UFSM

CIÊNCIA e NATURA

ISSN 2179-460X
OPEN ACCESS

Ci. e Nat., Santa Maria, v. 48, e94007, 2026 • https://doi.org/10.5902/2179460X94007
Submitted: 10/08/2025 • Approved: 05/25/2026 • Published: 06/18/2026

Biology-Botany

A species on the margins of science: A critical analysis of the scientific output on *Anemopaegma arvense* (Vell.) Stellfeld ex de Souza in Brazil

Uma espécie à margem da ciência: Análise crítica da produção científica sobre *Anemopaegma arvense* (Vell.) Stellfeld ex de Souza no Brasil

Angela Liberali Pinheiro[I], Luciana Botezelli[I], Ernesto de Oliveira Canedo Junior[II]

[I] Universidade Federal de Alfenas, Alfenas, MG, Brasil
[II] Universidade do Estado de Minas Gerais, Belo Horizonte, MG, Brasil

ABSTRACT

Anemopaegma arvense (Vell.) Stellfeld ex de Souza (Bignoniaceae), commonly known as catuaba, is widely used in Brazilian traditional medicine due to its pharmacological potential. Despite its medicinal importance and threatened status, ecological and conservation studies remain critically underrepresented, which may compromise the development of effective management and preservation strategies. This study aimed to analyze the scientific production on *A. arvense* through a bibliometric approach, seeking to identify research trends, authorship patterns, and knowledge gaps. A bibliometric survey was conducted using the Web of Science and Scopus databases, based on 28 publications retrieved from 1978 to 2024. Indicators such as author productivity, keyword co-ocurrence, and Lotka's Law were employed to assess publication patterns and the distribution of the most prolific contributors. The results revealed a clear disciplinary bias toward pharmacological research, with limited representation of ecological and conservation studies. This thematic asymmetry indicates that the lack of studies on geographic distribution, population dynamics, and environmental pressures may increase the species' vulnerability. Therefore, expanding ecological investigations and promoting interdisciplinary integration are essential to support the conservation and sustainable use of *Anemopaegma arvense*.

Keywords: Bibliometrics; Conservation of natural resources; Pharmacology; Ethnobotany; Biodiversity

RESUMO

Anemopaegma arvense (Vell.) Stellfeld ex de Souza (Bignoniaceae), comumente conhecida como catuaba, é amplamente utilizada na medicina tradicional brasileira devido ao seu potencial farmacológico.

Apesar de sua importância medicinal e de seu *status* de ameaça, os estudos ecológicos e de conservação permanecem criticamente sub-representados, o que pode comprometer o desenvolvimento de estratégias efetivas de manejo e preservação. Este estudo teve como objetivo analisar a produção científica sobre *A. arvense* por meio de uma abordagem bibliométrica, buscando identificar tendências de pesquisa, padrões de autoria e lacunas de conhecimento. Para isso, foi realizado um levantamento bibliométrico nas bases de dados *Web of Science* e *Scopus*, com base em 28 publicações recuperadas entre 1978 e 2024. Indicadores como produtividade de autores, co-ocorrência de palavras-chave e Lei de Lotka foram empregados para avaliar os padrões de publicação e a distribuição dos autores mais prolíficos. Os resultados revelaram um claro viés disciplinar em direção à pesquisa farmacológica, com representação limitada de estudos ecológicos e de conservação. Essa assimetria temática indica que a carência de estudos sobre distribuição geográfica, dinâmica populacional e pressões ambientais pode aumentar a vulnerabilidade da espécie. Portanto, a ampliação das investigações ecológicas e a promoção da integração interdisciplinar são essenciais para subsidiar a conservação e o uso sustentável de *Anemopaegma arvense*.

Palavras-chave: Bibliometria; Conservação dos recursos naturais; Farmacologia; Etnobotânica; Biodiversidade

1 INTRODUCTION

Anemopaegma arvense (Vell.) Stellfeld ex de Souza, a specie of Bignoniaceae native to South America, occurs in Brazil mainly in the Cerrado and Atlantic Forest biomes, including montane grasslands (Firetti, 2024). Commonly known as “true catuaba,” it has long been incorporated into Brazilian traditional medicine and is valued for its bioactive compounds associated with antioxidant, anti-inflammatory, aphrodisiac, neuroprotective, and antifungal effects, supporting its popular use in conditions related to fatigue, sexual dysfunction, and nervous disorders (Mello et al., 2010; Souza et al., 2013; Costanzo et al., 2013; Firetti et al., 2017). Owing to this pharmacological potential, the species has attracted growing scientific and commercial interest, particularly in phytochemical and biomedical research (Pereira et al., 2007; De Andrade et al., 2008; Ittiyavirah; Hameed, 2014).

In parallel with its medicinal relevance, *A. arvense* has raised concern from a conservation perspective. The species is currently classified as Endangered (EN) at the national level, a status associated with the combined effects of unsustainable harvesting and habitat loss caused by agricultural expansion, urbanization, and landscape

fragmentation (MMA, 2022; Firetti, 2024). This scenario is especially critical because the species occurs in two of the main Brazilian biodiversity hotspots, where increasing anthropogenic pressure threatens both species persistence and ecosystem integrity. In addition, population studies have indicated substantial genetic diversity in *A. arvense*, an important attribute for long-term adaptation and resilience under environmental change (Firetti-Leggieri et al., 2011). Morphologically, the species exhibits traits such as a subshrub habit, woody roots, and xylopodia, as well as a marked resprouting capacity, which favor persistence in seasonal grassland environments subject to drought and other edaphic constraints (Batistini et al., 2009; Firetti-Leggieri et al., 2014).

Despite the growing body of knowledge on its medicinal properties and the relevance of its ecological and conservation attributes, the scientific literature on *A. arvense* remains dispersed across distinct disciplinary approaches and has not yet been systematically evaluated. This fragmentation makes it difficult to identify the main research trends, the most influential authors and institutions, and, above all, the thematic gaps that still limit a more integrated understanding of the species.

In this context, bibliometric analysis represents a useful approach for examining the structure and evolution of scientific production, allowing the identification of publication patterns, authorship trends, and predominant research themes (Vouga Chueke & Amatucci, 2022; Padilha et al., 2023). Therefore, the present study aimed to analyze the scientific output on *A. arvense* through a bibliometric perspective, with the purpose of identifying research trends, authorship patterns, and knowledge gaps.

2 METHODOLOGY

This study adopted a quantitative approach based on a systematic literature review supported by bibliometric techniques, aiming to map the scientific output related to *Anemopaegma arvense*. According to Da Silva et al. (2022), a bibliometric-based systematic review must follow organized, transparent, and replicable procedures for the retrieval, processing, cleaning, and analysis of scientific data. Therefore, the

methodological design was structured to ensure reproducibility, taxonomic accuracy, and robustness in the interpretation of bibliometric indicators.

2.1 Data Sources and Search Strategy

The selected databases were Web of Science (WoS) (http://www.webofknowledge.com) and Scopus (http://www.scopus.com), due to their wide international use, reliability, multidisciplinary coverage, and advanced functionality for filtering and exporting standardized bibliographic metadata (Aria & Cuccurullo, 2017). These databases were also selected because they are commonly used in bibliometric studies and allow the extraction of information related to authorship, institutional affiliation, publication sources, citation metrics, keywords, and document types.

No temporal filter was applied, meaning that all publications indexed in the databases up to September 2024 were considered. The search strategy employed the terms "*Anemopaegma arvense*" and "*Anemopaegma mirandum*," combined with the Boolean operator "OR" in uppercase. These descriptors were selected because they correspond to the currently accepted scientific name of the species and to a taxonomic synonym previously used in the literature (Moraes & Kafure, 2020; Firetti-Leggieri et al., 2014). To assess the sensitivity of the search criteria and reduce the risk of excluding publications indexed under historical nomenclature, an additional verification was conducted using the basionym "*Bignonia arvensis*" Vell. This supplementary search was conducted using the original dataset to identify possible omissions associated with taxonomic variation, and did not identify additional eligible records beyond those already retrieved using the accepted name and synonym.

Specific filters were applied on each platform to increase precision and reproducibility. In WoS, the "Topic" filter was used, allowing the search terms to be identified in titles, abstracts, and keywords. In Scopus, the equivalent filters "abstract, title and keywords" were applied. This strategy was adopted to ensure that the retrieved

records were directly associated with the species of interest and not only with broader or tangential topics.

2.2 Inclusion and Exclusion Criteria

To ensure the consistency and relevance of the sample, clear inclusion and exclusion criteria were established before data analysis. All the publications available in WoS and Scopus up to September 2024 were included, with no language or time restrictions. Eligible documents had to contain at least one of the defined descriptors from the search strategy and be indexed in one of the selected databases. The search included scientific articles, reviews, conference proceedings, book chapters, and conference papers, provided that they contained complete and analyzable bibliographic metadata.

Records were excluded when they presented incomplete metadata (e.g., missing titles, abstracts, author names, publication year, or source information). Documents were also excluded when, after exploratory reading of titles, abstracts, and keywords, they were found to be unrelated to the research topic. Duplicate entries identified during the merging of WoS and Scopus were removed to avoid biases caused by repeated publications. When duplicate detection could not be resolved automatically due to differences in formatting or metadata structure, records were inspected manually.

