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Green Synthesized Transition Metals Nanoparticles Using *Murraya koenigii* Root Extract and their Comparative Study of Characterization

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Abstract

Plant root-mediated green synthesis of nanomaterials has been increasingly gaining popularity due to its eco-friendly nature and cost-effectiveness. Current work describes the green synthesis of silver and copper nanoparticles using *Murraya koenigii* roots extract as a capping agent. This study was conducted for the synthesis of nanoparticles using two exclusive salts (silver nitrate and copper sulfate) with the aid of *Murraya koenigii* root extract. We did comparative study of synthesized silver and copper nanoparticles using about 10 g of *Murraya koenigii* root. Roots were weighed separately and transferred into 250 ml beakers containing 100 ml distilled water and boiled for about 25 minutes. Solutions were then filtered to get clear extracts. The extract was taken for the reduction of Ag^+ and Cu^{2+} ions, 10 ml of *Murraya koenigii* root extract was added drop wise to 10 ml of silver nitrate and copper sulphate solution (1:1ratio). The reduction reaction was studied by observing the colour change. Confirmation of silver and copper nanoparticles formation and plasmonic resonance can be found by analyzing the absorbance data of UV-VIS spectroscopy, Fourier Transform Infrared (FTIR), which were used to determine the functional groups on the cell surface that may be involved in the nanoparticle synthesis. Morphology and size of silver and copper nanoparticles were investigated using Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) experiments.

Keywords: Silver nitrate (AgNO_3); Copper (II) sulphate (CuSO_4); *Murraya koenigii* root; Green synthesis; Nanoparticles

Introduction

Nanoscience technology is one of the recent scientific fields which is on the increase as it has potential applications in the fields of in sequence and message technologies, biotechnology and medicine, optoelectronics and solar-cell. Nanoscience and nanotechnology principally help in arrangement of the synthesis, description and investigation of a variety of kind of nanostructure resources (Atawodi and Olowoniyi, 2015). Nanostructures make up a link surrounded by molecules and unlimited large systems. Individual nanostructures include clusters, quantum dots, nanocrystals, nanowires, and nanotubes while collections of nanostructures involve arrays, assemblies, and superlattices of the individual nanostructures. Vegetation gives an improved proposal for nanoparticles synthesis because they are at no cost as of poisonous chemicals as well as give natural capping agents (Raza et al., 2016).

Silver Nanomaterials

suitable to fast industrialization and urbanization, our atmosphere is going through colossal break awake and a huge quantity of hazardous and unnecessary chemical, gas or substance are free, and so now it is our need to learn with reference to the secrets to be current in the environment and its yield which leads to the development of improvement in the synthesis process of nanoparticles. (Cunningham et al., 2022) Silver nanoparticles are one of the shows potential yields in the nanotechnology production. The improvement of dependable process for the synthesis of silver nanomaterials is a main feature of recent nanotechnology investigates. One of such shows potential processes is green synthesis. Silver nanoparticles can be synthesized by several physical, chemical and natural methods (Rajkumar et al., 2016).



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Copper Nanoparticles

One of the earliest uses of copper nanoparticles was to color glass and ceramics during the ninth century in Mesopotamia. This was done by creating a glaze with copper and silver salts and applying it to clay pottery. When the pottery was baked at high temperatures in reducing conditions, the metal ions migrated to the outer part of the glaze and were reduced to metals. The end result was a double layer of metal nanoparticles with a small amount of glaze in between them.

When the finished pottery was exposed to light, the light would penetrate and reflect off the first layer. The light penetrating the first layer would reflect off the second layer of nanoparticles and cause interference effects with light reflecting off the first layer, creating a luster effect that results from both constructive and destructive interference (Cristea et al., 2017).



Fig. 1. *Murraya koenigii* Plant

Murraya koenigii (curry leaves)

India is frequently known by enormous biodiversity of medicinal plants. Among them *Murraya koenigii* have a lot of bioactive principles due to which plant has been proven as the medicinally important plant but least or no attention received by the scientist. *Murraya koenigii* is proven as the natural medicinal plant (Küünal et al., 2016).

