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Traditional Knowledge of Forest Medicinal Plants of Munduruku Indigenous People - Ipaupixuna

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Authors' contributions

This work was carried out in collaboration between both authors. Author PCO performed the ethnobotanical analyses and wrote the article. Author BCOQS conducted ethnobotanical interviews, recorded photographs and made the excicatas. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: The traditional knowledge about the use of typical flora of forests such as the Amazon rainforest, is undoubtedly an intangible richness of indigenous populations. Recording this knowledge to value it is essential in the construction of contemporary history, especially in the present times of invasion of the Indigenous Territories. Thus, the objective of this research was to elucidate from ethnobotanical diagnoses the useful flora of Munduruku indigenous families, as a renewable and exploitable natural resource. The working hypothesis was to confirm the dependency of these local communities on the forests, while medicinal environments.
Study Design: The structure of the research was based on three moments: 1. Intervention with the human component (conducting interviews with indigenous families); 2. Intervention with the plant component (preparation of the excicatas of the cited plants and taxonomic identification); 3. Analysis of human and plant components (ethnobotanical study).
Place and Duration of Study: The research developed in a village called Ipaupixuna, whose indigenous families are from Munduruku ethnic group. The duration of the research was six (6) months.

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Methodology: The analysis was characterized by Quantitative ethnobotany whose variables analyzed were Relative Frequency of Citation, Use Valour, Level of Fidelity, Relative Popularity and Rank Order Priority. The statistical analysis comprised a Linear Pearson Correlation Matrix for dimensioning the correlation between the ethnobotanical variables.
Results: The results showed rich diversity of species, with 110 plants being raised used by indigenous families in five categories: medicinal, food, crafts, construction and cosmetics. *Arecaceae* was the botanical family with the highest number of medicinal species. *Dipteryx odorata* was the specie with the highest Relative Frequency, while *Plectranthus amboinicus and Caesalpinia ferrea* as well as *Fredericia chica* presented high Use Value for the indigenous.
Conclusions: The indigenous families of Munduruku ethnic group of Tapajós river Basin studied in this research, have in the Forest and in its backyards, sources of plants for multiple uses, thus evidencing the high dependence between indigenous people and Forests. The creation of new spaces called Medicinal Forests and Ethnogardens is essential to contributing to the health safety of indigenous families.

Keywords: Ethnobotany; medicinal forests; ethnogardens; amazon natural resources.

1. INTRODUCTION

The legal Amazon with its indigenous cultural diversity reveals to us every day, a traditional knowledge about medicinal plants from the forest, rich and essential not only for valuing the healing traditions and sustainable use of the forest, but also for possible prospects about technological innovation of phytopharmaceuticals. The forest therefore works as a great source of socioeconomic sustainability for traditional populations such as indigenous populations, since from there, they remove plants for various uses, such as food, for construction, for handicrafts, for mystical rituals, but above all, they extract medicinal plants. This last category of plants in most works [16,19,9,20] is the one with the greatest diversity, which further demonstrates the vital character that forests in the Amazon have for indigenous populations, that is, they represent the health security of these villages that are always in remote areas. These indigenous territories are currently threatened by illegal deforestation, illegal mining and the expansion of soy monoculture in the Amazon, are some of the examples, therefore, of the fragility that forest ecosystems are experiencing and, consequently, indigenous families as well.

In this scenario of indigenous territorial insecurity, specifically in the Tapajós River Basin, daily life is revealed in a resilient way in the wisdom of traditional populations regarding the use of forest plants according to research in this region [22,18,23,27,28,21]. These authors, from research with ethnobotany in the Tapajós River Basin in the last decades, observed the diversity that exists between the traditional knowledge of quilombolas (afro descendants), indigenous people, riverside and lowland agroextractivists, as well as common plant species between these groups, such as thick leaf (Plectranthus amboinicus (Lour.) Spreng), suggesting transmission of knowledge throw different traditional populations.

In other countries in the Legal Amazon, such as Peru, they also describe a great diversity of traditional knowledge about the use of medicinal plants. In a study of the medicinal plants of North of Peru [5], the majority (83%) of the 510 species used were native to Peru, where 50% of them used in the colonial times disappeared from the pharmacopoeia. This is a typical knowledge erosion in the contexts of traditional communities, that occurs contemporary.

In this scenario, the objective of this research was to perform ethnobotanical diagnosis in the Indigenous Village of Ipaupixuna which is under threat from its territory and therefore from its traditional knowledge, in order to systematically record and value such knowledge in the modern indigenous cultural universe. It was also proposed the creation of models of medicinal forests and ethnogardens based on the value of use that the mentioned plant species had for indigenous families.

2. MATERIALS AND METHODS

2.1 Social and Economic Aspects

The place of study was Ipaupixuna Village located in the municipality of Santarém in West of Pará state, whose geographic coordinates are 02º32´46" S, 54º20'15" W. The families are

of Munduruku ethnicity and practice agroextractivism in their territory as a way of economic survival, with cassava (*Manihot Sculenta Crantz*) and corn (*Zea Mays L.)*the main agricultural crops planted. Other species are those produce oils, native fruits, fibers and wood, both extract from forest throw seasonal extraction. Currently, the Ipaupixuna village is threatened by deforestation and expansion of soybean (*Glycine max L.)*in situ and regionally on second level heading.

2.2 Research Dynamics

The ethnobotanical analysis was carried out in five stages: A. presentation of the research to Cacique (leader of Village and the families involved) and request for authorization to perform it; B. Registration of research with SISGEN (National System for the Management of Genetic Heritage and Associated Traditional Knowledge) as well as it occurred out under the Nagoya Protocol on Access to Genetic Resources; C. Conducting interviews / family, twenty in all; D. Taxonomic identification of the mentioned species: inicially the small branches of leaves/flowers were collected which were pressed between cardboards for further drying; once the plant material was completely dried, it was mounted on cardboard and attached a label with collection information, scientific and vulgar name of the plant; E. Data synthesis, calculation and ethnobotanical analysis.

2.3 The Evaluated Parameters and Statisctical Approach

The parameters evaluated were: A. Relative Citation Frequency (FRC): FRC = FC / N, where: FC = number of informants who mentioned a given species; N = total number of informants; B. Use Value (UV): UV = (ΣU) / N, where ΣU = sum of number of uses of a given species mentioned by the informants and N = total number of informants. The Use Value identifies the importance that each species of plant has for informants[25]; C. Fidelity Level (FL): identifies the consensus that informants have on the main use of a given species in relation to other uses [11], with the formula FL = (Ip / Iu) x 100%, where: Ip = number of informants who cited the use of a given species for the main therapeutic indication and Iu = total number of informants who mentioned the plant for any therapeutic indication, multiplied by 100; D. Rank Order Priority (ROP): identifies which species are a priority for population studied [2], ROP = NF x PR Where: FL = level of fidelity and PR is relative popularity of species; E. Relative Popularity (RP) is given by the ratio of the number of informants who cited a given species, by the number of informants who cited the most cited species. The statistical analysis comprised a Linear Pearson Correlation Matrix for dimensioning the correlation between the ethnobotanical variables. The statistical program used was BIOSTAT 5.3 [3].

