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Mapping the Scientific Landscape of *Brahmi* (*Bacopa monnieri*): A Systematic Bibliographic and Bibliometric Review

A.A. Gajarmal*, S. Mahesh and S.R. Baheti

Central Council for Research in Ayurvedic Sciences (CCRAS) - Central Ayurveda Research Institute (CARI), Moti Bagh Road, Patiala, Punjab - 147001, India.

Bacopa monnieri (BM) is a traditional medicinal herb with growing scientific interest, yet its research landscape remains fragmented, with gaps in clinical validation and mechanistic understanding. This study conducted a systematic bibliographic and bibliometric review of global BM research from January 2000 to March 2025, analysing 1,665 documents retrieved from PubMed (469) and Scopus (1,196) using VOSviewer to examine publication trends, thematic clusters, author collaborations, and journal contributions, with key journals including *Journal of Ethnopharmacology* (80 citations), *Industrial Crops and Products* (58), and *South African Journal of Botany* (41). Results revealed steady growth in BM research, especially in neuropharmacology, phytochemistry, and integrative medicine, with six thematic clusters covering pharmacognosy, antioxidant properties, neuroprotection, and clinical applications. High-impact authors such as Kornkanok Ingkaninan and Pulok K. Mukherjee showed strong collaboration networks. Despite progress, challenges remain, including limited standardised clinical trials and molecular mechanism studies. The review provides a roadmap for future research, emphasising standardised extract preparation, omics-based studies, sustainable cultivation, and evidence-based therapeutic applications of *Bacopa monnieri*.

Keywords: *Bacopa monnieri*; neuroprotection; cognitive enhancement; *Ayurveda* medicine; bibliometric analysis

I. INTRODUCTION

Bacopa monnieri (BM) is a perennial creeping herb traditionally used in the *Ayurveda* system of medicine. Its accepted *Latin* name, *Bacopa monnieri* (L.) Wettst., follows the nomenclature of the 'World Flora Online' (WFO, 2024). In *Sanskrit*, it is referred to as Nir-Brahmi, Brahmi, and Aindri, while in English it is commonly known as Water Hyssop, Indian Pennywort, or Thyme-Leaved Gratiola (Shailja Choudhary *et al*., 2021). Native to wetlands of India, Nepal, Sri Lanka, and China, it has spread globally due to its adaptability and medicinal value (Qaiser *et al*., 2023). Classified in *Ayurveda* as a *Medhya Rasayana*, BM has been extensively studied for its ability to support memory (Roodenrys *et al*., 2002), learning, and cognition (Stough *et al*., 2001). Modern pharmacological studies confirm many of these claims, demonstrating its potential in managing Alzheimer's disease, depression, and anxiety through mechanisms such as antioxidant activity, neurotransmitter modulation, and improved synaptic communication (Vyas *et al*., 2019). A and Br active compounds, bacosides A and B, are considered central to these neuropharmacological effects (Singh *et al*., 1988). Beyond neurocognitive applications, BM also exhibits anti-inflammatory, hepatoprotective, and immunomodulatory properties (Roy *et al*., 2024), underscoring its broad therapeutic scope.

*Corresponding author's e-mail: dgalaxy78@gmail.com

Although *Ayurveda* describes BM in detail, with properties such as *Madhura* (sweet), *Tikta* (bitter), and *Kashaya* (astringent) tastes, *Laghu* (light) and *Sara* (mobile) qualities, *Shita* (cooling) potency, and a *Madhura* (sweet) post-digestive effect (API, 2006), these descriptions are better understood today through modern pharmacological validation. Traditional texts credit BM with a wide range of actions including *Medhya* (cognitive enhancement), *Rasayana* (rejuvenation), *Vishahara* (detoxification), and *Vatahara* (neuromodulation). Correspondingly, contemporary studies highlight its role as a neural tonic, memory enhancer (Aguiar & Borowski, 2013), and a potential therapeutic option for neurodegenerative conditions like Alzheimer's disease (Joshi *et al.*, 2021). Its phytochemical profile includes alkaloids such as brahmine and herpestine, saponins like bacosides, and other metabolites including D-mannitol, betulic acid, stigmasterol, and b-sitosterol, which together contribute to its wide range of pharmacological effects. These include antioxidant, anti-cancer (Mishra *et al.*, 2024), antibacterial (Mehta *et al.*, 2022; Kuruvalli *et al.*, 2023), anxiolytic (Bhattacharya & Ghosal, 1998), anti-diabetic (Kapoor *et al.*, 2009), hepatoprotective (Menon *et al.*, 2010), and vasodilatory activities, among others (Shukia *et al.*, 1987; Fatima *et al.*, 2022).

The pharmacological activity of BM is largely attributed to bacosides, which are known to enhance neuronal protein synthesis, restore synaptic function, and regulate neurotransmitter levels such as serotonin (Mathur *et al.*, 2016). As such, Brahmi continues to be valued as a *Medhya Rasayana* in *Ayurveda* (Kulkarni *et al.*, 2012) and is increasingly recognised in integrative medicine for its nootropic and neuroprotective effects. While multiple pharmacological and clinical studies have validated these properties, the research field remains fragmented, with many gaps in standardised clinical trials, mechanistic studies, and global collaboration.

