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Journal of Ethnopharmacology

journal homepage: www.elsevier.com/locate/jep

Do ferns and lycophytes function as medicinal plants? A study of their low representation in traditional pharmacopoeias



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ARTICLE INFO

Article history:

Received 10 June 2015

Received in revised form

1 September 2015

Accepted 2 September 2015

Available online 10 September 2015

Keywords:

Ethnobiology

Ethnobotany

Traditional ecological knowledge

Medicinal plants

Medicinal pteridophytes

ABSTRACT

Ethnopharmacological relevance: Ethnobotany is becoming an important tool for understanding how traditional medical systems are organized and which variables affect their structure and dynamics. However, some phenomena observed in ethnobotanical studies led us to question whether such phenomena are real or methodological artifacts. The small proportion of ferns and lycophytes in ethnobotanical surveys of medicinal plants is one such phenomenon, and its causes should be identified using different approach levels. The present study aimed to clarify the reasons for a low representation of these two groups in studies of medicinal plants.

Materials and methods: The present study considered the following hypotheses: 1) ferns and lycophytes are little represented in different ethnobotanical studies because of inadequate data collection methods to record these species; 2) ferns and lycophytes are little represented because of the local perception of their low therapeutic efficacy; and 3) species of ferns and lycophytes are represented in local pharmacopoeias in proportion to the size of their families. We chose rural communities from Chapada do Araripe, Northeast Brazil to test our hypotheses. Data on the medicinal plant repertoires of the communities and on the perceived therapeutic efficacy of ferns were obtained using two different methods, semi-structured interviews associated with free lists and a checklist interview, both applied to local specialists. The resulting data were analyzed differently for each test. In addition, data regarding the total flora x medicinal flora ratio were obtained with a floristic survey and accessing data banks from previous studies performed by our research team.

Results: All hypotheses were confirmed, showing that all three factors contributed to the low representation of these plant groups as medicinal resources. The present study showed that free-list interviews are not a good method to access traditional knowledge of medicinal ferns and lycophytes and that the use of visual stimuli can help the memory of the informants, thus making it possible to associate the perceived characteristics with plant use. The results also showed that individuals perceive these plants as inferior therapeutic resources compared to angiosperms, which contributes to knowledge of their use not being transmitted. The final result of the present study was that the distribution of medicinal fern and lycophyte species within families was consistent with the total flora x medicinal flora ratio. This result indicates that even if the most appropriate data collection method was used for the ethnobotanical survey, the number of species would not be as expressive as that of angiosperms.

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1. Introduction

Plants have been used in traditional medicine since antiquity and are an important therapeutic resource for approximately 80%

of the planet's population (WHO, 2001; Maciel et al., 2002). Traditional knowledge regarding the use of medicinal plants has been the main focus of ethnobotanical studies (Albuquerque and Hanazaki, 2006). However, ferns and lycophytes are not often indicated as medicinal in ethnobotanical surveys because the number of species in these surveys is low compared to other vascular plants (Moerman, 1979, 1991; Ankli et al., 1999; Di-Stasi et al.,

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2002; Leonti et al., 2003; Amiguet et al., 2006; Bletter, 2007).

However, the low number of medicinal ferns and lycophytes in ethnobotanical studies is not consistent with their attributed therapeutic potential. For example, Banerjee and Sen (1980) analyzed the antimicrobial activity of 114 species from these plant groups and observed that 73 (64%) were effective. According to these authors, the antimicrobial activity of these plants is not lower than that of any other plant group. In a more recent study, Singh et al. (2008) observed that some species of the genus *Adiantum* exhibited a higher antimicrobial activity than the commercial antibiotics Gentamicin and Ketoconazole. A recent review by Keller and Prance (2015) shows that ferns and lycophytes have been reported in several studies as sources of compounds with antioxidant activity. Other medicinal properties, such as anti-inflammatory, analgesic, antimutagenic, immunomodulatory, and neuromodulatory have been observed in pharmacological studies of these plant groups (Goldberg and Cooper, 1975; Lee and Lin, 1988; Wu et al., 2005; Nonato et al., 2009). Many of these properties result from the biological activity of secondary metabolites present in these plants, e.g., triterpenes, alkaloids, phenols, flavonoids, saponins, and tannins (Santos et al., 2010a).

In Brazil, studies focused on some native ferns and lycophytes showed pharmacological activity corresponding to their use in popular medicine (Santos et al., 2010a). For example, the analgesic activity of *Adiantum raddianum* C. Presl. occurs because of a large amount of triterpenes (Bresciane et al., 2003). The traditional use of *Microgramma squamulosa* (Kaulf.) Sota for ulcer treatment was also supported by a pharmacological study that indicated the tannins present in this species were responsible for the antiulcer activity (Suffredini et al., 1999). Although there is agreement between the properties attributed by popular medicine and the biological activity observed in pharmacological studies, there are no studies that compare the therapeutic efficacy of ferns and lycophytes perceived by local people and their actual therapeutic efficacy.

