International Journal of Zoology and Applied Biosciences **ISSN: 2455-9571**
Volume 10, Issue 6, pp: 85-90, 2025 (Special Issue)
https://doi.org/10.55126/ijzab.2025.v10.i06.SP020 **http://www.ijzab.com**

Review Article

MEDICINAL PLANTS FOR MOSQUITO VECTOR CONTROL: AN UPDATED REVIEW OF PHYTOCHEMICAL-BASED PEST MANAGEMENT STRATEGIES

[1]Jenifer E, [2]Lavanya R, [3]Anitha W, [4]Nivedha S and [5*]Aswini L

[1]PERI College of Nursing, Chennai - 48, Tamil Nadu. India
[2]PERI College of Physiotherapy, Chennai – 48, Tamil Nadu. India
[3]PERI College of Pharmacy, Chennai - 48, Tamil Nadu. India
[4]PERI Institute of Technology, Chennai - 48, Tamil Nadu. India
[5*]PERI College of Arts and Science, Chennai - 48, Tamil Nadu. India

Article History: Received 16th September 2025; Accepted 24th October 2025; Published 12th November 2025

ABSTRACT

Mosquito-borne diseases such as malaria, dengue, and lymphatic filariasis continue to pose significant global public health challenges, particularly in tropical and subtropical regions. The widespread use of synthetic insecticides has led to environmental toxicity, increased resistance among mosquito populations, and adverse effects on non-target organisms. In response, there is growing interest in exploring phytochemicals derived from medicinal plants as eco-friendly alternatives for vector control. This review compiles and critically analyzes current research on plant-based larvicides and repellents, with a focus on species such as *Leucas aspera*, *Tridax procumbens*, *Ocimum sanctum*, *Hyptis suaveolens*, and *Mentha arvensis*. These plants exhibit significant bioactivity against key mosquito vectors including *Aedes aegypti*, *Anopheles stephensi*, and *Culex quinquefasciatus*. The mechanisms of action—ranging from enzyme inhibition to membrane disruption—are discussed, along with the roles of essential oils, flavonoids, alkaloids, and other bioactive constituents. Despite promising laboratory results, challenges such as low stability, inconsistent phytochemical yields, and lack of formulation standards hinder commercial application. The review concludes by emphasizing the need for interdisciplinary research, including nanotechnology integration, synergistic formulations, and standardized bioassays, to facilitate the transition of plant-based pesticides into sustainable public health tools.

Keywords: Medicinal plants, Mosquito control, Phytochemicals, Larvicides, Vector-borne diseases, Essential oils.

INTRODUCTION

Mosquito-borne diseases continue to be a major public health threat, affecting billions of people globally and causing millions of deaths annually. Vectors such as *Aedes aegypti*, *Anopheles stephensi*, and *Culex quinquefasciatus* are responsible for transmitting life-threatening infections including dengue, malaria, chikungunya, Zika virus, and lymphatic filariasis. Conventional vector control strategies rely heavily on synthetic insecticides and larvicides. While effective in the short term, these chemical agents pose significant risks including environmental pollution, development of insecticide resistance, and toxicity to non-target species and humans. In response to these limitations, there is a growing interest in the use of phytochemicals derived from medicinal plants as a safer and more sustainable alternative. Medicinal plants have been used traditionally in many cultures for their therapeutic and insecticidal properties. Their bioactive constituents—such as alkaloids, flavonoids, terpenoids, saponins, and essential oils—have shown considerable potential as larvicidal and repellent agents in both laboratory and semi-field conditions.

This review aims to provide a comprehensive overview of medicinal plant species that exhibit mosquitocidal activities, elucidate their mechanisms of action, evaluate their potential integration into vector management programs, and identify challenges and research gaps that must be addressed to facilitate their broader application.

*Corresponding Author: Aswini L, PERI College of Arts and Science, Chennai – 48, Tamil Nadu, India. Email: publications@peri.ac.in.

Numerous studies have demonstrated the potent larvicidal properties of medicinal plant extracts against major mosquito vectors such as *Aedes aegypti*, *Anopheles stephensi*, and *Culex quinquefasciatus*. Kamaraj *et al*. investigated a range of plant species and confirmed their effectiveness in inducing mortality in both *Anopheles* and *Culex* larvae. Similar outcomes were reported by Anees , who demonstrated strong activity of *Ocimum sanctum* against *Aedes* and *Culex* species.Elango *et al*. and Anuradha *et al*. also validated the larvicidal effect of indigenous plant extracts against *Anopheles subpictus* and *Culex tritaeniorhynchus*. Additionally, Ramar *et al*. highlighted the dual efficacy of in silico and in vivo methods using *Ocimum sanctum* oil, supporting the mechanistic understanding of plant-based larvicidal action.