3. RESULTS AND DISCUSSION

The results showed a rich diversity of plants useful to indigenous Mundurukus families, who reported a total of eighty eight (88) plants (Table 2) distributed in 39 botanical families, where medicinal species are mentioned for 30 therapeutic indications. These plants are in these categories; medicinal, food, handicrafts, construction and cosmetics, although some of them are used in more than one category. These data suggest the high level of sustainability of these families, who remove a large part of their needs from the forest. These data are in agreement with works [5], who also observed different subcategories of medicinal plants reported by families in Northern Peru, such as: common and exotic plants, plants for common diseases, plants only used by healers, and plants with magical purposes, a very interesting and systematic way to organize the biodiversity of medicinal plants.

Among the categories of plants reported by the indigenous families of Ipaupixuna, species for medicinal use are in greater number, followed by plants for food and plants for handicrafts according to Fig. 1. These results suggest that health contexts in indigenous settings, with health posts sometimes far away, which means that the indigenous Munduruku population of Ipaupixuna, associated with the strong fact that they are culturally cured with resources from the local flora, exploit as many of these plants as possible. Sixty-eight (68) species for medical use were observed (Table 1), followed by thirty-seven (37) food species, seven (7) species for making handicrafts, two (2) for use as cosmetics and one (1) for construction. Thus, health and food issues in indigenous settings can largely be resolved with the practice of extractivism, thus, the importance of forest conservation in Indigenous Territories (ITs) is fundamental for survival and reproduction of indigenous Mundurukus populations. However, Ipaupixuna Village is currently experiencing threats from its

territorial limits due to the expansion of soy monoculture, where there has already been deforestation and that, consequently, the suppression of vegetation, which not only contributes to the loss of biodiversity but mainly to threat to the survival of indigenous populations that, according to this study, depends on 110 species of the forest.

When the results are analyzed taxonomically at the botanical family level (Fig. 2), we observe that some of them stand out, as is the case with Arecaceae; *Lamiaceae; Rutaceae; Malpighiaceae; Anacardiaceae; Fabaceae and Myrtaceae*. Therefore, these botanical families are of medicinal importance in indigenous backyards, given that some of them are cultivated (small) and others are in the forest. Thus, changes in landscapes of secondary or primary forests may interfere with the reproduction of traditional knowledge about tree species of medicinal use by indigenous populations. These data also point out that the cultivation and management of species of these botanical families is essential for their sustainability in agroextractive scenarios and the horizontal transmission (between different indigenous families) about traditional knowledge of botanical families overlaps those less mentioned as:*Adoxaceae; Amaranthaceae; Apocynaceae; Brassicaceae; Caricaceae; Dioscoreaceae; Iridaceae; Labiatae; Lecythidaceae; Meliaceae; Pedaliaceae; Piperaceae; Zingiberaceae.*

The Relative Frequency of Citation of the thirty-seven (37) medicinal species with the highest values demonstrated that Cumaru (*Dipteryx odorata (Aublet.) Willd)*; Jucá (*Caesalpinia ferrea Mart. Ex Tul.);* Mango (*Mangifera indica L.)*and Lemon (*Citrus limon (L) Burm.*) were the most cited (0.6), as shown in Fig. 3. These results indicate that such tree species should be protected in their backyards and / or forests given the importance for indigenous families in Ipaupixuna. Cumaru, mango, jucá and lemon, therefore, in indigenous settings it is an alternative for the densification of these species and medicinal safety of the Village. The Cumaru was mentioned for use against flu, pneumonia and stroke, while the Jucá (*C.ferrea)* for inflammation, injury, diarrhea; post-surgical recovery; weight loss and headache, which demonstrates its wide functionality. Scientific studies report in fact that the jucá has cellulose, amylase, anticoagulant and larvicidal activities against *A. aegypti* in the aqueous extract of seeds [6], as well as the analgesic and anti-inflammatory action [7,8]. It also was observed antimicrobial activity in a study of the extract of the stem of *C. ferrea* [10]. Thus, the traditional knowledge reported by the indigenous families of Ipaupixuna Village about the use of jucá is scientifically proven by countless works, hence the importance of preserving environments where this tree naturally occurs, that is, in the forests of indigenous territories.

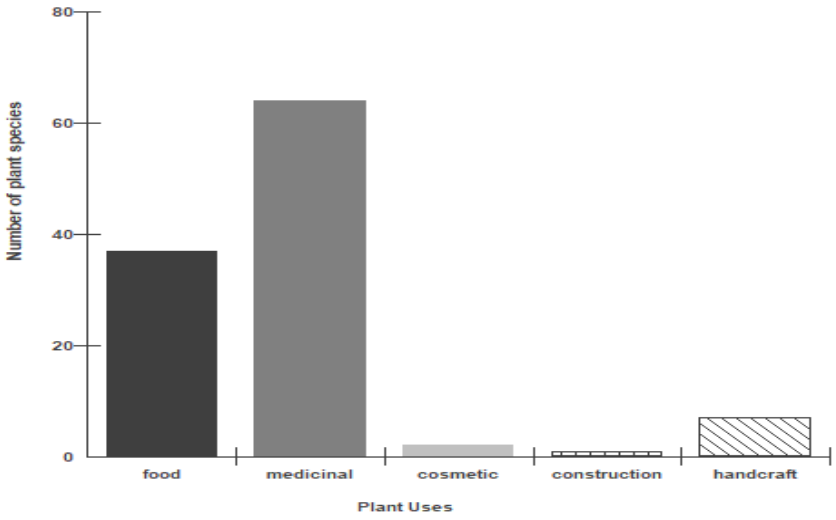

Fig. 1. Distribution of the number of species by category of use, totaling 110 plant species surveyed by the indigenous families of Ipaupixuna Village, Santarém, Brazil

