

Use and traditional knowledge of *Byrsonima crassifolia* and *B. coccolobifolia* (Malpighiaceae) in a Makuxi community of the Roraima savanna, northern Brazil

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ABSTRACT

Byrsonima crassifolia and *B. coccolobifolia*, popularly known as mirixis, muricis, mantecos or nances, are common fruit species in the Amazonian savannas. Their fruits are used in the preparation of juices and other beverages, while the other parts of the plants are used for different purposes in some indigenous communities. The aim of the present ethnobotanical study was to investigate the knowledge and traditional uses of mirixis in the Darora Indigenous Community, of the Makuxi ethnicity, in the São Marcos Indigenous Land, state of Roraima, northern Brazil. The knowledge on these species among the residents was analyzed considering their gender and age. A survey was carried out by means of semi-structured interviews with 60 respondents (36 men and 24 women), between 18 and 84 years of age. Data from the interviewees was compared between genders and two age groups (< 40 and ≥ 40 years of age). Ethnobotanical indices (Informant diversity value; Informant equability value) were calculated, and no significant differences were found in the diversity of uses between genders ($U = 283.0000$, $p > 0.05$) and age groups ($U = 359.5000$, $p > 0.05$), indicating that the knowledge on the species is evenly distributed among residents. Results show that both species are used for different purposes in the food, fuelwood and medicinal categories in the Darora Community, and this knowledge is widely shared among adult men and women of all ages.

KEYWORDS: Fuel-use, food, medicinal plants, plant conservation, northern Brazilian Amazon.

Uso e conhecimento tradicional de *Byrsonima crassifolia* e *B. coccolobifolia* (Malpighiaceae) em uma Comunidade Makuxi na Savana de Roraima, extremo norte do Brasil

RESUMO

Byrsonima crassifolia e *B. coccolobifolia*, popularmente conhecidas como mirixis, muricis, mantecos ou nances, são espécies de frutíferas comuns que ocorrem nas savanas amazônicas. Os seus frutos são utilizados na preparação de sucos e outras bebidas, enquanto outras partes das plantas são utilizadas para diferentes fins em algumas comunidades indígenas. O objetivo do presente estudo etnobotânico foi investigar o conhecimento e usos tradicionais dos mirixis na Comunidade Indígena Darora, da etnia Makuxi, na Terra Indígena São Marcos, no estado de Roraima. Este trabalho analisou o conhecimento dessas espécies entre os moradores da comunidade. A pesquisa foi realizada por meio de entrevistas semi-estruturadas com 60 participantes (36 homens e 24 mulheres), entre 18 e 84 anos de idade. Os dados das entrevistas foram comparados entre gêneros e dois grupos de idade (< 40 anos de idade e ≥ 40 anos de idade). Índices etnobotânicos (Valor de diversidade do informante; Valor de equabilidade do informante) foram calculados, e não houve diferenças significativas na diversidade de usos entre os gêneros ($U = 283,0000$, $p > 0,05$) e grupos de idade ($U = 359,5000$, $p > 0,05$), indicando que o conhecimento das espécies é uniformemente distribuído entre os moradores. Os resultados mostraram que ambas as espécies são usadas com finalidades nas categorias alimentícia, combustível e medicinal na Comunidade Darora, e o conhecimento é amplamente compartilhado entre homens e mulheres, independentemente da faixa etária.

PALAVRAS-CHAVE: Combustível, alimentação, plantas medicinais, conservação vegetal, extremo norte da Amazônia brasileira.

INTRODUCTION

Mirixis, muricis or mantecos (nances, in English) are fruit species of the Malpighiaceae family, which are commonly found in the natural savanna regions of Amazonia (Benezar and Pessoni 2006). In the state of Roraima, northern Brazil, these fruits are popularly used in the preparation of juices and other beverages, especially those of the species *Byrsonima crassifolia* (L.) Kunth and *B. coccolobifolia* Kunth. Local indigenous communities use the timber for fuelwood, food and medicines. Regionally, the species are often found together (Barbosa *et al.* 2014; Neves *et al.* 2015). However, *B. crassifolia* is generally more abundant (Barbosa *et al.* 2005); it presents smaller fruits with pulp and seed aroma that can be described as fruity, sweet, floral, pungent and similar to rancid cheese odor, due to different chemical components (Rezende and Fraga 2008). According to Pott and Pott (1994), abundance and fruit size differ between the two species, allowing their easy identification.

