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# Rapid ethnobotanical diagnosis of the Fulni-ô Indigenous lands (NE Brazil): floristic survey and local conservation priorities for medicinal plants

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**Abstract** This study was developed as part of the project "Studies for Environmental and Cultural Sustainability of the Fulni-ô Medical System: Office on handling medicinal plants". The Fulni-ô people are located in Pernambuco State, Northeastern Brazil. One of the components of this project was an ethnobotanical diagnosis of the indigenous land, where a phytosociological survey was performed in an area of *Caatinga* vegetation, located at Ouricuri settlement. Based on these ethnobotanical data, we calculated a conservation priority index aiming to rank species that should receive immediate attention from the Fulni-ô people. We identified 44 woody plants, 50% of which have a medicinal use. Among these, six plants were considered highly vulnerable and in need of immediate conservationist attention, in order to ensure the perpetuation of these species and the sustainability of traditional therapeutic practices of the Fulni-ô: *Anadenanthera colubrina*, *Myracrodruon urundeuva*, *Lippia* sp., *Spondias tuberosa*, *Maytenus rigida,* and *Sideroxylon obtusifolium*. We recommend the direct involvement of the Fulni-ô people in the conservation and the management of local resources by implementing a management plan and monitoring strategies for the populations of plants considered most important by the indigenous group.

**Keywords** Ethnobotany · Sustainable use · Semi-arid · Seasonal Forests · Traditional botanical knowledge

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## 1 Introduction

Many of the current discussions on the conservation of tropical ecosystems undoubtedly derive from concerns regarding loss of biodiversity, particularly of the complex cultural systems associated with it. Since the formulation of the Belém Declaration during the First International Ethnobiology Congress in 1988, the role of traditional populations in the conservation, maintenance and generation of biodiversity has become more evident (see Engels et al. 2010). The approaches that integrate the biological and cultural dimensions of Brazilian ecosystems are still rare or incipient, thus limiting the advances in the search for alternatives to the use, management, and conservation of biological resources. Similarly, threats to biodiversity can also translate into threats to the lifestyle, practices, knowledge, and subsistence of the people who depend on these resources.

As such, it is fundamental to understand how resources are used and how this information can contribute to sustainable-use strategies. From this knowledge, it is possible to design strategies leading to alternatives that respect the need of conservation along with the traditions of the people who use those resources. The traditional knowledge of medicinal plants, for example, is of great practical importance to humanity. About 80% of the world population depends on popular medicine (Rodrigues and Casali 2002); two-thirds of the species used are collected directly from nature, especially in tropical countries (Chlodwig 1993).

For many indigenous people, the use of medicinal plants constitutes an important element in their traditional therapeutic practices. In Pernambuco state, for example, the Fulni-ô Indians use a great diversity of plants (Silva et al. 2006; Albuquerque et al. 2008). However, no study has been conducted to directly assess the sustainability of their traditional practices, taking into consideration both their demands and the *Caatinga*'s (dry forest NE Brazil) ability to meet these needs. Thus, it is necessary to provide an initial diagnosis focusing on the creation of future strategies and recommendations for the use of local resources. Moreover, in a wider context, the Fulni-ô people interact with domains of a vegetal formation increasingly present in the debates on biodiversity conservation in Brazil, the Caatinga.

There are strong arguments to introduce local communities in conservation strategies. First, the establishment of a realistic scenario for the sustainability of local therapeutic practices that considers the diversity of these practices can be detached from the environmental context where this proposal is applied. Second, although the people do not have an exact notion of "biodiversity", undoubtedly, there is interest in preserving the resources that constitute the key elements of their traditional health care practices. Finally, the local communities could be involved in the decision-making about the future of their biological resources, and these decisions could be informed by the ethnobotanical diagnosis. According to Tuxill and Nabhan (2001), an approach focused on local communities is justified by the fact that a great part of the world's resources are also local ones; therefore, conservation strategies in situ may benefit from the knowledge provided by these communities, and their practices may support such conservation.

In this study, we present the partial results of a rapid ethnobotanical diagnosis of the Fulni-ô, Indigenous Land (IL) conducted under the scope of the project "Studies for Environmental and Cultural Sustainability of Fulni-ô Medical System: Office on handling Fulni-ô medicinal plants (PE)". The project was executed by the Associação Mista Cacique Procópio Sarapó (Mixed Association Cacique Procópio Sarapó—AMCPS), a Fulni-ô non-governmental organization that had funding and technical guidance from the Area of Indigenous Traditional Medicine/Project VIGISUS II/Health National Foundation (FUNASA 2007). The project was initiated in July 2007 and concluded in December 2008. The project consisted of an action-research enterprise, built on a participatory, multidisciplinary, and multiethnic approach. The action component involved anthropological research action, ethnobotanical diagnosis, and pharmaceutical action. It is noteworthy that the contributions of the indigenous staff to the participatory character of the project and to the establishment of an intercultural dialog formed the structural aspect of the action developed in the project.

The ethnobotanical diagnosis obtained information about the consumption of the commonly used forest resources that comprise the Fulni-ô medical system. In this study, the term "medical system" (Kleinman 1978) is defined as a symbolic system encompassing notions of health and disease, health care practices, the practitioners, therapeutic resources and itinerary, and evaluation. We should emphasize that the indigenous medical systems consist of holistic systems that extend to all social aspects of the people. This system establishes inherent relationships with social organization, cosmology, and the environment.

The ethnobotanical diagnosis was not designed to examine the local plant diversity alone without taking into consideration the significance attributed to these plants by the Fulni-ô, but instead was developed as an approach that was cognizant of the real-world picture to make decisions affecting the access, use, and management of local resources. Therefore, the project proposal was developed from the needs of the Fulni-ô community and attempts to strengthen their knowledge and traditional health care practices.