In this context, bibliometric analysis provides a systematic and data-driven approach to assess the global research landscape. Bibliographic reviews are no longer limited to cataloguing but serve as strategic tools to evaluate trends, research gaps, and collaboration patterns. Using databases like PubMed and Scopus, coupled with tools such as VOSviewer and Bibliometrix, this study aims to map the scientific progress on BM from January 2000 to March 2025. Unlike traditional reviews, bibliometric analysis allows for the visualisation of publication patterns, author networks, and citation impacts. Previous bibliometric studies on medicinal plants, such as those on *Ashwagandha* and *Curcumin*, have offered insights into research growth and hotspots; however, a comprehensive scientometric evaluation of BM is still lacking. This study therefore seeks to fill that gap, highlighting BM's traditional uses, pharmacological significance, and research trajectory, while also identifying areas for future investigation.

II. MATERIALS AND METHODS

The bibliometric analysis was conducted using data exclusively retrieved from PubMed and Scopus. Although this may omit some literature indexed in other databases like Web of Science or Google scholar, PubMed and Scopus database provides comprehensive coverage in areas of pharmacology, neuroscience and ethnomedicine relevant to BM.

A. Literature Search

The literature search was conducted using a combination of relevant keywords in the Title, Abstract, and Keywords fields. Initially, the terms "*Bacopa monnieri*" OR "*Brahmi*" were used; however, to ensure a comprehensive dataset, additional synonyms and common names were included, namely "*Herpestis monniera*", "water hyssop", "Indian pennywort", and "thyme-leaved gratiola". Thus, the final search strings applied were, for PubMed – ("*Bacopa monnieri*" [Title/Abstract] OR "*Brahmi*" [Title/Abstract] OR "*Herpestis monniera*" [Title/Abstract] OR "water hyssop" [Title/Abstract] OR "Indian pennywort" [Title/Abstract] OR "thyme-leaved gratiola" [Title/Abstract]); for Scopus – TITLE-ABS-KEY ("*Bacopa monnieri*" OR "*Brahmi*" OR "*Herpestis monniera*" OR "water hyssop" OR "Indian pennywort" OR "thyme-leaved gratiola"). The time frame of the study was restricted from January 2000 to March 2025. The selection of search terms was developed collaboratively by all authors. Synonyms and spelling variations for *Bacopa monnieri* were identified through preliminary scoping searches in PubMed and Scopus, consultation of controlled vocabularies such as MeSH, and cross-checking with standard ethnobotanical references. The final set of terms was validated independently by multiple authors to ensure completeness and consistency before execution of the database queries. The search strategy and keyword validation followed recommended practices for bibliometric reviews (Azizan *et al.,* 2025). The VOS viewer bibliometric analysis software was preferred for this study over other similar software mainly because of its efficiency in analysing research outputs in clusters (Obileke *et al*., 2022; Omoregbe *et al*., 2020). Additionally, VOS viewer constructs and offers a visual representation of research networks in bibliometric analysis (Moral-Muñoz *et al*., 2020). The tool VOSviewer was used for keyword co-occurrence, and citation analysis. A keyword-based search was performed using terms such as "*Bacopa monnieri*" OR "*Brahmi*" in the databases. Filters such as article type, language and publication years were applied where needed. The search results were exported in .nbib format. The .nbib file was converted to a plain text format (.csv) compatible with VOSviewer. VOSviewer was set to analyse bibliographic data (Figure 1). The type of analysis was selected as co-occurrence (keywords) and citation analysis. A minimum threshold of 10 occurrences was applied to filter significant terms. Keywords were validated independently by multiple authors, cross-checked with Medical Subject Headings (MeSH) to ensure consistency and relevance. The full counting method was applied, clustering resolution was set at 1.0, and normalisation employed the association strength method. The software generated network maps showing clusters based on term similarity. Nodes represent items (keywords), and links represent co-occurrence or collaboration strength. The resulting visualisations were used to identify major themes, research trends, and influential contributors, following established bibliometric methodologies (Azizan *et al*., 2025). Due to differences in database indexing and coverage, both PubMed and Scopus datasets were analysed to ensure comprehensive inclusion of relevant literature.

B. Screening and Deduplication

Retrieved records were exported from PubMed and Scopus into Mendeley software for reference management. Duplicate and incomplete records were automatically detected by the software and further confirmed through manual verification. A total of 302 duplicates and partial records were removed, leaving a final dataset of 1665 unique publications on BM. The retrieval and deduplication process is presented in the PRISMA flow diagram (Figure 1).

C. Inclusion Criteria

The bibliometric analysis included publications from January 2000 to March 2025 that were indexed in PubMed and Scopus. Eligible records were required to mention *Bacopa monnieri*, *Brahmi*, or their synonyms (e.g., *Herpestis monniera*, water hyssop, Indian pennywort, thyme-leaved gratiola) in the title, abstract, or keywords. The dataset consisted of original research articles, review papers, and other peer-reviewed scholarly works that explored pharmacological properties, therapeutic applications, clinical studies, ethnobotanical relevance, or molecular investigations of *Bacopa monnieri.* Only English-language publications, or those with English abstracts and sufficient bibliographic metadata (such as author details, keywords, and publication year), were considered suitable for analysis in VOSviewer.

