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Clarissa Lessa Nascimento

Graduate Program in Biodiversity and Conservation (PPGBC)

Júlio Marcelino Monteiro

Graduate Program in Biodiversity and Conservation (PPGBC)

José Ribamar Sousa Júnior

sousajr@ufpi.edu.br

Graduate Program in Biodiversity and Conservation (PPGBC)

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“Local knowledge, extractivism and population status of *Terminalia glabrescens* Mart. in the Northeast of Brazil”

*Clarissa Lessa Nascimento, Júlio Marcelino Monteiro, José Ribamar Sousa Júnior**

Programa de Pós-Graduação em Biodiversidade e Conservação (PPGBC), Universidade Federal do Piauí (UFPI), Floriano, PI, Brasil, Laboratório de Etnobiologia e Conservação (LECON)

*Corresponding author: José Ribamar Sousa Júnior (email: sousajr@ufpi.edu.br)

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Abstract

Terminalia glabrescens Mart. is a native tree widely exploited in Northeastern Brazil, particularly known for its medicinal and timber properties. Although it is frequently harvested, the consequences of extractive practices have not been assessed; therefore, this study examined the uses and influences of extractivism on the species population status. Semi-structured interviews were conducted with 86 participants, who mentioned 27 different uses across six categories: medicinal, technological, construction, fuel, food, and Fodder. Three plots of 50 x 50 m were demarcated, where individuals were identified, measured for diameter, and their height was visually estimated. The study indicated a preference for collecting trees of tall and intermediate size and thickness, which are considered ideal and versatile for various uses. An association was found between the forms of use and the gender of the participants, with men having more citations in all use categories, particularly in the timber context. It was observed that the population of the species did not fit the "inverted J" model, suggesting that extractivism may primarily affect trees in intermediate size classes. Although this study does not directly assess levels of exploitation, the results may be attributed mainly to timber exploitation.

Keywords: Plant resource use, ethnobotany, woody plant, population ecology.

Resumo

A *Terminalia glabrescens* Mart. é uma árvore nativa amplamente explorada no Nordeste do Brasil, destacando-se especialmente por suas propriedades medicinais e madeiras. Embora seja frequentemente coletada, as consequências das práticas extrativistas não foram avaliadas, este estudo, portanto, verificou os usos e influências do extrativismo no status populacional da espécie. Foram feitas entrevistas semiestruturadas com 86 participantes, os quais mencionaram 27 formas de uso distribuídas em seis categorias: medicinal, tecnológico, construção, combustível, alimentação e forragem. Três parcelas de 50 x 50 m foram demarcadas, onde os indivíduos foram identificados, medidos em diâmetro e tiveram a altura visualmente estimada. O estudo indicou uma preferência pela coleta de árvores de tamanho e espessura altas e intermediárias, consideradas ideais e versáteis para diversos usos. Houve associação entre as formas de uso com o gênero dos participantes, em que os homens tiveram mais citações em todas as categorias de uso, principalmente no contexto madeireiro. Observou-se que a população da espécie não se adequou ao modelo de “J invertido”, sugerindo que o extrativismo pode afetar, sobretudo, as árvores que estão nas classes intermediárias. Embora este estudo não avalie diretamente os níveis de exploração, este resultado pode ser atribuído principalmente à

exploração madeireira.

Palavras-chave: Uso de recursos vegetais, etnobotânica, planta lenhosa, ecologia populacional.

1 Introduction

From the understanding of plant resource use patterns and ecological analyses, it is possible to elucidate how the collection patterns of certain species can exert intense use pressure, often leading to eventual local extinction [1]. Unregulated harvesting can directly impact on the population structure and dynamics of plant species subjected to extraction, resulting in decreased growth and reproduction rates of individuals [2]. This impact of exploitation is intrinsically related to the part of the plant being harvested, collection patterns, and species regeneration potential [3].

It is important to emphasize that each use associated with a plant has unique characteristics, which may vary depending on sociocultural and environmental contexts. This is evidenced by the fact that knowledge and use of plant resources are not uniform across genders, seemingly determined by the social roles men and women play [4]. The practices of men and women related to plant use are intrinsically linked to social, cultural, and economic factors, which can influence the conservation and valuation of natural resources [5]. In general, the studies that looked at gender, especially with a focus on medicinal plants, indicated that women were able to identify more plants than men [6,7], with gender being considered the predictor variable for the number of species known [8,9,7]. Or even studies looking at specific categories of use, such as timber [10] and medicinal [11], for example, or even the main categories of use in general [7].

The pressure on plant resources due to their different uses and availability increases the risk of exploitation occurring at detrimental levels, contributing to population decline [12]. Studies focusing on the use and conservation aspects of plant species often utilize combined ethnobotanical and ecological information to diagnose the population status of species facing greater use pressure [13,14,15]. Within this context, the *Terminalia glabrescens* Mart, popularly known as ‘catinga de porco’, emerges as an intriguing subject of study, given the medicinal significance of the genus [16], especially due to the bark extraction of *T. glabrescens* [16]. According to these authors, the extraction of the bark from the ‘catinga de porco’ tree should be done in the smallest possible size, thus contributing to its regeneration. Additionally, species of the Combretaceae family are widely distributed in ecotone areas between the Cerrado

and the Semideciduous Seasonal Forest [17]. Representatives of the genus *Terminalia* are used in traditional medicine in several countries due to their rich source of secondary metabolites [18,19,20], which also stand out for their timber and fuel properties [21]. *Terminalia glabrescens* is a native species that has been extensively explored by local communities in Northeastern Brazil for timber and medicinal purposes.

