

Review Article

Mapping ethnobotanical aspects of the iconic Mandacaru cactus, *Cereus jamacaru* DC. in Brazil: a scientometric review

Mapeamento de aspectos etnobotânicos do icônico cacto Mandacaru, *Cereus jamacaru* DC. no Brasil: uma revisão cienciométrica

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Abstract

Cereus jamacaru DC. occurs in the central-eastern region of Brazil and is among the best-known cacti in the country. Its phytochemical properties and fruits hold great significance to the local communities. We examined published ethnobotanical studies regarding *C. jamacaru* (mandacaru) undertaken between 2000 to 2024, to better understand its traditional uses and relationships with human communities in Brazil. The literature review was carried out by consulting the databases Google Scholar (166 articles), Scopus (1 article) and Web of Science (2 articles), and followed the PRISMA 2020 protocol. A total of 169 articles were identified, of which 45 were deemed relevant. The most frequent uses of *C. jamacaru* include medicinal (cited in 32 articles), human consumption as a non-conventional food (22), and forage (18). *C. jamacaru* is often cited to treat health conditions such as kidney problems, flu and inflammations, but it's also used for construction and crafts. Our results highlight the diverse and vital uses of *C. jamacaru* for human communities. Furthermore, we demonstrate the pattern of knowledge production regarding the ethnobotany of this species and the challenges for its conservation and the preservation of associated traditional knowledge.

Keywords: caatinga, cactaceae, traditional knowledge, ethnobotany, mandacaru.

Resumo

Cereus jamacaru DC. ocorre na região centro-oriental do Brasil e está entre os cactos mais conhecidos do país. Suas propriedades fitoquímicas e seus frutos têm grande importância para as comunidades locais. Examinamos estudos etnobotânicos publicados sobre *C. jamacaru* (mandacaru) realizados entre 2000 e 2024, para melhor entender seus usos tradicionais e as relações com as comunidades humanas do Brasil. A revisão da literatura foi realizada consultando as bases de dados Google Scholar (166 artigos), Scopus (1 artigo) e Web of Science (2 artigos), seguindo o protocolo PRISMA 2020. Um total de 169 artigos foram identificados, dos quais 45 foram considerados relevantes. Os usos mais frequentes do *C. jamacaru* incluem medicinal (citado em 32 artigos), consumo humano como alimento não convencional (22) e forrageiro (18). *C. jamacaru* é frequentemente citado para tratar condições de saúde, como problemas renais, gripe e inflamações, mas também é utilizado para construção e artesanato. Nossos resultados destacam os diversos e vitais usos do *C. jamacaru* para as comunidades humanas. Além disso, demonstramos o padrão de produção de conhecimento sobre a etnobotânica dessa espécie e discutimos sobre os desafios para sua conservação e a preservação do conhecimento tradicional associado a ela.

Palavras-chave: caatinga, cactaceae, conhecimento tradicional, etnobotânica, mandacaru.

1. Introduction

The relationships between human populations and plants are deeply intertwined and have profoundly influenced cultural practices, traditional medicine, and belief systems throughout history (Oliveira et al., 2011; Jin et al. 2022; Magalhães et al., 2022; Albuquerque et al., 2023). This relationship results not only in a vast reservoir of traditional knowledge regarding plant species and their uses, but also generates profound biocultural heritages,

as the dependence of local communities on these plants goes beyond medicine and food purposes, reaching a spiritual and religious connection (Pedrosa et al., 2020a, b; Jin et al., 2022; Albuquerque, 2023; Coqueiro et al., 2024; Santos-Neves et al., 2024; Sharif et al., 2024).

For instance, the number of ethnobotanical studies in Brazil has increased in recent decades, exploring various aspects of the relationship between humans and plants.

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Received: June 4, 2024 – Accepted: August 14, 2024



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These studies range from case studies (Lins Neto et al., 2021) to reviews (Santos-Neves et al., 2024) and research on nutritional potential (Nascimento et al., 2013). They often aim to document useful plants and analyze their potential uses, such as medicinal (Santoro et al., 2015; Hussain et al., 2022), forage (Nunes et al., 2015), construction (Lucena et al., 2007), fuel (Ramos & Albuquerque, 2012), and food (Nascimento et al., 2013). These studies have shown that native species such as *Macropsysanthus grandiflorus* (Mart. ex Benth.) L.P. Queiroz & Snak (mucunã), *Hymenaea courbaril* L. (jatobá), and *Syagrus cearensis* Noblick (coco-católé) are widely used and recognized for their high nutritional value, consisting strategic plants to improve human diets (Jacob et al., 2020). Additionally, species like *Psidium cattleianum* Sabine, *Eugenia uniflora* L., and *E. punicifolia* (Kunth) DC. have been used by various human communities for their medicinal properties, such as antibacterial, antifungal, and anti-inflammatory effects, and are used to treat a wide range of conditions, including sore throat, flu, and stomachache (Santos-Neves et al., 2024).

