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Mapping the Landscape of Neem Tree Research: Insights into Chemicals and Polymers through Bibliometric Exploration

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Abstract

Azadirachta indica A. Juss, often referred to as Neem, is a rapidly developing tree that falls under the Meliacea family. For more than two millennia, Indians has relied on neem oil for its healing properties. Thus, to know the importance of neem tree, the study is needed. The Neem tree has been a subject of extensive research owing to its diverse array of chemicals and polymers with multifaceted applications. This bibliometric exploration aims to map the research landscape surrounding the Neem tree, shedding light on the key chemical compounds and polymer-based materials derived from this botanical marvel. It investigates the distribution of research output across geographical regions, identifying prolific contributors and emerging research hubs. Moreover, it delineates the chronological evolution of research themes, from traditional applications to cutting-edge innovations. Thus, the focus of study is to know different aspects of neem tree and its medicinal importance in human life. In order to provide a summary of research activity in this area and identify its most significant features, this work presents a bibliometric analysis of the neem plant.

Keywords: Phytochemical Analysis, Therapeutic Properties, Botanical Investigations, Polymeric extracts, Natural Product Chemistry.

INTRODUCTION

Azadirachta indica, a rapidly growing evergreen tree, can attain heights of 15-20 meters. It is one of two species within the genus, the other being M. azedarac. Native to India and Pakistan, Azadirachta thrives in tropical and semi-tropical climates. Neem oil is extracted from the plant's fruits and seeds. The bark, leaves, seeds, and flowers of the tree are all reputed to have therapeutic qualities and are utilized to make a wide range of medical concoctions.

The medication and its different forms have been referenced in Ayurvedic scriptures and Samhitas, as well as the uses of this medication. It is thought that neem products have anthelmintic, antifungal, antidiabetic, antibacterial, antiviral, sedative, and contraceptive properties. Plant pests can also be managed with neem treatments. It has also been demonstrated to be useful in treating indolent ulcers, rheumatism, and persistent syphilitic sores. Together, bark, leaf, root, flower, and fruit treat pthysis, biliary ailments, itching, skin ulcers, and blood morbidity [1],[2].

Phytopharmacologists were initially made aware of the plant by Indian scientists. While employed at Delhi University at British India's Scientific and Industrial Research Laboratory in 1942, three bitter compounds—named nimbin, nimbinin, and nimbidin—were isolated from neem oil. Azadirachtin is a complex secondary metabolite found in the seeds [3-5] Figure 1.

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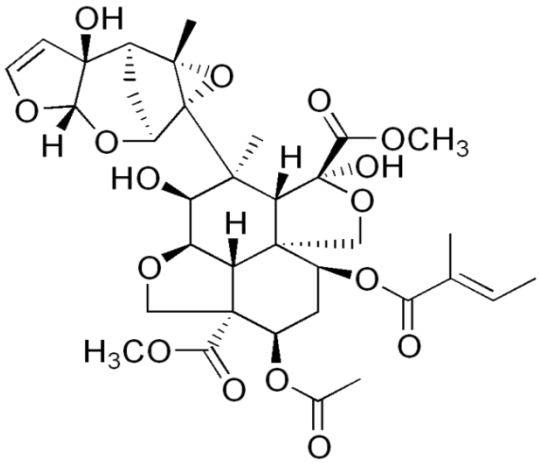