Although there are pharmacological records of *Terminalia glabrescens* [22,23], there are no studies detailing the local ecological knowledge associated with the species, especially regarding use categories and the importance of this plant resource for the subsistence of local populations and biodiversity, especially considering the gender variable (men and women). Thus, this study aimed to assess whether the extraction of *Terminalia glabrescens* (forms of use, exploited parts, and collection patterns) could affect the species' population status in an exploitation area.

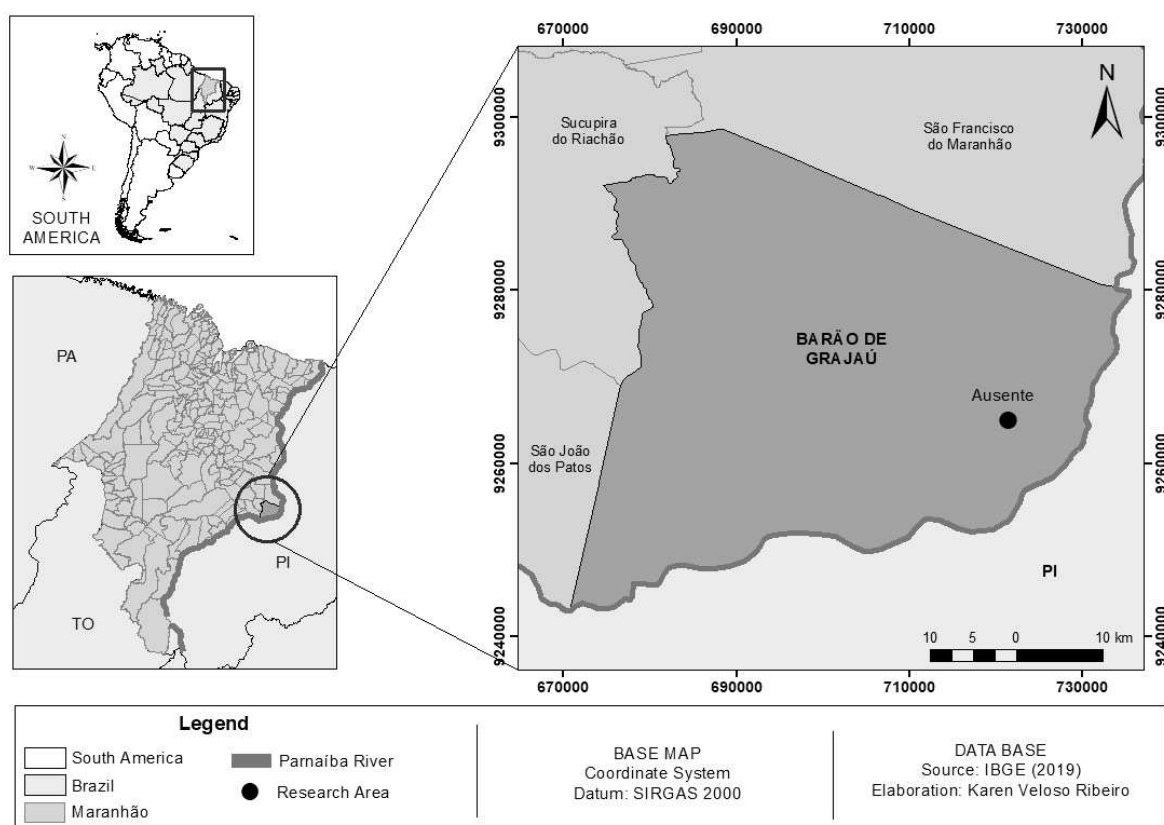
This study focuses on the analysis of the population status of *Terminalia glabrescens* in the area exploited, assessing the impact of use and collection patterns on the sustainability of the species. To achieve this, we combine quantitative and qualitative ethnobotanical approaches to investigate the different uses and the main influences. The hypothesis suggests that the participants' practices of use significantly affect the population status of *Terminalia glabrescens*, resulting in changes in the population dynamics that may lead to its decline. Additionally, the influence of gender on different uses of the species was analyzed.

2 Methods

2.1 Study area

This study was carried out in the rural community of Ausente, municipality of Barão de Grajaú, state of Maranhão (Fig. 1), Northeastern Brazil (6° 38'46.98" S and 42°59'49.14" W). The region has a sub-humid tropical climate with temperatures ranging from 27 °C to 37 °C. Precipitation is well-defined in summer and rare in winter, concentrated between November and April, with an increase in temperature from May to October [24]. The region is characterized as an ecotone between the Caatinga and Cerrado biomes, consisting of trees and shrubs ranging from 3 to 12 m in height, structured in two strata: an arboreal/shrub stratum with

108 sparse and twisted trees and another herbaceous/grass stratum.



109
 110 **Fig. 1** Location of the rural community of Ausente, municipality of Barão de Grajaú, state of
 111 Maranhão, Northeastern Brazil, and areas of phytosociological and ethnobotanical collections
 112 of *T. glabrescens*.

113 114 2.2 Data collection

116 Initially, an exploratory survey was conducted to confirm the occurrence of the species
 117 in the selected locations and evidence of knowledge and use. The study was approved by the
 118 Research Ethics Committee of the Federal University of Piauí (CEP/UFPI), process number
 119 64256622.1.0000.5660, registered in the Biodiversity Authorization and Information System
 120 (SISBIO), process number 87073, and the National System for the Management of Genetic
 121 Heritage and Associated Traditional Knowledge (SISGEN), registration - A86B9BA. During
 122 the interviews, participants were asked to sign an Informed Consent Form. Individuals were
 123 selected using the snowball sampling method [25]. The following criteria were considered for
 124 participant inclusion: minimum age of 18 years, knowledge and use of the species. Semi-
 125 structured interviews [25] were conducted with questions related to socio-economic profile,

plant parts, uses, preparation methods, collection time, and collection patterns.