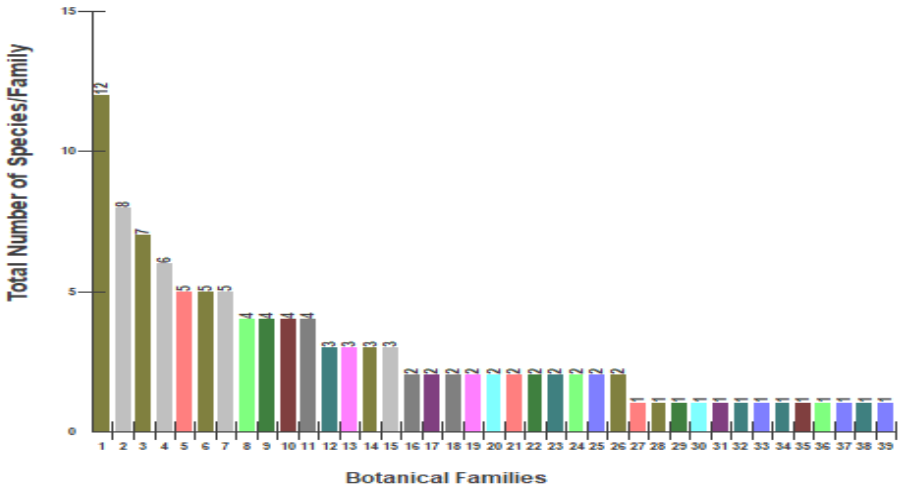

Fig. 2. Total number of medicinal species cited per indigenous family – Ipaupixuna Village, Santarém, Pará, Brazil*

**1. Arecaceae; 2.Lamiaceae; 3.Rutaceae; 4. Malpighiaceae; 5.Anacardiaceae; 6.Fabaceae; 7. Myrtaceae; 8. Alliaceae; 9.Euphorbiaceae; 10.Lauraceae; 11.Poaceae; 12.Annonaceae; 13. Bignoniaceae; 14. Caryocaraceae; 15. Musaceae; 16. Acanthaceae; 17. Apiaceae; 18. Asphodelaceae; 19.Asteraceae; 20.Bixaceae; 21.Humiriaceae; 22.Malpighiaceae; 23.Moraceae; 24.Rubiaceae; 25.Solanaceae; 26.Verbenaceae; 27.Adoxaceae; 28.Amaranthaceae; 29.Apocynaceae; 30.Brassicaceae; 31.Caricaceae; 32.Dioscoreaceae; 33.Iridaceae; 34.Labiatae; 35.Lecythidaceae; 36. Meliaceae; 37. Pedaliaceae; 38.Piperaceae; 39. Zingiberaceae*

As for the specie Cumarú or tonka bean, *(Dipteryx odorata*), also with a high relative frequency of citation by the interviewed families, scientific studies point to its anticancer action [15], which studying some compounds isolated from the cumarú seed extract, such as cassane diterpene, Dipteryx acid, a new isoflavonolignan, 5-methoxyxanthocercin A, as well as four known active compounds, isoliquiritigenin, 6,4'-dihydroxy-3'-methoxyaurone, sulfuretin, and balanophonin, observed a reduction in cancer advancement in rat mammary cells. Like the jucá (*Caesalpinia ferrea Mart. Ex Tul.)* , the cumarú is a tree specie found naturally in forest ecosystems. Investing in the enrichment of secondary forests with cumarú plants can guarantee not only the medicinal use of this specie for future generations in indigenous scenarios, but also for increasing the income of these populations in function of the high commercial value that cumarú seeds have for the pharmaceutical industry and cosmetic.

Regarding the Use Value of medicinal species for Munduruku indigenous families interviewed, one species stands out, Thick Leaf, also called Malvarisco (*Plectranthus amboinicus* (Lour.) Spreng.). This species was mentioned for coughing, asthma, cleaning eyes, flu, inflammation and injury, in accordance with another study [13]. After this species, the others in decreasing order of Use Value were *Caesalpinia ferrea Mart. ex Tul.; Garlic (Allium sativum L.); Ginger / Mangarataia (Zingiber officinale Roscoe.); Lemon (Citrus limon (L) Burm.); Mango (Mangifera indica L.) and Crajirú (Fredericia chica (Bonpl.) LG Lohmann)* as Fig. 4. Interesting to note that although the Cumaru has been the most cited species together with jucá (*Caesalpinia ferrea*), lemon and mango, however, it does not constitute the species with the highest Use Value, but the Thick leaf (*Plectranthus amboinicus*). Therefore, to think about systematic planting throw vegetable garden is where the thick leaf or malvarisco (*Plectranthus amboinicus*) can be the main crop, it would be essential to maintain the tradition of making tea, syrup or ointment with this plant.

Along with *Plectranthus amboinicus*, garlic (*Allium sativum L.)*and ginger / Mangarataia (*Zingiber officinale)* also appeared as species with high Use Value, which, because they are herbaceous, can easily be grown in medicinal gardens or as usual, in the backyards of the houses. Garlic was mentioned for stomach pain, headache, high blood pressure; thud, gas and worms, while ginger for flu, cough; sore throat,

colic and inflammation. Such reports by the indigenous people of Ipaupixuna Village and therefore of the traditional knowledge of the Munduruku ethnic group are confirmed by scientific works [1,29], who observed antimicrobial properties in garlic [14,26,12], and immunostimulants [17]. Thus, the diversity of diseases that the indigenous people can cure due to the use of cultivated flora such as thick leaves, garlic and ginger is real.

Such results show how important are indigenous or ethno-gardens, as little agro-ecosystems vital to maintaining the health of the family (individual) and the indigenous community (collective), too much in function of the solidary habit of exchanging plants between families. Improving ethno-gardens from an agronomic point of view should always be the next step from this research.

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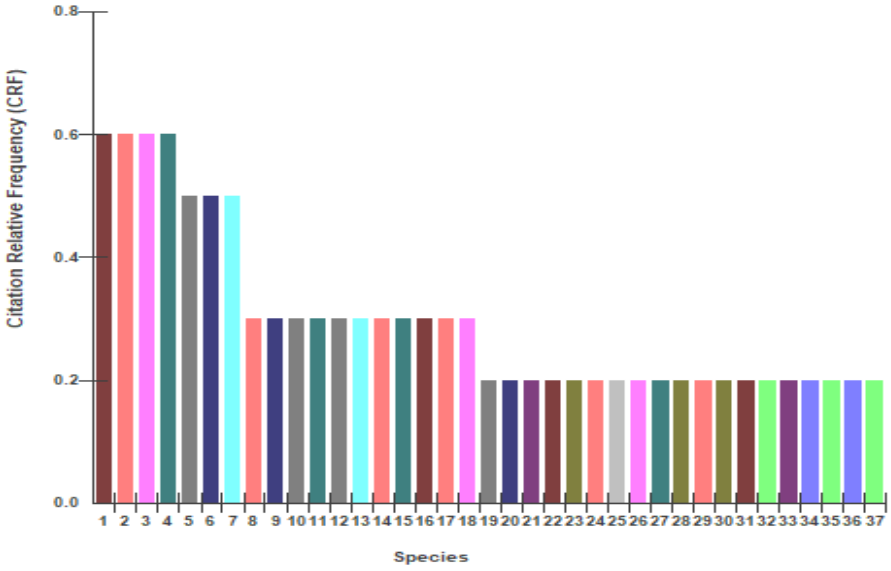

Fig. 3. Relative Frequency of Citation of the first 37 species * of a total of 68 medicinal plants referenced for Munduruku families - Ipaupixuna, Amazon, Brazil*