The Cactaceae family is highly relevant for various communities in the dry northeastern region of Brazil, particularly in the Caatinga ecosystem (Lima-Nascimento et al., 2019, 2021; Coqueiro et al., 2024). In this family, the specie *Cereus jamacaru* DC. (Mandacaru), occurs in the central-eastern region of Brazil and is among the best-known cacti in the country (Taylor and Zappi, 2004). Its size and notable adaptation to arid conditions has made it an iconic plant for local human populations (Taylor and Zappi, 2004), especially in the northeastern Brazil, where its distinctive physical characteristics and predominant presence in the semiarid landscapes make it a central element in folklore and mythological narratives (Lobo et al., 2022). The Mandacaru cactus is symbolically associated with resistance, adaptation, and perseverance – attributes valued by populations continually facing severe climatic and socioeconomic challenges (Pedrosa et al., 2020a; Lima-Nascimento et al., 2021, 2024).

Beyond the morphology and wide distribution of *C. jamacaru*, the phytochemical properties and fruits of the species hold great significance to the local communities (Pedrosa et al., 2020a; Lima-Nascimento et al., 2021, 2024). In traditional medicine, for example, various parts of this cactus are used to treat a wide range of ailments, such as gastrointestinal diseases, inflammation, pain, and infections, indicating the presence of bioactive compounds with therapeutic effects (Lima-Nascimento et al., 2021). Additionally, the fruits and stems of the Mandacaru are frequently employed to prepare teas, infusions, and ointments (Andrade et al., 2006; Cardoso et al., 2021). Thus, given its wide distribution in northeastern Brazil and biocultural significance for local communities, it's important to understand the production pattern of ethnobotanical knowledge regarding *C. jamacaru* in the northeastern Brazil.

Considering the cultural diversity of the northeastern Brazil and the array of uses of *C. jamacaru* (Almeida and Fernandez, 2024; Coqueiro et al., 2024), a scientometric review offers a better understanding of the complex interactions between human populations and Mandacaru plants, identifying knowledge gaps and guiding future

research for the conservation and sustainable use of the species (Lima-Nascimento et al., 2021). In this context, the present scientometric review is designed to comprehensively analyze the progression of ethnobotanical publications focused on *C. jamacaru* in the Northeast of Brazil, highlighting the deeply rooted role of the species in traditional medicine, cultural practices, and local beliefs. Additionally, we aim to evaluate the pattern of knowledge production on *C. jamacaru* ethnobotany, the conservation challenges for this species, and how this species is used across the country.

2. Material and Methods

The search was divided into three different stages (“identification”, “screening and inclusion”, and “extraction”), following the PRISMA 2020 protocol (Page et al. 2021a, b) (Figure 1). No time period filter was applied.

2.1. Identification

Considering the guiding question of this study, which is to map the research presenting the ethnobotanical use categories of *Cereus jamacaru* in the northeastern

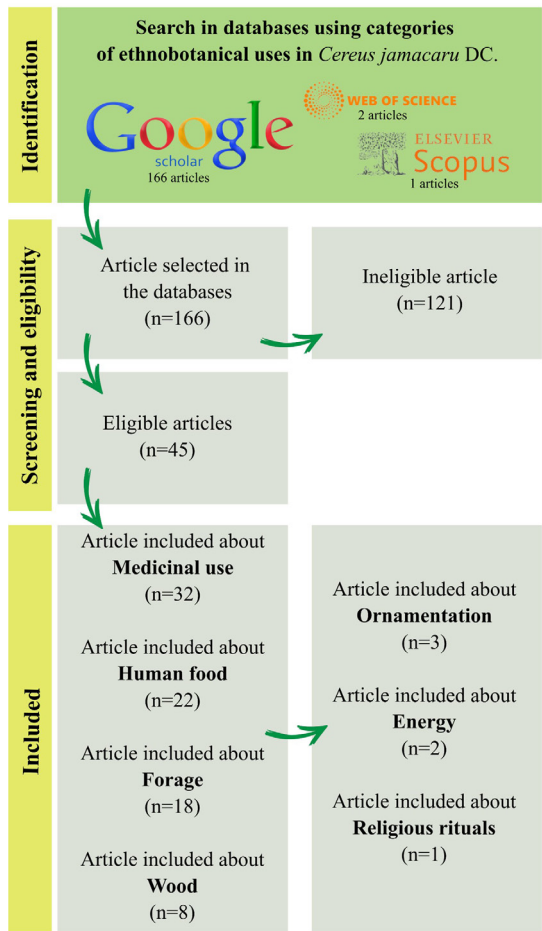


Figure 1. PRISMA flow diagram for article selection.

region of Brazil, we selected ethnobotanical studies identified through the search of specific descriptors of these categories in the titles, abstracts, and keywords of published studies. The databases Google Scholar, Scopus and Web of Science were used to obtain the studies due to their good performance (Bramer et al., 2017). We applied the symbol “*” to include synonyms of the descriptor words, with the Boolean operator “AND” and “OR”, (“*Cereus jamacaru*” OR “mandacaru”) AND (“Brazil”) AND (“Ethnobotany” OR “traditional use” OR “traditional knowledge” OR “knowledge on the use of natural resources”). Course completion works (monographs, dissertations, theses, and books) were not considered. All searches were conducted using English terms, although only texts published in English, Portuguese, or Spanish were considered.

2.2. Screening and inclusion

To filter only articles with relevant information for the ethnobotanical uses of *C. jamacaru*, we initially screened the abstracts and then the full manuscripts to determine if they met the predefined eligibility criteria: (i) original articles published in Portuguese, English, or Spanish; (ii) ethnobotanical studies that included the Cactaceae family conducted in Brazil; (iii) articles that focused or included *C. jamacaru* among the studied species and provided indications of its ethnobotanical uses. Finally, the articles that met all these criteria were analyzed in detail, as explained in the following section 2.3 *Extraction*. Studies that did not meet the eligibility criteria were excluded from the analyses and classified as gray literature (non-legible).