D. Exclusion Criteria

Exclusion criteria omitted studies published outside the January 2000– March 2025 time frame, non-peer-reviewed sources such as newsletters, blogs, or magazines, and publications unrelated to BM. Works in languages other than English without English abstracts or bibliometric metadata, duplicate entries, and records lacking essential citation information were also excluded. In addition, publications that mentioned *Brahmi* only in passing, without substantive focus on its pharmacological, clinical, or therapeutic aspects, were removed to ensure the dataset retained analytical relevance and integrity for bibliometric mapping.

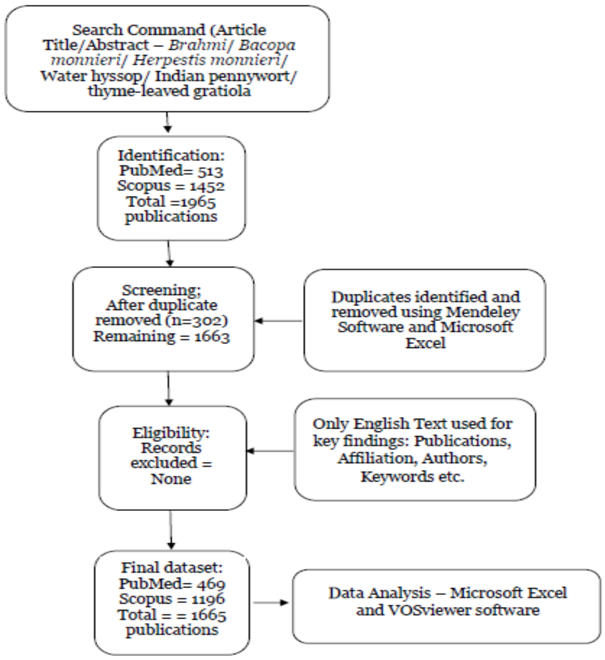

Figure 1. PRISMA flow diagram of the literature search and screening process

III. RESULTS AND DISCUSSION

A. PubMed

PubMed is a free and authoritative database maintained by the U.S. National Library of Medicine, offering access to over 35 million citations for biomedical literature. It is widely used by researchers and healthcare professionals for evidence-based information from peer-reviewed journals.

1. Research trends on Bacopa monnieri

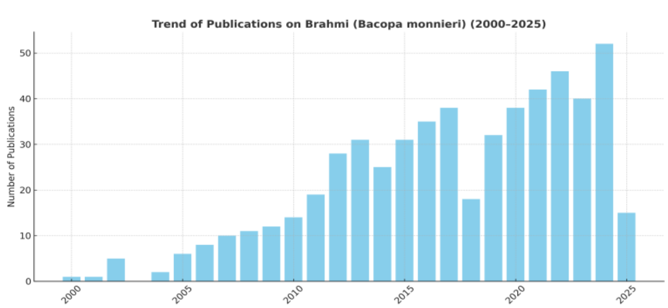

Figure 2. Rising research trends on *Bacopa monnieri* in PubMed (2000–2025)

From year January 2000 to March 2025, a total of 469 articles were recorded in the PubMed database. In recent years, research interest in BM has shown a consistent upward trend, reflecting its growing significance in scientific and medical studies. The number of publications related to BM has steadily increased, with 52 articles in 2024, 40 in 2023, and 46 in 2022, demonstrating sustained academic attention. The latest data up to March 2025 already indicates 15 publications, suggesting continued exploration of its pharmacological and therapeutic potential. This increasing volume of research underscores the herb's relevance in neuroscience, cognitive enhancement, and traditional medicine, reaffirming its importance in both *Ayurveda* and modern phytotherapy. From year January 2000 to March 2024, out of 469 articles, 152 are related to clinical studies and 72 are related to review articles (Figure 2). Data visualisation and cluster mapping in VOSviewer were performed following established bibliometric methodologies (Azizan *et al.*, 2025).

2. The co-authorship analysis

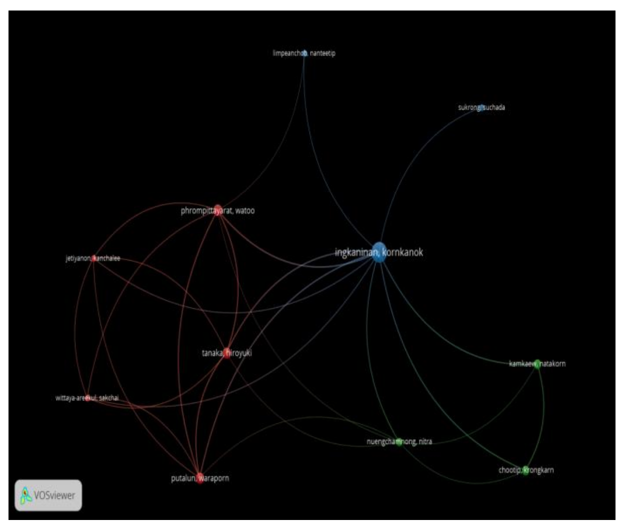

Figure 3. The co-authorship analysis of *Bacopa monnieri* related publications in PubMed

