UNIVERSIDADE FEDERAL RURAL DE PERNAMBUCO

PRÓ-REITORIA DE PESQUISA E PÓS-GRADUAÇÃO

PROGRAMA DE PÓS-GRADUAÇÃO ETNOBIOLOGIA E CONSERVAÇÃO DA NATUREZA

O EMPREGO MEDICINAL DE ESPÉCIES LENHOSAS PROTEGE-AS DA PRESSÃO PARA USOS MADEIREIROS?

JÉSSIKA PRISCILA COSTA DA SILVA

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ABSTRACT

Several ethnobiological studies have been showing the impacts of the extraction of timber forest products and indicate some factors that may contribute to the selection of plant species by local populations, such as the availability, and physical-chemical attributes of the species. However, little is known about the interactive effect between local uses, that is, how the use of a species for a given purpose can affect its use for another purpose. In this sense, we propose the hypothesis that species of high importance in a category of more specialized use may have their use reduced to other categories with a more general nature. For this study, we will investigate the interaction between medicinal and timber use, seeking to test the following prediction: woody plants of high medicinal importance are less used for timber purposes than other woody plants, as the first use protects them from the latter. To this end, the investigation was carried out in three rural communities, located within the National Park of Catimbau, in the state of Pernambuco. The free-list technique was applied to identify the woody plants used as medicinal in the community. The interviewees checked grades for the species according to their perceived efficiency for timber purposes and their perceived local availability. For data analysis, a GLM (Poisson family) was performed, whose response variable was the species' timber popularity and the explanatory variables were medicinal popularity, perceived availability and perceived efficiency. Correlations were also performed between the variables explained to observe possible biases in the hypothesis test. Our results point to a small, but significant, protective effect of medicinal use over wood use, which is evidence favorable to the hypothesis. The variables availability and perceived efficiency proved to be important predictors of timber use. The correlations between the explanatory variables ruled out the possibility of bias in the hypothesis test. In this way, the maintenance of the medicinal importance of certain species can constitute an important biocultural conservation strategy.

Keywords: Biocultural conservation, use of plant resources, interaction of uses.

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RESUMO

Diversos estudos etnobiológicos têm demonstrado os impactos da extração de produtos florestais madeireiros e indicam alguns fatores que podem contribuir para a seleção de espécies vegetais pelas populações locais, como disponibilidade e atributos físico-químicos das espécies. No entanto, pouco se sabe sobre o efeito interativo entre os usos locais, ou seja, como o uso de uma espécie para uma determinada finalidade pode afetar seu uso para outra finalidade. Portanto, propomos a hipótese de que espécies de alta importância em uma categoria de uso mais especializado podem ter seu uso reduzido para outras categorias de natureza mais generalista. Para este estudo, investigaremos a interação entre uso medicinal e lenhoso, tentando testar a seguinte previsão: plantas lenhosas de alta importância medicinal são menos utilizadas para fins lenhosos do que outras plantas lenhosas, uma vez que o primeiro uso as protege do último, Por Para tanto, a pesquisa foi desenvolvida em três comunidades rurais, localizadas dentro do Parque Nacional do Catimbau, no estado de Pernambuco. A técnica de listagem livre foi aplicada para identificar as plantas lenhosas utilizadas como medicamentos na comunidade. Os entrevistados atribuíram notas às espécies de acordo com sua eficiência percebida para fins madeireiros e sua disponibilidade local percebida. Para analisar os dados, foi realizado um GLM (família Poisson), cuja variável resposta foi a popularidade da madeira da espécie e as variáveis explicativas foram a popularidade medicinal, a qualidade percebida para fins de madeira e a disponibilidade e disponibilidade percebidas. Também foram feitas correlações entre os variáveis explicativas para busca de possíveis vieses no teste de hipótese. Nossos resultados indicam um efeito protetor pequeno, mas significativo, do uso medicinal sobre o uso da madeira, o que é uma evidência favorável para a hipótese de proteção. As variáveis percepção de disponibilidade e eficiência foram importantes preditores do uso da madeira. Correlações entre as variáveis explicativas afastaram a possibilidade de viés no teste de hipótese. Desta forma, manter a importância medicinal de certas espécies pode constituir uma importante estratégia de conservação biocultural.

Palavras-chave: Conservação biocultural, uso de recursos vegetais, interação de usos.

1. INTRODUÇÃO

Vários estudos etnobotânicos tentam entender quais fatores interferem na seleção de recursos vegetais por parte das populações locais, bem como sua importância biocultural (Silva et al., 2007; Albuquerque, 2013; Gonçalves et al., 2016). Para fins madeireiros, destacam-se a disponibilidade (Tabuti, 2006; Cardoso et al., 2012) e a qualidade da madeira (Silva, 2002; Ramos et al., 2007). Para o uso medicinal, a literatura tem evidenciado um importante papel da eficiência percebida (Ferreira Júnior; Ladio; Albuquerque, 2011; Molares; Ladio, 2014), da eficiência mensurada por parâmetros fitoquímicos e farmacológicos (Omar et al., 2000; Araújo et al., 2008) e das propriedades organolépticas (Shephad Jr. 2004;).

Desse modo, em se tratando de critérios de seleção, percebe-se que cada categoria de uso possui características particulares, e essas podem mudar de acordo com os contextos socioculturais e ambientais (Ramos et al., 2007; Chettri e Sarma, 2009; Fonseca Filho et al., 2016). Um exemplo desses critérios foi o primeiro teste da hipotese da aparência aplicada à etnobotânica por Phillips e Gentry (1993). Os autores relacionaram a disponibilidade do recurso com a importância local para as pessoas. Sendo assim, as plantas mais disponíveis (aparentes) teriam uma maior chance de serem experimentadas e adicionadas ao sistema cultural (Phillips e Gentry, 1993).

Um estudo recente de meta-análise sobre esta hipotese mostrou que a disponibilidade é muito mais importante para os usos madeireiros do que, por exemplo, para o uso medicinal (Gonçalves et al., 2016). Essa menor importância da disponibilidade como critério de seleção de plantas medicinais indica um caráter mais especializado deste uso, já que ele está muitas vezes ligado à presença de determinados compostos bioativos. Já os usos madeireiros, em sua maioria, tendem a ser mais generalistas, de maneira que mais espécies possam ser úteis (Medeiros, 2010).

Ainda que existam muitos estudos etnobotânicos sobre critérios de seleção de espécies vegetais, a literatura carece de estudos sobre interação entre os usos, ou seja, como o emprego de uma planta para um dado fim pode influenciar no seu uso para outra finalidade. Diante disso, propomos a hipótese segundo a qual espécies com alta importância em uma categoria de uso mais especializada podem ter seu uso reduzido para uma categoria mais generalista, uma vez que outras espécies possam ser úteis para esta última finalidade. Esperamos que plantas lenhosas de alta importância medicinal sejam menos usadas para fins madeireiros do que outras plantas lenhosas, pois o primeiro uso protege-as do último.

Neste trabalho buscamos compreender se espécies com alta importância medicinal estão sendo protegidas de usos mais destrutivos por populações locais, e assim propor abordagens de conservação biocultural, reconhecendo, no entanto, a necessidade de abordagens diferentes para contextos socioambientais distintos.

1. REVISÃO DE LITERATURA

Esta revisão retrata o conhecimento e uso de plantas úteis por comunidades locais. Primeiramente, são apresentados aspectos relativos às diferenças nos critérios de seleção de plantas. No segundo tópico são discutidos impactos dos recursos madeireiros e não-madeireiros, ficando evidente que os usos das categorias alimentícias e medicinais tendem a apresentar menor impacto, em virtude da influência da parte utilizada e intensidade.

2.1 Critérios de seleção de plantas úteis

2.1.1 Critérios de seleção de plantas medicinais

A disponibilidade vem sendo apontada como preditora do uso de espécies medicinais. A exemplo disso, um estudo verificou que o maior uso medicinal estava atrelado a uma maior facilidade em localizar a planta perto de casa (LUCENA et al., 2008). O mesmo foi evidenciado por Oliveira e Menini Neto (2012), correlacionando a facilidade de coleta com o uso frequente de folhas, devido a sua disponibilidade. Entretanto, uma meta-analise da hipótese da aparência mostrou que a variável disponibilidade não é tão importante para espécies medicinais (GONÇALVES et al., 2016), já que, quando são reunidos todos os estudos que já foram realizados sobre o tema, essa variável não possui um poder preditivo significativo sobre a categoria acima mencionada.

Um fator bastante importante na seleção de plantas medicinais é a eficiência química. Neste sentido, Araújo et al. (2008) observaram, em estudo realizado no semiárido brasileiro, que as plantas mais importantes para inflamação e cicatrização foram justamente as que possuíam maiores teores de taninos. Além disso, uma relação entre importiancia da planta e atividade antimicrobiana foi encontrada em estudo com povos indígenas norte-americanos (Omar et al., 2000).

A cultura também exerce grande influência nos critérios de seleção, sendo ela um fator-chave, por definir se a espécie serve para fins medicinais ou não, mas também para determinar a intensidade de uso e a sua importância cultural (ANKLI et al., 1999; MEDEIROS et al., 2016). Algumas espécies podem deixar de ser utilizadas como medicinais em determinados períodos ou por determinados grupos de pessoas, mesmo possuindo repertório químico que sustente seu uso, por elas estarem revestidas por tabus culturais (Monica et al., 2016).