2.3. Extraction

Following the screening process, the selected studies were examined in detail and extracted the following information: the use categories cited for *C. jamacaru* (e.g. Medicinal use, Human food, Forage, Wood, Ornamentation, Energy and Religious rituals), popular knowledge, and the phytogeographical domains of the studies (Figure 2). To understand who are the main contributors involved in research of this species ethnobotanical aspects, we identified the Institutes of Higher Education (HEIs) in Brazil based on the affiliations of the first author of each article. Additionally, this scenciometric review investigated the temporal evolution of published articles. These integrated analyses allowed us not only to understand the geographic regions of investigations on *C. jamacaru* ethnobotany, but also to reveal how interest and engagement in this specific field of study have evolved.

3. Results

3.1. Studies' characteristics

The database search yielded a total of 169 studies on the ethnobotanical aspects of *C. jamacaru* (Google Scholar: 166, Scopus: 1, Web of Science: 2, and Scielo: 0). After the screening process, 121 articles were deemed ineligible and only 45 studies met the inclusion criteria (Figure 1). We encountered no publications related to

the ethnobotanical aspects of *C. jamacaru* before the year 2001 (Figure 2 and Table 1). Therefore, the data collected represent the last 24 years of knowledge production.

There is a notable increase (27%) in the production of ethnobotanical articles from 2011 onwards, except for 2017, during which no publications appeared (Figure 2B). Also, we observed a substantial growth in research on *C. jamacaru* during the period from 2011 to 2024 (83%) that addressed various facets of its ethnobotanical use (Figure 2B). The analysis of the articles regarding *C. jamacaru* identified several ethnobotanical use categories. Medicinal use was addressed in 32 articles, whereas human consumption as a non-conventional food is found in 22 articles, and the use category related to forage was mentioned in 18 articles (Figure 3). The least frequent use categories in the studies analyzed were religious rituals (1), energy (2), and ornamental (3) (Table 1 and Figure 3).

Additionally, we observed a significant concentration of studies of *C. jamacaru* produced by institutes of higher education (HEIs) in the states of northeastern Brazil (Figure 4). Surprisingly, only one study was conducted by researchers from São Paulo State (Universidade Estadual Paulista – UNESP). Among northeastern states, Pernambuco stood out as the main research hub, with a total of 19 published articles; 13 were produced by the Federal Rural University of Pernambuco – UFRPE, while the Federal University of Pernambuco – UFPE contributed six studies (Figures 2A and 4). A total of 12 studies originated from institutes of higher education in Paraíba State, of which the Federal University of Paraíba (UFPB) and the Federal University of Campina Grande (UFCG) contributed six published articles each (Figure 4).

Three studies were produced by universities in Piauí State [two by the Federal University of Piauí (UFPI) and one by the Federal Institute of Piauí (IFPI)] and three by universities in Bahia State [two by the Bahia Federal University (UFBA) and one by the Feira de Santana State University (UEFS)]. Both the states of Ceará (UFC and UECE) and Rio Grande do Norte (UFRSA and UFRN) produced two articles each. Alagoas (UNEAL) and Maranhão (UFMA) produced only one study each, demonstrating a varied regional distribution of ethnobotanical research on *C. jamacaru* in the northeastern region of Brazil (Figure 2).

4. Discussion

4.1. Mandacaru, a multifaceted plant in all usage categories

Cereus jamacaru stands as an iconic and emblematic plant found in northeastern Brazil, with multifaceted roles in providing food resources, economic benefits, and valuable folk knowledge (Nunes et al., 2012; Silva, 2015). Communities inhabiting the arid regions of Brazil exhibit remarkably varied utilizations for diverse parts of this cactus (Figure 5). This plant is particularly notable in the traditional medicine for its therapeutic versatility, being recommended for treating a wide array of conditions, including kidney, urethral, liver, respiratory, and spinal issues, as well as ailments such as warmth, syphilis, flu, cough, bronchitis, ulcers, constipation,