Among the 86 people interviewed, 41.86% were women and 58.14% were men, with a higher male presence associated with the habit of collecting and spending more time in the forest. The age range of the participants was 24 to 76, with a predominance of individuals between 40 and 60 years old. In terms of income, 26.74% had no income, 58.14% earned as much as or below minimum wage, and 15.12% earned more than minimum wage. Additionally, 32.56% of the participants were farmers. Regarding education, 16.28% were illiterate, 61.63% had completed elementary school, 19.77% had completed high school, and only 2.33% had studied in higher education. These data reveal a diversity in income and education, highlighting socioeconomic challenges evidenced by low income and education levels.

To assess the population status, three plots of 50 x 50 meters (sampling units) covering a total area of 0.75 hectares were demarcated. These plots were selected in the vicinity of the community, where traces of timber collection were identified, specifically signs of bark removal from the species under study. These traces included visible cutting marks on the trees and areas with removed bark, indicating collection activity. In all plots, individuals were tagged with aluminum plates, each with a unique number for tracking, and were measured for height (in meters) and circumference (in centimeters) to assess the impact of the collection on the trees. Individual height measurements were estimated visually, and circumference measurements were taken with a measuring tape. For inclusion of individuals in the sample, we established the criterion of measuring the Circumference at Breast Height (CBH) from ≥ 10 cm at a height of 1.30 m above ground level [26]. For analysis, the CBH was converted to Diameter at Breast Height (DBH) based on the following formula: $[DBH = (CBH / \pi)]$ [27].

2.3 Data analysis

The aforementioned uses were organized into categories according to the citations provided by the participants, carefully considering the specific information collected during the interviews. These categories were developed and adjusted based on the relevance and frequency of the responses, ensuring they accurately reflected the local knowledge and practices [28]. We used the Plant Part Value (PPV) index to measure the degree of consistency among informants regarding the part used, calculated by dividing the number of informants who mentioned the bark by the total number of informants. We also used the Use Diversity Value (UDV) index to measure the importance of the use categories and how they contribute to the total use value, calculated by dividing the number of use categories by the total number of informants [29,30].

Differences in use values assigned by different genders (men and women) in the community were compared using the Kruskal-Wallis test. The Chi-square test was used to check differences in use categories between men and women. Responses regarding selection patterns were analyzed based on the percentage of participant preferences for the most frequently extracted tree thickness and height.

To assess the population status of *Terminalia glabrescens* in the three sampled plots, individuals were classified into height classes with 1 m intervals and diameter classes with 5 cm intervals. Subsequently, the population's fit to the negative exponential reverse J-shaped model, characteristic of stable and self-replacing populations [31,32], was verified. The inverted J model, also known as the inverted J distribution, describes a typical population structure in ecology, where the density of individuals is higher in smaller size classes (such as young individuals or sprouts) and decreases as one moves to larger size classes, resulting in a graphical pattern resembling an inverted letter "J" [33]. This pattern indicates a population that is in equilibrium, with a high recruitment rate of young individuals, suggesting that the species has a good regeneration potential and remains stable over time. All histograms and statistical tests were performed using RStudio software version 4.3.2 [34].

3 Results

3.1 Uses, extracted plant parts, and collection patterns

Participants mentioned 27 different uses distributed into six categories, with the medicinal category (11) being the most prominent, followed by technology (7), construction (5), fuel (2), food (1), and Fodder (1) (Table 1), showing that the species has widely recognized versatility. Of the total respondents, 84 (98%) recognized *T. glabrescens* as a medicinal resource and attributed 11 therapeutic indications to it (Table 1). Medicinal use for stomach ache received the highest number of mentions (61 citations), followed by general inflammations (59 citations), with citations of use from both bark and leaves. The use of *T. glabrescens* for fencing (31), charcoal (21), and rafters for house roofs (19) also stood out, revealing the importance of the species for treating ailments and providing wood for construction and fuel (Table 1).

Table 1 Different uses of *Terminalia glabrescens* Mart., cited by the rural community of Ausente, municipality of Barão de Grajaú, state of Maranhão, Northeastern Brazil. NC= Number of citations. Total participants = 86.

Category	Uses	Part used	NC
Food	Beverage coloring	Bark	3
Fuel	Coal	Stem (trunk)	21
	Firewood	Stem (trunk)	6
Construction	Rafter	Stem (trunk)	19
	Gate	Stem (trunk)	1
	Fence	Stem (trunk)	31
	Clapboard	Stem (trunk)	3
	Board	Stem (trunk)	4
Fodder	Feeding cattle/goats	Leaves	2
Medicinal	Cold	Leaves	1
	Diabetes	Bark	1
	Stomach ache	Leaves	8
		Bark	53
	Kidney pain	Bark	1
	Migraine	Bark	6
	Liver	Bark	7
	Flu	Bark	1
	Inflammations	Bark	47
		Leaves	11
		Root	1
	Cleans the blood	Bark	1
	Prostate	Bark	1
	Ulcer	Bark	1
Technology	Scythe handle	Stem (trunk)	2
	Hoe handle	Stem (trunk)	4
	Chair	Stem (trunk)	6
	Door box	Stem (trunk)	2

	Flowerbed	Stem (trunk)	3
	Home shelf	Stem (trunk)	1
	Slingshot	Stem (trunk)	1
Total	27		

The prominence of the medicinal category compared to others uses was evident, as it obtained the highest UDV, followed by construction, fuel, technology, fodder, and food (Fig. 2). Regarding the plant part used as a resource, participants mentioned different uses for almost all parts, with the bark having the highest PPV, followed by the stem, leaf, and root (Fig. 3).