Algumas características organolépticas, como o sabor, o odor, e a textura, exercem grande influência na seleção de plantas medicinais (SHEPHAD Jr. 2004). Com relação ao sabor, destaca-se nos sistemas médicos o amargo, de maneira que a maioria das espécies medicinais utilizadas por diferentes populações humanas são indicadas com sabor amargo pelas pessoas (ANKLI et al., 1999; BRETT, 1998; HEINRICH et al., 1992).

2.1.2 Critérios de seleção de plantas madeireiras

A maioria dos critérios abordados nos estudos etnobotânicos foca na categoria medicinal. Entretanto, estudos também relatam os critérios para seleção de espécies madeireiras. Dentre eles, a disponibilidade e a eficiência são os mais representativos (TABUTI; DHILION, LYE, 2003; RAMOS et al., 2008).

Para a categoria madeireira, estudos etnobotânicos relatam sobre o uso de espécies vegetais lenhosas para diversas finalidades. Medeiros (2010) encontrou dois padrões de usos distintos para lenha: (1) padrão especializado, com plantas especificas selecionadas pela sua qualidade e (2) padrão generalista, com a utilização de espécies mais disponíveis no ambiente, sejam elas de boa qualidade para combustível ou não.

Um estudo comparou os usos de diversas categorias madeireiras e verificou que as duas comunidades de Angical, no Piauí levam em consideração qualidade dos recursos vegetais como um critério de seleção (Da Fonseca Filho et al., 2016). Outro estudo verificou que o critério de seleção para combustível também foi a qualidade, relatando atributos químicos específicos (CHETTRI e SARMA, 2009). Ramos et al., (2008) observaram que a durabilidade da madeira, o poder calorífico e sua facilidade em queimar explicaram o uso combustível das espécies vegetais.

A disponibilidade local é um fator importante para explicar a seleção de espécies empregadas como combustível (utilizadas para lenha e carvão vegetal) e também para construção (casas, cercas, etc.), como indicado por uma meta-análise a respeito da hipótese da aparência (Gonçalves et al., 2016). No entanto, no mesmo estudo, a disponibilidade não explicou o emprego destas para tecnologias (fabricação de objetos). Assim sendo, a importância da disponibilidade para a maior parte dos fins madeireiros indica que este uso costuma ser mais generalista que outros usos como o medicinal.

Diferente de outras categorias, tecnologia apresenta usos mais especializados, com poucas espécies utilizadas para a produção de objetos (LUOGA et al., 2000; AGUILAR; CONDIT, 2001). Assim, fica claro que, para algumas categorias madeireiras, além da disponibilidade, os atributos físico-químicos, são também importantes, como a qualidade da madeira.

2.2 Usos e impactos: produtos madeireiros e não-madeireiros

2.2.1 Produtos florestais não-madeireiros

Os recursos florestais não madeireiros são todos os recursos encontrados na floresta, como flores, frutos, cascas, galhos entre outros, com exceção da madeira (SOLDATI & ALBUQUERQUE, 2010). Tais recursos representam uma substancial fonte de renda e alimentação de várias populações que vivem da extração desses recursos em vários países (WUNDER, 1998).

Arnold e Perez (2001) verificaram que o uso dos recursos não madeireiros pode contribuir para conservação de florestas tropicais, pois o mesmo não afeta tanto as populações vegetais. Além disso, a importância comercial de certos recursos não-madeireiros pode aumentar o valor dessas florestas.

Entretanto, quando a coleta desse recurso é feita de forma desordenada, pode afetar a estrutura e dinâmica populacional das espécies submetidas ao extrativismo. E o resultado mais direto é a diminuição das taxas de crescimento e reprodução dos indivíduos (TICKTIN, 2004). Assim, o impacto da exploração vai depender da parte que é explorada e do potencial de regeneração da espécie (CAMPOS et al., 2016).

A coleta de frutos, quando feita de forma não sustentável, pode diminuir o processo de disseminação da espécie, afetando seu recrutamento. A exemplo disso, temos o estudo de Almeida et al., (2011), que observou que a coleta do fruto do buriti (*Mauritia flexuosa* L.) e fibras das piaçavas (*Aphandranatalia* [Balslev& A.J. Hend.]Barfod) mostrou-se altamente danosa, causando a mortalidade em plantas adultas das espécies.

Devido a alta preferência por certos recursos não madeireiros em algumas comunidades, espécies vegetais podem ter sua população reduzida drasticamente e podem até ser extintas localmente. Por exemplo, o estudo de Stewart (2009) feito em Camarões, encontrou uma alta mortalidade de indivíduos férteis, refletindo na diminuição de frutos e no baixo recrutamento de plântulas, sinalizando que a continuação da coleta de cascas da espécie *Prunus africana* (Hook. f.) Kalkman torna-se uma ameaça para a espécie.

Outro caso semelhante foi estudado por Pinheiros (2001), que observou uma grande mudança no Maranhão, onde o jaborandi (*Pilocarpus microphyllus* Stapfex ex. Holm) era um recurso natural que beneficiava muitas pessoas na zona rural, foi privatizado. A expansão de pilocarpina (um alcaloide de uso oftalmológico) caminhou para um esgotamento e ameaça de extinção ao recurso vegetal.

2.2.2 Produtos florestais madeireiros

Já dentre os recursos florestais madeireiros, destaca-se a extração de madeira para obtenção de lenha. Quando a coleta é feita com o indivíduo vivo (madeira verde), ela é considerada uma das formas de uso mais danosas à biodiversidade florestal (TABUTI et al., 2003; FAO, 2003). Estudos demonstram que as principais causas de extinção de espécies lenhosas são as taxas de crescimento da população humana e da pobreza (JHA & BAWA 2006, FAO 2009). Esse crescimento acaba forçando as pessoas a adotarem métodos insustentáveis (BAILLIE et al. 2004; AUGUSSEAU et al. 2006).

Um estudo feito em Balawoli na Ugandapor Tabuti (2012) observou que a escassez de várias espécies de plantas lenhosas foi devido ao tipo de corte mais destrutivo (corte raso) que a população local adotava.

O estudo de DaFonsecaFilho (2016), verificou que dentro da categoria madeireira, os usos para construção e fitocombustível foram os mais citados. E as espécies mais citadas foram as que possuíam alta versatilidade, ou seja, eram utilizadas em várias categorias. Essa observação pode indicar que as espécies preferidas na comunidade podem estar sofrendo pressão de uso.

Cavalcanti et al., (2015) estudou os efeitos da extração de lenha para a produção de óleo de pequi (*Caryocar coriaceum*Wittm.). Este estudo demonstrou que eram conhecidas 28 espécies de 10 famílias botânicas para a produção do óleo. Entretanto, evidenciou que apenas 14 (50%) espécies eram usadas como combustível para a produção do óleo, constatando que existe uma pressão maior nesse grupo de espécies.

Alguns estudos identificaram espécies com múltiplos usos e hipotetizaram que essas espécies podem estar sofrendo pressão de uso, devido a sua versatilidade (LUOGA et al., 2000; DONALDSON e SCOTT, 1994). Porém, a maioria desses estudos, que relacionaram espécies preferidas com pressão de uso não testou se os múltiplos usos estão interferindo nas populações vegetais (ver PRANCE et al., 1987; KALA, 2007; SAMANT et al., 2000; CHETTRI et al., 2002; RAMOS et al., 2008).

Sendo assim, por mais que os usos madeireiros e não madeireiros tenham impactos, o corte raso da madeira tem efeitos mais danosos, por se tratar de coleta mais destrutiva. E os trabalhos já mencionados aqui, mostram que a preferência por certas espécies pode ter efeitos drásticos nas populações vegetais.

2. REFERÊNCIAS

AGUILAR, S., CONDIT, R. Use of native tree species by an Hispanic community in Panama. **Economic Botany**, v. 55, n. 2, p. 223-235. 2001.

ALBUQUERQUE, U. P. de. et al. Medicinal plants of the Caatinga (semi-arid) vegetation of NE Brazil: A quantitative approach. **Journal of Ethnopharmacology,** v. 114, p.325–354, 2007.

ALBUQUERQUE, U.P. de. et al.. Etnobiologia: Bases ecológicas e evolutivas 1. Ed. (1ª) 2013. ALBUQUERQUE, U.P. de. et al. Pode o ambiente influenciar as nossas escolhas sobre o uso de recursos naturais? Evidência da aparência**.**1 ed**.** Recife: Editora NUPEEA, p., 102–126, 2013.

ALBUQUERQUE, U.P. et al. Introdução a Etnobiologia 1. Ed. (1ª). 2013. CAMPOS, J. L. A. et al. O manejo e a domesticação da natureza: O extrativismo de recursos vegetais.1ª Recife: Editora NUPEEA, p.,143-150, 2015.

SILVA, ALMEIDA, G. da. et al. Levantamento dos impactos ambientais causados pelo extrativismo na área sul do parque nacional serra do divisor – ACRE. Enciclopédia Biosfera, Centro Científico Conhecer - Goiânia, vol.7, N.13; pág. 1220. 2011.

ANKLI, A; STICKER, O. HEINRICK, M. Yucatec Maya plants versus non medicinal plants: indigenous charecterization and selection. **Human Ecology,** 27(4): 557-580. 1999.

ARAÚJO, T.A.S. et al. Anew approach to study medicinal plants with tannins and flavonoids contents from the local knowledge. **Journal of Ethnopharmacology**, v.120, p. 72-80, 2008.