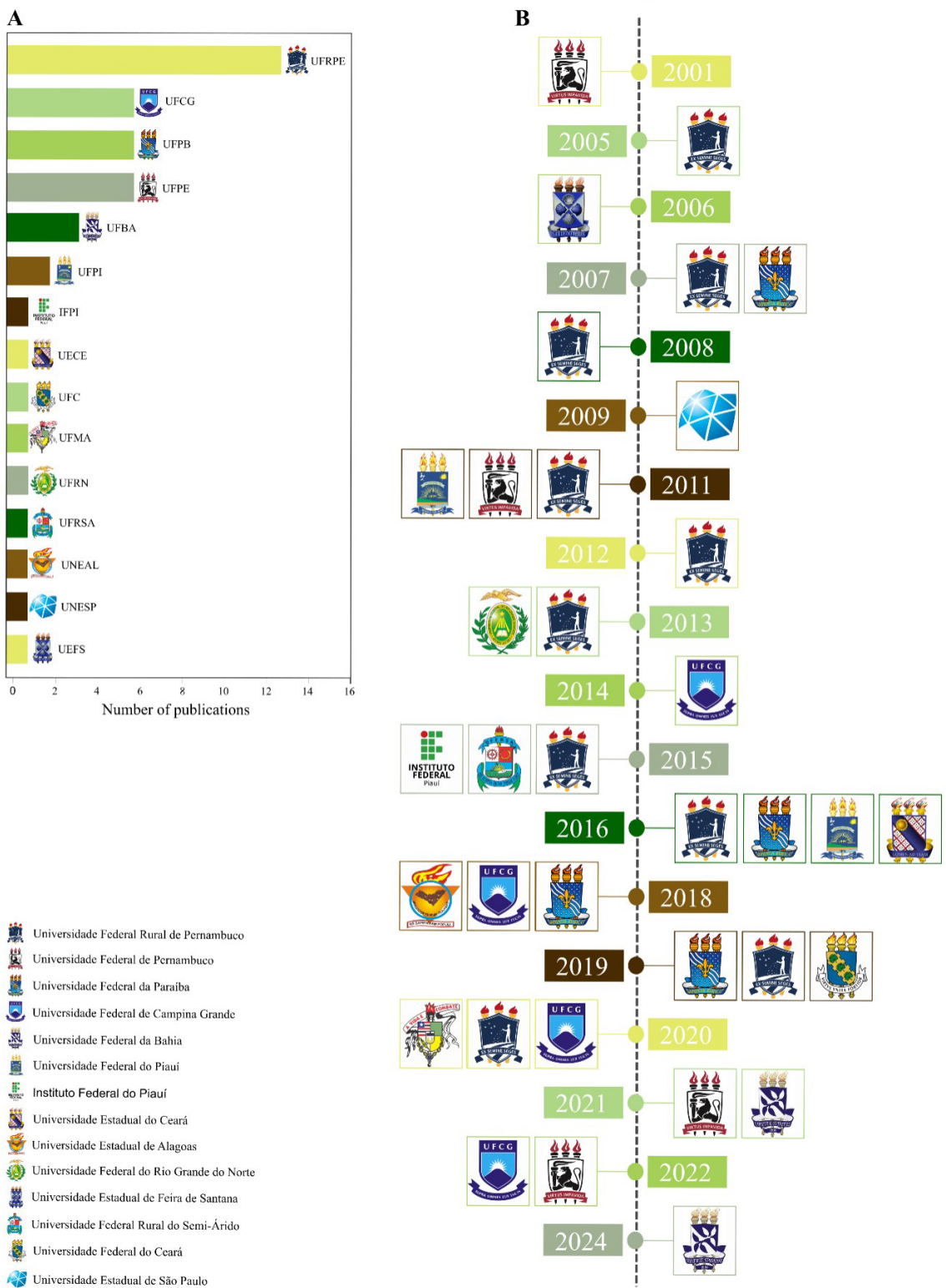


Figure 2. Annual distribution of studies published on the categories of ethnobotanical uses of *Cereus jamacaru* DC by Brazilian higher education institutions. **(A)** The number of works published by higher education institutions; **(B)** timeline with the production of articles during the years 2000-2024.

Table 1. Ethnobotanical use categories of *Cereus jamacaru* DC. in scientific articles published in Brazil from 2000 to 2024: (W) wood, (F) forage, (HF) human consumption as a non-conventional food, (M) medicinal, (RR) religious rituals, (O) ornamentation, and (E) energy.

