IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 5, September 2026
Impact Factor: 8.2

# Flower-Mediated Green Synthesis of Functional Nanomaterials: Recent Advances and Emerging Applications-A Brief Review

**Dr. P.B. Nagore[1] and Dr. K.G. Mane[2]**
M.T.E.S.'s Doshi Vakil Arts College and G.C.U.B. Science and Commerce College, Goregaon-Raigad, Maharashtra
kanchanmane13@gmail.com[1]

**Abstract :** *The increasing demand for sustainable nanotechnology has stimulated the development of environmentally benign approaches for nanomaterial synthesis. Flowers represent an attractive biological resource because their tissues contain diverse phytochemicals capable of participating in precursor reduction, nucleation, growth, and surface stabilization. This mini-review summarizes recent advances in flower-mediated green synthesis of functional nanomaterials, with emphasis on metallic, metal oxide, doped, hybrid, and composite systems. The influence of synthesis parameters and mechanisms with the flower as a green nanofactory is discussed. The contribution of phenolics, flavonoids, terpenoids, proteins, carbohydrates, pigments. Recent applications in photocatalysis, environmental remediation, antimicrobial activity, sensing, agriculture, and biomedical fields are reviewed. Particular attention is given to emerging systems such as flower-derived CuO, ZnO, Fe2O3, Ag-doped ZnO, and multifunctional Ag/Au nanoparticles. Overall, flower-mediated synthesis provides a promising route for producing functional nanomaterials while integrating green chemistry, phytochemistry, and sustainable materials development.*

.

**Key Words:** Flower-mediated synthesis; Green nanotechnology; Functional nanomaterials; Phytochemicals; Metal oxide nanoparticles; Nanocomposites; Photocatalysis; Sustainable synthesis

## I. INTRODUCTION

Nanotechnology has become an important multidisciplinary field because materials at the nanoscale exhibit physicochemical properties that can differ substantially from their bulk counterparts. High surface-to-volume ratio, tunable optical properties, enhanced catalytic activity, distinctive electronic behaviour, and size-dependent biological interactions have made nanomaterials valuable in catalysis, environmental remediation, antimicrobial systems, sensing, energy, agriculture, food technology, and biomedical research. Metallic nanoparticles, metal oxides, carbon-based nanostructures, and nanocomposites are therefore being extensively investigated to develop advanced functional materials [1].

The properties of nanomaterials depend strongly on particle size, morphology, composition, crystallinity, and surface chemistry, which are influenced by the synthesis route. Conventional physical and chemical methods such as chemical reduction, sol–gel processing, precipitation, hydrothermal synthesis, and thermal decomposition can provide effective control over material formation, but may require high energy input, elevated temperatures, organic solvents, or hazardous reducing and stabilizing agents [2]. These limitations have encouraged the development of greener synthesis strategies based on renewable biological resources.

Plant-mediated synthesis has received considerable attention because plants contain diverse phytochemicals capable of participating in nanoparticle formation. Phenolics, flavonoids, terpenoids, alkaloids, proteins, carbohydrates, pigments, and organic acids may function as reducing, complexing, capping, and stabilizing agents [3]. Consequently, plant extracts can provide several functions simultaneously, reducing the need for additional synthetic reagents.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 5, September 2026 Impact Factor: 8.2

Among different plant resources, flowers represent an attractive and comparatively specialized feedstock. Floral tissues contain a complex mixture of secondary metabolites and pigments that can interact with metal precursors and developing nanoparticle surfaces. Earlier reviews established the potential of flowers for the synthesis of metallic and metal oxide nanoparticles and identified their antimicrobial, catalytic, antioxidant, and biomedical applications. More recent work has extended this field toward photocatalytic, sensing, agricultural, and multifunctional nanomaterials [4,5].

Flowers also have an important sustainability dimension. Large quantities of flowers are discarded after ornamental, horticultural, religious, and ceremonial use, creating an underutilized source of renewable biomass. Their utilization for nanomaterial synthesis provides an opportunity to convert floral waste into value-added functional materials within a waste-to-wealth framework. Recent research on floral waste-derived ZnO nanoparticles has highlighted their potential for water treatment, agriculture, and biomedical applications, demonstrating the broader role of floral residues in sustainable nanomaterial development [6].

