BME Horizon Vol 1 Issue 2 2023
DOI: 10.37155/2972–449X–vol1(2)–69

RESEARCH ARTICLE

Open Access

Green Synthesis of Copper Oxid Nanoparticles Using *Allmania nodiflora* Leaf Extract and Its Characterization

Thenmozhi M *, Manimegalai V and Joy Glory C

Department of Biotechnology, Selvam College of Technology, Namakkal, 637003, India.

***Correspondence to:** Thenmozhi M, Department of Biotechnology, Selvam College of Technology, Namakkal, 637003, India; Email: thenmozhi.marudhadurai@gmail.com.

Received: June 26, 2023; **Accepted:** October 18, 2023; **Published Online:** October 23, 2023

How to cite: Thenmozhi M, Manimegalai V and Joy Glory C. Green Synthesis of Copper Oxid Nanoparticles using Allmania nodiflora Leaf Extract and Its Characterization. *BME Horizon*, 2023; 1(2):69.
Doi:https://doi.org/10.37155/2972-449X-vol1(2)-69 .

Abstract: Nanoparticles are unique in nature and have a large surface area; these are the reasons for choosing nanoparticles in various medical as well as industrial purposes. Copper oxide nanoparticles were synthesised from the leaves of *Allmania nodiflora* to study the dye degradation ability since dye degradation has become a difficult task in recent days. Synthesised copper oxide nanoparticles were characterised using X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), and Fourier Transform Infrared Spectroscopy (FT-IR). The photocatalytic activities of the synthesised nanoparticles were analysed using UV-Visible spectroscopy. All the characterization methods ensured the prepared copper oxide particles were nanoparticles. There were no studies performed in synthesizing copper oxide nanoparticles using *Allmania nodiflora*. In addition to the analysis synthesized copper oxide nanoparticles purity also ensured using EDX results using Energy Dispersive X-ray analysis.
Keywords: Copper oxide; Nanoparticles; SEM; XRD; FTIR

1. Introduction

In recent years, Copper Nanoparticles have attracted much attention of researchers due to its application in wound dressings and biocidal properties, potential industrial use such as gas sensors, catalytic process, high temperature superconductors and solar cells. In literature, the Cu nanoparticles are synthesized from (a) vapor deposition, (b) electrochemical reduction, (c) radiolysis reduction, (d) thermal decomposition, (e) chemical reduction of copper metal salt and (f) room temperature synthesis using hydrazine hydrate and starch [1]. Recent advances in nanotechnology have led to the extensive development in different fields containing a synthesis of nanoparticles, nanotubes and nanowires, due to their Surface Enhanced Raman Scattering (SERS) and Surface Plasmon Resonance (SPR) [2].

Numerous investigations into the characteristics of nano sized objects and their production using various techniques for their practical use have been a feature of science and technology progress in recent years [3]. One of the most active areas of research in materials science is nanotechnology, which can be characterised as the fusion of technologies from several fields [4]. It has paved the door for several applications in medicines, catalysis, microelectronics, and biological sensors, which is a major service to humanity [5]. Due to their employment in numerous fields and their atomic or molecular particles with at least one dimension between 1 and 100 nanometers that exhibit novel features when compared to bulk materials, nanoparticles have recently attracted a lot of attention. Nanoparticles differ in their chemical and physical processes based on their size, shape, morphology, and high surface to volume ratio [6].

There were various studies performed on producing ZnO nanoparticles, AgO nanoparticles, etc. Various metal nanoparticles synthesized for various industrial purposes, in particular ZnO oxide nanoparticles, are produced and studied for their photocatalytic activity, dye sensitizing activity, etc. [7-9]. Various kinds of tests were performed to ensure their uniqueness and the proposed activity [10-14].

In this study we have choosen to synthesize Copper and copper oxide nanoparticle synthesize because of its wide adaptability and its therapeutic activity. Copper and copper oxide nanoparticles attract much attention because of their distinguished catalytic, mechanical, magnetic, electric and thermal properties; in addition to their versatile applicability in many fields including agricultural, industrial, environmental and medical applications. Furthermore, copper and copper oxide nanoparticles can be used in catalysis, sensors, degradation of dyes, fungicidal and nanomedical applications [15].There are several uses for copper oxide (CuO), from energy conversion and storage to environmental science, electronics, and sensors [16]. Due to their simplicity and a variety of valuable physical characteristics, such as electron correlation effects, spin dynamics, and high temperature superconductivity, CuO nanoparticles have attracted a lot of attention [17]. CuO nanoparticles' special qualities and possible uses have drawn a lot of interest in the past.

