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Research Article

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Temporal assessment of the medicinal plant trade in public markets of the state of Paraíba, northeastern Brazil

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ABSTRACT

**Background:** Open and public markets are the main providers of medicinal plants in urban environments. The present study evaluated the medicinal plants sold in public markets in different municipalities in the mesoregions of the state of Paraíba, northeast of Brazil, and the possible variations in the supply of these plants in the markets over the course of a year.

**Methods:** Thirty-five traders of medicinal plants were interviewed in four mesoregions of different climatic and phytophysiognomic characteristics (ranging from Caatinga to Atlantic Forest). The versatility of the species sold was elucidated using the Relative Importance Index (IR), and the set of species sold by each informant in each mesoregion was compared with each other by similarity analysis Anosim-One, and by the analysis of main coordinates.

**Results:** *Punica granatum*, *Zingiber officinale*, and *Myracrodruon urundeuva* were the species with the highest RI. The analysis of similarity showed distinct differences between the Sertão and all other mesoregions. The analysis highlighted that a mesoregion had an intermediate similarity pattern in relation to the others, for which we suggest the term "biocultural ecotone" or “cultotone”. The absence of 88 species in at least one of the trading locations at some stage of the fieldwork was recorded.

**Conclusions:** The commercialized species do not seem to have a presence / absence relationship in relation to the period of the year or the mesoregion, and there seem to have been changes in the inventory of plants commercialized in markets in recent years. We identified an intermediate zone of knowledge and use of species commercialized between the studied localities.

**Keywords:** Urban ethnobotany, Caatinga, Atlantic Forest, similarity analysis, relative importance.
Background

The knowledge about, and use of medicinal plants, are themes that remain one of the main study topics in ethnobotany. Many recent studies in Brazil and around the globe have recorded the knowledge and use of medicinal plants, both in rural [e.g. 1–8] and urban areas [e.g. 9–15].

In urban areas, open and public markets are some of the main sources of medicinal plants. There it is possible to find these products traded, and to observe variations with regard to both the plant parts sold and the inventory of available species over time. Several studies observed the predominance of the medicinal use of non-permanent plant structures, such as leaves [8,16,17]. Some studies in Brazil showed that overall, changes in the list of traded species occurred as a function of the temporal availability or the demand for certain species in the market [10,18–20]. In other cases, it was possible to observe a relatively constant inventory of medicinal plants, with the inclusion of some new species over time, e.g. in La Paz, Bolivia [21], both in the short and medium term [21]. When observing broader temporal contexts, the changes in the inventory of medicinal plants can become more evident, as observed in Peru, where the local pharmacopeia has been changing since the colonial period [22].

The climate and the predominant phytophysiognomy in a given region can also influence the set of traded species or the plant parts used. From this perspective, the more ample use of permanent plant structures such as bark and roots, has been often documented from drier areas, such as the Caatinga [23–25] (semi-arid region of Brazil), as well as in Savannah and Desert areas in Africa [26–28]. In humid areas, it has been more common to observe a greater use of leaves, such as in the Atlantic Forest [29] and the Amazon [30], as well as in rainforest areas in Asia [17,31,32].

In addition to the availability of the specific plant parts used, several other factors can influence the availability of traded products, such as seasonality [18,20], demand [18], and
local environmental factors [33]. Repeated sampling can be useful to identify and understand these variations in the medicinal plant products available for trade [10,33].

Variations in the availability of traded plants have also been observed when comparing different public markets, even in nearby areas [21] or in long-term comparisons with previous studies [19,21]. Another issue that can influence the trade and use of medicinal plants is globalization, especially due to the increase and use of social and digital media to advertise and trade these products [34], and the medicinal plant trade in the international context [13].

The present study aimed to assess the medicinal plants traded in the public markets of municipalities in four mesoregions of the state of Paraíba, northeastern Brazil, each with its independent climatic and phytophysiognomy characteristics, but with two well-defined biomes: the Caatinga semi-arid region, and the Atlantic Forest humid region. The assessment was performed by documenting the species used, and the possible variations in their availability in the markets throughout the year. We hypothesized that there would be a greater influence of seasonality on the availability of medicinal plants for trade in the interior of the state, a region with a semi-arid climate, than in the coast, which is subject to higher humidity over the year, especially with respect to native species.

In addition, based on the analysis of the information recorded in our study, we propose the possible existence of a zone that we called "biocultural ecotone" or "cultotone", i.e. a region marked not only by a transition in the vegetation but perhaps of the knowledge and practice in the use of medicinal plants, somewhat similar to the concept of ecotone. This perspective could be an interesting guiding tool for future research involving the trade in medicinal plants.
Material and methods

Study area

The study was conducted in public markets of seven municipalities of Paraíba, distributed in the four mesoregions of the state: João Pessoa and Sapé (Mata Mesoregion), Guarabira and Solânea (Agreste Mesoregion), Monteiro (Borborema Mesoregion), and Patos and Itaporanga (Sertão Mesoregion). The predominant phytophysiognomy in the municipalities of João Pessoa and Sapé is Atlantic Forest, while Caatinga vegetation predominates in the remaining municipalities (Figure 1). These mesoregions are defined by socioeconomic and environmental characteristics, showing marked climatic variations. In 2017, when our fieldwork was already in progress, the IBGE (Brazilian Institute of Geography and Statistics) changed the division of the geographic regions of Brazil, modifying the configuration and the classification as Mesoregions and Microregions into Intermediate Regions and Immediate Regions, respectively [35]. For this study, we adopted the Mesoregion and Microregion classification, because this classification allows better visualization of the different phytophysiognomies of the state, considering that the new Regional Division of Brazil is more focused on socioeconomic aspects [35], not highlighting the environmental differences.