We present floristic data pertaining to an ethnobotanical diagnosis of the Fulni-ô Indigenous Land. The lack of information on species considered useful resources can negatively affect the progress of management plans, the design of conservation priorities, and the definition of strategies of exploitation. Therefore, the data presented here aimed to provide initial and basic information to enable the Fulni-ô people to make decisions for the management of their natural resources. Additionally, we applied a quantitative measure, modified for this study, as a tool to rank priority species for conservation. A quantitative tool can be extremely objective in prioritizing resources for conservation in situ. To adopt this perspective with the community's support may result in conservation efforts with promising results. The establishment of priorities also involves the characterization of threats that a population or plant community face as a whole.

## 2 Materials and methods

### 2.1 Study area

The Fulni-ô people inhabit the interior of Pernambuco State (NE Brazil), an indigenous land that is bordered by the Águas Belas municipality, which, in turn, is relatively close to the Alagoas State border (Fig. 1). Águas Belas is geographically positioned at 9° 06′ 45″ S and 37° 07′ 15″ W, 315 km from the capital of Pernambuco State and has the interstate roads BR 232 and 423 as its major access routes (CONDEPE/FIDEM 2006). Located in the meridional arid region, locally called "agreste" (a transition of agreste and interior of the State), this municipality is part of the hydrographic basin of Ipanema River and has a semi-arid, hot, and humid climate, with an average temperature of 25°C and Caatinga vegetation (Silva 2003; CONDEPE/FIDEM 2006). The municipality's population is 35,374 inhabitants within 886 $km^2$ of total area (CONDEPE 1981; CONDEPE/FIDEM 2006). The Fulni-ô Indigenous land has an area of approximately of 11,500 ha and is located 500 m from the city of Águas Belas (CONDEPE 1981; Sá 2002). Currently, the Fulni-ô population comprises 3,667 people in the main settlement, 122 people in Xixiakhlá settlement and 517 people either without a settlement or homeless.

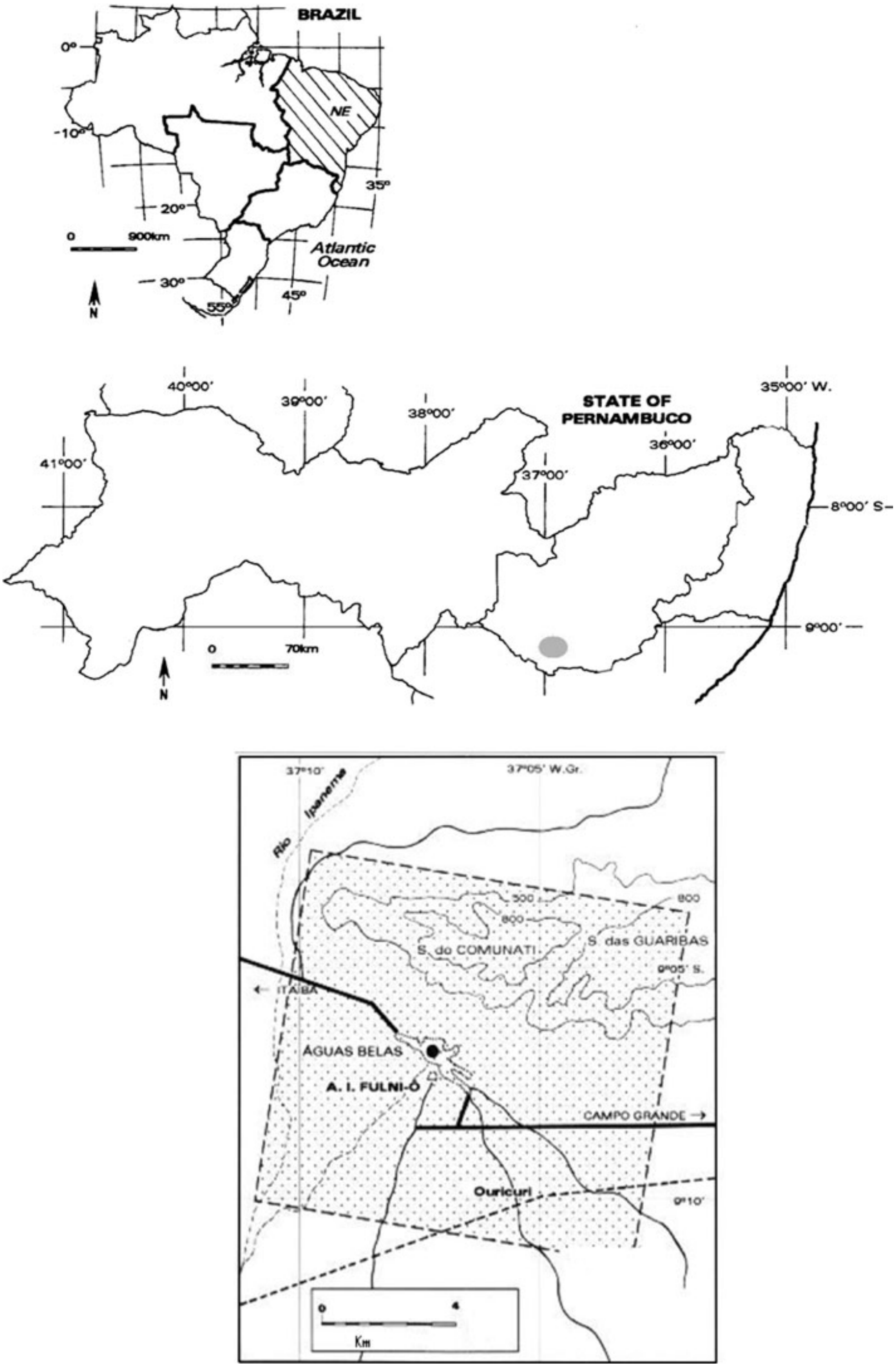


**Fig. 1** Localization of the Fulni-ô community, municipality of Águas Belas (Pernambuco State), in the semi-arid region of northeastern Brazil

