Integrating ethnobotany and plant-based Nanoparticles: A bibliometric of their role in sustainable material physics

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Ethnobotany Research and Applications 31:53 (2025) - http://dx.doi.org/10.32859/era.31.53.1-13
Manuscript received: 27/05/2025 - Revised manuscript received: 01/08/2025 - Published: 03/08/2025

Review

Abstract

Background: The convergence of plant-derived nanoparticles and ethnobotanical knowledge represents a promising frontier in material science. Nanoparticles synthesized from plant-based phytochemicals offer a non-toxic, environmentally friendly alternative to conventional chemical methods, aligning with the principles of sustainable nanotechnology. Ethnobotanical insights play a critical role in guiding the selection of plant species, many of which possess long-standing cultural and pharmacological value.

Methods: A comprehensive literature search was conducted using the Scopus database for the period 2007-2025. Data were analyzed using Biblioshiny from the bibliometrix library (R-based) tools, including VOSviewer, to map publication trends, author collaborations, and keyword co-occurrences.

Results: This study reveals a rapidly growing global research trend integrating plant-derived nanoparticles with ethnobotanical knowledge, highlighting strong international collaborations and a focus on sustainable, bioactive applications such as antioxidants and anticancer properties. India leads this interdisciplinary field, partnering with multiple countries to advance eco-friendly nanotechnologies that combine traditional wisdom and modern science for innovative material and biomedical solutions.

Conclusions: There is revolutionary potential for sustainable material science when plant-derived nanoparticles and ethnobotanical knowledge are integrated. This fusion is a strategic step toward developing green nanotechnologies that are both environmentally friendly and culturally informed, fostering innovation that addresses global health and ecological challenges.

Keywords: Plant-Derived Nanoparticles, Ethnobotany, Phytochemicals, Material Science, Nanotechnology, Bibliometric

Background

The development of nanotechnology has opened new possibilities in material science, particularly through the use of plant-based synthesis pathways. Plant-derived nanoparticles, synthesized using phytochemicals such as flavonoids, terpenoids, and alkaloids, offer eco-friendly, cost-effective, and biocompatible alternatives to conventional nanoparticle production

methods (El-Saber Batiha *et al.* 2020; Iravani 2011). This approach, often referred to as green synthesis, has gained increasing attention for biomedical, catalytic, and environmental applications.

The eco-friendly nature of plant-based synthesis is particularly vital as it reduces the reliance on harmful chemicals typically employed in conventional nanoparticle production methods. Traditional methods often lead to toxic byproducts and environmental degradation, while green synthesis, as elucidated by Virkutytė and Varma, not only mitigates these issues but also enhances the potential for sustainable materials development (Virkutyte and Varma 2011). Moreover, the advantages of employing plant extracts include their availability, cost-effectiveness, and intrinsic bioactivity, which are critical in various applications, particularly in biomedical fields where biocompatibility is paramount (Álvarez-Chimal and Arenas-Alatorre 2023).

For example, Iravani and Zolfaghari demonstrated the effective synthesis of silver nanoparticles using the bark extract of Pinus eldarica, showing how plant materials can be utilized effectively in the biogenic production of nanoparticles (Iravani and Zolfaghari 2013). Similarly, Kalpana and Rajeswari observed the green synthesis of various sizes of ZnO nanoparticles using plant extracts, affirming the versatility and efficacy of plant-derived pathways in nanofabrication (Kalpana and Devi Rajeswari 2018).

In parallel, ethnobotany, the study of traditional knowledge and cultural practices regarding plant use, plays a crucial role in guiding the selection of appropriate plant sources for nanoparticle synthesis (Aboyewa *et al.* 2021). Indigenous knowledge not only preserves species with high pharmacological relevance but also enriches the scientific community's understanding of plant functionality based on centuries of empirical use.

For instance, research by Henríquez *et al.* emphasizes how indigenous knowledge can guide the selection of biogenic materials for nanotechnology applications, thereby not only conserving biodiversity but also leveraging centuries of empirical usage to inform modern scientific practices (Castillo-Henríquez *et al.* 2020). This is vital as it helps identify plants that can yield nanoparticles with desired chemical and physical properties, ultimately leading to innovations in material sciences.

In the context of material physics, plant-derived nanoparticles exhibit unique physicochemical behaviours that influence key parameters such as dielectric permittivity, band gap modulation, and charge carrier dynamics. For instance, biogenic nanoparticles synthesized using flavonoid-rich plant extracts have demonstrated tunable band gap properties due to quantum confinement and surface state modifications, making them promising candidates for optoelectronic and photonic applications (Ahmed *et al.* 2016; Mittal *et al.* 2013). Additionally, their high surface-to-volume ratio and eco-friendly surface chemistry enhance their suitability in energy harvesting, catalysis, and biosensing platforms.

The incorporation of ethnobotanical knowledge in nanoparticle synthesis further distinguishes this approach from conventional methods. Unlike chemical or purely mechanistic green methods, ethnobotany integrates empirical, culturally transmitted knowledge that identifies bioactive plant species with high functional potential. This enables a more targeted selection process, ensuring that the plant species used not only possess rich phytochemical profiles but are also sustainable and locally accepted (Kharissova *et al.* 2013). As such, ethnobotanical pathways foster innovation that is not only scientifically robust but also culturally inclusive and environmentally responsible.

However, despite the growing interest in both plant-based nanomaterials and ethnobotanical applications, there remains a noticeable gap in bibliometrics addressing how these two domains intersect. In particular, the contribution of ethnobotanical knowledge to the advancement of material science through nanoparticle innovation has yet to be thoroughly mapped and evaluated. This study aims to fill that gap by conducting a bibliometric analysis to uncover trends, collaborations, and thematic clusters that define this interdisciplinary research area. Such investigations would not only bolster the scientific community's understanding of how traditional knowledge can inform modern nanotechnology but also highlight potential areas for future research and application (Pramod Patil and Chaudhari 2021; Sindhura *et al.* 2014).

