

Ethnobotanical study of anti-malarials among communities in the municipal of Portel-PA, Brazil

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Abstract

Nearly all cultures use medicinal plants as a vital dietary resource, the ingredients collected from their surroundings being used for food and medicine. This study will provide the basis for further ethnopharmacological research by documenting the use of medicinal plants traditionally employed by the communities along the Aruanã River to treat malaria and related symptoms. While this is the first ethnobotanical study in this region, the socio-economic profile will also be evaluated as part of this study. We also aimed to review literature on traditional use of the cited species for comparison. Ethnobotanical data was collected using semi-structured interviews with 23 participants, which cited 29 species used to prevent and/or cure malaria and related symptoms. The interviewees ranged in age from 14 to 83, with 73.91% women, and 47.83% illiterate. Medicinal plants gathered from the wild and cultivated in gardens have been traditionally used to treat malaria and related symptoms among riverine communities. Documenting this local knowledge to compare with reviewed literature regarding efficacy and toxicity would be an essential part in the search for a new antimalarial agent.

Keywords: Ethnobotanical. Medicinal plants. Malaria. Communities. Antimalarial.

Introduction

The Amazon Basin supports the largest remaining tract of tropical rainforest on the planet, being an ecosystem with the most diverse species, yet to be fully discovered^[1-3]. Rich in both bio and cultural diversity, the Amazonian rainforest contributes towards global medicine, with medicinal plants possessing unique and varied biochemicals, which are one of the principal resources used to treat a variety of diseases^[4-6].

Due to their close contact and dependence on the local biodiversity as a therapeutic resource, communities in remote rainforest areas have considerable experience with medicinal plants^[7]. This relationship between humans and plants is a source of information for ethnobotanical research, besides playing a key role in the

exploitation and discovery of natural plant resources, which has scarcely been catalogued, despite the significant species diversity^[8,9,6].

In the effort to control malaria, medicinal plants continue to be the integral part in identifying new, efficient, and safe compounds, thus calling for the necessity to research ethnobotanical knowledge of the Amazonian population within this region^[10]. Malaria is caused by *Plasmodium* parasites, which infect *Anopheles* mosquitoes. *Plasmodium falciparum* and *Plasmodium vivax*, are species found in the Amazonian forest, and generally are most prevalent in populations where the temperature and rainfall are suitable^[11]. In the Amazon region, malaria remains an important public health problem in spite of intense efforts to control it^[12]. According to the World Health Organization (WHO), the incidence rate of malaria between 2016 and 2017 increased, largely due to increase in Brazil, *P. vivax* being the predominate specie^[13].

Despite the vast range of antimalarials available in the Amazon region, high rates of malaria reoccurrences in isolated communities gives reason to suspect possible drug-resistant parasites, rendering the malaria treatment with chloroquine, pyrimethamine, and sulfadoxine drugs ineffective, having been used worldwide for centuries^[14,15,7,16]. In an environmentally sustainable manner, many isolated populations in the amazon use their biodiversity as an integral source for daily needs, with detailed and varied knowledge of the medicinal plants in their surrounding environment. Due to geographic isolation and limited access to medical care, malaria continues being a threat to riverine communities in the Amazon Basin. This explains how ethnopharmacological knowledge plays an important role in the employment of various species to prevent, treat and even cure malaria, and related diseases^[17-19].

Unfortunately, there has lacked consistent reports demonstrating the prevalence of malaria related diseases especially among children, due to single or repeated malaria episodes. According to the World Malaria Report (WMR), in sub-Saharan Africa, iron deficiency and malaria infection often coincide, anemia being a direct, as well as indirect, consequence of malaria. When promptly diagnosed and treated, mild cases of malaria can defer development whereas in severe cases the outcome is usually mortality^[12]. With this scenario in view, the present study sought to recover knowledge and practices associated with plant resources as part of an important strategy linked to the conservation of biodiversity and the discovery of new medicines. It becomes necessary to evaluate socioeconomic aspects where medicinal plants are the most accessible for a population that depends on them to cure their infirmities, since the occurrence of frequent diseases have a correlation to human living conditions.