The Mata Paraibana Mesoregion is characterized by a hot and humid climate [36] with three climate types according to the classification by Köppen: Aw (tropical, with a dry season in winter), Am (high rainfall), and As (hot and humid tropical, with dry winter) [37]. The Mata Paraibana shelters what little is left of the Atlantic Forest in Paraíba, most which has been destroyed anthropogenic impact, especially the expansion of sugarcane production. This zone also incorporates beaches, plateaus, floodplains, and estuaries [36].

The Agreste comprises a transition area between the humid and the semi-arid climate [36], belonging to the Köppen climate types As and Bsh (hot semi-arid) [37]. Its vegetation represents also a transition area between the Atlantic Forest and the Caatinga [36].
The Borborema comprises the central area of the state of Paraíba, located in the geomorphological unit of the Borborema Plateau [36]. It shows the Köppen climate types As and Bsh [37], with the lowest rainfall levels in the state, and salty, thin, and rocky soils.

The Sertão comprises several depressions, with a semi-arid climate, and a vegetation characteristic of the Caatinga [36]. This area is divided between the Köppen climate types Bsh (hot semi-arid) and As (hot and humid tropical, with dry winter) [37].

Before beginning the interviews, previous visits were made to identify locations that met the objectives of the study. It was impossible to conduct the research in some of the visited municipalities (Figure 1), either because they did not have a public market or because there were no medicinal plants traded in the market.

**Data collection**

Visits were made to the trading locations of medicinal plants in the public markets of the municipalities. After initial contact to properly present and explain the purposes of the study, the medicinal plant traders in the markets were invited to sign the Free Consent Form (TCLE) required by the National Health Council through the Research Ethics Committee (Resolution 466/12) (Protocol: 82943618.0.0000.5188) and to participate in the research. A total of 35 traders were interviewed (13 in the Mata Paraibana; 10 in the Agreste; 4 in the Borborema; 8 in the Sertão). The free list technique was used based on the following question: “Which medicinal plants do you sell?” Subsequently, for each plant, details on their origin (was a plant from the local vegetation?; did it come from other regions?; was it imported?), considering both native and exotic species, and registering their applications, properties, preparation, parts used, and contraindications. Repeat interviews were performed each trimester during one year, starting August 2017, in order to evaluate if a species was either absent or added in relation to the previous periods. During each interview, a list of all plants...
available in a specific trade location was compiled, and further details were obtained on the use of each species.

The identification of the traded species was made by acquiring fertile specimens in the markets and collecting the cited species in the field when possible, and then comparing the material with the corresponding literature. The names and families of the species were confirmed using REFLORA (Flora do Brasil 2020) [38] and the Missouri Botanical Garden database (Tropicos) [39]. The herborized plants were sent to the Herbarium Jaime Coelho de Moraes (EAN) of the Federal University of Paraíba (UFPB), Center of Agricultural Sciences (CCA) for confirmation of the identification and incorporation into the plant collection.

**Data analysis**

The therapeutic indications mentioned by the informants were classified into body systems (categories defined by the WHO for each property) [40]. The NSC (Number of Body Systems) and NP (Number of Properties) for each species were calculated according to Bennett and Prance [41], with the following equations:

\[
NSC = \frac{NSCE}{NSCEV}
\]

Where NSC refers to the number of body systems, resulting from the division of the number of body systems treated by a given species (NSCE) by the total number of body systems treated by the most versatile species (NSCEV), considering as the most versatile the species that obtained the greatest diversity of body systems.

The following equation was used for the NP:

\[
NP = \frac{NPE}{NPEV}.
\]

Where NP is the number of properties, resulting from the division of the number of properties attributed to a given species (NPE) by the number of properties attributed to the
most versatile species (NPEV), considering as the most versatile the species that obtained the highest number of properties.

Subsequently, also based on Bennett and Prance [41], the Relative Importance (RI) of each species was calculated by the following equation:

\[
RI = \frac{NSC}{NP}
\]

This method highlights the most versatile species or those with the greatest diversity of uses. It consists of a quantitative method that is not directly influenced by the number of citations for a given species but rather by the diversity of applications inferred to a species. The maximum value obtained is 2; the closer to this value is the RI of the plant, the greater its versatility, also considering that the RI of the species is high when \(\geq 1\).

The one-way ANOSIM permutation test was used to assess the degree of similarity of the species used between mesoregions (Bray-Curtis distance and 9999 permutations). This test produces an R result that ranges from −1 to +1, which may indicate no significant difference between groups (\(R < 0.25\)), while values between 0.25 < R < 0.5 indicate some data similarity and values of \(R > 0.75\) indicate different results, with total difference when \(R = 1\). Principal Coordinates Analysis (PCoA) using the Bray-Curtis distance was employed to generate a graph representing these differences between the cited species. The software Past 3.22 was used in the analyses. Data tabulation in the software was made based on a presence and absence matrix in binary code, in which 1 represented the presence of the species considered in the trade location and 0 represented the absence.

**Results**

A total of 163 species were identified at least to genus level, belonging to 151 genera and 76 families. Seventeen species remained unidentified. The most common families were Fabaceae (19 species), Asteraceae (12), Lamiaceae (11), and Myrtaceae (6) (Table 1). A high
relative importance value was recorded (RI≥1) for 32 species, among which 11 were native to Brazil, and 21 were exotic (Table 2). The species that obtained the highest RI values were *Punica granatum* L. (Pomegranate; RI = 2), *Zingiber officinale* Roscoe (Ginger; 1.78), and *Myracrodruon urundeuva* Allemão (Aroeira; 1.69) (Tables 1 and 2). The categories with the highest number of citations for each mesoregion were: unspecified diseases and symptoms; digestive system; endocrine system, nutrition, and metabolism; and respiratory system, with varying prevalence according to each mesoregion (Figure 2).

