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Synthesis of copper nanoparticles with aegle marmelos leaf extract

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ABSTRACT

In this study, Aegle Marmelos leaves were collected from Rajgurunagar area. The Aegle Marmelos leaf extract was prepared in deionised water and used for the biosynthesis of copper nanoparticles. This prepared extract added to 1mMol of copper chloride solution. The colour of the solution changes from faint blue to green colored; this confirms that there is a formation of Cu nanoparticles. The synthesized Cu nanoparticles were characterized by X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR) spectrum and we calculate the size of Cu nanoparticles from XRD and found 48 nm. The merits of this method are easily starting material, inexpensive and process is simple to carry and pollution free.

KEYWORDS

Cu nanoparticles;
Aelge marmelos;
Copper chloride.

INTRODUCTION

Due to wider applications of Metal nanoparticles, more researchers are attracted to this field. Some applications of nanoparticles are (a) a catalyst in organic chemistry[1], (b) thermal and optical properties[2], (c)biological application[3]. In recent years, Synthesis of etal Nanoparticles using plant leaf extract has attracted attention of many researchers because of availability of materials, inexpensive and process is easy to carry out in any laboratory, use of non-toxic reagent.

In recent years, Cu nano particles have attracted much attention of researchers due to its application in industrial and medical application. The biological property shown by Cu nanoparticles are wound dressings and biocidal properties[4-5], antibacterial[6], potential industrial use such as gas sensors, catalytic process, high temperature superconductors and solar cells[7-9].

In literature, the Cu nanoparticles are synthesized from (a) vapor deposition[10], (b) electrochemical reduction[11], (c) radiolysis reduction[12], (d) thermal decomposition[13], (e) chemical reduction of copper metal salt[14] and (f) room temperature synthesis using hydrazine hydrate and starch[15], (g) Under supercritical conditions[16], (h) using Chitosan via chemical methods[17]. In recent, green synthesis of Cu nanoparticles was achieved by using microorganisms[18], plant extract[19].

Aegle Marmelos is commonly known as Bael which is a historic plant of India. *Aegle Marmelos* belongs to Rutaceae family and grown as a temple garden plant and leaves are used to pray Lord Shiva. *Aegle Marmelos* is an important medicinal plant with several ethanomedicinal applications in traditional and folk medicine systems. Traditionally, *Aegle Marmelos* is used in the treatment of diarrhea and dysentery. The leaves of this plant used to cause infertility/abortion in women[20]. More than 100 chemical compounds were isolated from different part of this tree. The leaves of this tree contain

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polyphenol, alkaloids, phenylpropanoids and terpenoids. Recently, A. *Marmelos* leaves are used in the synthesis of Ag nanoparticles[21]. In this paper, we report the synthesis of Cu nanoparticles from the leaves of *A. Marmelos*.

EXPERIMENTAL

Material

All the chemical reagents used in this experiment were of analytical grade purchased from Loba chemicals. The *A. Marmelos* 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 80^0C. The resulting product was filtered and stored in refrigerator for further experiments.

Methods

Synthesis of Cu nanoparticles using *A. Marmelos* leaf extractsFor the Cu nanoparticles synthesis, 1 ml of *A. Marmelos* leaf extract was added to 100 ml of 1mM aqueous copper chloride solution in a 250 ml Erlenmeyer flask. The flask was then ept 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 80^0C.

RESULTS AND DISCUSSION

First, we collect the *A. Marmelos* leaves from Rajgurunagr and these leaves cut into small parts and washed with tap water to remove dust particles. These leaves boiled in de-ionized water to dissolve organic compounds. After few minutes boiling the water solution acquires a brown color which indicates that organic compounds are dissolved in water and stored in refrigerator. Next we prepared 1mM of copper chloride solution by dissolving 0.13gm of copper chloride in 100ml water and in this solution 1ml of *A. Marmelos* leaves extract added and we observed that change in color of copper sulfate solution. All these changes monitor with photos are shown Figure 1. The synthesized Cu nanoparticles are characterized by XRD and FTIR

A marmelos leaf

A marmelos leaf extract

Copper chloride solution

Copper chloride solution + A marmelos leaf extract

Figure 1: A. Marmelos leaf extract, copper chloride solution and copper chloride solution with A. Marmelos leaf extract

spectrum and we calculate the size of Cu nanoparticles from XRD. The colour of the solution changes from faint blue to green colored; this confirms that there is a formation of Cu NP.

XRD studies

XRD pattern of Cu nanoparticles obtained by using *A. Marmelos leaf borth* extract is shown in Figure 2., the sample demonstrated a high crystallinity level with diffraction angles of 21.09°, 28.8°, 29.20° and 34.10° which correspond to the characteristic face centered cubic (fcc) of copper lines indexed at (111), (211), (211) and (220). The diffraction angle observed at 20.4° is related to the *A. Marmelos*. The size of the NPs obtained were estimated to be 48 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.