The investigation in this paper focused on greenly synthesised copper oxide nanoparticles utilising an *Allmania nodiflora* leaf extract (**Figure 1**). The resulting nanoparticles' characteristics were examined using conventional methods as UV-Vis, FT-IR, XRD, SEM, and EDX.

Figure 1. Allmania nodiflora leaves

2. Materials and Methods

2.1 Plant material and Extraction

Fresh leaves of *Allmania nodiflora* were collected from Kangayam, Tirupur district, Tamil Nadu, India. Fresh leaves were washed and dried in the shade at room temperature for 15 days. The extraction of plant materials was carried out following the maceration method. 10 grammes of the powdered material were then extracted using 70% ethanol in Erlenmeyer flasks (150 mL), and the ratio of plant material mass to solvent volume was 1:6. Before use, the mixtures were kept for 24 hours in tightly sealed vessels at room temperature.

2.2 Synthesis of Copper Nanoparticles

The *Allmania nodiflora* leaf extract is grained and makes 50 mL (1:4) of the leaf extract mentioned **in Figure 2**. The synthesis of CuO nanoparticles involved the mixing of aliquot amounts of copper oxide and *Allmania nodiflora* leaf extract in water. The 50 mL of *Allmania nodiflora* leaf extract was added to 450 mL of copper acetate (1M) aqueous boiled solution and kept at boiling condition for 2 hours to get the blue colloids (**Figure 3a, 3b, 3c**). After heating, the blue-coloured solution will turn brown and contain black particles. The reduction rate was found to increase with an increase in the quantity of the *Allmania nodiflora* leaf extract, and the reaction rate was completed after 24 hours. The material was powdered using a mortar and pestle, so it got a fine powder, which is easy for further characterization [18].

2.3 Characterization of Copper Oxide Nanoparticles

The characterization of copper oxide nanoparticles was done using the following methods: UV-Vis, FT-IR, XRD, SEM, and EDAX. To explore the optical characteristics of nanoparticles, UV-visible absorption spectroscopy is crucial [19]. By using the cited technique, which uses a Shimadzu apparatus (Shimadzu-1800 operating in the wavelength 1233 range 200-900 nm), the optical property of copper oxide nanoparticles was examined. In a quartz cell, the analysis was carried out with distilled water serving as the reference solvent. By using an FTIR spectrophotometer (Nicolet iS5, Thermo Fisher Scientific) in the spectrum region of 400–4000 cm^{-1}, it was possible to determine the functional groups of the extract and the chemical makeup of the nanoparticles. By employing an Xray diffractometer (Rigaku Miniflex 600) and a Cu-K crystal with a radius of 1.5406, the structure and grain size of copper oxides were studied at two different angles, spanning from 10° to 80°. Utilising scanning electron microscopy (SEM-TESCAN VEGA 3) and an energy dispersive X-ray analysis (EDAX), the nanoparticles' structure and morphology were studied [20].

3. Results and Discussion

3.1. Plant Sample Preparation

Figure 2. *Allmania nodiflora* leaf extract

3.2 Synthesis of Nanoparticles

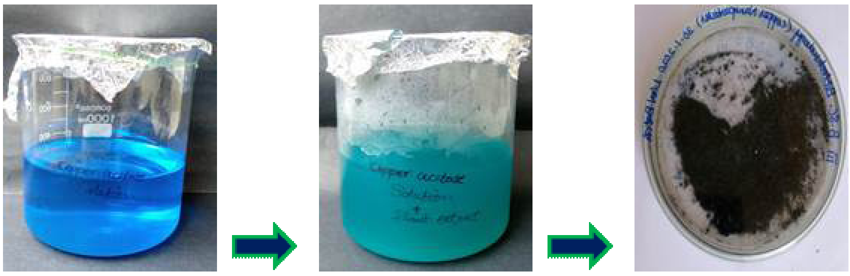
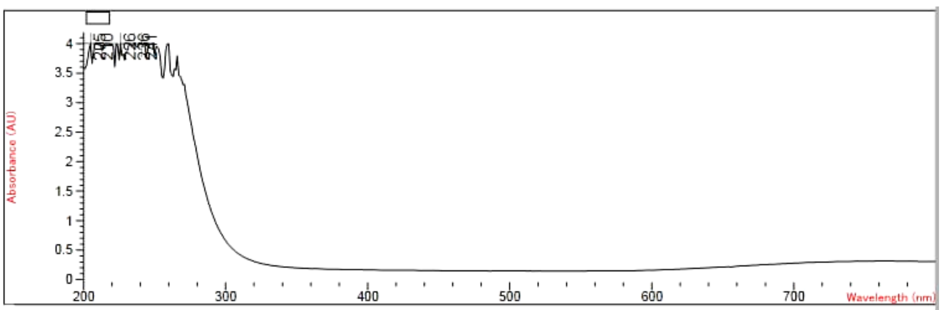