Despite its advantages, flower-mediated synthesis faces challenges arising from variations in plant source, phytochemical composition, extraction conditions, and reaction parameters, which can affect nanoparticle properties and reproducibility. Standardization, mechanistic understanding, scale-up, safety assessment, and lifecycle evaluation are therefore essential [7]. This mini-review highlights recent advances in flower-mediated green synthesis of functional nanomaterials, synthesis mechanisms, key parameters, characterisation, and emerging applications in photocatalysis, environmental remediation, sensing, agriculture, and biomedicine, etc.

## II. FLOWERS AS GREEN NANOFACTORIES: PHYTOCHEMICAL BASIS

The ability of flowers to support nanomaterial synthesis is closely associated with their rich phytochemical composition. Floral tissues contain primary metabolites such as carbohydrates and proteins as well as secondary metabolites including phenolic acids, flavonoids, tannins, terpenoids, alkaloids, pigments, sterols, and other bioactive molecules. The relative abundance of these compounds differs considerably between plant species and can change with environmental and physiological conditions. The term “green nanofactory” is useful because a flower extract may provide several chemical functions during synthesis. Electron-donating groups present in phenolic and flavonoid molecules can participate in reduction processes, while hydroxyl, carbonyl, carboxyl, amino, and other functional groups may coordinate metal ions or adsorb onto nanoparticle surfaces. Such interactions can influence nucleation and subsequent particle growth. Once nanoparticles form, organic molecules adsorbed on their surfaces may act as capping or stabilizing species, limiting uncontrolled aggregation [4,5,8].

## III. MECHANISM AND FACTORS AFFECTING FLOWER-MEDIATED SYNTHESIS

Flower-mediated synthesis generally follows a bottom-up process in which phytochemicals interact with metal precursors, promoting reduction or complexation, nucleation, particle growth, and surface capping/stabilization:

Flower → extraction → phytochemical release → precursor interaction → nucleation → growth → stabilization → nanomaterial

For metallic nanoparticles, phytochemicals can reduce metal ions to zerovalent atoms, followed by nucleation and growth, while adsorbed biomolecules help prevent aggregation. In metal oxide synthesis, phytochemical–metal complexes may undergo hydrolysis, precipitation, drying, and, when required, calcination. Thus, both synthesis and post-treatment influence the final nanoparticle properties [4,9].

### 3.1 Influence of Synthesis Parameters

Nanoparticle size, morphology, crystallinity, and stability are strongly affected by flower species, extract concentration, precursor concentration, pH, temperature, reaction time, and post-treatment. The phytochemical composition varies among flower species, while extract and precursor concentrations influence nucleation and growth. pH affects phytochemical ionization and metal-ion interactions, whereas temperature and reaction time control reaction kinetics. For metal oxides, calcination can improve crystallinity and remove organic residues but excessive heating may increase

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 5, September 2026 Impact Factor: 8.2

particle size and reduce surface area. Recent studies confirm that optimization of these parameters is essential for obtaining reproducible nanomaterials with desired properties. Flower-derived AgNPs from Xanthoceras sorbifolia and floral-waste-mediated ZnO nanoparticles demonstrate the importance of controlling extract composition and reaction conditions [6,10]

## VI. FLOWER-MEDIATED SYNTHESIS OF FUNCTIONAL NANOMATERIALS

### 4.1 Metal Nanoparticles

#### 4.1.1 Silver nanoparticles

Silver nanoparticles (AgNPs) remain the most extensively investigated flower-mediated nanomaterials because of their strong optical properties, antimicrobial activity, and catalytic performance. Recent studies demonstrate increasing diversification of flower sources and applications.

Erythrina indica flower extract has been used for the synthesis of spherically shaped AgNPs, with polyphenols proposed to contribute to both reduction and capping. The resulting particles showed antibacterial activity and photocatalytic degradation of Reactive Orange 16, achieving approximately 90% degradation under sunlight irradiation [11].

