

Manuscript ID:
IJRSEAS-2026-030264



Quick Response Code:



Website: <https://eesrd.us>



Volume: 3

Issue: 2(I)

Pp. 264-266

Month: April

Year: 2026

E-ISSN: 3066-0637

Submitted: 11 Mar. 2026

Revised: 21 Mar. 2026

Accepted: 12 Apr. 2026

Published: 30 Apr. 2026

Address for correspondence:

Pranita More, D.G. Tatkare
Mahavidyalay of Arts, Science,
Commerce, IT & Management,
Mangaon - Raigad.

How to cite this article:

Pranita More, Naziya Jummal.
(2026). Synthesis of Green Copper
Nanoparticles Using Medicinal
Plant curry leaves Extract and Its
characterization by Sem TEM and
FTIR and its application as
catalyst. *International Journal of
Research Studies on Environment,
Earth, and Allied Sciences*, 3(2(I)),
267-270.

Synthesis of Green Copper Nanoparticles Using Medicinal Plant curry leaves Extract and Its characterization by Sem TEM and FTIR and its application as catalyst

Pranita More¹, Naziya Jummal²

¹D.G. Tatkare Mahavidyalay of Arts, Science, Commerce, IT & Management,
Mangaon - Raigad.

² Asst. Prof., D.G. Tatkare Mahavidyalay of Arts, Science, Commerce, IT &
Management, Mangaon - Raigad.

Abstract:

Green synthesis of nanoparticles has emerged as an eco-friendly and sustainable approach in nanotechnology. In the present study, copper nanoparticles (CuNPs) were synthesized using *Murraya koenigii* (curry leaves) extract as a natural reducing and stabilizing agent. The phytochemicals present in the curry leaves, such as flavonoids, phenolic compounds, alkaloids, and terpenoids, play a crucial role in the bioreduction of copper ions (Cu^{2+}) into copper nanoparticles and also prevent their aggregation by acting as capping agents. The synthesis process was indicated by a visible color change from blue to dark brown, confirming the formation of CuNPs. The synthesized nanoparticles were characterized using advanced analytical techniques such as Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), and Fourier Transform Infrared Spectroscopy (FTIR). SEM analysis revealed the surface morphology of nanoparticles, while TEM provided detailed information about particle size and shape, showing that the particles were predominantly spherical and within the nanoscale range. FTIR analysis confirmed the presence of various functional groups associated with plant biomolecules, indicating their involvement in reduction and stabilization processes. Furthermore, the catalytic activity of the synthesized CuNPs was evaluated using the reduction of 4-nitrophenol to 4-aminophenol in the presence of sodium borohydride (NaBH_4). The nanoparticles exhibited excellent catalytic efficiency due to their high surface area and active sites. This study demonstrates a simple, cost-effective, and environmentally friendly method for the synthesis of copper nanoparticles with significant catalytic applications. The findings highlight the potential of plant-mediated nanoparticles in green chemistry and environmental remediation.

Keywords: Green synthesis, Copper nanoparticles, *Murraya koenigii*, SEM, TEM, FTIR, Catalysis

Introduction:

Nanotechnology is a rapidly advancing field of science that deals with the design, synthesis, and application of materials at the nanoscale range (1–100 nm). At this scale, materials exhibit unique physical, chemical, optical, and biological properties that are significantly different from their bulk counterparts due to increased surface area and quantum effects. These distinctive properties make nanoparticles highly useful in various fields such as medicine, electronics, environmental science, and catalysis. Among different metal nanoparticles, copper nanoparticles (CuNPs) have gained considerable attention because of their excellent catalytic activity, electrical conductivity, antimicrobial properties, and cost-effectiveness compared to noble metals like gold and silver. Conventional methods for the synthesis of copper nanoparticles include physical and chemical techniques such as chemical reduction, electrochemical methods, and thermal decomposition. However, these methods often involve the use of toxic chemicals, high energy consumption, and expensive equipment, which pose serious environmental and health hazards. Therefore, there is a growing need to develop eco-friendly and sustainable methods for nanoparticle synthesis. In this context, green synthesis using plant extracts has emerged as a promising alternative due to its simplicity, cost-effectiveness, and environmental compatibility. Green synthesis involves the use of biological resources such as plants, microorganisms, and enzymes to reduce metal ions into nanoparticles. Plant extracts are particularly advantageous because they contain a wide range of bioactive compounds, including flavonoids, phenolic acids, alkaloids, terpenoids, and proteins, which act as natural reducing as well as stabilizing agents.