BENNETT, B.C; PRANCE, G.T. Introduced plants in the indigenous pharmacopoeia of Northern South America. **Economic Botany**, v.54, p.90–102, 2000.

CAVALCANTI, M. C. B. T et al. Implications from the Use of Non-timber Forest Products on the Consumption of Wood as a Fuel Source in Human-Dominated Semiarid Landscapes. **Environmental Management** (New York), v. 56, p. 389-401, 2015.

CHETTRI, N; SARMA, E. A scientific assessment of traditional knowledge on firewood and fodder values in Sikkim, India. **Forest Ecology and Management**. v.257, p. 2073-2078, 2009.

CLEMENT, Y. N. et al. Perceived efficacy of herbal remedies by users accessing primary healthcare in Trinidad. **BMC Complementary and Alternative Medicine**, v.7, n.4, 2007.

CRUZ, M.P. et al. “I eat the manofe so it is not forgotten”: local perceptions and consumption of native wild edible plants from seasonal dry forests in Brazil. **Journal of Ethnobiology and Ethnomedicine,** v. 10, p. 1-11. 2014.

DA FONSECA FILO, Irineu Campelo et al. Uso de recrusos madeireiros em duas comunidades rurais de Angical do Piauí/PI, Brasil. **Desenvolvimento e Meio Ambiente**, V. 38, ago. 2016. ISSN 2176-9109.

DONALDSON, J.S; SCOTT, G. Aspects of human dependence on plant diverty in the Cape Mediterranean-type ecosystem. **South Africa Journal of Science**. V.90, p. 338-342, 1994.

FAO. State of the World's Forests. Food and Agriculture Organization of the United Nations, Rome, Italy. 2009.

FAO. Wood energy. Promoting sustainable energy systems. Forest products division. Rome, oct, 2003.

FERREIRA JÚNIOR, W.S., LADIO, A.H., ALBUQUERQUE, U.P. Resilience and adaptation in the use of medicinal plants with suspected anti-inflammatory activity in the Brazilian Northeast. **Journal of Ethnopharmacology,** v. 138,238–252, 2011.

GONÇALVES, P. H. S., ALBUQUERQUE, U. P., and MEDEIROS, P. M. de. The most commonly available woody plant species are the most useful for human populations: a meta-analysis. **Ecological Applications**, 26(7), 2016, pp. 2238–2253.

KAKUDIDI, E. K. A study of plant materials used for house construction around Kibale National Park, western Uganda. **African Journal of Ecology** 45.2007.

KHAFAGI, I. K; DEWEDAR, A. The efficiency of random versus ethno-directed research in the evaluation of sinai medicinal plants for bioactive compounds. **Journal of Ethnopharmacolgy**71: 265-375. 2000.

KRISTENSEN, M.K; LYKKE, A.M. Informant-based valuation of use and conservation preferences of savanna trees in Burkina Faso. **Economic Botany**, v. 57, n. 2, p. 203-217, 2003.

LADIO, A. H; LOZADA, M. Edible wild plant use in a Mapuche Community of north-western Patagonia. **Human Ecology** 28, 53-71. 2000.

LUCENA, Reinaldo Farias Paiva de et al. Local Uses of Native Plants in an Area of Caatinga Vegetation (Pernambuco, NE Brazil). **Ethnobotany Research and Applications**, v. 6, p. 003-014, apr. 2008. ISSN 1547-3465.

LUOGA, E.J; WITKOWSKI, E.T.F; BALKWILL, K. Differential utilization and ethnobotany of trees in Kitulanghalo forest reserve and surrounding communal lands, Eastern Tanzania. **Economic Botany**, v. 54, n. 3, p. 328-343. 2000.

MEDEIROS, Patrícia Muniz de. Uso de produtos madeireiros para fins domésticos em uma área de Floresta Atlântica no noroeste brasileiro. Tese (Dutorado em Botânica). Universidade Federal Rural de Pernambuco. 2010.

MOLARES, S; LADIO, A. Medicinal plants in the cultural landscape of a Mapuche-Tehuelche community in arid Argentine Patagonia: an eco-sensorial approach. **Journal of Ethnobiology and Ethnomedicine**, v. 10, n. 61, 2014.

MORALES, S; LADIO, A. Chemosensory perception and medicinal plants for digestive aliments in a Mapuche Community in NW Patagonia, Argentina. **Journal of Ethnopharmacology** 123(3): 397-406. 2009.

MONICA, K.C. et al. Traditional Controls of Harvesting and Conserving Medicinal Plants in Keiyo South Sub-County, Kenya.**International Journal of Humanities and Social Science**, v. 6, n. 11, 2016.

OLIVEIRA, E.R; MENINI-NETO, L. Levantamento etnobotânico de plantas medicinais utilizadas pelos moradores do povoado de Manejo, Lima Duarte – MG. **Revista Brasileira de Plantas Medicinais**. v.14, n.2, p.311-320, 2012.

RAMOS, M. A. et al. Use and knowledge of fuelwood in an area of Caatinga vegetation in NE Brazil. **Biomass and Bioenergy**, v. 32, n. 6, p. 510–517, 2008.

RAMOS, MARCELO ALVES. **Plantas usadas como combustível em uma área de caatinga (Nordeste do Brasil): seleção de espécies, padrões de coleta e qualidade do recurso.** Dissertação (mestrado em ciências florestais) Universidade Federal Rural de Pernambuco. 2007.

STEWART, K. Effects of bark haverst and other human activity on populations of the African cherry (*Prumus Africana*) on Moun Oku, Cameroon. **Forest Ecology and Management**. V.258, p. 1121-1128, 2009.

TABUTI, J.R.S; DHILLION, S.S; Lye, K.A. Traditional herbal drugs of Bulamogi, Uganda: plants, use and administration. **Journal of Ethnopharmacology**, v. 88: 19–44. 2003.

TICKTIN, T. The ecological implications of harvesting non-timber forest products. **Journal of Applied Ecology**, 41, 11-21, 2004.

WUNDER, S. Value determinants of plant extractivism in Brazil. Rio de Janeiro: **IPEA (Instituto de Pesquisa Econômica Aplicada)**, 1998.

PINHEIRO, Claudio Urbano B. Extrativismo, cultivo e privatização do jaborandi (PilocarpusmicrophyllusStapfexHolm.; Rutaceae) no Maranhão, BrasilExtrativismo, cultivo e privatização do jaborandi (PilocarpusmicrophyllusStapfexHolm.; Rutaceae) no Maranhão, Brasil. **Acta Bot. Bras.**, São Paulo , v. 16, n. 2, p. 141-150, Apr. 2002.

O uso medicinal pode proteger as espécies de plantas do uso da madeira? Evidências do Nordeste do Brasil

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Can medicinal use protect plant species from wood uses? Evidence from Northeastern Brazil

JESSIKA PRISCILA COSTA DA SILVA[1], PAULO HENRIQUE GONÇAVES[2], ULYSSES PAULINO ALBUQUERQUE[3], RAFAEL RICARDO VASCONCELOS DA SILVA[4], PATRÍCIA MUNIZ DE MEDEIROS[5]*

[1]Programa de Pós-graduação em Etnobiologia e Conservação da Natureza (PPGETNO), Universidade Federal Rural de Pernambuco, Brazil
[2,3]Laboratório de Ecologia e Evolução de Sistemas Socioecológicos, Departamento de Botânica, Universidade Federal de Pernambuco (UFPE), Brazil
[4,5] Centro de Ciências Agrárias, Universidade Federal de Alagoas, Brazil

*Autor para correspondência: Laboratório de Ecologia, Conservação e Evolução Biocultural (LECEB), Centro de Ciências Agrárias, Universidade Federal de Alagoas, BR 104, Mata do Rolo, 57100000, Rio Largo, Alagoas, Brasilpatricia.muniz@gmail.com

Highlights

- Previous studies have not investigated the interactive effects between use-categories in social-ecological systems
- Being valuable as medicinal for domestic purposes decreases the collection and use of native species for woody purposes.
- Other factors (perceived efficiency and availability) are more important than medicinal popularity in defining woody use.
- This protective effects of specialized over generalist uses should be tested under other social-ecological contexts.

ABSTRACT

Several ethnobotanical studies have attempted to understand the criteria for the differential use of plant resources. However, we need more effort to understand the interaction between local uses: how using a species for a given purpose may affect its use for another purpose. Thus, we hypothesize that high importance species in a more specialized category of use may have their use reduced for other categories with a more generalist nature. We have conducted the study in three rural communities in northeastern Brazil, set in seasonally dry tropical forest areas. We applied the free-list technique to identify woody species used for medicinal and/or wood purposes (fuelwood, construction and technology). Respondents rated the species according to their efficiency for wood purposes and their local availability. We performed a multiple regression to assess the effects of medicinal popularity, perceived availability, and perceived efficiency for wood uses over the species popularity for wood uses. Our results showed that medicinal use has a significant protective effect against wood uses. Perceived availability and efficiency were significant explanatory variables for wood use. Maintaining the medicinal importance of certain species can be a powerful tool in protecting their populations against more harmful uses.

Keywords: Ethnobotany, biodiversity conservation, interaction of uses, tropical dry forest.