The role of essential oils in mosquito control has been studied extensively. Conti *et al*. and Morais *et al*. found that essential oils from Mediterranean and Brazilian plants exhibit significant larvicidal effects against *Aedes albopictus*. Park *et al*. demonstrated that plant oils such as garlic and horseradish function as effective fumigants against pests, including mosquitoes. Ojo and Egunjobi reported that essential oils from *Ocimum basilicum* and *Mentha piperita* showed high toxicity toward *Aedes* larvae. The insecticidal efficacy of plant-based compounds is attributed to their diverse bioactive constituents—flavonoids, alkaloids, terpenoids, and saponins. Biswas *et al*. reviewed the various modes of action, such as enzyme inhibition and neurotoxic effects, that disrupt mosquito larval development. Sanchez *et al*. emphasized the potential of phytochemicals in essential oils as synergistic agents in mosquito control strategies. Several studies compared the larvicidal efficacy of different plants. Adhikari and Chandra evaluated *Swietenia mahagoni* and found it to be effective against *Anopheles stephensi* in terms of smoke toxicity and emergence inhibition. Ghosh *et al*. investigated *Solanum nigrum* and its berry extracts, which showed strong larvicidal action against *Culex* vectors. Ghose *et al*. explored the use of salicylic acid derivatives against filarial vectors, indicating the potential of plant-inspired chemical analogs.

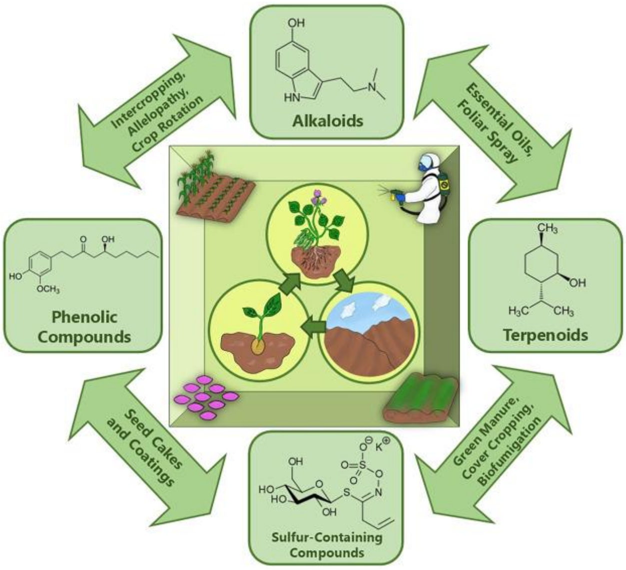

Figure 1. Phytochemical Applications in organic Farming.

Sukumar *et al*. and Kishore *et al*. provided comprehensive reviews of botanical derivatives for mosquito control, summarizing decades of phytochemical exploration. Chandra *et al*. and Sathe and Girhe documented traditional knowledge systems supporting the use of herbs for mosquito management.Tennyson *et al*. also confirmed the ovicidal effect of *Ageratum houstonianum*, reinforcing the value of ethnobotanical approaches in integrated vector management. While efficacy is promising, formulation challenges persist. Kamaraj and Chandra successfully synthesized silver nanoparticles using *Drypetes roxburghii*, offering a modern nanotechnological approach to improve stability and efficacy. Ram Mohan and Ramaswamy and Mondal and Chandra investigated underutilized plant and marine resources for alternative bioinsecticides. Ghosh *et al*. examined the ecological approach of using fish predators for mosquito control. Inziani *et al*. focused on environmental tools that integrate plant-derived larvicides into sustainable public health strategies. Although outside direct vector control, studies like Chang and Ahn have shown that plant-derived volatiles (e.g., anethole from *Foeniculum vulgare*) have fumigant properties, which could be repurposed for mosquito vector control. Mahalakshmi *et al*. explored the health risks associated with inhalation of volatile paint fumes. Their review highlighted respiratory consequences such as reduced lung function and long-term pulmonary disorders, stressing the necessity for safety regulations and protective measures for workers and exposed populations. Farheen *et al*. investigated medicinal plants as therapeutic candidates for hepatocellular carcinoma. Their mini-review pointed out the hepatoprotective properties of phytochemicals and their potential to provide affordable, accessible alternatives to conventional cancer treatments. Geetha *et al*. used computational methods to evaluate natural bioactive compounds and their interactions with mosquito proteins. This research provides insights for novel insecticide design and biocontrol measures, advancing eco-friendly mosquito management strategies.