Northeastern Roraima comprises the largest area of natural savanna in the Brazilian Amazonia, locally known as 'lavrado', 'campos do rio Branco' or 'campos de Roraima', covering approximately 43.000 km² in area (Barbosa and Campos 2011). Roraima's savanna is part of the Rio Branco-Rupununi vegetation complex, which extends from Venezuela to the Republic of Guyana (Barbosa and Fearnside 2005), forming a large mosaic of non-forest ecosystems (open vegetation with low tree density) and forest (island forests, gallery forests, and *buritizais*), with dominance of open vegetation areas (Barbosa *et al.* 2007).

Several indigenous lands are located within this huge open vegetation area, including the Raposa/Serra do Sol Indigenous Land and the São Marcos Indigenous Land. The open savanna areas are important sources of plant products for native peoples, and the two sympatric *Byrsonima* species are traditionally used by many indigenous communities (Perez 2010).

The two *Byrsonima* species have been consistently reported in phytosociological studies from the Roraima savanna. The density of these species varies depending on the vegetation type. However, most often *B. crassifolia* presents greater numbers of individuals in relation to *B. coccolobifolia* (Miranda and Absy 2000; Miranda *et al.* 2002; Barbosa *et al.* 2005). Despite the common presence of these species in the open vegetation area, no studies have described the use and traditional knowledge by local indigenous communities (Guéze *et al.* 2015). The lack of ethnobotanical studies reduces the possibility of developing clear and effective conservation strategies for these important species at the level of local indigenous communities. This fact is directly related to two factors: (i) the intense modification Roraima savanna has suffered due to monocultures and afforestation of exotic species (Aguiar Jr *et al.* 2014.) and (ii) the displacement of most of the young people in search of employment and

facilities in nearby urban centers (Heck *et al.* 2005). Both factors change the local social relationships, with direct influence on community structure. Since plant use preferences are conditioned by gender and different age groups, and these preferences are generally associated with the division of labor in the community (Voeks 2007; Camou-Guerrero *et al.* 2008; Almeida *et al.* 2012), these new relations of population and age structure may cause an erosion of traditional knowledge that is difficult to reverse.

In this context, studies on the population structure and ethnobotany of plant species used by people in the indigenous communities are important and necessary, so they can potentially be used as tools for management and conservation strategies. The present ethnobotanical study aimed to investigate the indigenous knowledge and the traditional uses of *B. crassifolia* and *B. coccolobifolia* in a community of the northern Amazonian savanna region. The knowledge on these species among the community residents was analyzed considering the gender and the age of the respondents.

MATERIALS AND METHODS

São Marcos Indigenous Land (TISM) comprises about 654110 ha and 42 indigenous communities of the Makuxi, Taurepang and Wapixana ethnicities. The present study involved a group of the Makuxi ethnicity of the Darora Community, that lives in a region known as *Baixo* São Marcos (3° 10'42" N; 60° 23'34" W). The study area is at 90 km from the state capital, Boa Vista (Figure 1). The local climate is tropical savanna (Aw), according to the Köppen classification, with average annual temperature of 27.8 °C, and average annual rainfall of ~1.650 mm. The driest period occurs between the months of December and March (\pm 9 % annual rainfall), and the wettest months are between May and August (\pm 70 % annual rainfall) (Barbosa 1997).

The occupation of the Darora Community occurred around 1941, when some families from the Xumina Community (Raposa/Serra do Sol Indigenous Land) migrated to the region due to the difficulty of finding areas for agriculture. The community has a strong aptitude for agriculture and animal livestock, understood by them as necessary for food and sustenance. Extractivism is still used and is always related to the construction of houses, fences, and fruit collection.

There is also a small building where medical and dental care is regularly offered to residents by government agencies. According to the data of these government agencies, 40 families and 184 people live in Darora, of which 50 are men and 43 are women over 18 years old; and five are men and six are women over 60 years old. Residents cited a total of nine men and 12 women, but they were not found, since many of them move from the community to the city of Boa Vista searching for

