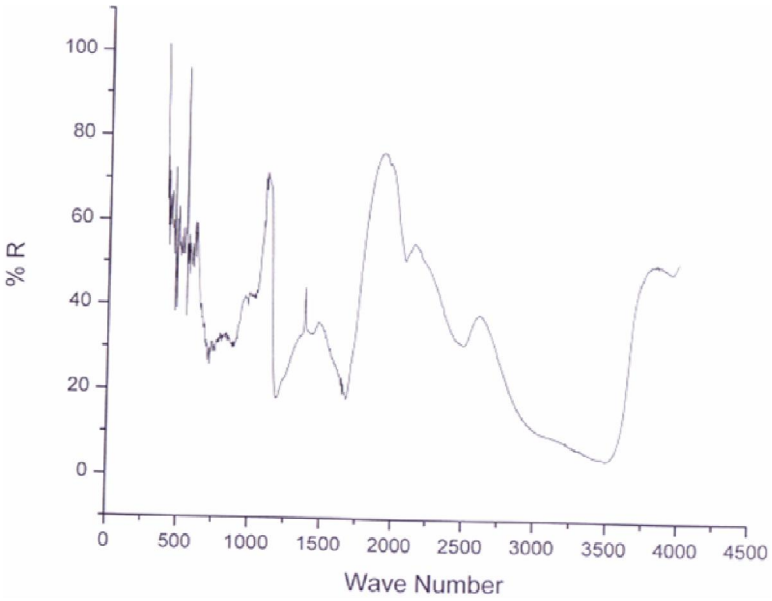

Figure 3 : FTIR spectrum of synthesized of Cu NP using coriander leaf extract

tion and stabilization of Cu nanoparticles in aqueous medium.

XRD

XRD pattern of synthesized Cu nanoparticles using Coriander leaf borth extract is shown in Figure 3. The sample demonstrated a high crystallinity level with diffraction angles of 22.74°, 27.55°, 29.63°, and 33.12° which correspond to the characteristic of face centered cubic of copper lines indexed at (111), (211), (210) and (220). The diffraction angle observed at 21.3° which is related to the Coriander leaf extract. The average size of the copper NPs was found to be 13.88nm. The size of the NPs was determined using Debye-Scherrer eqation, which may indicate a high surface area, and surface area to volume ration of the nanocrystals. The equation is written below:

$$D = k\lambda/\beta cos\theta$$

Where; D= Grain Size; K= Scherer's constant (0.9 to 1.0 for spherical particle); β= the width at Half Maxima of peaks in XRD; θ = Corresponding angle for peaks

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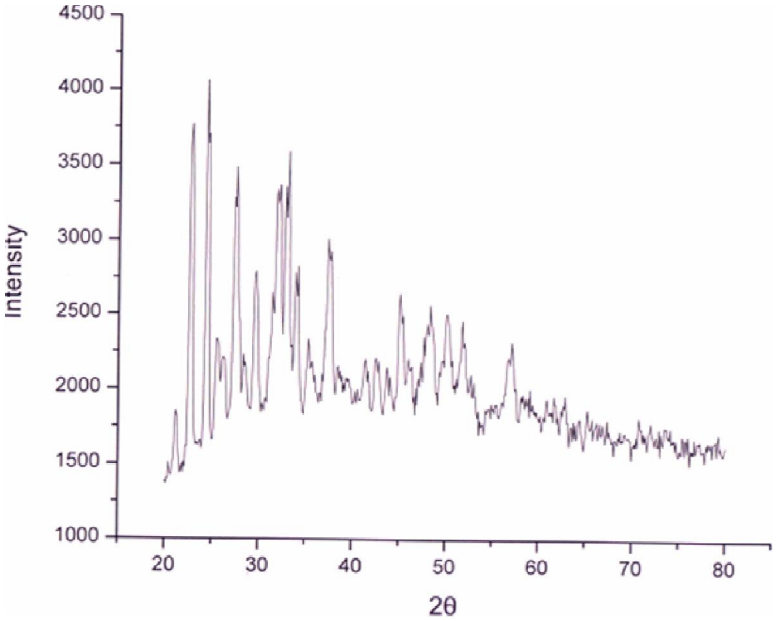

Figure 4 : XRD pattern of Cu NP obtained from coriander leaf extract

Comparison of Size of Cu NP with other reported methods

Entry	Size in nm	Method	Reference
1	14 and 50nm	Syzygium aromaticum (Cloves) aqueous extract	[21]
2	37 to 110nm	Magnolia kobus leaf extract	[20]
3	77nm	Ocimum Sanctum	[19]
4	11.66nm to 14.65nm	Coriander leaf extract	In this paper

The size of copper nanoparticle was found in the range of 11.66nm to 14.65nm.

CONCLUSION

In conclusion, here we report green and vegetable assisted synthesis of Cu nanoparticles using coriander leaf extract. The coriander leaf extract was found efficient for synthesis of copper nanoparticle. This method has merits over other reported methods are easily available starting materials, inexpensive process, easy to carry out in any college level laboratory, reaction condition are simple, avoid use of expensive, hazardous and toxic reagent and pollution free. The size of prepared nanoparticle is very small compare to other reported methods. Study of the biological and catalytic activity of this nanoparticle is underway in our laboratory.

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