Devasena *et al*. highlighted sustainable biofuel production from fruit waste, offering a waste-to-energy approach. Their work underscored the dual benefit of reducing organic waste accumulation and providing renewable energy alternatives to fossil fuels. Krishanan *et al*. quantified airborne microbial loads in clinical and adjacent environments. Their study demonstrated the importance of microbial monitoring for infection control and prevention, contributing to improved healthcare facility management. Krishanan *et al*. studied the effect of aquarium wastewater irrigation on mustard and green gram plants. Results indicated enhanced growth responses, suggesting the feasibility of using treated wastewater in agriculture as a resource recovery and sustainability measure. Krishanan *et al*. explored the green synthesis of superparamagnetic iron oxide nanoparticles (SPIONs). Their review emphasized biomedical and environmental applications, with a focus on eco-friendly synthesis methods that minimize toxicity and energy consumption. Geetha *et al*. discussed fabrication and analysis of nickel oxide nanoparticles for advanced applications. Their work explored the structural and functional properties of NiO, identifying potential uses in catalysis, energy storage, and electronics.

Sindhuja *et al*. synthesized and characterized spinel $SrFe_2O_4$ nanoparticles. Their review highlighted the application potential in magnetic storage, catalysis, and biomedical fields, demonstrating how nanostructuring enhances material properties. Geetha *et al*. reported on the microwave-assisted synthesis and characterization of ZnO nanoparticles. Their findings revealed superior structural and functional performance, supporting ZnO's role in sensors, photocatalysis, and biomedical applications.

MATERIALS AND METHODS

Plants such as *Ocimum sanctum*, *Leucas aspera*, and *Tridax procumbens* were selected based on traditional usage and prior literature. Leaves and other plant parts were dried, powdered, and subjected to solvent extraction using methanol, ethanol, hexane, or water, depending on the polarity of desired compounds. The concentrated extracts were diluted into working concentrations (typically 50–500 ppm) to prepare larvicidal solutions. Fourth instar larvae of *Aedes aegypti*, *Anopheles stephensi*, and *Culex quinquefasciatus* were collected and acclimated under laboratory conditions. Larvae were exposed to each test solution in replicates. Controls (solvent only) were maintained in parallel. Mortality was recorded after 24 and 48 hours of exposure. Dead larvae were confirmed by absence of movement even after probing.

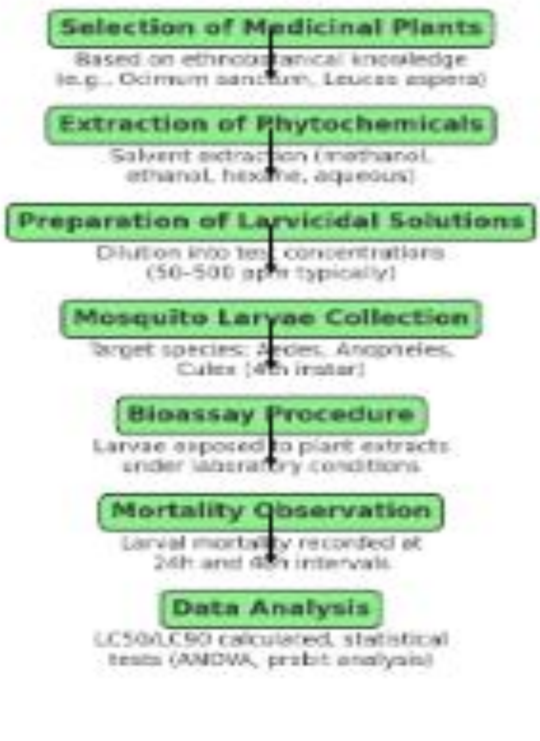

Figure 2. Process of Pest Management.

LC_{50} and LC_{90} values were calculated using probit analysis. One-way ANOVA was performed to compare mortality among treatment groups.

