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Tapajós river communities in savannah ecosystems: Ethnobotanical profile and diversity of traditional knowledge

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Abstract

In contexts of Amazonian rural communities, the Ethnobotany as an important approach to rescue, characterize and valorize the traditional knowledge of riverside communities at Amazon Forest, for keep the intellectual property rights of these communities and guarantees the necessary conditions for maintenance socio-cultural structures in a process of traditional knowledge reproduction, associated with economic and environmental interests. The objective of this research was to characterize the ethnobotanical profile and the diversity of traditional knowledge about the use of plants among the three riverside communities in savannah ecosystems at Tapajos River Basin. The methodology characterizes for an interview per family in each community and then, the date will analyzed to determine the follow variables; The Relative Frequency of Citation (RFC) of plant species; Value of Use (VU); Fidelity Level (FL); Relative Popularity (RP) and Rank Order Priority (ROP). The results shown that plant traditional knowledge by riparian communities in Tapajós River Basin presents diversity among the communities studied, which is a rich scenario, with a greater or less homogeneity of this knowledge diversity by community. Medicinal plants such as Erva Cidreira (*Lippia alba*); Capim Santo (*Cymbopogon citratus*) and Cumaruzinho (*Justicia pectoralis*) deserve attention, since they are the species with the highest values of use by these communities.

Keywords: amazonia, value of use, medicinal plants, *Lippia alba*

Introduction

Ethnobotany as a relatively new discipline that seeks to study the dynamics of integration human cultures with use of plants for medicinal, cultural, religious and / or conservationist purposes (Franco; Rodrigues, 2007) [27], is Fundamental in contexts of Amazonian rural communities, sometimes determinant for the survival of these peoples, almost always distant from health centers. The development of ethnobotany, developed always through orality between generations in rural families, is particularly important because it allows the knowledge; wisdom and practices of the local population take action in search of solutions to health, production and conservation problems. In addition to this, the rescue, conservation and recognition of traditional crops and popular knowledge are indispensable tools for the agro ecological transition (Delwing *et al.*, 2007) [7]. One of the categories raised in ethnobotanical studies is medicinal plants, whose use is extremely important in promoting the health of remotely located communities, and this knowledge is of great interest in ethnobotany and ethno-pharmacological chemistry (Oliveira 2010) [21]. Such studies can occur in a random, ethological, chemotaxonomic or ethnodirigid manner (Albuquerque 2006) [1].

Brazil has hundreds of traditional indigenous and non-indigenous groups who have extensive knowledge about the different forms of exploitation and management of natural resources, especially on plant species (Fonseca-Kruel *et al.* 2005) [8], especially regarding the use of plants for Therapeutic purposes. Therefore, ethnobotany can considered as an instrument for valuing traditional knowledge where the intellectual property rights of local communities respected, and guarantees the necessary conditions for the maintenance of socio-cultural structures in a process of reproduction of traditional knowledge associated with economic and environmental interests (Rodrigues *et al.*, 2009) [26]. Thus, the ethnobotanical medical study is an important tool to leverage the discoveries of potentially active molecules and generation of patents that will benefit Brazilian patients and researchers at a time when Brazil must assume a clear position of defense of its biological heritage before the international community (Rezende; Monteiro, 2002) [25].

In the northeastern region of Brazil, ethnobotanical studies in the Littoral Zone of Pernambuco state, the category of medicinal plants was the one that presented the highest number of species in all the communities studied among the other categories (food, commerce, construction, magic, others). Plants used mainly in the treatment of respiratory diseases, problems in the digestive system, as antifebrile, renal problems, anti-inflammatory and cicatrizing activity (Silva *et al.*, 2005) [8, 31].