Figure 3. (**a**) Copper Acetate; (**b**) Copper acetate solution; (**c**) Synthesized CuO solution + leaf extract solution, nanoparticles Powder sample.

3.3 Characterization of Copper Oxide Nanoparticles

3.3.1 UV–Visible Spectroscopy

A highly helpful method for examining the durability of metal nanoparticles in aqueous solutions and the production of nanoparticles is UV-visible spectroscopy. The spectrum of CuO nanoparticles made from copper acetate that absorb UV light. The produced copper nanoparticles showed an absorption peak at 200–226 nm (**Figure 4**), which is identical to the absorption of CuO nanoparticles. In light of the absence of any other discernible peaks, this spectrum alone supports the presence of CuO. The incidence of surface plasmon absorption reflects the size and form of the nanoparticles [21].



#	Name	Peaks (nm)	Abs (AU)
1		205.0	4.00000
1		210.0	4.00000
1		226.0	4.00000

#	Name	Peaks (nm)	Abs (AU)
1		236.0	4.00000
1		241.0	4.00000

Figure 4. Represented the UV-vis spectra of green synthesized CuO nanoparticles using *Allmania nodiflora* leaf extracts.

3.3.2 FTIR Spectroscopy Analysis

Based on the peak value in the infrared radiation region, the functional groups of the active components were identified using FTIR spectroscopy. **Figure 5** displays the FTIR spectra of control leaf extract (before to a reaction without copper acetate) and synthesised CuO nanoparticles (after a reaction without copper acetate). The O-H groups of alcohols and phenols can be blamed for the broad and powerful peak at around 3442 cm^{-1}. With the synthesised CuO nanoparticles, this signal migrated to the lower field at 3393 cm^{-1}. Stretching of the C-H band is ascribed to the band at 2919 cm^{-1}. the peaks in the range of 665-1421 cm^{-1} have been attributed to alcohols, phenolic groups, and C-N stretching vibrations of amines [22].

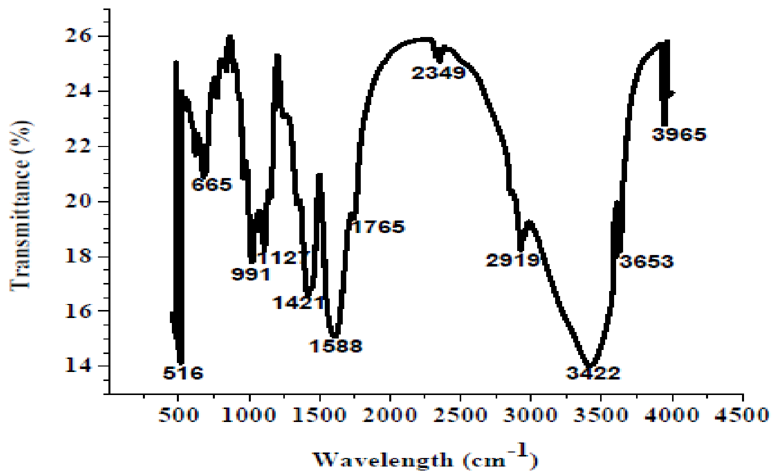


Figure 5. FTIR spectra of green synthesized CuO nanoparticles using *Allmania nodiflora* leaf extracts.

3.3.3. X-Ray Diffraction Spectroscopy Analysis

The XRD pattern for Cu/CuO-nanoparticles produced by *Allmania nodiflora* leaf extract is shown in **Figure 6**. The (111), (200), (113), (311), and (220) planes of CuO nanoparticles are represented by the diffraction peaks at 2Θ = 33.24°, 35.52°, 53.72°, 58.33°, 60.23°, and 62.87°, respectively. The diffraction peaks at 2 Θ = 22.3° and 28.3° correspond to the (111) and (200) planes of Cu nanoparticles [23].