2.3 Data Extraction, Processing, and Analysis

The systematic search in WoS and Scopus conducted in September 2024, initially retrieved 48 documents related to *A. arvense*, with 20 from WoS and 28 from Scopus. Bibliometric data were exported from WoS in text format (.txt) and from Scopus in spreadsheet format (.csv), following the export formats recommended for compatibility with bibliometric analysis in R and to reduce processing errors. Data conversion and processing were performed using R software (R Core Team, 2021) with the Bibliometrix package (Aria & Cuccurullo, 2017). Bibliometrix was selected because

it provides a comprehensive and reproducible environment for science mapping, allowing standardized conversion, merging, and descriptive analysis. The exported files were first converted into BibTeX format using the convert2df function. Subsequently, the datasets were unified and normalized using the data_combined function, which removed duplicates and adjusted the variable structures.

The next step involved applying the biblioAnalysis function, followed by the summary function. The first provided descriptive bibliometric outputs, including data on authors, journals, and citations. The second summarized these outputs with statistical metrics such as number of documents, authors, citations, and bibliometric indices. However, during a manual revision of the output, serious inconsistencies were identified that affected the entire dataset. Several articles were listed in both databases with slight variations in fields such as author names, citation counts, or entry formatting, which hindered an automatic duplicate detection via the data_combined function. Additionally, author name parsing errors, such as treating compound surnames as distinct individuals, and citation grouping issues compromised the reliability of the results generated by automated functions.

2.4 Analyzed Variables

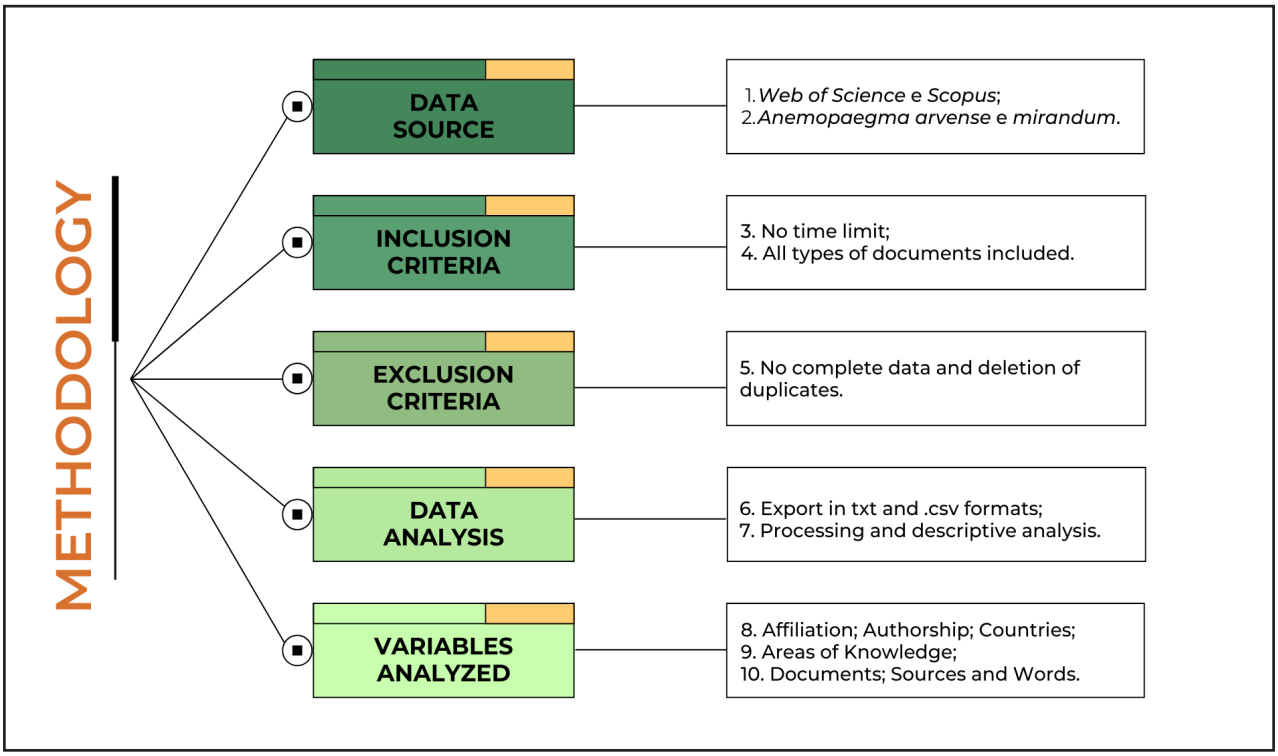
The bibliometric analysis considered a set of variables grouped into analytical categories to facilitate the systematization and interpretation of the results. Initially, variables related to the institutional affiliation were assessed to identify the most productive institutions over time. Next, the authorship was analyzed, with a focus on the most influential authors, along with the application of Lotka's Law to evaluate the distribution of productivity among researchers. The geographic dimension was addressed in the "countries" category, which included national output, international collaboration, and citation counts by country.

Regarding the documents, the analysis included an annual scientific output, globally most-cited articles, average citations per year, and total yearly citations.

Journals and keywords were also examined to identify the most relevant publication venues, keyword frequency over time, and word cloud generation. Finally, the distribution of subject areas associated with the publications was evaluated, based on the core theme of each study.

The results were organized into five categories for the presentation: (i) Affiliation (highlighting the most relevant institutions), (ii) Authorship (showing the most productive authors and applying Lotka's Law), (iii) Countries (covering the most-cited countries, national production, and international collaboration), (iv) Documents (reporting the annual production and the most-cited works), and (v) Sources and Keywords (revealing the keyword frequency and the word cloud) (figure 1). Visualizations were generated using the ggplot2 package in the R software (R Core Team, 2021).

Figure 1 – Infographic showing the methodological steps applied for the systematic literature review



Source: Authors (2025)

3 RESULTS AND DISCUSSION

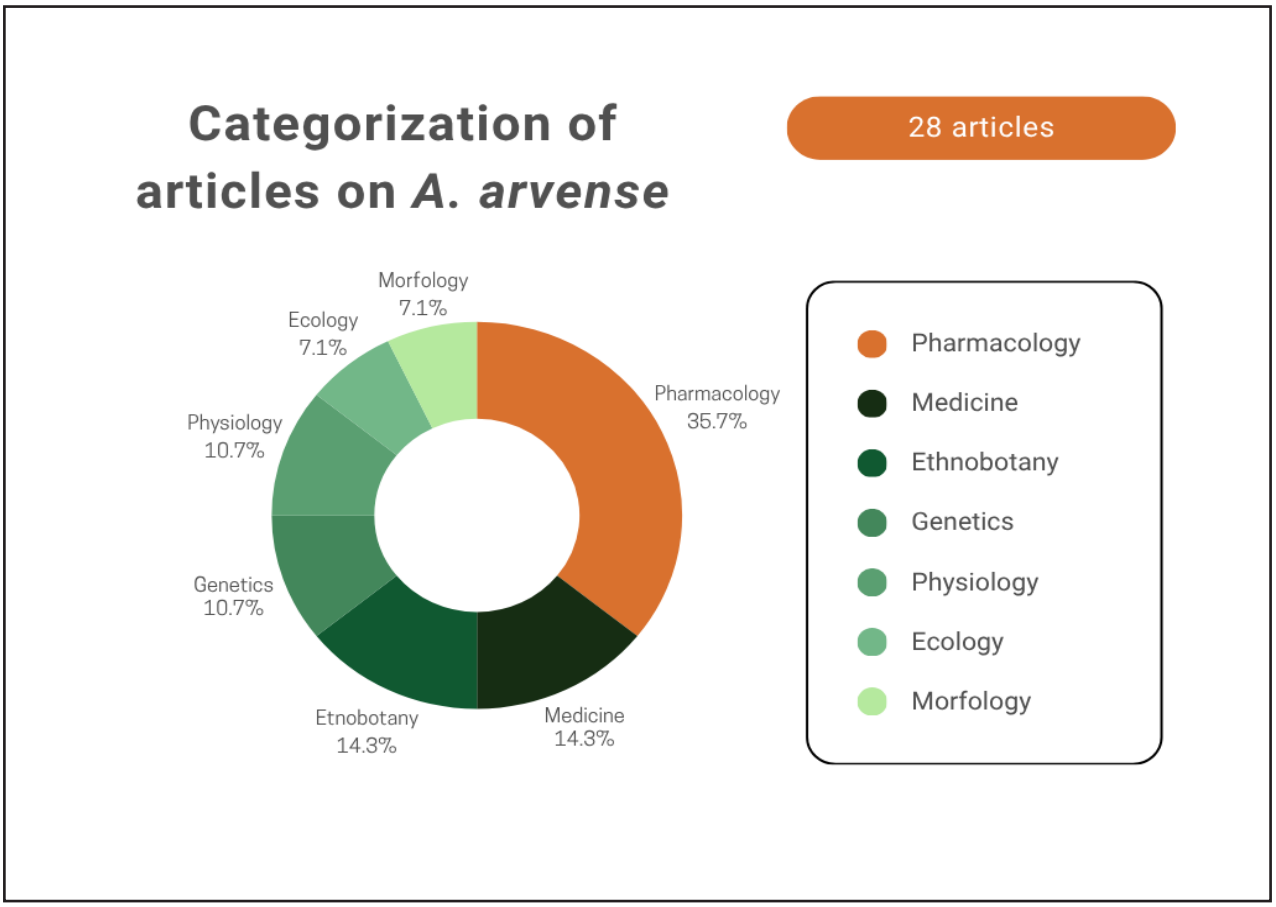
During data processing, inconsistencies in the metadata exported from WoS and Scopus were identified, including duplicate records, variations in author names, differences in citation counts, and formatting discrepancies. These limitations required manual curation before the bibliometric indicators could be interpreted. Although such inconsistencies are not uncommon in bibliometric studies, they reinforce the need for careful data validation, particularly when dealing with small and taxonomically specific datasets.