** 1 – Cumaru (*Dipteryx odorata *(Aublet.) Willd.); 2 – Jucá (Caesalpinia ferrea Mart. ex Tul.); 3 – Manga (*Mangifera indica *L.); 4 – Lemon (Citrus limon (L) Burm.); 5 – Uxi amarelo (Endopleura uchi (Huber) Cuatrec.); 6 – Abacate (Persea americana Mill.); 7 – Ginger/Mangarataia (*Zingiber officinale *Roscoe.); 8 – Santo Grass/Lemon grass (Cymbopogon citratus (DC.) Stapf.); 9 – Nail of Cat (*Uncaria tomentosa *(Wild) DC); 10 – Orange (*Citrus x sinensis *(L.)Osbeck.); 11 – Açaí (Euterpe oleracea Mart.); 12 – Thick Leaf/Malvarisco (Plectranthus amboinicus (Lour.)Spreng.); 13 – Pião Roxo (Jatropha gossypiifolia L.); 14 – Purple Ipê (*Handroanthus impetiginosus *(Mart. ex DC.)Mattos); 15 – Andiroba (*Carapa guianensis *Aubl.); 16 – Sucuba (Himatanthus sucuuba (Spruce ex Mull.Arg.) Woodson); 17 – Sara-tudo (Justicia acuminatissima (Miq.) Bremek.); 18 – Cidreira (Lippia alba (Mill.) N.E.Br.); 19 – Cashew (*Anacardium occidentale *L.); 20 – Soursop (*Annona muricata *L.); 21 – Crajirú (Fredericia chica (Bonpl.) L.G. Lohmann); 22 – Coramina (Pedilanthus tithymaloides (L.) Poit.); 23 – Piquiá (Caryocar villosum (Aubl.) Pers.); 24 – Murici (*Byrsonima crassifolia *(L.) H.B.K.); 25 – Eucalyptus(*Eucalyptus globulus *Labill.); 26 – Purple Cotton (Gossypium barbadense L.); 27 – Coco (Cocos nucifera L.); 28 – Small bilberry(Plectranthus barbatus Andrews); 29 – Marupazinho (Eleutherine plicata Herb.); 30 – Salva of Marajó (Lippia origanoides Kunth); 31 – Babosa (*Aloe vera *(L.) Burm); 32 – Elixir Paregórico (Piper callosum Ruiz & Pav.); 33 – Arruda (*Ruta graveolens *L.); 34 – Mastruz (*Dysphania ambrosioides *(L.) Mosyakin & Clemants); 35 – Alfavaca (Ocimum americanum L.); 36 – Garlic(*Allium sativum *L.); 37 – Preciosa (Aniba canelilla (Kunth) Mez.)*

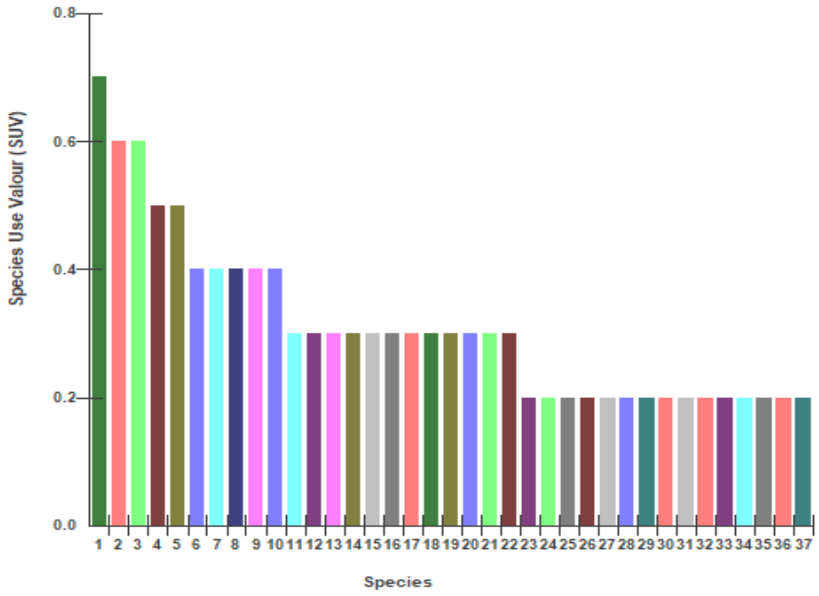

Fig. 4. Use Value (SUV) of the first 37 species of medicinal plants* of a total of 68 referenced for Munduruku families - Ipaupixuna, Amazon, Brazil*

**1 - Thick Leaf/Malvarisco (Plectranthus amboinicus (Lour.) Spreng.); 2 – Jucá (Caesalpinia ferrea Mart. ex Tul.); 3 - Garlic (Allium sativum L.); 4 - Gengibre/Mangarataia (*Zingiber officinale *Roscoe.); 5 – Limão (Citrus limon (L) Burm.); 6 - Manga (*Mangifera indica *L.); 7 - Crajirú (Fredericia chica (Bonpl.) L.G. Lohmann); 8 - Abacate (Persea americana Mill.); 9 - Ipê roxo (*Handroanthus impetiginosus *(Mart. ex DC.) Mattos); 10 – Pião branco (Jatropha curcas L.); 11 - Uxi amarelo (Endopleura uchi (Huber) Cuatrec.); 12 - Cumaru (*Dipteryx odorata *(Aublet.)Willd.); 13 – Cashew (Anacardium occidentale L.); 14 - Orange (*Citrus x sinensis *(L.) Osbeck.); 15 - Pião Roxo (Jatropha gossypiifolia L.); 16 - Eucalipto (Eucalyptus globulus Labill.); 17 – Purple Cotton (Gossypium barbadense L.); 18 – Hortelãzinho (Mentha x villosa Huds.); 19 - Salva do Marajó (Lippia origanoides Kunth); 20 - Babosa (*Aloe vera *(L.) Burm); 21 - Alfavaca (Ocimum americanum L.); 22 – Malva do Reino (Plectranthus amboinicus (Lour.) Spreng.); 23 - Preciosa (Aniba canelilla (Kunth) Mez.); 24 - Graviola (Annona muricata L.); 25 – Japana Roxo (Eupatorium triplinerve M.Vahl.); 26 - Açaí (Euterpe oleracea Mart.); 27 - Piquiá (Caryocar villosum (Aubl.) Pers.); 28 - Murici (Byrsonima crassifolia (L.) H.B.K.); 29 – Pupunha (Bactris gasipaes Kunth.); 30 - Coco (Cocos nucifera L.); 31 - Marupazinho (Eleutherine plicata Herb.); 32 – Azeitoneira (Syzygium jambolanum (Lam.) DC); 33 – Melhoral (Justicia pectoralis Jacq.); 34 – Amora (Morus nigra L.); 35 - Andiroba (Carapa guianensis Aubl.); 36 - Sucuba (Himatanthus sucuuba (Spruce ex Mull.Arg.) Woodson); 37 – Arruda (Ruta graveolens L.)*

The Rank Order Priority (Fig. 5) of the species raised in the ethnobotanical study, it was observed that the three most priority medicinal species for the Munduruku indigenous population studied were cumarú (tonka bean), lemon and Uxi-amarelo (*Endopleura uchi)*. The Uxi-amarelo (*E. uchi*) has been reported for use in inflammation; phlegm and cleanse (sanitization). In a study [24], the *Endopleura uchi* presents the polyphenol-rich water extract from the stem bark,that exhibited substantial antioxidant activity *in vitro* and *in vivo*, as well as the anti-aging properties. Thus, coumaru (tonka bean) and lemon appear not only as medicinal species with the highest relative frequencies of citation, but also as priority species to the indigenous population of Ipaupixuna Village.