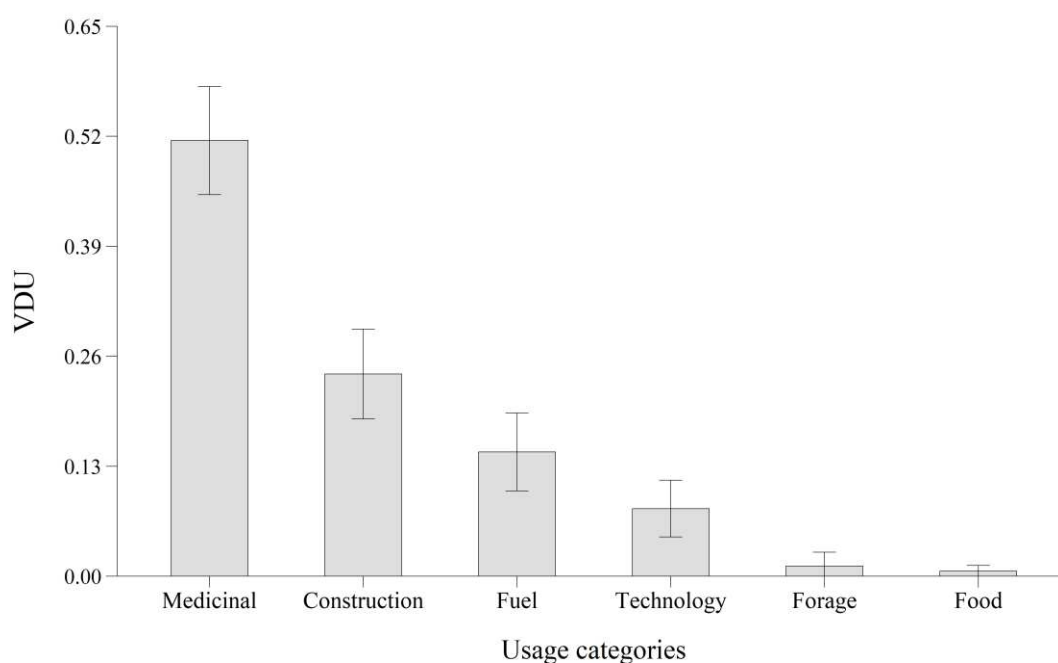


Fig. 2 Use-Diversity Value (UDV) index for *Terminalia glabrescens* in the rural community of Ausente, municipality of Barão de Grajaú, state of Maranhão, Northeastern Brazil.