### 2.2 Ethnographical and historical aspects

The oldest data on the Fulni-ô population date back to their settlement, circa 1749, consisting of 322 Indians (Pinto 1956; CONDEPE 1981). A part of the most fertile properties of the people was ceded to the Church and later leased to a white population, from which the city of Águas Belas developed (Pinto 1956; CONDEPE 1981; Diaz 1983). The first demarcation of the land "donated" by the provincial government to the Fulni-ô population dates to around 1875 (Diaz 1983). According to this author, in 1928 the area was divided by representatives of the Ministry of Agriculture, Industry and Trade, which, at the time, included the Indian Protection Service. Thus, individual land titles were issued on an interim basis, to the indigenous community. From 1929, these, in turn, began to lease their land to non-Indian inhabitants of the municipality of Águas Belas (Diaz 1983).

The Fulni-ô has a calendar clearly marked by the annual Ouricuri ritual occurring between September and November. This ritual is performed at the Ouricuri settlement, considered sacred by the Fulni-ô people, and to which they move during these 3 months. In this settlement, the entrance of non-Indians is not allowed by the Shaman (Pajé) or Tribal chief, named Cacique (Sá 2002). In the major settlement, due to the proximity to the urban center of Águas Belas city, the extraction of vegetal resources for medicinal purposes seems to be limited to sporadic incursions into the Caatinga forest near to the settlement, which is depleted as a consequence of the uncontrolled urbanization process in Águas Belas. The "Ouricuri Forest" is located in the settlement where the ritual of the Ouricuri Festival is performed and serves as the major source of resource use due to its proximity and the relative decrease in access to the city.

The Fulni-ô people keep much of the knowledge of their cosmology and religion secret from outsiders. Because their traditional health care practices are intrinsically involved in these aspects of their culture, much of the Fulni-ô medical system is secret. The use of medicinal plants and other raw materials in the preparation of medicine are one of the aspects most shared with non-Indians, although not completely. It is worth noting that the knowledge and health care practices of the Fulni-ô are not characterized only by the use of medicinal plants or other raw materials, but also by prayers in Portuguese and *yaathê*, the native Fulni-ô language, which belongs to the Macro-Jê linguistic branch, as well as by ceremonies associated with their ritual life.

These plants are, without a doubt, a key element in the medical practices of the Indians of Águas Belas (See Pinto 1956). Sá (2002) argues that biomedicine has greatly contributed to traditional healing practices and has intensified due to deforestation in the region. The existence of different healing traditions in a community must be examined in its cognitive, institutional and behavioral aspects. Although deforestation and lack of access to traditional resources may affect the traditional knowledge of medicinal plants, such erosive phenomena are much more complex and only a specific study can determine what may actually be occurring in the case of the Fulni-ô.

### 2.3 Floristic survey

The project followed the research-action methodology[1] and had the participation of members of the Mixed Association Cacique Procópio Sarapó and the Fulni-ô community in

[1] According to Thiollent (2005:16), the research-action is "*a kind of social research based on empirical evidence, which is designed and performed in close association with an action or resolving a collective problem, and where the researchers and participants that represent the situation or problem are involved in a cooperative or participatory way*".

**Fig. 2** Overview of Ouricuri Forest (sample site) in the Fulni-ô Indigenous Land (Pernambuco, NE Brazil)

the activities developed in the three action lines of the project. The participation of the indigenous collaborators was essential to the development of the ethnobotanical diagnosis, because these collaborators defined the vegetation sampling sites. The sampling was conducted in a Caatinga area, with previous authorization from the Fulni-ô exclusively to perform the study under the project, so generalizations for all territories should be taken with caution. The sampling was not exhaustive but was relevant and expressive for the goals of the diagnosis. The analysis was focused on the Ouricuri forest (Fig. 2) because it meets the following requirements: (1) it is an area where the resources are exploited continuously by the Fulni-ô people, mainly because it is located near the main settlement; (2) the forest experiences a high exploitation pressure, especially between September and November, due to the Ouricuri ritual when the Fulni-ô settle at the site; (3) it conforms to the concept of a "common use resource" adopted in this study, as a place of collective appropriation and with controlled access to the non-Indians.

Four sites were selected by the Indian members in two areas that meet the following requirements (Fig. 3): (1) they permitted access to non-indigenous members of the Project Team, consisting of two sites before the Ouricuri settlement, and two immediately after; (2) they represented sites of resources extraction; (3) they captured the heterogeneity of inhabitants and local diversity. We had no specific objectives with these procedures, but aimed to cover a well-represented range of local vegetation and to ensure the best possible accuracy in recording the plant diversity in the region.