Therefore, conserving primary or secondary forests in threatened indigenous landscapes such as Ipaupixuna Village, due to the advance of soybean monoculture, is not only preserving biodiversity but especially the medicinal flora that is it, essential to the health of indigenous populations in the Tapajós River Basin.

Regarding the Relative Popularity (RP) of the medicinal species diagnosed with the interviewed families, it was observed that Cumaru (*Dipteryx odorata (Aublet.) Willd.);* Jucá *(Caesalpinia ferrea Mart. ex Tul.)*and Mango *(Mangifera indica L.)*were the species with 100% relative popularity as shown in Fig. 6. Next with 80% the lemon species (*Citrus limon (L) Burm.); Uxi-amarelo (Endopleura uchi (Huber) Cuatrec.)* andAvocado

*(Persea Americana Mill.)*and with 50% popularity the Lemon Grass (*Cymbopogon citratus (DC.) Stapf.);* Unha-de-gato *(Uncaria tomentosa (Wild) DC*); Orange (*Citrus sinensis* (L.) Osbeck.); Açaí (*Euterpe oleracea Mart.*); Thick Leaf/Malvarisco (*Plectranthus amboinicus (Lour.) Spreng*.); Japana roxa (*Jatropha gossypiifolia L.*); Ipê roxo (*Handroanthus impetiginosus (Mart. ex DC.) Mattos*); Andiroba (*Carapa guianensis Aubl.)* ; Sucuba (*Himatanthus sucuuba (Spruce ex Mull.Arg.)* Woodson) and Sara-tudo (*Justicia acuminatissima (Miq.) Bremek.).*

Thus, many of these species are arboreal and have in the forest their natural environment, in this context the social service that the forest provides to indigenous populations is fundamental for the permanence of these families in villages, that is, as villagers. In addition to the biodiversity intrinsic to forests, their socioeconomic functionality for traditional peoples in the Tapajós River Basin, specifically Ipaupixuna village, can be proven by our ethnobotanical results, where the binomial traditional people – forest, are inseparable.

When we evaluated the dimension of correlation between the five ethnobotany variables studied, we observed according to Table 1 that there is a positive Pearson linear correlation (r) of 99.63 % between the variables Relative Frequency and Relative Popularity, indicating that the increase in the value of one of these variables causes the increase in the second variable, which was actually confirmed in the study, because the species cumarú or tonka bean (*Dipteryx odorata (Aublet.) Willd*.)had the highest Relative Frequency and the highest Relative Popularity.

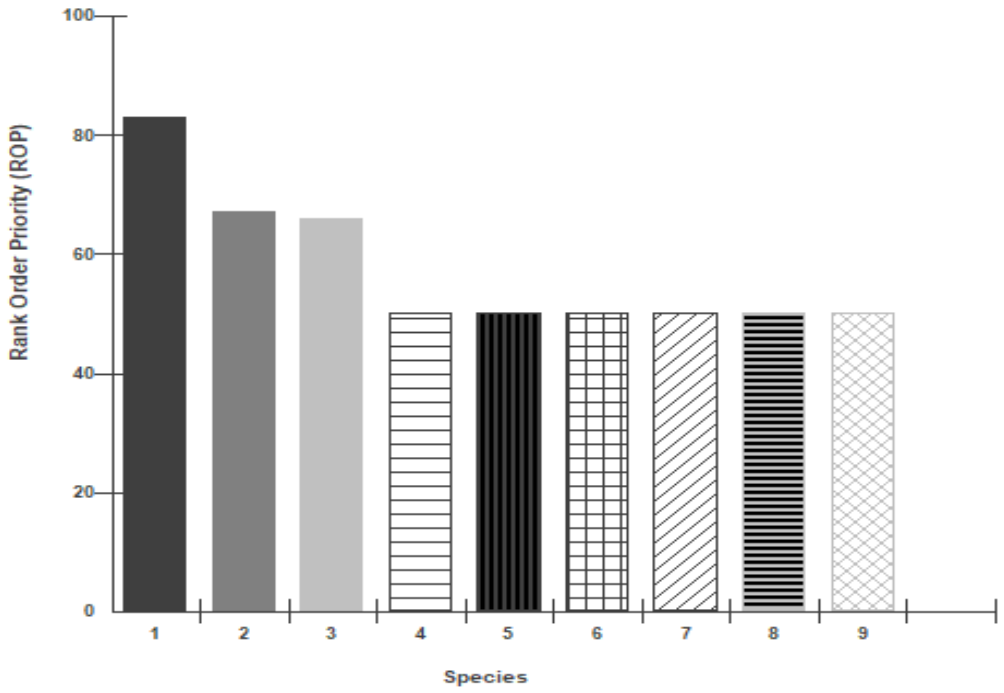

Fig. 5. Rank Order Priority of the first 10 species* of medicinal plants important to the indigenous population of Ipaupixuna, Santarém, Brazil*

**1 – Cumaru (Dipteryx odorata (Aublet.) Willd.); 2 - Lemon (Citrus limon (L) Burm.); 3 - Uxi amarelo (Endopleura uchi (Huber) Cuatrec.); 4 - Capim Santo/Lemon grass (Cymbopogon citratus (DC.); 5 - Unha de Gato (Uncaria tomentosa (Wild) DC); 6 - Jucá (Caesalpinia ferrea Mart. ex Tul.); 7 – Tick leaf/Malvarisco (Plectranthus amboinicus (Lour.) Spreng.); 8 - Ipê roxo (Handroanthus impetiginosus (Mart. ex DC.) Mattos); 9 - Sara-tudo (Justicia acuminatissima (Miq.) Bremek.); 10 - Gengibre/Mangarataia (Zingiber officinale Roscoe.)*

Table 1. Pearson Linear Correlation Matrix among the five (5) variables studied, the following, Variable 1=Relative Frequency of Citation (RF); Variable 2= Use Value (VU); Variable 3=Fidelity level (FL); Variable 4= Relative Popularity (PR); Variable 5= Rank Order Priority (ROP) considering the universe of 68 medicinal plants raised.* r= Pearson Correlation Index ; R2= Determination Index