The plant parts traded most commonly for medicinal use were leaves, bark, and seeds, varying only with regard to their prevalence in each mesoregion (Figure 3). The use of flowers stood out in the Borborema region (Figure 3). In the context of this study the stem was considered as both the shoot and its subterraneous structures (rhizome and bulb), when present.

Among the recorded species, 27 (16.07% of the total) were found only in the Mata mesoregion. However, the Sertão showed the highest exclusivity, with 45 species (26.79%). The Agreste mesoregion had only four exclusive species (2.38%), while the Borborema mesoregion had only three exclusive species (1.79%) (Table 1). The one-way ANOSIM multivariate analysis demonstrated similarity among the set of species traded in the mesoregions, with exception for the Sertão, which was significantly different from allo other mesoregions (R=0.2136; p<0.0018), showing significant variation compared to the Mata (R=0.2632; p<0.0074), Agreste (R=0.3752; p<0.0036), and Borborema mesoregions (R=0.3888; p<0.0187). The principal coordinate analysis (PCoA) highlighted the similarity between the plant species traded by the informants in three of the mesoregions compared to the Sertão (Figure 4).
Table 1. Medicinal plants traded in public markets of the Mata, Agreste, Borborema, and Sertão mesoregions of Paraíba, northeastern Brasil, indications, and categories of medicinal use and Relative Importance (RI) of each species. Categories: BCS = Blood and cardiovascular system; CUD = Cultural diseases; DIS = Digestive system; ENM = Endocrine system, nutrition, and metabolism; EXI = External injuries; INT = Intoxication; MBD = Mental and behavioral diseases; MSS = Musculoskeletal system; NEO = Neoplasms; NES = Nervous system; PAD = Parasitic diseases; PRP = Pregnancy and parturition; RES = Respiratory system; RSS = Reproductive system and sexual health; SES = Sensory system; SST = Skin and subcutaneous tissue; UDS = Unspecified diseases and symptoms; URS = Urinary system.

| Family         | Scientific name | Local/Vernacular name | Medicinal use categories | Mesoregion | RI  |
|----------------|-----------------|-----------------------|--------------------------|------------|-----|
| **Acanthaceae**|                 |                       |                          |            |     |
|                | Justicia pectoralis Jacq. | Chachambá          | RES (cough, hoarseness, expectoration); DIS (indigestion) | Mata       | 0.47|
| **Adoxaceae**  |                 |                       |                          |            |     |
|                | Sambucus australis Cham. & Schldtl. | Sabugueira      | NES (tranquilizer), UDS (fever), BCS (high blood pressure), PAD (measles, infection), RES (cough, flu) | Mata; Agreste; Borborema; Sertão | 0.81|
| **Alismataceae**|                 |                       |                          |            |     |
| **Echinodorus sp.** | Chapéu de couro | ENM (diabetes, weight loss, uric acid); BCS (immunity); MSS (bone pain, joints); UDS (pain) | Mata; Sertão | 0.88 |
|---------------------|-----------------|------------------------------------------------------------------------------------------|--------------|------|

**Amaranthaceae**

| *Dysphania ambrosioides* (L.) Mosyakin & Clemants | Mentruz | RES (flu, expectoration), PAD (worm infection) | Borborema | 0.22 |
|---------------------------------------------------|---------|-----------------------------------------------|-----------|------|

| *Gomphrena demissa* Mart. | Capitãozinho | RES (cough, flu, expectoration) | Sertão | 0.3 |
|---------------------------|--------------|---------------------------------|--------|-----|

**Amaryllidaceae**

| *Allium sativum* L. | Alho | ENM (cholesterol, "reduce the levels", weight loss); RSS (erectile dysfunction); BCS (anticoagulant, stroke); PAD (worm infection); RES (tiredness) | Mata; Sertão | 1.06 |
|---------------------|------|---------------------------------------------------------------------------------|--------------|------|

| *Allium sp.* | Cebolinha branca | RES (cough, flu, hoarseness, expectoration, bronchitis, sinusitis, common cold); UDS (fever); DIS (baby colic); URS (diuretic) | Borborema; Sertão | 1.07 |

**Anacardiaceae**

| *Anacardium occidentale* L. | Cajú roxo | SST (wound healing); UDS (inflammation); DIS (intestine inflammation); EXI (stop bleeding); PAD (antibiotic); RSS (uterus inflammation, vaginal discharge, prostate) | Borborema; Sertão | 1.17 |
| Plant Name                        | Common Name | Uses                                                                 | Location                  | Value |
|----------------------------------|-------------|----------------------------------------------------------------------|---------------------------|-------|
| *Myracrodruon urundeuva*         | Allemão     | UDS (inflammation); URS (prostate); SST (wound healing, pruritus); DIS (gastritis); EXI (stop bleeding); MSS (bone inflammation); PAD (antibiotic); ENM (menopause); BCS (high blood pressure, blood) | Mata; Agreste; Sertão     | 1.69  |
| *Schinus terebinthifolia* Raddi  | Aroeira     | UDS (inflammation); SST (wound healing); DIS (intestine inflammation) | Mata                      | 0.52  |
| *Schizophragma brasiliensis* Engl.| Baraúna    | UDS (inflammation); SST (wound healing); URS (kidneys); MSS (spine); RSS (prostate) | Mata; Agreste; Sertão     | 0.87  |