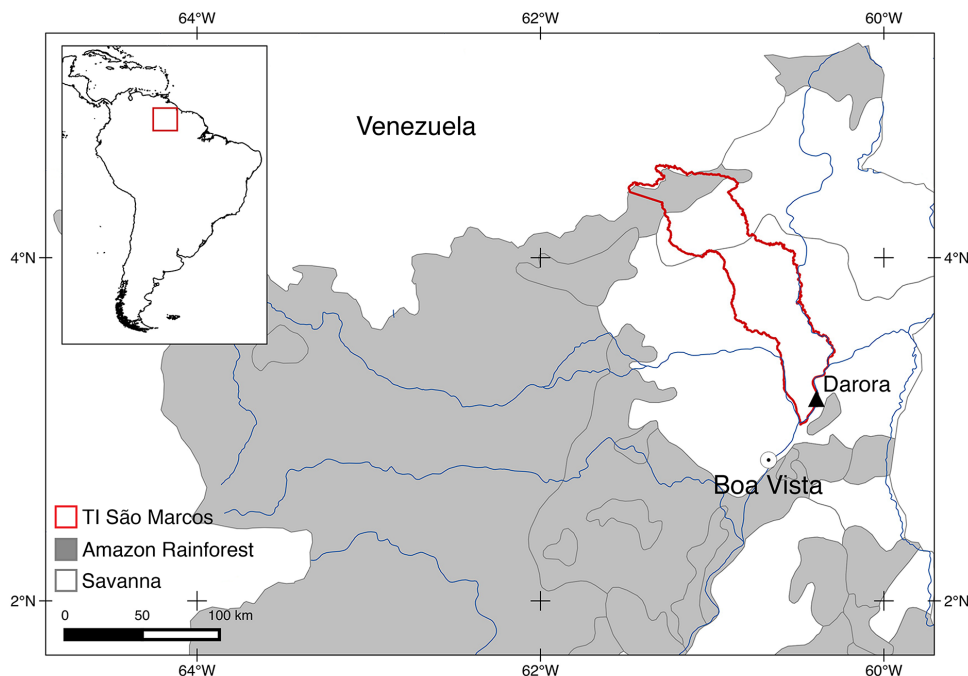


Figure 1. Location of the Darora Indigenous Community – São Marcos Indigenous Land (TISM), in the state of Roraima, northern Brazil. This figure is in color in the electronic version.

employment and further education. Seven residents were not included in the survey, since they are Makuxi from the Republic of Guyana, and have recently settled in the community. Only one woman declined to participate.

There are two public schools in the Darora Community: one for pre-school, supported by the Boa Vista City Hall, and one for elementary school and high school, supported by the State Government. All residents speak Portuguese fluently. The Makuxi language, from the Karib linguistic trunk, is taught in pre-school, but is rarely spoken by the residents, with only two teachers and one elderly speakers.

Ethics and legal aspects

This study is part of the research project “Use and conservation of plant resources by indigenous communities in northern Roraima”, of the Graduate Program in Biological Sciences (Botany), of the National Institute of Amazonian Research (INPA) and Roraima State University. It was submitted to and approved by the Ethics Committee for Human Research of INPA and the National Commission of Ethics in Research with Humans (CEP-INPA/CONEP) (permit # 814.370 – 2014). The study was authorized by the National Foundation for Indigenous People (FUNAI) (process # 08620.002869/2014–15), and by the National Institute for Historical and Artistic Heritage (IPHAN) (process # 01450.001678/2014-88).

Ethnobotanical Survey

For the collection of ethnobotanical data, semi-structured interviews were carried out with 60 respondents (36 men and 24 women) of 38 families, between 18 and 84 years of age. All households in the community were visited, and each resident was invited to participate in the survey. The purpose of the research was explained, and those who agreed to participate in the interview were given an Informed Consent (TCLE) form to be signed.

The interviews were carried out from November 2014 to November 2015. At first, the respondents indicated the collection sites of the studied species in non-forest areas of savanna, and then the free list technique was used on the species they knew in this environment type, as suggested by Albuquerque *et al.* (2014). Mirixis obtained one of the highest number of citations. In a second phase, semi-structured interviews were carried out according to Albuquerque *et al.* (2014), with questions about mirixi collection, forms of use, and plant parts used. Responses were grouped into the categories Food, Medicinal, Fuel, and Handicraft, adapted from previous studies (Lins Neto *et al.* 2008; Lucena *et al.* 2012).

Botanical material was collected and identified, with the aid of parataxonomists and group-specific experts, and local floras and guides (Melo and Barbosa 2007; Flores and Rodrigues 2010). Samples were incorporated into the

herbarium of the Federal University of Roraima (UFRR), with the numbers 8482 (*Byrsonima crassifolia*) and 8483 (*B. coccolobifolia*). Classification followed the Angiosperm Phylogeny Group IV (APG IV 2016).

Data analysis

Differences in the knowledge and use of species between men and women of different ages were analyzed. Data from the interviews were compared between genders and two age groups (< 40 and ≥ 40 years of age) (Albuquerque *et al.* 2014). Two quantitative measures were developed to analyze the knowledge and the use of species: the informant diversity value (IDV), and the informant equability value (IEV) (Byg and Balslev 2001). The IDV measures how respondents use the species and how their different uses are distributed among them, while the IEV measures the degree of homogeneity of the respondent's knowledge, regardless of the number of respondents. Age category 1 (< 40 years of age) had seven women and 14 men; and age category 2 (≥ 40 years) had 13 women and 24 men. The Mann-Whitney test was used to explore the differences between the values and the categories.