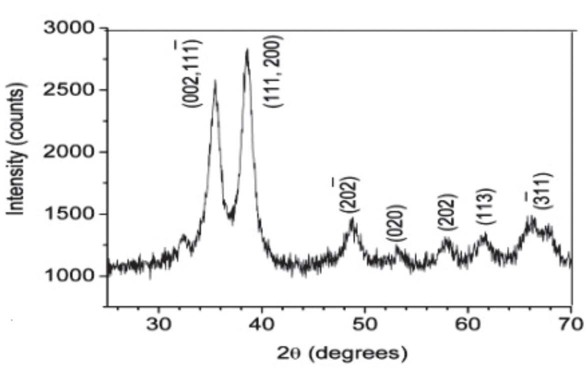


Figure 6. XRD pattern of *Allmania nodiflora* synthesized CuO NPs

3.3.4 Sem Coupled with Edx Analysis

By employing *Allmania nodiflora* leaf extract, green CuO nanoparticles that were produced at different concentrations were analysed by SEM. CuO nanoparticles were clearly indicated and dispersed in the analysis of SEM, respectively shown in **Figure 7**. The characteristic photos showed that the particles had a surface aggregation and a hexagonal quartzite structure. This outcome suggests that the CuO nanoparticles variation. The XRD data is supported by the SEM analysis. Additionally, granules are evenly dispersed around the substrate surface, covering it well. The components of *Allmania nodiflora* leaf extract demonstrate how CuO nanoparticles were used to manage the smooth surface morphology and grain size of the particles. CuO nanoparticles are formed with a more regular structure and in hexagonal and transparent shapes as the quantity of *Allmania nodiflora* leaf extract increases [23].

EDX, short for energy-dispersive X-ray spectroscopy The EDX analysis was used to determine the purity of the CuO NPs. The EDX spectrum of CuO NPs is shown in **Figure 8**. The element composition found in the samples was ascertained using EDX. The EDX data was found to consist of two components, Cu (76.3%) and O (23.7%), according to the results. This finding supports the excellent purity of the CuO nanoparticles [25,26].

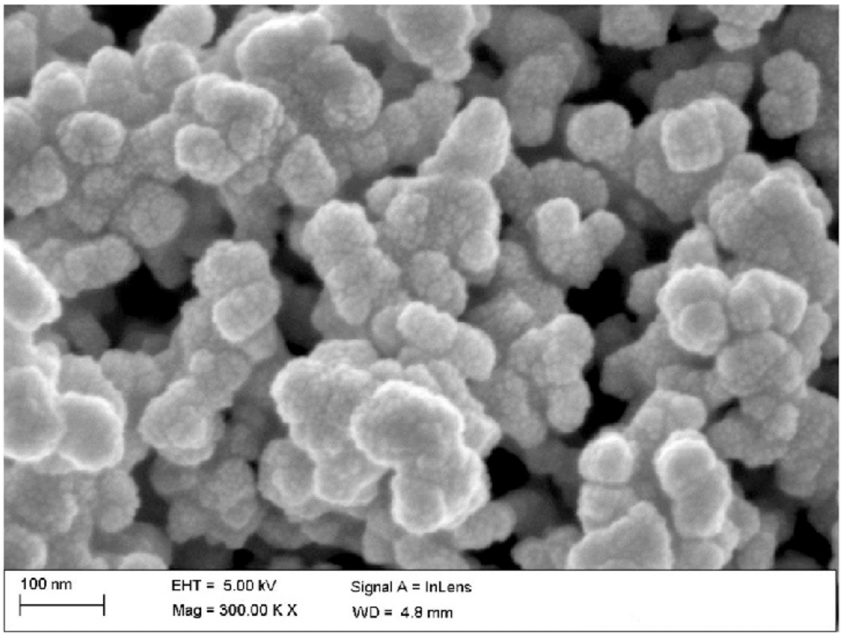


Figure 7. SEM image of the synthesized CuO nanoparticles using *Allmania nodiflora* leaf extracts.