**Annonaceae**

| Plant Name                        | Common Name | Uses                                                                 | Location                  | Value |
|----------------------------------|-------------|----------------------------------------------------------------------|---------------------------|-------|
| *Annona muricata* L.             | Graviola    | DIS (gastritis); NEO (cancer); ENM ("reduce the levels" diabetes); UDS (inflammation) | Mata; Sertão              | 0.76  |
| *Xylopia aromática* (Lam.) Mart. | Imbira      | DIS (bellyache, indigestion, stomach, stomach ache); UDS (pain); RSS (menstrual cramps); MSS (back pain) | Mata; Agreste; Sertão     | 0.88  |

**Apiaceae**

| Plant Name                        | Common Name | Uses                                                                 | Location                  | Value |
|----------------------------------|-------------|----------------------------------------------------------------------|---------------------------|-------|
| *Anethum graveolens* L.          | Endro       | NES (tranquilizer, insomnia); UDS (pain); BCS (heart, jaundice, high blood pressure, tachycardia); DIS (intestinal colic, stomach ache, gallbladder pain, constipation, indigestion); RSS (menstrual cramps) | Mata; Agreste; Borborema; Sertão | 1.37  |
| *Centella sp.*                   | Centelha asiática | ENM (weight loss)                                              | Mata; Sertão              | 0.17  |
| *Coriandrum sativum* L.          | Coentro     | BCS (high blood pressure); ENM (cholesterol, menopause); DIS       | Mata; Agreste;           | 1.06  |
| Family          | Species                          | Common Name       | Uses                                      | Regions       | Similar Species |
|-----------------|----------------------------------|-------------------|-------------------------------------------|---------------|-----------------|
|                | *Foeniculum vulgare* Mill.       | Erva doce         | BCS (high blood pressure); UDS (fever, dizziness, headache); INT (Intoxication); ENM (menopause); DIS (bellyache) | Borborema; Sertão | NES (tranquilizer, depression, insomnia); RES (sinusitis, runny nose); Mata; Agreste; |
|                | *Pimpinella anisum* L.           | Erva doce         | BCS (high blood pressure); UDS (fever, dizziness, headache); INT (Intoxication); ENM (menopause); DIS (bellyache) | Borborema; Sertão | NES (tranquilizer, depression, insomnia); RES (sinusitis, runny nose); Mata; Agreste; |
|                | *Hancornia speciosa* Gomes       | Mangaba           | BCS (high blood pressure)                  | Mata          |                 |
|                | *Ilex sp.*                       | Chá mate          | DIS (indigestion)                          | Mata; Borborema |                 |
|                | *Cocos nucifera* L.              | Côco              | BCS (jaundice); URS (diuretic)             | Sertão        |                 |
|                | *Copernicia prunifera* (Mill.)   | Carnaúba          | URS (kidneys)                              | Sertão        |                 |
|                | H.E. Moore                       |                   |                                           |               |                 |
|                | *Syagrus oleracea* (Mart.) Becc. | Côco catolé       | MSS (spine); URS (kidneys, kidney stones, urinary tract infection); DIS | Mata; Agreste; |                 |