On the other hand, in the northern region of Brazil, specifically in the Amazon forest there is a high diversity of species, making this biome of vital importance for health, since the high chemical diversity related to biological

diversity suggests a greater possibility of compounds with activity therapy (Suffredini & Daly, 2001). One hundred and two ethno species of medicinal use collected in the communities of São João do Tupé and the Central Colony, located in the surroundings of the Rio Negro Basin, resulting in 86 botanical species, gathered in 52 families. The main uses were for the treatment of inflammations and pains, gastrointestinal diseases and diseases related to the liver and kidneys. Some plants have restricted application and used in the treatment of one disease (38 species), while others offer broader applications such as copaiba and Marajo, which were indicated for the treatment of seven diseases each (Scudeller & Veiga, 2009) [29]. In Rondônia, ethnobotanical studies in the communities of Rolim de Moura and Santa Luzia identified five species that were more reliable to analyze chemically, due to the importance they carry out locally through the calculations of the Consensus Factor Index between Informers and Relative Importance (Jesus & Possimoser, 2013). According to Shanley & Luz (2003) [30], 211 ethno pharmacies among herbs, shrubs and trees were used in the inventory carried out in 23 establishments selling medicinal plants in Belém, which are used to treat cramps, urinary infections, fevers, coughs, wounds and fatigue.

In this context, this research based on scenarios of riparian populations of Tapajós River, whose objective was to characterize the ethnobotanical profile and the diversity of traditional knowledge about the use of plants among the three riverside communities studied in savanna ecosystems.

Material and Methods

Description of the study area

The study area is located within the Eixo-Forte Agro-Extractive Program (PAE), created by the National Institute of Colonization and Agrarian Reform (INCRA) in 2005 and has an area of 12,689.00 hectares and consists of sixteen communities (PINTO, 2013) [24]. According to INCRA, this modality of settlement is destined to the exploitation of extractive wealth, through economically viable, socially just and ecologically sustainable activities carried out by the populations with the origin of extractive communities (PINTO, 2013) [24]. This region was contemplated in 2012 with the Local Productive Arrangement Project of Medicinal and Phyto therapeutic Plants (APLFITO-STM), promoted by the Ministry of Health as a strategy to implement the National Program of Medicinal Plants and Phytotherapeutics (PNPMF) of 2006. The Eixo-Forte region is located along the highway PA-457 (Everaldo Martins highway) corresponding to the coordinates (2º 24'S, 54º 58'W) and (2º 32'S and 54º 46'W). This region characterized by the presence of savannas. The average annual precipitation in the region is 1,950 mm with a pronounced dry season between June and December, and a rainy season from January to May. The dominant climate in the region is hot and humid, with annual average temperatures varying between 25º and 28ºC. According to the climatic classification of Köppen, Santarém is in the climatic type Am, that is, the climate is humid equatorial with a well-defined dry season and another with high rainfall indexes.

The project developed in the communities of Ponta de Pedras, São Raimundo and Pajussara as follows; each family of farmers interviewed using a semi-structured questionnaire, after signing a Free and Informed Consent Form. The sample was 18 farmers, eight from the community of São Raimundo, seven from the community of Ponta de Pedras and three from the community of Pajussara. The plants mentioned collected and placed in a herbarium, after botanical identification (Scudeller; Veiga; Araújo-Jorge, 2009) [29].

Variables studied

a. The Citation Relative Frequency (RFC): The relative frequency of citations is obtained through the formula: RFC = FC / N, where FC is the number of informants who mentioned the use of the species and N is the total number of informants.
b. Value of use (VU): was calculated using the formula VU = (ΣU) / N, where ΣU is the sum of the number of uses for the species and N is the total number of informants.
c. FL (Fidelity Level): which is based on the agreement between informants responses for main therapeutic indications FL = (Ip / Iu) x 100%, where lp is equal to the number of uses per plant per symptom and lu Is equal to the number of plant uses for any purpose.
d. Relative Popularity (RP): calculated by the ratio of the number of informants who cited a given species, by the number of informants who cited the most cited specie.
e. ROP (Rank Order Priority): is calculated using the formula ROP = FL x RP, where FL is the loyalty level and RP is the relative popularity.

Statistical analysis

The following statistical analyzes were performed; 1. Descriptive statistics, 2. Friedman tests, 3. Kruskal Whalis tests and 4. Shannon Winner test. The program used was Bioestat 5.3 (Ayres, 2015).