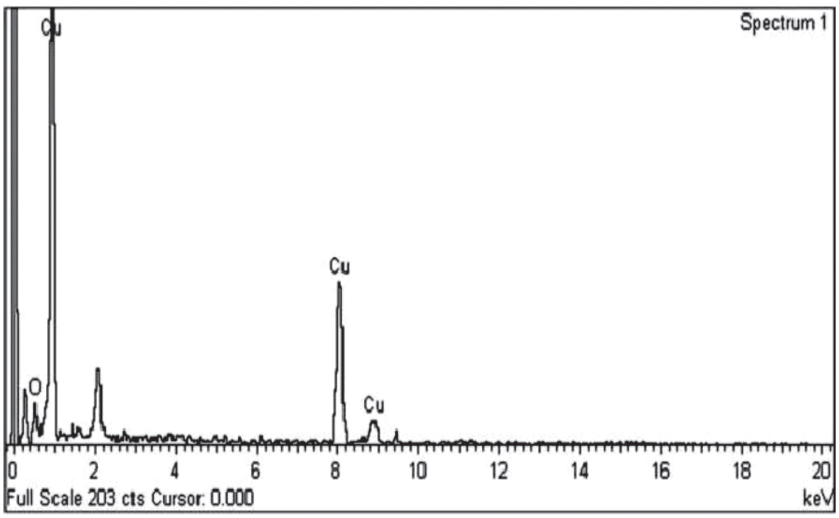


Figure 8. EDX of the CuO Nanoparticles

4. Conclusion

CuO nanoparticles with reasonably well-defined dimensions are produced when *Allmania nodiflora* leaf extract reduces Cu^{2+} ions, and the ideal conditions are 50 mL of extract in 450 mL of 1M copper acetate, pH 9, and 70 °C. It was discovered that the CuO nanoparticles had a hexagonal form with an average crystal size of 52.2 nm. In comparison to manufactured CuO nanoparticles, those produced by plants are more stable and release ions less frequently. UV-Vis spectroscopy was originally used to confirm the synthesised CuO nanoparticles, and XRD measurements were used to demonstrate their crystallinity [27]. By FTIR, different multifunctional plant extract groups were confirmed. SEM provided a clear indication of the dispersion of CuO nanoparticles, and EDX verified the purity of the CuO nanoparticles. An improved alternative to chemical synthesis for the production of CuO nanoparticles is green synthesis, which is pollution-free and environmentally benign [28]. Eco-friendliness and compatibility are two advantages of synthesising nanoparticles from natural resources like plant extracts.

Conflict of Interest

The authors declare no conflict of interest.

References

[1] Marano F. and Guadagnini R. Health impacts of nanomaterials. In nanoscience and nanotechnology. *Journal of Nanoscience*, 2016;12:273-286.

[2] Shende S., Ingle AP, Gade A., *et al*. Green synthesis of copper nanoparticles by Citrus medica Linn. (Idilimbu) juice and its antimicrobial activity. *World journal of microbiology and biotechnology*, 2015;28:65-873.

[3] Thakur S., Sharma S., Thakur S., *et al*. (2018). Green synthesis of copper nano particles using Asparagus adscendensroxb. Root and leaf extract and their antimicrobial activities. *International journal of current microbiology and applied science*, 2018;7(4): 112-116.

[4] Simakin AV, Voronov VV, Kirichenko NA, *et al*. Nanoparticles produced by laser ablation of solids in liquid environment. *Journal of Applied Physics*, 2004;79:1127-1132.

[5] Banumathi B., Vaseeharan B., Periyannan R., *et al*. Exploitation of chemical, herbal and Nano formulated acaricides to control the cattle tick, Rhipicephalus (Boophilus) microplus a view at. *Journal of Nanoscience*, 2017;6:223-229.

[6] Sankar R., Manikandan P., Malarvizhi V., *et al*. Green synthesis of colloidal copper oxide nanoparticles using Caria papaya and its application in photocatalytic dye degradation. *Journal of Molecular Spectroscopy*, 2014;121:746-750.

[7] Shashanka R., Parham T., Abdullah CK, et al. Photocatalytic degradation of Rhodamine B (RhB) dye in waste water and enzymatic inhibition study using cauliflower shaped ZnO nanoparticles synthesized by a novel one-pot green synthesis method. *Arabian journal of chemistry*, 2021;14:1-13.

[8] Shashanka R., Halil E, Volkan MY, *et al*. Fabrication and characterization of green synthesized ZnO nanoparticle based dye-sensitized solar cells. *Journals of science: Advanced materials and devices*, 2020; 5:185-191.

[9] Shashanka R., Yasemin K., Recep T., *et al*. Antimicrobial investigation of CuO and ZnO nanoparticles prepared by a rapid combustion method. *Physical chemistry research*, 2019;799-812.

[10] Shashanka R., Jayaprakash GK., Prakashaiah BG, *et al*. Electrocatalytic determination of ascorbic acid using a green synthesized magnetic nano-flake modified carbon paste electrode by cyclic voltammetric method. *Materials research innovation*, 2021;26(4):229-239.