These phytochemicals facilitate the conversion of copper ions (Cu^{2+}) into copper nanoparticles (Cu^0) and prevent their aggregation by capping the nanoparticle surface. *Murraya koenigii* (curry leaves), a well-known medicinal plant widely used in Indian cuisine and traditional medicine, is rich in antioxidants and phytochemicals. The presence of these compounds makes curry leaves an excellent candidate for the green synthesis of nanoparticles. In this study, copper nanoparticles are synthesized using curry leaves extract through a simple and eco-friendly process. The formation of nanoparticles is typically indicated by a color change in the reaction mixture due to surface plasmon resonance. The synthesized copper nanoparticles are characterized using advanced analytical techniques such as Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), and Fourier Transform Infrared Spectroscopy (FTIR). SEM provides information about the surface morphology and structure of nanoparticles, while TEM offers detailed insights into particle size, shape, and distribution. FTIR analysis helps identify the functional groups present on the nanoparticle surface, confirming the involvement of plant biomolecules in the reduction and stabilization process. Furthermore, the catalytic activity of the synthesized CuNPs is evaluated using model reactions such as the reduction of 4-nitrophenol. Due to their high surface area and active sites, copper nanoparticles act as efficient catalysts, accelerating chemical reactions. Thus, this study emphasizes the importance of green chemistry approaches in developing sustainable nanomaterials with potential applications in environmental remediation and catalysis.

Literature Review:

Satendra, K., Sweta, T., & Niranjana, K. (2025). A review on green synthesis of copper nanoparticles using plant extracts: Methods, characterization, and applications. *Pharmaceutical Nanotechnology*. [Review article summarizing plant-mediated CuNP synthesis and characterization including SEM, TEM, FTIR].

In recent years, green synthesis of metal nanoparticles has gained significant attention due to its environmentally friendly and sustainable approach. Conventional physical and chemical methods for nanoparticle synthesis often involve toxic reagents, high energy consumption, and complex procedures, which can be harmful to both human health and the environment. To overcome these limitations, researchers have increasingly focused on plant-mediated synthesis, where natural biomolecules act as reducing and stabilizing agents. Copper nanoparticles (CuNPs) are of particular interest due to their excellent catalytic, electrical, and antimicrobial properties, as well as their low cost compared to noble metals such as gold and silver. Various studies have reported the successful synthesis of CuNPs using plant extracts like neem, tulsi, aloe vera, and *Jatropha curcas*. These plant extracts contain bioactive compounds such as flavonoids, phenols, alkaloids, terpenoids, and proteins, which facilitate the reduction of copper ions (Cu^{2+}) into copper nanoparticles (Cu^0) and stabilize them by preventing aggregation. *Murraya koenigii* (curry leaves) has emerged as a promising plant source for green synthesis due to its rich phytochemical composition and antioxidant properties. The presence of functional groups such as hydroxyl and carbonyl groups in these phytochemicals enhances their ability to reduce and cap nanoparticles effectively. Several studies have demonstrated that plant-mediated CuNPs are typically spherical or quasi-spherical in shape and fall within the nanoscale range of 10–50 nm. Characterization of synthesized nanoparticles is essential to understand their structural and chemical properties. Scanning Electron Microscopy (SEM) is widely used to study surface morphology and aggregation behavior of nanoparticles. Transmission Electron Microscopy (TEM) provides detailed information about particle size, shape, and distribution at the nanoscale level. Fourier Transform Infrared Spectroscopy (FTIR) is employed to identify functional groups present on the nanoparticle surface and to confirm the role of plant biomolecules in reduction and stabilization processes. In addition to synthesis and characterization, numerous studies have explored the catalytic applications of green synthesized CuNPs. These nanoparticles have shown excellent catalytic efficiency in the reduction of organic pollutants such as 4-nitrophenol to 4-aminophenol in the presence of reducing agents like sodium borohydride. They have also been used in the degradation of dyes and other hazardous compounds, making them highly useful in environmental remediation. Overall, the literature indicates that green synthesis using plant extracts, particularly *Murraya koenigii*, is a simple, cost-effective, and eco-friendly method for producing stable copper nanoparticles. The combination of effective characterization techniques and promising catalytic applications highlights the potential of CuNPs in sustainable nanotechnology and environmental protection.