Once the sample sites were identified, we plotted 50 quadrant points in each site for a theoretical sample of 200 quadrant points in total. However, we surveyed 199 points because the last sampling point was located in an area that was difficult to access. The sampling design consisted of setting 10 lines of 50 m, in each of the 4 sites, perpendicular to trails or main roads that avoided border areas or areas adjacent to developed areas, and the lines were spaced by 10 m from each other. Every 10 m, a point was set on each sampling line. For each sample inventoried, we recorded the distance to the apex of the quadrant, the circumference at ground level (CGL) (inclusion criteria diameter ground

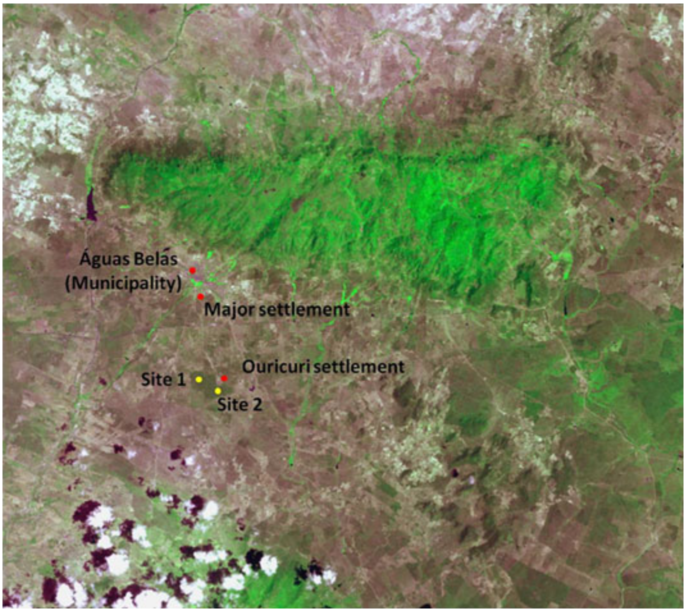


**Fig. 3** Image of the municipality of Águas Belas, Pernambuco (NE Brazil) (1:100000). CBERS, CCD sensor, UTMWGS84, RGB342 composition, November 2002 (Laboratory of GIS and Remote Sensing: GEOSERE/Universidade Federal Rural de Pernambuco)

level ≥3 cm) (Rodal et al. 1992), and an estimate of the total height. The sampling considered all the woody individuals that met the inclusion criteria. Moreover, for total local diversity, we collected all fertile individuals that were not sampled. During all the sampling and recording processes in the field, at least one holder of Fulni-ô traditional knowledge was present.[2] Most of the field activities had the participation of two interethnic groups, composed either of researchers and Indians collaborators or researchers and non-Indian technicians. The phytosociological parameters that characterized the community were calculated using FITOPAC 1.0 software (Shepherd 1995).

The sampled plants were identified by their native names by at least two holders of traditional knowledge, selected with care for their knowledge. The criteria for the participation of these holders of traditional knowledge were their availability to participate in the fieldwork and community consensus on their knowledge of local resources. The holders of traditional knowledge were encouraged to carefully examine the samples and attribute a local name for each one of them. Occasionally, the plant was unknown to them, or they did not report any direct use of it.

[2] The concept **holders of traditional knowledge** refer to the practitioners of the Fulni-ô medical system. Those people are characterized by focused knowledge of health care practices, related to health maintenance and diseases treatments. They are political and religious leaders, also with profound knowledge on cosmology, the Ouricuri ritual and the environment. The holders of knowledge are classified in the following categories: shaman (pajé), elders, prayers (both male and female), and midwives. There were also two people who did not fit in these two categories and were great supporters of the Project, Xyce and Txhleká, as called themselves, experts in medicinal plants and "garrafeiro"—a person who prepares the medicine using generally medicinal plants and other raw materials.

The plants were identified and incorporated into the collection of the herbarium of Prof. Vasconcelos Sobrinho (PEUFRP), Department of Biology, Universidade Federal Rural de Pernambuco, Brazil. The samples consist only of biological and testimonial records of the flora presented in the region; this material does not contain information about the traditional knowledge of the Fulni-ô Indians.

### 2.4 Local conservation priorities for medicinal plants

The establishment of local priorities for conservation can be a useful tool to guide community decision-makers as they develop strategies of the future use of local resources. We chose to apply the measure of conservation priority to medicinal plants employed by Dzerefos and Witkowski (2001) with some modifications to compensate for the limitations discussed by Oliveira et al. (2007). Based on the analytical parameters calculated for the vegetal community (relative density), we applied the following equation to calculate the conservation priority (CP) of one species, whose criteria are explained in Table 1: CP = 0.5 (BS—biological score) + 0.5 (RU —risk of use).

Step 1: BS = $D \times 10$ (score for relative density)
Step 2: RU = $0.5\ (H) + 0.5\ (U) \times 10$ ($H$ is the risk of collection, and $U$ is the value of use).

Oliveira et al. (2007) pointed out that one limitation of this technique is not considering that other potentially more harmful uses could also be associated with medicinal plants.

**Table 1** Criteria and scores used to calculate conservation priorities of medicinal plants (modified from Dzerefos and Witkowski 2001)

| Criteria | Scores |
|---|---|
| (A) Relative density in the area (*D*) | |
| Non-registered—very low (0–1). | 10 |
| Low (1 < 3.5). | 7 |
| Medium (3.5 < 7). | 4 |
| High (≥7). | 1 |
| (B) Risk of collection (*H*) | |
| Destructive collection of the plant or over-exploitation of roots or bark. Collection represents the removal of the individual. | 10 |
| Collection of perennial structures such as barks and roots, and collection of part of the stem to extract latex, without killing the individual. | 7 |
| Collection of perennial aerial structures such as leaves, which may affect the plant's energetic investment, survival, and reproductive success in the long term. | 4 |
| Collection of transitory structures as flowers and fruits. The regeneration of the population may be altered in the long term by collecting the seed supply, but the individual itself is not affected. | 1 |
| (C) Local importance (*L*) | |
| Very high (species listed by >75% of local informants). | 10 |
| Moderately high (50–75% of local informants). | 7 |
| Moderately low (25–50% of local informants). | 4 |
| Very low (<25% of local informants). | 1 |
| (D) Diversity of use (*V*) | |
| For each type of medicinal use 1 point is added, for a maximum of 10 points. | 1–10 |

To fix this problem, we added the variable "associated wood-use" (WU), with a score of 10. So, the new equation is structured as CP = 0.5 (BS—biological score) + 0.5 (RU—risk of use) + WU (10 points in case of wood-use).