[11] Shashanka R., Jayaprakash GK., Anup P., *et al*. Electrolytic investigation by improving the charge kinetics between carbon electrodes and dopamine using bio-synthesized CuO nanoparticles. *Catalysts*, 2022;12(9):994-1011.

[12] Minakshi J, Shabnam A, Navinchandra GS. Ultrasonic assisted green synthesis of Ag: Cdo nanocubes and nanospheres using *citrus limon* leaves for effective degradation of organic dyes. *Journal of industrial and engineering chemistry*, 2019;69:269-284.

[13] Shilpa J., Akshara PS., Navichandra GS. An efficient photocatalytic degradation of organic dyes under visible light using zinc stannate (Zn2SnO4) nanorods prepared by microwave irradiation. *Nano-structures and Nano-objects*, 2020;21:1-10.

[14] Aruna MS., Navichandra GS. 3D ZnO sunstar rose nanoflowers morphology with surfactant-assisted reflux exhibit excellent optical properties and photocatalytic activity against hazardous organic dyes. *Optical materials*. 2023;136:1-10

[15] Marano F., Guadagnini R. Health impacts of nanomaterials. In nanoscience and nanotechnology. *Journal of Nanoscience*, 2016;12:273-286.

[16] Elwy A., Mohamed M., Sherif F., *et al*. Evaluation of In vitro Nematicidal Efficiency of Copper Nanoparticles against Root-knot Nematode Meloidogyne Incognita. *South Asian Journal of Parasitology*, 2019;23:1-6

[17] IpsaSubhankari K. and Nayak P.L Synthesis of Copper Nanoparticles Using Syzygiumaromaticum(Cloves) Aqueous Extract by Using Green Chemistry World. *Journal of Nanoscience and Nanotechnology*, 2013;2(1):14-17.

[18] Ashutosh KS., Siavash I. Green Synthesis and Spectroscopic Characterization of Nanoparticles. *International Publishing Switzerland*, 2016;83:65-99.

[19] Abboud Y., Saffaj T., Chagraoui A., *et al*. Biosynthesis, Characterization and antimicrobial

activity of copper oxide nanoparticles (CONPs) produced using brown alga extract (Bifurcaria bifurcate). *Applied Nanoscience*, 2014;4:571-576.

[20] Ahmad N., Sharma S. Green Synthesis of Silver Nanoparticles Using Extracts of Ananas comosus. *Green and Sustainable Chemistry*, 2012;2:141-147.

[21] Jayakumarai G., Gokulpriya C., Sudhapriya R., *et al*. Phytofabrication and characterization of monodisperse copper oxide nanoparticles using Albizialebbeck leaf extract. *Applied Nanoscience*, 2015;5:1017-1022.

[22] Dilaveez R., Mahendiran D, Senthil KR., *et al*. Invitro antioxidant and antidiabetic activities of zinc oxide nanoparticles synthesized using different plant extracts. *Bioprocess and biosystems engineering*, 2017;40(6):943-957.

[23] Muhammad I., Khana MI., Kalsoom A., *et al*. Physica. Photosynthesis of silver nanoparticles; naked eye cellulose filter paper dual mechanism sensor for mercury ions and ammonia in aqueous solution. *Journal of material science: Materials in electronics*, 2019;30:7367-7383.

[24] K. Mujeeb K., Merajuddin K., Syed FA., *et al*. Green synthesis of silver nanoparticles mediated by Pulicaria glutinosa extract. *International Journal of Nanomedicine* , 2013;8:1507-1516.

[25] Koshy J., Soosen M., Samuel A., *et al*. Optical properties of CuO nanoparticles. *AIP conference proceedings*, 2011;1391(1):576-578.

[26] Mahmoud N., Mohammad sajadi S., Roastami-Vartooni A., *et al*. Green synthesis of CuO nanoparticles using aqueous extract of *Thymus vulgaris L*. Leaves and their catalytic performance for L-arylation of indoles and amines. *Journal of colloid and interface science*, 2016;466:113-119.

[27] Berra D, Eddine LS., Boubaker B., *et al*. Green synthesis of copper oxide nanopartciles by phoenix dactylifera L leaves extract. *Digest journal of nanomaterials and biostructures*, 2018;13(4):1231-1238.

[28] Manasa D J., Chandrashekar KR., Madhu kumar DJ., *et al*. *Mussaenda frondosa L* mediated facile green synthesis of copper oxide nanoparticles-Characterization, photocatalytic and their biological investigations. *Arabian journal of chemistry*, 2021;14:1-16.