Previously reported evidence results from anecdotal observations, and there are no reports of previous studies that explain the apparent low representation of ferns and lycophytes in ethnobotanical surveys of medicinal plants. To fill this gap, the present study tested the following three hypotheses:

1) Ferns and lycophytes are little represented in ethnobotanical studies because the data collection methods were not appropriate to record these species; 2) ferns and lycophytes are little represented because they are perceived as less effective medicinal resources than angiosperms; and 3) fern and lycophyte species are represented in local pharmacopoeias proportionally to the size of their families.

Relative to the first hypothesis, Albuquerque and Hanazaki (2006) argued that a data collection method should be selected to best achieve the proposed objectives. Numerous methods may replace or supplement traditional interviews. For example, the checklist interview uses visual stimuli that direct the informant toward the field of interest of the researcher (Santos et al., 2011). The information is therefore obtained without the informant knowing which taxonomic group the sampled plants belong to (Medeiros et al., 2014).

Regarding the second hypothesis, several factors can influence the preference for using a given plant. One factor is therapeutic efficacy. However, there is not always an agreement between preference for a resource and its therapeutic properties (Medeiros et al., 2013a). There can be a “meaning response”, or a placebo effect, which has a therapeutic action that is more closely related to psychological factors than to the bioactive compounds of a given resource (Moerman and Jonas, 2002). Similarly, plants with interesting biological activities from the therapeutic perspective may not be locally selected because of cultural influences

(Medeiros et al., 2013a). Investigating the local preference for a given therapeutic resource may therefore lead to different evidence of the local medical system, culture, and the plant.

Finally, the third hypothesis is related to the distribution of medicinal species within botanical families, a topic that has actually received quite some attention in ethnobotany (Moerman, 1991; Weckerle et al., 2012; Medeiros et al., 2013b). The literature shows that medicinal plants tend to be non-proportionally distributed within families, meaning that people tend to overuse some families and underuse others (Moerman, 1991). This type of approach assumes that different taxonomic groups have different therapeutic potentials associated to a particular chemical repertoire, which would result in the differential selection of plants to be included in local pharmacopoeias. Therefore, the chemical repertoires of the different plant families would determine whether they follow the total flora \times medicinal flora ratio or are above or below that ratio. However, when the distribution of medicinal species within the botanical families follows the total flora \times medicinal flora ratio, the number of medicinal species is directly linked to the number of species of each botanical family in nature. Thus, studies on the pattern of medicinal species distribution of medicinal ferns and lycophytes within families can indicate whether the low representation of these groups in ethnobotanic surveys is caused by the low species diversity.

2. Materials and methods

2.1. Study area

The study was performed at the Chapada do Araripe, in areas surrounding the Araripe National Forest (Floresta Nacional do Araripe, FLONA-Araripe). The Chapada do Araripe is a Brazilian environmental preservation area created in 1997. It is located in the states of Ceará, Pernambuco, and Piauí and occupies approximately one million hectares. FLONA-Araripe is a conservation unit of sustainable use created by Decree No. 9226 on 2 May 1946. It has an area of 38,262.33 ha and includes regions of the municipalities of Missão Velha, Nova Olinda, Jardim, Crato, Santana do Cariri, and Barbalha, all in the state of Ceará, Brazil (IBAMA, 2004).

FLONA-Araripe is one of the 27 areas of high biological importance in Brazil and a priority for performing biological surveys (Silva et al., 2004, 2012). It also has a large variety of habitats because of the presence of different vegetation types, cerrado (Brazilian savanna, 48.53%), cerradão (transitional tropical forest, 27.49%), mountain wet forest (22.47%), and carrasco (low shrubby forest, 1.51%), all surrounded by xeromorphic vegetation characteristics of the caatinga biome, in which they are included (IBAMA, 2004). The region has a rural and extractivist population, which generates a large portion of its income from the extraction of non-timber resources, such as the fruits of *Caryocar coriaceum* Wittm. (pequi), and latex from *Himatanthus drasticus* (Mart.) Plumel (janaguba) (IBAMA, 2004; Silva et al. 2004). There is also a considerable richness and diversity of ferns and lycophytes (Paula-Zarate, 2004), which makes it appropriate for studies on the traditional knowledge of local pteridophytes.

The region has a hot and humid tropical climate with a rainy season between January and May and a mean yearly temperature between 24 and 26 °C (IBAMA, 2004). Although it is located in a semi-arid area, water is an abundant resource at FLONA-Araripe, particularly along the FLONA mountain slope, where there are abundant natural water springs in the evergreen forest (IBAMA, 2004). These forests have microclimates, medium to high altitudes (600–900 m, 901–1100 m), and tend to have a higher richness and diversity of ferns and lycophytes (Paula-Zarate, 2004).

An ethnobotanical survey was performed at the rural

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