Materials and Methods

This study employs a bibliometric analysis approach to analyze global trends related to the research on plant-based nanomaterials and their integration with ethnobotany. The bibliometric analysis method was chosen for its capability to provide a comprehensive mapping of scientific publications, author and country collaborations, and emerging key themes within this interdisciplinary topic.

Data collection

Data were sourced from Scopus, one of the most reputable scientific literature databases. Keywords included terms such as *plant-based nanomaterials*, *green synthesis nanoparticles*, *ethnobotany*, *traditional knowledge*, *nanotechnology in plants*, and other relevant combinations. Inclusion criteria encompassed articles, review papers, books, and international conference proceedings published in English-language journals between 2007 and 2025. Publications unrelated to the core topic were excluded. Data was saved in Comma Separated Values (CSV) format and analyzed with VOSviewer.

Data analysis

The bibliometric data collected were rigorously analyzed utilizing two primary software tools: VOSviewer and Biblioshiny from the bibliometrix library (R-based). VOSviewer facilitated the network visualization graph and overlay visualization graph. Concurrently, Biblioshiny was employed to conduct comprehensive statistical bibliometric analyses, encompassing the evaluation of annual research trend topics, identification of the most productive institutions, mapping of international country collaborations, average citation trends per year, flow diagram sankey, thematic mapping analysis, and trend topics of key research.

Analysis stages

This study focused on analyzing publication trends to observe the development of integrating ethnobotany and plant-derived nanoparticles. Additionally, it examined international collaborations by evaluating research partnerships among countries, highlighting leading nations in this field. To uncover key themes, keyword analysis and network visualizations were performed to identify the main topics and frequently discussed subtopics within the literature.

Data Validation and Interpretation

Findings were validated by comparing results from both software tools to ensure data consistency. To strengthen the validity of the dataset and detect conceptual proximity among articles, a bibliographic coupling approach was adopted using shared citation networks, as recommended (Van Eck and Waltman 2014). Subsequent interpretation focused on developing strategic recommendations for integrating ethnobotany and plant-derived nanoparticles (Table 1).

Table 1. main data information from search results in Scopus

Category	Details
Timespan	2007:2025
Sources (Journal, Books)	84
Documents	106
Annual Growth Rate (%)	12.98
Document Average Age	4.45
Average Citations/Doc	12.75
References	7771
Keywords Plus (ID)	2160
Author Keywords (DE)	357
Author	458
Single-Authored Docs	9
Co-Authors per Doc	4.82
International Co-authorship	30.19%

Results and Discussion

Through a bibliometric analysis approach, this study provides a comprehensive overview of global research dynamics on integrating plant-derived nanoparticles and ethnobotany. The results are structured to highlight four key dimensions: (1) publication trends and international collaborations, (2) thematic mapping and keyword trends, (3) keyword co-occurrence and research network analysis, (4) nanoparticles, nanotechnology, and material innovation, and (5) Institutional productivity and country collaboration.

Integration of Ethnobotanical Knowledge in Nanoparticle Synthesis

The integration of ethnobotanical knowledge in nanoparticle synthesis represents an innovative approach, effectively bridging traditional wisdom and modern nanotechnology. Local knowledge about specific plant species, passed down through generations, provides a fundamental basis for selecting plants suitable for nanoparticle synthesis. Species such as

Azadirachta indica, Moringa oleifera, and various other local plants are preferred due to their rich phytochemical profiles, including bioactive compounds like flavonoids, terpenoids, and phenolics, which efficiently reduce metal ions into stable and biologically active nanoparticles. Traditional extraction methods, particularly aqueous extractions practiced by local communities, have proven effective in producing nanoparticles with optimal size and stability. This ethnobotanical approach also positively impacts biodiversity conservation by enhancing the economic value of significant plants while simultaneously empowering communities through active involvement in nanoparticle production and innovation processes. Although challenges persist, such as standardization of methods and protecting indigenous intellectual property rights, this integration promises substantial opportunities for sustainable materials development, environmental preservation, and improvement of local socioeconomic welfare.

Publication Trends and International Collaborations

The bibliometric analysis identified 106 relevant publications on integrating plant-derived nanoparticles and ethnobotany, published between 2007 and 2025. These documents span 84 journals and books, indicating the field's interdisciplinary nature. The annual growth rate of publications is 12.98%, suggesting a consistently rising scholarly interest in green nanotechnology based on ethnobotanical knowledge.