Figure 1. Chemical structure of *Azadirachta indica*

A bibliometric analysis of a single journal paints a picture of the journal and provides a description that goes beyond the surface level of understanding. It can reveal the caliber, excellence, and performance of journals in any industry, in any country or region. In addition, it provides information about the direction of the research being driven and how it affects the author's decision about which channels to use to find information related to the communication or research goals. [6-8]. The journal under examination is frequently evaluated based on its caliber, the level of influence it makes in an area, the analysis also examined the journal's capacity to disseminate information, its pattern of authorship and collaboration within the field, its influence on the national and international stages, and its reputation as a platform for various subfields of research. Put differently, individual periodical studies have been conducted for a variety of causes spanning different fields and geographical areas. According to “Nebelong-Bonnevie and Frandsen”, single journal studies offered a comprehensive, multifaceted image of a single publication's features. To determine the attributes, caliber, and standing of the journal, bibliometric indicators are nearly always employed as the evaluation instrument for single journal research [9-11]. The bibliometric research on individual journals grouped under wide topic groups will be reviewed in this study. Tiew in 1997 wrote the first review of a single journal study. "A review of bibliometric research conducted by a single scientific journal from 1969 to the present" is the clear and specific objective of the review [12-14]. The US, followed by Europe, Russia and India account for more than half of the authors active in the journal. This article will provide a bibliometric analysis of individual journals published after 1997 between 1998 and 2008. [15-17].

It is generally accepted that the Russian phrase "naukometriya" (measuring of science), which was first used by Nalimov and Mulchenko in 1969, is where the word "scientometrics" originated. The public's familiarity with the term expanded with the publication of De Solla Price's "Science Since Babylon" in its second edition. But it was the debut of the Scientometrics journal. Scientometrics. A Global Journal for Every Quantitative Aspect of Science, Science Policy, and Science of Science 0138-9130 is the ISSN Sept. 1978; Vol. 1, No. 1. Amsterdam's Elsevier Science Publishing Company and Budapest's Adémiai Kiadó. Most recent edition accessible (as of September 2001): Scientometrics. As of September 2001, Scientometrics is the most recent issue that is accessible. Budapest's Akadémiai Kiadó and Dordrecht's Kluwer Academic Publishers that convinced everyone in question that there is, in fact, a separate study field operating under this moniker [18-19]. As the journal's subtitle states to this day, Tibor Braun, the journal's founder and current Editor-in-Chief, intended for the publication to serve as a common hub for all types of quantitative science research. Therefore, it makes sense to assume that a summary of the journal will also take into account how the field of study has evolved over the previous few decades. I cannot promise an impartial and objective summary because I have been a scientometrics researcher for around 25 years and have served on the editorial board of the journal Scientometrics for nearly 20 of those years. What I can provide is a compilation of data regarding the journal that comes from "first-hand" knowledge [20].

In some other researches, microcrystalline cellulose from Citrus x sinensis sweet orange peel fruit waste-based biomass for polymer composite applications has been discussed[21].In yet another research a sustainable alternative for synthetic fibres in polymer composites reinforcement is discussed[22]. Influence of washing with sodium lauryl sulphate (SLS) surfactant on different properties of ramie fibres has been discussed[23]. Extraction and characterization of fiber from the flower stalk of Sansevieria cylindrica[24] is discussed. A review on natural fiber composites: Polymer matrices, fiber surface treatments, fabrication methods, properties, and applications[25] has also been reviewed for our study.

Humans and animals have long relied on plants. In China, 800–400 BC. in India and 1500 AD in Egypt. Date palm or Phoenix dactylifera L. is considered one of the earliest fruit plants. The Arabs refer to it as the "Tree of Life" and "nakhla." The countries surrounding the Arabian Gulf are thought to be its native home (Chandra, Chandra & Gupta), Its tree has been utilized for many different things, including as making paper, building materials, animal feed, and domestic items. However, until 1969, there was little interest at all in date palms in scientific inquiry. Only 28 publications were published between 1938 and 1969—a lengthy 42-year period—after the first publication was officially registered. The amount of scholarly literature on date palm has been gradually increasing as a result of these advancements [1-5]. Numerous bibliometric studies have been conducted to examine the features of particular literary corpora. This method can be used to predict publishing trends, detect research trends, and track the expansion of knowledge across a range of areas. It is also possible to investigate "longitudinal shifts in concept clusters" using bibliometric analysis [7-10]. Scientists are interested in such research, according to a study conducted by Zus'man, which examined the usage of bibliometrics among 294 scientists [11-13]. Our understanding of the creation and interchange of information in the scientific realm is aided by the analysis of citations that show the flow of documentary material across disciplines. In order to determine the research emphasis and significant patterns that may be emerging, a demographic analysis of a certain body of literature might be employed.