After duplicate removal, metadata screening, and manual validation, the final corpus consisted of 28 publications published between 1978 and 2024. Out of these, 20 were published in international journals and eight in Brazilian journals, considering the origin of the publication venue. This curated dataset provided the basis for the subsequent analyses of thematic distribution, annual production, citations, affiliations, authorship, countries, sources, and keywords.

To identify the main thematic orientations of the literature, the 28 publications were classified according to their central focus, based on titles, abstracts, and keywords. This classification allowed the identification of dominant research fields and the relative position of ecological and conservation studies within the overall scientific production on *A. arvense*.

The thematic categorization revealed seven main fields of study: pharmacology (35.7%), medicine (14.3%), ethnobotany (14.3%), genetics (10.7%), physiology (10.7%), ecology (7.1%), and morphology (7.1%) (figure 2). These results indicate a clear disciplinary bias toward biomedical and pharmacological approaches, while ecological and conservation-oriented studies remain marginal. This imbalance is particularly relevant because *A. arvense* is a threatened medicinal species whose sustainable use depends not only on knowledge of its bioactive compounds but also on information about its populations, habitats, ecological interactions, and responses to environmental pressures.

Figure 2 – Classification by field of study of the 28 articles on *A. arvense* found in the bibliometric analysis



Source: Authors (2025)

3.1 Overview of the produced articles

The analysis of the 28 selected publications showed that scientific production on *A. arvense* is largely concentrated in the areas of pharmacology, phytochemistry, and ethnobotany. This pattern is also reflected in the main publication venues, especially journals focused on medicinal plants, pharmacognosy, and ethnopharmacology. Such concentration indicates that the species has been primarily investigated as a source of bioactive compounds and traditional medicinal knowledge, rather than as a threatened component of native ecosystems.

Within the pharmacological and phytochemical literature, most studies focused on the characterization of plant extracts, isolation of bioactive compounds, and evaluation of antioxidant, cytoprotective, antimicrobial, anti-inflammatory, or stimulant properties. Although these studies provide relevant evidence for the medicinal potential of *A. arvense*, they are predominantly oriented toward biological activity and product development. As a result, they rarely address the ecological conditions required for the maintenance of natural populations or the potential impacts of harvesting on species persistence.

Ethnobotanical studies reinforce the cultural and medicinal relevance of catuaba in Brazil, particularly in relation to traditional uses associated with fatigue, sexual dysfunction, and nervous system disorders. However, the connection between traditional knowledge and conservation remains weakly explored. The literature documents use and pharmacological potential more frequently than it evaluates whether current or potential exploitation is compatible with population regeneration, habitat integrity, or sustainable management.

Morphological, anatomical, and taxonomic studies contribute to the correct identification of plant material and are especially relevant because several species are commercialized under the popular name “catuaba”. These contributions are important for quality control and for avoiding taxonomic confusion in pharmacological research and commercial supply chains. Nevertheless, this line of research also remains insufficiently integrated with ecological and conservation questions.

Overall, the literature reveals an imbalance between the medicinal relevance attributed to *A. arvense* and the limited ecological knowledge available for the species. Key aspects such as population structure, reproductive biology, pollination, seed dispersal, recruitment, demographic dynamics, habitat specificity, and responses to anthropogenic disturbance remain poorly represented. This gap is critical because the sustainable use of a threatened medicinal species requires information not only about its chemical properties, but also about its ecological viability in natural environments.

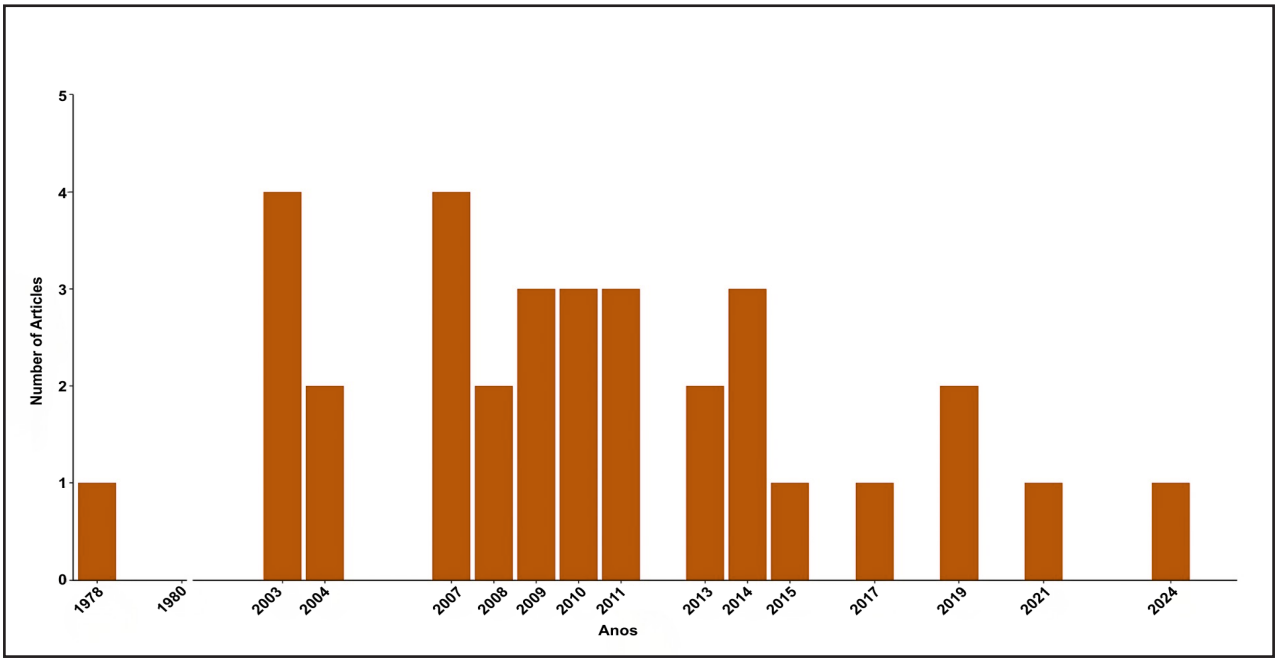
3.2 Documents

The annual scientific production on *A. arvense* showed a discontinuous pattern over time. The first record dates back to 1978, followed by a long period without indexed publications until the early 2000s (figure 3). After this interval, production increased only punctually, with peaks in 2003 and 2007, followed by sparse publications and no clear trend of sustained growth. This pattern indicates that *A. arvense* has not become a consolidated or continuous research subject, despite its medicinal relevance and threatened status.

Specifically, regarding *A. arvense*, the few ecological studies available are concentrated in more recent years, particularly after 2017, indicating a delayed emergence of interest in the species' environmental and conservation-related aspects. This scenario underscores the scarcity of continuous ecological investigations and points to a promising yet underexplored research field. Although the most recent data do not reveal a significant increase in the number of publications, a diversification in methodological approaches and research domains has been observed. In recent decades, for example, robust pharmacological studies have validated antioxidant activities, as seen in the works of Zielinski & Haminiuk (2019) and Uchino et al. (2004), while ethnobotanical explorations have been conducted in distinct sociocultural contexts, such as the study by Ferraro et al. (2021).

The temporal distribution also reveals that ecological and conservation-related studies have appeared only sporadically. Rather than forming a continuous research line, these contributions are isolated within a broader literature dominated by pharmacological and ethnobotanical approaches. This discontinuity limits the accumulation of ecological knowledge and makes it difficult to identify temporal changes in population status, habitat degradation, or responses to disturbance. Therefore, the publication pattern suggests not only a low number of studies, but also the absence of a sustained research agenda focused on the conservation biology of the species.

Figure 3 – Annual scientific production on the species *A. arvense*, from 1978 to 2024



Source: Authors (2025)

The long interval between the first record in 1978 and the resumption of publications in the early 2000s suggests that research on *A. arvense* did not follow a continuous trajectory. This discontinuity may reflect broader historical and institutional factors, such as shifting research priorities, limited funding for native medicinal plants, and the late consolidation of legal and conservation frameworks for Brazilian ecosystems. However, this temporal gap should be interpreted with caution, since bibliometric data alone do not allow a direct causal relationship to be established between publication patterns and environmental policy changes. In addition, because this study was restricted to two major international databases, Web of Science and Scopus, it is possible that non-indexed publications, local journals, technical reports, theses, dissertations, or other forms of literature were not captured, particularly during the periods of apparent publication gaps. Rather than indicating the complete absence of studies, the gap highlights the historically fragmented attention given to the species, especially from an ecological and conservation perspective.

The analysis of the most globally cited documents showed that the bibliometric visibility of *A. arvense* is mainly associated with studies in ethnopharmacology, medicinal plant surveys, phytochemistry, and antioxidant activity. However, some highly cited publications included *A. arvense* only as one among several medicinal species, rather than as the central object of investigation. This distinction is important because citation counts may overestimate the specific scientific impact of the species when broader reviews or ethnobotanical surveys are included in the corpus. Therefore, the most cited documents do not necessarily correspond to the most detailed or species-specific contributions on *A. arvense*.