Results and Discussions

Sixty-eight (68) medicinal plants listed according to their popular names, among which 44 species identified in 25 families according to Table 1. The relative frequency of citations (Figure 1) shows that Cidreira (*Lippia alba*) is the plant with the highest relative frequency of citations (0.83) followed by Capim Santo (*Cymbopogon citratus*) (0.44) and Babosa (0.33). These data suggest that Cidreira (*Lippia alba*) is of great importance for health maintenance in these communities. Therefore, understanding the physiology of these plants is necessary to promote new ways of managing them in agriculture. These data are in apparent agreement with the data found in the in Rondônia, which verified in an ethnobotanical regional study that among the plants that obtained the highest number of citations were mint, boldo, lemon grass, lemon balm, rue, mint -pine, cotton and alfavaca (Lima And Santos, 2006) [17].

When the descriptive statistics of the relative frequency of medicinal plants were carried out by community (Table 2), it was observed that the community of Pajussara obtained the highest relative frequency of citations of medicinal plants (0.16) followed by the community of Ponta de Pedras (0.14) and São Raimundo (0.11) suggesting that communities apparently present the same traditional knowledge. The application of the Friedman test to compare the relative frequencies of citations of medicinal plants in each

community, showed according to Table 3 and Figure 2, that these were not significant (p = 0.2368). Confirming the result of the descriptive statistics. Although the communities in question are relatively distant and the exchange of residents is not so frequent, it may be observed that the traditional knowledge about medicinal plants is relatively the same, although in Pajussara a tendency towards greater knowledge has been revealed.

Four species identified in the three communities for the same conditions. They Cidreira (*Lippia alba*) and Passionflower used as a sedative, Arruda for headache and Improvement for Fever. Cidreira also used in the three communities for Stomach Pain.

Through the use of Shannon Winner test, it was possible to estimate the diversity of knowledge among the communities, finding that it was higher in the community of São Raimundo (0.81) followed by Ponta de Pedras community (0.76), and then by Pajussara Community (0.46), as shown in Table 4. In Pajussara, the homogeneity of knowledge about the use of medicinal plants was higher (0.96) followed by the communities of São Raimundo and Ponta de Pedras where very similar values were found (0.89). These data suggest that traditional knowledge passed more evenly among families in the Pajussara community, and less in other communities.

The plants with the highest value of use were Cidreira (0.72) Capim Santo (0.50), Mint (0.50), Babosa (0, 44), Arruda (0.38), Mejoral (0,33) Mint Leaf Thick, White Paw, Sara All, Came From Here, Purple Cotton, Cumaru, and Pareto Elixir as shown in Figure 3.

In view of these data, it suggested that these species deserve more studies on plant physiology so that in the future it will be possible to propose management forms more appropriate to the local reality in order to produce plants with greater therapeutic efficiency.

The Erva Cidreira (*Lippia alba*), has been throughout the study demonstrating its great importance in traditional local medicine, has been popularly used as a sedative, stomachache, colic, fever, flu, headache, cough, nausea, gas, hydration and malaise. This is in agreement with the information by Aguirre *et al.* (2006). In relation to Capim Santo *(Cymbopogon citratus)*, the popular uses reported for bad looks, calming, flu, stomach pain, headache, colic indigestion, pain, gas and intestinal problem. This is in agreement with the information collected from the literature (Blanco *Et al.*, 2009; Carbajal; Gomes; Koh *et al.* 2012) [3]. The affections mostly taken care of populations with the use of medicinal plants, as seen in Figure 4, influenza / cold, stomach pain, broken / evil eye, headache and inflammation. The data found are partially divergent from those collected in an ethnobotanical survey in the communities of São João Tupé that demonstrated that the plants mainly used in the treatment of inflammation and pain, gastrointestinal diseases and diseases related to the liver and kidneys (Scudeller *et al.*, 2009) [29].