MATERIALS AND METHODS

Plant Samples

Murraya koenigii root used in this work was collected from the garden at Seelappadi, Dindigul.

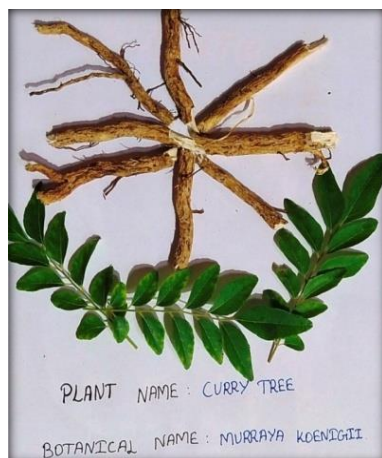


Fig. 2. *Murraya koenigii* root

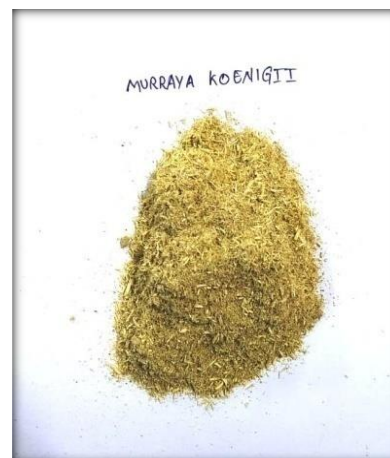


Fig. 3. *Murraya koenigii* root powder

Instrument Required

UV-visible light Spectroscopy (UV), Fourier Transform Infrared (FTIR).

Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM).

Chemical Reagent Required

Silver nitrate (AgNO_3) and Copper (II) sulfate (CuSO_4) used for the synthesis of silver nanoparticles was procured from ILE Company Limited Madurai, Tamilnadu.



Fig. 4. Silver nitrate



Fig. 5. Silver nitrate powder

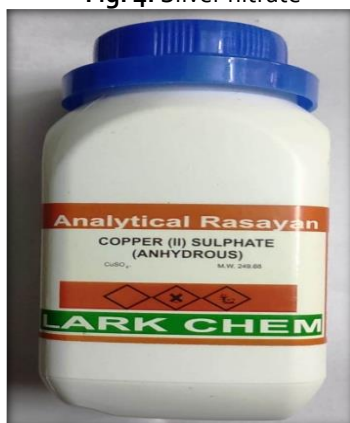


Fig. 6. Copper sulphate



Fig. 7. Copper sulphate powder

Preparation of the Root Extract

Indian medicinal plant *Murraya koenigii* root was selected, on the basis of low-cost neighborliness, ease of accessibility and medicinal property. Fresh and healthy Roots were collected locally and rinsed methodically first with tap water followed by distilled water to remove all the dust and unnecessary observable particles, cut into small pieces and after that the root was dried in room temperature and grinded in home mixer. Glassware was cleaned with concentrated nitric acid and washed thoroughly with water followed by freshly prepared demonized double distilled water before use. About 10 g of *Murraya koenigii* root were weighed separately and transfer into 250 ml beakers containing 100 ml distilled water and boiled for about 25 min. The extracts were then filtered thrice through Whitman No. 1 filter paper to remove particulate matter and to get clear solutions which were then cooled (4°C) in 100 ml Erlenmeyer flasks for further experiments (Adelere and Lateef, 2016).

Synthesis of Silver Nanoparticles

For the synthesis of silver nanoparticles, 1mM silver nitrate and *Murraya koenigii* root extract were taken. For the reduction of Ag^+ ions, 10 ml of *Murraya koenigii* root extract was added drop wise to 10 ml of 1 mM silver nitrate solution (1:1 ratio). A different color change was observed after 24 hrs as the solution turned into brown from yellow solution at room temperature suggesting formation of silver nanoparticles. The color became brown and turned into dark brown (Sivakumar et al., 2019).

Synthesis of Copper Nanoparticles

For the synthesis of copper nanoparticles, 1mM copper sulphate and plant *Murraya koenigii* root extracts were taken. 10 ml of *Murraya koenigii* root extract was added drop wise to 10 ml of 1 mM

copper sulphate solution. A different color change was observed after 24 hrs. as the solution turned into brown from yellow solution at room temperature suggesting formation of copper nanoparticles. The initial blue color of the reaction mixture eventually turned to brown-black (Sivakumar et al., 2019).