**Apocynaceae**

**Aquifoliaceae**

**Arecaeeae**
| Family          | Species                          | Common Name                          | Use(s)                          | Location | Usage |
|-----------------|----------------------------------|--------------------------------------|---------------------------------|----------|-------|
| Aristolochiaceae| *Aristolochia* sp.                | Cipó-de-mil-homem                    | DIS (indigestion)               | Mata     | 0.17  |
| Asparagaceae    | *Agave* sp.                      | Agave branco                         | UDS (inflammation); ENM (cholesterol) | Agrest; Sertão | 0.35  |
|                 | *Sansevieria trifasciata* Prain  | Espada de São Jorge                  | URS (kidneys); UDS (inflammation) | Sertão    | 0.35  |
| Asphodelaceae   | *Aloe vera* (L.) Burm. f.        | Babosa                               | SST (wound healing)             | Mata      | 0.17  |
| Asteraceae      | *Acanthospermum hispidum* DC.    | Espinho de cigano                    | RES (flu, bronchitis)           | Sertão    | 0.24  |
|                 | *Ageratum conyzoides* L.         | Mentraste                            | RSS (regulation of menstruation); UDS (inflammation) | Sertão    | 0.35  |
|                 | *Artemisia* sp.                  | Artemísia                            | UDS (inflammation)             | Mata      | 0.17  |
|                 | *Baccharis* sp.                  | Carqueja                             | ENM (liver, liver fat, weight loss, diabetes, cholesterol, blood fat); URS (diuretic, kidneys) | Borborema; Sertão | 0.72  |
| Plant Name                        | Common Name     | Uses                                      | Regions          | Rating |
|----------------------------------|-----------------|-------------------------------------------|------------------|--------|
| *Bidens pilosa* L.               | Picão preto     | UDS (inflammation)                        | Mata             | 0.17   |
| *Egletes viscosa* (L.) Less.      | Macela          | DIS (indigestion, diarrhea, stomach, liver, intestine, intestinal infection); ENM (diabetes) | Mata; Agreste; Borborema; | 0.66   |
| *Gymnanthemum amygdalinum*       | Alcachofra      | ENM (cholesterol, diabetes, liver inflammation, liver fat) | Mata; Borborema; | 0.36   |
| (Delile) Sch. Bip. ex Walp.       |                 |                                           | Sertão           |        |
| *Helianthus annuus* L.            | Girassol        | musculoskeletal system (rheumatism, bursitis); BCS (high blood pressure) | Mata; Agreste; Borborema; | 0.99   |
|                                  |                 |                                           | Sertão           |        |
| *Matricaria chamomilla* L.        | Camomila        | URS (urethral inflammation); SST (lighten skin spots); BCS (high blood pressure) | Borborema;       | 1.17   |
|                                  |                 |                                           | Sertão           |        |
| *Solidago chilensis* Meyen       | Arnica          | UDS (pain); MSS (joints); EXI (wounds, blood clot) | Mata; Sertão     | 0.58   |
| *Taraxacum officinale* F.H. Wigg. | Dente de leão   | ENM (liver fat, weight loss); NES (memory); MSS (joints); DIS (intestine); BCS (blood circulation) | Mata; Borborema; | 0.93   |
|                                  |                 |                                           | Sertão           |        |
| *Vernonanthura phosphorica*       | Assa peixe      | URS (kidneys)                             | Mata             | 0.17   |
| (Vell.) H. Rob.                  |                 |                                           |                  |        |
| Family         | Species                      | Common Name | Uses                                           | Habitat | Latitude |
|---------------|------------------------------|-------------|------------------------------------------------|---------|----------|
| Bignoniaceae  | *Anemopaegma* sp.            | Catuaba     | UDS (inflammation); RSS (aphrodisiac); MSS (bone pain) | Mata; Sertão | 0.52     |
|               | *Handroanthus heptaphyllus*  | Pau d'arco roxo | UDS (pain, inflammation); NEO (cancer); RSS (cysts, myoma, ovary) | Mata; Sertão | 0.88     |
|               | *Handroanthus* sp.           | Pau d'arco  | URS (kidneys)                                  | Agreste  | 0.17     |
|               | *Jacaranda* sp.              | Caroba      | SST (pruritus, skin irritation); BCS (depurative) | Sertão   | 0.41     |
| Bixaceae      | *Bixa orellana* L.           | Urucum      | ENM (reduce cholesterol)                       | Mata; Sertão | 0.17     |
| Boraginaceae  | *Heliotropium indicum* L.    | Fedegoso    | PRP ("female cleaning after childbirth")       | Sertão   | 0.17     |
|               | *Heliotropium nicotianaefolium* | Sete Sangrias | URS (kidneys)                                  | Mata; Sertão | 0.17     |
|               | *Symphytum officinale* L.    | Confrei     | ENM (uric acid); SES (labyrinthitis); UDS (inflammation) | Mata; Sertão | 0.52     |
|               | *Varronia curassavica* Jacq. | Erva balieira | UDS (inflammation)                            | Mata     | 0.17     |
| Brassicaceae  | *Brassica* sp.               | Mostarda    | BCS (thrombosis, CVA, stroke, circulation); MSS (rheumatism); UDS (pain, headache, swelling) | Mata; Agreste; Borborema; | 0.83     |
| Family                | Genus                  | Species                  | Common Name(s)         | Habitat(s) | Locations |
|-----------------------|------------------------|--------------------------|------------------------|------------|-----------|
| Rorippa nasturtium-aquaticum | (L.) Hayek             | Agrião                   | RES (bronchitis, asthma) | Sertão     | 0.24      |
| Burseraceae           | Commiphora leptophloeos | Imburana                 | RES (flu), MSS (osteoarthritis) | Mata; Agreste; | 0.35      |
| Cereus jamacaru DC.   |                        | Cardeiro                 | URS (kidneys)          | Sertão     | 0.17      |
| Cactaceae             | Melocactus zehntneri    | Coroa de Frade           | RES (tiredness, asthma) | Mata       | 0.24      |
| Capparaceae           | Cynophalla flexuosa    | Feijão brabo             | MSS (back pain)        | Sertão     | 0.17      |
| Caprifoliaceae        | Valeriana sp.          | Valeriana                | NES (tranquilizer)     | Mata       | 0.17      |
| Caryocaraceae         | Caryocar sp.           | Pequi                    | RES (flu, cough)       | Sertão     | 0.24      |
### Celastraceae

**Monteverdia rigida** (Mart.) Biral  
Bom nome  
UDS (pain, inflammation, infection), MSS (fracture healing, joints); EXI  
Mata; Sertão;  
Agreoste  
0.94

**Monteverdia ilicifolia** (Mart. ex Reissek) Biral  
Espinheira santa  
DIS (stomach, stomach pain, gastritis, ulcer, gastroesophageal reflux, heartburn, hepatitis, cirrhosis); MSS (joint pain); UDS (inflammation); BCS (anticoagulant)  
Mata; Agreste; Borborema; Sertão  
1.13