In contrast, publications addressing ecological interactions, genetic diversity, and conservation biology showed lower citation performance, even though they are strategically important for understanding the persistence of natural populations. This contrast reveals an asymmetry between scientific visibility and conservation relevance: pharmacological studies tend to accumulate greater citation impact, whereas ecological studies remain less frequent and less visible, despite being essential for management and conservation planning.

The citation analysis reinforces this imbalance (Table 1). The most cited publications are primarily associated with ethnobotanical surveys, medicinal plant reviews, and pharmacological or phytochemical investigations. In several cases, *A. arvense* appears as one of many species included in broader studies, which means that citation performance should not be interpreted as a direct measure of species-specific knowledge. Conversely, studies with greater relevance for ecology and conservation tend to show lower citation visibility, reflecting the peripheral position of this research line within the scientific production on the species.

Table 1 – Description of the most globally cited published documents on *A. arvense*, highlighting their citation rates

(To be continued...)

Title	Total citations	CT per year	CT normalized
Ethnobotanical study of medicinal plants used by Ribeirinhos in the North Araguaia Microregion, Mato Grosso, Brazil	167	23,85	1,00
Medicinal resources of species from Cerrado of Mato Grosso: a bibliographic study	118	5,6	0,23
Brazilian plants as possible adaptogens: An ethnopharmacological survey of books edited in Brazil	77	4,52	0,18
Nectaries on the fruit of Crescentia and other Bignoniaceae	57	1,23	0,05
Flavan-3-ol-phenylpropanoid conjugates from *Anemopaegma arvense* and their antioxidant activities	31	1,82	0,07
Tonic, fortifier and aphrodisiac: adaptogens in the Brazilian folk medicine	27	2,7	0,08
Effects of the extract of *Anemopaegma mirandum* (Catuaba) on Rotenone-induced apoptosis in human neuroblastomas SH-SY5Y cells	26	1,62	0,06
Changes in the trade in native medicinal plants in Brazilian public markets	24	2,18	0,09
Classification of commercial Catuaba samples by NMR, HPLC and chemometrics	23	1,43	0,05
Chromosome studies in bignonieae (Bignoniaceae): The first record of polyploidy in *Anemopaegma*	16	1,23	0,05
Anatomical study of the Cerrado species *Anemopaegma arvense* (Vell.) Stellf. ex de Souza (catuaba), *Zeyheria montana* Mart. (shepherd's purse) and *Jacaranda decurrens* Chamisso (caroba) - Bignoniaceae	16	0,94	0,03
Morphological, chemical and functional analysis of Catuaba preparations	16	0,75	0,03
Potent protecting effects of Catuaba (*Anemopaegma mirandum*) extracts against hydroperoxide-induced cytotoxicity	15	0,75	0,03
Micropropagation of *Anemopaegma arvense*: conservation of an endangered medicinal plant	11	0,72	0,02
Using leaf anatomy to solve taxonomic problems within the *Anemopaegma arvense* species complex (Bignonieae, Bignoniaceae)	9	0,90	0,03

Table 1 – Description of the most globally cited published documents on *A. arvense*, highlighting their citation rates

(Conclusion)

Title	Total citations	CT per year	CT normalized
Evaluating belowground bud banks of native species from Cerrado: Structural, chemical, and ecological approaches	90	3,00	0,13
Seed germination and triterpenoid content of *Anemopaegma arvense (*Vell.) Stellfeld varieties	8	0,47	0,02
Genetic diversity of natural populations of *Anemopaegma arvense* (Bignoniaceae) in Cerrado of São Paulo State, Brazil	8	0,53	0,02
Herbs treating Parkinson's disease	7	0,70	0,02
Development of gluten-free cookies from medicinal plants (Guaraná - Paullinea cupana and Catuaba - *Anemopaegma mirandum*) aiming at copper, iron, and zinc supplementation	6	0,40	0,02
Isolation of flavonoids from Anemopaegma arvense (Vell) Stellf. ex de Souza and their antifungal activity against *Trichophyton rubrum*	5	0,45	0,02
In vitro rooting of Catuaba (*Anemopaegma arvense* (Vell.) Stell. ex de Souza), a medicinal plant from Cerrado	4	0,44	0,02
Toxicity study of a phytotherapic with *Anemopaegma mirandum*, *Cola nitida*, *Passiflora alata*, *Paullinia cupana*, *Ptychopetalum olacoides* and thiamin in rabbits	3	0,21	0,01
The traditional use of native Brazilian plants for male sexual dysfunction: Evidence from ethnomedicinal applications, animal models, and possible mechanisms of action	3	0,00	0,00
Evaluation of the Phenolics and in vitro Antioxidant Activity of Different Botanical Herbals Used for Tea Infusions in Brazil	1	0,20	0,1
Tropane alkaloids from a Brazilian bark traded as "Catuaba"	1	0,04	0,00
USO of factor planning to evaluate the level of germination of *L. Sativa* and *L. Esculentum* front of two medicinal plants in capital	0	0,00	0,00
Medicinal plant bioactivity - Catuaba (*Anemopaegma arvense* (Vell) Stellfeld JF & de Souza) on S*podoptera frugiperda* (JE Smith) Lepidoptera: Noctuidae) in the larval stage	0	0,00	0,00

Source: Organized by the authors (2025), based on bibliometric data retrieved from Web of Science and Scopus in September 2024 and processed in R using the Bibliometrix package. TC: Total Citations accumulated by each document up to the reference year of the study (2024); TC per year: average annual citation rate, calculated by dividing the total number of citations by the number of years since publication up to 2024; Normalized TC: normalized citation indicator generated by Bibliometrix, which adjusts citation counts according to the citation pattern of documents published in the same year, allowing comparisons among publications from different periods

This result indicates that the scientific relevance attributed to *A. arvense* has been shaped mainly by its pharmacological potential, while ecological information remains fragmented and weakly visible. Such a pattern may influence future research priorities, since highly cited biomedical studies can reinforce the perception of the species primarily as a pharmacological resource, rather than as a threatened native plant requiring integrated conservation strategies.

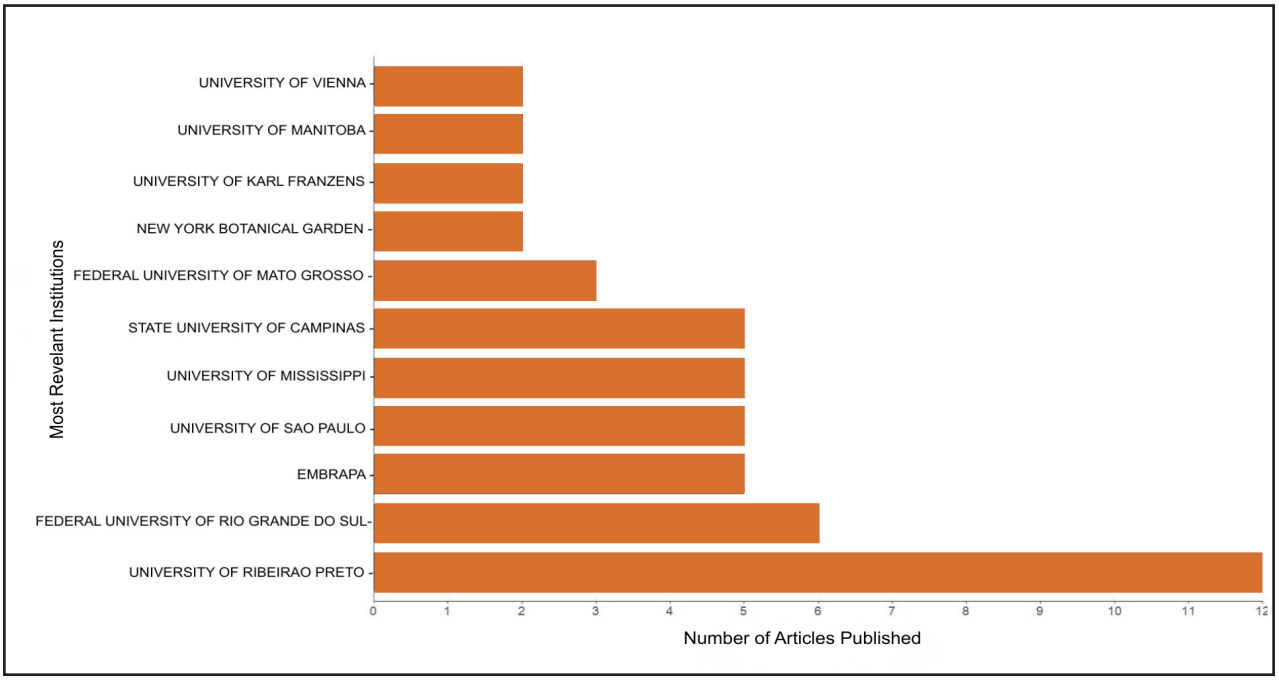
The analysis of the three citation metrics, Total Citations (TC), TC per year, and Normalized TC, showed a consistent pattern: the highest bibliometric visibility of *A. arvense* is mainly associated with studies in ethnopharmacology, medicinal plant surveys, phytochemistry, and antioxidant activity. However, some of the most cited documents included *A. arvense* only as one among several medicinal species, rather than as the central object of investigation. This distinction is important because citation performance may overestimate the species-specific scientific impact when broader reviews, ethnobotanical surveys, or multi-species studies are included in the corpus. Conversely, publications addressing ecological interactions, genetic diversity, and conservation biology showed lower citation performance across the evaluated metrics, despite their strategic importance for understanding the persistence of natural populations.