More recently, Murraya paniculata flower-mediated AgNPs were characterized using UV–Visible spectroscopy, FTIR, XRD, FESEM, TEM, and XPS; the particles were predominantly spherical with an average size of 27.8 nm and exhibited catalytic activity towards 4-nitrophenol reduction [12].

Recent work has also demonstrated applications beyond conventional antimicrobial testing. AgNPs prepared using Plumeria obtusa flower extract were reported as highly sensitive materials for Cr (VI) detection, with a reported detection limit in the picomolar range [13]. This illustrates the potential of flower-mediated nanoparticles for analytical sensing.

The recent literature also includes Senna auriculata, Bougainvillea glabra, Punica granatum, and Peltophorum pterocarpum flower-mediated AgNPs [14,15,16]. The 2025 Peltophorum pterocarpum study, investigated AgNPs for catalytic degradation of Acid Blue 113, demonstrating the continued expansion of flower-mediated AgNPs into environmental catalysis [17].

#### 4.1.2 Gold nanoparticles

Gold nanoparticles (AuNPs) are attractive because of their optical, catalytic, and biomedical properties. Floral extracts containing phenolic compounds and pigments can participate in Au (III) reduction and stabilize the resulting nanoparticles. Recent comparative research using Hibiscus sabdariffa and Pelargonium domesticum floral extracts reported AuNPs and AgNPs with antioxidant properties and comparatively low cytotoxic and ecotoxic effects compared with chemically synthesized controls [18]. Such comparative studies are important because they move beyond the assumption that green synthesis is automatically safer and instead provide experimental toxicity comparisons. Alghuthyami et al. (2021) synthesized gold nanoparticles from floral extract of Polianthes tuberosa L for antibacterial and cytotoxicity studies [19]. Rey-Mendez et al. (2022) synthesized AuNPs by Hypericum perforatum L. flower extract for antioxidant activities, along with stem and leaf extracts employed for the same purpose [20].

#### 4.1.3 Selenium nanoparticles

Selenium nanoparticles provide another important class of flower-mediated materials because selenium has potential applications in agriculture, antioxidant systems, and biomedicine. Allamanda cathartica flower extract has been used as both reducing and capping medium for SeNP synthesis. The resulting particles demonstrated antimicrobial activity and promoted seed germination and growth of Brassica campestris under salt stress [21]. This study illustrates the potential of flower-mediated nanomaterials in nanofertilizer and agricultural stress-management applications.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 5, September 2026
Impact Factor: 8.2

### 4.2 Metal Oxide Nanomaterials

#### 4.2.1 Zinc oxide

ZnO nanoparticles possess optical, antimicrobial, photocatalytic, and semiconductor properties. Flower extracts have been investigated for their preparation because floral phytochemicals can participate in precursor complexation and stabilization.

A comprehensive 2024 review specifically examined floral-waste-mediated ZnO nanoparticles and their applications in water treatment, agriculture, and biomedical engineering [6]. The review emphasized that floral extracts containing polyphenols, flavonoids, reducing sugars, tannins, and related compounds can influence ZnO formation and surface properties.

Experimental studies have also reported ZnO nanoparticles synthesized using Althea officinalis flower extract, with wound-healing properties [22]. These results demonstrate how flower-derived ZnO can combine material functionality with biologically active surface chemistry.

#### 4.2.2 Copper oxide

CuO is particularly attractive for environmental applications because of its semiconductor properties and photocatalytic potential. In 2024, Tecoma stans flower extract was used for biosynthesis of CuO nanoparticles, followed by investigation of antibacterial, anticancer, and photocatalytic activities [23]. Another recent study employed Jasminum sambac flower extract for CuO synthesis and investigated its ability to degrade methylene blue in water under UV and solar irradiation [24]. Such studies are particularly relevant to sustainable wastewater treatment. Calotropis gigantea flower-mediated CuONPs were synthesized in most recent studies for antioxidant and antibacterial applications [25].

#### 4.2.3 Iron oxide nanoparticles

Iron oxide nanomaterials, particularly $Fe_2O_3$ and $Fe_3O_4$, offer magnetic, catalytic, adsorption, and environmental applications. Melia azedarach flower extract has been used to synthesize iron oxide nanoparticles, with phenolic compounds proposed as reducing and capping constituents towards biological applications [26].