The co-authorship analysis of BM related publications reveals a well-defined collaborative structure, with distinct clusters of researchers contributing significantly to the field. The central figure in this network is Kornkanok Ingkaninan, who shows the highest level of collaboration across multiple clusters, indicating her pivotal role in bridging research groups. Her connections span across authors such as Nanteetip Limpeanchob, Suchada Sukrong, and Nitra Nuengchamnong, reflecting both interdisciplinary and inter-institutional collaborations. The red cluster, comprising authors like Watoo Phrompittayarat, Hiroyuki Tanaka, Waraporn Putalun, and Sakchai Wittaya-areekul, displays a tightly knit network, suggestive of sustained co-publication efforts likely focused on phytochemistry and analytical studies. Similarly, the green cluster including Natakorn Kamkaew, Krongkarn Chootip, and Nitra Nuengchamnong suggests a secondary collaborative group, potentially engaged in pharmacological and neuroscientific research. The co-authorship visualisation emphasises the collaborative nature of BM research in Southeast Asia, especially Thailand and Japan. The centrality of Kornkanok Ingkaninan indicates her influence in shaping research directions, possibly by integrating traditional herbal knowledge with modern pharmacological and biochemical techniques. Such networks are crucial for driving translational research, encouraging methodological innovation, and maintaining scientific momentum in the field of neuropharmacognosy (Figure 3).

3. The institutional collaboration

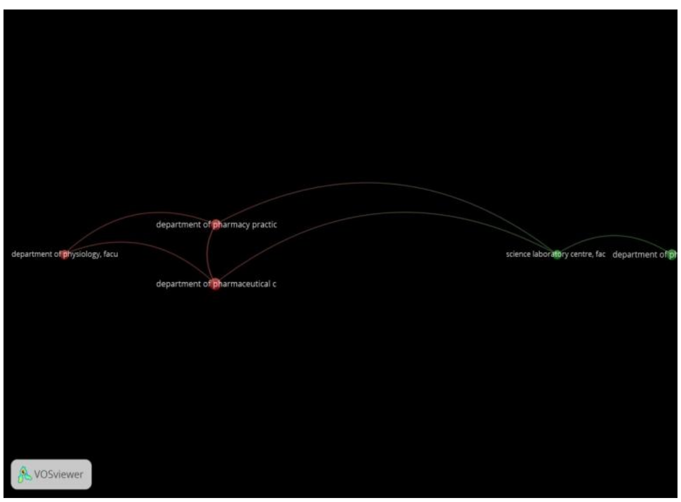

Figure 4. The institutional collaboration of *Bacopa monnieri* research in PubMed

The institutional collaboration analysis indicates a modest yet meaningful network of academic partnerships in BM research. Two primary clusters are evident, each representing collaborative efforts within and between institutions. The first cluster (red nodes) includes the Department of Pharmaceutical Chemistry, Department of Physiology, and Department of Pharmacy Practice, all possibly from the same or closely associated faculty, indicating a multidisciplinary approach combining pharmaceutical sciences and physiological studies. The second cluster (green nodes) includes the Science Laboratory Centre and another Department of Pharmaceutical Chemistry, suggesting inter-departmental and potentially inter-institutional collaborations, possibly between research and teaching laboratories. These connections demonstrate that while collaboration exists, it is relatively limited in scope and density, reflecting the need for broader institutional networking. Enhanced interdisciplinary and inter-institutional collaboration can foster more robust and innovative research outputs in phytopharmacology, especially in complex subjects like neuropharmacological effects of BM. Strengthening these academic linkages could help unify diverse scientific approaches, such as phytochemistry, pharmacodynamics, and clinical validation, thus advancing evidence-based applications of traditional medicinal plants (Figure 4).

4. Co-occurrence by MeSH keywords

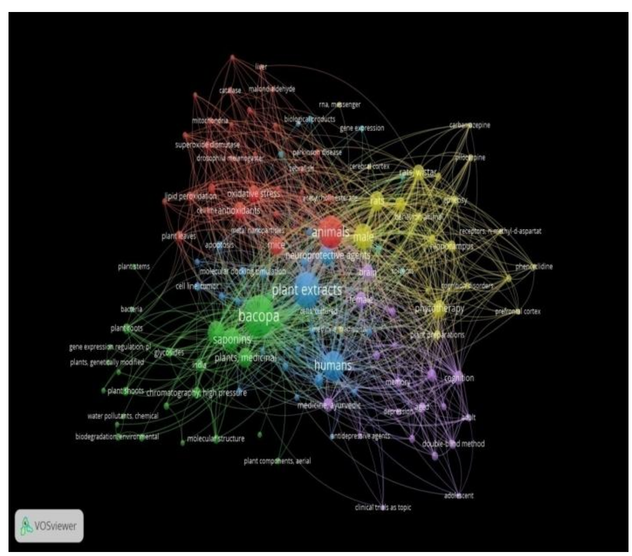

Figure 5. A bibliometric co-occurrence analysis of MeSH terms related to *Bacopa monnieri* research in PubMed