### Chrysobalanaceae

**Microdesmia rigida** (Benth.) Sothers & Prance  
Oiticica  
ENM (diabetes), MSS (muscle strain)  
Mata; Sertão  
0.35

### Cleomaceae

**Cleome spinosa** Jacq.  
Mussambê  
RES (expectoration, cough)  
Sertão  
0.24

### Combretaceae

**Combretum fruticosum** (Loefl.) Stuntz  
Mufumbo  
RES (flu, cough)  
Sertão  
0.24

**Combretum glaucocarpum** Mart.  
João Mole  
BCS (swollen heart)  
Mata  
0.17

### Convolvulaceae
| Species                                      | Common Name                     | Use(s)                                | Regions     | Value |
|----------------------------------------------|---------------------------------|---------------------------------------|-------------|-------|
| *Operculina macrocarpa* (L.) Urb.             | Batata de purga                 | DIS (purgative), BCS (anticoagulant, hemorrhoids), UDS (inflammation) | Mata; Agreste; Sertão | 0.58  |
| *Costaceae*                                   |                                 |                                       |             |       |
| *Costus spicatus* (Jacq.) Sw.                 | Cana da índia                   | URS (kidney problems, urinary tract infection) | Mata         | 0.24  |
| *Cucurbitaceae*                               |                                 |                                       |             |       |
| *Luffa operculata* (L.) Cogn.                 | Cabacinha                       | RES (sinusitis); SST (shrink lumps)   | Mata; Agreste; Sertão | 0.35  |
| *Momordica charantia* L.                     | Melão de São Caetano            | BCS (hemorrhoids)                     | Sertão       | 0.17  |
| *Sicana odorifera* (Vell.) Naudin             | Croá                            | RSS (cysts, myoma), ENM (thyroid), URS (kidney stones), UDS (inflammation) | Mata; Agreste | 0.76  |
| *Wilbrandia* sp.                              | Cabeça de negro                 | ENM (blood clotting), SST (shrink lumps) | Mata; Agreste; Sertão | 0.35  |
| *Erythroxyllaceae*                            |                                 |                                       |             |       |
| *Erythroxylum* sp.                            | Rompe gibão                     | MSS (back pain, joints), NES (nerves) | Sertão       | 0.41  |
| *Equisetaceae*                                |                                 |                                       |             |       |
| *Equisetum giganteum* L.                     | Cavalinha                       | URS (kidney stones, urinary tract infection, kidneys, diuretic), ENM | Mata; Sertão | 1.17  |
(weight loss); UDS (infection); NEO (breast cysts); RSS (prostate); UDS (inflammation)

| Euphorbiaceae |          |                                    |                                  |                                |                        |       |
|---------------|----------|------------------------------------|---------------------------------|--------------------------------|------------------------|-------|
| *Cnidoscolus quercifolius* Pohl | Fabela | UDS (inflammation); URS (kidney stones); DIS (gastritis, ulcer); RSS (vaginal discharge, myoma, cysts, prostate) | Agreste; Sertão | 0.94 |
| *Cnidoscolus urens* (L.) Arthur | Urtiga branca | UDS (inflammation, infection); SST (wound healing); DIS (appendix); RSS (prostate); NEO (cancer); RES (cough) | Mata; Agreste; Sertão | 1.51 |
| *Croton* sp. | Velame branco | MSS (bone pain, rheumatism); | Agreste; Sertão | 0.24 |

| Fabaceae |          |                                    |                                  |                                |                        |       |
|----------|----------|------------------------------------|---------------------------------|--------------------------------|------------------------|-------|
| *Abarema cochliacarpos* Gomes Barneby & J.W. Babetenom | Grimes | UDS (inflammation); SST (wound healing); NEO (cancer); PAD (antibiotic); RSS (uterus inflammation); MSS (bone inflammation); DIS (gastritis) | Mata; Agreste; Sertão | 1.22 |
| *Amburana cearensis* (Allemão) | Cumarú | RES (expectorant, sinusitis, flu, cough); BCS (hemorrhoid); UDS (inflammation) | Mata; Agreste; Sertão | 0.71 |
| *Anadenanthera colubrina* Angico |          | RES (cough, flu, expectorant); UDS (inflammation) | Mata; Agreste; Sertão | 0.47 |
| Species                        | Common Name        | Regions                                                                 | Notes                                                                 |
|-------------------------------|--------------------|-------------------------------------------------------------------------|----------------------------------------------------------------------|
| *Bauhinia* sp.¹                | Mororó             | ENM (diabetes, cholesterol)                                             | Mata; Sertão 0.24                                                     |
| *Bauhinia* sp.²                | Pata de vaca       | ENM (diabetes, cholesterol); MSS (spine problems); UDS (inflammation)  | Borborema; Sertão 0.58                                                |
| *Cajanus cajan* (L.) Huth      | Feijão gandú       | NEO (intestinal cancer), ENM (diabetes), BCS (thrombosis)              | Mata 0.52                                                            |
| *Cenostigma pyramidale* (Tul.) | Catingueira        | RES (cough, flu); DIS (bellyache); ENM (cholesterol)                   | Agreste; Sertão 0.58                                                 |
| E. Gagnon & G.P. Lewis         |                    |                                                                         |                                                                      |
| *Erythrina velutina* Willd.    | Mulungú            | NES (insomnia, tranquilizer, nerve weakness, memory); RES (cough)       | Mata; Agreste; Sertão 0.53                                            |
| *Glycyrrhiza glabra* L.        | Alcaçuz            | RES (expectoration)                                                     | Mata 0.17                                                            |
| *Hymenaea courbaril* L.        | Jatobá             | erectile dysfunction; URS (kidney problems); BCS (anemia); ENM          | Borborema; Sertão 1.42                                                |
| (fortifying, rickets) UDS (inflammation, pain) |
| *Libidibia ferrea* (Mart. ex Tul.) | Jucá              | MSS (bone pain, spine, tendinitis, bursitis, spine inflammation); URS  | Mata; Agreste; Sertão 1.29                                            |
| L.P. Queiroz                   |                    | (kidney pain); SST (lumps); RSS (cysts); UDS (inflammation); RES        |                                                                      |
|                               |                    | (expectorant)                                                           |                                                                      |
| Scientific Name                        | Common Name     | Usage and Properties                                                                 | Regions          | Density |
|---------------------------------------|-----------------|--------------------------------------------------------------------------------------|------------------|---------|
| *Mimosa tenuiflora* (Willd.) Poir.    | Jurema preta    | UDS (inflammation); SST (wound healing); BCS (hemorrhoid)                           | Mata; Sertão     | 0.52    |
| *Mimosa sp.*                         | Malícia         | SST (wound healing)                                                                  | Sertão           | 0.17    |
| *Mucuna urens* (L.) Medik.            | Coronha         | UDS (inflammation, pain); MSS (herniated disc, spine inflammation)                  | Agrest; Sertão   | 0.65    |
| *Myroxyylon peruiferum* L. f.         | Bálsamo         | RES (expectorant)                                                                    | Mata; Sertão     | 0.17    |
| *Piptadenia sp.*                      | Jurema branca   | DIS (gastritis)                                                                      | Sertão           | 0.17    |
| *Ptredon emarginatus* (Vogel.) Kunth  | Sucupira        | MSS (spine pain, spine inflammation, herniated disc, joint pain, bone pain, bone inflammation, osteoarthritis), DIS (sore throat), ENM pain, BCS (thrombosis, high blood pressure), RES (sinusitis, tonsillitis), URS (kidneys) DIS (indigestion, constipation, "release dry feces", intestinal colic), ENM pain, BCS (thrombosis, high blood pressure), RES (sinusitis, tonsillitis), URS (kidneys) DIS (indigestion, constipation, "release dry feces", intestinal colic), ENM | Mata; Agrest; Borborema; Sertão | 1.54    |
| *Senna sp.*                           | Sena            | DIS (gastritis)                                                                      | Borborema; Sertão | 1.12    |
| *Tamarindus indica* L                | Tamarindo       | BCS (anemia)                                                                         | Mata; Sertão     | 0.17    |