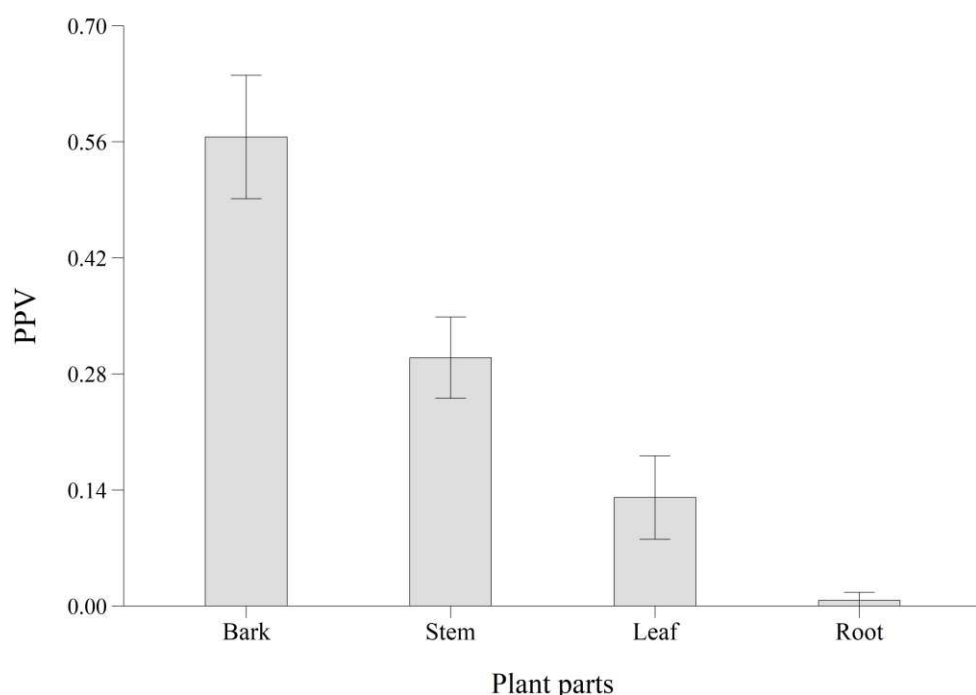


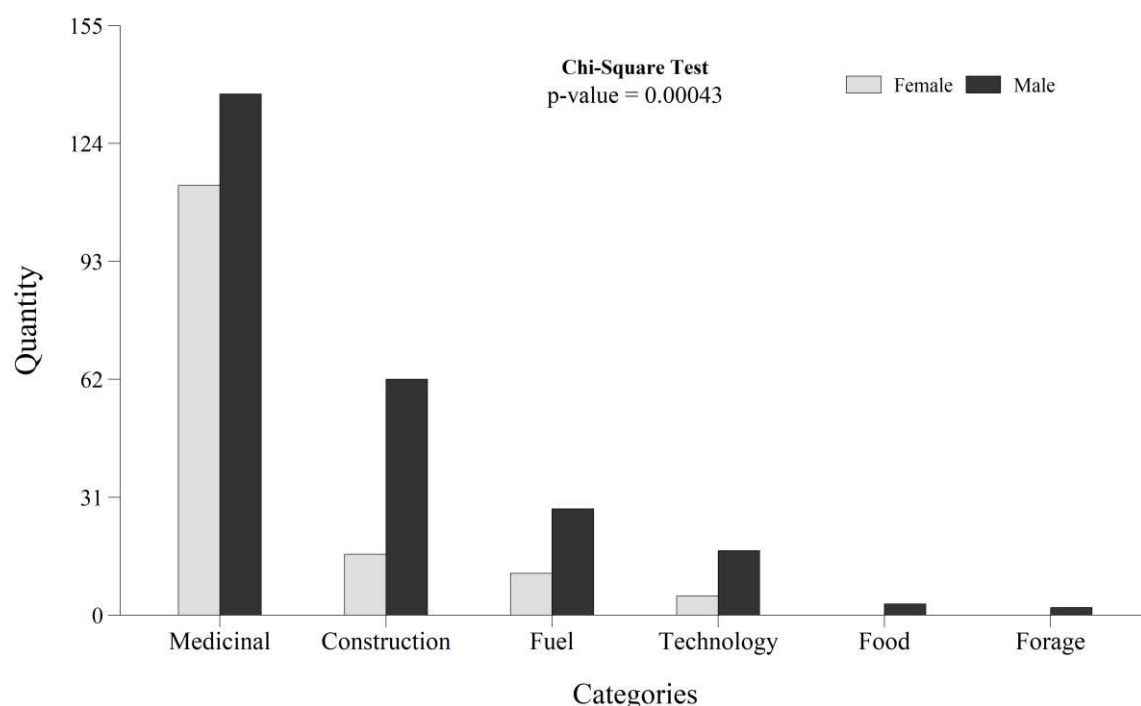
Fig. 3 Plant Part Value (PPV) for *Terminalia glabrescens* in the rural Community of Ausente, municipality of Barão de Grajaú, state of Maranhão, Northeastern Brazil.

Regarding collection patterns, there was a preference for taller and thicker trees, as confirmed by 55% (n=47) of participants expressing a preference for trees of these patterns, considered ideal and versatile for various uses within the community. The findings also revealed a preference for trees of intermediate size and thickness, representing 20% (n=17) of responses, and 26% (n=22) of participants indicated a preference for both sizes and thicknesses, which is generally used in the construction of fences, rafters, and tool making.

3.2 Influence of gender on different uses of the species

The comparison between genders revealed a significant difference ($H = 6.994$, p-value = 0.008), indicating a positive association in preferences or use patterns of the species between genders in the studied sample. Furthermore, considering the use categories, a significant difference was also identified ($X^2 = 22.5$, p-value = 0.0004), in which men demonstrated a significantly higher number of citations in all use categories, with emphasis on categories related to construction, fuel, and technology (Fig. 4).

257



258 **Fig. 4** Result of the chi-square test of differences in use citations by categories according to
 259 woman (W) and man (M) for *Terminalia glabrescens* Mart. in the rural community of Ausente,
 260 municipality of Barão de Grajaú, state of Maranhão, Northeastern Brazil.

261

262 3.3 Population Status

263

264 A total of 34 individuals were identified in the three plots (Table 2), where the
 265 predominance of individuals in the smallest diameter classes (between 3-20 cm) was observed,
 266 with a significant decrease in intermediate classes (between 20-35 cm in diameter) and larger
 267 classes (between 35-50 cm in diameter). With respect to height data, we found a reduction in
 268 trees with heights less than 2 m and in the tallest classes (between 6 and 10 m). Therefore,
 269 Figure 5 shows an unequal distribution with a concentration in only one class and a low number
 270 of individuals in the other classes. The population status of *T. glabrescens* is affected by the
 271 collection patterns of the species, as the population distribution does not follow the negative
 272 exponential pattern, the expected configuration of a reverse “J-shaped” model distribution,
 273 there is a concentration of individuals in the smaller classes, but a significant reduction in the
 274 intermediate and larger classes. This suggests that, while there are new individuals entering the
 275 population (i.e., young individuals), they are not able to grow and reach the larger diameter and
 276 height classes. This phenomenon may be attributed to the selective extraction of larger trees,

especially for uses such as timber and construction, as can be seen in figure 6.

Table 2 Phytosociological parameters for the population of *Terminalia glabrescens* Mart. in the rural community of Ausente, municipality of Barão de Grajaú, state of Maranhão, Northeastern Brazil.

Parameters	Maximum	Minimum	Average $\pm$ SD
DBH (cm)	46.14	3.18	10.28 $\pm$ 10.01
Height (m)	10	2	3.90 $\pm$ 1.96

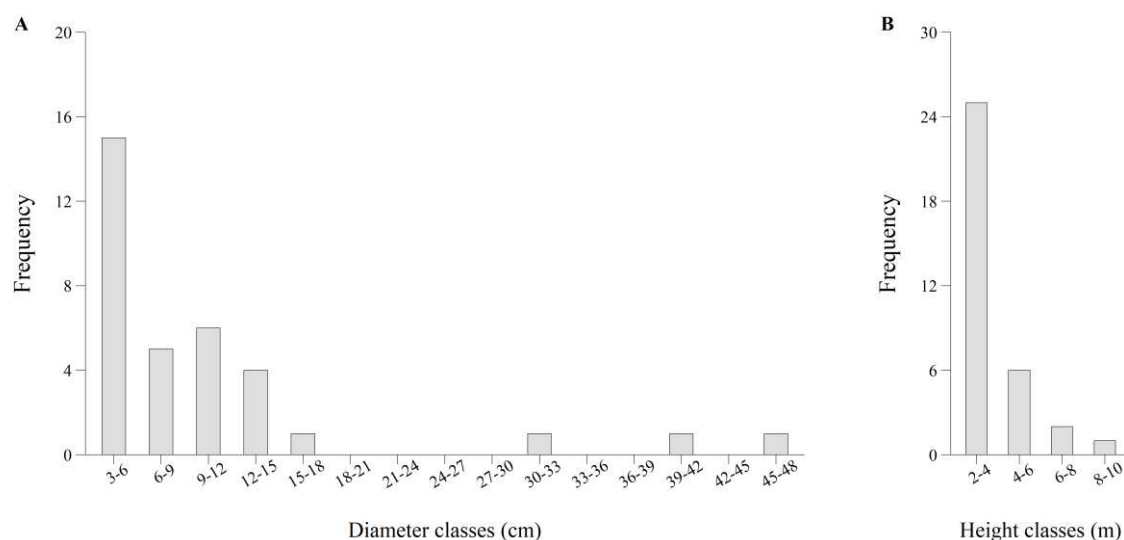


Fig. 5 Diametric and height distribution for *Terminalia glabrescens* Mart. in the rural community of Ausente, municipality of Barão de Grajaú, state of Maranhão, Northeastern Brazil.