1. Background

Small-scale extraction of timber and non-timber forest products for domestic and commercial purposes is among the human activities that may alter the structure and dynamics of species populations and, in some cases, of entire ecosystems. Ecologists currently see these activities as chronic anthropogenic disturbances given that – unlike deforestation – they do not lead to immediate ecosystem alterations. Still, they can bring critical long-term consequences (Singh, 1998).

Although the idea of chronic anthropogenic disturbances has brought theoretical contributions to ecology and conservation, most studies on the subject failed to place humans as part of the ecological processes. They often consider human actions under a general "disturbance" label without properly investigating the reasons behind people's decisions concerning the use of forest products (see Albuquerque et al., 2018 for a detailed discussion).

Several studies have identified the effects of the extraction of plant resources in plant populations and/or communities (Schmidt et al., 2007; Amusa et al., 2010; Baldauf et al., 2013; Kunwar et al., 2020). However, we still need to improve our understanding of the criteria people in local communities adopt when choosing which plants to collect. This research program has been an important part of recent ethnobiological investigations.

Ethnobiological case-studies point to species abundance and efficiency (commonly measured by wood quality attributes) as the main determinants of people choices during wood collection for domestic purposes (Tabuti et al., 2003; Ramos et al. 2008; Cardoso et al., 2015; Gonçalves et al., 2016). To what concerns medicinal plants, therapeutic efficiency, cultural aspects, and organoleptic properties are important drivers of plant use (Brett and Heinrich, 1998; Clement et al., 2007; Caetano et al., 2020).

Thus, besides being influenced by the social-ecological context, the variables that explain species' use may also change depending on each use-category's particular characteristics. A meta-analysis of the ecological apparency hypothesis showed that availability is a much more important driver of wood use than medicinal use (Gonçalves et al., 2016). This pattern is possibly due to the more general character of wood uses, amplifying the role of availability. In contrast, medicinal use is more specialized and dependent on physicochemical attributes (Gonçalves et al., 2016). Such features may be, for example, the presence of certain compounds, which will lead to the plant's bioactivity.

Despite the increasing number of ethnobotanical studies regarding the selection criteria for plant uses, there is a lack of studies on the interactive effects between use categories, or studies on eventual protective effects, making it necessary to investigate such processes. In terms of plant protection, domestication studies have shown that several locally important species or genotypes (especially of edible plants) faced *in situ* management, which includes protection from competitors and herbivores, dispersion in natural and anthropic areas, and tolerance of individual plants during the clearance of vegetation (Casas et al., 2007; Álvarez-Ríos et al., 2020). However, they did not directly account for interactions between use-categories, and efforts are needed to quantitatively evaluate whether important plants for some specific purposes are currently being protected from other (more damaging) uses.

The identification of protective effects may be of great importance for biodiversity conservation since it strengthens the argument that not only biodiversity should be conserved, but also the whole body of knowledge, practices and symbols towards it (see, for example, Seele et al., 2019). Thus, we hypothesize that species of high importance in a more specialized and less damaging category of use may have their use reduced to other categories with a more generalist and more damaging nature. This phenomenon would happen because, for generalist uses, there are other equally advantageous options, which would allow to "reserve" certain species for uses of which they are not easily replaceable.

Therefore, this study is aligned with the social-ecological theory of maximization (Albuquerque et al., 2019). One of the theory's models – the environmental maximization model – suggests that the differential use of natural resources by human populations follow a logic of cost reduction and benefit amplification, conferring a maximum return among the parameters that influence the use of resources. However, the cases raised by Albuquerque et al. (2019) and studies on plant selection criteria (Gama et al., 2018; Santos et al., 2018; Caetano et al., 2020) often restrict cost and benefit analyzes to a given category of use (mostly medicinal). Therefore, we need to deepen our understanding of how the integrative effects of different use-categories may behave in terms of maximization.

Here, we investigated the interaction between medicinal and wood uses, testing the following prediction of the hypothesis: woody plants of high medicinal importance are less used for wood purposes (fuelwood, construction and technology) than other woody plants because the first use protects them from the latter. The opposite relation (wood uses protecting species from medicinal uses) is not expected because, as medicinal uses are often less harmful than wood uses, the extraction of medicinal resources would not restrict plant's use for woody purposes.

2. Methods

2.1. Study area and socioeconomic characteristics

We conducted this study in the Catimbau National Park (8º24'00" to 8º36'35" S; 37º0'30" to 37º1'40" W), located in Pernambuco, Northeastern Brazil. The Park encompasses the municipalities of Buíque, Ibimirim, Sertânia, and Tupanatinga (MMA, 2017). It is 295 km away from Recife and has 62,294.14 hectares (Bragagnolo et al., 2016). It is located in a region of warm semiarid climate (BSh, according to the Köppen classification) (Alvares et al., 2013). The rainfall range within the Park (from 480 to 1100 mm/year) affects the communities plant structure (Rito et al., 2017).

The study area is placed in the Caatinga domains, an ecoregion that belongs to the Seasonally Dry Tropical Forest and Woodlands (SDTFW) biome (Queiroz et al., 2017). The SDTFWs comprise non-fire-adapted, tree-dominated, succulent-rich, grass-poor, dry tropical forests, woodlands, and bushlands, ecosystems in frost-free areas where rainfall is less than 1800 mm/year, with erratic rainfall patterns (Queiroz et al., 2017).

During the Portuguese conquest (16th century), people belonging to the Prakió ethnic group (also named Paratió) inhabited the Catimbau National Park region (Sampaio, 2011). Currently, part of the region's inhabitants identifies themselves with the Kapinawá indigenous ethnic group (Sampaio, 2011; Andrade, 2014). In the late 1990s, FUNAI (the official Brazilian State's indigenous institution) ratified about 12,400 ha south of the Park as the Kapinawá indigenous territory. However, it did not include families from three communities living inside the Park (including one of the studied villages – Malhador). These excluded communities identify themselves as Kapinawá people (Andrade, 2014).

Currently, within the Park, there are about 300 families, distributed among 17 rural populations, mainly subsisting of extensive livestock and agriculture, and extracting different forest products for timber, fuelwood, handcraft, medicine, and food (Sfair et al., 2005). The extraction of forest products is almost completely performed for self-consumption. One exception is the collection of *Commiphora leptophloeos* (Mart.) J.B.Gillett. trunks for handcraft. Such practice is an additional source of income for some local dwellers. Most families use fuelwood for cooking purposes, and some of them alternate fuelwood and cooking gas. However, as cooking gas prices have increased in the last years, its local consumption is decreasing.

We have performed our study in three communities: Malhador, Batinga and Muquém (Figure 1). Among the studied communities, the Malhador community is the most populous, with 94 inhabitants in 37 households. The population of Batinga includes 71 residents in 31 households. The community of Muquém has 69 inhabitants in 21 households.

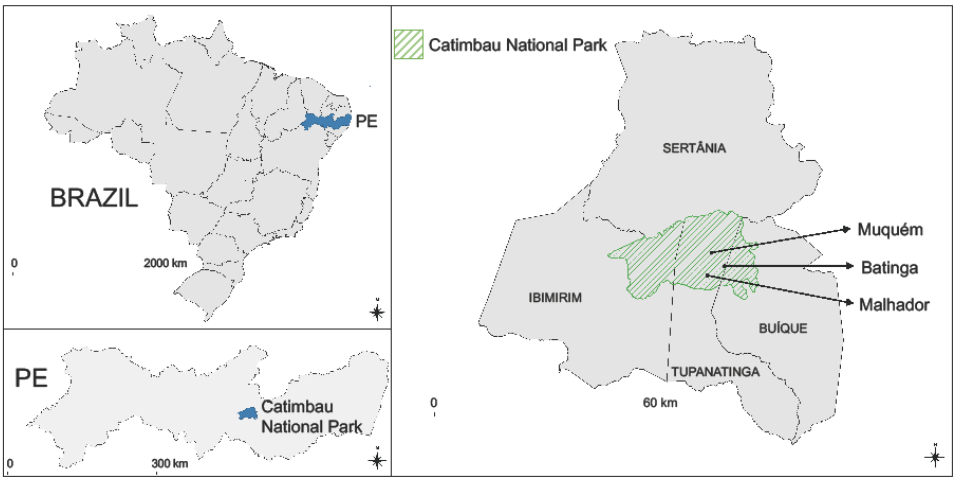


Figure 1. Location of the rural communities of Malhador, Batinga and Muquém, placed in the Catimbau National Park, Northeastern Brazil.

In the three communities, most people have as their primary source of informed income the welfare benefits provided by the federal government, as the practice of agriculture has been weakened due to the lack of rain affecting the region. Some of the Malhador community residents have a teaching degree and work in schools in their community or in an urban area near the Park.

During the rainy season (March to July), residents grow some types of beans, maize and cassava. Some animals such as goats, cattle and poultry are mostly raised for their consumption. In all three communities, residents need to travel to an urban area (Vila do Catimbau) near the Park for medical access and regular education; communities lack basic health facilities as well as Middle and High School. In Batinga and Malhador they have a Primary School.

2.2. Data collection

This study was approved by the Research Ethics Committee of the University of Pernambuco (89890317.7.0000.5207) based on the Resolution 466/2012 of the National Health Council for conduction of research with human beings. Authorization was obtained from ICMBio/SISBIO to develop activities for scientific purposes and collect botanical material in the area of Catimbau National Park in Buíque.

We made our first visit to the villages in August 2017. Since the beginning of the study, we have maintained informal conversations with families from these villages. We have also joined some local religious rituals, such as the *toré* (a ritual commonly performed by some indigenous peoples of Northeastern Brazil) and the *novenas* (a catholic celebration that occurs for nine consecutive days to provide blessings).