These results reveal an asymmetry between scientific visibility and conservation relevance. The scientific importance attributed to *A. arvense* has been shaped mainly by its pharmacological potential, while ecological information remains fragmented and weakly visible. This pattern reinforces the urgency of considering the species beyond its value as a source of medicinal resources. As a threatened native plant, *A. arvense* should also be understood as part of the ecological dynamics of the ecosystems where it occurs, requiring studies on population structure, habitat conditions, ecological interactions, regeneration, and responses to anthropogenic pressures. Such an integrated perspective is essential to support conservation planning, sustainable management, and the maintenance of the ecological functions associated with the species.

3.3 Affiliations and Countries

The analysis of the affiliations indicates that research on *A. arvense* is concentrated (in this study) in a limited number of Brazilian institutions, with additional participation from international universities and research centers (figure 4). This pattern is expected, considering that the species is native to Brazil and is associated with Brazilian biodiversity and traditional medicine. However, the institutional distribution also suggests that knowledge production remains concentrated in specific research groups, particularly those linked to pharmacology, phytochemistry, and plant anatomy.

Figure 4 – National and international affiliations that have been published on the species *A. arvense* and their respective contributions



Source: Authors (2025)

The predominance of Brazilian institutions should be interpreted as a strategic strength, since national leadership is essential for research involving native biodiversity and genetic resources. It is consistent with the patterns observed in other native medicinal plants, such as *Paullinia cupana* Kunth (guaraná) and *Pfaffia glomerata*

(Spreng.) Pedersen (Brazilian ginseng), whose scientific exploration is often led by national institutions with occasional international collaborations (Marques et al., 2019; De Oliveira et al., 2009; Ribeiro et al., 2024). Although these species have gained a greater international recognition, especially due to their integration into global production chains, a significant portion of the knowledge generated about them remains outside the public domain, as it is associated with private research initiatives aimed at the development of patented pharmaceutical and nutraceutical products. This phenomenon limits the data dissemination in scientific journals and distorts the perception of the actual volume of research output. At the same time, the relatively low level of international co-authorship indicates that collaborative networks remain limited. This may restrict methodological diversification, access to complementary analytical tools, and the integration of ecological, pharmacological, and conservation approaches.

International collaboration appears mainly associated with the pharmacological potential of the species, especially the identification and characterization of bioactive compounds. In contrast, conservation-oriented research networks are less evident in the dataset. This asymmetry suggests that future collaborations should move beyond bioprospecting and include ecological monitoring, population genetics, habitat assessment, restoration ecology, and sustainable management.

Therefore, the affiliation and country analyses reveal not only where knowledge on *A. arvense* is produced, but also which research priorities have been institutionally consolidated. The challenge is to transform Brazil's central role in the study of the species into an interdisciplinary research agenda capable of supporting conservation policies, sustainable use, and the protection of natural populations.

In the case of *A. arvense*, its lower visibility in international databases may not only stem from a less industrial exploitation but also from a lack of interdisciplinary studies integrating pharmacological, ecological, and conservationist aspects. The academic research thus plays a strategic role in providing a robust scientific foundation that can support both public policy formulation and the development of conservation tools for

the species and its natural habitats. It is essential for future studies to move beyond commercial valorization to include the generation of ecological data that can strengthen the environmental management and the sustainable use of Brazil's biodiversity.

3.4 Authorship

The authorship analysis showed that the 28 publications were produced by 114 authors, with only one single-authored paper. Most authors contributed to one or two publications, while a small number appeared more frequently in the dataset. This pattern suggests a dispersed authorship structure, but with the presence of specialized research clusters focused mainly on pharmacology, phytochemistry, and plant anatomy.

This distribution of author productivity is consistent with Lotka's Law (figure 5), in which most contributors publish only one paper, while a small group accounts for a proportionally larger share of the scientific output. In the case of *A. arvense*, this pattern also indicates that the field is not yet supported by a broad and continuous research community. Instead, knowledge production appears to depend on a limited number of groups and occasional contributions.

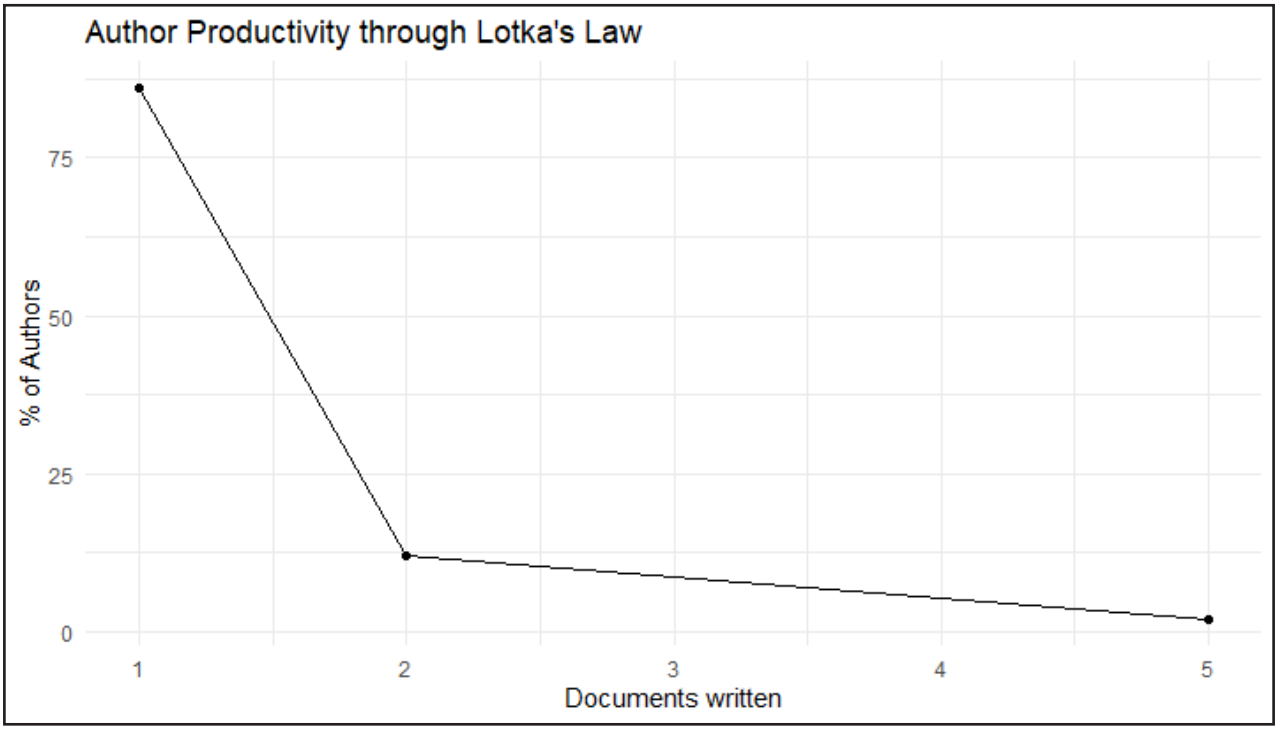
From a conservation perspective, this authorship pattern is relevant because the scarcity of recurrent ecological research groups may help explain the limited accumulation of knowledge on population dynamics, reproductive biology, and habitat requirements. Thus, the issue is not only the low number of publications, but also the limited continuity and specialization of research efforts directed toward ecological and conservation questions.

Such a pattern is widely observed across various scientific disciplines, including studies on native medicinal species. For instance, Souza et al. (2020), in their bibliometric study on *Stryphnodendron adstringens* (Mart.) Coville (barbatimão), also confirmed a high concentration of scientific output among a few contributors. Therefore, in line with previous bibliometric analyses on Brazilian native medicinal

plants, the low evenness in the distribution of research efforts among the authors observed in the present study for *A. arvense* adheres to the pattern predicted by Lotka's Law.

Bradford's and Zipf's Laws were not applied because the final corpus contained only 28 publications, which was insufficient to generate statistically representative distributions of journals or lexical patterns. Bradford's Law requires a broader dispersion of journals to identify productivity zones, whereas Zipf's Law depends on a larger and more diverse set of terms. Therefore, the analysis was restricted to indicators considered more robust and interpretable for a small, species-specific dataset.

Figure 5 – Authors' productivity based on the bibliometric analysis of studies on *A. arvense*



Source: Authors (2025)

3.5 Sources and Keywords

The word cloud generated reflects recurring themes and thematic relationships within the literature on *A. arvense*, highlighting both traditional aspects and potential gaps for future research (figure 6). The predominance of the terms "Brazil" (10

occurrences), “medicinal plant” (6), and “traditional medicine” (3) confirms Brazil as the central region of study and underscores the medicinal relevance of *A. arvense*. These findings emphasize the role of the plant as both a cultural and pharmacological resource, particularly within the Cerrado and Atlantic Forest biomes (Firetti et al., 2017). Under the theoretical frameworks of ethnobotany and ethnopharmacology, this reflects the appreciation of Brazilian biodiversity and its link to traditional healthcare practices (Ferreira et al., 2021).

Figure 6 – Word cloud of the most frequently occurring terms found in the keywords and abstracts of the 28 analyzed articles; the larger the font size, the higher the frequency of occurrences

Source: Authors (2025)

This finding is confirmed by the frequency of terms such as “bark” and “plant extract” (four occurrences each), as well as “tannins” and “tropane alkaloid” (two each),

underscoring the importance of Catuaba's chemical properties and its medicinal applications. These compounds reflect the ongoing ethnopharmacological interest in identifying bioactive substances for phytotherapeutic development. Bioprospecting could be applied to further explore the connection between these compounds and their therapeutic potential, including the analysis of triterpenes and flavonoids for neuroprotective and antioxidant applications, as previously reported by Pereira et al. (2007) and De Andrade et al. (2008). However, the simultaneous presence of "unclassified drug" (4) suggests that some studies have not yet fully categorized the bioactive compounds, indicating an opportunity for complementary investigations.