There were 45 conditions treated primarily with medicinal plants in a universe of 68 ethno - drugs. This data is proportionally higher than that found by Kumar & Bharati, (2014) [15] in the Tharu tribes in Dudhwa Park in Nepal who found 97 ethnopharmacates for treatment of 49 conditions. The ROP (Rank Order Priority) of the plants that had the greatest use for each condition were Cidreira (*Lippia alba*) as relaxing drug (44.44), Lemon for Influenza / Cold (26.66), Cidreira for Stomach Pain (16), Passionflower as Soothing (15) (15, 15) Capim Santo (*Cymbopogon citratus*) as Relaxing (13.33) and *Aloe* for Burns and Injuries (10, 10). In a master's thesis defended in 2013, Braga *et al.* (2013) [4], demonstrated that Arruda (FL = 100) was indicated in the treatment of tummy and stomach pains. The Cidreira (*L. Alba*), Arruda and Capim Santo (*Cymbopogon citratus*) are often mentioned in ethnobotanical studies of Amazonian or non-native populations (Braga, 2013; Guimarães, 2010; Lima; Santos, 2006; Monteiro, 2002) [10, 25, 17]. However, studies have shown that the determination of these consensus indices and the establishment of correlation between them makes it possible to gauge the importance of medicinal plants to local population through the frequency and consistency of their use, with a large margin of safety (Moura *Et al.*, 2005) [20]. Taking into account only the Loyalty Level (NF) it is not possible to fully evaluating the relevance of a particular species for a specific use, since only one person cited several treatments that obtained a level of 100% fidelity. Thus, the need to interpret these data in concomitance with ROP (Rank Order priority) is clear.

Table 1: Medicinal plants and Relative Frequency of Citations (FRC) observed by rural families at Ponta de Pedras, São Raimundo and Pajussara communities, Santarém, Pará, Brasil.

Popular name	Nome científico	Família	Frequência Relativa de Citações
Abacate	*Persea americana* Mill.	Lauraceae	0.055555556
Alfavaca	*Ocimum micranthum* Willd.	Lamiaceae	0.166666667
Algodão Roxo	*Gossypium arboreum* L.	Malvaceae	0.166666667
Amor Crescido	*Portulaca pilosa* L.	Portulacaceae	0.055555556
Anador	*Alternanthera bettzichiana* (Regel) G.Nicholson	Amaranthaceae	0.111111111
Andiroba	*Carapa guianensis* Aubl.	Meliaceae	0.055555556
Arruda	*Ruta graveolens* L.	Rutaceae	0.277777778
Babosa	*Aloe vera* (L.) Burm. f.	Xanthorrhoeaceae	0.333333333
Barbatimão Branco	*Plathymenia reticulata* Benth.	Fabaceae	0.055555556
Barbatimão Roxo	*Bowdichia virgilioides* Kunth	Fabaceae	0.055555556
Boldinho	*Coleus barbatus* (Andrews) Benth.	Lamiaceae	*0.166666667*
Boldo	*Coleus barbatus* (Andrews) Benth.	Lamiaceae	*0.166666667*
Boldo Amargo	*Coleus barbatus* (Andrews) Benth.	Lamiaceae	*0.055555556*
Boldo Fedorento	*Coleus barbatus* (Andrews) Benth.	Lamiaceae	0.055555556
Boldo Folha Larga	*Plectranthus barbatus* Andrews	Lamiaceae	0.055555556