Variables	**1 and 2**	**1 and 3**	**1 and 4**	**1 and 5**	**2 and 3**	**2 and 4**	**2 and 5**	**3 and 4**	**3 and 5**	**4 and 5**
n (pairs)	68	68	68	68	68	68	68	68	68	68
r Pearson	0.6137	-0.7518	0.9963	0.8422	-0.4270	0.5825	0.4807	-0.7528	-0.3292	0.8488
R2	0.3766	0.5653	0.9925	0.7093	0.1824	0.3393	0.2310	0.5667	0.1084	0.7205
P	.0001	.0001	.0001	.0001	.0003	.0001	.0001	.0001	.0061	.0001
CorrelationMatrix	**Variable 1**	**Variable 2**	**Variable 3**	**Variable 4**	**Variable 5**					
Variable 1	1.0000	---	---	---	---					
Var. 2	0.6137	1.0000	---	---	---					
Was. 3	-0.7518	-0.4270	1.0000	---	---					
Was. 4	0.9963	0.5825	-0.7528	1.0000	---					
Var. 5	0.8422	0.4807	-0.3292	0.8488	1.0000					

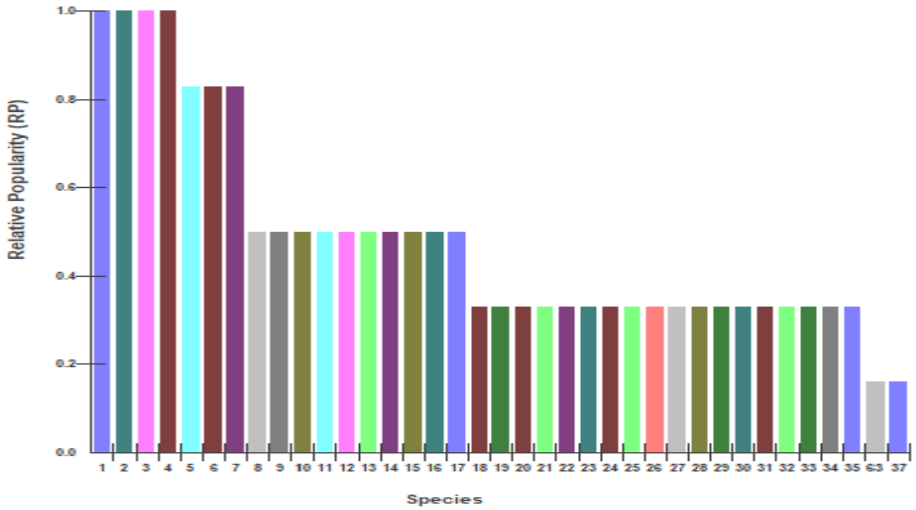

Fig. 6. Relative Popularity (RP) of the first 37 species of medicinal plants important to the indigenous population of Ipaupixuna*

** 1 – Cumaru (Dipteryx odorata (Aublet.) Willd.); 2 – Jucá (Caesalpinia ferrea Mart. ex Tul.); 3 - Mango (Mangifera indicates L.); 4 – lemon (Citrus limon (L) Burm.); 5 – Yellow Uxi (Endopleura uchi (Huber) Cuatrec.); 6 – Avocado (Persea Americana Mill.); 7 -Ginger/Mangarataia (Zingiber officinale Roscoe.); 8 - Capim Santo/Capim Lemon (Cymbopogon citratus (DC.)Stapf.); 9 - Cat's Nail (Uncaria tomentosa (Wild) DC); 10 - Orange (Citrus x sinensis (L.)Osbeck.); 11 – Acai (Euterpe oleracea Mart.); 12 – Thick Leaf/Malvarisco (Plectranthus amboinicus (Lour.)Spreng.); 13 – Purple Top (Jatropha gossypiifolia L.); 14 – Purple Ipê (Handroanthus impetiginosus (Mart. ex DC.)Mattos); 15 -Andiroba (Carapa guianensis Aubl.); 16 – Sucuba (Himatanthus sucuuba (Spruce ex Mull.Arg.) Woodson); 17 – Sara-tudo (Justicia acuminatissima (Miq.) Bremek.); 18 – Lemon Balm (Lippia alba (Mill.) N.E.Br.); 19 – Cashew (Anacardium occidentale L.); 20 – Soursop (Annona muricata L.); 21 – Crajirú (Fredericia chica (Bonpl.) L.G. Lohmann); 22 – Coramina (Pedilanthus tithymaloides (L.) Poit.); 23 – Piquiá (Caryocar villosum (Aubl.) Pers.); 24 -Murici (Byrsonima crassifolia (L.) H.B.K.); 25 – Eucalyptus (Eucalyptus globulus Labill.); 26 – Purple Cotton (Gossypium barbadense L.); 27 – Coco (Cocos nucifera L.); 28 – Small bilberry (Plectranthus barbatus Andrews); 29 - Marupazinho (Eleutherine plicata Herb.); 30 – Salva do Marajó (Lippia origanoides Kunth); 31 – Babosa (Aloe vera (L.) Burm); 32 - Paregoric Elixir (Piper ruiz callosum & Pav.); 33 – Arruda (Ruta graveolens L.); 34 – Mastruz (Dysphania ambrosioides (L.) Mosyakin & Clemants); 35 – Alfavaca (Ocimum americanum L.); 36 – Precious (Aniba canelilla (Kunth) Mez.); 37 – Coffee (Coffea arabica L.)*

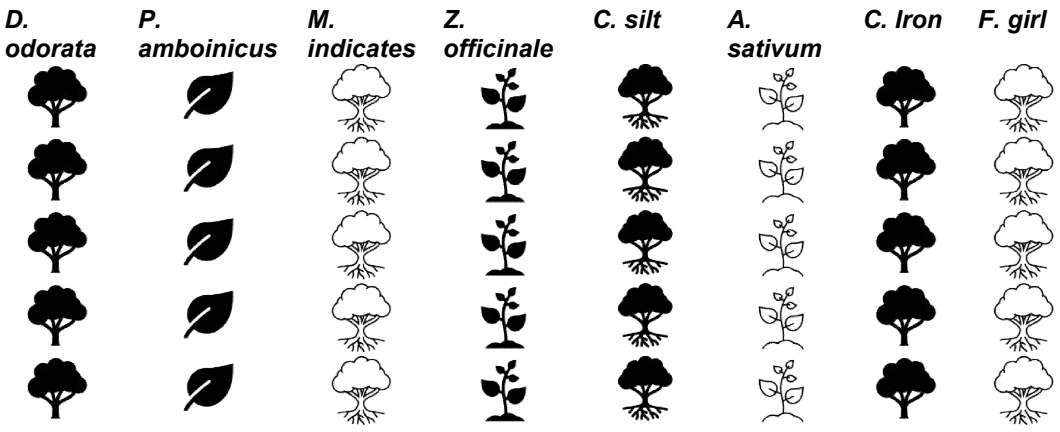

Fig. 7. Composition model of Medicinal *Forest* based on ethnobotanical diagnosis, formed by 8 species (arboreal and herbaceous); *Dipteryx odorata, Plectranthus amboinicus, Caesalpinia ferrea, Allium sativum, Zingiber officinale, Citrus limon, Mangifera indica and Fredericia chica*