**Humiriaceae**

| Scientific Name                        | Common Name     | Usage and Properties                                                                 | Regions          | Density |
|---------------------------------------|-----------------|--------------------------------------------------------------------------------------|------------------|---------|
| *Endopleura uchi* (Huber) Cuatrec.    | Uxi amarelo     | RSS (uterus, cysts, polycysts, myoma, uterus inflammation)                           | Mata; Sertão     | 0.42    |

**Illiciaceae**
| Species | Common Name | Uses |
|---------|-------------|------|
| *Illicium verum* Hooker | Anil estrelado | BCS (heart, high blood pressure); MSS (bone pain, back pain); DIS (indigestion, bellyache, liver, stomach ache); UDS (pain); RSS (colic) |

**Lamiaceae**

| Species | Common Name | Uses |
|---------|-------------|------|
| *Lavandula angustifolia* Mill. | Alfazema | DIS (baby colic, constipation, intestine); RES (cough); NES (tranquilizer), UDS (colic, pain, fever), CUD ("evil eye"), BCS (jaundice); PAD (infection) |
| *Melissa officinalis* L. | Melissa | RES (tranquilizer) |
| *Mentha sp.* | Hortelã | RES (flu, expectoration); ENM (weight loss); PAD ("bacteria in the stomach"); BCS (prevent strokes) |
| *Mesosphaerum suaveolens* (L.) Kuntze | Alfazema braba | DIS (bellyache, constipation, intestine); ENM (cholesterol, diabetes, weight loss) |
| *Ocimum sp.*¹ | Manjericão | CUD ("bad air"); RES (flu) |
| *Ocimum sp.*² | Alfavaca | RES (sinusitis) |
| *Origanum sp.* | Orégano | ENM (menopause); NEO (cancer); DIS (constipation); NES (insomnia); PAD (candidiasis); RES (cough) |
| *Rosmarinus officinalis* L. | Alecrim | BCS (arrhythmia, high blood pressure, heart problems, circulation) |
CVA); DIS (stomach ache, constipation, indigestion); NES (depression, tranquilizer, meningitis); UDS (headache); RES (sinusitis, tiredness, asthma); ENM (thyroid)

| Scientific Name | Common Name | Description |
|-----------------|-------------|-------------|
| *Salvia hispanica* L. | Chia | ENM (weight loss, appetite suppressant, menopause); DIS (intestinal regulation) |
| *Salvia officinalis* L. | Sálvia | ENM (weight loss) |
| *Vitex gardneriana* Schauer | Jaramataia | URS (kidneys, prostate), ENM (diabetes, cholesterol) |