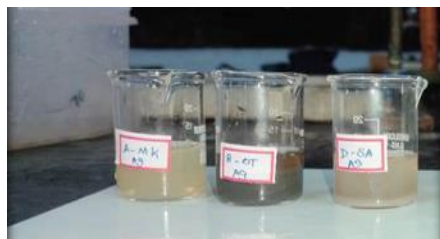


Fig. 8. Synthesis of silver nanoparticles



Fig. 9. Synthesis of Copper Nanoparticles

After the Synthesis of silver and Copper Nanoparticles

After 48 hrs. of incubation, the colour change was observed. This indicates that the nanoparticles were synthesized from the plant materials with the help of aqueous solution. Then this solution was centrifuged at 10,000 rpm for 20 min. The pellets were taken after centrifugation. The dried pellets were collected in a micro-centrifuge tube and the pellets were used for further analyses.



Fig. 10. Silver and Copper Nanoparticles

Characterization of Silver and Copper Nanoparticles

The characterized by confirmation of silver and copper nanoparticles formation and plasmonic resonance can be found by analyzing the absorbance data of UV-VIs spectroscopy, Fourier Transform Infrared (FTIR), to determine the functional groups on the cell surface that may be involved in the nanoparticle synthesis. Morphology and size of silver and copper nanoparticles were investigated using Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) experiments (Sivakumar et al., 2019).

RESULTS AND DISCUSSIONS

UV-VIS Spectroscopy

The optical properties of the synthesized silver and copper nanoparticles were analyzed by this technique.

Synthesis of Silver and copper Nanoparticles

UV-vis spectroscopy of silver nanoparticles synthesized by *Murraya koenigii* medicinal plants root extract confirms absorption peak.

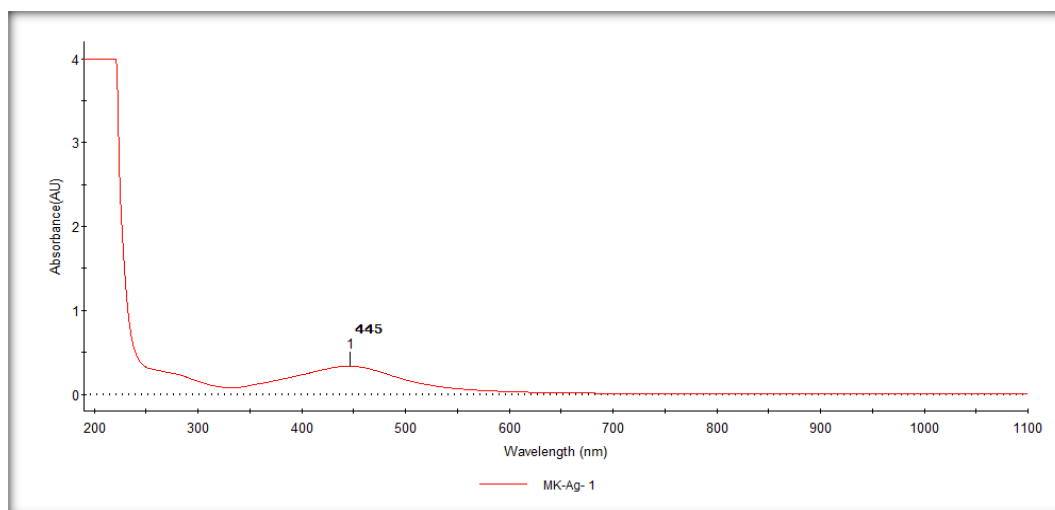


Fig. 11. UV-vis spectroscopy of silver nanoparticles synthesized by *Murraya koenigii* medicinal plants root extract confirmed by absorption peak.

Reduction of the metal ion to metal nanoparticles during exposure to the plant root extract could be followed by color change and thus UV-vis spectroscopy. Preliminary characterization was carried out using UV-visible spectrophotometer at absorption wavelength of 200–1100 nm. The absorption peak observed at 445 nm is the characteristic peak of silver nanoparticles. UV-vis spectroscopy of copper nanoparticles synthesized by *Murraya koenigii* medicinal plants root extract confirmed by absorption peak.