Title	Categories	Authors/ Year of publication
The use of medicinal plants by the cultural descendants of African people in Brazil	M	Albuquerque (2001)
Life strategy and chemical composition as predictors of the selection of medicinal plants from the caatinga (Northeast Brazil)	M	Almeida et al. (2005)
Utilização de cactáceas por sertanejos baianos. Tipos conexivos para definir categorias utilitárias	W-F-HF-M-O	Andrade et al. (2006)
Is the use-impact on native caatinga species in Brazil reduced by the high species richness of medicinal plants?	M	Albuquerque and Oliveira (2007)
Medicinal and poisonous diversity of the flora of “Cariri Paraibano”, Brazil	M	Agra et al. (2007)
Medicinal plants of the caatinga (semi-arid) vegetation of NE Brazil: A quantitative approach	M	Albuquerque et al. (2007)
A new approach to study medicinal plants with tannins and flavonoids contents from the local knowledge	M	Araújo et al. (2008)
Patents of drugs extracted from Brazilian medicinal plants	M	Balbani et al. (2009)
Chemical characterization of native wild plants of dry seasonal forests of the semi-arid region of northeastern Brazil	HF	Nascimento et al. (2011)
Use of participatory methods in the creation of a catalog of medicinal plants	M	Vieira et al. (2011)
Dynamics of medicinal plants knowledge and commerce in an urban ecosystem (Pernambuco, Northeast Brazil)	M	Monteiro et al. (2011)
Resilience and adaptation in the use of medicinal plants with suspected anti-inflammatory activity in the Brazilian Northeast	M	Ferreira Júnior et al. (2011)
Caatinga plants with nutritional potential: a review from the work “Contribution to the study of the Flora from Pernambuco, Brazil” (1954) by Dárdano de Andrade Lima	W-F-HF -M-E	Nunes et al. (2012)
Knowledge, use and management of native wild edible plants from a seasonal dry forest (NE, Brazil)	HF	Cruz et al. (2013)
Potencial de uso dos recursos vegetais em uma comunidade rural no semiárido potiguar	F-HF	Roque and Loila (2013)
Knowledge and use of wild food plants in areas of dry seasonal forests in Brazil	F-HF-M	Nascimento et al. (2013)
Food flora in 17th century northeast region of Brazil in História Naturalis Brasiliae	Fr- HF	Medeiros and Albuquerque (2014)
Local knowledge about fodder plants in the semi-arid region of Northeastern Brazil	F-HF	Nunes et al. (2015)
Cactáceas: recurso alimentar emergencial no semiárido, Nordeste do Brasil	F-HF	Chaves and Barros (2015)
Physical-chemical characteristics and antioxidant potential of seed and pulp of <i>Ximenia americana</i> L. from the semiarid region of Brazil	M	Sarmento et al. (2015)
Diversidade de uso das cactáceas no Nordeste do Brasil: uma revisão	W-F-HF-M-O-E	Silva (2015)
Plantas medicinais e suas indicações ginecológicas: estudo de caso com moradoras de Quixadá, CE, Brasil	M	Silva et al. (2016)
The role of local disease perception in the selection of medicinal plants: A study of the structure of local medical systems	M	Ferreira Júnior et al. (2016)
Inventory in situ of plant resources used as fuel in the Semiarid Region of Northeast Brazil	W	Lima et al. (2016)
Ethnobotanical and ethnoveterinary study of medicinal plants used in the municipality of Bom Princípio do Piauí, Piauí, Brazil	M	Castro et al. (2016)
Inventário in situ como método para avaliação da extração de recursos madeireiros na caatinga: estudo de caso no município de Cabaceiras (Paraíba, Brasil)	W-F	Lima et al. (2018)
Conhecimento e uso das plantas da caatinga por agricultores locais moradores de uma comunidade rural do município de Pesqueira, estado de Pernambuco	F-HF-M	Lima-Nascimento et al. (2018)
Conhecimento botânico local sobre Cactáceas: um estudo de caso no município de Boqueirão, Paraíba, Nordeste do Brasil	F-HF	Machado et al. (2018)
What factors guide the selection of medicinal plants in a local pharmacopoeia? A case study in a rural community from a historically transformed Atlantic Forest landscape	F-HF-M	Silva et al. (2018)
Ethnobotany of native cacti in the northeast region of Brazil: can traditional use influence availability?	M-F-HF-M	Lima-Nascimento et al. (2019)
Levantamento etnobotânico de plantas medicinais em comunidades rurais localizadas na Unidade de Conservação Tatu-Bola, município de Lagoa Grande, PE - Brasil	M	Albegaria et al. (2019)
Medicinal plants of the Caatinga, northeastern Brazil: Ethnopharmacopeia (1980–1990) of the late professor Francisco José de Abreu Matos	M	Magalhães et al. (2019)
Biodiverse food plants in the semiarid region of Brazil have unknown potential: A systematic review	F-HF-M	Jacob et al. (2020)
Use of medicinal plants of Brazilian Caatinga in a perspective of solidarity economy	M	Santos and Santos (2020)
Potencial de uso de espécies vegetais de áreas de dunas em São Luís, Maranhão, Brasil	W-F-HF-M-O	Carvalho et al. (2020)
Traditional management of Cactaceae by local populations in the semiarid region of Brazil	F-HF-M	Pedrosa et al. (2020b)

Table 1. Continued...

Title	Categories	Authors/ Year of publication
Knowledge and use of Cactaceae in rural communities in the semiarid region of Paraíba, northeastern Brazil	F-HF	Pedrosa et al. (2020a)
Can medicinal use protect plant species from wood uses? Evidence from Northeastern Brazil	W-M	Silva et al. (2021)
Nutritional and technological potential of cactus fruits for insertion in human food	HF	Cardoso et al. (2021)
Traditional management of Cactaceae: <i>Cereus jamacaru</i> DC as the native cactus most managed by rural communities in areas of Caatinga in Brazil	F-HF-M	Lima-Nascimento et al. (2021)
Ethnobotany as a parameter for the study of cultural mimicry among Roma people	HF-M-RR	Lobo et al. (2022)
Physical, nutritional, and bioactive properties of mandacaru cladode flour (<i>Cereus jamacaru</i> DC.): An unconventional food plant from the semi-arid Brazilian Northeast	HF	Martins et al. (2022)
Ethnomedical uses, biocompounds and biological properties of <i>Cereus jamacaru</i> DC. (Cactaceae): a comprehensive review	M	Almeida and Fernandez (2024)
Trends in research on cacti: the food of the future	HF	Coqueiro et al. (2024)

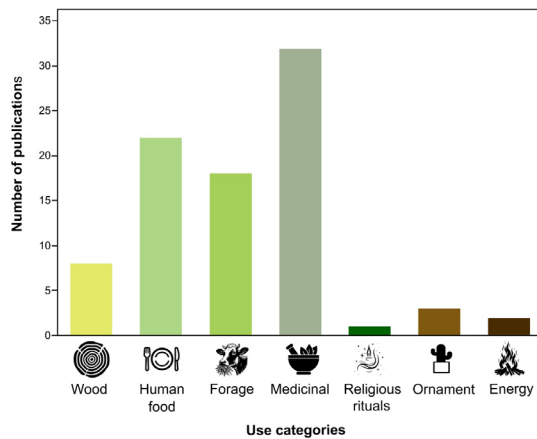


Figure 3. Numbers of published works citing each ethnobotanical use category of *Cereus jamacaru* DC.

hypertension, rheumatism, enteritis, fever, and ovarian cysts, among others (Andrade et al., 2006; Pio et al., 2019; Silva et al., 2021). It is also prescribed as an expectorant, antiemetic, diuretic, and for menstrual regulation, as documented by Andrade et al. (2006). The breadth of its uses and applications in traditional medicine underscores the significance of the Mandacaru cactus as a therapeutic resource in the Caatinga region, especially for the low-income families (Nunes et al., 2012; Albergaria et al., 2019; Almeida and Fernandez, 2024).