REVIEW OF LITERATURE

Numerous studies on plants, herbs, crops, specialized periodicals, and particular subjects have been done. In his 2017 article, Nirmal Singh conducted a study to analyze the growth of scientific literature on Azadirachta indica (Neem) in journals using bibliometric analysis. He also included a summary of research activities conducted on the topic, delving into various facets of the body of literature. A bibliometric survey of the literature on meteorology from 2006 to 2009 was conducted by Krishnamurthy [5]. 1651 articles from the ISI Web of Science were gathered by him. His study's findings demonstrated that several authors produced the greatest number of papers, and that the growth rate of publications peaked in 2009.

In the paper titled "A bibliometric analysis of the Punica granatum L. literature," Charlene L. Al-Qallaf [6] explored the intellectual structures of Punica granatum L. (Pomegranate) literature to identify trends and patterns. He assessed the body of literature, publishing kinds, author distribution, language dispersion, and journal literature features in this study.

Using Bradford's and Lotka's laws, Gyan Singh [7] carried out a bibliometric analysis of Embelia Ribes to identify the numerous research trends in this area. Bradford's law of dispersion was found to fit the study's results, which had a distribution of $1:n:n^2$.

Hameed et al. [8] used an aqueous neem extract and biodegradable, mucoadhesive biopolymers to create controlled-delivery nanofibers using electrospinning, a more environmentally friendly and sustainable method of manufacturing. Consequently, the synthesized biocompatible nanofibrous materials with a biphasic release profile may find use in soft tissue scaffolds, transdermal carriers, and wound dressings, among other biomedical applications.

Achutha et. al, [9] Employing the solvent casting technique, Neem Oil (NO) was incorporated into the polymer matrix to develop antimicrobial films utilizing Polyvinyl Alcohol (PVA). The intermolecular hydrogen bonding between PVA and active NO constituents effectively impedes NO migration from the polymer matrix. The resultant polymer film exhibited notable antifungal and antibacterial efficacy against Rhizopus and Aspergillus niger, as well as Pseudomonas aeruginosa and Escherichia coli. Additionally, when compared to conventional packaging materials prevalent in the market, it significantly prolonged the shelf life of food products.

Ramesh et al. [11] examined a few features of the citations extracted from two cowpea bibliographies spanning the years 1888 through 1973. It was discovered that the literature increased every 20 years, that 87% of the literature was written in English, and that journals were the most widely used publication medium. Subbaiah conducted a study examining 1,373 citations on Indian grape research from 1901 to 1981, based on a comprehensive published bibliography. The study revealed that journals were the main source of information, research activities were concentrated in specific regions, and collaborative research was increasing. They discovered that whereas 1.2% of the authors contributed to 27.4% of the papers, 89.02% of the 1,111 publications were written by several authors. It is important to note that 96.4% of all papers were written in English, while over 56% of this literature was created in India. Anwar analyzed 530 references related to Nigella sativa, commonly known as black seed, sourced from 20 different databases. Additionally, for this collection of references, 28 titles (9.3%) were identified as core journals. It demonstrated how, since 1971, the amount of literature has increased, going from one citation annually to 46 papers in the 1990s. Chemistry and the Medical Sciences produced the majority of the literature. Approximately two-fifths of the publications were provided by 36 (13.8%) out of 261 journals, and four-fifths of the citations were the outcome of teamwork. The research language for this topic was English.