Table 2. List of plants useful for Munduruku indigenous families at Ipaupixuna Village, as well, life form, therapeutic indications and forms of use

Vulgar name	Scientific name	Life form	Therapeutic indication	Form of Use
Medicinal Plants				
1. Abacate	*Persea americana* Mill.	Tree	Anemia, sinusitis, malaria, flu	Tea, syrup
2. Açaí	*Euterpe oleracea* Mart.	Palm tree	Anaemia, hepatitis	Tea
3. Alecrim do norte	*Baccharis dracunculifolia* D.C.	Tree	Stomach pain	Tea
4. Alfavaca	*Ocimum canum* L.	Herb	Flu, headache, phlegm	Bath
5. Algodão roxo	*Gossypium barbadense* L.	Tree	Inflammation	Juice, syrup, tea
6. Alho	*Allium sativum* L.	Bulb	Stomach pain, headache, high blood pressure, thud, gases, worm	Syrup
7. Amora	*Morus nigra* L.	shrub	Losing weight, inflammation	Tea
8. Andiroba	*Carapa guianensis* Aubl.	Tree	Injury, cough	Oil
9. Aroeira	*Schinus terebinthifolius* Raddi	Tree	Inflammation	Tea, syrup
10. Arruda	*Ruta graveolens* L.	Herb	Stroke, headache	Juice, tea
11. Azeitoneira	*Syzygium jambolanum* (Lam.) DC	Tree	Amoeba, diarrhea	Tea
12. Babosa	*Aloe vera* (L.) Burm	Herb	Inflammation, herniated disc, burn	Use the natural juice
13. Banana	*Musa* spp.	Herb	Flu	Tea
14. Barbatimão	*Dimorphandra mollis* Benth.	Tree	Inflammation	Syrup, bath, bottled
15. Boldo grande	*Plectranthus barbatus* Andrews	Tree	Pain in the stomach and liver	Tea
16. Boldo pequeno	*Plectranthus neochilus* Schltr.	Herb	Stomach pain	Tea
17. Café	*Coffea arabica* L.	Shrub	Flu	Tea, bath, syrup
18. Caju	*Anacardium occidentale* L.	Tree	Diarrhea, feminine hygiene, injury	Juice, bath, syrup
19. Canela	*Cinnamomum verum* J. Presl.	Tree	High pressure	Tea
20. Capim santo (capim Limão)	*Cymbopogon citratus* (DC.) Stapf.	Herb	Flu	Bath, tea
21. Castanha	*Bertholletia excelsa* Bonpl.	tree	Hepatitis	Drink the water of bark
22. Cidreira	*Lippia alba* (Mill.) N.E.Br.	Herb	Fever	Tea
23. Coco	*Cocos nucifera L.*	Palm tree	Stroke, soothing	Water
24. Coramina	*Pedilanthus tithymaloides* (L.) Poit.	shrub	Heart disease	Tea
25. Crajirú	*Fredericia chica* (Bonpl.) L.G. Lohmann	shrub	Stomachache, ameba, injury, anemia	Bath, decoction tea
26. Cumaru	*Dipteryx odorata* (Aublet.) Willd.	Tree	Flu, pneumonia, stroke	Tea, juice, syrup
27. Cupuaçu	*Theobroma grandiflorum* (Willd. ex Spreng)	Shrub	Flu	Bath

Vulgar name	Scientific name	Life form	Therapeutic indication	Form of Use
	K.Schum.			
28. Elixir paregórico	*Piper callosum* Ruiz & Pav.	Herb	Stomach pain	Tea
29. Eucalipto	*Eucalyptus globulus* Labill.	Tree	Cough, fever, flu	Syrup, tea
30. Extrato	Not found	Shrub	Phlegm	Bath
31. Folha grossa (malvarisco)	*Plectranthus amboinicus* (Lour.) Spreng.	Herb	Cough, asthma, clean the eyes, flu, inflammation, red, injury	Syrup, juice, eyesore, picks up the wilted leaf and places it on the skin.
32. Gengibre (mangarataia)	*Zingiber officinale* Roscoe.	Rhizome	Influenza, cough, sore throat, colic, inflammation	Tea, candy
33. Gergelim	*Sesamum indicum* L.	shrub	Stroke	Juice, put in the legs
34. Goiaba	*Psidium guajava L.*	Shrub	Injury	Bath
35. Graviola	*Annona muricata* L.	Tree	Heart disease, cancer	Tea
36. Hortelãnzinho	*Mentha x villosa* Huds.	Herb	Gas, stomach pain, worm	Tea, syrup
37. Ipê roxo	*Handroanthus impetiginosus* (Mart . ex DC.) Mattos	Tree	Cancer, inflammation, flatness, stomach pain	Tea, syrup, bath, bottled
38. Japana roxa	*Eupatorium triplinerve* M.Vahl.	Shrub	Stomach pain, anemia	Tea, bath
39. Jatobá	*Hymenaea courbaril* L.	Tree	Inflammation	Syrup, female hygiene, bottled
40. Jucá	*Caesalpinia ferrea* Mart. ex Tul.	Tree	Inflammation, injury, diarrhea, operation recovery, lose weight, headache	Juice, tincture, bath, tea
41. Laranja	*Citrus xsinensis* (L.) Osbeck.	shrub	Flu, heart disease, stomach pain	Bath, tea
42. Limão	*Citrus limon* (L) Burm.	shrub	Cough, sore throat, flu, fever, high pressure	Syrup, bath, tea
43. Malva do reino	*Plectranthus* spp.	Shrub	Flu, earache	Tea
44. Mamão macho	*Carica papaya* L.	Herb	Heart	Tea
45. Manga	*Mangifera indica* L.	Tree	Flu, inflammation, injury, caught	Bath, syrup
46. Manjericão	*Ocimum basilicum* L.	Herb	Worm	Bath, tea, syrup
47. Marcela	*Pluchea sagittalis Lam. Cabrera*	Shrub	Stomach pain	Tea
48. Marupazinho	*Eleutherine plicata* Herb.	Rhizome	Worm, diarrhea	Tea, syrup
49. Mastruz	*Dysphania ambrosioides* (L.) Mosyakin & Clemants	Shrub	Worm	Juice, tea
50. Melhoral	*Justicia pectoralis* Jacq.	Herb	Flu, worm	Tea
51. Meracilina	*Alternanthera brasiliana*	Shrub	Inflammation	Tea
52. Muruci	*Byrsonima crassifolia* (L.) H.B.K.	Tree	Injury, cough	Bath, syrup
53. Pião branco	*Jatropha curcas* L.	Shrub	Injury, toothache, cancer, inflammation	Tea, milk, bottled
54. Pião roxo	*Jatropha gossypiifolia* L.	Shrub	Tummy pain, bleeding, flu	Syrup, tea, juice, bath
55. Piquiá	*Caryocar villosum*	Tree	Swelling	Bath