A bibliometric co-occurrence analysis of MeSH (Medical Subject Headings) (Dhammi & Kumar, 2014) terms related to BM research reveals six prominent thematic clusters, each representing key focus areas in the literature. The green cluster centres around *bacopa*, *saponins*, and *medicinal plants*, highlighting the pharmacognostic and phytochemical investigations of the herb. This cluster connects with studies involving chromatographic techniques, plant anatomy, and molecular structures—indicating significant interest in chemical profiling and quality control. The red cluster encompasses terms like *oxidative stress*, *antioxidants*, *superoxide dismutase*, and *lipid peroxidation*, reflecting a major emphasis on the antioxidant properties of BM. These studies often employ models like *Drosophila melanogaster*, *mice*, and *rats*, linking closely with the blue cluster focused on *neuroprotective agents* and *plant extracts*. This cluster underscores experimental validations of neuroprotective mechanisms, including anti-apoptotic and mitochondrial modulation pathways. The yellow cluster is dominated by terms like *rats*, *Wistar*, *hippocampus*, and *behaviour, animal*, denoting extensive usage of rodent models to study cognitive and neurological outcomes. The purple cluster connects *phytotherapy*, *memory*, *cognition*, *double-blind method*, and *clinical trials*, revealing a strong translational dimension in the field, with numerous clinical and behavioural investigations assessing the efficacy of BM in humans. Finally, the light blue cluster featuring *humans*, *Ayurvedic medicine*, and *traditional medicine* signifies the contextual grounding of research in ethnopharmacology and integrative health. The close linkage of *Ayurveda* with both clinical and mechanistic clusters demonstrates the herb's dual presence in traditional and evidence-based frameworks. Overall, the co-occurrence network illustrates a multidisciplinary research landscape, integrating phytochemistry, preclinical experimentation, neurobiology, and clinical sciences. This diversity affirms BM as a phytotherapeutic agent of growing global relevance, supported by converging lines of inquiry from both traditional and modern biomedical sciences (Figure 5).

5. Network visualisation of research trends in Bacopa monnieri and neuroprotection

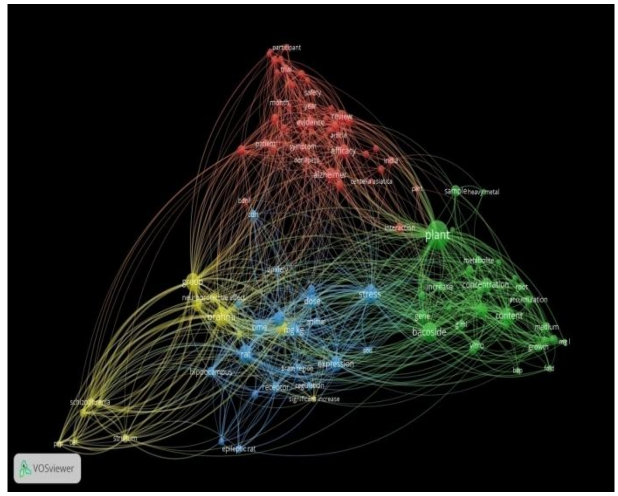

Figure 6. Network visualisation of research trends of *Bacopa monnieri* and Neuroprotection in PubMed

The network visualisation generated using VOSviewer represents the co-occurrence of keywords in research related to BM and its neuroprotective effects. The clusters indicate different research themes: the red cluster is centred on clinical trials, Alzheimer's disease, and evidence-based efficacy; the green cluster focuses on plant metabolites, bacoside concentration, and phytochemical accumulation; the blue cluster highlights stress, gene expression, and neurophysiological responses in animal models; and the yellow cluster links BM with schizophrenia, hippocampus-related studies, and neuroprotective effects. The interconnected nature of the clusters suggests a growing body of research integrating traditional medicine, pharmacological validation, and clinical applications in cognitive and neurodegenerative disorders (Figure 6).

6. Temporal evolution of research on Bacopa monnieri and neuroprotection

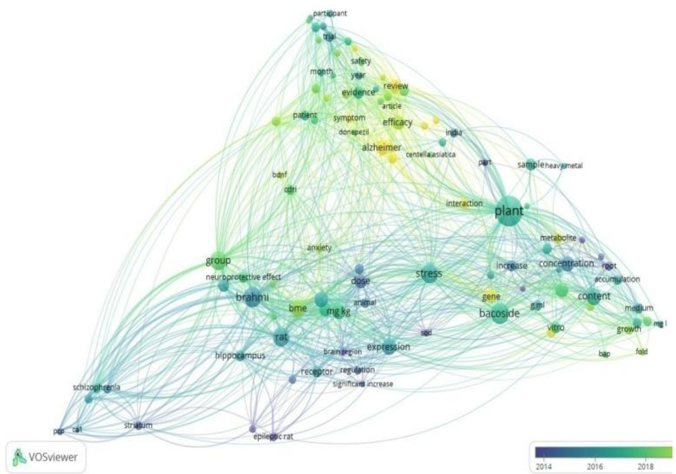

Figure 7. Temporal evolution of research on *Bacopa monnieri* and Neuroprotection in PubMed

The overlay visualisation of keyword co-occurrence, generated using VOSviewer, illustrates the temporal progression of research on BM and its neuroprotective properties from 2014 to 2020. The colour gradient from blue (older research) to yellow (recent studies) indicates evolving research focus areas. Earlier studies (2014–2016) were centred around animal models, hippocampal effects, and schizophrenia, whereas more recent research (2018–2020) shifted toward clinical trials, efficacy evaluations, and plant-based metabolite analysis. The increasing connections between *Bacopa* BM, Alzheimer's disease, and stress biomarkers suggest a growing emphasis on translational research, bridging preclinical studies with human clinical applications (Figure 7).

B. Scopus

Scopus is a journal indexing and abstract database that has research publication links produced by Elsevier (Burnham, 2006). Scopus also offers comprehensive insights and access to data on research publications in many disciplines with life and natural sciences leading the pack (Md Khudzari *et al.*, 2018). To explore collaborative patterns among authors, a co-authorship analysis was conducted using VOSviewer for the Scopus database.