RESULTS

Use and local knowledge

Byrsonima crassifolia and *B. coccolobifolia* are known locally by indigenous people as *mirixi vermelho* (red mirixi) and *mirixi branco* (white mirixi), respectively. However, during the interviews, only five respondents distinguished the two species. The respondents affirmed that *mirixi*, *mirixi vermelho* and *mirixi branco* had the same uses. Respondents also reported that the difference between the two types of mirixis is based on the color of the flower (*B. crassifolia* is yellow, while *B. coccolobifolia* is white) (Figure 2), and on the shape of the leaves (*B. coccolobifolia* presents "rounder" leaves). In addition, *B. crassifolia* was reported to present darker red colored timber when compared with *B. coccolobifolia*.

The species are widely known to Darora residents, since 58 respondents (38 men and 20 women) confirmed having knowledge of at least one use for the two species (Figure 3). Although differences were recorded between the IEV for men and women, and between IDV and IEV for men and women ≥ 40 years of age, no significant differences were observed in the diversity of uses (IDV and IEV) (gender, $U = 283.0000$, $p > 0.05$; age, $U = 359.5000$, $p > 0.05$), indicating that the knowledge on the use of the species is equally distributed between the groups (Table 1).

Respondents indicated 11 different uses for mirixi, including: food, medicine, fuel and handicraft (Table 2). Six respondents (10.3%) described the use of mirixi bark for leather tanning and *buriti* palm (*Mauritia flexuosa* L.) fibers dyeing for artisanal purposes. This low number reflects the

fact that the activity of leather tanning is no longer used, while the practice of dyeing *buriti* fibers is restricted to a few artisans in the community.

The use of *B. crassifolia* and *B. coccolobifolia* as food was cited by 53 respondents (88.3%). Of these, *in natura* consumption of fruits (21% citations), and preparation of mirixi wine or fruit juice (79% citations) were the most commonly given responses, showing that the community has extensive knowledge on the use of the species as food.

The use in the medicinal category was cited by 41 respondents (68.3%), and bark soaked in water (88% of

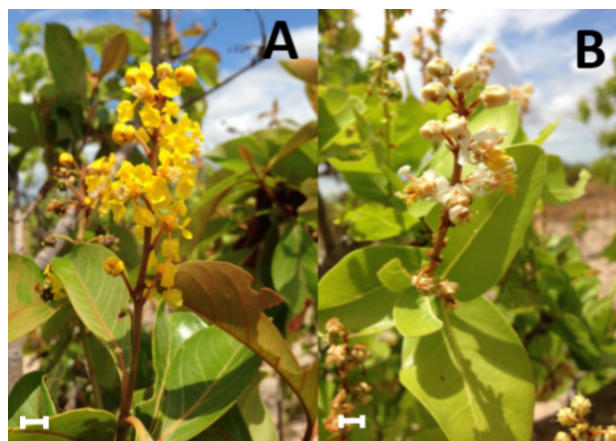


Figure 2. (A) – Inflorescence of *Byrsonima crassifolia*; (B) - Inflorescence of *B. coccolobifolia*. Scale bar: A-B: 1 cm. This figure is in color in the electronic version.

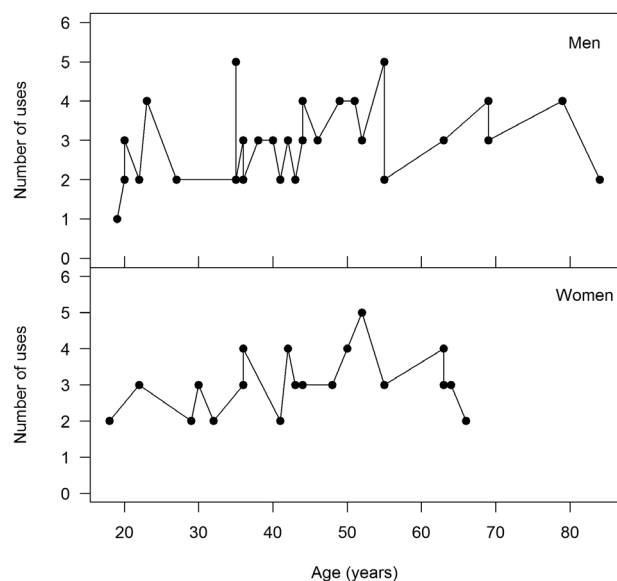


Figure 3. Number of uses for the mirixis (*Byrsonima crassifolia* and *B. coccolobifolia*) by respondents (men and women) per age class (years) in the Darora Indigenous Community, São Marcos Indigenous Land (TISM), Roraima, Brazil.