Vulgar name	Scientific name	Life form	Therapeutic indication	Form of Use
	(Aubl.) Pers.			
56. Preciosa	*Aniba canelilla* (Kunth) Mez.	Tree	Stomach pain, fever	Tea
57. Pupunha	*Bactris gasipaes* Kunth.	Palm tree	Swelling, earache	Oil
58. Sabugueira	*Sambucus nigra* L.	Tree	Measles	Tea
59. Salva do Marajó	*Lippia origanoides* Kunth	Shrub	Stomach pain, colic, worms	Syrup, tea
60. Sara-tudo	*Justicia acuminatissima* (Miq.) Bremek.	Shrub	Inflammation, injury	Tea, syrup, bath, bottled
61. Sucuba	*Himatanthus sucuuba* (Spruce ex Mull.Arg.) Woodson	Tree	Cough, Inflammation	Milk, syrup, bath, bottled
62. Sulfa	Not found	Shrub	Injury	Tea
63. Tangerina	*Citrus reticulada* Blanco.	Tree	Flu	Bath, tea, Syrup
64. Trevo roxo	*Scutellaria purpurascens* Sw.	Tree	Headache	Bath
65. Unha de gato	*Uncaria tomentosa* (Wild) DC	Vine	Inflammation	Tea, syrup, bath, bottled
66. Urucum	*Bixa orellana* L.	Shrub	Cough	Syrup
67. Uxi amarelo	*Endopleura uchi* (Huber) Cuatrec.	Tree	Inflammation, phlegm, feminine hygiene	Tea, syrup, bath, bottled, oil
68. Verônica	*Dalbergia monetaria* L.	Tree	Inflammation	Bath, decoction tea
Food Plants				
69. Alfavaca	*Ocimum canum* L.		-	Spices
70. Biribá	*Rollinia mucosa* (*Jacq*.) Baill	Tree	-	Natural fruit
71. Buriti	*Mauritia flexuosa* L.	Tree	-	Natural fruit
72. Cacau	*Theobroma cacao* L.	Tree	-	Natural fruit
73. Cará	*Dioscorea alata* L.	Tuber	-	Cooked
74. Cebola	*Allium cepa* L.	Bulb	-	Spices
75. Cebolinha	*Allium fistulosum* L.	Bulb	-	Spices
76. Chicória	*Eryngium foetidum* L.	Herb	-	Spices
77. Cominho	*Cuminum cyminum* L.	Herb	-	Spices
78. Couve	*Brassica oleracea L. var. acephala DC.*	Legume	-	Cooked
79. Ingá grande	*Inga macrophylla* Kunth ex Willd.	Tree	-	Natural fruit
80. Ingá pequeno	*Inga edulis* Mart.	Tree	-	Natural fruit
81. Jaca da Bahia	*Artocarpus heterophyllus* Lam.	Tree	-	Natural fruit
82. Macaxeira	*Manihot esculenta* Crantz	Rhyzome	-	Cooked
83. Najá	*Attalea maripa* (Aubl.) Drude	Tree	-	Cooked
84. Pimenta de cheiro	*Capsicum chinense* Jacq.	Herb	-	Spices

Vulgar name	Scientific name	Life form	Therapeutic indication	Form of Use
85. Pimentão	*Capsicum annum* L.	Herb	-	Spices
86. Tucumã	*Astrocaryum aculeatum* G. Mey	Palm	-	Cooked
Handcraft Plants				
87. Bambu	*Bambusa vulgaris* Schrad. ex J.C.Wendl.	Tree	-	Natural
88. Cuieira	*Crescentia cujete* L.	Tree	-	Benefited

Similarly, Pearson's linear correlation was high and positive (r = 0.8422) between the variables Relative Frequency of Citation (RF) and Rank Order Priority (ROP), which was once again proven by the results previously mentioned, where the cumarú obtained the highest values for these variables above. However, a negative correlation (-0.7528) was found between the variables Fidelity Level (FL) and Relative Popularity (RP), indicating that when the Fidelity Level value increases for a given species, the relative popularity of this species decreases. And finally, we observed a high and positive correlation (r=0.8488) between Relative Popularity (RP) and Rank Order Priority (ROP) suggesting that, as the relative popularity of a given medicinal species increases, the Rank Order Priority of this species also increases, and this has been proven to cumarú (tonka bean) and lemon.

Finally, from all ethnobotany analysis performed, we propose here the introduction of two new terms, as well as the implementation of them are the *Medicinal Forests* and the *Ethnogardens.*The proposition of *medicinal forests* lies in the fact that many medicinal species mentioned by the indigenous families interviewed in this research are tree and native plants of primary or secondary forests, which are far from homes, threatened by deforestation, fire and land invasion. Thus, implementing such *Medicinal forests* in places closer to indigenous residences would be an alternative as shown in Fig. 7.

As for Ethnogardens the proposition lies in the fact that the ethnobotanical survey conducted showed a rich diversity of small domesticated plants cultivated in the backyards of the houses. The Munduruku indigenous culture, which traditionally cultivates medicinal plants in its backyards, from the introduction of the Ethnogardens can have an improvement of this structure as a way of valuing this space for the safety of individual (family) and collective (indigenous community) health.

4. CONCLUSION

The Munduruku indigenous population of Ipaupixuna Village has a rich traditional knowledge about medicinal plants and 110 species are diagnosed in the ethnobotanical survey. The category of medicinal plants presented the highest number of plants reported, indicating the potential and importance that flora as an exploitable natural resource in forest ecosystems, has for indigenous populations. The species *Dipteryx odorata, Plectranthus amboinicus, Caesalpinia ferrea, Allium sativum, Zingiber officinale, Citrus limon, Mangifera indica* and *Fredericia chica* presented a significant Use Value for indigenous families. We conclude that from the ethnobotany analysis it is necessary not only to preserve the native forests in indigenous territories as an exploitable medicinal resource, but create a new space, a space of planted forests, here called *Medicinal Forests.* Similarly, it was concluded that the improvement of indigenous backyards (*Ethnogardens*) is important, to consolidate the cultivation and production of medicinal plant species useful to indigenous communities, thus contributing to the health safety of these Munduruku families.

CONSENT

All authors declare that 'written informed consent was obtained from the leader of indigenous people, Sir Manoel Batista da Rocha*,* for publication of this manuscript.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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