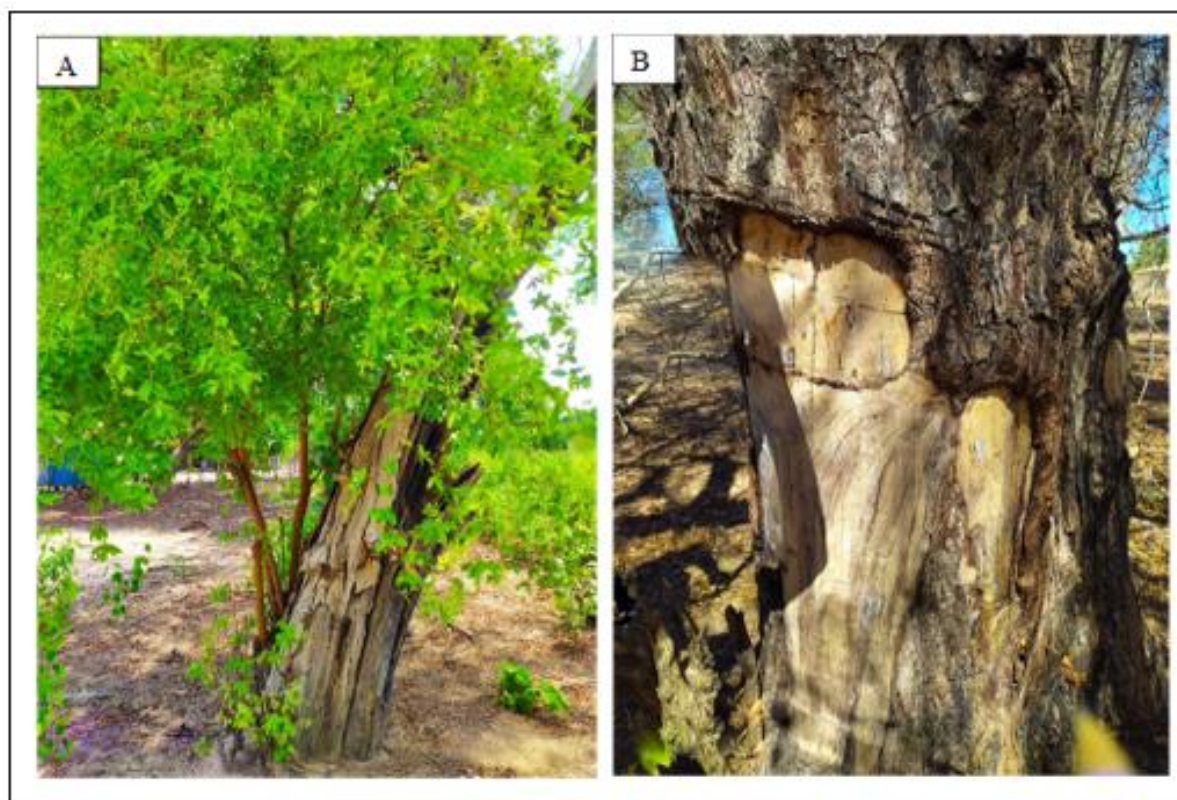


Fig. 6 **A** Young tree growing on a dead trunk with evidence of the effects of a previous bark extraction process. **B** Evidence on the tree trunk after removing the bark of *Terminalia glabrescens* Mart. (Combretaceae) in the rural community of Ausente, municipality of Barão de Grajaú, state of Maranhão, Northeastern Brazil.

4 Discussion

4.1 Uses, extracted parts, and collection patterns of *Terminalia glabrescens*

Terminalia glabrescens is important for local subsistence and economy, as residents use the species for numerous purposes, ranging from obtaining timber resources to serving as a source of fuel and medicine. This diversity of use not only demonstrates the plant's versatility but also indicates the species' relevance in the daily practices and traditions of the local community, representing a notable resource in various aspects.

The medicinal uses of the species are related to its potential for antibacterial, antifungal, anticancer, hepatoprotective, and anti-inflammatory activities [22, 23, 35], which may be associated with the presence of pharmacological compounds such as terpenes, tannins, phenolic substances, flavonoids, lignans, and simple phenols, among others, thereby confirming the phytochemical and therapeutic properties of [20, 22, 36].

Although there are no studies specifically on the bark for medicinal purposes, species of the *Terminalia* genus have had compounds isolated and have been the subject of research on their phytochemical properties. A previous study found gastroprotective properties against gastric ulcers in the bark of *T. arjuna* [37]. According to [38], arjunolic acid and triterpene extracted from the bark of *T. arjuna* provided significant cardiac protection by increasing antioxidant levels, such as superoxide dismutase, catalase, and ascorbic acid.

Ethnobotanical studies on the use of stem bark for medicinal purposes report that these plant parts are mainly removed because they are more accessible and available in large-sized species and can be abundantly harvested [39, 40]. In turn, other studies indicate that this choice is closely related to continuous availability compared to more ephemeral parts, such as leaves [29, 41, 42]. However, high levels of bark extraction can negatively affect the growth of stripped trees [43].