We conducted ethnobotanical data collection from April to August 2018. We visited all households in the studied communities and interviewed one adult for each household. The respondent could be the male or female head of the household and we prioritized the person that was more engaged in collecting woody native species., Our sample resulted in 56 residents, 24 in Malhador, 15 in Muquém and 17 in Batinga. From these, 40 were men and 16 were women. We did not find some of the householders even after three visits at different times and days. In such cases, the household was excluded from our sample. This procedure resulted in the exclusion of 13 households in Malhador, 14 in Batinga and six in Muquém.

Before beginning the research, we introduced the study's purposes to the participants and asked them to sign the Informed Consent (IC). We applied the free-list technique (Alexiades, 1996) to identify plants used in communities for wood and medicinal purposes. We used the following guiding questions: which plants do you use for wood purposes? What plants do you use for medicinal purposes? Which medicinal plants are woody?

We selected the species directly cited as medicinal and/or wood purposes for the scoring exercise. Respondents assigned grades from 1 to 4 (1 for very low, 2 for reasonable, 3 for high, and 4 for very high) according to the species' perceived wood availability and quality. We also asked the respondents whether or not they used each plant they mentioned. We adopted this procedure to avoid considering plants that the interviewee only knows but does not effectively use for wood purposes. We collected knowledge data because the study is part of an umbrella project developed in the region. However, we did not use it for this study. We also collected socioeconomic data from all informants through structured interviews such as gender, age, occupation, income, place of origin, educational level, and residence time.

After collecting ethnobotanical data, we conducted a guided tour (Alexiades, 1996) with a key-informant to collect plants mentioned by the informants. Species identification was performed by experts from the Agricultural Research Institute (IPA) and the Federal University of Pernambuco (UFPE). We deposited the exsiccates in the Herbarium Dárdano de Andrade-Lima (IPA) and the Herbarium Sérgio Tavares (HST) of the Federal Rural University of Pernambuco (UFRPE).

2.3. Data analysis

Before performing the statistical analysis, we filtered our database to consider only the medicinal species classified as woody by the interviewees and those directly cited for wood purposes. We opted to use the emic concept of "woody species" instead of a formal classification, and we are aware of possible biases from this choice. For example, shrubs that are not suitable for timber uses were considered woody by the interviewees because they are employed for fuelwood purposes.

We only considered citations of use. Therefore, when the interviewee claimed to know but not use the plant, this information was discarded. Subsequently, we filtered the database to eliminate idiosyncratic information that could skew the results. Therefore, we excluded from the analysis species cited by less than 10% of interviewees, regardless of the use-category.

For the species that remained in the analysis, we calculated the means for the perceived wood quality and perceived availability scores (sum of scores for the plant divided by the total number of interviewees who attributed scores to it). We measured popularity by considering the total number of people who cited a given plant for medicinal purposes (absolute value). The same was applied for popularity for wood purposes. Data on popularity for wood uses was log-transformed to reach a normal distribution (log of the number of people who cited the species + 1).

To test our prediction that medicinal uses protect the plant from being used for wood purposes, we performed a simple regression, having the popularity for medicinal purposes as the explanatory variable and the popularity for wood purposes as the response variable. Both variables were standardized before the analysis.

Besides employing a simple model, we also controlled for the effects of species availability and quality. Therefore, we also tested the medicinal popularity variable in a multiple regression model. The model also contained two other variables that the literature has shown as important to explain the popularity for wood purposes: the perceived availability and the wood's perceived quality (Hora et al., 2021). We performed this joint analysis because the inclusion of known explanatory variables (availability and efficiency) of wood popularity could give greater robustness to the final explanatory model (lower AIC value).

We also conducted Spearman correlation tests between the explanatory variables to search for multicollinearity. By controlling for availability and efficiency and testing for multicollinearity, we avoid possible biases in the protection hypothesis test. If the most popular medicinal plants were precisely the least efficient for wood purposes, then a possible inverse relationship between medicinal popularity and popularity for wood purposes would not necessarily be because medicinal use protects it from wood use. It could instead happen because highly popular medicinal species are not adequate for wood uses. Moreover, suppose the most popular medicinal plants are the least available. In that case, an eventual inverse relationship between popularity for medicinal and wood purposes could happen because the low availability would prevent important medicinal species from being highly used for wood purposes.

We also performed an Analysis of Variance (ANOVA) to compare the models with and without the variable' medicinal popularity'. We did such a procedure because, as our focus is on medicinal popularity, such a variable can only be considered a good predictor if the model that contains it is significantly better at capturing the data variation than the model without it.

Since the number of plant species included in our analysis was relatively small (n=43) to deal with three independent variables, we also ran a "least absolute shrinkage and selection operator" (Lasso) regression to triangulate data analysis. This approach is widely used for high dimensional data but is also recommended to deal with small samples (Finch and Finch, 2016). We searched for the most parsimonious model that explains a substantial amount of variance in the dependent variable. The variables were standardized before the analyses.

We standardized data for all regression procedures (simple, multiple and Lasso regressions) because our variables were measured at different scales, and this procedure can reduce biases in result interpretation. With standardization, the units of regression coefficients become the same, which makes comparisons easier. For example, the popularity for medicinal purposes, measured by the number of people who cited a species, can have values that are ten times as high as the perceived availability or perceived efficiency (measured on a 5-point Likert scale). Therefore, in the multiple regression without standardization, coefficient values would be of -0.02, 0.34, and 0.46 for the variables mentioned above, respectively (and not -0.34, 0.49, and 0.57, as shown in the results section). The low coefficient value for medicinal popularity, in this case, would be due to its different scale when compared to the other variables.

The analyzes were performed using the software R version 3.4.1. (The R Foundation for Statistical Computing). We used the packages' scales', 'glmnet', and 'lassopv'.

3. Results

3.1. General aspects of medicinal and wood use

Forty-three species were cited by 10% or more of the participants. The most popular plants for wood purposes were the species: *Croton conduplicatus* Kunt, *Senegalia bahiensis.* (Benth.) Seigler & Ebinger, *Poincianella microphylla* (Mart. ex G.Don) L.P.Queiroz, and *Lippia origanoides* Kunth. The most popular medicinal species were *Astronium urundeuva* (Allemão) Engl., *Ximenia americana* L., *Hymenaea courbaril* L., and *Sideroxylon obtusifolium* (Roem. & Schult.) T.D.Penn (Table 1). Therefore, there was no overlap between the four most important species used for medicine and the five most important used for wood purposes.

The most cited wood use was firewood (41.5% of the plant-use citations), followed by the construction of fences (30.8%). Household construction elements were much less cited (19.9%), considering that many households are constructed in masonry. For this reason, most elements for house construction were related to roof confection. Other uses (furniture, handicrafts charcoal and tools) accounted for 7.9% of citations.

Table 1. Popularity, perceived availability and perceived wood quality values of species cited in three rural communities in the Catimbau National Park, Northeastern Brazil.

Species	Common name	Average perceived Availability	Average perceived wood quality	Popularity for wood purposes (% of interviewees)	Popularity for medicinal purposes (% of interviewees)	Voucher number
Algrizea minor Sobral et al.	Araçá	2.7	2.1	2.2	13.0	93451
Amburana cearensis (Allemão) A.C. Sm.	Imburana de cheiro	1.8	2.2	0.0	37.0	*
Anacardium occidentale L.	Cajueiro	3.2	2	8.7	34.8	93683
Anadenanthera colubrina (Vell.) Brenan var.*cebil* (Griseb.) Altschul	Angico	2.6	3	32.6	26.1	91698
Annona leptopetala (R.E.Fr.) H.Rainer	Pinha	2.8	2.8	4.3	0.0	93471
Aspidosperma pyrifolium Mart. & Zucc.	Pereiro	2.1	3.1	13.0	0.0	93686
Balfourodendron molle (Miq.) Pirani	Cocão	2.8	3.5	10.9	0.0	93687
Bauhinia acuruana Moric.	Mororó	2.3	2.3	0.0	13.0	93434
Cajanus cajan (L.) Huth	Feijão andú	1	1	2.2	2.2	91617
Cereus jamacaru DC.	Mandacaru	2.7	1.3	2.2	19.6	*
Cf. *Ruprechtia laxiflora* Meisn	Caixão	2.6	2.6	4.3	0.0	*
Commiphora leptophloeos (Mart.) J.B.Gillett	Imburana de cambão	2.9	2.5	28.3	41.3	93685
Croton conduplicatus Kunth	Quebra-faca	3.3	3.3	82.6	21.7	**
Croton micans Sw.	Sacatinga	3.2	2.9	34.8	37.0	*
Cynophalla flexuosa (L.) J.Presl	Feijão bravo	3	2.5	2.2	2.2	93438