The value of use (*U*) is defined as the average of the sum of the local importance (*L*) and the diversity of use (*V*) as the introduced modification (see Table 1). In the original equation, the researcher should select the variable with the highest score. The other modification is related to the score determination for the local importance (*L*) that follows a change in the original number of informants (0–20%) who reported the use for one species (see Dzerefos and Witkowski 2001). This range of variation in the number of informants was redefined in our study and is shown in Table 1.

Considering the woody plants in indigenous Fulni-ô land that had multiple uses that would confer additional pressure, we added 10 points (the WU score) to the CP value to represent that specificity of the final list of priorities. Finally, based on the final CP, we placed each one of the species into the following categories, modified from Dzerefos and Witkowski (2001). Category 1, CP > 80, encompasses high priority species with controlled and monitored extraction; category 2, 60 < CP < 80 includes species that have monitored collection associated with a specific study on the sustainability of the exploitation; category 3, CP < 60, includes species adequate for more intensive extraction for medicinal purposes.

The ethnobotanical data necessary to calculate the value of use (*U*) and the other parameters for risk of use were obtained from an ethnobotanical survey in the main IL Fulni-ô settlement, involving a multidisciplinary team (biologists, forest engineers, pharmaceutics, and anthropologists) and a multiethnic team (researchers and indigenous collaborators). During this phase, we performed semi-structured interviews with 344 Indians, who comprised 16.22% of the adult population over 15 years of age. More details about this survey see Albuquerque et al. (2010). For the "associated wood-use", we used data from informal interviews with holders of traditional knowledge and especially data from an ethnobotanical study conducted by Silva (2003) on the same site.

## 3 Results

### 3.1 Floristic survey

From the vegetation inventory, at least 44 taxa were identified at the genera level distributed among 22 botanical families. The holders of Fulni-ô traditional knowledge did not reveal any medicinal use for 19 species and also did not attribute local names (Table 2) for 12 plants. Table 2 shows the identified species and their local abundance. The botanical families most represented in terms of number of species were Fabaceae (10 spp.), Euphorbiaceae (5 spp.), Rubiaceae (5 spp.), and Anacardiaceae (3 spp.).

Several species and genera found during the survey were characteristic of Caatinga areas, such as *Myracrodruon urundeuva*, *Schinopsis brasiliensis*, and *Caesalpinia pyramidalis*. The most abundant plants were *Caesalpinia pyramidalis* (150 individuals), *Aspidosperma pyrifolium* (114), *Bauhinia cheilantha* (105), *Comiphora leptophloeos* (46), and *Piptadenia stipulaceae* (51). The species with the highest importance value (IV) in the surveyed area are presented in descending order (Table 2): *Caesalpinia pyramidalis*, *Aspidosperma pyrifolium*, *Bauhinia cheilantha*, *Commiphora leptophloeos*, *Piptadenia stipulacea*, *Sideroxylon obtusifolium*, *Coutarea hexandra*, *Mimosa tenuiflora*, *Maytenus rigida*, and *Myracrodruon urundeuva*. The floristic and structural features of the area

**Table 2** List of plants collected during floristic inventory in the Fulni-ô Indigenous Land, Águas Belas (Pernambuco, NE Brazil) and their respective local names