Boldo Grande	*Plectranthus barbatus* Andrews	Lamiaceae	0.055555556
Breu Branco	*Dacryodes microcarpa* Cuatrec.	Burseraceae	0.055555556
Cana Mansa	Costus arabicus L.	Costaceae	0.055555556
Canela	*Cinnamomum zeylanicum* Blume	Lauraceae	0.055555556
Capim Limão	*Cymbopogon citratus* (DC.) Stapf	Poaceae	0.055555556
Capim Santo	*Cymbopogon citratus* (DC.) Stapf	Poaceae	0.444444444
Carmelitana	*Lippia alba* (Mill.) N.E. Br. ex Britton & P. Wilson	Verbenaceae	0.166666667
Cidreira	*Lippia alba* (Mill.) N.E. Br. ex Britton & P. Wilson	Verbenaceae	0.833333333
Citronela	*Cymbopogon winterianus* Jowitt	Poaceae	0.055555556
Corama	*Bryophyllum calycinum* Salisb.	Crassulaceae	0.055555556
Crajiru	*Arrabidaea chica* (Bonpl.) B. Verl.	Bignoniaceae	0.055555556
Cumaru	*Dipteryx odorata* (Aubl.) Willd.	Fabaceae	0.166666667
Cumaruzinho	*Justicia pectoralis* Jacq.	Acanthaceae	0.222222222
Diabinho	*Alternanthera ficoidea* (L.) Sm.	Amaranthaceae	0.055555556
Escama de Pirarucu	*Bryophyllum calycinum* Salisb.	Crassulaceae	0.166666667
Gengibre	*Zingiber officinale* Roscoe	Zingiberaceae	0.222222222
Goiaba Branca	*Psidium guineense* Sw.	Myrtaceae	0.055555556
Hortelã Folha Grossa	*Plectranthus barbatus* Andrews	Lamiaceae	0.277777778
Hortelã Nenem	*Mentha pulegium* L.	Lamiaceae	0.055555556
Hortelã Vick	*Mentha spicata* L.	Lamiaceae	0.111111111
Hortelãzinha	*Mentha pulegium* L.	Lamiaceae	0.333333333
Jabuticaba	*Plinia cauliflora* (Mart.) Kausel	Myrtaceae	0.055555556
Japana	*Ayapana triplinervis* (M. Vahl) R. M. King & H. Rob.	Asteraceae	0.055555556
Jucá	*Caesalpinia ferrea* Mart. ex Tul.	Fabaceae	0.055555556
Limão	*Citrus limon* (L.) Osbeck	Rutaceae	0.222222222
Manjericão	*Ocimum basilicum* L.	Lamiaceae	0.222222222
Maracujá	*Passiflora edulis* Sims	Passifloraceae	0.222222222
Marupaí	*Eleutherine plicata* Herb.	Iridaceae	0.055555556
Marupazinho	*Eleutherine plicata* Herb.	Iridaceae	0.222222222
Mastruz	*Chenopodium ambrosioides* L.	Amaranthaceae	0.111111111
Melhoral	*Plectranthus amboinicus* (Lour.) Spreng.	Lamiaceae	0.277777778
Mucuracaá	Petiveria alliacea L.	Phytolaccaceae	0.055555556
Noni	*Morinda citrifolia* L.	Rubiaceae	0.055555556
Pau de Angola	*Piper alatipetiolatum* Yunck.	Piperaceae	0.055555556
Peão branco	*Gossypium herbaceum* L.	Malvaceae	0.222222222
Peão roxo	*Jatropha gossypiifolia L.*	Euphorbiaceae	0.166666667
Salva de Marajó	*Hyptis crenata* Pohl ex Benth.	Lamiaceae	0.055555556
Sara Tudo	*Justicia pectoralis* Jacq.	Acanthaceae	0.333333333
Sucuba	*Himatanthus articulatus* (Vahl) Woodson	Apocynaceae	0.055555556
Trevo Cumaru Roxo	*Justicia pectoralis* Jacq.	Acanthaceae	0.055555556
Uriza	*Pogostemon heyneanus* Benth.	Lamiaceae	0.055555556