A particularly significant recent development is the green synthesis of Fe2O3 nanoparticles using Rhododendron arboreum flower extract. The resulting material demonstrated anti-inflammatory and other bioactivities [27]. This represents a significant shift from simple nanoparticle synthesis toward application-oriented functional magnetic nanomaterials.

#### 4.2.4 Doped, Hybrid and Composite Nanomaterials

The field is gradually moving beyond single-component nanoparticles toward multifunctional systems. Doping and composite formation can modify optical, electronic, magnetic, catalytic, and biological properties.

An important example is the green synthesis of Ag-doped ZnO using Nelumbo nucifera flower extract. The resulting material was evaluated for antibacterial activity and structural, morphological, and optical characteristics [28]. Incorporating Ag into ZnO can improve charge separation and antimicrobial properties compared with the individual components.

Flower extracts have also been used in the preparation of nanocomposite systems. Recent work using Andrographis paniculata flower extract and gum ghatti produced a silver nanocomposite and investigated its anticancer potential [29]. Such systems demonstrate that plant extracts can participate not only in nanoparticle formation but also in the development of more complex functional materials. Singh et al. synthesized Cu-ZnO NPs using flower extract of Rosa sinesis towards antibacterial studies [30]. The ZnO-Ag nanocomposites were prepared using Tagetes erecta flower extract for photocatalytic and antibacterial studies [31]. The ZnO-CuO nanocomposites were recently reported from hibiscus extract and optical, morphological and antioxidant properties were highlighted in this study [32].

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 5, September 2026
Impact Factor: 8.2

Table 1. Representative recent flower-mediated functional nanomaterials

| Flower Source | Synthesized Nanomaterial | Applications | Reference |
|---|---|---|---|
| Erythrina indica | AgNPs | Antibacterial activity and photocatalytic degradation | [11] |
| Murraya paniculata | AgNPs | Reduction of 4-nitrophenol | [12] |
| Plumeria obtusa | AgNPs | Sensing of Cr (VI) | [13] |
| Hibiscus sabdariffa and Pelargonium domesticum | AuNPs and AgNPs | Antioxidant and anticancer activities | [18] |
| Polianthes tuberosa L | AuNPs | Antibacterial and cytotoxicity studies | [19] |
| Allamanda cathartica | SeNPs | Seed germination | [21] |
| Althea officinalis | ZnONP | Wound healing | [22] |
| Tecoma stans | CuONPs | Antibacterial, antioxidant and photocatalytic | [23] |
| Rhododendron arboreum | Fe2O3NPs | Anti-inflammatory and other biological applications | [27] |
| Nelumbo nucifera | Ag-doped ZnO NPs | Antibacterial | [28] |
| Tagetes erecta | ZnO-Ag NCs | Antibacterial and Photocatalytic | [31] |
| Hibiscus rosa sinsis | ZnO-CuO NCs | Antioxidant | [32] |

## V. CHARACTERIZATION OF FLOWER-MEDIATED NANOMATERIALS

Comprehensive characterization is essential to confirm nanoparticle formation and establish their structural, morphological, optical, and surface properties. UV–Vis spectroscopy monitors nanoparticle formation through characteristic absorption/SPR bands, while FTIR identifies phytochemical functional groups involved in reduction and capping. XRD determines crystalline phase, crystallinity, and crystallite size, whereas SEM/TEM provide information on morphology, particle size, and aggregation. EDX/XPS establish elemental composition and surface chemical states, while DLS, zeta potential, TGA, and BET provide information on colloidal stability, organic content, thermal behaviour, and surface area. Thus, combining complementary techniques provides more reliable characterization than relying on a single analytical method [33,34].

## VI. SOME SELECTED APPLICATIONS OF FLOWER-MEDIATED NANOPARTICLES

### 6.1 Photocatalysis and Environmental Remediation

Flower-mediated nanomaterials have gained significant interest in photocatalysis and environmental remediation. Semiconductor nanoparticles such as ZnO, CuO, $Fe_3O_4$, and their composites can generate reactive oxygen species under suitable irradiation, enabling the degradation of organic pollutants in water and wastewater [6,24,35].