Table 1. Measurements of knowledge regarding mirixis (*Byrsonima crassifolia* and *B. coccolobifolia*) in the Darora Community (Boa Vista, Roraima, Brazil). IDV – Informant Diversity Value, IEV – Informant Equability Value.

Variables	Values
Total respondents	58
Number of use citations	172
Types of use	11
Measures	Average and standard deviation (X ± SD)
Total IDV	0.271±0.088
Total IDV Women	0.277±0.075
IDV Women (< 40 years of age)	0.247±0.069
IDV Women (≥ 40 years of age)	0.294±0.076
Total IDV Men	0.268±0.096
IDV Men (< 40 years of age)	0.252±0.099
IDV Men (≥ 40 years of age)	0.277±0.095
Total IEV	0.593±0.195
Total IEV Women	0.610±0.165
IEV Women (< 40 years of age)	0.543±0.110
IEV Women (≥ 40 years of age)	0.646±0.166
Total IEV Men	0.584±0.210
IEV Men (< 40 years of age)	0.543±0.214
IEV Men (≥ 40 years of age)	0.608±0.208

citations) and the inner bark (12% citations) were the most cited uses. The tea made with the bark and water for digestive system disorders (diarrhea and dysentery) comprised of 61% citations. General healing and anti-inflammatory purposes for uterine and kidney inflammation were also cited.

The use of both species as fuel was reported by 81.7% respondents, with 96% as fuelwood and 4% as charcoal. The use of mirixis as fuelwood for the production of *cassava* flour is a very common practice observed in the field, together with copal wood (*Copaifera pubiflora* Benth.).

DISCUSSION

Juice and *in natura* consumption of *Byrsonima crassifolia* and *B. coccolobifolia* fruits was very common in the Darora Community. Similarly, the fruit consumption of both species is very common in the savanna region by both indigenous and non-indigenous people (Melo and Barbosa 2007; Barbosa *et al.* 2005). This consumption is based on the fact that the taste and the aroma (flavour) are quite unique, and fruits can be used in their pure form or in a variety of products, such as juice, ice cream, candy and liqueurs (Benezar and Pessoni 2006).

Darora residents regularly use the two *Byrsonima* species as medicinal products for digestive disorders, such as diarrhea and dysentery. This finding is in accordance with an extensive scientific documentation about the medicinal use of *Byrsonima* spp., including their anti-inflammatory, antimicrobial and

Table 2. Use categories and parts of mirixi plants (*Byrsonima crassifolia* and *B. coccolobifolia*) used in the Darora Community (Boa Vista, Roraima, Brazil). Number of respondents: 58 (38 men and 20 women). Age category < 40: seven women and 14 men; ≥ 40: 13 women and 24 men.

Use categories	Uses	Part of plant	Number of citations	Number of citations/ gender and age categories				
				Women		Men		
				< 40	≥ 40	< 40	≥ 40	
Medicinal	Diarrhea	Bark	26					
		Inner bark	3					
	Cuts	Bark	11					
		Inner bark	2					
	General inflammation	Bark	7	6	12	8	28	
		Inner bark	1					
		Sore throat	Bark	2				
		Uterus inflammation	Bark	1				
	Kidneys	Bark	1					
		<i>In natura</i> consumption	Fruit	15				
Food	Juice	Fruit	45	8	15	17	20	
	Fuelwood	Stem	49					
Fuel	Charcoal	Stem	3	4	14	12	22	
	Tincture	Bark	6	1	1	1	3	

antioxidant activities (Sannomiya *et al.* 2005; Michelin *et al.* 2008; Sousa *et al.* 2014). Some specific examples are the molluscidal action of *Byrsonima coccolobifolia* against *Biomphalaria glabrata*, and its effective bactericidal action against *Staphylococcus aureus*, *Bacillus cereus*, *Pseudomonas aeruginosa*, and *Escherichia coli* (Alves *et al.* 2000; Pereira 2011). For *B. crassifolia*, methanol extracted from leaves showed strong giardicidal activity (Amaral *et al.* 2006), while ethyl acetate extracted from roots proved to be effective against *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Shigella flexneri*, *Staphylococcus aureus*, *S. epidermidis*, *Micrococcus luteus* and *Streptococcus pneumoniae* (Martinez-Vazquez *et al.* 1999).

The two species are mostly used as source of energy for cooking in the Darora Community, since few homes use bottled gas for this purpose. In arid and semi-arid areas, the plants are also used as a source of energy for cooking food, especially where bottled gas is costly or difficult to be regularly obtained (Monteiro *et al.* 2006). In addition, use of *B. coccolobifolia* as fuelwood and charcoal, the species is also used as forage during animal feed shortage periods, as an ornamental plant, and as timber for furniture (Pott and Pott 1994).