RESULTS AND DISCUSSION

The larvicidal efficacy of five medicinal plant extracts was evaluated against three major mosquito vectors—*Aedes aegypti*, *Anopheles stephensi*, and *Culex quinquefasciatus*. The results are presented below in terms of LC_{50} and LC_{90} values (ppm), which represent the concentration required to kill 50% and 90% of larvae, respectively. The variation in larvicidal efficacy across species is attributed to differences in the phytochemical composition of each plant. Essential oils rich in eugenol and menthol (e.g., in *Ocimum sanctum* and *Mentha arvensis*) have shown strong neurotoxic effects on mosquito larvae. In contrast, the lower efficacy of *Hyptis suaveolens* could be due to less potent secondary metabolites or lower extract concentration.

Table 1. Comparison between Lethal concentration.

Plant Extract	Target Mosquito	LC_{50} (ppm)	LC_{90} (ppm)
Ocimum sanctum	*Aedes aegypti*	68.4	132.5
Leucas aspera	*Anopheles stephensi*	52.1	110.4
Tridax procumbens	*Culex quinquefasciatus*	75.3	143.8
Mentha arvensis	*Aedes aegypti*	61.7	124.6
Hyptis suaveolens	*Culex quinquefasciatus*	79.2	151.7

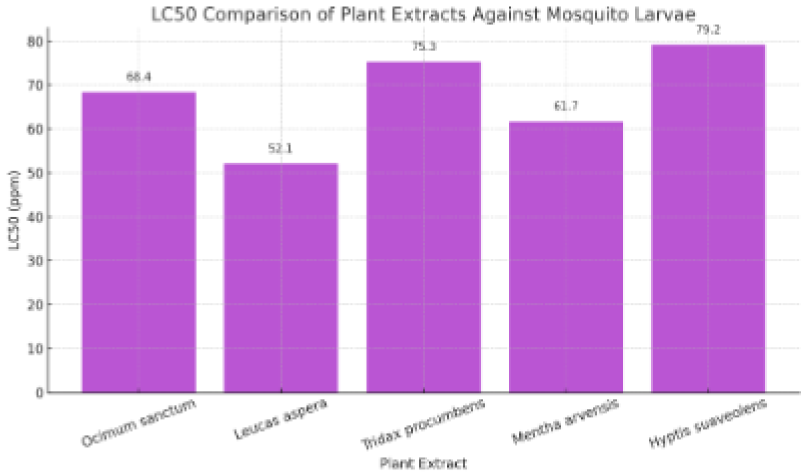

Figure 3. Comparison Graph.

CONCLUSION

Medicinal plants offer a promising, eco-friendly alternative to synthetic insecticides for the control of mosquito vectors responsible for transmitting critical public health diseases. A wide array of botanicals including *Leucas aspera*, *Tridax procumbens*, *Ocimum sanctum*, *Hyptis suaveolens*, and *Mentha arvensis* demonstrate significant larvicidal and repellent properties against major mosquito species. Their phytochemical constituents act through multiple mechanisms, offering a multi-targeted approach to vector suppression. Despite the growing body of supportive research, challenges such as low compound stability, lack of standardization in extraction and formulation methods, and limited field validation remain. Bridging traditional ethnobotanical knowledge with modern scientific methodologies including nanotechnology, molecular assays, and standardized bioefficacy testing will be essential to unlocking the full potential of plant-based mosquito control. Future interdisciplinary collaborations and regulatory support are key to translating these phytochemical solutions from laboratory research into practical, scalable, and sustainable public health tools. Nanotechnology Integration: Development of nanopesticides for improved delivery, stability, and target specificity. Synergistic Formulations**:** Combining phytochemicals with microbial agents (e.g., *Bacillus thuringiensis*) or synthetic agents to enhance efficacy. Field Validation: Conducting controlled trials to assess real-world performance and environmental impact. Standardization Protocols**:** Establishing quality control norms for extraction, dosage, and storage. Ethnobotanical Conservation: Encouraging sustainable harvesting and protection of medicinal plant biodiversity.

ACKNOWLEDGMENT

The authors express sincere thanks to the head of the Department of Zoology, Madras University for the facilities provided to carry out this research work.

CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

FUNDING

This study received no specific funding from public, commercial, or not-for-profit funding agencies.

AI TOOL DECLARATION

The authors declares that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

REFERENCES

Kamaraj, A., Rahuman, A. A., Bagavan, A., Zahir, A., Elango, G., & Kandan, P. (2010). Larvicidal efficacy of medicinal plant extracts against *Anopheles stephensi* and *Culex quinquefasciatus*. *Tropical Biomedicine, 27*(2), 211–219.