Material and Methods

Description of the study area

This study was conducted along the Aruanã River, located in the municipality of Portel, a subregion of the Marajó archipelago in the state of Pará, Brazil (**FIGURE 1**). What today is the municipal of Portel was home to the Nheengaiba Indians in 1653, thus attributing to its present rich culture, and currently having an area of 25,384.96 km², equivalent to 2.03% of the territory of the state of Pará^[20]. According to^[21], the study area has a rainy tropical climate, characterized as hot and humid, with two well-defined seasons: rainy months (February through April) and dry months (August through October). The region has an annual rainfall of approximately 2,200 mm, and the annual average temperature is 21°C. In terms of religion, the populations in this study area are predominately Christian, the majority being Catholics followed by Protestants. There

are churches in this area as well. There is no organized sewage system; therefore, the residents dispose of their waste by open burning on their properties or in the river, over which most of the houses are built.

The communities in this study live approximately 110 kilometers from the city of Portel, or eighteen hours by boat. According to the Ministry of Health^[22], the municipality of Portel has high indices of malaria. Due to the yearly outbreak of the disease, a clinic on the Aruanã River, to which access is fluvial, is responsible for diagnosing and treating malaria. Fuel for small boats is scarce along the river, thus considered a highly valued resource. Ethnobotanical data were collected through semi-structured interviews randomly selected along the river. The medicinal plant information collected for this report was popular name, therapeutic indications, plant part used, preparation methods, and most frequent diseases that affects the family. The formularies applied included socioeconomic data such as gender, age, schooling level, profession, main income, and number of residents per home.

FIGURE 1: Map of homes interviewed in the municipal of Portel, within the state of Pará, Brazil.



Research authorization

Research authorizations were obtained to access associated traditional knowledge for scientific research purposes from CGEN/MMA, in the form of provisional measure N°A8B7E72. The Term of Free and Clarified Consentient, approved by the Research Ethics Committee from the Federal University of Pará n° 80535117.0.0000.0018, was read and signed by all the participants.

Socio-economic data collection

For data acquisition, two ethnobotanical field trips were performed during January and July 2018. The questions asked referred to the interviewees, such as name, age group, sex, schooling degree, and region of origin.

The communities comprise of native-born residents as well as those from various regions of the municipal, including neighboring municipalities. House-to-house interviews were conducted in which one interviewee gave the needed information on behalf of the remaining family members. The riverine communities along the Aruanã River make their livelihood from manioc and other cultural provisions, which they plant in small clearings near the riverbanks, as well as hunting and fishing. In riverine culture, the men hunt and clear the plots, while the women and children are responsible for planting, harvesting and processing manioc root into 'farinha', which is a staple food. The riverine people have a diversified economy based on fishing, hunting, small-scale agriculture, extraction and commercialization of forest products. The market for their products are trading boats, which trade in merchandise, such as coffee, beans, sugar, oil, and clothing. The riverine people use plants for a variety of purposes such as food, medicine, handcrafts, and construction.

Ethnobotanical data collection

A free list technique was used, which consisted of asking the informants to list any medicinal plants they knew and/or had used. For each specie mentioned, the participants described popular name, the plant part used, the preparation method, and the ailment for which the specie was indicated. While collecting ethnobotanical data, the interviewees showed their cultivated gardens where many medicinal plants are grown, as well as plant parts collected from the forest, for medicinal purposes. The riverine communities diverge in their notion of disease from Western ideas, due to the cultural and traditional context in which they are inserted. Therefore, we sought to categorize diseases mentioned by the participants that were related to malaria and liver disorders, such as fever, headache, anemia, hepatitis, and, as described by the interviewees, "for the liver".

For the principal plants mentioned, specimens were collected and deposited in the herbarium of the Museu Paraense Emílio Goeldi. The scientific names and the authorship were updated in accord with an online base of the Lista de Espécies da Flora do Brasil^[23] and plant names have been checked and updated with the online website (www.theplantlist.org) of the Royal Botanic Gardens^[24].

Data analysis

The Index of Relative Importance (RI) of medicinal plants used by the communities was calculated according to the methodology proposed by^[25] Excluding from this calculation, only the species mentioned by only one informant. The Index of Relative Importance is obtained by calculating the percentage of agreement on the

main uses of each species (CUP). Considering that the main uses meet the most cited indications, CUP is calculated as follows:

$$CUP = \frac{\text{Number of informants citing main uses} \times 100}{\text{Number of informants citing use of the species}}$$

Later the value of CUP was corrected by the correction factor (FC) where:

$$FC = \frac{\text{Number of informants citing the species} \times 100}{\text{Number of informants citing the species most cited}}$$

The CUP given is then corrected by the formula $CUP_c = CUP \times FC$ which is equivalent to RI.