Velmurugan, C., & Radhakrishnan, N. et al. [12] conducted a study wherein they compiled a list of the top 100 most cited publications in twenty doctoral dissertations in plant pathology submitted to Indian universities between 1980 and 1993. These top publications collectively accounted for 73.01% of the total citations. Additionally, Krishna and Kumar analyzed 8,401 citations found in 68 agricultural theses submitted to Indian institutions between 1996 and 2000. Mera (1998) examined topic, language, geographic distribution, author level and journal, and other characteristics. 4840 plant ecology citations from publications published between 1994 and 1995.

Nirmal Singh and colleagues [13] conducted a bibliometric analysis to elucidate the scholarly literature's evolution concerning Azadirachta indica in journals. Their study aimed to provide an overview of research activities on the topic, encompassing various aspects of scientific literature. The researchers utilized PubMed to retrieve data in August 2015, employing the term "Azadirachta indica" along with alternative search terms like "neem," "Indian lilac," and "margosa." The search was restricted to English-language journal papers published until 2014, resulting in 1,198 relevant publications. After data collection in Excel format, the researchers analyzed frequencies and percentages of publications. Additionally, they applied Bradford's law of dispersion to assess article distribution patterns and Lotka's law to evaluate author output. The findings revealed that nearly all publications (99.472%) involved multiple authors, and author productivity, considering both the first author and all authors, did not adhere to Lotka's law with a value of n=2. Moreover, the distribution of journal articles closely followed Bradford's law of scattering, indicating a significant contribution from a small number of core publications in the field of Azadirachta indica. This study contributes an insightful overview of research on Azadirachta indica.

Norazlina Hashim et al. [15] proposed that Azadirachta indica, or neem leaves, have demonstrated efficacy in medical and consumer goods because of the bioactive substances they contain. To maximize

the extract yield, the best solvent needs to be investigated. Two extraction techniques—Soxhlet and immersion methods—were used in this investigation to determine which yields a higher concentration of neem extract. Following weeks four and eight, the physical characteristics and stability tests were examined. The yield percentages obtained using the two techniques were noted. Every extract's crude oil produced a dark, foul-smelling solution with a high viscosity. The highest yield percentages were obtained from the immersion method's ethanol extraction (22.0%) and the Soxhlet extraction (21.5%), indicating that ethanol significantly enhanced the extraction process. Since distilled water is both economical and environmentally benign, it was chosen to investigate the solvent's possibilities using the immersion method. The amount extracted was less than what was achieved with other solvents, and extraction at 90°C produced the highest yield. Finally, at 90°C during extraction, the maximal yield of ethanol was obtained.

Mumtaz Ali Anwar et al. [16] proposed that a bibliometric analysis of the literature on Phoenix Dactylifera L (date palm) was conducted for this study. The aim of the study was to examine the geographical origin, topical focus, author patterns, language dispersion, and periodic expansion of literature on dates. A thorough search was conducted across various online library catalogs and associated databases to compile a final list of 2,465 citations. This dataset was then analyzed for different bibliographic features. Before 1970, there was hardly any publication on date palms; by the 1990s, there were over 80 papers published annually. The majority of this literature is derived from the fields of chemistry, biology, and agriculture. Approximately one-third of the citations were contributed by a tiny core of authors. Work done in collaboration produced four-fifths of the citations. About thirty-six journals publish about two-fifths of the publications. The two main contributors to this literature are Egypt and Iraq. The most common language is English. Scholars from several fields will find value in the results of this investigation. Additionally, it ought to inspire scientists to start doing joint and interdisciplinary research.

Syed et al. [17] suggested that the primary product is the date palm, which can be processed and rendered beneficial to humans through various techniques, including drying. Every year, there are more journal publications about dates 861. A bibliometric examination of date palms was finished in 2006. This research was done to finish the previous bibliometric study, and it collected important journal articles from 2017 to 2021. The principal aim of the study was to identify the Date Palm research topic and demographic review in journal articles for future research goals. This study uses bibliometric analysis to look at the findings of previous research on date palms. Total 154 journal articles were collected and analyzed according to several parameters, such as language, journal publishing, subject coverage, publication year, and informative reliability. The results of the investigation showed that English research articles outnumbered Malay ones. Sciencedirect.com is the greatest place to get scientific studies concerning dates. 42 journal papers, or 27% of the total, were collected in 2020.