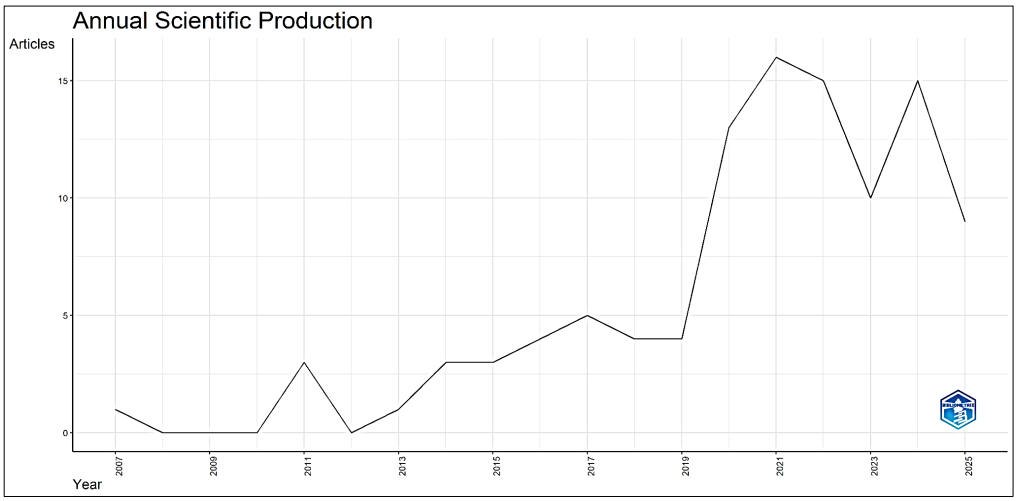


Figure 1. Annual Scientific Production Graph Related to the Research

This figure shows publication surges during 2019-2021 and 2023-2024. These periods likely reflect increasing global concerns about environmental sustainability and the emergence of green synthesis techniques as alternatives to chemical-based nanomaterials. The average document age of 4.45 years with a citation count of 12.75 per document indicates that most publications in this field are recent yet impactful. There are 458 contributing authors showing a well-distributed collaboration base. An average of 4.82 authors per article reflects strong inter-institutional cooperation.

Thematic Mapping and Keyword Trends

Using VOSviewer and Biblioshiny, a clear thematic mapping of the research domain was established, revealing core themes such as *phytochemicals*, *ethnobotany*, *nanoparticles*, *bioactivity*, and *drug delivery*. These themes not only indicate the scientific focus of the field but also reflect its interdisciplinary nature, bridging traditional knowledge and modern nanoparticles.

Figure 2 illustrates the average number of citations per year, reflecting the field's research impact and relevance. Citation trends show a steady rise from 2007, with notable peaks in 2014 and 2021, likely linked to key advances in green synthesis and biomedical applications of plant-based nanoparticles. The post-2022 decline may reflect the limited citation window for recent publications rather than reduced interest. Overall, the field demonstrates sustained scientific influence, with citation patterns aligning closely with major developments. This highlights the growing role of ethnobotany in nanoparticle research and underscores the importance of ongoing interdisciplinary collaboration to maintain academic visibility. Thematic mapping using VOSviewer and Biblioshiny identified dominant research keywords such as ethnobotany, nanoparticles, phytochemistry, phytochemicals, antioxidant activity, anticancer, and drug delivery. These keywords cluster into four main thematic groups: (i) green synthesis and phytochemicals, (ii) bioactivity and pharmacological functions, (iii) traditional plant use and indigenous knowledge, and (iv) sustainable materials science.

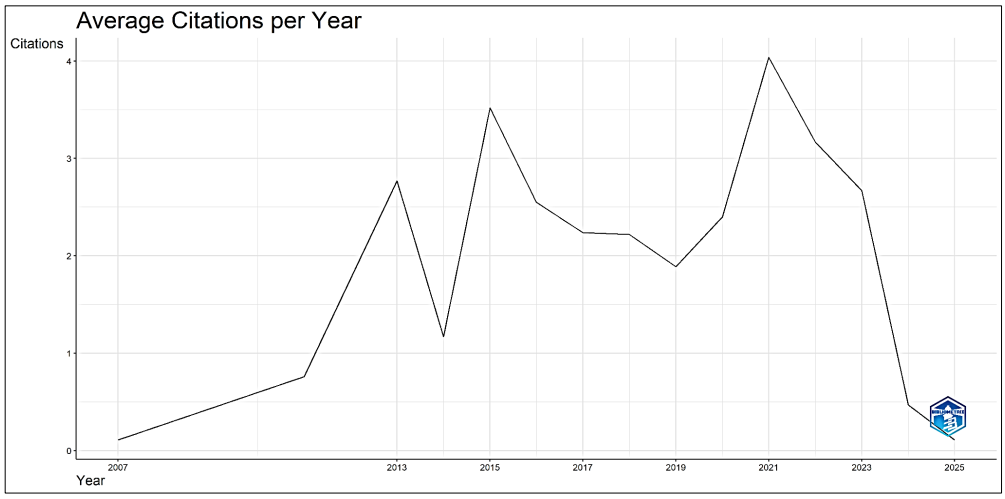


Figure 2. Average Citation Trends per Year

In addition to revealing core research directions, the thematic mapping also emphasizes the chronological development of focus areas within the field. For instance, earlier studies between 2007 and 2013 largely cantered on fundamental phytochemical analysis and the green synthesis of metal nanoparticles. However, from 2014 onward, there was a marked transition toward application-based research, particularly in the biomedical and sensor domains. This shift is evident in the rising frequency of keywords such as anticancer, quorum sensing inhibition, and bioactive compounds, which signal a growing emphasis on functional materials derived from ethnobotanical sources (Fernando and Cruz 2020; Kumar *et al.* 2024). The emergence of clusters around drug delivery systems and sustainable nanomaterials also suggests that researchers are increasingly aligning traditional plant knowledge with advanced material engineering. Such integration paves the way for innovative solutions in diagnostics, targeted therapies, and environmentally responsible technologies (Castillo-Henríquez *et al.* 2020; Zhao *et al.* 2022).

While thematic mapping reveals strong biomedical and pharmacological themes, the explicit connection to material physics remains underexplored in much of the existing literature. Specifically, there is a need to contextualize how plant-derived nanoparticles have evolved from basic green synthesis toward applications in solid-state physics and nanophotonics. Several recent studies highlight promising use cases, such as plasmonic sensors utilizing biogenic gold nanoparticles for enhanced electromagnetic field confinement (Hoyos *et al.* 2019) , dielectric modulation in thin films through ZnO nanoparticles synthesized from plant extracts (Kalpana and Rajeswari 2018), and band gap engineering in semiconductor materials for solar cell applications using green-synthesized CuO and TiO_2 nanoparticles (Naaz *et al.* 2024; Vetrimani *et al.* 2022). Recent advances by Song *et al.* (2022) demonstrate the successful design of porous TiO_2/carbon dot nanoflowers with enhanced surface areas, significantly improving photocatalytic degradation efficiency and reinforcing the multifunctional potential of green-synthesized nanomaterials in environmental and energy applications (Song *et al.* 2022). These examples illustrate the potential of integrating ethnobotanical knowledge with nanomaterial engineering to develop functional devices in optoelectronics, photovoltaics, and sensor technology.