Literature review

The literature reviewed was from scientific journals in academic database (Google Scholar, SciELO, and Science Direct) of published papers up to 2019 to compare indication of cited species for malaria and malaria-related liver disease. The articles used to compare indication of species cited by the interviewees, were ethnobotanical studies carried out in Brazilian territory.

Results and Discussion

Socioeconomic characteristics of the informants

Twenty-three adults were interviewed in the communities along the Aruanã River, citing twenty-nine species to prevent and/or cure malaria and malaria-related liver diseases. Of those interviewed, seventeen were women (73.91%) and six (26.09%) were men. Only six interviewees were born in neighboring municipalities, yet all of the informants live permanently on the Aruanã River. The interviewees were divided into three age groups, 10 (43.48%) in the range of 14 to 36 years old, 9 (39.13%) were 37 to 59 years old, and 4 (17.39%) were in the range of 60 to 83 years old. All interviewees were married or lived in a marital state, except for three participants that were either single, widowed or divorced. In terms of schooling level, 11 (47.83%) of the interviewees were illiterate and 12 (52.17%) had either completed or partially completed elementary schooling (**TABLE 1**). Due to precarious lifestyle in the communities, such as health services and schools, indigenous knowledge becomes a relevant therapeutic alternative, thus making it pertinent to being collected and documented.

TABLE 1: Demographic characteristics of respondents (n= 23).

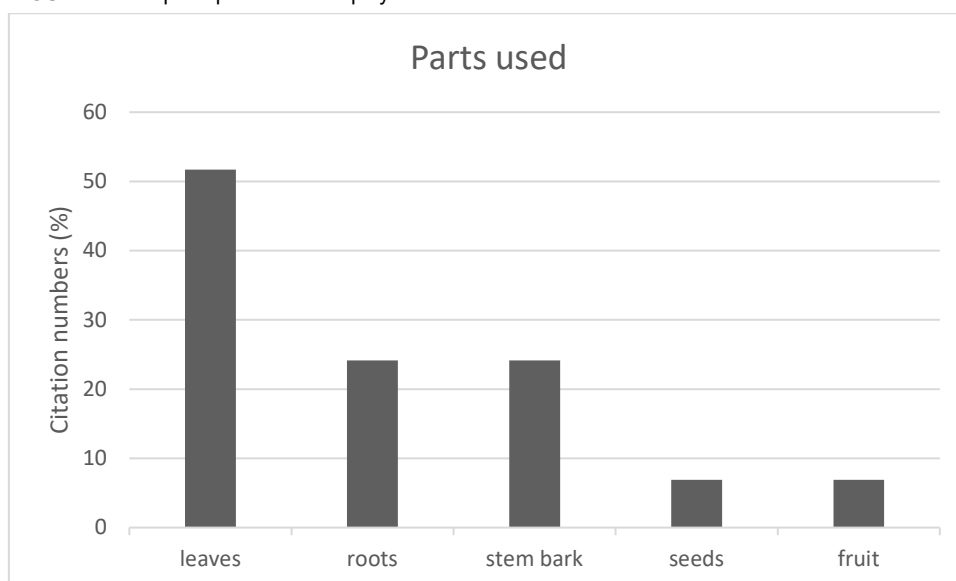
Characteristic	Frequency
Gender	
Male	6
Female	17
Age	
14 to 36	10
37 to 59	9
60 to 83	4
Education	
Illiterate	11
Primary Education	12

Diversity of medicinal plants and their uses

Interviewees indicated plants, taxonomically identified as 29 different species, distributed in 18 families, the Asteraceae family with the greatest number of species (27.8%), followed by Fabaceae (22.2%), Rutaceae (16.7%), Arecaceae (11%), and Solanaceae (11%). Species were cited by the communities along the Aruaná River with palliative, prophylactic and curing purposes for malaria and related ailments such as fever, headache, anemia, and liver disease.