| Family | Scientific name | Local name | N | RD | RDO | RF | IV |
|---|---|---|---|---|---|---|---|
| Amaranthaceae | *Gomphrena vaga* Mart.* | Alenta cavalo | 1 | 0.13 | 0.01 | 0.16 | 0.30 |
| Anacardiaceae | *Myracrodruon urundeuva* Allemão* | Aroeira | 21 | 2.66 | 2.42 | 2.93 | 8.01 |
| | *Schinopsis brasiliensis* Engl.* | Braúna | 15 | 1.90 | 3.25 | 2.28 | 7.42 |
| | *Spondias tuberosa* Arruda* | Umbuzeiro | 1 | 0.13 | 0.14 | 0.16 | 0.43 |
| Apocynaceae | *Aspidosperma pyrifolium* Mart.* | Pereiro | 114 | 14.43 | 12.01 | 12.85 | 39.29 |
| Bignoniaceae | *Anemopaegma* sp. | Cipó de vaqueiro | 1 | 0.13 | 0.02 | 0.16 | 0.31 |
| Bombacaceae | *Chorisia* sp.* | Barriguda | 1 | 0.13 | 0.49 | 0.16 | 0.78 |
| Boraginaceae | *Cordia leucocephala* Moric. | Moleque duro | 3 | 0.38 | 0.08 | 0.49 | 0.95 |
| Burseraceae | *Commiphora leptophloeos* (Mart.) J.B. Gillett* | Imburana, imburana brava, imburana de cambão | 46 | 5.82 | 8.97 | 6.34 | 21.14 |
| Capparaceae | *Capparis flexuosa* (L.) L.* | Feijão bravo | 6 | 0.76 | 1.42 | 0.98 | 3.15 |
| | *Capparis jacobinae* Moric. ex Eichler | Inço | 5 | 0.63 | 0.14 | 0.81 | 1.58 |
| Erythroxylaceae | *Erythroxylum suberosum* A. St.-Hil. | – | 1 | 0.13 | 0.12 | 0.16 | 0.41 |
| Celastraceae | *Maytenus rigida* Mart.* | Bom nome | 23 | 2.91 | 2.41 | 3.25 | 8.58 |
| Euphorbiaceae | *Acalypha multicaulis* Müll. Arg.* | Canela de nambu | 10 | 1.27 | 0.23 | 1.46 | 2.96 |
| | *Croton rhamnifolius* Willd. * | Velame | 3 | 0.38 | 0.07 | 0.49 | 0.93 |
| | *Ditaxis malpighiacea* (Ule) Pax & K. Hoffm.* | Sassafrás, sassafrás fêmea | 13 | 1.65 | 0.44 | 1.79 | 3.87 |
| | *Jatropha mollissima* (Pohl) Baill.* | Pinhão, pinhão bravo | 24 | 3.04 | 0.93 | 3.58 | 7.55 |
| | *Sapium* sp. | Burra leiteira | 6 | 0.76 | 1.34 | 0.98 | 3.08 |
| Fabaceae | *Acacia bahiensis* Benth. | Espinheiro vermelho | 25 | 3.16 | 1.08 | 3.09 | 7.34 |
| | *Anadenanthera colubrina* (Vell.) Brenan var. *cebil* (Griseb) Altschul* | Angico de caroço | 7 | 0.89 | 1.00 | 0.98 | 2.86 |
| | *Bauhinia cheilantha* (Bong.) Steud.* | Mororó | 105 | 13.29 | 8.13 | 9.92 | 31.34 |
| | *Caesalpinia leiostachya* (Benth.) Ducke* | Pau ferro | 1 | 0.13 | 0.87 | 0.16 | 1.16 |
| | *Caesalpinia pyramidalis* Tul.* | Catingueira | 150 | 18.99 | 29.15 | 17.56 | 65.69 |
| | *Chloroleucon foliolosum* (Benth.) G.P. Lewis* | Arapiraca, espinheiro vermelho, jurema branca | 7 | 0.89 | 0.48 | 1.14 | 2.50 |
| | *Enterolobium contortisiliquum* (Vell.) Morong | Tamborí | 1 | 0.13 | 0.01 | 0.16 | 0.30 |
| | *Mimosa tenuiflora* (Willd.) Poir.* | Jurema preta, jurema vermelha | 13 | 1.65 | 6.87 | 1.79 | 10.30 |
| | *Parapiptadenia zehntneri* (Harms) M.P. Lima & H.C. Lima* | Angico monjolo | 4 | 0.51 | 0.27 | 0.65 | 1.42 |
| | *Piptadenia stipulacea* (Benth.) Ducke* | Angico branco, espinheiro branco | 51 | 6.46 | 2.94 | 6.50 | 15.90 |
| Malpighiaceae | *Ptilochaeta bahiensis*Turcz. | Pau de caixão | 7 | 0.89 | 0.27 | 1.14 | 2.29 |
| Nyctaginaceae | *Guapira noxia* (Netto) Lundell* | Piranha | 11 | 1.39 | 0.45 | 1.63 | 3.47 |
| Polygonaceae | *Ruprechtia laxiflora* Meisn. | Pau de caixão | 11 | 1.39 | 1.39 | 1.46 | 4.24 |

**Table 2** continued

| Family | Scientific name | Local name | N | RD | RDO | RF | IV |
|---|---|---|---|---|---|---|---|
| Rhamnaceae | *Rhamnidium molle* Reissek | Ameixa fêmea | 2 | 0.25 | 0.05 | 0.33 | 0.63 |
| | *Ziziphus joazeiro* Mart.* | Juazeiro | 9 | 1.14 | 0.49 | 1.46 | 3.09 |
| Rubiaceae | *Alibertia* (cf.) *rigida* K. Schum. | – | 2 | 0.25 | 0.02 | 0.33 | 0.60 |
| | *Coutarea hexandra* (Jacq.) K. Schum. | Canela de veado, baia | 36 | 4.56 | 2.74 | 4.39 | 11.68 |
| | *Guettarda platypoda* DC. | – | 1 | 0.13 | 0.02 | 0.16 | 0.31 |
| | *Guettarda* sp. | – | 1 | 0.13 | 0.02 | 0.16 | 0.31 |
| | *Randia armata* (Sw.) DC. | – | 1 | 0.13 | 0.01 | 0.16 | 0.30 |
| Sapindaceae | *Cardiospermum corindum* L. | – | 1 | 0.13 | 0.02 | 0.16 | 0.31 |
| Sapotaceae | *Sideroxylon obtusifolium (*Humb. ex Roem. & Schult.) T.D. Penn.* | Quixaba | 22 | 2.78 | 7.65 | 3.58 | 14.02 |
| Solanaceae | *Capsicum parvifolium* Sendtn. | Pau bodogue | 15 | 1.90 | 1.23 | 2.28 | 5.40 |
| Verbenaceae | *Lantana camara* L.* | Camará branco ou chumbinho | 1 | 0.13 | 0.01 | 0.16 | 0.30 |
| | *Lippia* sp.* | Alecrim bravo | 1 | 0.13 | 0.01 | 0.16 | 0.30 |
| Vitaceae | *Cissus simsiana* Schult. & Schult. f. | – | 1 | 0.13 | 0.04 | 0.16 | 0.33 |
| Undetermined | Undetermined 1 | – | 1 | 0.13 | 0.01 | 0.16 | 0.30 |
| | Undetermined 2 | – | 2 | 0.25 | 0.09 | 0.33 | 0.67 |
| | Undetermined 3 | – | 5 | 0.63 | 0.15 | 0.49 | 1.27 |
| | Undetermined 4 | – | 1 | 0.13 | 0.01 | 0.16 | 0.30 |
| | Undetermined 5 | – | 1 | 0.13 | 0.02 | 0.16 | 0.31 |

*N* Number of individuals, *RD* relative density, *RDO* relative dominance, *RF* relative frequency, *IV* importance value. * Indicates medicinal use

indicate that the vegetation surveyed is deciduous, thorny, and characteristic of species found in more humid environments inside the semi-arid portion of northeastern Brazil.