As shown in the Three-Field Plot (Figure 3), a strong link between authors, abstract terms, and keywords reflects a unified research direction focused on bioactive nanoparticle synthesis, highly relevant to material physics. Contributors like Batiha, Shekhawat, and Pandey emphasize the role of ethnobotanical knowledge in selecting plants rich in phytochemicals that act as reducing and capping agents in green synthesis processes. These plant-based nanoparticles exhibit tailored physical properties such as size, morphology, and surface charge, which directly affect their optical, electronic, and catalytic behavior, key parameters in nanophysics. The frequent appearance of terms like *phytochemistry*, *nanoparticles*, *phytoconstituents*, and *anticancer* underscores applications not only in pharmacology but also in material physics domains such as biosensing, energy conversion, and functional coatings. This integration bridges traditional botanical knowledge with modern materials science, driving sustainable innovation in advanced functional materials.

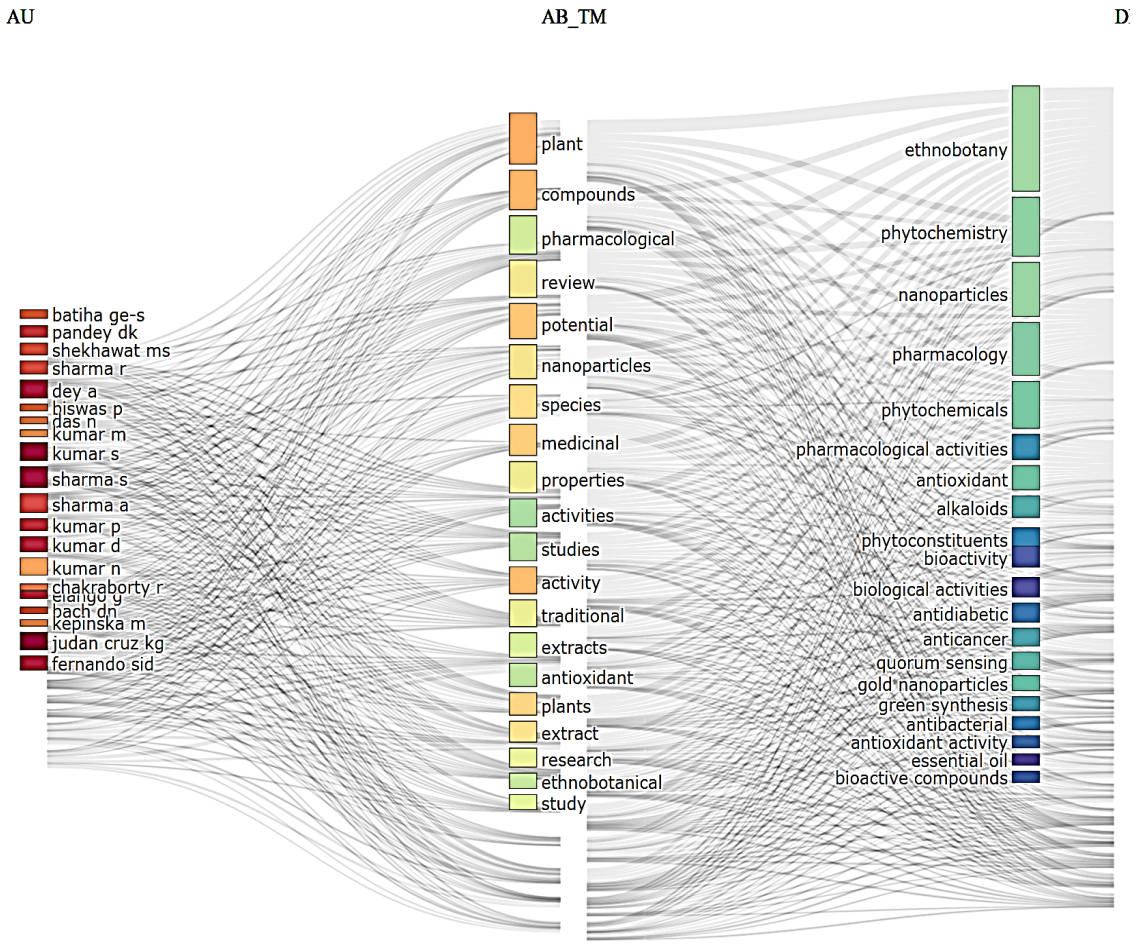


Figure 3. Flow Diagram (Sankey Diagram) of the Relationship Between Three Key Elements: Authors (AU), Abstract Terms (AB_TM), and Keywords (DE).

The integration of plant-derived nanoparticles with ethnobotanical knowledge presents a coherent pathway toward sustainable innovation in material physics, as illustrated in Figure 4 . Ethnobotanical knowledge facilitates the identification of plants rich in bioactive phytochemicals, which function effectively as natural reducing agents and stabilizers in nanoparticle synthesis. This green synthesis approach leverages physical principles, particularly surface chemistry and particle stability, to produce nanoparticles with controlled sizes, morphologies, and enhanced physical properties, including optical, electronic, and catalytic behaviors.