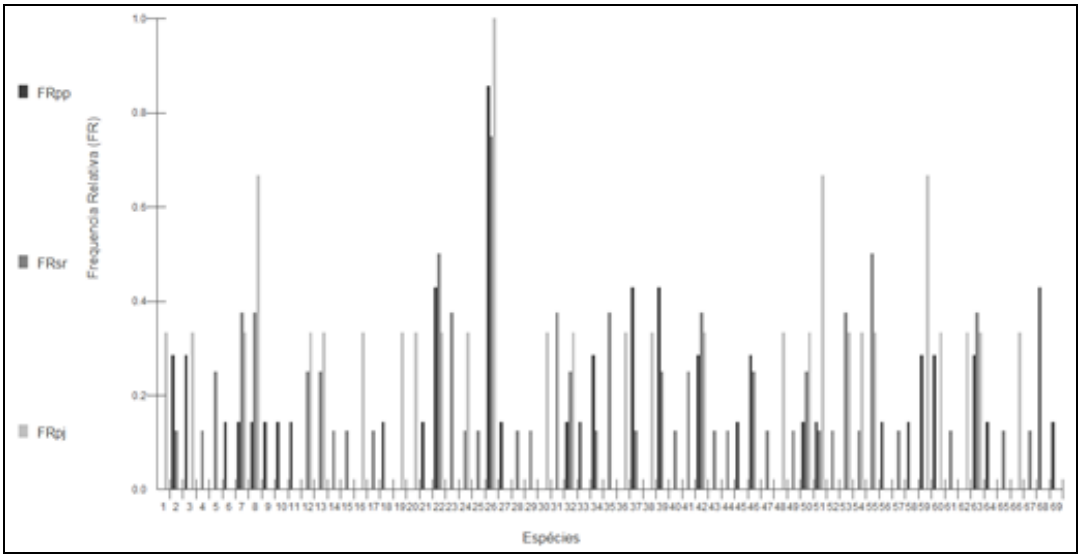

Fig 1: Relative frequency of Citations (FRC) of plant species raised in the communities of Ponta de Pedras, São Raimundo and Pajussara, Santarém, PA, Brazil.

Table 2: Descriptive statistics about the Relative Frequency of Citations (FRC = NC / N where NC = Number of informants who cited the species and N = total number of informants) of the medicinal plants raised in the communities of Ponta de Pedras, São Raimundo and Pajussara.

Frequency Relative (FR)	FR Ponta de Pedras	FR São Raimundo	FR Pajussara
Size amount	68	68	68
Minimum	0.0000	0.0000	0.0000
Maximum	0.8571	0.7500	1.0000
Total Amplitude	0.8571	0.7500	1.0000
Arithmetic Media	0.1077	0.1395	0.1594
Standard deviation	0.1576	0.1583	0.2185

Table 3: Friedman Test comparing the relative frequencies of citations (FRC = Number of individuals that quoted the species / total number of individuals in each community, Ponta de Pedras, São Raimundo and Pajussara).

Parameters	Communities		
FRC	Ponta de Pedras	FRC São Raimundo	FRC Pajussara
Ranks Sum =	129.0000	149.0000	136.0000
Ranks Media =	1.8696	2.1594	1.9710
(p) =	0.2248		