The present results indicate that the knowledge on mirixis is evenly distributed among gender and age groups in the Darora community. Similarly, the knowledge on the tree species, *Stryphnodendron rotundifolium* Martius, showed no differences between gender and age groups in a community of the Brazilian Savanna (Feitosa *et al.* 2014). In arid environments, the knowledge of men and women is related to daily activities; women are the traditional holders of the knowledge on medicinal and food species (Voeks 2007), while men are the traditional holders of the knowledge on timber use (Silva *et al.* 2011; Monteiro *et al.* 2006). In contrast, the knowledge on the food species *Spondias tuberosa* Arruda was evenly distributed between men and women, despite gender differentiation in daily activities (Lins Neto *et al.* 2010).

Studies that indicate better knowledge on plant use among elder than among younger people are common (Monteiro *et al.* 2006). For instance, Hanazaki *et al.* (2000) carried out a study in two Caiçara communities in the Atlantic Forest, and observed that older people were more acquainted with craft and medicinal use of plants. The present study also showed no differences between age categories, despite a the slight trend for wider knowledge on *Byrsonima* among older men (55-70 years) and women (45-60 years) when compared with young inhabitants (see Figure 3). This suggests that the knowledge on plant species decreases after a certain age, as observed by Albuquerque *et al.* (2011), with the Fulni-ô indigenous people in Northeastern Brazil, and by Ayantunde *et al.* (2008), with ethnic groups in Southwestern Niger.

CONCLUSION

Mirixis, *Byrsonima crassifolia* and *B. coccolobifolia*, are used for different purposes in the food, fuel and medicinal categories in the Darora Indigenous Community. The knowledge on the indigenous people in Darora on mirixis is evenly distributed among gender and age groups.

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REFERENCES

- Aguiar Jr, A.; Barbosa, R.I.; Barbosa, J.B.F.; Mourão Jr, M. 2014. Invasion of *Acacia mangium* in Amazonian savannas following planting for forestry. *Plant Ecology and Diversity*, 7: 359-369.
- Albuquerque, U.P.; Lucena, R.F.P.; Lins-Neto, E.M.F. 2014. Selection of research participants. In: Albuquerque, U.P.; Cunha, L.V.F.C.; Lucena, R.F.P.; Alves, R.R.N. (Ed.) *Methods and techniques in Ethnobiology and Ethnoecology*. Springer Protocols Handbooks, New York, p.1-13.
- Albuquerque, U.P.; Soldati, G.T.; Sieber, S.S.; Ramos, M.A.; Sá, J.C.; Souza, L.C. 2011. The use of plants in the medical system of the Fulni-ô people (NE Brazil): A perspective on age and gender. *Journal of Ethnopharmacology*, 133: 866-873.
- Almeida, C.F.C.B.R.; Ramos, M.A.; Silva, R.R.V.; Melo, J.G.; Medeiros, M.F.T.; Araújo, T.A.S.; Almeida, A.L.S.; Amorim, E.L.C.; Alves, R.R.N. Albuquerque, U.P. 2012. Intracultural variation in the knowledge of medicinal plants in an urban-rural community in the Atlantic forest from Northeastern Brazil. *Evidence-based Complementary and Alternative Medicine*, 2012: 679373.
- Alves, T.M.; Silva, F.A.; Brandão, M. *et al.* 2000. Biological screening of Brazilian medicinal plants. *Memórias do Instituto Oswaldo Cruz*, 95: 367-373.
- Amaral, F.M.M.; Ribeiro M.N.S.; Barbosa-Filho, J.M.; Reis, A.S.; Nascimento, F.R.F.; Macedo, R.O. 2006. Plants and chemical constituents with giardicidal activity. *Revista Brasileira de Farmacognosia*, 16: 696-720.
- Angiosperm Phylogeny Group IV. 2016. An update of the Angiosperm Phylogeny Group classification for orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society*, 181: 1-20.
- Ayantunde, A.A.; Briejer, M.; Hiernaux, P.; Udo, H.M.J.; Tabo, R. 2008. Botanical knowledge and differentiation by age,