In the field of ethnobotany, the terms "ethnobotany" (2) and "traditional medicine" (3) reinforce the species' cultural significance, particularly in Brazilian traditional healing practices. This perspective could be analyzed in light of the concept of *biocultural heritage*, which integrates traditional knowledge and biodiversity (Lindholm & Ekblom, 2019; Bastos et al., 2022). It also highlights the need for a closer collaboration between local communities and researchers to ensure ethical and sustainable applications of traditional knowledge, as emphasized in policy frameworks such as the Convention on Biological Diversity (CBD). Furthermore, the low frequency of terms such as "commerce" and "controlled study" (2 each) suggests that the translation of this knowledge into commercial or evidence-based practices remains limited.

Although the terms "biodiversity" (2) and "conservation" (4) are present, their low frequency indicates an underrepresentation of ecological dynamics in *A. arvense* research, already highlighted in this study as essential for the resilience of the grassland ecosystems and the ecological interactions within their habitats. Theoretically, this reinforces the need to address the species' sustainability within an integrated model that includes both medicinal exploitation and environmental management strategies.

The co-occurrence analysis of terms, represented through the word cloud, revealed a methodological pattern similar to that proposed by Klarin (2024), who

employs this technique to map intellectual structures and identify thematic gaps in scientific domains. Our results demonstrated that the academic production on *A. arvense* is heavily concentrated in pharmacological journals such as *Planta Medica* and the *Journal of Ethnopharmacology*, while the ecological and conservation aspects remain underexplored. This thematic imbalance underscores the utility of a co-occurrence analysis as a diagnostic tool to guide future research toward the neglected areas. For example, although terms like "Catuaba" and "medicinal plants" frequently appear, conservation-related words were rarely observed, reinforcing the need to redirect the research efforts toward ecological questions critical for developing management and conservation strategies for the species.

The keyword mapping provided a detailed view of dominant themes and gaps related to ecological and conservation issues, emphasizing the need for an interdisciplinary approach to balance the research focus on this species. One of the most promising conservation-related themes for *A. arvense* is its genetic diversity, which is essential for resilience and adaptation, and could be further investigated through interdisciplinary collaborations and comparative studies across vegetation types. Genetic diversity studies, such as those by Batistini et al. (2009), could be expanded to include habitat fragmentation and anthropogenic pressures. Incorporating concepts such as *ecological adaptability* and *ecosystem services* could enrich the discussions on the ecological role of *A. arvense*, particularly in fragmented habitats and regions under anthropogenic stress (Soh et al., 2019; He et al., 2019). Studies since 2019 have emphasized the importance of interdisciplinary approaches that combine genetic resilience with the ecosystem service maintenance to ensure the conservation of medicinal plants in threatened environments (He et al., 2019; Sharma & Birman, 2024).

The lack of ecological research on *A. arvense* may jeopardize its conservation, increasing the species' vulnerability to anthropogenic pressures. Recent studies support this trend, emphasizing the importance of genetic diversity for the resilience and adaptive capacity of medicinal plants. Kadam & Pawar (2020) argue that the

conservation of medicinal species must go beyond the sustainable harvesting and include strategies to preserve the genetic diversity both *in situ* and *ex situ*. Similarly, Nuraga et al. (2022) show that genetic variability plays a key role in the species survival and sustainable utilization, reinforcing the need for ecological research to complement pharmacological studies.

Another relevant aspect for the conservation of *A. arvense* involves the use of modern biotechnologies that may assist in preserving the genetic diversity, which is directly related to the ecological resilience. Maintaining this diversity in natural populations is essential for adaptation to environmental changes (Niazian, 2019; Carvalho et al., 2019). Additionally, Wang (2020) highlights that threatened medicinal species require population management strategies to prevent genetic erosion, which could impair their regeneration and propagation. Thus, the underrepresentation of ecological studies on Catuaba poses a significant risk to its conservation, underscoring the need to integrate genetic, ecological, and pharmacological approaches to ensure its long-term sustainability and protection.

Taken together, the bibliometric indicators reveal that *A. arvense* occupies an ambiguous position in the scientific literature. On the one hand, it is recognized as a medicinal species of pharmacological and cultural importance. On the other hand, it remains scientifically marginal in terms of ecological and conservation knowledge. This asymmetry is the main contribution of the present study: it shows that the conservation of *A. arvense* cannot be supported only by evidence of medicinal potential. A more integrated research agenda is required, combining species identification, population ecology, reproductive biology, habitat assessment, genetic diversity, and sustainable use.

In conclusion, the scarcity of ecological research on *A. arvense* is particularly concerning given its presence in vulnerable ecosystems such as the Atlantic Forest and the Highland Grasslands, where habitat fragmentation and environmental degradation are increasing. The absence of data on population distribution, reproductive patterns,

and ecological interactions and responses to anthropogenic pressures limits a precise assessment of the species' conservation status and hinders the implementation of effective conservation strategies. In this context, the presence of studies on *A. arvense* in internationally visible databases such as Web of Science and Scopus is strategically important, as it increases the visibility of the species as a research object and may stimulate the interest of new researchers, institutions, and collaborative networks.

The marginal position of *A. arvense* in ecological and conservation research reflects a broader pattern observed for several components of Brazilian biodiversity. Recent studies have shown that native species and ecosystems with limited scientific visibility tend to remain underrepresented in conservation agendas, public policies, and research funding priorities. This is particularly evident in Brazilian grassy ecosystems and savannas, which have historically been undervalued in scientific and conservation frameworks despite their high biodiversity and ecological importance (Overbeck et al., 2022). Similarly, gaps in ecological data reporting and spatial biases in plant surveys may prevent poorly studied species from being adequately considered in conservation planning, especially in regions undergoing rapid habitat loss (Guimarães et al., 2024; Silveira et al., 2025). In this context, increasing the presence of *A. arvense* in internationally indexed databases is not only a matter of scientific visibility, but also a strategic step toward attracting new researchers, strengthening interinstitutional and international collaborations, and supporting more interdisciplinary studies. Without this visibility, threatened native species may remain at the margins of conservation, being recognized mainly for their economic or medicinal potential rather than for their ecological relevance and vulnerability.

4 CONCLUSIONS

This study provides a critical bibliometric overview of the scientific production on *Anemopaegma arvense*, revealing a clear thematic imbalance in which pharmacological and ethnobotanical approaches predominate, while ecological and

conservation studies remain critically underrepresented. Based on 28 publications retrieved from Web of Science and Scopus between 1978 and 2024, the analysis showed that research on the species has advanced mainly in relation to its medicinal potential, but remains limited regarding population dynamics, geographic distribution, ecological interactions and responses to environmental pressures. This gap is particularly relevant because *A. arvense* is a threatened medicinal species whose sustainable use depends on the integration of pharmacological knowledge with ecological and conservation evidence. Therefore, this study contributes by identifying the main trends and limitations of the existing literature, emphasizing the need for an interdisciplinary research agenda capable of supporting conservation strategies, sustainable management, and the responsible use of Brazilian biodiversity.

REFERENCES

Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of informetrics*, *11*(4), 959975. https://doi.org/10.1016/j.joi.2017.08.007.

Bastos, J. G., Kury, L., Hanazaki, N., Capozzi, R., & Fonseca-Kruel, V. S. D. (2022). A biodiversity hotspot losing its biocultural heritage: the challenge to biocultural conservation of brazilwood (*Paubrasilia echinata*). *Frontiers in Forests and Global Change*, *5*, 696757. https://doi.org/10.3389/ffgc.2022.696757

Batistini, A. P., Telles, M. P. C., Bertoni, B. W., Coppede, J. D. S., Moro, F. V., França, S. D. C., & Pereira, A. M. S. (2009). Genetic diversity of natural populations of *Anemopaegma arvense* (Bignoniaceae) in the Cerrado of São Paulo State, Brazil. *Genetics and Molecular Research*, *8*(1), 52–63. https://doi.org/10.4238/vol8-1gmr538.

Brandão, M. D. G. L., Cosenza, G. P., Pereira, F. L., Vasconcelos, A. S., & Fagg, C. W. (2013). Changes in the trade in native medicinal plants in Brazilian public markets. *Environmental monitoring and assessment*, *185*, 7013–7023. https://doi.org/10.1007/s10661-013-3081-y.

Carvalho, Y. G., Vitorino, L. C., Souza, U. J. D., & Bessa, L. A. (2019). Recent trends in research on the genetic diversity of plants: Implications for conservation. *Diversity*, *11*(4), 62. https://doi.org/10.3390/d11040062.

Costanzo, C. D. G., Fernandes, V. C., Zingaretti, S., Beleboni, R. O., Pereira, A. M. S., Marins, M., ... & Fachin, A. L. (2013). Isolation of flavonoids from *Anemopaegma arvense* (Vell) Stellf. ex de Souza and their antifungal activity against *Trichophyton rubrum*. *Brazilian Journal of Pharmaceutical Sciences*, *49*, 559–565. https://doi.org/10.1590/S1984-82502013000300017.