Gian Singh et al. [18] proposed that in order to provide a summary of research activity in this area and highlight its key features the study aims to provide a bibliometric analysis of the scientific output related to the plant Embelia ribes. The terms "Embelia Ribes" and "Vidanga" were included in the searches, which were limited to published papers. Numerous evaluations center on the expansion of literature, patterns of authorship, the most prolific writers, the subject's core periodicals, the most productive institutions and nations. Conclusions: Two or three writers collaborated on the majority of the pieces. With a number of n = 2, author productivity did not conform entirely to Lotka's law. This publication offers a summary of research efforts related to the Embelia ribes plant.

Andrei-Flavius Radu et al. [19] proposed that the pathophysiological mechanism of rheumatoid arthritis (RA), an inflammatory illness of heterogeneous origin with an autoimmune genesis, is not fully understood. Although RA pharmacotherapy is based on compounds that are physiologically or chemically active and can produce a clinical remission, the disease is still incurable. Consequently,

much therapeutic development is still needed, and adjuvant medicines can be crucial in the hunt for cutting-edge RA therapy approaches. Using in silico techniques, the current work focused on investigating possible phytocompounds and phytocompound derivatives as agents for RA therapy. In this context, the potential impact of five phytoconstituents found in different structures of Embelia ribes on target proteins of therapeutic interest in Rheumatoid Arthritis (RA) was evaluated using in silico methods. Through this technique, ligands not currently employed in clinical practice were identified.

JASIST was reviewed by Koehler et al. [20] who noted that it was a seminal archive record that has influenced the LIS discipline for a considerable amount of time. The study examined 2257 publications written by 3518 writers that were published between 1950 and 1999 (JASIST, formerly known as American Documentation, the former name of JASIS). The writers noted shifts in the features of the articles (length, kind, and quantity of footnotes), as well as the study examined the characteristics of the authors, including gender, number of authors, corporate authorship, co-authorship, and international authorship. Articles from unfunded research by lone authors were seen to be giving way to more and more multi-authored works from other nations or areas that were supported. According to the experts, this indicated a more intricate and collaborative study endeavor. In conclusion, papers that are published in reputable journals may serve as a window into the latest developments and patterns in a field. A journal study also looks at a variety of characteristics and how those variables change over time. As Koehler et al. pointed out. "Journal articles provide numerous explicit and implicit variables that indicate the development of the Journal and the field it represents."

DISCUSSION

Objectives

Because Azadirachta indica A. Juss is used so widely in so many different therapeutic formulations, more and more research is being done on its natural components on a daily basis. This paper presents a bibliometric analysis of Azadirachta indica A. Juss.:

1. An increase in academic studies on Azadirchta indica A. Juss.
2. Co-author trends in publications for Azadirachta indica A. Juss.
3. Top magazine ranked by rating.
4. Research results are presented in different documents.
5. Geographical distribution of articles

PubMed (“The National Library of Medicine (NLM)”)

It is the "National Center for Biotechnology Information (NCBI)"-administered open-access repository of biomedical and life sciences journal publications at the "National Library of Medicine (NIH/NLM)," which is a division of the U.S. National Institutes of Health.

The information was retrieved on November 2017. an advanced search with "Neem" as a backup search phrase and "Azadirachta indica" as the index term that appears in the title. Books, journal articles, proceedings, and other miscellaneous items up to 1968 were excluded from the search results. Data were gathered from 454 papers in total, tabulated in MS-EXCEL, and then examined to produce the different indicators.