The vegetal species cited in the survey are listed in **TABLE 2**, including family, vernacular name, part used, therapeutic indication, and Index of Relative Importance (RI). The plant parts mostly employed for medicinal uses were the leaves (52%), **FIGURE 2**. Thus being compatible to similar studies in Mato Grosso and Minas Gerais^[26,27], Santa Catarina^[28], Pará^[25], and Rio Grande do Sul^[18], yet differing from quilombola communities in Oriximiná, Pará, which cited mostly bark^[7]. The plant part used varies according to the region, for instance, according to^[9], in the Atlantic forest, leaves are the most commercialized plant part. The preparation methods employed were teas, by decoction, and baths. Information obtained in this survey through interviews, mentioned common names and popular uses of the species indicated by the communities, as shown in **TABLE 2**.

FIGURE 2: The plant parts most employed.



The Index of Relative Importance (RI) was calculated in relation to 29 species. This index was obtained by calculating the CUPc (corrected percentage of agreement on the main uses). According to^[25], the values of RI between 0 and 24 indicates species little used by the community, whereas between 25 and 49, intermediate use of species and values between 50 and 100, species widely used by the community.

Thirty-one percent of medicinal plant species cited by informants had a value of RI index between 25 a 49 (species of intermediate use). RI was most in about 51.7% of the species (little use) and the RI of 17.2% of the species was high, indicating plants that are widely used by the population (**TABLE 2**). Species with a high Index of Relative Importance were *Plectranthus barbatus Andrews* (100%), *Quassia amara L* (71.43%), *Citrus cf. aurantium L* (71,43%), and *Justicia secunda* (Vahl) (57.14%). Similar ethnobotanical studies carried out in Brazil showed similar indications of the species mentioned by the communities along the Aruaná River as shown in **TABLE 2**.

The results obtained in this study show that these communities employ a large variety of plants, possibly elevating the risk of intoxication due to a lack of scientific investigations. According to^[29], safe and efficient methods applied to the use of medicinal plants by communities can be questioned, since some use a variety of species that either have yet to be investigated or are considered toxic when administered orally, thus evidencing the necessity of an educational process in some populations. Most of the medicinal plants used, are cultivated in small gardens or balconies, followed by native plants collected in the nearby forest (**FIGURE 3**). It was noted in this study, that the inhabitants traditionally use many plants to treat common diseases, this information being transmitted from generation to generation orally.

TABLE 2: Vegetal species used as medicinal plants among the inhabitants of the Aruanã River. Family and scientific names, common name, growth form, source, origin, indication, plant part used, and corrected percentage of agreement on the main uses (CUPc %) equivalent to Relative Importance (R.I.).

Family/scientific name	Popular name	Growth form	Source	Origin	Ailments	Parts used	CUPc (%)	Author
Acanthaceae								
<i>Justicia secunda</i> (Vahl)	fosangue	shrubby	cultivated	-	anemia	leaves	57.14	-
Anacardiaceae								
<i>Mangifera indica</i> Wall.	mangueira	tree	cultivated	exotic	fever	leaves	14.29	[2]
Areaceae								
<i>Euterpe precatoria</i> Mart	açaí	tree	gathered	native	anemia	root; seed	42.86	[7]
<i>Bactris gasipaes</i>	pupunha	tree	gathered	native	anemia	roots	28.57	[30]
Asteraceae								
<i>Xanthium cavanillesii</i>	carrapichão	herb	gathered	native	liver	roots	28.57	[7]
<i>Tanacetum vulgare</i> L	catinga de mulata	herb			headache	leaves	14.29	[30]
<i>Spilanthes acmella</i> (L) Murray	jambu	herb	gathered	native	liver	leaves	28.57	[18]
<i>Bidens pilosa</i> L.	picão	herb	gathered	native	liver; hepatitis	leaves; root	42.86	[10]
Bignoniaceae								
<i>Fridericia chica</i> (Bonpl.) L.G.	pariri	herb	cultivated	native	anemia	leaves	71.43	[31]
Bixaceae								
<i>Bixa orellana</i> L.	urucum	shrubby	cultivated	native	anemia	roots	14.29	[32]
Cecropiaceae								
<i>Cecropia</i> sp.	embauba	tree	gathered	native	liver	leaves	14.29	[26]
Euphorbiaceae								
<i>Jatropha curcas</i> L.	pião-branco	shrubby	cultivated	exotic	headache	leaves; fruit	42.86	[10]
Fabaceae								
<i>Dipteryx odorata</i>	cumarú	tree	gathered	native	malaria; fever	seeds	14.29	[33]
<i>Hymenaea courbaril</i>	jatobá	tree	gathered	native	anemia	stem bark	14.29	[17]
<i>Schizolobium amazonicum</i>	paricá	tree	cultivated	exotic	liver	leaves	14.29	[34]
<i>Vouacapoua americana</i> Aubl	acapú	tree	gathered	native	anemia	stem bark	14.29	-
Lauraceae								