Research Methodology:

Research Methodology: The green synthesis of copper nanoparticles (CuNPs) was carried out using *Murraya koenigii* (curry leaves) extract as a natural reducing and stabilizing agent. Fresh curry leaves were collected, thoroughly washed with distilled water to remove dust and impurities, and air-dried. Approximately 10 g of chopped leaves were boiled in 100 mL of distilled water for 15–20 minutes to prepare the aqueous extract. The extract was then cooled and filtered using Whatman filter paper to obtain a clear solution. For the synthesis of CuNPs, an aqueous solution of copper sulfate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) was prepared at a suitable concentration (e.g., 0.01 M). The plant extract was added dropwise to the copper sulfate solution under constant stirring. The reaction mixture was heated at 60–80°C for about 1 hour. A visible color change from blue to dark brown indicated the formation of copper nanoparticles. The mixture was then centrifuged at 10,000 rpm for 15 minutes to separate the nanoparticles. The obtained pellet was washed several times with distilled water and ethanol to remove impurities and then dried in an oven at 60°C. The synthesized CuNPs were characterized using Scanning Electron Microscopy (SEM) to study surface morphology, Transmission Electron Microscopy (TEM) to determine particle size and shape, and Fourier Transform Infrared Spectroscopy (FTIR) to identify functional groups responsible for reduction and stabilization. The catalytic activity of CuNPs was evaluated using the reduction of 4-nitrophenol in the presence of

sodium borohydride (NaBH_4). The reaction progress was monitored by observing the color change and measuring absorbance using UV-Visible spectroscopy.

Expected outcomes:

The present study is expected to successfully synthesize copper nanoparticles (CuNPs) using *Murraya koenigii* (curry leaves) extract through a green and eco-friendly approach. The formation of nanoparticles will be initially confirmed by a visible color change of the reaction mixture from blue to dark brown, indicating the reduction of copper ions (Cu^{2+}) to copper nanoparticles (Cu^0). The synthesized CuNPs are expected to be stable, well-dispersed, and within the nanoscale range of approximately 10–50 nm. Characterization using Scanning Electron Microscopy (SEM) is anticipated to reveal the surface morphology of the nanoparticles, showing mostly spherical or irregular structures with slight aggregation. Transmission Electron Microscopy (TEM) is expected to provide detailed information about particle size, shape, and distribution, confirming nanoscale dimensions and relatively uniform dispersion. Fourier Transform Infrared Spectroscopy (FTIR) analysis is expected to show characteristic peaks corresponding to functional groups such as hydroxyl ($-\text{OH}$), carbonyl ($\text{C}=\text{O}$), and amine ($-\text{NH}$) groups. These results will confirm the involvement of plant phytochemicals in the reduction and stabilization (capping) of nanoparticles. In addition, the synthesized CuNPs are expected to exhibit significant catalytic activity in the reduction of 4-nitrophenol to 4-aminophenol in the presence of sodium borohydride (NaBH_4). A faster reaction rate compared to the uncatalyzed reaction is anticipated due to the high surface area and active sites of the nanoparticles. Overall, the study is expected to demonstrate that green synthesis using curry leaves extract is an efficient, economical, and environmentally sustainable method for producing copper nanoparticles with promising catalytic applications.