Year-wise distribution

Based on the information gathered, 454 publications about Azadirachta indica A. Juss were published over a 49-year period (1968–2017). Up until 1988, the growth rate was quite steady, averaging one or two articles every two years. The 1990s and 2000s saw an uptick in the growth rate. The growth rate reached its maximum between 2010 and 2017, when 186 papers were published overall. This two-decade productivity boost can be attributed to the emergence of new trends and technologies that continue to pique scientists' and researchers' interests in their fields of study. Figure 2. Displays the distribution by decade**.**

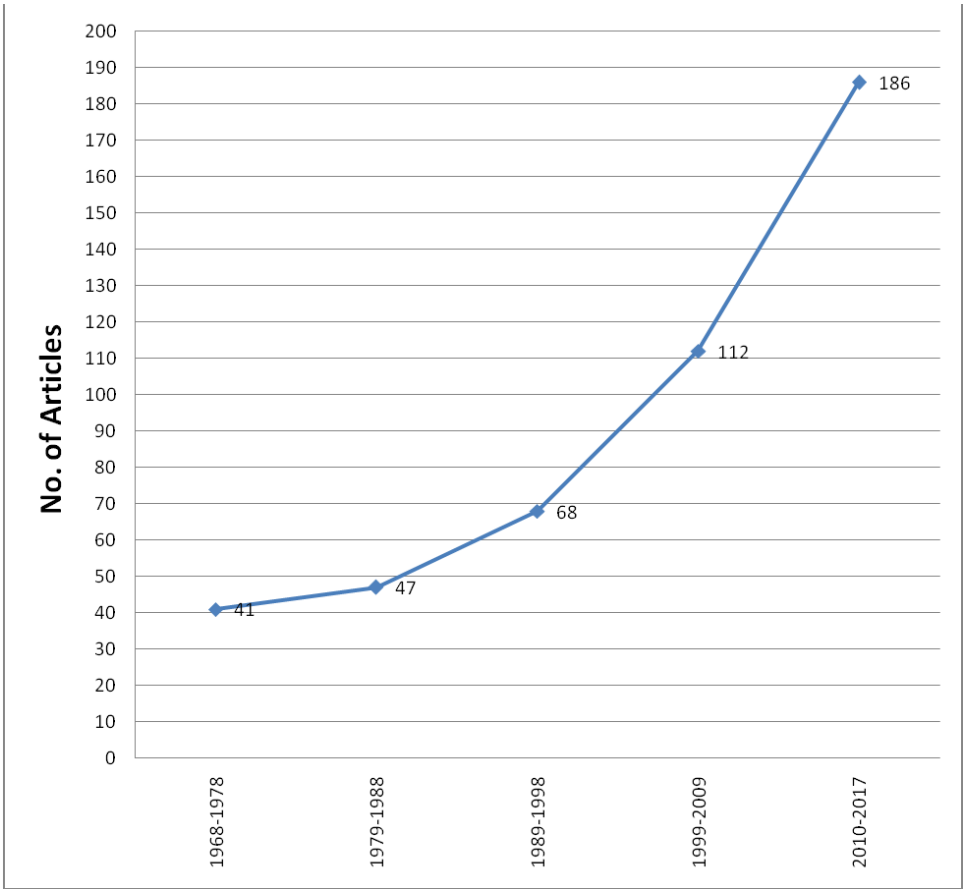

Figure 2 Year wise distribution of articles

Geographical distribution

The nations that have produced the most research on Azadirachta indica A. Juss With 48.02% of the total research output on Azadirachta indica A. Juss, India has been discovered to be the most productive nation overall. Nigeria comes in second with 8.59% and the USA with 7.497% of the total articles produced. On the plant Azadirachta indica A. Juss, Germany published 30 publications (6.61%), Brazil and Pakistan published 27 articles (5.95%), while China published 20 articles (4.41%).