The resultant nanoparticles, derived through ethnobotanical-informed methods, show significant potential in advancing functional materials for optoelectronics, energy harvesting, and sensor technologies (Naaz *et al.* 2024; Vetrimani *et al.* 2022). This synergy between traditional botanical knowledge and contemporary physics-based nanoparticle research highlights a promising route toward sustainable and high-performance materials, aligning closely with the goals of modern applied physics in developing eco-friendly, efficient, and innovative technological solutions.

Keyword Co-occurrence and Research Network Analysis

To better understand the structure and focus of research on ethnobotany and plant-derived nanoparticles, keyword co-occurrence networks were generated using VOSviewer. These visualizations provide a comprehensive overview of the dominant research themes and their interconnections over time. Figure 5a (overlay visualization) shows frequently used keywords such as ethnobotany, phytochemistry, nanoparticles, and phytochemicals at the center of the network. Newer keywords like gold nanoparticles, quorum sensing inhibition, and antioxidant activity appear in yellow, indicating recent research trends focused on biomedical applications. Meanwhile, Figure 5b (cluster visualization) displays thematic groupings, with clusters linking anticancer and phytochemicals (red), pharmacological activity and bioactive compounds (blue/purple), and green synthesis topics. The central role of ethnobotany and phytochemistry underscores their integrative function across

disciplines. Together, these figures illustrate how research is expanding from basic synthesis to targeted therapeutic innovations rooted in traditional knowledge.

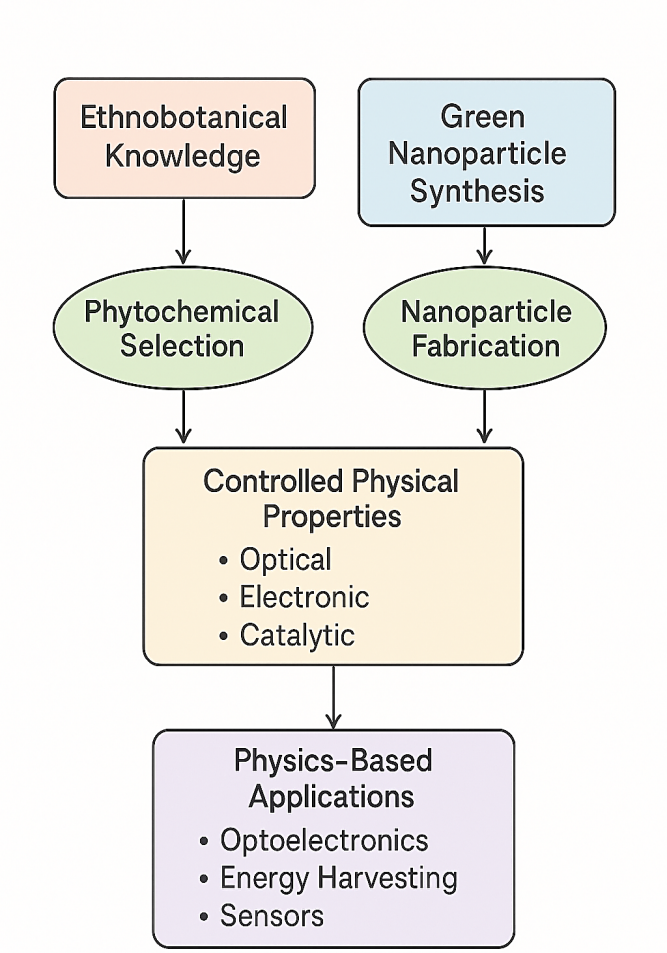
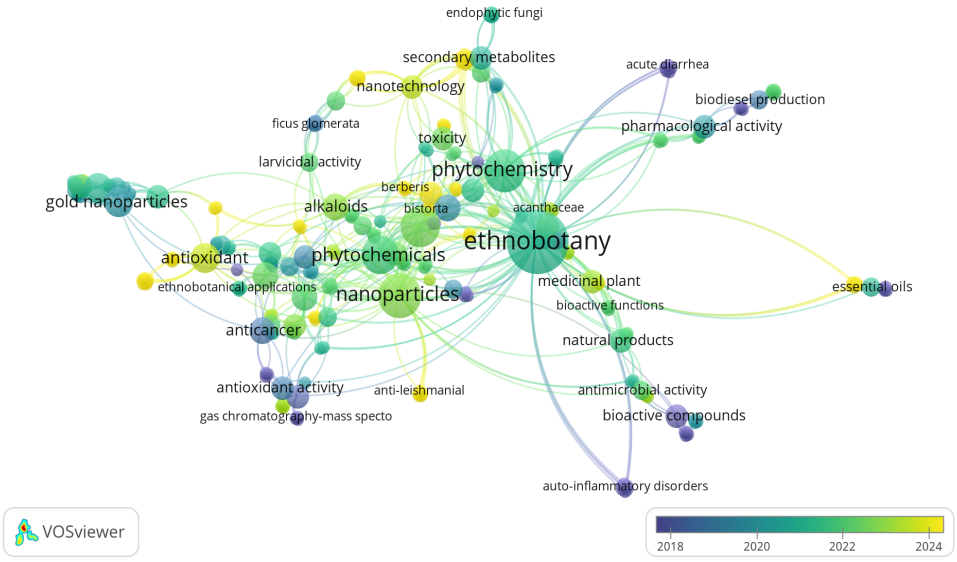
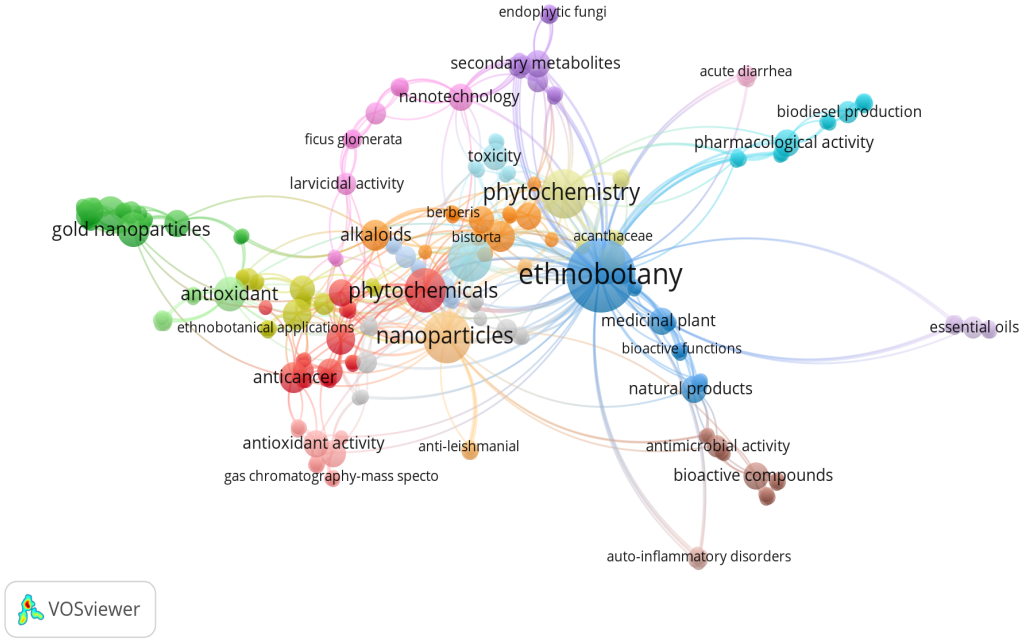