Da Silva, M. O., de Souza, L. V., & Bastos, M. H. R. (2019). Bibliometria: análise quantitativa da produção científica sobre o teletrabalho e suas contribuições para o desenvolvimento regional brasileiro. *Revista Saber Digital*, *12*(2), 1–16. https://revistas.faa.edu.br/SaberDigital/article/view/785.

Daolio, C., Beltrame, F. L., Ferreira, A. G., Cass, Q. B., Cortez, D. A. G., & Ferreira, M. M. (2008). Classification of commercial catuaba samples by NMR, HPLC and chemometrics. Phytochemical Analysis: An International *Journal of Plant Chemical and Biochemical Techniques*, *19*(3), 218–228. https://doi.org/10.1002/pca.1019.

De Andrade, D. V. G., de Oliveira, D. M., Barreto, G., Bertolino, L. A., Saraceno, E., Capani, F., & Giraldez, L. D. (2008). Effects of the extract of *Anemopaegma mirandum* (Catuaba) on Rotenone-induced apoptosis in human neuroblastomas SH-SY5Y cells. *Brain research*, *1198*, 188–196. https://doi.org/10.1016/j.brainres.2008.01.006.

De Oliveira, K. E. D., Takase, I., & Gonçalves, É. C. B. D. A. (2009). Development of gluten-free cookie from medicinal plants (Guaraná-Paullinea cupana and Catuaba-*Anemopaegma mirandum*) aiming at copper, iron, and zinc supplementation. *Food Science and Technology*, *29*, 631–635. https://doi.org/10.1590/S0101-20612009000300027.

De Paula Loiola, P., Cianciaruso, M. V., Silva, I. A., & Batalha, M. A. (2010). Functional diversity of herbaceous species under different fire frequencies in Brazilian savannas. *Flora-Morphology, Distribution, Functional Ecology of Plants*, *205*(10), 674–681. https://doi.org/10.1016/j.flora.2010.04.006

Dos Santos, C. A. L., Hassan, W., Duarte, C. M., Lino, B. I. D., Noronha, A. H., da Silva, P. A. G., ... & Barros, L. M. (2025). A bibliometric analysis of five medicinal plants for wound healing. *Pharmacological Research-Natural Products*, 100153. https://doi.org/10.1016/j.prenap.2025.100153.

Elias, T. S., & Prance, G. T. (1978). Nectaries on the fruit of *Crescentia* and other Bignoniaceae. *Brittonia*, *30*, 175–181. https://doi.org/10.2307/2806648

Fernandes, M. M., Lima, A. H. S., & Wanderley, L. L. (2022). Fragmentação florestal na Bacia Hidrográfica do Rio São Francisco, Brasil. *Cerne*, *28*(1), e103291. https://doi.org/10.5902/1980509845253.

Ferraro, A., da Silva, G. S., de Aguiar, C. L., & Appezzato-da-Glória, B. (2021). Evaluating belowground bud banks of native species from Cerrado: structural, chemical, and ecological approaches. *Flora*, *281*, 151852. https://doi.org/10.1016/j.flora.2021.151852.

Ferreira, M. V., Lebuino, L. P., & Santos, J. S. (2021). Plantas medicinais de uso tradicional na região sul paraense: um estudo etnobotânico. *Research, Society and Development*, *10*(12), e592101220778-e592101220778. https://doi.org/10.33448/rsd-v10i12.20778.

Firetti, F. (2024). *Anemopaegma* in Flora e Funga do Brasil. Jardim Botânico do Rio de Janeiro. Available at: https://floradobrasil.jbrj.gov.br/FB112500.

Firetti-Leggieri, F., da Costa, I. R., Lohmann, L. G., Semir, J., & Forni-Martins, E. R. (2011). Chromosome studies in Bignonieae (Bignoniaceae): the first record of polyploidy in *Anemopaegma*. *Cytologia*, *76*(2), 185–191. https://doi.org/10.1508/cytologia.76.185.

Firetti-Leggieri, F., Lohmann, L. G., Semir, J., Demarco, D., & Castro, M. M. (2014). Using leaf anatomy to solve taxonomic problems within the *Anemopaegma arvense* species complex (Bignonieae, Bignoniaceae). *Nordic Journal of Botany*, *32*(5), 620–631. https://doi.org/10.1111/j.1756-1051.2013.00275.x.

Firetti, F., Zuntini, A. R., Gaiarsa, J. W., Oliveira, R. S., Lohmann, L. G., & Van Sluys, M. A. (2017). Complete chloroplast genome sequences contribute to plant species delimitation: a case study of the *Anemopaegma* species complex. *American Journal of Botany*, *104*(10), 1493–1509. https://doi.org/10.3732/ajb.1700302.

Glasl, S., Presser, A., Werner, I., Haslinger, E., & Jurenitsch, J. (2003). Tropane alkaloids from a Brazilian bark traded as "Catuaba". *Scientia Pharmaceutica, 71*(2), 113–119. https://doi.org/10.3797/scipharm.aut-03-12

Guarim Neto, G., & Morais, R. G. D. (2003). Recursos medicinais de espécies do Cerrado de Mato Grosso: um estudo bibliográfico. *Acta Botanica Brasilica*, *17*, 561–584. https://doi.org/10.1590/S0102-33062003000400009.

Guimaraes, A. F., de Alagao Querido, L. C., Rocha, T., de Jesus Rodrigues, D., Viana, P. L., de Godoy Bergallo, H., ... & Dala-Corte, R. B. (2024). Disentangling the veil line for Brazilian biodiversity: An overview from two long-term research programs reveals huge gaps in ecological data reporting. *Science of the Total Environment*, *950*, 174880. https://doi.org/10.1016/j.scitotenv.2024.174880.

He, X., Liang, J., Zeng, G., Yuan, Y., & Li, X. (2019). The effects of interaction between climate change and land-use/cover change on biodiversity-related ecosystem services. *Global Challenges*, *3*(9), 1800095. https://doi.org/10.1002/gch2.201800095.

Ittiyavirah, S. P., & Hameed, J. (2014). Herbs treating Parkinson's disease. *Biomedicine & Aging Pathology*, *4*(4), 369–376. https://doi.org/10.1016/j.biomag.2014.08.003.

Kadam, S. T., & Pawar, A. D. (2020). Conservation of medicinal plants: A review. *International Journal of Ayurvedic Medicine*, *8*, 3890–3895. https://doi.org/10.46607/iamj0807112020.

Klarin, A. (2024). How to conduct a bibliometric content analysis: Guidelines and contributions of content co-occurrence or co-word literature reviews. *International Journal of Consumer Studies*, *48*(2), e13031. https://doi.org/10.1111/ijcs.13031.

Kletter, C., Glasl, S., Presser, A., Werner, I., Reznicek, G., Narantuya, S., ... & Jurenitsch, J. (2004). Morphological, chemical and functional analysis of catuaba preparations. *Planta Medica*, *70*(10), 993–1000. https://doi.org/10.1055/s-2004-832627.

Lindholm, K. J., & Ekblom, A. (2019). A framework for exploring and managing biocultural heritage. Anthropocene, *25*, 100195. https://doi.org/10.1016/j.ancene.2019.100195.

Marques, L. L. M., Ferreira, E. D. F., de Paula, M. N., Klein, T., & de Mello, J. C. P. (2019). *Paullinia cupana*: a multipurpose plant–a review. *Revista Brasileira de Farmacognosia*, *29*(1), 77–110. https://doi.org/10.1016/j.bjp.2018.08.007.

Mauro, C., Pereira, A. M. S., Silva, C. D. P., Missima, J., Ohnuki, T., & Rinaldi, R. B. (2007). Anatomical study of species from savanna-like formation, *Anemopaegma arvense* (Vell.) Stellf. ex de Souza (catuaba), *Zeyheria montana* Mart. (bolsa-de-pastor) and *Jacaranda decurrens* Chamisso (caroba)-Bignoniaceae. *Revista Brasileira de Farmacognosia*, *17*, 262–265. https://doi.org/10.1590/S0102-695X2007000200021.

Mello, J. R. B. D., Mello, F. B. D., & Langeloh, A. (2010). Toxicity study of a phytotherapic with *Anemopaegma mirandum*, *Cola nitida*, *Passiflora alata*, *Paullinia cupana*, *Ptychopetalum olacoides* and thiamin in rabbits. *Latin American Journal of Pharmacy*, *29*(8), 1431–1435. http://www.latamjpharm.org/resumenes/29/8/LAJOP_29_8_2_1.pdf.

Mendes, F. R. (2011). Tonic, fortifier and aphrodisiac: adaptogens in the Brazilian folk medicine. *Revista Brasileira de Farmacognosia*, *21*, 754–763. https://doi.org/10.1590/S0102-695X2011005000097.

Mendes, F. R., & Carlini, E. A. (2007). Brazilian plants as possible adaptogens: an ethnopharmacological survey of books edited in Brazil. *Journal of Ethnopharmacology*, *109*(3), 493–500. https://doi.org/10.1016/j.jep.2006.08.024.

Ministério do Meio Ambiente. (2022). Portaria MMA n° 148, de 7 de junho de 2022. Diário Oficial da União, *108*, 74. https://www.in.gov.br/en/web/dou/-/portaria-mma-n-148-de-7-de-junho-de-2022-406272733.n

Moraes, L. L. D., & Kafure, I. (2020). Bibliometria e ciência de dados um exemplo de busca e análise de dados da Web of Science (WoS). RDBCI: *Revista Digital de Biblioteconomia e Ciência da Informação*, *18*, e020016. https://doi.org/10.20396/rdbci.v19i0.8658521/22560.