## 3.2 Local conservation priorities for medicinal plants

Of the 44 identified plants in the vegetal inventory (Table 2), 25 (56.8%) were classified as medicinal and entered in the calculation of local conservation priorities. Among this cluster of species, only four (*Gomphrena vaga*, *Lippia* sp., *Croton rhamnifolius*, and *Acalypha multicaulis*) have only their leaves used, which is a potentially less harmful activity. The remaining plants have their stem bark collected, which is a very common type of exploitation among *Caatinga* plants and is standard for the woody plants in the region. Table 3 shows an approximation of what would be a trial list of priority species for local conservation, in order of importance.

Nine species were included in category 1, which implies that they require the greatest attention in conservation efforts. In this set, we should highlight three species whose presence in the category may be relative because the index prioritized them due to their low densities: *Chrololeucon foliolosum*, *Parapiptadenia zehntneri*, and *Capparis flexuosa*. With the exception of these three species, this category requires special attention mainly because of their relative importance and popularity in the Fulni-ô medical system. The species *Myracrudruon urundeuva* and *Sideroxylon obtusifolium* should be highlighted

**Table 3** Trial list to organize the 25 species indicated as having medical uses that were surveyed in the Ouricuri Forest, Fulni-ô Indigenous land, Águas Belas

| Scientific name | D | H | NI | L | NU | V | U | CP |
|---|---|---|---|---|---|---|---|---|
| *Anadenanthera colubrina** | 10 | 7 | 22 | 1 | 21 | 10 | 5.5 | 91.25 |
| *Myracrodruon urundeuva* * | 7 | 7 | 304 | 10 | 74 | 10 | 10 | 87.50 |
| *Chloroleucon foliolosum** | 10 | 7 | 5 | 1 | 7 | 7 | 4 | 87.50 |
| *Parapiptadenia zehntneri* * | 10 | 7 | 4 | 1 | 5 | 5 | 3 | 85.00 |
| *Capparis flexuosa* * | 10 | 7 | 2 | 1 | 3 | 3 | 2 | 82.50 |
| *Lippia sp.* | 10 | 4 | 219 | 7 | 35 | 10 | 8.5 | 81.25 |
| *Spondias tuberosa* | 10 | 7 | 32 | 1 | 19 | 10 | 5.5 | 81.25 |
| *Maytenus rigida* * | 7 | 7 | 92 | 4 | 45 | 10 | 7 | 80.00 |
| *Sideroxylon obtusifolium** | 7 | 7 | 130 | 4 | 28 | 10 | 7 | 80.00 |
| *Caesalpinia leiostachya* | 10 | 7 | 4 | 1 | 8 | 8 | 4.5 | 78.75 |
| *Schinopsis brasiliensis** | 7 | 7 | 15 | 1 | 19 | 10 | 5.5 | 76.25 |
| *Mimosa tenuiflora** | 7 | 7 | 65 | 1 | 18 | 10 | 5.5 | 76.25 |
| *Guapira noxia** | 7 | 7 | 38 | 1 | 30 | 10 | 5.5 | 76.25 |
| *Ziziphus joazeiro** | 7 | 7 | 72 | 1 | 33 | 10 | 5.5 | 76.25 |
| *Gomphrena vaga* | 10 | 4 | 18 | 1 | 15 | 10 | 5.5 | 73.75 |
| *Chorisia sp.* | 10 | 7 | 7 | 1 | 4 | 4 | 2.5 | 73.75 |
| *Croton rhamnifolius* | 10 | 4 | 18 | 1 | 10 | 10 | 5.5 | 73.75 |
| *Jatropha mollissima* | 7 | 7 | 15 | 1 | 15 | 10 | 5.5 | 66.25 |
| *Piptadenia stipulacea** | 4 | 7 | 15 | 1 | 18 | 10 | 5.5 | 61.25 |
| *Ditaxis malpighiacea* | 7 | 7 | 1 | 1 | 1 | 1 | 1 | 55.00 |
| *Commiphora leptophloeos* | 4 | 7 | 101 | 4 | 27 | 10 | 7 | 55.00 |
| *Acalypha multicaulis* | 7 | 4 | 1 | 1 | 2 | 2 | 1.5 | 48.75 |
| *Caesalpinia pyramidalis** | 1 | 7 | 56 | 1 | 24 | 10 | 5.5 | 46.25 |
| *Bauhinia cheilantha** | 1 | 7 | 62 | 1 | 23 | 10 | 5.5 | 46.25 |
| *Aspidosperma pyrifolium** | 1 | 7 | 19 | 1 | 15 | 10 | 5.5 | 46.25 |

*D* Score for relative density in the area, *H* risk of collection, *U* value of use, *CP* conservation priority, *NI* number of individuals, *NU* total number of uses, *L* local importance, *V* diversity of medicinal use. * Associated timber-use

because apart from being very popular among the Fulni-ô, several individuals in the study area showed signs of intense stem bark extraction (Fig. 4).

Category 2 is composed of 10 species. We note that the presence of *Chrorisia* sp. is justified by its low local availability but not necessarily for its popularity as a medicinal plant. The species *Schinopsis brasiliensis* and *Ziziphus joazeiro* should also be highlighted because, in addition to their combined popularity and relatively low abundance, the former is included in the Brazilian list of endangered species.

Category 3 encompasses six species. Although most of them are relatively popular among the Fulni-ô, they have a high local availability. This indicates that the results of conservation priority indices are influenced by the relative density (variable used to measure the local availability). Thus, some plants, despite their position in the top of the list, are less popular among the Fulni-ô because of their low availability. Although many of these plants do not enjoy great popularity as medicinal plants, at least one, *Aspidosperma pyryfolium*, is heavily used for timber purposes.