Figure 4. Conceptual Framework Integrating Ethnobotanical Knowledge and Green Nanoparticle Synthesis for Physics-Based Applications



(a)



(b)

Figure 5. Network Visualization Graph (a) and Overlay Visualization (b) Generated using VOSviewer, illustrating the co-occurrence of author keywords in publications related to the integration of ethnobotany and plant-derived nanoparticle research.

Together, Figures 5a and 5b reveal not only the thematic coherence within the field but also its temporal evolution. The growing density and complexity of keyword relationships indicate increasing specialization and diversification. This progression highlights the field's transition from conceptual development to targeted therapeutic innovations, driven by the fusion of indigenous knowledge systems and green nanotechnological practices.

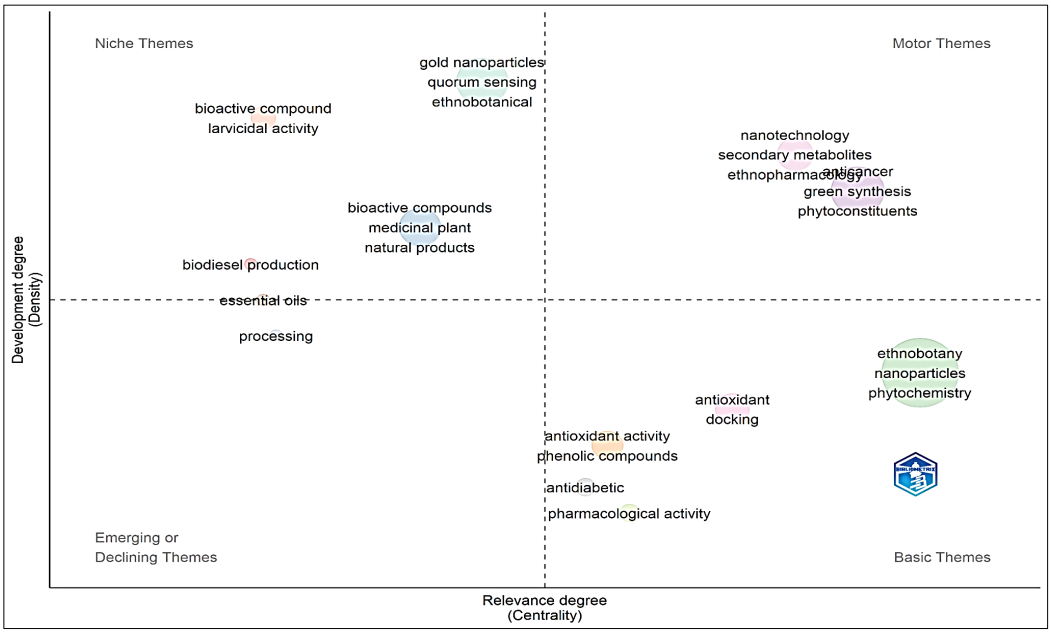


Figure 6. In-depth Interpretation Graph of Each Quadrant, Theoretical Relevance, and Practical Implications in the Integration of Ethnobotany and Plant-Based Nanoparticle Research Based on Thematic Mapping Analysis.

Thematic mapping in Figure 6 reveals key research directions with strong implications in material and applied physics. In quadrant motor themes, terms like nanotechnology, green synthesis, phytoconstituents, and anticancer indicate well-developed, central topics aligned with the synthesis and functionalization of nanomaterials. Basic themes such as ethnobotany, nanoparticles, and phytochemistry serve as the conceptual foundation for designing plant-based nanomaterials with tunable physical properties. Niche themes like gold nanoparticles, quorum sensing, and ethnobotanical highlight specialized areas relevant to smart material development, especially for sensor and biomedical physics applications.

Meanwhile, emerging or underdeveloped keywords such as antioxidant activity and pharmacological activity point to bio-nano interfaces where electron transfer and reactivity are of growing interest in nanomedicine. Collectively, these themes show how ethnobotanical insights and green nanoparticle synthesis intersect with modern physics research, supporting innovation in sustainable materials, energy systems, and nanophotonic devices in line with the Sustainable Development Goals (SDGs). This synergy underscores the roles of interdisciplinary research efforts in addressing critical challenges in health, medicine, and environmental sustainability (Zhao *et al.* 2022; Tregubov *et al.* 2018).