Dalbergia cearensis Ducke	Amora	1	3	15.2	0.0	93689
Eucalyptus globulus Labill.	Eucalipto	1	2.5	2.2	10.9	*
Eugenia crenata Vell.	Camboim	2.5	2.1	2.2	45.7	*
Eugenia duarteana Cambess	Maçã do mato	3	1.4	6.5	2.2	93497
Guapira cf. *laxa* (Netto) Furlan	Piranha	3.3	2.4	13.0	0.0	*
Handroanthus impetiginosus (Mart.ex DC.) Mattos	Pau d'arco	2.6	3.3	47.8	15.2	**
Hymenaea courbaril L.	Jatobá	2	2.2	0.0	65.2	93442
Jatropha mollissima (Pohl.) Baill.	Pinhão bravo	3	2	0.0	4.3	91703
Lantana camara L.	Chumbinho	1.8	3.2	39.1	4.3	91684
Libidibia ferrea (Mart. exTul.) L.P.Queiroz	Pau-ferro	2	2	2.2	34.8	93448
Lippia origanoides Kunth	Alecrim	2.9	2.7	56.5	0.0	93457
Lonchocarpus araripensis Benth.	Rabo de cavallo	3	2.5	4.3	0.0	93690
Mimosa tenuiflora (Willd.) Poir.	Jurema preta	2	2.7	13.0	26.1	**
Moquiniastrum oligocephalum (Gardern) G. Sancho	Candinheiro	2.3	3.2	23.9	0.0	93423
Astronium urundeuva (Allemão) Engl.	Aroeira	1.5	2.6	0.0	67.4	**
Myroxylon peruiferum L.f.	Balsamo	2.4	2.9	13.0	45.7	*
Parapiptadenia zehntneri (Harms) M.P.Lima & H.C.Lima	Angico branco	2.9	2.9	15.2	4.3	93441
Peltogyne pauciflora Benth.	Coração de negro	2.5	2.2	10.9	0.0	93435
Pilosocereus pachycladus F.Ritter	Faxeiro	2.7	2	10.9	0.0	*
Poeppigia procera C. Presl	Pau branco	3.3	2.3	39.1	0.0	93432
Poincianella microphylla (Mart. ex G.Don) L.P.Queiroz	Catingueira	3.3	3	58.7	17.4	93473
Prosopis juliflora (Sw.) DC.	Algaroba	1.6	3.1	19.6	13.0	93440

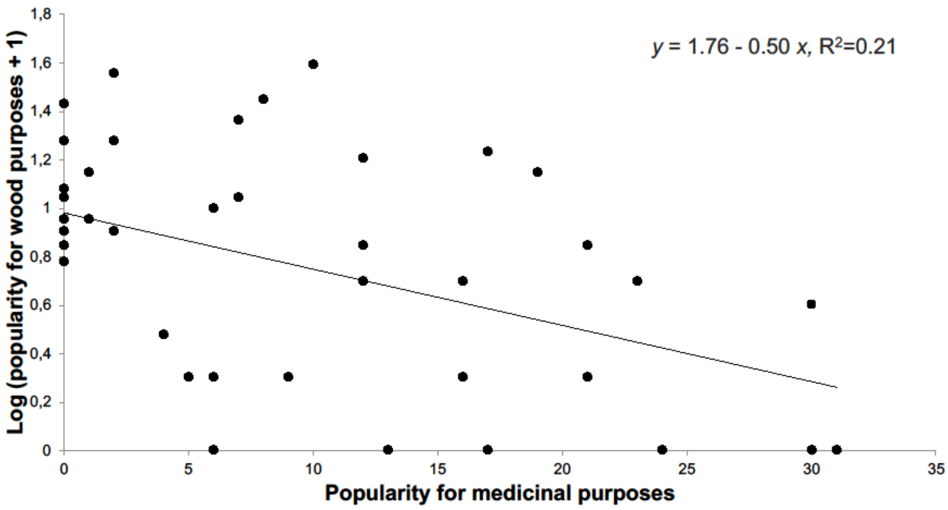
Schinopsis brasiliensis Engl.	Barauna	2	3.2	8.7	26.1	**
Senegalia bahiensis (Benth.) Seigler & Ebinger	Espinheiro-branco	3.6	3.4	76.1	4.3	93428
Senna spectabilis var.*excelsa* (Schrad.) H.S. Irwin & Barneby	Canafistula	4	3	2.2	2.2	**
Sideroxylon obtusifolium (Roem. & Schult.) T.D.Penn.	Quixabeira	1.8	2.5	0.0	52.2	**
Spondias tuberosa L..	Umbuzeiro	2.7	2.1	4.3	8.7	*
Ximenia americana L.	Ameixa	2.6	2.5	6.5	65.2	**
Ziziphus aff. *cotinifolia* Reissek	Juazeiro	3	1.7	0.0	28.3	91676
Unidentified 1	Espinheiro	3	3.2	8.7	50.0	***
Unidentified 2	Jurema branca	2.9	2	17.4	0.0	***
Unidentified 3	Angico-de-bezerro	3	2.1	21.7	15.2	***
Unidentified 4	Quebra-faca	2	1.5	0.0	6.5	***
Unidentified 5	Rasgabeiço	2.8	1.7	17.4	2.2	***
Unidentified 6	Sassafraz	3.4	2.8	28.3	2.2	***
Unidentified 7	Sucupira branca	2.3	3.3	6.5	0.0	***
Unidentified 8	Carrasco	2.7	2.9	21.7	0.0	***
Unidentified 8	Cedro	2	1.7	0.0	4.3	***
Unidentified 10	Jequiri	2.3	2.7	0.0	13.0	***

*Identified in the field; **Collected. but not deposited in herbarium (fertile material); ***Not identified

3.2. The most popular medicinal plants are not popular for wood purposes

Evidence favorable to the hypothesis was identified. The simple model demonstrated a significant protective effect of medicinal use on the wood use. Thus, plants with greater medicinal popularity are less frequently used for wood purposes. The linear regression model only explained a small portion of data variance (R^2= 0.21; p<0.01). The scatter plot (Figure 2) shows that the wood uses are low for all plants of great medicinal popularity. It indicates that protection acts disproportionately, higher in plants of too high medicinal popularity.

Figure 2. Scatterplot of popularity for medicinal purposes versus popularity for wood purposes in three rural communities in the Catimbau National Park, Northeastern Brazil. Popularity was measured in terms of the number of people who cited the species. The regression equation (above) was calculated with standardized values. AIC=123.0.



3.3. Medicinal value remains an important predictor even after controlling for availability and efficiency

The model with three independent variables (popularity for medicinal use, efficiency and availability) had all of them with a significant impact on the species importance for woody purposes (Table 2). The explanatory power of the model was moderate (R^2=0.63)

Although the three variables help explain wood popularity, the efficiency and availability variables interfere more consistently than the medicinal popularity variable. It means that medicinal use protects species from wood use, but it is not the main criterion for the differential use of wood products.

Table 2. Results of the multiple regression analysis performed to analyze which factors influence the species popularity for wood purposes in three rural communities in the Catimbau National Park, Northeastern Brazil.

Fixed effects	**Standardized model**			
	t-value	Coefficient (b)	Standard error	p-value
Popularity for medicinal purposes	-3.06	-0.34	0.11	0.00
Average Perceived Availability	4.45	0.49	0.11	0.00
Average score of perceived efficiency	5.24	0.57	0.11	0.00
AIC	96.39			
R^2	0.63			

ANOVA indicated that the model that included medicinal popularity was significantly better than the model without it (F=7.1; p<0.05). Correlation analyzes between the independent variables (perceived efficiency *x* perceived availability, perceived efficiency *x* medicinal popularity, and perceived availability *x* medicinal popularity) did not identify significant relationships (p> 0.05 for all) (Figure 3). Thus, there was no multicollinearity in the model.

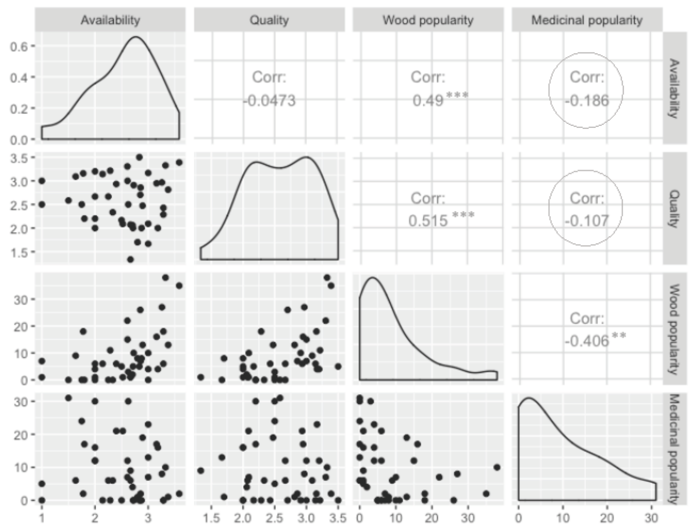


Figure 3. Scatterplot for correlation matrix between mean perceived availability, mean perceived quality for wood purposes, wood popularity and medicinal popularity in rural communities in the Catimbau National Park, Northeastern Brazil. Circles were used to highlight the correlations between medicinal popularity and the other two explanatory variables (quality and availability). **p<0.01 and ***p<0.001.

The lasso regression with the optimal lambda (0.015) indicated that the three variables were predictors of the frequency of use (Table 3). This model behaved very similarly to the multiple regression model.

For both multiple regression and Lasso regression, perceived efficiency was the variable with higher coefficients. According to people's responses, the main reasons for considering a species as efficient were related to its resistance and versatility. In terms of resistance, people highlighted that efficient plants last long when being burnt, are not easily degraded by insects and last long in contact with moisture. Regarding versatility, some people mentioned during the interviews that efficient plants had to be useful for both firewood and construction, and that they had to be potentially useful regardless of their State (green/recently collected or dry).