**Fig. 4** Bark damage in two local medicinal plants in Fulni-ô Indigenous Land (Pernambuco, NE Brazil). **a** *Myracrodruon urundeuva* Allemão (aroeira). **b** *Caesalpinia leiostachya* (Benth.) Ducke (pau ferro)

## 4 Discussion

### 4.1 Floristic survey

Despite human habitation and the strong signs of selective exploitation being indicative of precarious conditions in the area, the survey showed an extensive richness of species and families, similar to that found in other regions of deciduous vegetation in Northeastern Brazil (see, as an example, Alcoforado-Filho et al. 2003; Albuquerque et al. 2005; Lucena et al. 2007). This species richness can serve as a base for future reforestation projects, in particular for plants used more frequently by the Fulni-ô people. Among the most expressive families, Fabaceae and Euphorbiaceae have been highlighted in several other studies conducted in Caatinga areas (see, Lemos and Rodal 2002; Alcoforado-Filho et al. 2003). Most of the families (15) were represented by a single species. Most of these species have been cited in other studies as being of floristical importance (Sampaio 1995, 1996; Alcoforado-Filho et al. 2003). A. *pyrifolium, P. stipulacea,* and *C. pyramidalis* are normally very common species in different studies conducted in northeastern Brazil (see Sampaio 1995, 1996). The species *C. leptophloeos* and *M. urundeuva,* for example, occur in several areas of the Brazilian Northeast and are usually among the ten most important plants in phytosociological terms (cf. Alcoforado-Filho et al. 2003).

Unlike what was found in the surveyed area in the Fulni-ô IL, *S. obtusifolium* (*quixabeira*) seldom occupy a prominent position in northeastern deciduous forests (see Santos et al. 2008). This is one of the most important plants in the Fulni-ô medical system (Silva et al. 2006), occupying the seventh position in terms of local abundance, along with *M. rigida* and *M. urundeuva*. Among all species surveyed, seven had a great cultural meaning for the Fulni-ô Indians (see Silva et al. 2006). Those species are *Myracroduon urundeuva*, *Lippia* sp., *Amburana cearensis*, *Aspidosperma pyrifolium*, *Syderoxylon obtusifolium*, *Maytenus rigida,* and *Ziziphus joazeiro*.

### 4.2 Local conservation priorities for medicinal plants

The importance of individual plants in the Fulni-ô medical system can vary significantly. For example, *M. urundeuva* has the greatest therapeutic versatility in Fulni-ô healthcare practices (Albuquerque et al. 2008) and had greater versatility than 389 medicinal plants registered for the Caatinga (Albuquerque et al. 2007). Its medicinal uses, cultural importance, and timber-associated use may exert considerable pressure on the population of this species.

Many medicinal plants exploited by the community also had other uses. This multiple use of species is common in the *Caatinga* (Albuquerque et al. 2005; Lucena et al. 2007); therefore, an approach that does not consider these additional uses tends to underestimate the pressure on these populations. Species could be affected by the combination of different exploitative events (Gaoue and Ticktin 2007) or by the damage level to the individual or population.

The establishment of conservation priorities, as a practical tool for decision-making, has been gaining territory in the ethnobotany literature (for example, Dhar et al. 2000; Janni and Bastien 2000; Dzerefos and Witkowski 2001; Kala et al. 2004; Oliveira et al. 2007; Albuquerque et al. 2009). Guided by different criteria and goals, these proposals should be discussed by the scientific community to avoid being framed as rigid and inflexible rules without considering the ecological and local cultural features that affect their use. In this study, we noted that the applied index, although modified, still tends to identify the species with low local availability.

The low local availability of one species is not necessarily linked to an over-exploitation but could be a result of genetic and demographic variation that regulated the size of the population (Tuxill and Nabhan 2001). This indicates the necessity of considering the ecological characteristics of a population when a sustainable collection practice is planned (see Cunningham 2001). Similarly, the fact that a species had many uses does not indicate that all of them are active and shared by the entire group of users. Therefore, it is necessary to carefully study the dynamics of use of species in the region.

Regarding the conservation priority index (CP) applied in this study, even with the modification introduced to minimize aspects already known to be fragile, some species were highly valued because of the weight some variables exerted on the calculation of priority. Therefore, we recommend that researchers follow these steps: (1) after the list is generated, verify whether any species was over-valued in relation to the local availability (rarity) regarding the real use and local popularity, which can be assessed by indirect measures of how much the resource is used; (2) perform the same verification process noting the diversity of uses, which may affect the position of the species on the list because one plant may have several local uses but be cited by only one or few people.

## 5 Conclusions

The species richness in the surveyed area, the Ouricuri Forest of the Fulni-ô Indigenous Land, is extensive when compared to the richness of other *Caatinga* areas of northeastern Brazil. This richness can serve as a basis for future reforestation projects, especially for the most used plants in the Fulni-ô medical system. These plants enjoyed a great prestige and popularity; six of the nine plants considered here ranked with a high priority for conservation: *Anadenanthera colubrina*, *Myracrodruon urundeuva*, *Lippia* sp., *Spondias tuberosa*, *Maytenus rigida*, and *Sideroxylon obtusifolium*.

We can certainly assert that the situation in the vegetal community of the Ouricuri forest, the most important site of collection for the Fulni-ô people, deserves immediate attention. Moreover, any harvesting activity that occurs without respect for the ecology of species will result in additional pressures on these plant populations and contribute negatively to the environmental sustainability of the Fulni-ô traditional practices.

Additionally, we believe it will be necessary to assess the demand of plants required locally, in order to formulate strategies on resource collection that do not jeopardize the existence of these plants in nature. We also recommend the direct involvement of the Fulni-ô people in the conservation and management of local resources through the creation of management plans and monitoring strategies.

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