Nanoparticles, Nanotechnology, and Material Innovation

The overlay visualization (Figure 5b) reveals a notable shift in research from fundamental studies of nanoparticles and nanotechnology toward practical innovations in plant-based materials. Core topics such as nanoparticles, phytochemicals, and plant-derived nanotechnology have increasingly dominated recent literature, highlighting the growing importance of sustainable methods, particularly green synthesis approaches utilizing phytochemicals from plants like *Azadirachta indica*, *Murraya koenigii*, and *Artemisia afra* (Musara and Aladejana 2020). These phytochemicals serve as natural reducing agents, enabling the eco-friendly production of metal nanoparticles like gold and silver, which are critical for advanced material applications in catalysis, environmental sensing, and the development of multifunctional smart materials. For instance, Ibrahim *et al.* (2024) successfully demonstrated the use of silver nanoparticles synthesized from *Acacia raddiana* leaf extract in optical sensors for detecting heavy metals such as mercury, copper, lead, and cobalt, showcasing how green nanomaterials informed by ethnobotanical sources can function in precision sensing applications.

The integration of these bio-nanostructures significantly enhances the performance and environmental sustainability of new materials. Furthermore, while the primary focus remains on material science innovation, these developments also have important implications for biomedicine, facilitating advancements in biocompatible drug delivery systems and targeted therapies with minimal toxicity (Fernando and Cruz 2020; Batiha *et al.* 2020). For instance, silver nanoparticles synthesized from *Acacia raddiana* leaf extract have been employed in surface plasmon resonance (SPR) sensors to detect heavy metals such as mercury, copper, lead, and cobalt. (Ibrahim *et al.* 2024).

However, the scalability of green synthesis remains limited by variations in plant metabolites and the lack of standardized protocols for mass production. Addressing these challenges is crucial for integrating ethnobotanically-informed nanoparticles into industrial material applications (Mahmoudi *et al.* 2011). Despite the widespread biomedical emphasis, the optical, dielectric, and plasmonic responses of plant-derived nanoparticles deserve further exploration to fully harness their utility in nanophotonics, piezoelectric nanogenerators, and metamaterial design.

Institutional Productivity and Country Collaboration

Table 2 presents the top 10 institutions contributing to ethnobotany-related nanoparticle research, with VIT University and Banaras Hindu University at the forefront. These institutions are pivotal in promoting multidisciplinary collaboration, often combining expertise in nanoscience, pharmacology, and ethnobotany.

International co-authorship accounts for 30.19% of all publications, highlighting the globalized nature of this research domain. India, due to its rich tradition in Ayurvedic medicine and biodiversity, is the most prolific contributor, followed by collaborations with the United States, China, South Africa, and the United Kingdom. This figure shows India as the hub of collaboration, with thick connection lines to global partners. The map demonstrates a robust exchange of knowledge and scientific resources that enables multi-institutional and multidisciplinary advancement in the field. These international collaborations play a vital role in developing standardized protocols for nanoparticle synthesis, improving biocompatibility, and promoting culturally informed approaches in science.

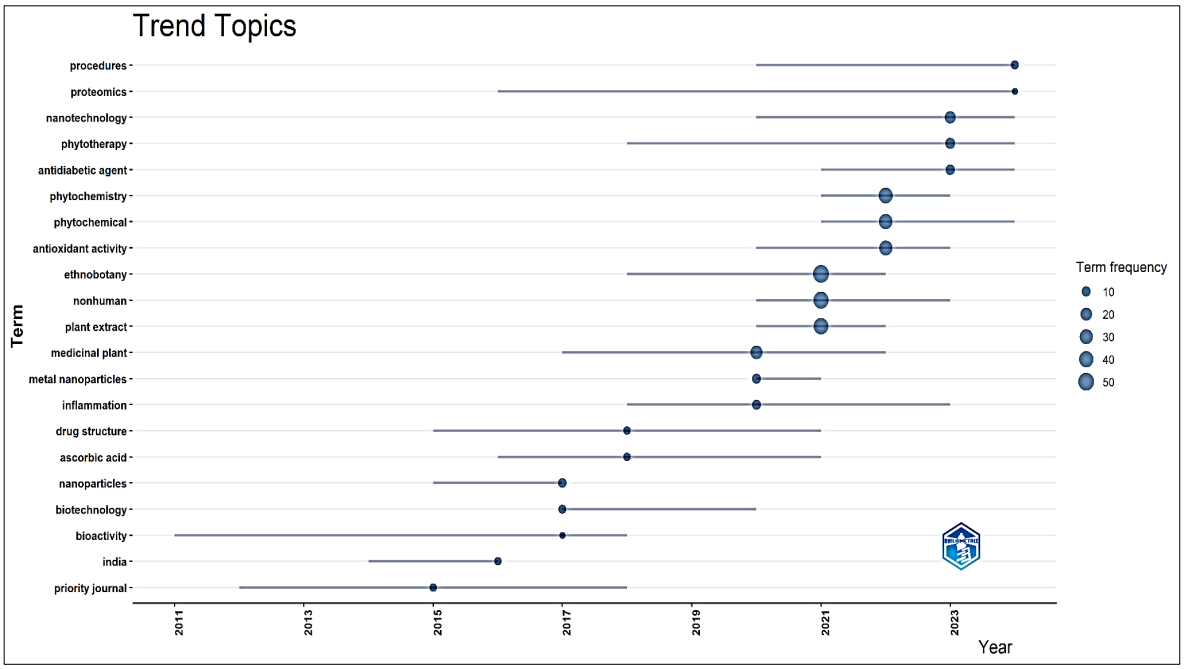


Figure 7. Trend topics of key research terms on plant-derived nanoparticles and ethnobotany (2007 - 2025)