- gender and ethnicity in Southwestern Niger. *Human Ecology*, 36: 881-889.
- Barbosa, C.Z.R.; Mendonça, M.S.; Rodrigues, R.S. 2014. Seedling morphology of three sympatric savanna species of *Byrsonima*: First evidence of cryptogeal germination in Malpighiaceae and an overlooked seedling type in eudicots. *Flora*, 209: 401-407.
- Barbosa, R.I. 1997. Distribuição das chuvas em Roraima. In: Barbosa, R.I., Ferreira, E.J., Castellon, E.G. (eds.) *Homem, Ambiente e Ecologia no Estado de Roraima*. Instituto Nacional de Pesquisas da Amazônia. Manaus, Amazonas, p.325-335.
- Barbosa, R.I.; Campos, C.; Pinto, F.; Fearnside, P.M. 2007. The "Lavrados" of Roraima: Biodiversity and Conservation of Brazil's Amazonian Savannas. *Functional Ecosystems and Communities*, 1: 29-41.
- Barbosa, R.I.; Campos, C. 2011. Detection and geographical distribution of clearing areas in the savannas ('lavrado') of Roraima using Google Earth web tool. *Journal of Geography and Regional Planning*, 4: 122-136.
- Barbosa, R.I.; Fearnside, P.M. 2005. Fire frequency and area burned in the Roraima savannas of Brazilian Amazonia. *Forest Ecology and Management*, 204: 371-384.
- Barbosa, R.I.; Mourão Jr, M.; Silva, S.J.R. 2005. *Fenologia do mirixi [Byrsonima crassifolia (L.) H.B.K. (Malpighiaceae)] em áreas de savana aberta do estado de Roraima*. Comunicação técnica nº14. Empresa Brasileira de Pesquisa Agropecuária, Boa Vista, Roraima, 6p.
- Barbosa, R.I.; Nascimento, S.P.; Amorim, P.A.F.; Silva, R.F. 2005. Notas sobre a composição arbóreo-arbustiva de uma fisionomia das savanas de Roraima, Amazônia Brasileira. *Acta Botanica Brasílica*, 19: 323-329.
- Benezar, R.M.C.; Pessoni, L.A. 2006. Biologia floral e sistema reprodutivo de *Byrsonima coccolobifolia* (Kunth) em uma savana amazônica. *Acta Amazonica*, 36: 159-168.
- Byg, A.; Balslev, H. 2001. Diversity and use of palms in Zahamena, eastern Madagascar. *Biodiversity and Conservation*, 10: 951-970.
- Camou-Guerrero, A.; Reyes-García, V.; Martínez-Ramos, M.; Casas, A. 2008. Knowledge and use value of plant species in a Rarámuri community: A gender perspective for conservation. *Human Ecology*, 36: 259-272.
- Eden, M. 1970. Savanna vegetation in the northern Rupununi, Guyana. *Journal of Tropical Geography*, 30: 17-28.
- Feitosa, I.S.; Albuquerque, U.P.; Monteiro, J.M. 2014. Knowledge and extrativism of *Stryphnodendron rotundifolium* Mart. in a local community of the Brazilian Savanna, Northeastern Brazil. *Journal of Ethnobiology and Ethnomedicine*, 10: 64.
- Flores, A.S.; Rodrigues, R.S. 2010. Diversidade de Leguminosae em uma área de savana do estado de Roraima, Brasil. *Acta Botanica Brasílica*, 24: 175-183.
- Guéze, M.; Luz, A.C.; Paneque-Gálvez, J.; Macía, M.J.; Orta-Martínez, M.; Pino, J.; Reys-García, V. 2014. Are ecologically important tree species the most useful? A case study from indigenous people in the Bolivian Amazon. *Economic Botany*, 20: 1-15.
- Hanazaki, N.; Tamashiro, J.Y.; Leitão-Filho, H.F.; Begossi, A. 2000. Diversity of plant use in two caíçara communities from the Atlantic Forest coast, Brazil. *Biodiversity and Conservation*, 9: 597-615.
- Heck, E.; Loebens, F.; Carvalho, P.D. 2005. Amazônia indígena: conquistas e desafios. *Estudos Avançados*, 19: 237-255.
- Lins Neto, E.M.F.; Ramos, M.A.; Oliveira, R.L.C.; Albuquerque, U.P. 2008. The Knowledge and harvesting of *Myracrodruon urundeuwa* Allemão by Two Rural Communities in NE Brazil. *Functional Ecosystems and Communities*, 2: 66-71.
- Lins Neto, E.M.F.; Peroni, N.; Albuquerque, U.P. 2010. Traditional knowledge and management of umbu (*Spondias tuberosa*, Anacardiaceae): an endemic species from the semi-arid region of Northeastern Brazil. *Economic Botany*, 64: 11-21.
- Lucena, R.F.P.; Medeiros, P.M.; Araújo, E.L.; Alves, A.G.C.; Albuquerque, U.P. 2012. The ecological apparency hypothesis and the importance of useful plants in rural communities from Northeastern Brazil: an assessment based on use value. *Journal of Environmental Management*, 96: 106-115.
- Martinez-Vasquez, M.; Gonzalez-Esquinca, A.R.; Cazares-Luna, L.; Moreno-Gutierrez, M.N.; Garcia-Argáez, A.N. 1999. Antimicrobial activity of *Byrsonima crassifolia* (L.) H.B.K. *Journal of Ethnopharmacology*, 66: 79-82.
- Melo, M.C.; Barbosa, R.I. 2007. Árvores e arbustos das savanas de Roraima – Guia de Campo Ilustrado. 1st ed. PMBV/ CONSEMMA, Boa Vista, 36p.
- Michelin, D.C.; Sannomiya, M.; Figueiredo, M.E.; Rinaldo, D.; Santos, L.C.; Souza-Brito, A.R.M.; Vilegas, W.; Salgado, H.R.N. 2008. Antimicrobial activity of *Byrsonima* species (Malpighiaceae). *Brazilian Journal of Pharmacognosy*, 18: 690-695.
- Miranda, I.S.; Absy, M.L. 2000. Fisionomia das Savanas de Roraima, Brasil. *Acta Amazonica*, 3: 423-441.
- Miranda, I.S.; Absy, M.L.; Rebêlo, G.H. 2002. Community Structure of Woody Plants of Roraima Savannas, Brazil. *Plant Ecology*, 164:109-123.
- Monteiro, J.M.; Almeida, C.F.C.B.R.; Albuquerque, U.P.; Lucena, R.F.P.; Florentino, A.T.N.; Oliveira, R.L.C. 2006. Use and traditional management of *Anadenanthera colubrina* (Vell.) Brenan in the semi-arid region of northeastern Brazil. *Journal of Ethnobiology and Ethnomedicine*, 2:1-7.
- Monteiro, J.M.; Albuquerque, U.P.; Lins Neto, E.M.F.; Araújo, E.L.; Amorim, E.L.C. 2006. Use patterns and knowledge of medicinal species among two rural communities from northeastern Brazil's semi-arid region. *Journal of Ethnopharmacology*, 105: 173-186.
- Müeller-Dombois, D.; Ellenberg, H. 1974. *Aims and methods of vegetation ecology*. John Wiley & Sons, New York, 574p.
- Neves, L.C.; Silva, P.M.C.; Lima, C.G.B.; Bastos, V.J.; Roberto, S.R. 2015. Study to determine the optimum harvest date of Murici (*Byrsonima coccolobifolia* Kunth.) from quality and functional attributes. *Scientia Horticulturae*, 188: 49-56.
- Pereira, V.V. 2011. *Estudo fitoquímico de Byrsonima coccolobifolia Kunth (Malpighiaceae) e de atividade biológica de espécies do gênero Byrsonima*. Masters thesis, Universidade Federal dos Vales do Jequitinhonha e Mucuri, Diamantina, Minas Gerais. 126 p.