Among the multiple uses attributed to this plant, the treatment of gastrointestinal problems, such as diarrhea and constipation, stands out as one of the most common (Andrade et al., 2006). Ethnobotanical studies have recorded the traditional practice of using cactus roots and stems to prepare teas and infusions to alleviate such problems (Lima-Nascimento et al., 2018). The fruit pulp is often used to prepare syrups and teas that are considered to have diuretic and anti-inflammatory properties (Lucena et al., 2013). These local uses demonstrate a plethora of medicinal applications associated with the species in Brazil (Albuquerque and Oliveira, 2007; Albuquerque et al., 2007).

Additionally, Almeida and Fernandez (2024) highlighted the remarkable diversity of bioactive compounds found in mandacaru. Among these compounds are alkaloids, such as phenethylamine, hordenine, tyramine, N-methyltyramine, and tyrosine, as well as flavonoids, phenolic compounds like flavonoids and tannins, proteins, oleic acid, geranyl acetone, benzoquinone, anthraquinone, phenol, cinnamic acid, valeric acid, among others (Almeida and Fernandez, 2024). This variety of compounds endows Mandacaru with vast potential as both a medicinal and food resource.

The ethnobotanical studies have discussed about the direct and indirect impacts of consuming this cactus for its conservation. Notably, different parts of the plant have food uses, with the fruits, the mucilage removed from the cladodes (Figure 4), and even entire portions of the cladodes being widely consumed (Lucena et al., 2013; Lima-Nascimento et al., 2019). This results in less intense use-pressure on any given individual plant and thus a greater chance of its post-exploitation survival (Lucena et al., 2012; Andrade et al., 2006).

The fruits also gain high significance during periods of water scarcity, as they produce a succulent pulp rich in nutrients and essential vitamins and minerals vital to human nutrition (Nascimento et al., 2013; Lima-Nascimento et al., 2019). Of the total carbohydrates in the fresh fruits pulp (13.43 g/100 g), almost 80% of it consist in dietary fiber, with 89% of this fiber being insoluble (Soares et al. 2021). Notably, the total antioxidant capacity of the raw fruit skin is approximately 1.5 times greater than that of the raw pulp (Soares et al., 2021). The nutritional potential of the mandacaru fruits and cladodes is heightened as saponins, tannins, flavones, flavonols, and xanthones can be found in them (Almeida et al., 2022). The presence of these bioactive compounds underscores the significance of this species for human food and forage, contributing to income generation and improving the nutrition for both humans and animals (Almeida et al., 2022).

However, some studies conducted in rural communities in northeastern Brazil have highlighted the unsustainable use of various other Cactaceae species (Lima-Nascimento et al., 2018, 2019, 2021), with practices that involve their complete destruction to feed cattle, sheep and goats (Lucena et al., 2012, 2013). Among the most representative Cactaceae species used

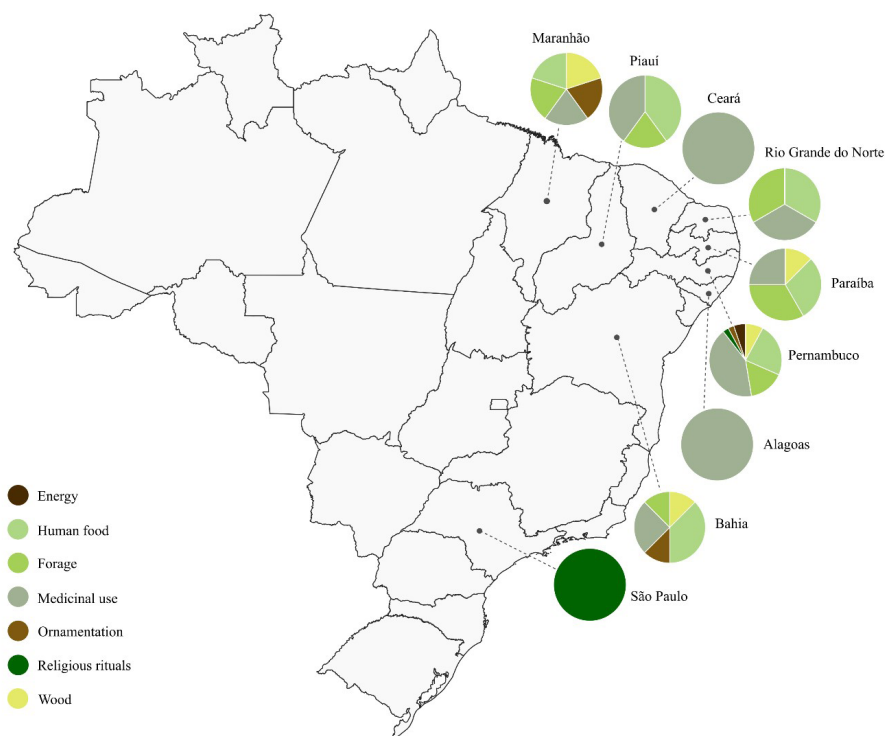


Figure 4. Distribution of ethnobotanical use categories of *Cereus jamacaru* DC. among Brazilian states based on publications.