Findings & Discussion

The majority of the articles were authored by library professionals affiliated with college and university libraries, with 96.2 percent of the contributions originating from India. Books were in second place with 19.9% of the sources listed, after journals with 50.1%. The results' limited validity and potential lack of representation of Indian LIS journals are caused by the short sample size of issues. It was discovered that three published studies bibliometrically examined the “Malaysian Journal of Library & Information Science (MJLIS)”. Published biannually, MJLIS is a publication of the “University of Malaya's Faculty of Computer Science and Information Technology”. The publication is indexed in Library Literature, Social Science Citation Index, Scopus, and Library and Information Science Abstracts. The initial study, conducted in 2002 by Tiew, Abrizah, and Kiran, focused on articles published between 1996 and 2000. The research ascertained the quantity of publications released in each volume during the five-year period, the nature of the publications, The analysis encompassed various aspects, including the distribution of references within each volume and article, authorship patterns, identification of prolific writers, affiliation and geographic distribution of contributors, article lengths, subject matter, and the extent of author and journal self-citation. The average distribution of references per piece, according to the statistics, was 22.5 citations. Most articles included one to ten references. Articles with many authors (52.6%) marginally surpassed those with only one author (47.4%). Malaysia accounted for 45 percent of the authors, with India (31.2%) and Bangladesh (11.2%)

following closely behind. Most of the articles were supplied by authors connected to library schools, particularly those connected to the "University of Malaya's Faculty of Computer Science and Information Technology" library school, which publishes the journal. 39.5% of the 76 papers exhibited author self-citation, while 27.6% involved journal self-citation. Aryati and Wilson conducted a subsequent analysis of MJLIS in 2008, examining publication and citation trends from 2001 to 2006. They compared their findings with those of Tiew, Abrizah, and Kiran (2002) using the $\chi 2$ test, with a significance level set at 0.05. The analysis encompassed various aspects including the number of published articles, references per article, authorship patterns and productivity, authors' geographical and institutional affiliations, subject categories, self-citations by authors and journals, article lengths, and citation analyses. They discovered that most of the papers had, on average, between eleven and twenty citations. Two-author publications were increasingly common, while the University of Malaya's Faculty of Computer Science and Information Technology library school scholars were still the most prolific writers. Most of the writers were from Malaysia, then Bangladesh and India. Contributions from writers connected to university libraries increased. While journal self-citation was only 15%, the number of self-citations was 40%.

Reweaving protein crystallizing molecules is done to investigate the molecular folding process. The ligand-protein interaction is predicted with great precision by the correct molecular docking procedure, as indicated by the RMSD value of 0.78 Å computed using AutoDock Tools. In molecular docking studies, ligands engage with target molecules via diverse non-covalent interactions, including hydrophobic interactions, hydrogen bonding, van der Waals forces, and electrostatic interactions. A docking simulation is used to estimate the best direction and shape for a ligand within a protein binding site.

The data on the increase of the Phyoenix dactylifera L literature at 5-year intervals. The first two publications, which were out in 1938 and 1951, are not included in the data, and eight publications lacked the year of publication. With a mean of 0.88 publications each year, almost little research or publication interest is shown up until 1969. This can be compared with the first expansion of literature about the Middle Eastern plant Nigella sativa (Anwar, 2005). There is a noticeable increase in the amount of literature starting in 1971, when 23 publications were created, as opposed to just nine in 1970. This trend kept going at a constant pace until 1984, when the figure hit 79. The number of publications produced between 1985 and 1989 increased dramatically—114 in 1985 and 110 in 1989. But in 1990, the number abruptly declines to 79 publications, and in 1993, it rises once more to 103. The primary cause of this expansion is the developed research infrastructure in the nations where date palm has historically been grown. It is clear that date palm has drawn interest from several scholars worldwide, representing a wide range of fields. Compared to the two articles from 1965, there were 90 publications in 2004, the study's last year. The increasing tendency appears to have leveled out, and the annual publishing output may stay in the 80–100 range. If the productivity stays in that range, it will be satisfying. Examining the impact of multiple wars on Iraq's research output—the country is the world leader in date palm research—is an intriguing subject that has to be investigated. Researcher interest in Pheonix dactylifera L. as a nutritional tree spans a wide range of fields, including Agriculture, Animal Sciences, Chemistry, and Medicine. It is therefore exceedingly difficult to organize this mass of literature under issues of similar rank because its topical coverage is so wide and occasionally so specific in nature. Several databases give each article many extremely detailed descriptors, making it challenging to choose just one. To facilitate the creation of general categories, each of these quotations was given a single, broad subject. With the guidance of an expert from a similar field, this was accomplished. To provide a couple of instances: Biological sciences and agriculture share plant growth and tissue culture; medical and animal sciences share antimicrobial compounds, medicinal qualities, and fertility/anti-fertility effects.