<i>Persea americana</i> Mill	abacateiro	tree	cultivated	exotic	anemia	leaves	28.57	[10]
Lecythidaceae								
<i>Bertholletia excelsa</i>	castanheira	tree	cultivated	native	hepatitis	stem bark	28.57	[10]
Leguminosae-Fabaceae								
<i>Ormosia coutinhoi</i> Ducke	buiuçu	climber	gathered	native	headache	stem bark	14.29	-
Lamiaceae								
<i>Plectranthus barbatus</i> Andrews	boldo	herb	cultivated	exotic	liver; malaria	leaves	100	[26]
Meliaceae								
<i>Cedrela fissilis</i>	cedro	tree	gathered	native	fever	stem bark	14.29	[7]
Poaceae								
<i>Cymbopogon citratus</i>	capim marinho	herb	cultivated	exotic	malaria	leaves	14.29	[7]
Rutaceae								
<i>Ruta graveolens</i> L	arruda	herb	cultivated	exotic	headache	leaves	14.29	[7]
<i>Citrus cf. aurantium</i> L	laranjeira	tree	cultivated	exotic	anemia; fever	leaves; fruit	71.43	[32]
<i>Citrus limon</i> (L) <i>Burm.</i> F	limãoleira	tree	cultivated	exotic	fever; headache	leaves	28.57	[10]
Simaroubaceae								
<i>Quassia amara</i> L	quina	tree	gathered	native	malaria	stem bark	71.43	[10]
Solanaceae								
<i>Physalis pubescens</i> L	camapu	herb	gathered	native	fever	roots	14.29	[10]
<i>Solanum paniculatum</i> L	jurubeba	shrubby	cultivated	native	fever	roots	14.29	[2]
-	urimbó		gathered	native	headache	stem bark	14.29	-

FIGURE 3: Medicinal plants cultivated in balconies.



Although not knowing the chemical constituents of medicinal plants, popular observation of use and efficacy is relevant to unclosethe therapeutic value of frequently prescribed phytotherapeutics^[17]. Various studies have

evidenced the use of diverse plant species by different ethnic groups, serving as bases for understanding regional medicinal flora^[29]. According to^[26], traditional medicinal knowledge needs to be documented for future research to validate traditional phytotherapies with the intent to conserve traditional medicine.

The safe use of medicinal plants is an important subject that requires further scrutiny, and yet too often overlooked. The study of medicinal plants not only contributes to a safer use of these resources by the populations, as well as brings to light the efficacy of new drugs for the treatment of diverse illnesses^[35,36,25].

Access to health services is one of the major difficulties encountered by the riverine communities, thus making medicinal plants a source of primary health care. The informants repeatedly mentioned the difficulties in accessing the clinic as well as lack of pharmaceutical drugs and materials necessary for treating basic health issues. Thus showing the important role medicinal plants play in the communities along the Aruanã River. Studies have evidenced similar results in^[37].

Despite the larger number of participants being in the youngest age group, indicating no evidence of knowledge loss, ethnobotanical knowledge needs to be documented for future research so that traditional phytotherapy may be validated with the intent to conserve traditional medicine. Studies ^[38,27] evidenced that the main way of knowledge transmission between generations requires intense contact between younger and older members of the society. There are differences between the knowledge of men and women; in general, women dominate the knowledge of plants that grow near residences, while men know more about plants that grow in the forest^[27].

Conclusion

This study in the communities along the Aruanã River showed that the indigenous knowledge, acquired through generations of experience with nature in understanding regional medicinal flora, could serve as a base for future studies to test what these riverine people practice for treating frequent diseases. Investigations in regards to scientific and botanical research are scarce in the location of this study, attributing relevance to this research and possibly being the first scientific paper on this subject in the local area.

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Authors' contributions

Kelly Davis (undergraduate) contributed in collecting plant samples and information from the interviewees, and drafted the paper. Danielly O. Guimarães contributed to collecting interviewees' information, analysis of the data, and critical reading of the manuscript. Timothy Davis contributed in compiling the map of the study area and critical reading of the manuscript. All the authors have read the final manuscript and approved the submission.

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