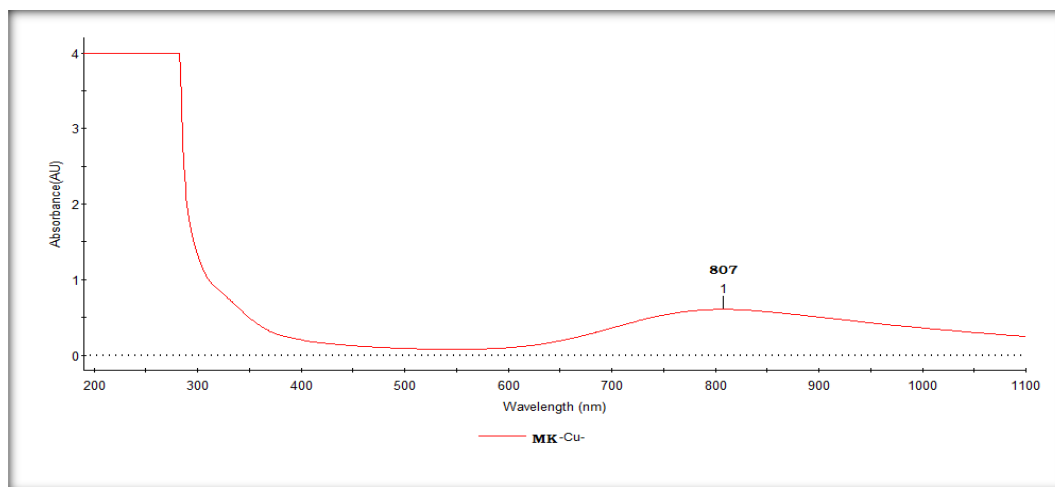


Fig. 12. UV-vis spectroscopy of copper nanoparticles synthesized by *Murraya koenigii* medicinal plants root extract confirms absorption peak.

Reduction of the metal ion to metal nanoparticles during exposure to the plant root extract could be followed by color change and thus UV-vis spectroscopy. Preliminary characterization was carried out using UV-visible spectrophotometer at absorption wavelength of 200–1100 nm. The absorption peak observed at 807 nm is the characteristic peak of copper nanoparticles (Sivakumar et al., 2022).

Fourier transform infrared spectroscopy (FT-IR)

The FTIR spectrum confirmed the presence of functional groups such as alcohols, phenols, alkanes, alkynes, aldehydes, carboxylic acids, aromatics, nitro compounds, amines, etc. The Nanoparticles was passed into the FTIR and the functional groups of the components were Separated based on its peak ratio.

FT-IR spectrum of silver nanoparticles synthesized by *Murraya koenigii* root medicinal plants extract showed different peaks at value FT-IR spectrum of AgNps recorded in the range of 400–4000 cm^{-1} . As observed, The peak at 3452.26(cm^{-1}) expected from organic O-H stretching with contribution from any water might retained in the sample or other mineral derived from hydroxyl group and the band at 2078.52(cm^{-1}) corresponds to the N=C=S stretching of isothiocyanate. The fine peak at 1637.96(cm^{-1}) was attributed to the conjugated alkene C=C stretching mode. The sharp peak around 1384.25(cm^{-1}) shows the presence of C=C stretching aldehyde and the absorption peak at 1113.21(cm^{-1}) corresponds to the C-N stretching primary aliphatic amines present in the root extract. The strong peak around 624.58(cm^{-1}) shows the presence of C-I stretching halo compound. This indicates that the biological molecule in the root extract has a dual function of stabilization and formation of AgNps (Ingle et al., 2019).