FTIR

FTIR measurements were carried out to identify the biomolecules for capping and efficient stabilization of the metal nanoparticles synthesized by *A. Marmelos* leaf broth. The FTIR spectrum of Cu nanoparticles is shown in Figure 3. The band at 3355 cm^{-1} corresponds to O-H stretching H-bonded alcohols and phenols. The assignment at 1590 cm^{-1} corresponds to N-H bend primary amines. The peak at 1430 cm^{-1} corresponds

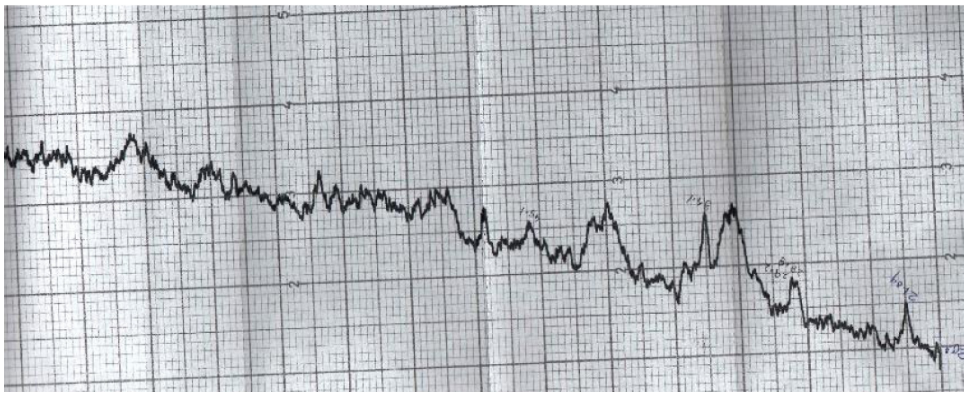

Figure 2 : XRD pattern of Cu nanoparticles using Bael leaf extract

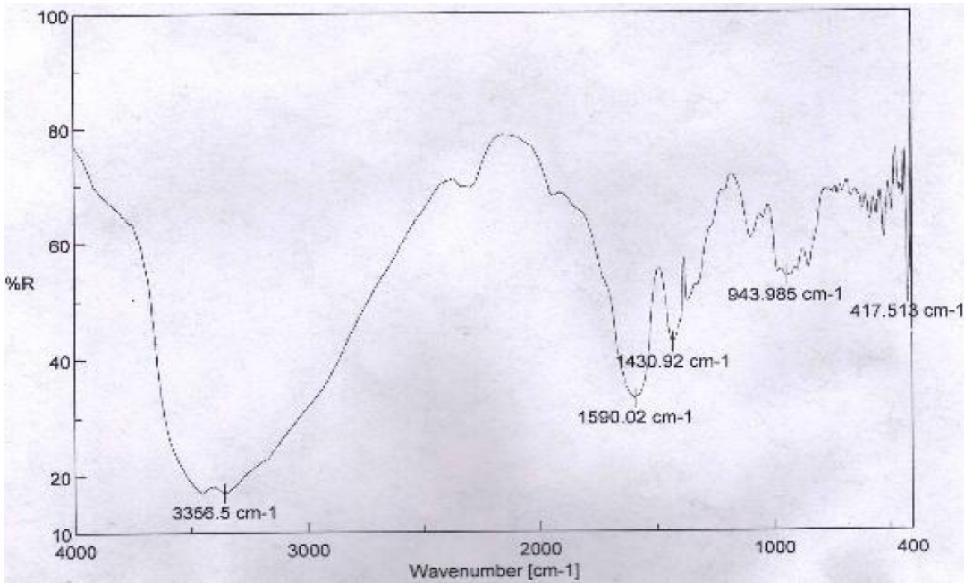

Figure 3 : FTIR spectrum of Cu nanoparticles using Bael leaf extract

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to C-N stretching of aromatic amine group. Therefore the synthesized nanoparticles were surrounded by proteins and metabolites such as terpenoids having functional groups of alcohols, ketons, aldehydes and carboxylic acids. From the analysis of FTIR studies we confirmed that the phenolic group has the stronger ability to bind metal indicating that the phenols could possibly from the metal nanoparticles (i.e., capping of Cu nanoparticles) to prevent agglomeration and thereby stabilize the medium. This suggests that the biological molecules could possibly perform dual functions of formation and stabilization of Cu nanoparticles in the aqueous medium.

CONCLUSIONS

In conclusion, here we report green and biological synthesis of Cu nanoparticles using leaf borth extract of *A. Marmelos*. This method has advantageous over other reported methods are easily available starting materials, inexpensive and process is simple to carry in any college level laboratory, use of toxic reagent is avoided and pollution free.

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