FUTURE SCOPE

1. ***Biological Activity and Medicinal Potential:*** Further exploration of the bioactive compounds present in neem and their pharmacological properties could be a fruitful avenue. Research might delve deeper into its antimicrobial, anti-inflammatory, antiviral, and antifungal properties,

potentially leading to the development of new pharmaceuticals or natural remedies for various human ailments.

2. ***Plant Protection and Pest Management:*** Given neem's natural insecticidal properties, continued research could focus on developing sustainable pest management strategies based on neem extracts or derivatives. This could involve studying its efficacy against specific pests, optimizing formulation methods for application, and exploring its potential as an environmentally friendly alternative to synthetic pesticides.
3. ***Agroforestry and Sustainable Agriculture:*** Neem has been traditionally used in agroforestry systems for soil improvement, erosion control, and providing shade and fodder. Future research could investigate its role in enhancing soil health, promoting biodiversity, and contributing to sustainable agricultural practices, particularly in the context of climate change and resource conservation.
4. ***Bioremediation and Environmental Applications:*** Neem's ability to tolerate and even thrive in degraded or polluted environments suggests its potential for phytoremediation purposes. Research could explore its effectiveness in mitigating soil or water pollution, detoxifying contaminants, and restoring ecosystems in polluted areas.
5. ***Nutritional and Functional Food Applications****:* Neem leaves, seeds, and oil contain valuable nutrients and bioactive compounds with potential health benefits. Future studies could focus on optimizing extraction methods, evaluating nutritional profiles, and exploring innovative uses of neem-derived products in functional foods, dietary supplements, or nutraceuticals.
6. ***Traditional Knowledge and Ethnobotanical Practices:*** Neem has a long history of traditional use in various cultures for medicinal, agricultural, and cultural purposes. Research could involve documenting and preserving indigenous knowledge related to neem cultivation, processing, and utilization, as well as investigating its cultural significance and socio-economic implications in different communities.
7. ***Biotechnology and Genetic Improvement:*** Advances in biotechnology, such as genetic engineering and biotic stress tolerance, could be applied to enhance neem's agronomic traits, yield potential, and resilience to environmental stresses. Research might focus on identifying and characterizing key genes involved in desirable traits, developing improved cultivars, and implementing molecular breeding techniques for neem improvement.

CONCLUSION

The findings reveal a significant increase in academic studies on Azadirachta indica A. Juss over the years, with a notable surge in research output observed particularly in the past two decades. Collaborative authorship emerges as a prominent trend in publications related to Azadirachta indica A. Juss, with the majority of articles featuring multiple authors. Through bibliometric analysis, the study illuminates the significance of Neem-derived chemicals and polymers in various fields. It underscores the rich potential of Neem in pharmaceuticals, agriculture, and materials science. This collaborative approach reflects the interdisciplinary nature of Neem research and underscores the importance of shared knowledge and expertise in advancing scientific understanding. Overall, this bibliometric analysis offers valuable insights into the growing body of literature on Azadirachta indica A. Juss, providing a comprehensive overview of research activity and highlighting key trends and patterns. This research contributes to a deeper understanding of the therapeutic potential and scientific significance of Neem, paving the way for future research and innovation in this field.

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