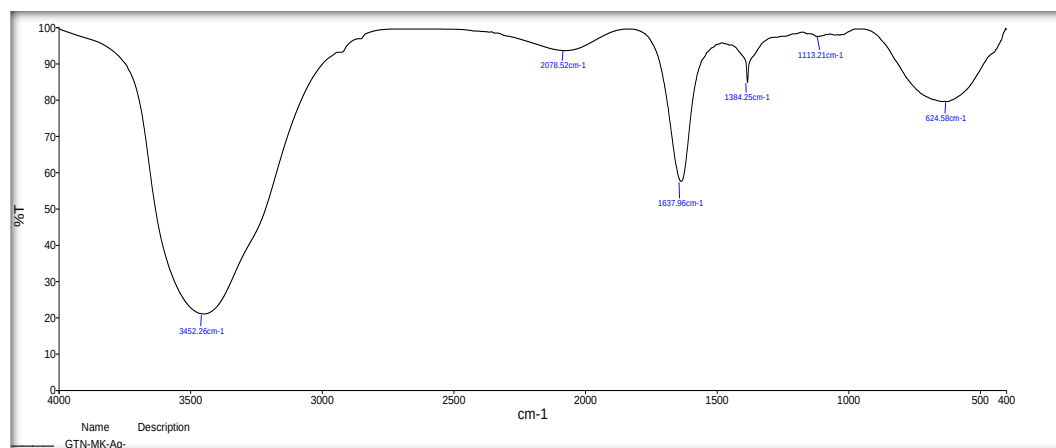


Fig. 13. FT-IR spectrum of silver nanoparticles synthesized by *Murraya koenigii* root medicinal plants extract

Table 1. FT-IR spectrum of Silver by *Murraya koenigii* root extract

Frequency Range	Absorption (cm^{-1})	Appearance	Group	Compounds class
3550-3200	3452.26(cm^{-1})	Strong, Broad	O-H stretching	Alcohol
2140-1990	2078.52(cm^{-1})	Strong	N=C=S stretching	Isothiocyanate
1650-1600	1637.96(cm^{-1})	Medium	C=C stretching	Conjugated alkene
1390-1380	1384.25(cm^{-1})	Medium	C=C stretching	Aldehyde
1250-1020	1113.21(cm^{-1})	Medium	C-N stretching	Amine
600-500	624.58(cm^{-1})	Strong	C-I stretching	Halo compound

FT-IR spectrum of copper nanoparticles synthesized by *Murraya koenigii* root medicinal plants extract showed different peaks at value. The peak at 3446.24 (cm^{-1}) expected from organic O-H stretching with contribution from any water might retained in the sample or other mineral derived from hydroxyl group and the band at 2075.40 (cm^{-1}) corresponds to the N=C=S stretching of isothiocyanate. The fine peak at 1634.46 (cm^{-1}) was attributed to the conjugated alkene C=C stretching mode. The sharp peak around 1384.43 (cm^{-1}) shows the presence of C=C stretching aldehyde and the absorption peak at 1103.66 (cm^{-1}) corresponds to the C-N stretching primary aliphatic amines present in the root extract. The strong peak around 668.73 (cm^{-1}) shows the presence of C-Br stretching halo compound. The strong peak around 616.44 (cm^{-1}) shows the presence of C-I stretching halo compound. The main stretch for copper nanoparticles was found at 615 – 619 cm^{-1} . Therefore, the synthesized copper nanoparticles were found to be surrounded by metabolites and phytochemicals such as flavonoids and terpenoids etc. FT-IR studies proved that the phytochemicals present in the plant extract not only reduce copper ions into copper nanoparticles but also bind copper (capping of copper nanoparticles) to prevent from agglomeration and thereby stabilize the medium.