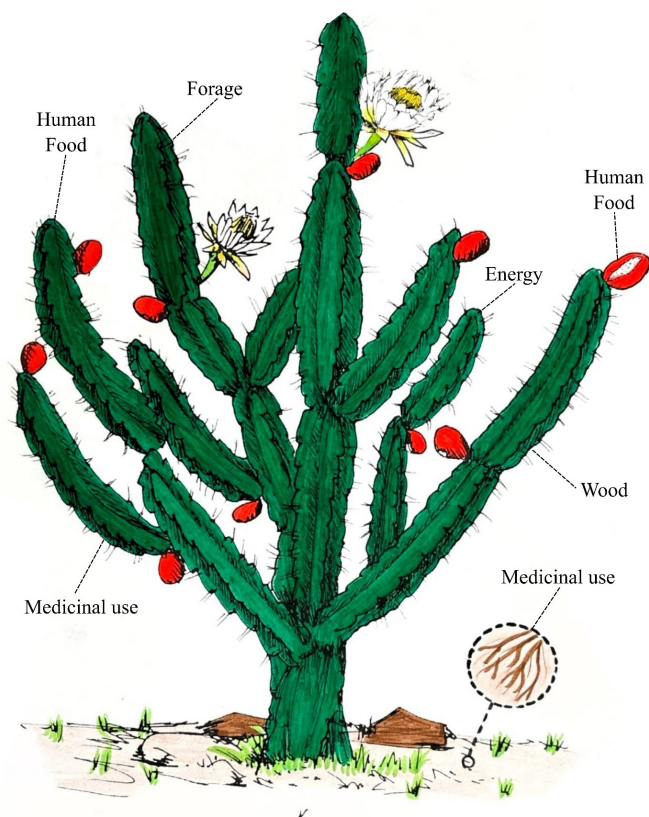


Figure 5. Parts of *Cereus jamacaru* DC. that are used for each ethnobotanical use category (Illustration: Cavalcante and Melo 2015).

for feeding animals are: *C. jamacaru*, *Melocactus zehntneri* (Britton & Rose) Luetzelb., *Opuntia dillenii* (Ker Gawl.) Haw, *Pilosocereus pachycladus* subsp. *pernambucoensis* (Ritter) Zappi, *Xiquexique gounellei* (F.A.C. Weber) Lavor & Calvente subsp. *gounellei*, *P. chrysostele* (Vaupe) Byles & GD Rowley, *Tacinga palmadora* (Britton & Rose) N.P.Taylor & Stuppy, and *T. inamoena* (K.Schum.) N.P.Taylor & Stuppy (Lucena et al., 2012, 2013, 2015a, b; Lima-Nascimento et al., 2019). This destructive utilization underscores the necessity of reconsidering how the plants are used by rural communities, given their potential long-term negative impacts.

The aridity in the Brazilian semiarid region is projected to increase by the second half of the 21st century due to rainfall reductions, temperature increases, and water deficits (Marengo and Bernasconi, 2015), significantly diminishing the availability of resources for animal feed (Cavalcanti et al., 2015). This situation echoes previous documentation of a similar scenario in a rural community in Paraíba State (Lucena et al., 2015a, b) and highlights the urgency of sustainable strategies and adaptive measures to mitigate the adverse effects of prolonged droughts. In light of the crescent aridity and loss of forage plants, the *C. jamacaru*, as many Cactaceae species, can store water in their tissues and survive the prolonged droughts (Lucena et al., 2012, 2013). The use of this species as forage extends beyond northeastern Brazil (Lucena et al., 2012, 2013, 2015a; Nunes et al., 2015). The strategic use of *C. jamacaru* and other Cactaceae species in animal feed can not only contribute to the conservation of other natural resources, by reducing their use intensity, but can also offer a sustainable and resilient alternative in the face of climate change and soil degradation (Lucena et al., 2015a; Nunes et al., 2015).

Far from being restricted to animal husbandry and medicinal proposes, the uses of the *C. jamacaru* extends to rural construction, with cactus hedgerows, for example, being commonly planted in several parts of the world, including in countries such as Cuba (Fuentes, 2005) and Mexico (Casas, 2002; Rodríguez-Arévalo et al., 2006). Mandacaru stem wood has versatile roles in construction and craft practices (Silva et al., 2021). When properly prepared, stem wood can be used as a structural element in rural constructions, such as fences and small animal shelters (Lima-Nascimento et al., 2019; Silva et al., 2021). The fibers of this cactus are used to produce artisanal objects such as baskets and mats (Roque and Loiola, 2013).

Not limited to just utilitarian purposes, *C. jamacaru* plants can also provide shade and decorate houses and yards (Machado et al., 2018). In a rural context, mandacaru cacti can be used to fill in gaps in conventional wooden and barbed wire fences delimiting pastures, plantations, and residences (Lima et al., 2018). In addition to providing a unique aesthetic to the boundaries of these properties, this plant has a crucial role in protecting against invasions by large animals (Machado et al., 2018) due to the spines, thus helping to guarantee the integrity of fenced areas (Roque and Loiola, 2013).