The use of timber was mainly cited as a source of fuel, commonly destined for charcoal and firewood production. This practice is consistent with studies indicating that the species has physical and chemical properties related to high energy performance [44, 45]. Additionally, residents stated that the wood is highly resistant to termites (Order Isoptera, Phylum Arthropoda), a fact reported in studies of species of the *Terminalia* genus, such as *T. fagifolia* Mart., which has natural resistance to decomposition caused by fungi [46].

Recent studies emphasize the importance of timber resources for rural communities [47, 48], as they are distant from urban centers and close to natural vegetation areas from which wood is frequently collected [49], not only for obtaining firewood but also for use in construction, such as fences, roofs, and boards [50], contributing to increased pressure of use on firewood resources [51].

In the community under study, where access to education and economic opportunities is limited, *Terminalia glabrescens* wood can be an accessible resource for both fuel and construction. A recent study found correlations between wood consumption and socioeconomic factors, such as income, educational level, and number of inhabitants per residence, with lower monthly income and lower educational levels being associated with greater dependence on timber resources [52].

In the study area, we found that the extraction of *Terminalia glabrescens* trunks follows a pattern in which community members prefer to collect intermediate-sized trunks with greater diameter and height. The PPV of the bark and stem (trunk) in the community indicates that these parts are the most exploited of the species. This is evidenced by the fact that for medicinal use, height and diameter patterns may be more closely associated with the quantity of resources

to be extracted than its chemical property [53]. According to the same authors [53] reported that, for trees chosen for medicinal use, the major bark extraction areas occurred in diameter classes from small to intermediate.

As reported previously, tannin concentration was not related to species selection for medicinal use, evidencing that use preference is not determined by the chemical composition of the species but by tree diameter classes [54]. It is worth noting that excessive bark removal can be detrimental, as these trees tend to have lower survival and re-growth rates [55]. Additionally, in their study on bark regeneration in the case of *T. glabrescens*, [16] indicated that it is important to harvest from large (adult) individuals, removing the bark in thin, long strips and waiting two years before harvesting from the same individual again, thus contributing to mitigate the extraction damage with greater resilience.

Regarding wood resources, similar results were also identified in [56], which reported that wood uses, especially those related to construction, have shown a tendency for more selective collection, indicating that people tend to select trees with specific diameters, resulting in greater extraction pressure in certain phases of the life cycle of plant individuals. According to [28], the demand for species of this size for timber purposes is concerning, as high exploitation can damage vegetation and cause serious impacts on ecosystems. The quality and yield in the timber extraction process depend on the shape of the stem, without flattening or curvature. These woods from young and larger trees would have greater acceptance in the market due to their straight or less curved shape [57]. In this sense, although the consequences of extractive practices have not been heavily evaluated, the versatility of the *T. glabrescens*, combined with pressure from local use, especially for timber and medicinal purposes, may place the species at risk of extinction. Therefore, the information gathered here may contribute to the management and sustainable use of the species.

4.2 Gender affects the collection pattern

Our findings revealed a significant association in the use citations between genders, showing that men tend to mention a wider variety of uses. There was also a significant association between use categories and gender, with men having higher citations in all categories. This difference can also be attributed to divisions in the collection between genders, in which it is common for men to be responsible for searching for forest resources, highlighting the influence of social divisions of gender within a community, which can directly impact the relationships of use and management of local vegetation [58]. Oliveira et al [28] investigated

the uses of *Vellozia aff. sincorana*, mainly used as fuel to ignite fires in wood stoves, and found that men had greater knowledge about the species compared to women due to the historical use of these plants in rudimentary mining activities in the past, which were performed almost exclusively by men.

Similar results were reported by [58], which have indicated that men had broader knowledge about plants for construction categories and domestic goods, encompassing aspects associated with technology, compared to women in the community who showed greater knowledge related to the medicinal category. [59] observed that in the Fulni-ô indigenous community, located in Northeast Brazil, men have a broader knowledge in terms of the number of medicinal plants compared to women. However, regarding knowledge transmission, the authors noted that sharing among women was more significant, thus demonstrating the influence of gender on the local knowledge system.

Contrasting results were found by [60], who, when seeking to define the knowledge and use patterns of medicinal plants in traditional communities, did not observe statistically significant relationships between richness of knowledge and the informants' gender. [61], when analyzing knowledge of plant uses at different scales, did not detect significant differences globally, with men and women showing similar knowledge at the national and continental levels, although some significant differences were observed in specific contexts. However, the authors also noted a lack of significant differences in gender knowledge. These studies may indicate that broader contextual and cultural variables need to be considered when interpreting gender differences in plant knowledge. Regarding the community, since *Terminalia glabrescens* is a tree mainly found in the forest, it is possible that the greater knowledge about the species possessed by men is attributed to the time that they frequently dedicate to the collection of resources in the forest, especially in the context of timber use.

4.3 Intense extraction causes population decline.

The results of the population status of *Terminalia glabrescens* showed that the species did not fit the reverse J-shaped model, suggesting that collection patterns may impact trees in the intermediate and larger height and diameter classes. The local people's preference for intermediate and larger trees may result in considerable impacts on population structure, as the observation of the absence of individuals, especially in the intermediate classes, in the sampled areas suggests a potential threat to sustainability. In addition, through observations made during the field research activity, it was possible to diagnose traces of human impact on the plant, such

as cut trunks, bark extraction marks, fences built from the wood, as well as the low number of individuals in the largest diameter classes.

Although our findings do not allow for a direct and long-term assessment of exploitation levels or specific consequences by use category on the species population status, the decrease in trees in these diameter and height classes can mainly be attributed to timber exploitation. This occurs because timber harvesting tends to prioritize larger trees, which are more valued for their size and quality, resulting in selective extraction. The association between the decrease of individuals in these classes and exploitation activity indicates possible consequences for the ecological balance of the species in the studied region.