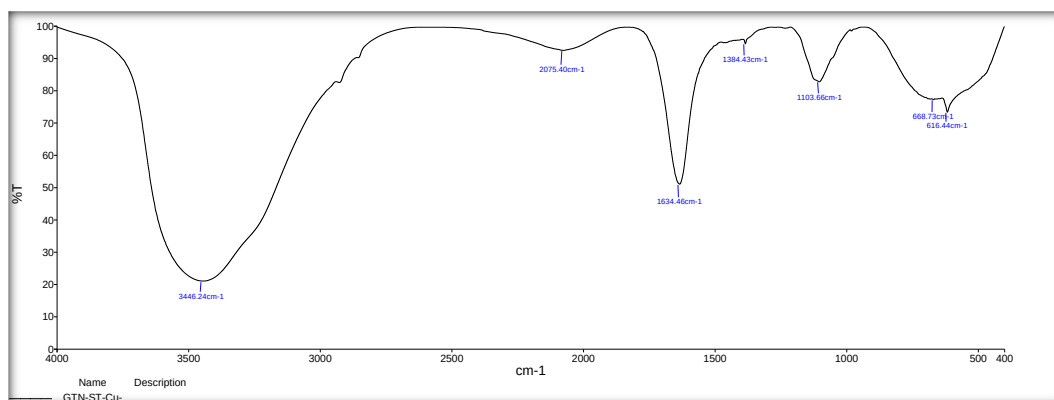


Fig. 14. FT-IR spectrum of copper nanoparticles synthesized by *Murraya koenigii* root medicinal plants extract

Table 2. FT-IR spectrum of copper by *Murraya koenigii* root medicinal extract

Frequency Range	Absorption (cm^{-1})	Appearance	Group	Compounds class
3550-3200	3446.24 (cm^{-1})	Strong, Broad	O-H stretching	Alcohol
2140-1990	2075.40 (cm^{-1})	Strong	N=C=S stretching	Isothiocyanate
1650-1600	1634.46 (cm^{-1})	Medium	C=C stretching	conjugated alkene
1390-1380	1384.43 (cm^{-1})	Medium	C=C stretching	Aldehyde
1250-1020	1103.66 (cm^{-1})	Medium	C-N stretching	Amine
690-515	668.73 (cm^{-1})	Strong	C-Br stretching	Halo compound
600-500	616.44 (cm^{-1})	Strong	C-I stretching	Halo compound

Scanning electron microscopy (SEM)

The morphology and size of the synthesized silver and copper nanoparticles (AgNPs) was analyzed by this technique. The retort of Scanning Electron Microscope (SEM) of Silver and Copper nanoparticles synthesized by *Murraya koenigii* medicinal plants root extract.

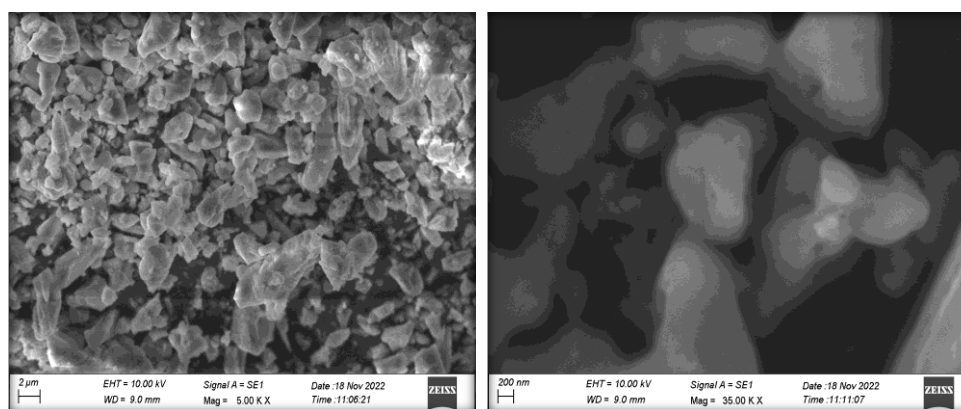


Fig. 15. Surface morphology of silver nanoparticle synthesized by

Murraya koenigii root extract

The retort of Scanning Electron Microscope (SEM) of silver nanoparticles green synthesized by using *Murraya koenigii* Indian medicinal plant root extract prepared using silver nitrate are shown in Fig. 15. SEM has provided the perspective of the morphology and size of the synthesized silver nanoparticles, that silver nanoparticles are cubical, rectangular, triangular and spherical in shape with uniform distribution. The aggregated particles formation may be due to the existence of phytochemicals present in the root extract. The average particles size measured from SEM images is around 100–200 nm (Sivakumar et al., 2022).