- Perez, I.U. 2010. *Uso dos Recursos Naturais vegetais na Terra Indígena Anaçá, Roraima*. Masters thesis, Universidade Federal de Roraima, Boa Vista, Roraima. 80p.
- Pott, A.; Pott, V.J. 1994. *Plantas do Pantanal*. Empresa Brasileira de Pesquisa Agropecuária, Corumbá, Mato Grosso. 320 p.
- Rezende, C.M.; Fraga, S.R.G. 2008. Chemical and Aroma Determination of the Pulp and Seeds of Murici (*Byrsonima crassifolia* L.). *Journal of the Brazilian Chemical Society*, 14: 425-428.
- Sannomiya, M.; Michelin, D.C.; Rodrigues, C.M.; Santos, L.C.; Salgado, H.R.N.; Hiruma-Lima, C.A.; Souza-Brito, A.R.M.; Vilegas, W. 2005. *Byrsonima crassa* Niedenzu (IK): antimicrobial activity and chemical study. *Revista de Ciências Farmacêuticas Básica e Aplicada*, 26: 71-75.
- Silva, F.S.S.; Ramos, M.A.; Hanazaki, N.; Albuquerque, U.P. 2011. Dynamics of traditional knowledge of medicinal plants in a rural community in the Brazilian semi-arid region. *Revista Brasileira de Farmacognosia*, 21: 382-391.
- Sousa, L.R.F.; Ramalho, S.D.; Fernandes, J.B.; Silva, M.F.G.F.; Iemma, M.R.C.; Corrêa, C.J.; Souza, D.H.F.; Lima, M.I.S.; Vieira, P.C. 2014. Leishmanicidal galloylquinic acids are noncompetitive inhibitors of arginase. *Journal of the Brazilian Chemical Society*, 25: 1832-1838.
- Voeks, R.A. 2007. Are women reservoirs of traditional plant knowledge? Gender, ethnobotany and globalization in northeast Brazil. *Singapore Journal of Tropical Geography*, 28: 7-20.

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