However, for both models, perceived availability had coefficient values relatively close to those for perceived efficiency. It means that both variables are almost equally important in the selection of species for wood uses.

Table 3. Standardized Model Coefficients (Lasso regression) for the analysis performed to analyze which factors influence the species popularity for wood purposes, in three rural communities in the Catimbau National Park, Northeastern Brazil.

Variable	Lasso
No. of citations of the medicinal plant	-0.30+
Average Perceived Availability	0.43+
Average score of perceived efficiency	0.50+

4. Discussion

This study provides evidence that the medicinal importance of woody plant species may give them a ban on the wood use. Ethnobiological literature has examples of species that are locally "protected" from logging because of their magical-religious importance (Tabuti et al., 2003). However, this study strengthens the idea that medicinal uses may also provide protection against wood use.

The protection of medicinal plants of high importance is probably associated with the crucial role of these species in people's survival through the treatment of diseases. Several of the highly important medicinal species in the Caatinga are used to treat or attenuate inflammatory processes, such as *Astronium urundeuva*, *Amburana cearensis* (Allemão) AC Sm *and Ximenia americana* (Silva et al. 2011; Souza et al., 2014).

The medicinal category inflammation consists of different responses of the human immune system to injuries and infections. In contexts of water scarcity and difficulties to access clean water (as in our studied communities), such restrictions directly influence hygiene conditions (Razzolini and Günther, 2008). These conditions may lead to a high incidence of pathogens, and it would be expected that the mechanisms for treating inflammation would be a highly relevant part of social-ecological systems. Ultimately, therefore, the protection of highly important medicinal plants is part of an ecological-evolutionary context associated with the survival of human populations.

While in line with the socioecological theory of maximization (Albuquerque et al., 2019), the findings of this study show that their models need to be planned to integrate the interactive effects of different use categories. Thus, in certain socio-environmental contexts, it is possible that maximization is not well evidenced within a category of use because it would be necessary to consider the relationships of the category with others that are part of the social-ecological system. Specifically, for the case of this study, the best explanatory model includes the variable' medicinal popularity', which indicates that a maximum return is only obtained when considering such factor (Figure 4). In other social-ecological contexts, the interactive effects can be even stronger, so it is possible that the plants most commonly used as wood are not the ones with the best quality/availability return. In this case, if the plants that would give the best return for wood purposes were precisely the most important from the medicinal point of view, the maximum return would only be observed when the two categories were evaluated together.

However, protective effects will probably not be found in every case, and under certain contexts, maximization may be properly interpreted without considering interactions between use-categories. Another study developed in Northeastern Brazil searched for correlations between use-categories in terms of plant importance (Barbosa et al., 2020). Although the study was not designed to test for protective effects, it could not find a correlation between the medicinal category and wood use-categories (fuelwood, construction and technology). Therefore, more studies are needed to account for factors that strengthen the protective effects.

When plants of medicinal relevance are protected from wood uses, management strategies should be considered to guarantee the sustainability of medicinal plant harvesting. In SDTFW areas, several of the medicinally important species are deciduous. Thus, people collect mainly the bark from these trees for medicinal purposes (Albuquerque, 2006). Bark extraction may also affect the plant's physiology and population dynamics, especially when it impacts water/nutrient pathways and supplies. Therefore, we should stimulate community-driven mechanisms for sustainable bark extraction. Actions should focus on harvesting techniques and strategies, for example, by leaving the inner bark for regeneration (Pandey et al., 2011). However, the need for (and viability of) conservation strategies are context-dependent and should be evaluated with studies on bark extraction for the Catimbau National Park.

This study has some limitations. First, the use-records for medicinal and wood purposes were obtained separately (although successively). It may have added some bias to the results, as memory would only benefit the citation of the most important medicinal and wood species. For example, a species may be used for medicinal and wood purposes, but, as it was much more important for medicinal purposes than for wood uses, it was forgotten in the last free-list.

Future studies should consider employing the checklist-interview technique (Alexiades, 1996). With this technique, all plants would be presented to the interviewee, and he/she would indicate the uses for each plant. Such a procedure could provide an additional mnemonic stimulus. We also suggest that future studies evaluate species wood quality and availability through local perception and other measures (e.g., wood density and fuel value for the quality and phytosociological parameters for availability). We used a single metric for wood efficiency, but this is a clear limitation of the study, considering that each particular wood use has distinct quality requirements.

Additionally, future studies should also consider performing an in-depth evaluation of people's perceptions towards plant use and management, including their specific impressions about the eventual existence of protective effects. Although, under our perspective, such an approach alone would not be enough to test the hypothesis, it could help to elicit conscious behaviors towards the protection of certain species.

In the studied context, firewood was the most cited wood use, and house construction did not play a relevant role in terms of use-citations. Literature has shown that firewood is a more generalist use than house construction (see, for example, Dahdouh-Guebas et al., 2000). For this reason, the much higher wood use for firewood over house construction certainly amplified the protective role of medicinal plants. Thus, a next step would be to test the hypothesis in areas where wood use for house construction is significant. The more specific requirements for house construction may weaken the protective role of medicinal use.

Finally, in the studied communities, the commercialization of plant resources for medicinal and wood purposes is not relevant. This particular scenario of local domestic use contributes to strengthening the hypothesis. Still, it is possible that whenever wood commerce takes place, especially to meet external demands, medicinal importance would not be enough to prevent logging. Whenever wood trade occurs, increasing the economic gains may often be considered more important than reserving certain species for medicinal purposes. On the other hand, if the trade is directed to the medicinal plants, the protection of such species from wood uses could be even more important, as it would influence income generation. Therefore, other contexts with commercial use of both wood and medicinal plants need to be considered in future studies.

5. Conclusion

Evidence from our research shows that, although perceived efficiency and availability are major drivers of wood popularity, there is a "conservation through use" system in the studied communities because important species are being spared from more harmful uses. Therefore, it is necessary to elaborate conservation strategies based on maintaining the medicinal importance of certain species, considering that *Astronium urundeuva*, *Ximenia americana*, *Hymenaea courbaril*, and *Sideroxylon obtusifolium* were more popular for medicinal uses in the community and were less mentioned for wood purposes. Therefore, policymakers should incorporate in their conservation actions the local valorization of the above-mentioned medicinal plants. One way to do it could be by promoting their knowledge and use among the youngest members of the community, considering that local knowledge of medicinal plants is eroding in several social-ecological contexts. Therefore, conservation plans in the region should include the enhancement of local knowledge on medicinal plants by stimulating the regular occurrence of workshops focusing on local knowledge sharing among different generations.

However, it is necessary to verify if the medicinal use itself would not be causing conservation problems for the species mentioned above, considering that it is not exempt from causing damage to these plants' populations. To achieve this purpose, we need studies that combine the investigation of medicinal plant species' ecological status with ethnobotanical information on use-intensity, use-frequency collection patterns, and a whole set of data on people's perceptions and world views concerning medicinal plant use and collection.

Additionally, it is also important to evaluate how use-pressure for wood uses is being distributed, especially among the non-medicinal species. Although medicinal importance may play a protective role in some woody species, such a process may decrease the options being considered for wood uses. Our study has indicated that only a few species actually benefit from a protective effect, which probably does not interfere much in the use-dynamics from a plant-community point of view. However, this issue needs to be addressed with proper research designs.

Therefore, challenges for future studies include testing the following hypotheses:

- Edible use also provides protection against wood uses, considering its specialized nature and the importance of wild edible trees for several local communities;
- Protection increases when the generalist use causes significant damage to plant populations, given that it would increase the chances for species loss and stimulate protective behaviors;
- Protection increases when several species used for specialized purposes are economically important for the local population, given that their loss would strongly impact income generation;
- Protection increases with social organization since behaviors towards protection may be more easily planned and managed in organized communities than communities with a lack of social organization.

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8. References

Albuquerque, U.P., 2006. Re-examining hypotheses concerning the use and knowledge of medicinal plants: a study in the Caatinga vegetation of NE Brazil. J. Ethnobiol. and Ethnomed. 30, 2. https://doi.org/10.1186/1746-4269-2-30.

Albuquerque, U.P., Gonçalves, P.H.S., Ferreira Júnior, W.S., Chaves, L.S., Oliveira, R.C.D.S., Silva, T.L.L.D., Santos, G.C.D., Araújo, E.D.L., 2018. Humans as niche constructors: Revisiting the concept of chronic anthropogenic disturbances in ecology. Perspect. Ecol. Conserv. 16, 1-11. https://doi.org/10.1016/j.pecon.2017.08.006.

Albuquerque, U.P., Medeiros, P.M., Ferreira Júnior, W.S., Silva, T.C., Silva, R.R.V., Gonçalves-Souza, T., 2019. Social-Ecological theory of maximization: basic concepts and two initial models. Biol. Theory. 14, 73–85. https://doi.org/10.1007/s13752-019-00316-8.

Alexiades, M.N., 1996. Collecting ethnobotanical data. Selected Guidelines for Ethnobotanical Research, in: Alexiades, M.N. (Ed.), Selected guidelines for Ethnobotanical Research: A Field Manual. The New York Botanical Garden Press, New York, pp. 53-94.

Alvares, C.A., Stape, J.L., Sentelhas, P.C., Moraes Gonçalves, J.L., Sparovek, G., 2013. Köppen's climate classification map for Brazil. Meteorol. Zeitschrift. 22, 711–728. https://doi.org/10.1127/0941-2948/2013/0507.