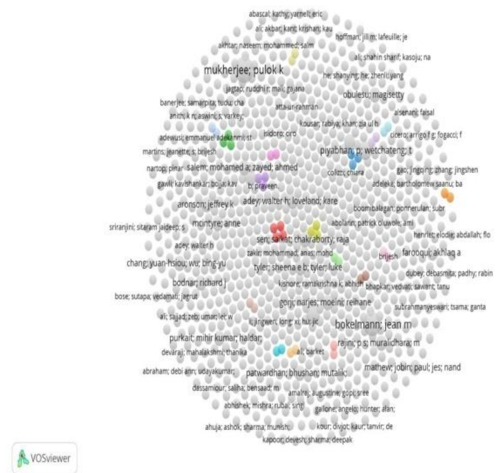

Figure 8. The co-authorship analysis of *Bacopa monnieri* related publications in Scopus

From year January 2000 to March 2025, a total of 1196 articles were recorded in Scopus. The resulting network visualisation (Figure 7) highlights key contributors and research clusters within the dataset. Each node represents an individual author, with the size of the node proportional to the number of publications or total link strength. Prominent authors such as *Mukherjee, Pulok K* and *Sen, Saikat* emerged as central figures, indicating high levels of collaboration and influence within the field. The color-coded clusters reflect distinct research groups actively engaged in thematic collaboration. The density and proximity of the nodes suggest an interconnected scholarly community, with several authors forming strong intra- and inter-cluster links. This analysis underscores the collaborative nature of the domain and helps identify influential researchers and emerging research networks. Keyword co-occurrence analysis revealed five dominant thematic areas in integrative medicine research, including phytotherapy, clinical trials, and ethnopharmacology, indicating the growing interdisciplinary approach in this domain. Citation network analysis identified Pulok K. Mukherjee (2015) and Saikat Sen (2017) as central references, reflecting their foundational role in phytochemical standardisation methods (Figure 8).

1. Collaborative and disciplinary trends in ethnopharmacology research

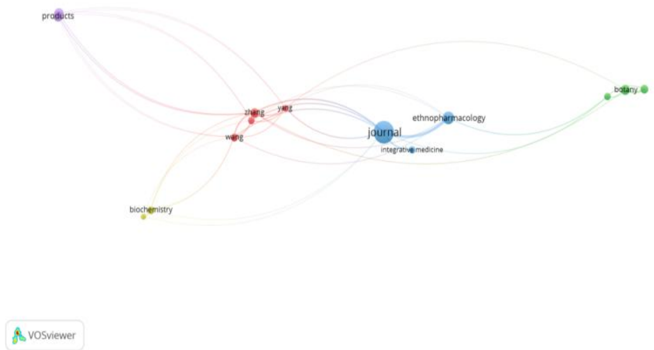

Figure 9. Collaborative and disciplinary trends in *Bacopa monnieri* research in Scopus

A bibliometric network visualisation reveals key research clusters in ethnopharmacology, integrative medicine, and related scientific disciplines. The figure illustrates distinct connections between subject areas such as botany, biochemistry, and pharmaceutical products, emphasising the interdisciplinary nature of medicinal plant research. Notably, influential researchers, including Zhang, Yang, and Wang, form a collaborative hub, likely contributing significantly to knowledge dissemination in ethnopharmacology. The central positioning of "journal" highlights the role of scientific publications in bridging various domains. These insights suggest that future research can benefit from enhanced cross-disciplinary and international collaboration, further advancing the evidence base for traditional medicine applications (Figure 9).

2. Mapping research trends in medicinal plants and neuroprotection

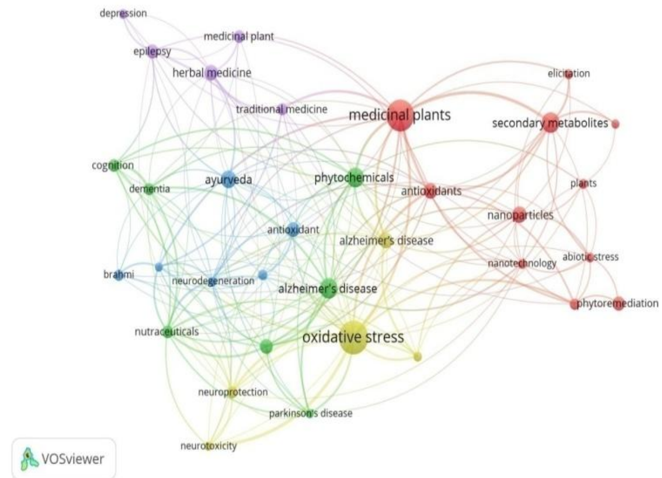

Figure 10. Mapping research trends of *Bacopa monnieri* and neuroprotection in Scopus

A keyword co-occurrence analysis highlights key thematic clusters in medicinal plant research, particularly their role in neurodegenerative diseases and oxidative stress. The network visualisation reveals strong interconnections between medicinal plants, phytochemicals, antioxidants, and oxidative stress, indicating their significance in combating neurodegenerative disorders such as Alzheimer's and Parkinson's disease. The prominence of *Ayurveda*, *Brahmi* (*Bacopa monnieri*), and nutraceuticals underscores the relevance of traditional medicine in modern therapeutic approaches. Another major cluster focuses on secondary metabolites, nanoparticles, and phytoremediation, suggesting a growing interest in biotechnology applications for enhancing medicinal plant efficacy. These insights emphasise the interdisciplinary nature of current research, bridging ethnopharmacology, phytochemistry, and nanotechnology, and highlight the need for further integrative studies on medicinal plants for neuroprotection (Figure 10).