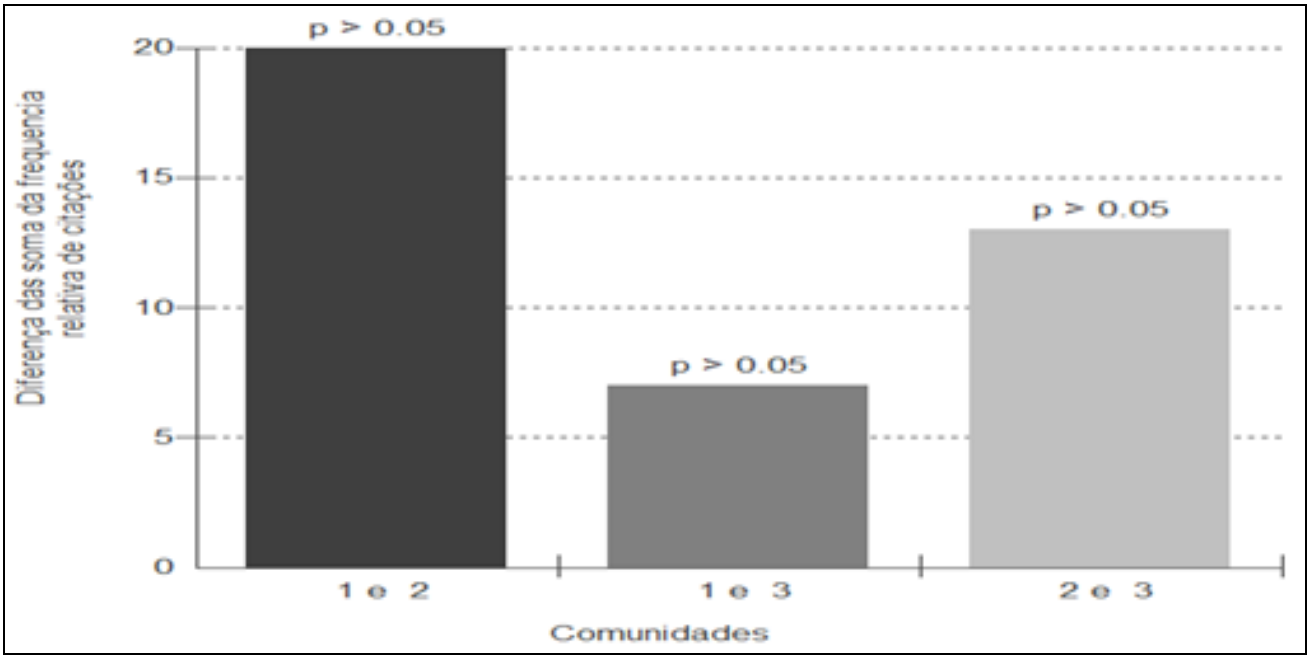

Fig 2: Results of the Friedman Test regarding the comparison of relative frequencies of citations (FRC = Number of individuals that quoted the species / total number of individuals in each community).

Table 4: Shannon - Wiener test for the diversity knowledge analysis of medicinal plants raised in the communities of Ponta de Pedras, São Raimundo and Pajussara, Santarém Pará, Brazil.

Communities	Ponta de Pedras	São Raimundo	Pajussara
Size amount	53	77	33
Categories Number	7	8	3
Shannon-Wiener Index	0.7589	0.8105	0.4606
Maximum diversity	0.8451	0.9031	0.4771
Homogenity	0.8980	0.8974	0.9653
Heterogenity	0.1020	0.1026	0.0347

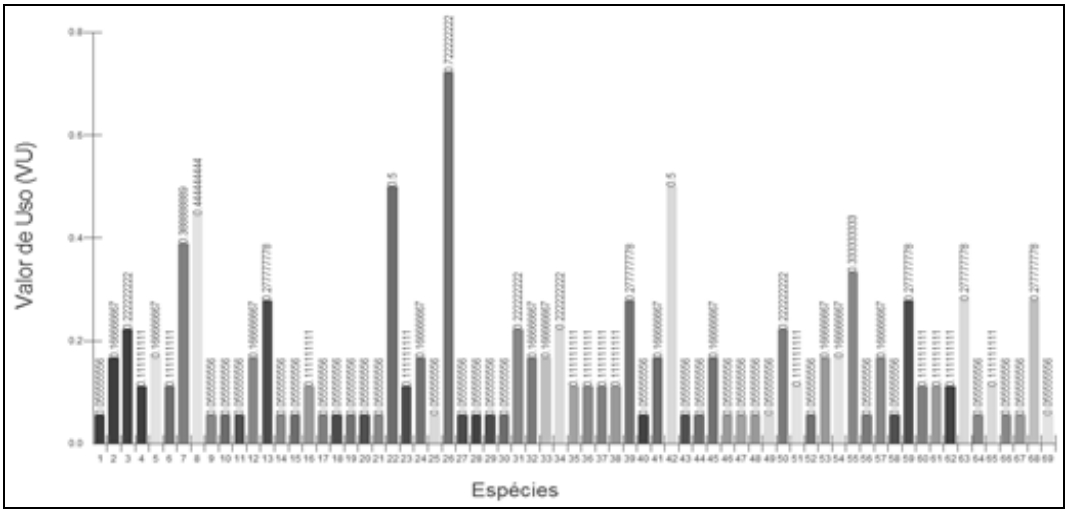

Fig 3: Results of Use Values (VU Sum of uses / N = total number of informants) of the 69 medicinal plants raised in the communities of Ponta de Pedras, São Raimundo and Pajussara, Santarém Pará, Brazil.