In addition to the numerous use categories already mentioned, mandacaru also plays a traditional role as a bioindicator of rainfall in semiarid regions (Lucena et al., 2012). Also, this cactus has significant cultural relevance,

and the ethnobotanical knowledge that is transmitted orally from generation to generation represents an essential part of the identity and cultural heritage of local communities in the Brazilian semiarid region (Andrade et al., 2006; Carvalho et al., 2020). The history, mythology, and traditions of those human communities exhibit significant connections related to the use of *C. jamacaru*, transforming it into a symbol of resilience and adaptation to life in semiarid environments (Lima-Nascimento et al., 2019, 2021). Thus, the emblematic *C. jamacaru* not only contributes to the subsistence and culture of communities, but also plays a significant role in deciphering otherwise complex climate patterns, thus consolidating its position as a fundamental element in the lives of the people who share its environment.

4.2. Conservation of the most emblematic cactus in Brazil

The ethnobotanical uses of mandacaru by communities in the Brazilian semiarid region are part of a series of risks and challenges that deserve attention and appropriate solutions. As mentioned earlier, mandacaru is widely used in traditional medicine, as a human food resource, as livestock fodder, wood, and for other purposes (Cavalcanti et al., 2015; Chaves and Barros, 2015; Silva, 2015; Lima-Nascimento et al., 2018). Its excessive use, however, can lead to population decreases (Lima-Nascimento et al., 2018, 2024), and agricultural expansion, urbanization, the introduction of invasive species, and climate change can contribute to habitat reduction (Silva et al., 2018; Coqueiro et al., 2024), and traditional knowledge about mandacaru and its various properties may be lost over time.

In a recent study, Lima-Nascimento et al. (2024) discuss how traditional management practices of *C. jamacaru* alter the quantitative and spatiotemporal distribution of its resources (flowers, nectar, and fruits), in addition to impacting the production of reproductive structures and affecting the timing and intensity of flowering and fruiting phenophases. The study shows that in managed populations, the peaks of floral bud and mature fruit emergence occur earlier compared to unmanaged populations, although the duration of flowering and fruiting is long in all populations studied (Lima-Nascimento et al., 2024). Local management, although not deliberately aimed at selecting specific floral or reproductive characteristics, causes significant alterations. The removal of leaf litter and undesirable plants, as well as the pruning of *C. jamacaru* individuals, modifies local microclimatic conditions such as temperature, light, and humidity distribution under the plants. For example, the removal of competing plants reduces competition for light and soil nutrients, enhancing reproductive performance and resulting in a greater resource availability in managed individuals (Lima-Nascimento et al., 2024).

Proactive efforts should therefore be considered to preserve *C. jamacaru* through the implementation of sustainable management practices (Lima-Nascimento et al., 2019). Such actions would involve establishing protected areas where extraction is limited or prohibited, developing cultivation techniques to ensure plant replenishment for human use and educating communities about the

risks of over-exploitation (Pedrosa et al., 2020a; Lima-Nascimento et al., 2021). Additionally, research on sustainable alternatives for traditional uses of *C. jamacaru*, such as substitutes for its wood or alternative medicinal sources, could help reduce pressure on this species.

It will be essential to balance the needs of local communities with the preservation of *C. jamacaru* and its habitat (Machado et al., 2018). This will require collaborative approaches among communities, governments, and researchers to ensure that extraction practices are sustainable and that the plant will continue to fulfill its important ecological and socioeconomic roles in Brazil, especially in the northeastern semiarid region (Coqueiro et al., 2024), and that the mandacaru cactus and its ethnobotanical uses are preserved and diffused for future generations.

5. Conclusions

Ethnobotanical studies of Cactaceae underscore the socioeconomic importance of the emblematic *C. jamacaru* and highlight the fundamental importance of recording and preserving the traditional knowledge of communities in the semiarid region of northeastern Brazil. These studies evidenced a wide variety of uses of this specie, of which the medicinal applications were the most common. The mandacaru provides treatments for several conditions, including gastrointestinal disorders, skin problems, and diabetes. Furthermore, its presence is intertwined with the local culture and reflects the deep connection between the human populations and the Caatinga region where *C. jamacaru* thrives.

This is the first systematic review focused solely on the ethnobotanical aspects of the emblematic *C. jamacaru*. It represents an essential step towards acquiring a panoramic view of existing scientific production and identifying gaps as well as emerging topics. It is designed to contribute to future investigations, promote a deeper understanding of interactions between human communities and this iconic cactus in northeastern Brazil, as well as the family Cactaceae as a whole, and aid in the conservation of that knowledge.

Acknowledgements

We thank the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), Finance code 001, for the scholarships granted to the authors: AB-S (88887.686942/2022-00), SA-L (88882.347730 / 2019 - 01, 88887.898666/2023-00), ACAF (88887.686948/2022-00), MTDG (88887.723617/2022-00), PSNS (88887.630753/2021-00), and are grateful to the Postgraduate Program in Botany at the State University of Feira de Santana (PPGBot-UEFS). Thank the Programa de Pesquisa em Biodiversidade do Semiárido – PPBIO, Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq/MCTI, N° 441271/2023-5).

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