Flower-derived AgNPs have been reported to catalyse the reduction of 4-nitrophenol and the degradation of synthetic dyes [4,12,17]. Similarly, flower-mediated CuO nanoparticles have shown photocatalytic activity toward methylene blue degradation [36].

### 6.2 Antimicrobial Applications

Silver, ZnO, CuO, and other flower-mediated nanomaterials have demonstrated activity against Gram-positive and Gram-negative bacteria and, in some cases, fungi. Potential mechanisms include membrane disruption, oxidative stress, interaction with proteins and nucleic acids, and release of metal ions[4,5,18,34].

Recent AgNP studies involving Senna auriculata, Bougainvillea glabra, and other flowers have reported antibacterial activity [14,15]. However, antimicrobial performance should be interpreted together with concentration, exposure time, particle size, surface chemistry, and toxicity toward non-target cells.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 5, September 2026
Impact Factor: 8.2

### 6.3 Biomedical Applications

Flower-mediated nanoparticles are being investigated for antioxidant, anticancer, wound-healing, and drug-related applications. ZnO nanoparticles prepared using Calendula officinalis flower extract demonstrated antioxidant and wound-healing potential [37]. Senna auriculata-mediated AgNPs exhibited activity against MCF-7 breast cancer cells [14].

Nevertheless, in vitro biological activity should not automatically be interpreted as therapeutic efficacy. Future biomedical studies require detailed pharmacokinetic, toxicity, cellular-mechanism, and in vivo investigations.

### 6.4 Sensing Applications

The optical and surface properties of metallic nanoparticles make them useful for chemical and biological sensing. A notable example is Plumeria obtusa flower-mediated AgNPs used for selective Cr(VI) detection [13]. Carica papaya male-flower-mediated AgNPs have also been investigated for tryptophan sensing [38].

Flower-derived nanoparticles could therefore provide low-cost sensing platforms for environmental contaminants, biomolecules, and food-related analytes.

### 6.5 Agricultural Applications

Nanomaterials prepared using flowers may also have agricultural applications. The Allamanda cathartica-mediated SeNP study demonstrated antimicrobial effects against phytopathogens and improved mustard seed germination and growth under salt stress [21]. This suggests potential applications in nanofertilizers, plant protection, and stress management.

However, agricultural applications require careful assessment of nanoparticle dose, soil persistence, plant uptake, microbial interactions, and long-term ecological effects.

## VII. CONCLUSION

Flower-mediated green synthesis provides a promising route for producing a diverse range of functional nanomaterials using renewable biological resources. Floral phytochemicals can participate in precursor reduction, nucleation, growth, capping, and stabilization, thereby reducing the dependence on conventional chemical reagents. Recent research demonstrates the preparation of Ag, Au, Se, ZnO, CuO, $Fe_2O_3$, $Fe_3O_4$, doped materials, and composites using different flower extracts. Their applications have expanded from conventional antimicrobial studies toward photocatalysis, pollutant degradation, sensing, agriculture, wound healing, and other biomedical areas.

## REFERENCES

1. Boles, M. A.; Ling, D.; Hyeon, T.; Talapin, D. V. (2016). The surface science of nanocrystals. Nature Materials, 15, 141–153. https://doi.org/10.1038/nmat4526
2. Yadav, S., Singh, G., Mishra, S., Prajapati, H. C., Chauhan, D. S., & Quraishi, M. A. (2026). Green Synthesis Methods: Advances, Challenges, and Future Perspectives. Sustainable Chemistry One World, 100228.
3. Baba, I. A., Awe, O. B., Mustapha, S., Abubakar, M. A., Abdulkareem, A. S., Tijani, J. O., & Obayomi, K. S. (2026). Influence of plant-derived extracts on the synthesis, physicochemical properties, and applications of metal and metal oxide nanoparticles. Hybrid Advances, 100666. https://doi.org/10.1016/j.hybadv.2026.100666.
4. Kumar, H.; Bhardwaj, K.; Kuča, K.; Kalia, A.; Nepovimova, E.; Verma, R.; Kumar, D. (2020). Flower-Based Green Synthesis of Metallic Nanoparticles: Applications beyond Fragrance. Nanomaterials, 10, 766. https://doi.org/10.3390/nano10040766
5. Abdel-Halim, K. Y.; et al. (2020). Biogenic fabrication of nanomaterials from flower-based chemical compounds, characterization and their various applications: A review. Saudi Journal of Biological Sciences, 27, 3021–3030. https://doi.org/10.1016/j.sjbs.2020.05.012
6. Nguyen, D. T. C.; Nguyen, N. T. T.; Nguyen, T. T. T.; Tran, T. V. (2024). Recent advances in the biosynthesis of ZnO nanoparticles using floral waste extract for water treatment, agriculture and biomedical engineering.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 5, September 2026
Impact Factor: 8.2