3. Temporal trends in medicinal plant research for neuroprotection

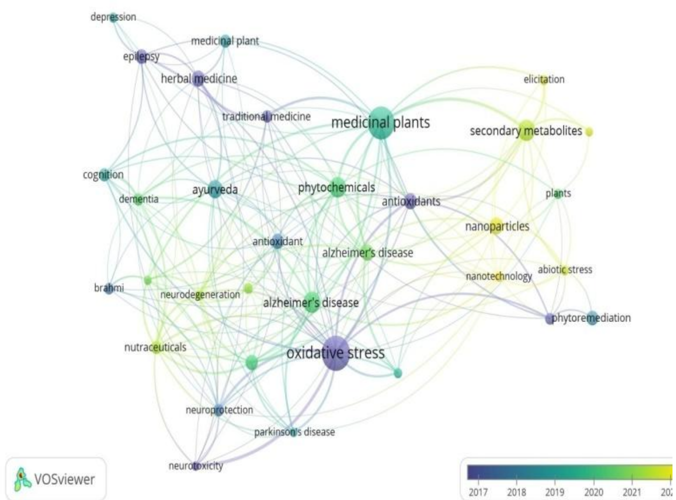

Figure 11. Temporal Trends in Research of *Bacopa monnieri* for Neuroprotection

The visualisation of keyword co-occurrence over time provides insights into the evolving landscape of medicinal plant research, particularly in neuroprotection. The colour gradient from blue (2017) to yellow (2022) indicates the progression of scientific focus. Initial studies concentrated on oxidative stress, neurodegeneration, and antioxidants, highlighting their fundamental role in neuroprotection. Over time, research has expanded to include secondary metabolites, nanoparticles, and nanotechnology, reflecting an increasing interest in enhancing bioavailability and therapeutic efficacy. Traditional medicine, including *Ayurveda* and herbal medicine, remains a key area, emphasising the integration of ethnopharmacology with modern scientific advancements. The prominence of Alzheimer's disease, Parkinson's disease, and cognition-related studies suggests a growing recognition of medicinal plants in combating neurodegenerative disorders. This trend underscores the importance of interdisciplinary research, merging phytochemistry, nanotechnology, and neurobiology to develop innovative therapeutic approaches (Figure 11).

C. Key Journals in the Dissemination of Bacopa monnieri Studies

Among the journals analysed, out of 249 journals, the *Journal of Ethnopharmacology* with impact factor 5.4 appeared most frequently, being cited 80 times. This was followed by *Industrial Crops and Products with impact factor 6.2*, which was mentioned 58 times. The *South African Journal of Botany* (*impact factor* 2.7) was cited 41 times, while *Chemosphere* (*impact factor* 8.1) appeared 24 times. Additionally, *Plant Physiology and Biochemistry* (*impact factor* 5.7) was referenced 22 times. This distribution highlights the prominent role these journals play in the field under review.

D. Top Cited Articles

The VOSviewer map highlights the most cited publications on BM. Mukherjee *et al.* (2007) received the highest citations (709), followed by Mishra *et al.* (2006) with 490, Bogaard *et al.* (2009) with 451, Kumar and Khanum (2012) with 433, and Saper, (2008) with 416. The larger node size of Mukherjee (2007) reflects its dominance, while the dispersed layout suggests that these influential works developed independently rather than within tightly connected clusters. In addition, other highly cited studies include Krishnaraj *et al.* (2012) with 392 citations, Russo and Borrelli (2005) with 379, Chaturvedi and Flint Beal (2013) with 377, Sarris *et al.* (2011) with 364, and Singh, Eapen and D'Souza (2006) with 360, further demonstrating the diverse yet influential contributions shaping the global research landscape on *Bacopa monnieri*.

E. Country-wise Collaboration Network

The bibliometric analysis revealed that research on BM has been dominated by contributions from India, which produced the highest number of publications (1144 documents), reflecting the herb's strong roots in Ayurveda and traditional medicine practices. The United States ranked second with 139 publications, highlighting its role in exploring BM through modern pharmacological and clinical research perspectives. Other notable contributors include Australia (68), Thailand (60), China (47), and Pakistan (46), indicating a growing regional interest in Asia-Pacific countries. Saudi Arabia (41), the United Kingdom (36), Malaysia (30), and Germany (28) also showed significant participation, though comparatively lower (Table 1). These figures suggest that while India remains the leading hub of BM research, global collaboration and interest are steadily expanding, particularly in countries with established programs in medicinal plants, pharmacognosy, and complementary medicine.