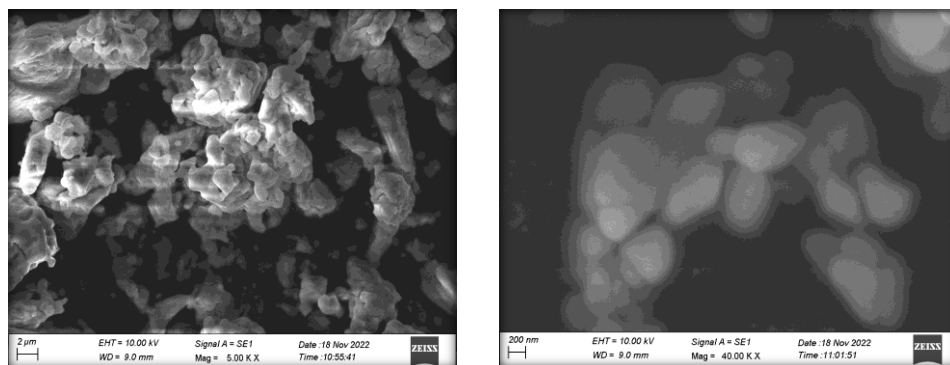


Fig. 16. Surface morphology of copper nanoparticle synthesized by *Murraya koenigii* root extract

The retort of Scanning Electron Microscope (SEM) of copper nanoparticles green synthesized by using *Murraya koenigii* Indian medicinal plant root extract prepared using copper sulphate are shown in Fig. 16. SEM has provided the perspective of the morphology and size of the synthesized copper nanoparticles, that copper nanoparticles are cubical, rectangular, triangular and spherical in shape with uniform distribution. The aggregated particles formation may be due to the existence of phytochemicals present in the root extract. The average particles size measured from SEM images is around 100–200 nm (Sivakumar et al., 2022).

Transmission electron microscope (TEM)

Transmission electron microscopy is a very important characterization analytical technique used for determining the crystalline nature and the morphological factors i.e., size, shape and polydispersity index of metallic NPs. Due to its high resolution, TEM is capable of displaying of magnified image of metallic nanoparticles. Transmission Electron Microscope (TEM) TEM image recorded from the drop-coated film of AgNPs synthesized by treating AgNO_3 solution with *Murraya koenigii* Indian medicinal plant root extract broth for 4 h. The micrograph clearly shows individual nanoparticles, almost spherical with diameters in the range of 5–25 nm. The measurement of size was performed along the largest diameter of the particles Ag. (Sivakumar et al., 2022)

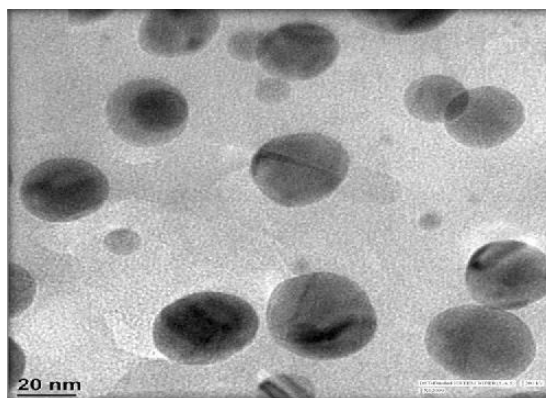


Fig. 17. Shape of silver nanoparticle synthesized by *Murraya koenigii* root extract

Transmission Electron Microscope (TEM) image recorded from the drop-coated film of CuNPs synthesized by treating CuSO_4 solution with *Murraya koenigii* Indian medicinal plant root extract broth for 4 h. The measurement of size was performed along the largest diameter of the particles Cu^{2+} . TEM is an important characterization tool for the direct imaging of nanomaterials to obtain quantitative measures of particle size, size distribution, shape and lattice fringes. The particle size and lattice fringes are measured using HRTEM (Model Philips TM-30, Philips Research Laboratories). The bright-field (BF) electron micrograph of the CuNPs produced at 100°C shows the micrograph clearly shows individual nanoparticles, almost spherical with diameters in the range of 5–20 nm (Sivakumar et al., 2022).