Nanoscale Advances, 6, 4047–4061. DOI: 10.1039/D4NA00133H.

7. Abegunde, S. M.; Afolayan, B. O.; Ilesanmi, T. M. Ensuring sustainable plant-assisted nanoparticles synthesis through process standardization and reproducibility: Challenges and future directions. Sustainable Chemistry One World 2024, 3, 100014.
8. Nguyen, N. T. T.; Nguyen, D. T. C.; Nguyen, T. T. T.; Tran, T. V. (2022). Recent advances on botanical biosynthesis of nanoparticles for catalytic, water treatment and agricultural applications: A review. Science of the Total Environment, 827, 154160. https://doi.org/10.1016/j.scitotenv.2022.154160.
9. Berta, L., Coman, N. A., Rusu, A., & Tanase, C. (2021). A review on plant-mediated synthesis of bimetallic nanoparticles, characterisation and their biological applications. Materials, 14(24), 7677. https://doi.org/10.3390/ma14247677.
10. Han, Y., Fu, R., Dai, Y., Tan, C., Wang, W., Guo, D., & Zhang, X. (2025). Leaf versus flower: green-synthesized silver nanoparticles from Xanthoceras sorbifolia leaf extract reveal superior antimicrobial and cytotoxic efficacy. RSC advances, 15(29), 23654-23669. https://doi.org/10.1039/d5ra02434j.
11. Selvam, K., & Saranya, K. (2023). Phyto-mediated synthesis of silver nanoparticles using flower extract of Erythrina indica and evaluation of their biological activities. Inorganic Chemistry Communications, 158, 111610. https://doi.org/10.1016/j.inoche.2023.111610
12. Mangamma, J. L., Sagar, P. V., Kumar, P. K., Prameeladevi, S., & Basavaiah, K. (2024). Eco-conscious Silver nanoparticles through "flower extract" of Murraya paniculata (L) Jack for reduction of 4-nitro phenol. Materials Letters, 377, 137438. https://doi.org/10.1016/j.matlet.2024.137438.
13. Shukla, S., & Mehata, M. S. (2023). Selective picomolar detection of carcinogenic chromium ions using silver nanoparticles capped via biomolecules from flowers of Plumeria obtusa. Journal of Molecular Liquids, 380, 121705. https://doi.org/10.1016/j.molliq.2023.121705.
14. Palanivel, R.; Muthumanickam, M.; Chinnathambi, A.; Subbiah, S. (2025). GC/MS analysis and green-synthesis of silver nanoparticles using Senna auriculata flower extract: Antibacterial, antioxidant effects and anticancer effects. Microbial Pathogenesis, 199, 107274. DOI: 10.1016/j.micpath.2024.107274.
15. Ansari, M. A.; Alomary, M. N. (2025). Biosynthesis of silver nanoparticles using Bougainvillea glabra flower extract: Antibacterial, antibiofilm and cytotoxicity studies. Biocatalysis and Agricultural Biotechnology, 67, 103663. DOI: 10.1016/j.bcab.2025.103663.
16. Shrivastava, S. K.; Kulshreshtha, A.; Gangwar, R. K.; et al. (2025). A novel approach for phyto-synthesis of silver nanoparticles using floral extract of Punica granatum for potent anti-cancerous and antibacterial capabilities. Discover Nano , 20, 184. DOI: 10.1186/s11671-025-04262-2.
17. Vinayagam, R.; Shetty, S. A.; Murugesan, G.; et al. (2025). Peltophorum pterocarpum flower mediated synthesis of silver nanoparticles and its catalytic degradation of Acid Blue 113 dye. Scientific Reports, 15, 26452.
18. Jamatia, T., Das, M. K., Mazumder, R., & Ichudaule. (2025). Floral extracts promising avenue for sustainable approach for nanoparticles: an updated review. Nanotechnology for Environmental Engineering, 10(2), 26. https://doi.org/10.1007/s41204-025-00423-x.
19. Alghuthaymi, M. A., Rajkuberan, C., Santhiya, T., Krejcar, O., Kuča, K., Periakaruppan, R., & Prabukumar, S. (2021). Green Synthesis of Gold Nanoparticles Using Polianthes tuberosa L. Floral Extract. Plants, 10(11), 2370. https://doi.org/10.3390/plants10112370.
20. Rey-Méndez, R., Rodríguez-Argüelles, M. C., & González-Ballesteros, N. (2022). Flower, stem, and leaf extracts from Hypericum perforatum L. to synthesize gold nanoparticles: Effectiveness and antioxidant activity. Surfaces and Interfaces, 32, 102181.https://doi.org/10.1016/j.surfin.2022.102181.
21. Sarkar, R. D., & Kalita, M. C. (2022). Se nanoparticles stabilized with Allamanda cathartica L. flower extract inhibited phytopathogens and promoted mustard growth under salt stress. Heliyon, 8(3). DOI: 10.1016/j.heliyon. 2022.e09076.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 5, September 2026
Impact Factor: 8.2