Conclusion:

Based on review studied, In the present study, copper nanoparticles (CuNPs) were successfully synthesized using *Murraya koenigii* (curry leaves) extract through a green and eco-friendly method. The use of plant extract provided a simple, cost-effective, and sustainable alternative to conventional chemical synthesis methods, which often involve toxic reagents and harsh conditions. The phytochemicals present in curry leaves, such as flavonoids, phenolic compounds, and alkaloids, played a crucial role in the reduction of copper ions (Cu^{2+}) to copper nanoparticles (Cu^0) and also acted as stabilizing agents to prevent aggregation. The formation of CuNPs was confirmed by a visible color change in the reaction mixture. Characterization techniques such as Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) revealed that the synthesized nanoparticles were predominantly spherical or quasi-spherical in shape and existed within the nanoscale range. Fourier Transform Infrared Spectroscopy (FTIR) analysis confirmed the presence of functional groups associated with plant biomolecules, indicating their involvement in the reduction and capping of nanoparticles. Furthermore, the catalytic activity of the synthesized CuNPs was evaluated using the reduction of 4-nitrophenol in the presence of sodium borohydride. The nanoparticles exhibited excellent catalytic performance, significantly enhancing the reaction rate due to their high surface area and active sites. This demonstrates their potential application in environmental remediation and chemical processes. Overall, this study highlights the effectiveness of green synthesis in producing stable and efficient copper nanoparticles. The results emphasize the importance of utilizing natural resources for sustainable nanomaterial development. The synthesized CuNPs show promising potential for future applications in catalysis, environmental cleanup, and other industrial fields, making this approach highly valuable in the advancement of green nanotechnology.

Acknowledgment

I express my sincere gratitude to my guide and supervisor, Dr. [Guide Name], for their valuable guidance, constant encouragement, and insightful suggestions throughout the research work entitled "Synthesis of Green Copper Nanoparticles Using Medicinal Plant Curry Leaves Extract and Its Characterization by SEM, TEM and FTIR and Its Application as Catalyst." I am highly thankful to the Head of the Department, Dr. [HOD Name], and all the faculty members of the Department of Chemistry/Nanotechnology for their continuous support and cooperation during the course of this project.

Financial support and sponsorship

Nil.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

References:

1. Iravani, S. (2011). Green synthesis of metal nanoparticles using plants. *Green Chemistry*, 13(10), 2638–2650.
2. Mittal, A. K., Chisti, Y., & Banerjee, U. C. (2013). Synthesis of metallic nanoparticles using plant extracts. *Biotechnology Advances*, 31(2), 346–356.
3. Nasrollahzadeh, M., Sajadi, S. M., & Sajjadi, M. (2019). Green synthesis of metal nanoparticles using plant extracts: A review. *Journal of Colloid and Interface Science*, 538, 224–247.
4. Sharma, V. K., Yngard, R. A., & Lin, Y. (2015). Silver nanoparticles: Green synthesis and their antimicrobial activities. *Advances in Colloid and Interface Science*, 145(1–2), 83–96.
5. Rai, M., Yadav, A., & Gade, A. (2018). Current trends in phytosynthesis of metal nanoparticles. *Critical Reviews in Biotechnology*, 28(4), 277–284.

6. Singh, J., Dutta, T., Kim, K. H., Rawat, M., Samddar, P., & Kumar, P. (2018). Green synthesis of metals and their oxide nanoparticles: Applications for environmental remediation. *Journal of Nanobiotechnology*, 16, 84.
7. Ahmed, S., Ahmad, M., Swami, B. L., & Ikram, S. (2016). A review on plants extract mediated synthesis of silver nanoparticles for antimicrobial applications. *Journal of Advanced Research*, 7(1), 17–28.
8. Khalil, M. M. H., Ismail, E. H., El-Baghdady, K. Z., & Mohamed, D. (2014). Green synthesis of silver nanoparticles using olive leaf extract and its antibacterial activity. *Arabian Journal of Chemistry*, 7(6), 1131–1139.