The finding that timber use categories are more related to the decline in plant species populations than other categories is an observation found in the study by [62], where the correlation between construction and fuelwood categories and the perceived plant population decline revealed that these categories are responsible for the greatest pressure on the use of medicinal plants.

In this context, wood collection for fuel use is a common practice in rural communities, and usage patterns can have significant impacts on plant structure. The effects of fuelwood collection were investigated by [63], and the removal of canopy trees for fuelwood induced depressed seed dispersal processes and affected tree recruitment success. Additionally, the collection practice can often focus on a specific group of species. [47] found that wood extraction led to greater uniformity in the plant community, negatively affecting overall density. The authors reported that dominant species were not affected by wood collection, while species most used for fence construction are potentially threatened.

A previous work investigating the impact of *Stryphnodendron rotundifolium* bark extraction for medicinal uses revealed that collection has significant impacts on species reproduction, interfering with gene flow and affecting vital processes such as pollination and seed dispersal of tree species. The study also highlighted the importance of considering the short-term effects of plant exploitation and its repercussions on species population and reproductive dynamics [15].

On the other hand, [64] found that medicinal use exerts a significant protective effect against wood exploitation, as species of high importance in a specialized use category may experience reduced use in more generalist categories. Thus, maintaining the medicinal importance of certain species can be a powerful tool for protecting their populations against more harmful uses. Importantly, collection practices carried out without proper management can have significant consequences for the ecosystem and forest sustainability, as extractive

pressure can compromise not only the population status of plant species but also the future availability of these resources heavily used by local communities. A limitation of this study is not employing an ecological approach that would analyze areas before extraction to assess the conservation status of the species; thus, the direct consequences of long-term collection cannot be indicated. However, the results of different uses, exploited parts, and collection patterns associated with phytosociological data constitute a crucial tool that can provide information on which factors of extractive activity can impact the population structure of the species.

5 Conclusion

Terminalia glabrescens serves as a versatile source of resources, ranging from timber extraction to its use as fuel and medicine. The differences in use between genders reveal an existing sociocultural dynamic within the community, and it is important to consider the distinct knowledge and practices of each gender in order to contribute information for sustainable resource management in the community.

The information on collection patterns, different uses, and explored parts, together with the data on species population structure, indicates that timber collection may be associated with a potentially more harmful impact on the species. Thus, this study provides ethnobotanical and ecological information that can identify the level of community dependence on the resource, providing data on use patterns and possible consequences of exploitation.

However, further studies aimed at estimating the long-term impact of extractivism are required, given that this investigation did not assess the conservation status of the species through the analysis of areas before extractivism nor the specific influence of collection levels on the population structure.

Author contributions

C.L.N.: Conceptualization, Methodology, Investigation, Data Curation, Writing – Original Draft, Writing – Review and Editing, Visualization.

J.M.M.: Methodology, Writing – Review and Editing, Supervision.

J.R.S.J.: Supervision, Writing, data analyses – Review and Editing.

All authors have read and agreed to the published version of the manuscript.

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Data availability

The data that support the findings of this study are held by the Federal University of Piauí (UFPI) under the supervision of Dr. José Ribamar Sousa Júnior and are available from the authors upon reasonable request.

Declarations

Ethics approval and consent to participate

The study adhered to the International Society of Ethnobiology Code of Ethics (ISE: <https://www.ethnobiology.net/code-of-ethics>). Verbal informed consent was obtained from all participants prior to interviews. Participants were fully informed about the research purpose, methods, and their rights, including the right to withdraw at any time. In addition, this study followed the ethical guidelines of the National Health Council of Brazil and was approved by a Research Ethics Committee involving human participants, through the Certificate of Presentation for Ethical Consideration (CAAE 64256622.1.0000.5660).

Consent for publication

All participants allowed the authors to share their responses and photographs for publication purposes. Ethical guidelines and rules of the International Society of Ethnobiology (ISE) were strictly followed.

Competing interests

The authors declare no competing interests.

Author details

1 Programa de Pós-Graduação em Biodiversidade e Conservação (PPGBC), Universidade Federal do Piauí (UFPI), Teresina, PI, Brazil

2 Universidade Federal do Piauí (UFPI), Floriano, PI, Brazil

Corresponding author: José Ribamar Sousa Júnior (sousajr@ufpi.edu.br)

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Appendix

Tables and figures

Figure 1. Location of the rural community of Ausente, municipality of Barão de Grajaú, state of Maranhão, Northeastern Brazil, and areas of phytosociological and ethnobotanical collections of *T. glabrescens*. (Source: Ribeiro 2023).

Figure 2. Use-Diversity Value (UDV) index for *Terminalia glabrescens* in the rural community of Ausente, municipality of Barão de Grajaú, state of Maranhão, Northeastern Brazil.

Figure 3. Plant Part Value (PPV) for *Terminalia glabrescens* in the rural Community of Ausente, municipality of Barão de Grajaú, state of Maranhão, Northeastern Brazil.

Figure 4. Result of the chi-square test of differences in use citations by categories according to woman (W) and man (M) for *Terminalia glabrescens* Mart. in the rural community of Ausente, municipality of Barão de Grajaú, state of Maranhão, Northeastern Brazil.

Figure 5. Diametric and height distribution for *Terminalia glabrescens* Mart. in the rural community of Ausente, municipality of Barão de Grajaú, state of Maranhão, Northeastern Brazil.

Figure 6. A – Young tree growing on a dead trunk with evidence of the effects of a previous bark extraction process. **B** – Evidence on the tree trunk after removing the bark of *Terminalia glabrescens* Mart. (Combretaceae) in the rural community of Ausente, municipality of Barão de Grajaú, state of Maranhão, Northeastern Brazil.