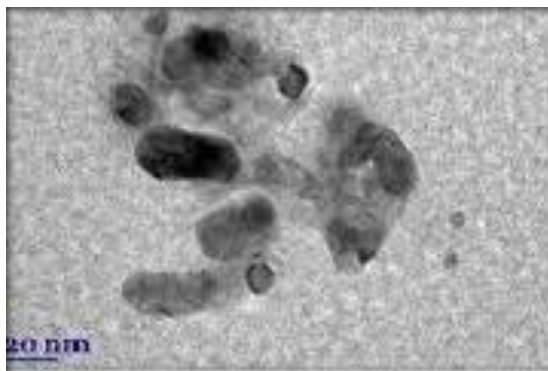


Fig. 18. Shape of copper nanoparticle synthesized by *Murraya koenigii* root extract

Conclusion

Consequently, in the present study, we focused on the biosynthesis, characterization of metal (Silver and Copper) nanomaterials. The process of purification of the synthesized NPs, identification of the suitable plant for synthesis, selection of the most suitable pathway for the synthesis of NPs with desired shape/size (Mozaffari et al., 2017). A comparative analysis of nanoparticle synthesis was done using two different metals (AgNO_3 and CuSO_4) and using *Murraya koenigii* Indian medicinal plant root extract. The fact that nanoparticle synthesis does take place by two metals with the copper sulphate giving better results than the silver nitrate. UV-VIS spectroscopy of silver and copper nanoparticles synthesized by *Murraya koenigii* medicinal plants root extract confirm the absorption peak observed at 445 nm which is the characteristic peak of silver nanoparticles and 807 nm as the characteristic peak of copper nanoparticles. The FTIR spectrum confirmed the presence of functional groups such as alcohols, phenols, alkanes, alkynes, aldehydes, carboxylic acids, aromatics, nitro compounds and amines. The morphology and size of the synthesized the silver nanoparticles (AgNPs) is around 90 nm in diameter and the copper nanoparticles (Cu^{2+} NPs) is around 100 nm in diameter. The average particle size and the shape were found to be cubical, rectangular, triangular and spherical and agglomerates were also observed. TEM was found to be a very important characterization analytical technique used for determining the crystalline nature and the morphological factors including size and shape.

References

- Adelere IA and Lateef A (2016) A novel approach to the green synthesis of metallic nanoparticles: the use of agro-wastes, enzymes and pigments. *Nanotechnology Rev* 5(6): 567-587.
- Atawodi SE-O and Olowoniyi OD (2015) Pharmacological and Therapeutic Activities of *Kigelia africana* (Lam.) Benth. *Ann Res Rev Biol* 5(1): 1-17.
- Cristea C, Tertis M, Galatus R, et al. (2017) Magnetic Nanoparticles for Antibiotics Detection. *Nanomaterials* 7:119.
- Cunningham B, Harper B, Brander S, et al. (2022) Toxicity of micro and nano tire particles and leachate for model freshwater organisms. *Journal of Hazardous Materials* 429: 128319. DOI: 10.1016/j.jhazmat.2022.128319.
- Küünal S, Kutti S, Rauwel P, et al. (2016) Biocidal properties study of silver nanoparticles used for application in green housing. *Int Nano Lett* 6: 191-197.
- Mozaffari S, Li W, Thompson C, et al. (2017) Colloidal nanoparticle size control: Experimental and kinetic modeling investigation of the ligand-metal binding role in controlling the nucleation and growth kinetics. *Nanoscale* 9: 13772-13785.
- Rajkumar KS, Kanipandian N, Thirumurugan R, et al. (2016) Toxicity assessment on haematology, biochemical and histopathological alterations of silver nanoparticles-exposed freshwater fish *Labeo rohita*. *Appl Nanosci* 6: 19-29.
- Raza MA, Kanwal Z, Rauf A, et al. (2016) Size- and shape-dependent antibacterial studies of silver nanoparticles synthesized by wet chemical routes. *Nanomaterials* 6: 74.

Sivakumar C, Pandiya Rajan A and Kousalya GN (2019) World Journal of Pharmaceutical Research. 8(9): 975-983.

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Author Contributions

CS, KR, AP and GNK conceived the concept, wrote and approved the manuscript.

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Availability of data and materials

Not applicable.

Competing interest

The authors declare no competing interests.

Ethics approval

Not applicable.



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