Nanisfi, M., Susilawati, S., & Gunawan, G. (2025). Trend of Traditional Medicine and ethnobotany research: A Bibliometrics Analysis. *Current Environmental Research*, *5*(1), 12–28. https://doi.org/10.56566/cer.v1i1.348

Niazian, M. (2019). Application of genetics and biotechnology for improving medicinal plants. *Planta*, *249*, 953-973. https://doi.org/10.1007/s00425-019-03099-1.

Nuraga, G. W., Feyissa, T., Tesfaye, K., Biswas, M. K., Schwarzacher, T., Borrell, J. S., ... & Heslop-Harrison, J. S. (2022). The genetic diversity of enset (*Ensete ventricosum*) landraces used in traditional medicine is similar to the diversity found in non-medicinal landraces.

Frontiers in Plant Science, *12*, 756182. https://doi.org/10.3389/fpls.2021.756182.

Overbeck, G. E., Vélez-Martin, E., da Silva Menezes, L., Anand, M., Baeza, S., Carlucci, M. B., ... & Müller, S. C. (2022). Placing Brazil's grasslands and savannas on the map of science and conservation. Perspectives in Plant Ecology, *Evolution and Systematics*, *56*, 125687. https://doi.org/10.1016/j.ppees.2022.125687

Padilha, A. F., Pietrobelli, S. R., Pereira, G. F., Finatto, T., Madeira, N. R., & Vargas, T. D. O. (2023). Análise bibliométrica da produção científica sobre plantas alimentícias não convencionais. *Interações (Campo Grande)*, *24*(2), 427–443. https://doi.org/10.20435/inter.v24i2.3830.

Pereira, A. M., Amui, S. F., Bertoni, B. W., Moraes, R. M., & França, S. C. (2003). Micropropagation of *Anemopaegma arvense*: conservation of an endangered medicinal plant. *Planta medica*, *69*(06), 571–573. https://doi.org/10.1055/s-2003-40644.

Pereira, A. M., Salomao, A. N., Januario, A. H., Bertoni, B. W., Amui, S. F., França, S. C., ... & Moraes, R. M. (2007). Seed germination and triterpenoid content of *Anemopaegma arvense* (Vell.) Stellfeld varieties. *Genetic Resources and Crop Evolution*, *54*, 849–854. https://doi.org/10.1007/s10722-006-9161-x.

Pires, E. V., De Carvalho, C. M., Da Costa, J. G., Pires, G. D. A., & Da Silva, E. M. (2019). USO of factor planning to evaluate the level of germination of *L. sativa* and *L. esculentum* front of two medicinal plantsitle in capital. https://doi.org/10.52571/PTQ.v16.n31.2019.894_Periodico31_pgs_884_891.pdf.

R Core Team (2021). *R: A language and environment for statistical computing. R Foundation for Statistical Computing*. http://www.r-project.org/

Ribeiro, R. V., Bieski, I. G. C., Balogun, S. O., & de Oliveira Martins, D. T. (2017). Ethnobotanical study of medicinal plants used by Ribeirinhos in the North Araguaia microregion, Mato Grosso, Brazil. *Journal of ethnopharmacology*, *205*, 69–102. https://doi.org/10.1016/j.jep.2017.04.023.

Ribeiro, S. T. C., Gancedo, N. C., de Oliveira, A. J. B., & Gonçalves, R. A. C. (2024). A comprehensive review of *Pfaffia glomerata* botany, ethnopharmacology, phytochemistry, biological activities, and biotechnology. *Journal of Ethnopharmacology*, 118003. https://doi.org/10.1016/j.jep.2024.118003.

Rieder, A., & Fernandes, R. S. (2011). Medicinal plant bioactivity–Catuaba (*Anemopaegma arvense* (Vell) Stellfeld JF & de Souza) on *Spodoptera frugiperda* (JE Smith) Lepidoptera: Noctuidae) in the larval stage. *Planta Medica*, *77*(12), PM210. https://doi.org/10.1055/s-0031-1282968.

Sharma, I., & Birman, S. (2024). Biodiversity loss, ecosystem services, and their role in promoting sustainable health. In The Climate-Health-Sustainability Nexus: Understanding the Interconnected Impact on Populations and the Environment (pp. 163-188). Cham:

Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-56564-9_7.

Silveira, P., dos Santos, J. S., Pena, J. C., de Lima, N. E., Vitorino, L. C., Martello, F., ... & Collevatti, R. G. (2025). The loss of an unknown biodiversity: Spatial gaps in plant survey and conservation in a Brazilian hotspot of biodiversity. *Biological Conservation*, *305*, 111098. https://doi.org/10.1016/j.biocon.2025.111098.

Soh, M. C., Mitchell, N. J., Ridley, A. R., Butler, C. W., Puan, C. L., & Peh, K. S. H. (2019). Impacts of habitat degradation on tropical montane biodiversity and ecosystem services: a systematic map for identifying future research priorities. *Frontiers in Forests and Global change*, *2*, 83. https://doi.org/10.3389/ffgc.2019.00083.

Souza, A. V., Oliveira, F. J. V., Bertoni, B. W., França, S. C., & Pereira, A. M. S. (2013). Michorrizical funghi studies in catuaba (*Anemopaegma arvense* (Vell.) Stell. ex de Souza), a medicinal plant from the Cerrado region at risk of extinction. *Revista Brasileira de Plantas Medicinais*, *15*, 646–654. https://doi.org/10.1590/S1516-05722013000500004.

Souza, A. V. V., Oliveira, F. J. V., Bertoni, B. W., França, S. C., & Pereira, A. M. S. (2015). Enraizamento in vitro de catuaba (*Anemopaegma arvense* (Vell.) Stell. ex de Souza), uma planta medicinal do Cerrado. *Revista Brasileira de Plantas Medicinais*, *17*, 51–58. https://doi.org/10.1590/1983-084X/ 12_191.

Souza, U. J. B. de, Vitorino, L. C., & Bessa, L. A. (2020). Trends in the scientific literature on *Stryphnodendron adstringens* (Leguminosae): an important Brazilian medicinal tree. *Multi-Science Journal*, *3*(1), 8–15. https://doi.org/10.33837/msj.v3i1.1108

Tabanca, N., Pawar, R. S., Ferreira, D., Marais, J. P., Khan, S. I., Joshi, V., ... & Khan, I. A. (2007). Flavan-3-ol-phenylpropanoid conjugates from *Anemopaegma arvense* and their antioxidant activities. *Planta medica*, *73*(10), 1107–1111. https://doi.org/10.1055/s-2007-981563.

Teixeira, T. M., Boeff, D. D., de Oliveira Carvalho, L., Ritter, M. R., & Konrath, E. L. (2024). The traditional use of native Brazilian plants for male sexual dysfunction: Evidence from ethnomedicinal applications, animal models, and possible mechanisms of action. *Journal of Ethnopharmacology*, *318*, 116876. https://doi.org/10.1016/j.jep.2023.116876.

Uchino, T., Kawahara, N., Sekita, S., Satake, M., Saito, Y., Tokunaga, H., & Ando, M. (2004). Potent protecting effects of catuaba (*Anemopaegma mirandum*) extracts against hydroperoxide-induced cytotoxicity. *Toxicology in vitro*, *18*(3), 255–263. https://doi.org/10.1016/j.tiv.2003.08.013.

Vouga Chueke, G., & Amatucci, M. (2022). Métodos de sistematização de literatura em estudos científicos: bibliometria, meta-análise e revisão sistemática. Internext: *Revista Electrônica de Negócios Internacionais da ESPM*, 17(2). https://doi.org/10.18568/internext.v17i2.704.

Wang, S. Q. (2020). Genetic diversity and population structure of the endangered species Paeonia decomposita endemic to China and implications for its conservation. *BMC Plant Biology*, *20*, 1–14. https://doi.org/10.1186/s12870-020-02682-z.

Zielinski, A. A., & Haminiuk, C. W. (2019). Evaluation of the phenolics and in vitro antioxidant

activity of different botanical herbals used for tea infusions in Brazil. *Current Nutrition & Food Science*, *15*(4), 345–352. https://doi.org/10.2174/1573401313666171020114727.

Authorship contributions

1 – Angela Liberali Pinheiro

Master's degree in Environmental Sciences from the Federal University of Alfenas
https://orcid.org/0000-0001-8066-6934 • liberalipinheiro@gmail.com
Contribution: Conceptualization, Data curation, Investigation, Methodology, Software, Visualization, Writing - original draft, Writing - review & editing

2 – Luciana Botezelli

PhD in Forestry Engineering from the Federal University of Lavras
https://orcid.org/0000-0002-5916-0442 • luciana.botezelli@gmail.com
Contribution: Conceptualization, Methodology, Project administration, Supervision, Validation, Writing - review & editing

3 – Ernesto de Oliveira Canedo Junior

PhD in Entomology from the Federal University of Lavras
https://orcid.org/0000-0002-9012-0051 • ernesto.canedo@uemg.br
Contribution: Conceptualization, Formal analysis, Funding acquisition, Methodology, Project administration, Resources, Software, Validation, Writing - review & editing

How to quote this article

Pinheiro, A. L., Botezelli, L., & Canedo Junior, E. O. (2026). A species on the margins of science: A critical analysis of the scientific output on *Anemopaegma arvense* (Vell.) Stellfeld ex de Souza in Brazil. *Ciência e Natura*, 48, e94007. DOI: 10.5902/2179460X94007. Available in: https://doi.org/10.5902/2179460X94007