22. Elhabal, S. F., Abdelaal, N., Saeed Al-Zuhairy, S. A. K., Elrefai, M. F. M., Elsaid Hamdan, A. M., Khalifa, M. M., & El-Nabarawi, M. A. (2024). Green synthesis of zinc oxide nanoparticles from althaea officinalis flower extract coated with chitosan for potential healing effects on diabetic wounds by inhibiting TNF-α and IL-6/IL-1β signaling pathways. International journal of nanomedicine, 3045-3070.https://doi.org/10.2147/IJN.S455270.
23. Nagaveni, A., Anusuya, M., Santhanaraj, D., Gunasekaran, S. G., Gitanjali, J., Thangabalu, S., & Rajakumar, K. (2024). Tecoma stans intermediated green synthesis of copper oxide nanoparticles, their characterization, paracetamol degradation and biological activities. Inorganic Chemistry Communications, 170, 113503. https://doi.org/10.1016/j.inoche.2024.113503.
24. Velmurugan, G., Chohan, J. S., Babu, K., Nagaraj, M., & Velumani, A. (2024). Exploring the efficacy of biosynthesized cupric oxide nanoparticles from Jasminum sambac flower extract in wastewater treatment: Experimental investigations and potential applications. Desalination and Water Treatment, 319, 100570. https://doi.org/10.1016/j.dwt.2024.100570.
25. Sonkusare, M., Meshram, S., & Verma, S. (2026). Floral-Mediated Synthesis of Copper Oxide Nanoparticles via Calotropis gigantea: Structural Insights, Antimicrobial and Antioxidant Activity. Chemistry Africa, 9(5), 234. https://doi.org/10.1007/s42250-026-01747-0.
26. Muzafar, W., Kanwal, T., Rehman, K., Perveen, S., Jabri, T., Qamar, F., & Shah, M. R. (2022). Green synthesis of iron oxide nanoparticles using Melia azedarach flowers extract and evaluation of their antimicrobial and antioxidant activities. Journal of Molecular Structure, 1269, 133824.https://doi.org/10.1016/j.molstruc.2022.133824.
27. Saba, I., Dhiman, V. K., Kalaichelvan, S., Subbarayan, R., Chauhan, A., Verma, R., & Ibrahim, A. A. (2025). From flowers to function: Structural and biomedical exploration of iron oxide nanoparticles synthesized from Rhododendron arboreum extract. Journal of Taibah University Medical Sciences, 20(5), 737-750 https://doi.org/10.1016/j.jtumed.2025.09.005.
28. Ramya, S., Kumar, S. P., Srinivasan, T. K., Aravind, T., Lingaraja, D., Ram, G. D., & Bhuvaneshwari, G. (2023). Green synthesis of Ag-doped ZnO using Nelumbo nucifera flower extract for antibacterial activity. Materials Today: Proceedings. https://doi.org/10.1016/j.matpr.2023.01.028.
29. Patil, S. S., Kulkarni, V. B., & Raghavendra, N. (2025). Synthesis of gum ghatti-Andrographis paniculata flower extract-silver nanocomposite and its potential anticancer effects. Sustainable Chemistry One World, 100110. https://doi.org/10.1016/j.scowo.2025.100110.
30. Singh, A. K. (2022). Flower extract-mediated green synthesis of bimetallic CuZn oxide nanoparticles and its antimicrobial efficacy in hydrocolloid films. Bioresource Technology Reports, 18, 101034. https://doi.org/10.1016/j.biteb.2022.101034.
31. López-López, J. R., Hernández-Chávez, M. A., López-López, M. D. J., Tejeda-Ochoa, A., Cervantes-Gaxiola, M. E., Parra-Unda, J. R., & Méndez-Herrera, P. F. (2025). Tagetes erecta—mediated green synthesis of ZnO–Ag nanocomposites: characterization and dual applications in solar photocatalytic degradation and antibacterial activity. Ceramics, 8(2), 45. https://doi.org/10.3390/ceramics8020045.
32. Hussein, N. N., Mohammed, K. A., Al-Mutleb Hamood, S. A., Sharma, S., Dwivedi, S. P., Subramonian, S., & Smerat, A. (2026). Phytochemical analysis of biosynthesized ZnO/CuO nanocomposites using hibiscus flower extract: unveiling of the antioxidant activity, microstructural morphology, structural, and optical properties. International Journal of Chemical Reactor Engineering, 24(6), 709-720. https://doi.org/10.1515/ijcre-2025-0175.
33. Tiwari, S., Pooja, A., Sharma, G. & Sharma, P. (2025). Green Synthesis of Nanoparticles from Flower Extracts: Innovative Applications in Floriculture. Archives of Current Research International, 25(6), 56–77. DOI: 10.9734/acri/2025/v25i61250.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 5, September 2026
Impact Factor: 8.2