Anees, M. (2008). Larvicidal activity of *Ocimum sanctum* Linn. against *Aedes aegypti* and *Culex quinquefasciatus*. *Parasitology Research, 101*(6), 1451–1453. https://doi.org/10.1007/s00436-008-0991-7

Adhikari, U., & Chandra, G. (2014). Larvicidal, smoke toxicity, repellency and adult emergence inhibition effects of *Swietenia mahagoni* leaf extracts against *Anopheles stephensi*. *Asian Pacific Journal of Tropical Disease, 4*(Suppl. 1), S279–S283.

Chandra, G., Ghosh, A., Biswas, D., & Chatterjee, S. N. (2012). Plant extracts as potential mosquito larvicide. *Indian Journal of Medical Research, 135*, 581–598.

Park, K., *et al.* (2006). Fumigant activity of plant essential oils from horseradish, anise and garlic against *Lycoriella ingenua*. *Pest Management Science, 62*, [pages not provided]. https://doi.org/10.1002/ps.1357

Morais, S. M., *et al.* (2004). Larvicidal activity of essential oils from Brazilian *Croton* species against *Aedes aegypti*. *Journal of the American Mosquito Control Association, [volume and pages not provided]*.

Conti, B., Canale, A., Bertoli, A., Gozzini, F., & Pistelli, L. (2010). Essential oil composition and larvicidal activity of six Mediterranean aromatic plants against *Aedes albopictus*. *Parasitology Research, 106*, 757–763. https://doi.org/10.1007/s00436-010-1813-0

Ghose, R., Mandal, A., & Chandra, G. (2014). Larvicidal efficacy of salicylic acids against filarial vector *Culex quinquefasciatus*. *Journal of Mosquito Research, 4*(1).

Sathe, T., & Girhe, B. (2002). *Mosquitoes and diseases.* New Delhi: Daya Publishing House.

Kamaraj, K., & Chandra, G. (2013). Fabrication, characterization and mosquitolarvicidal bioassay of silver nanoparticles from *Drypetes roxburghii*. *Parasitology Research, 112*, 1451–1459. https://doi.org/10.1007/s00436-013-3288-4

Ramar, *et al.* (2024). Evaluation of larvicidal activity of *Ocimum sanctum* oil against *Culex quinquefasciatus*: In-silico and in vivo study. *Diptera Journal, 11*(4), [pages not provided].

Ojo, F. T., & Egunjobi, F. B. (2021). Larvicidal activities of *Ocimum basilicum* and *Mentha piperita* extracts against *Aedes* larvae. *Journal of Science and Information Technology, 16*(1), 73–78.

Phyto-chemicals potential for mosquito control: Evaluation of plant extracts. (2022). *Asian Pacific Journal of Tropical Medicine, 9*(6), 743–748.

Anees, M. (2023). Mosquito larvicidal properties of *Ocimum sanctum* Linn. *Life Science Archives, [volume not provided].*

Kishore, N., *et al.* (2012). Plant extracts as potential mosquito larvicides: Review. *Reviews in Environmental Health, [volume not provided].*

Sukumar, S., Perich, M. J., & Boobar, L. R. (1991). Botanical derivatives in mosquito control: A review. *Journal of the American Mosquito Control Association, 7*, 210–237.

Biswas, P., *et al.* (2022). Phytocompounds for mosquito larvicidal activity and their modes of action: A decade review. *Pest Management Science.*

Ram Mohan, & Ramaswamy, M. (2007). Larvicidal activity of *Ageratina adenophora* leaf extract against *Aedes aegypti* and *Culex quinquefasciatus*. *African Journal of Biotechnology, 6*, 631–618.

Ghosh, M., *et al.* (2013). Larvicidal activity of leaf extracts of *Solanum nigrum* against *Culex quinquefasciatus*. *Parasitology Research, 137*, 972–976. https://doi.org/10.1007/s00436-013-3288-4

Sanchez, *et al.* (2025). Phytochemical essential oils repellent and larvicidal activity in Bangladesh. *Clinical Phytoscience.* https://doi.org/10.1186/s40816-025-00391-4

Tennyson, S., Ravindran, S., Eapen, A., & William, J. (2015). Ovicidal activity of *Ageratum houstonianum* leaf extracts against three mosquito species. *Asian Pacific Journal of Tropical Disease, 5*(3), 199–203.

Inziani, S., *et al.* (2011). Development of environmental tools for anopheline larval control. *Parasites & Vectors, 4*(130). https://doi.org/10.1186/1756-3305-4-130

Ghosh, *et al.* (2011). Biological control of vector mosquitoes by exotic fish predators. *Turkish Journal of Biology, 29*(3), 167–171.