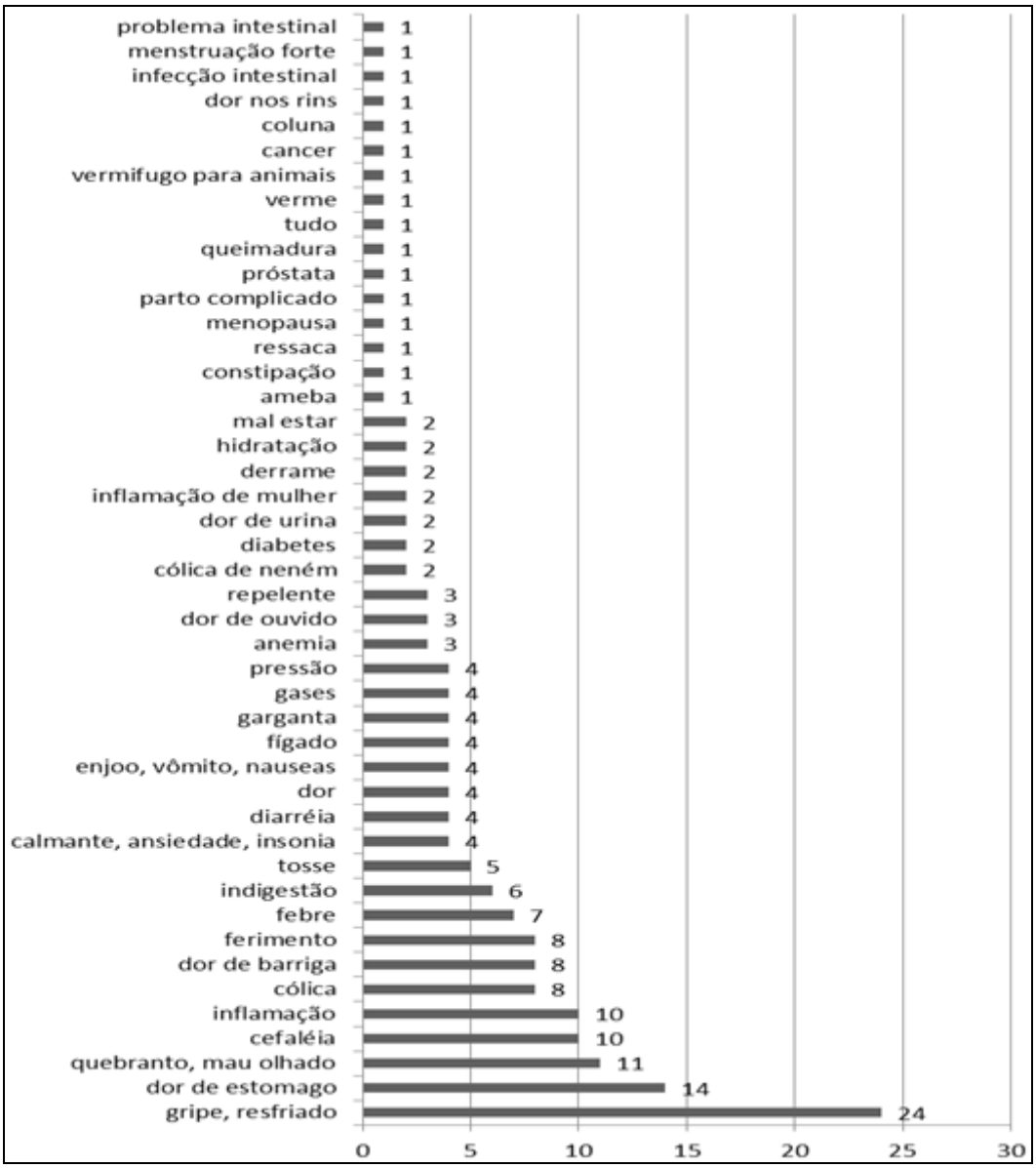

Fig 4: Relation of species of medicinal plants mentioned by affections.

Conclusions

Research concludes that the traditional plant knowledge by riparian communities in Tapajós River Basin presents diversity among the communities studied, which is a rich scenario, with a greater or less homogeneity of this diversity by community. Medicinal plants such as like Erva Cidreira (*Lippia alba*); Capim Santo (*Cymbopogon citratus*) and Cumaruzinho (*Justicia pectoralis*) deserve attention, since they are the species with the highest values of use. A high rate of diseases treated by medicinal plants indicated in the ethnobotanical survey observed, demonstrating the richness of the traditional knowledge of the riverside communities in savanna ecosystems in the Tapajós River Basin.

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