34. Eker, F., Akdaşçi, E., Duman, H., Bechelany, M. & Karav, S. (2025). Green Synthesis of Silver Nanoparticles Using Plant Extracts: A Comprehensive Review of Physicochemical Properties and Multifunctional Applications. International Journal of Molecular Sciences, 26(13), 6222. DOI: 10.3390/ijms26136222.
35. Fatimah, I., Wijayanti, H. K., Sagadevan, S., Oh, W.-C., & Ghazali, S. A. I. S. M. (2024). Ultrasound-assisted green synthesis of single phase $Fe_3O_4$ nanoparticles and its photocatalytic study for tetracycline photooxidation. Inorganic Chemistry Communications, 161, 112130. https://doi.org/10.1016/j.inoche.2024.112130.
36. Sinha, A. (2025). Plant-mediated biosynthesis of CuO nanoparticles for photocatalytic organic pollutant degradation (A Review). Russian Journal of General Chemistry, 95(11), 3177-3204.https://doi.org/10.1134/S1070363225604740.
37. Aydin Acar, C., Gencer, M. A., Pehlivanoglu, S., Yesilot, S., & Donmez, S. (2024). Green and eco-friendly biosynthesis of zinc oxide nanoparticles using Calendula officinalis flower extract: Wound healing potential and antioxidant activity. International wound journal, 21(1), e14413.https://doi.org/10.1111/iwj.14413.
38. ES, H. H., Bhattacharya, S., Varma, M. R., & Chandra, G. K. (2023). Carica papaya male flower mediated environmentally benign synthesis of silver nanoparticles towards the sensing of tryptophan. Materials Today: Proceedings. https://doi.org/10.1016/j.matpr.2023.03.731.