Table 1. Country-wise distribution of documents, citations and collaboration strength of BM research in traditional and herbal medicine related publications (Scopus, 2000–2025)

Name of Country	Number of documents	Number of citations	Total link strength
India	1144	28934	122
United States	139	6370	71
Australia	68	3720	36
Thailand	60	1529	13
China	47	1027	18
Pakistan	46	1102	29
Saudi Arabia	41	990	44
United Kingdom	36	2109	16
Malaysia	30	933	22
Germany	28	553	15

F. Trends, Gaps and Future Research Directions

The bibliometric analysis of BM research reveals several noteworthy trends over the past two decades. There has been a steady and significant increase in the number of publications, particularly from 2010 onwards, reflecting a growing global interest in the pharmacological and therapeutic applications of this herb. A notable shift toward evidence-based research is observed, with increasing numbers of randomised controlled trials, systematic reviews, and meta-analyses exploring its neurocognitive, antioxidant, and adaptogenic effects. Thematic clustering shows a strong focus on memory enhancement, neuroprotection, and anti-inflammatory activity, indicating the dominance of neuroscience and phytopharmacology as key disciplinary areas. International collaboration has also intensified, with substantial contributions from countries such as India, the United States, Australia, and China. Key journals such as the *Journal of Ethnopharmacology*, *Industrial Crops and Products*, and the *South African Journal of Botany* have emerged as influential platforms for disseminating research findings on BM.

The bibliometric patterns identified in this review provide actionable insights for guiding future collaborations and research investments. Leading authors and institutions mapped in this analysis can serve as potential hubs for building multicentric networks, particularly between countries with established strengths in BM research such as India, the United States, and Australia. Similarly, thematic clusters highlight priority areas where targeted funding could accelerate knowledge generation, such as neurocognitive applications, phytopharmacology, and clinical trials. Aligning collaboration and funding priorities with these bibliometric hotspots may enhance research efficiency, avoid duplication, and foster impactful translational outcomes. Moreover, integration of these insights into the agendas of major funding agencies and global policy frameworks, such as the WHO Traditional Medicine Strategy, can further support evidence-based expansion of BM research at both national and international levels.

While pharmacological studies are abundant, many lack detailed investigations into the underlying molecular and cellular mechanisms, particularly those involving neurogenesis and synaptic plasticity. Another challenge is the absence of standardised formulations, as inconsistencies in extraction methods, dosages, and phytochemical profiles hinder the ability to compare results across studies. Furthermore, there is limited interdisciplinary integration with fields such as systems biology, network pharmacology, multi-omics approaches (genomics, transcriptomics, proteomics, metabolomics), and AI-driven drug discovery, all of which hold promise for uncovering novel mechanisms and therapeutic targets. Age-specific clinical studies, particularly in paediatric and geriatric populations, are also underrepresented, despite traditional use of the herb in both age groups.

To advance the field, future research should prioritise standardisation and quality control in extract preparation, ensuring rigorous phytochemical characterisation and reproducibility. Mechanistic studies employing modern techniques such as genomics, proteomics, and metabolomics are essential to elucidate the pathways responsible for its therapeutic effects. Clinical research should be expanded to include larger, well-controlled trials across different age groups and health conditions, including cognitive disorders, attention deficit disorders, and neurodegenerative diseases. Exploring synergistic combinations of BM with other adaptogens or allopathic agents may yield enhanced therapeutic benefits. Ethnopharmacological studies documenting traditional knowledge from diverse communities can provide valuable insights and uncover novel uses. Lastly, sustainability-focused research on cultivation practices, conservation, and ecological impact is crucial to support increasing demand while preserving natural resources. In addition, the integration of AI-driven drug discovery, network pharmacology and multi-omics approaches offers powerful opportunities to accelerate target identification, optimise formulations, and deepen mechanistic insights, thereby advancing BM research toward clinical translation.

When viewed in the broader context of global herbal medicine bibliometric patterns, BM research follows trends observed for other medicinal plants such as ginseng, turmeric and *Ginkgo biloba*, where neuroscience and pharmacology driven investigations dominate the landscape. However, unlike turmeric and ginseng, which have achieved higher levels of clinical standardisation and international commercialisation, BM research remains largely fragmented in terms of extract uniformity and regulatory alignment. The continued growth of global herbal medicine bibliometrics highlights increasing interdisciplinarity and translational applications, suggesting that future BM studies could benefit from adopting similar frameworks to enhance global visibility, clinical acceptance, and integration into evidence-based practice.

IV. CONCLUSION

This review systematically maps the research landscape of (BM) from 2000 to 2025, revealing its expanding global significance in neuroprotection, cognitive health, and integrative medicine. Analysis of 469 PubMed and 1,196 Scopus records show a consistent rise in publications, with major contributions from Southeast Asia and central figures such as Kornkanok Ingkaninan and Pulok K. Mukherjee. Keyword and MeSH clustering confirm multidisciplinary interests in phytochemistry, oxidative stress, and clinical applications. BM's neuropharmacological promise, particularly through bacosides A and B, is increasingly validated, yet challenges remain most notably the scarcity of multicentre clinical trials, inadequate standardisation of extracts, and underexplored mechanistic pathways. Future research should emphasise rigorous phytochemical profiling, well-designed clinical trials across age groups and integrative approaches using omics and nanotechnology to realise BM's translational potential.

Beyond documenting BM's progress, this review advances bibliometric methodology by integrating PubMed and Scopus datasets with VOSviewer analyses. Co-authorship, institutional collaboration, and keyword mapping reveal hidden networks, research hotspots, and thematic trajectories. By combining bibliographic depth with bibliometric visualisation, the study demonstrates how such dual approaches can guide strategic collaboration, funding priorities, and policy alignment. This framework provides a replicable model for evaluating other medicinal plants, strengthening both ethnomedicine research and the methodological toolkit for evidence mapping in complementary and herbal pharmacology.

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VI. CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

VII. REFERENCES

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