Álvarez-Ríos, G.D., Pacheco-Torres, F., Figueredo-Urbina, C.J., Casas, A., 2020. Management, morphological and genetic diversity of domesticated agaves in Michoacán, México. J. Ethnobiol. Ethnomed.16, 3. https://doi.org/10.1186/s13002-020-0353-9.

Amusa, T.O., Jimoh, S.O., Aridanzi, P., Haruna, M., 2010. Ethnobotany and conservation of plant resources of Kainji Lake National Park, Nigeria. Ethnobot. Res. Appl. 8, 181–94. https://doi.org/10.1234/era.v8i0.349.

Andrade, L.E.A., 2014. "Kapinawá é meu, já tomei, tá tomado": organização social, dinâmicas territoriais e processos identitários entre os Kapinawá (master's dissertation, Federal University of Paraíba, Paraíba, Brazil). Retrieved from https://repositorio.ufpb.br/jspui/handle/tede/7611.

Baldauf, C., Santos, F.A.M., 2013 Ethnobotany, traditional knowledge, and diachronic changes in non-timber forest products management: a case study of Himatanthus drasticus (Apocynaceae) in the Brazilian Savanna. Econ. Bot. 67, 110–20. https://doi.org/10.1007/s12231-013-9228-5.

Barbosa, E.C., Cruz, R.S., Santos, G.M.C., Silva, R.R.V., Albuquerque, U.P., Medeiros, P.M., 2020. Use categories and local perception of decline in plant populations: a case study of woody medicinal plants in Northeastern Brazil. Econ. Bot. https://doi.org/10.1007/s12231-020-09502-3.

Bragagnolo, C., Gamarra, N.C., Malhado, A.C., Ladle, R.J., 2016. Proposta metodológica para padronização dos estudos de atitudes em comunidades adjacentes às unidades de conservação de proteção integral no Brasil. Biodiversidade Brasileira. 6, 190-208.

Brett, J.A., Heinrich, M., 1998. Culture, perception and the environment: The role of chemosensory perception. Angew. Bot. 72, 67-69.

Caetano, R.A., Albuquerque, U.P., Medeiros, P.M., 2020. What are the drivers of popularity and versatility of medicinal plants in local medical systems? Acta Bot. Bras. 34, 256-265. https://doi.org/10.1590/0102-33062019abb0233.

Cardoso, M.B., Ladio, A.H., Dutrus, S.M., Lozada, M., 2015. Preference and calorific value of fuelwood species in rural populations in Northwestern Patagonia. Biomass Bioenerg. 81, 514–20. https://doi.org/10.1016/j.biombioe.2015.08.003.

Casas, A., Otero-Arnaiz, A., Pérez-Negrón, E., Valiente-Banuet, A., 2007. In situ management and domestication of plants in Mesoamerica. Ann. Bot. 100, 1101–15. https://doi.org/10.1093/aob/mcm126.

Clement, Y.N., Morton-Gittens, J., Basdeo, L., Blades, A., Francis, M.J., Gomes, N., Janjua, M., Singh, A., 2007. Perceived efficacy of herbal remedies by users accessing primary healthcare in Trinidad. BMC Complement. Altern. Med. 7, 4. https://doi.org/10.1186/1472-6882-7-4.

Dahdouh-guebas, F., Mathenge, C., Kairo, J.G., Koedam, N., 2000. Utilization of mangrove wood products around mida creek (Kenya) amongst subsistence and commercial users. Econ. Bot. 54, 513–527.

Finch, W., Finch, M.H., 2016. Regularization methods for fitting linear models with small sample sizes: fitting the Lasso estimator using r. Pract. Assess., Res. Eval., 21, 7. https://doi.org/10.7275/JR3D-CQ04.

Gama, A.D.S., Paula, M., Silva, R.R.V., Ferreira Júnior, W.S., Medeiros, P.M., 2018. Exotic species as models to understand biocultural adaptation: Challenges to mainstream views of human-nature relations. PLoS One. 13:e0196091. https://doi.org/10.1371/journal.pone.0196091.

Gonçalves, P.H.S., Albuquerque, U.P., Medeiros, P.M., 2016. The most commonly available woody plant species are the most useful for human populations: A meta-analysis. Ecol. Appl. 26, 2238-2253. https://doi.org/10.1002/eap.1364.

Hora, J.S.L., Feitosa, I.S., Albuquerque, U.P., Ramos, M.A., Medeiros, P.M., 2021. Drivers of species' use for fuelwood purposes: A case study in the Brazilian semiarid region. J. Arid Environ. 185, 104324. https://doi.org/10.1016/j.jaridenv.2020.104324

Kunwar, R.M., Fadiman, M., Thapa, S., Acharya, R.P., Cameron, M., Bussmann, R.W., 2020. Plant use values and phytosociological indicators: implications for conservation in the Kailash Sacred Landscape, Nepal. Ecol. Indic. 108, 105679. https://doi.org/10.1016/j.ecolind.2019.105679.

MMA, 2016. Consulta de unidades de conservação. http://www.mma.gov.br/areas314protegidas/cadastro-nacional-de-ucs/consulta-por-uc (accessed 03 May 2017).

Pandey, A., Sahu, S., Yadav, S., 2011. Sustainable bark harvesting and phytochemical evaluation of alternative plant parts in Holarrhena antidysenterica R. Br. Sans (Kutaj). Int. J. Green Pharm. 5, 107. https://doi.org/10.4103/0973-8258.85166.

Queiroz, L.P., Cardoso, D., Fernandes, M.F., Moro, M.F., 2017. Diversity and evolution of flowering plants of the Caatinga Domain, in: Silva, J.M.C., Leal, I.R., Tabarelli, M. (Eds.), Caatinga: The largest tropical dry forest region in South America. Springer, New York, pp. 23-63.

Ramos, M.A., Medeiros, P.M., Almeida, A.L.S., Feliciano, A.L.P., Albuquerque, U.P., 2008. Can wood quality justify local preferences for firewood in an area of Caatinga (dryland) vegetation? Biomass Bioenerg. 32, 503-509. https://doi.org/10.1016/j.biombioe.2007.11.010.

Razzolini, M.T.P., Günther, W.M.R., 2008. Impactos na saúde das deficiências de acesso a água. Saúde e Sociedade. 17, 21-32. https://doi.org/10.1590/S0104-12902008000100003.

Rito, K.F., Arroyo-Rodríguez, V., Queiroz, R.T., Leal, I.R., Tabarelli, M., 2017. Precipitation mediates the effect of human disturbance on the Brazilian Caatinga vegetation. J. Ecol. 105, 828-838. https://doi.org/10.1111/1365-2745.12712.

Sampaio J.A.L., 2011. De caboclo a índio: etnicidade e organização social e política entre povos indígenas contemporâneos no nordeste do Brasil; o caso Kapinawá. Cadernos do LEME. 3, 88-191.

Santos, C.S., Barros, F.N., Paula, M., Rando, J., Nascimento, V.T., Medeiros, P.M., 2018. What matters when prioritizing a medicinal plant? A study of local criteria for their differential use. Acta Bot. Bras. 32, 296-302. http://dx.doi.org/10.1590/0102-33062017abb0336.

Schmidt. A., Belloni, I., Benedetti, I., Schmidt, I.B., Figueiredo, I.B., Scariot, A., 2007. Ethnobotany and effects of harvesting on the population ecology of Syngonanthus nitens (Bong.) Ruhland (Eriocaulaceae), a NTFP from Jalapão region, central Brazil. Econ. Bot. 61, 73–85. https://doi.org/10.1663/0013-0001(2007)61[73:EAEOHO]2.0.CO;2.

Seele, B.C., Esler, K.J., Cunningham, A.B., 2019. Biocultural diversity: a Mongolian case study. Ecol. Soc. 2019; 24:27. https://doi.org/10.5751/ES-11207-240427.

Sfair, J.C., Bello, F., França, T.Q., Baldauf, C., Tabarelli, M., 2018. Chronic human disturbance affects plant trait distribution in a seasonally dry tropical forest. Environ. Res. Lett. 13, 25005. https://doi.org/10.1088/1748-9326/aa9f5e.

Silva, M.I.G., Melo, C.T.V., Vasconcelos, L.F., Carvalho, A.M.R., Sousa, F.C.F., 2011. Bioactivity and potential therapeutic benefits of some medicinal plants from the Caatinga (semiarid) vegetation of Northeast Brazil: a review of the literature. Rev. Bras. Farmacogn. 22, 193-207. https://doi.org/10.1590/S0102-695X2011005000171.

Singh, S.P., 1998. Chronic disturbance, a principal cause of environmental degradation in developing countries. Environ. Conserv. 25, 1-2. https://doi.org/10.1017/S0376892998000010.

Souza, R.K.D., Silva, M.A.P., Menezes, I.R.A., Ribeiro, D.A., Bezerra, L.R., Souza M.M.A., 2014. Ethnopharmacology of medicinal plants of carrasco, northeastern Brazil. J. Ethnopharmacol. 157, 99-104. https://doi.org/10.1016/j.jep.2014.09.001.

Tabuti, J.R.S., Dhillion, S.S., Lye, K.A., 2003. Traditional herbal drugs of Bulamogi, Uganda: plants, use and administration. J. Ethnopharmacol. 88, 19–44. https://doi.org/10.1016/s0378-8741(03)00161-2.