Table 2. The 10 most productive institutions in ethnobotany research

Affiliation	Articles
VIT University	11
Banaras Hindu University	10
Central Luzon State University	10
Presidency University	10
Shoolini University of Biotechnology and Management Sciences	10
Chengdu University of Traditional Chinese Medicine	8
Randd Healthcare Division	8
Bharathidasan University	7
Csir-Indian Institute of Integrative Medicine	6
Jiangsu University of Science and Technology	6

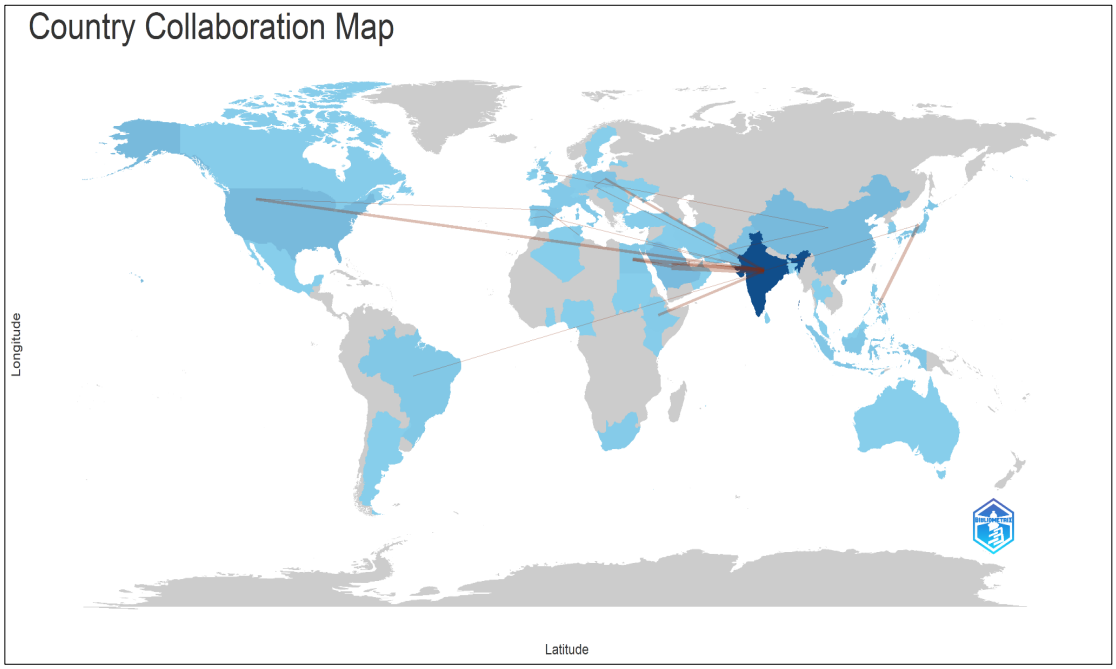


Figure 8. The Country Collaboration Map illustrates international co-authorship patterns in publications related to ethnobotany and plant-derived nanoparticles.

Conclusion

This systematic review and bibliometric analysis reveal that the integration of plant-derived nanoparticles and ethnobotanical knowledge presents a transformative opportunity in the development of sustainable materials within the scope of modern physics. Ethnobotanical insights, particularly in identifying culturally significant plants with rich phytochemical profiles, enable eco-friendly nanoparticle synthesis that aligns with core physical principles, including surface chemistry, particle stability, and functional material behavior. These green-synthesized nanoparticles exhibit tunable optical, electronic, and catalytic properties, making them highly relevant for applications in optoelectronics, energy harvesting, and sensor technology.

Thematic mapping confirms a research shift from conceptual development to targeted functionalization, supported by strong international collaborations, especially in regions with rich biodiversity and traditional medicinal systems such as India. The prominent keywords and research clusters consistently link traditional knowledge with high-impact physical applications, underscoring the strategic relevance of interdisciplinary approaches that merge ethnoscience, nanotechnology, and material physics.

Overall, this fusion of ethnobotany and nanophysics not only advances the field of sustainable material science but also contributes to broader global agendas, particularly the Sustainable Development Goals (SDGs) on clean technology, health, and innovation. Future research should continue to deepen this integration by exploring the physicochemical behavior of biogenic nanoparticles and scaling their application across emerging technologies while preserving the cultural knowledge systems from which they originate. Future initiatives should promote interdisciplinary research collaborations between material physicists, ethnobotanists, and process engineers to address standardization, enhance functionality, and ensure the cultural sustainability of green nanotechnologies.

Declarations

List of abbreviations: AU-Authors, AB_TM-Abstract Terms, and DE-Keywords, SDGs-Sustainable Development Goals, CSV Comma Separated Values.

Ethics approval and consent to participate: All participants were informed of the purpose of the research. They all gave informed consent to share information.

Consent for publication: The manuscript does not contain any individual person's data in any form. All authors have read and given their approval for the publication of the final manuscript.

Availability of data and materials: The data generated and analyzed are included in this article.

Competing interests: The authors affirm that they have no competing interests.

Funding: This research was supported by funding from Lembaga Pengelola Dana Pendidikan (LPDP) Indonesia.

Author contributions: IRS: Idea and conceptualization of the article and final proofreading. IZTD: Conducted bibliometric analysis and prepared the Results and Discussion section, as well as verified the completeness of the article data. NSM: Formulated the draft manuscript and compiled the Methodology section.

Acknowledgements

We are deeply grateful to Lembaga Pengelola Dana Pendidikan (LPDP), which is a division of the Republic of Indonesia's Ministry of Finance, for providing us with the crucial financial assistance that made our master's program possible.

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