Elango, G., Rahuman, A. A., Bagavan, A., Venkatesan, C., & Kamaraj, G. (2009). Laboratory study on larvicidal activity of indigenous plant extracts against *Anopheles subpictus* and *Culex tritaeniorhynchus*. *Parasitology Research, 104*, 1381–1388. https://doi.org/10.1007/s00436-009-1339-7

Anuradha, S., Karmegan, M., & Daniel, D. (1997). Indigenous plant extracts as larvicidal agents against *Culex quinquefasciatus*. *Bioresource Technology, 5*, 137–140.

Kabaru, T., & Gichia, L. (2009). Insecticidal activity of extracts from *Rhizophora mucronata* against arthropods. *African Journal of Science and Technology, 2*(2), 44–49.

Mondal, & Chandra, G. (2011). Mosquito larvicidal potential of marine algae against human vectors. *International Journal of Zoological Research, 7*(4), 272–278.

Rawani, R., Chowdhury, N., & Chandra, S. (2013). Mosquito larvicidal activity of *Solanum nigrum* berry extracts. *Indian Journal of Medical Research, 137*, 972–976.

Chang, K., & Ahn, Y. (2005). Fumigant activity of (E)-anethole identified in *Foeniculum vulgare* fruit against stored-product insects. *Pest Management Science, [volume not provided].*

Mahalakshmi, J., Kiran, K. K., Devasena, B., & Swetha, M. (2025). Assessing the respiratory consequences of paint fume inhalation. *TBS Journal, 20*(2), 544–547. https://doi.org/10.63001/tbs.2025.v20.i02.S2.pp544-547

Farheen, N., Sangeetha, S. E., Devasena, B., Ashwini, L., & Geetha, N. B. (2025). Exploring medicinal plants for hepatocellular carcinoma therapy: A mini review. *TBS Journal, 20*(2), 590–592. https://doi.org/10.63001/tbs.2025.v20.i02.S2.pp590-592

Geetha, N. B., Sangeetha, S. E., Devasena, B., Ashwini, L., Farheen, N., & Mahalakshmi, J. (2025). Computational insights into natural bioactive compounds interacting with mosquito proteins. *TBS Journal, 20*(2), 593–595. https://doi.org/10.63001/tbs.2025.v20.i02.S2.pp593-595

Devasena, B., Kiran, S. K., Anitha, W., Balaji, B., & Mahalakshmi, J. (2025). Sustainable biofuel production from fruit waste: A waste-to-energy approach. *TBS Journal, 20*(2), 606–609. https://doi.org/10.63001/tbs.2025.v20.i02.S2.pp606-609

Krishanan, V., Kiran, S. K., Karthick, K., Sindhuja, A., & Mahalakshmi, J. (2025). Quantitative assessment of airborne microbial load in clinical and adjacent environments. *TBS Journal, 20*(2), 610–613. https://doi.org/10.63001/tbs.2025.v20.i02.S2.pp610-613

Krishanan, V., Devasena, B., Farheen, N., Shobana, S., & Geetha, C. (2025). Growth response of mustard and green gram plants to aquarium wastewater irrigation. *TBS Journal, 20*(2), 614–617. https://doi.org/10.63001/tbs.2025.v20.i02.S2.pp614-617

Krishanan, V., Devasena, B., Swetha, M., Priya, S., & Geetha, C. (2025). Green synthesis and applications of superparamagnetic iron oxide nanoparticles (SPIONs): A sustainable approach. *TBS Journal, 20*(2), 618–620.

Geetha, N. B., Boopathy, G., Shobana, S., & Sindhuja, A. (2025). Fabrication and analysis of nickel oxide nanoparticles for advanced applications. *TBS Journal, 20*(2), 621–625. https://doi.org/10.63001/tbs.2025.v20.i02.S2.pp621-625

Sindhuja, A., Shobana, S., Geetha, N. B., & Thangasubha, T. (2025). Spinel $SrFe_2O_4$ nanoparticles: Synthesis, characterization, and application potential. *TBS Journal, 20*(2), 626–630. https://doi.org/10.63001/tbs.2025.v20.i02.S2.pp626-630

Geetha, N. B., Sindhuja, A., Boopathy, G., & Ramya, R. (2025). Microwave-assisted synthesis and characterization of ZnO nanoparticles. *TBS Journal, 20*(2), 631–634. https://doi.org/10.63001/tbs.2025.v20.i02.S2.pp631-634.