### Lauraceae

| Scientific Name | Common Name | Description |
|-----------------|-------------|-------------|
| *Cinnamomum* sp. | Canela | NES (tranquilizer, stimulant); ENM (weight loss, diabetes); BCS (low blood pressure, prevent blood clotting); DIS (throat, stomach ache); RES (hoarseness); UDS (vomiting); MSS (bones); EXI (bumps) |
| *Laurus nobilis* L. | Louro | DIS (diarrhea, indigestion, stomach); UDS (headache); URS (kidneys); UDS (headache) |
| *Persea americana* Mill. | Abacate | BCS (heart); URS (kidneys) |
| Family       | Species                                      | Common Name | Other Uses                                                      | Location | Medicinal Uses                                                                 |
|--------------|----------------------------------------------|-------------|-----------------------------------------------------------------|----------|---------------------------------------------------------------------------------|
| Lecythidaceae| *Bertholletia excelsa* Bonpl.                | Castanha do Pará | ENM (liver fat)                                                | Mata; Sertão | 0.17                                                                              |
| Linaceae     | *Linum usitatissimum* L.                     | Linhaça     | DIS (constipation, intestinal regulation); BCS (thrombosis, CVA); MSS (rheumatism); ENM (weight loss) | Mata; Agreste; Sertão | 0.82                                                                              |
| Lyrthaceae   | *Punica granatum* L.                         | Romã        | DIS (sore throat, gastritis, stomach, heartburn); RES (hoarseness, cough, tonsillitis); RSS (prostate, erectile dysfunction); BCS (heart); ENM (liver fat); UDS (inflammation); PAD (antibiotic); SST (wound healing); URS (kidneys) | Mata; Agreste; Borborema; Sertão | 2                                                                                  |
| Malvaceae    | *Abelmoschus esculentus* (L.) Moench         | Quiabo      | BCS (CVA); MSS (bones)                                         | Sertão   | 0.35                                                                              |
|              | *Chorisia glaziovii* (Kuntze) E. Santos      | Barriguda   | MSS (spine); URS (kidneys)                                     | Sertão   | 0.35                                                                              |
|              | *Gossypium herbaceum* L.                     | Algodão     | SST (furuncles)                                                | Sertão   | 0.17                                                                              |
| Plant Name                                | Species                        | Medicinal Uses                                                                 |
|------------------------------------------|--------------------------------|--------------------------------------------------------------------------------|
| Hibiscus sp.                             | Hibisco                        | ENM (diabetes, cholesterol, triglycerides, liver fat, weight loss); URS (diuretic); BCS (blood circulation, swelling, low immunity, blood pressure, prevent blood clotting); UDS (inflammation); DIS (liver inflammation) |
| Pseudobombax marginatum (A. St.-Hil., Juss. & Cambess.) A. Robyns | Imbiratanha                    | MSS (spine); URS (kidneys, kidney inflammation)                                 |
| Melastomataceae                          |                                |                                                                                  |
| Miconia albicans (Sw.) Triana            | Canela de velho                 | MSS (arthritis, osteoarthritis, bursitis, herniated disc, bone pain, joint pain, tendinitis, rheumatism, bone inflammation); UDS (pain, infection, headache, inflammation); PAD (Chikungunya) |
| Meliaceae                                |                                |                                                                                  |
| Cedrela odorata L.                       | Cedro                           | DIS (intestinal problems, constipation, bellyache); UDS (pain, inflammation)    |
| Menispermaceae                           |                                |                                                                                  |
| Cissampelos sympodialis                  | Milona                          | RES (cough, flu); ENM (diabetes, liver fat)                                    |

**Location:** Mata; Agreste; Borborema; Sertão

**Values:**

- Hibiscus sp.: 1.37
- Pseudobombax marginatum (A. St.-Hil., Juss. & Cambess.) A. Robyns: 0.41
- Miconia albicans (Sw.) Triana: 1.21
- Cedrela odorata L.: 0.53
- Cissampelos sympodialis: 0.47
| Family    | Species                  | Common Name       | Uses                                                                 | Regions                                      | Scores |
|-----------|--------------------------|-------------------|----------------------------------------------------------------------|----------------------------------------------|--------|
| Monimiaceae | *Peumus boldus* Molina | Boldo do Chile    | DIS (diarrhea, liver problems, stomach ache, indigestion, intestine), URS (kidneys), MBD (hangover), ENM (liver fat) | Mata; Agreste; Borborema; Sertão              | 1.13   |
| Moraceae   | *Brosimum gaudichaudii* Trécul | Mamica de cadela | SST (Vitiligo)                                                        | Mata                                         | 0.17   |
|           | *Morus* sp.              | Amora             | ENM (diabetes, menopause, weight loss, cholesterol), URS (diuretic), BCS (boost immunity, high blood pressure), UDS (inflammation) | Mata; Borborema; Sertão                      | 0.94   |
| Moringaceae | *Moringa* sp.           | Moringa           | NES (memory); NEO (cancer)                                            | Sertão                                       | 0.35   |
| Musaceae   | *Musa x paradisiaca* L.  | Banana            | RES (cough)                                                           | Sertão                                       | 0.17   |
| Myristaceae | *Myristica fragans* Houtt | Noz moscada       | SES (labyrinthitis); BCS (prevent strokes)                            | Mata; Agreste; Sertão                        | 0.35   |
| Myrtaceae  | *Eucalyptus globulus* Labill. | Eucalipto         | RES (sinusitis, common cold, flu, expectorant); NES (tranquilizer); DIS | Mata; Agreste                                | 1.06   |
| Family            | Scientific Name                          | Common Name | Uses                                      | Regions                           | Notes                        |
|-------------------|------------------------------------------|-------------|-------------------------------------------|-----------------------------------|------------------------------|
|                    | *Eugenia uniflora* L.                    | Pitanga     | DIS (bellyache)                           | Sertão                            |                              |
|                    | *Myrcia speciosa* (Amshoff) McVaugh      | Pedra-hume-kar | ENM (diabetes)                           | Mata                              |                              |
|                    | *Psidium guajava* L.                     | Guava       | DIS (bellyache)                           | Sertão                            |                              |
|                    | *Syzygium aromaticum* (L.) Merr. & L. M. Perry | Cravo      | UDS (headache, dizziness, bad breath); DIS (indigestion; toothache); SES (Labyrinthitis); NES (Insomnia, tranquilizer); BCS (high blood pressure) | Mata; Agreste; Borborema; Sertão |                              |
|                    | *Syzygium cumini* (L.) Skeels            | Oliveira    | ENM (weight loss, "reduce the levels"); NEO (cancer) | Sertão                            |                              |
| Nyctaginaceae      | *Boerhavia diffusa* L.                   | Pega pinto  | URS (kidneys, urinary tract infection)    | Sertão                            |                              |
| Olacaceae          | *Ximenia americana* L.                   | Ameixa      | DIS (gastritis); UDS (inflammation); SST (wound healing); ENM (cholesterol) | Mata; Agreste; Borborema; Sertão |                              |
| Opiliaceae         |                                          |             |                                           |                                   |                              |
| SciName                  | Common Name       | Morphology | Use(s)                                      | Region(s) | Frequency |
|-------------------------|-------------------|------------|--------------------------------------------|-----------|-----------|
| Agonandra brasiliensis Miers | Marfim            | RES (cough, flu) | Mata                                       | 0.24      |           |
| Papaveraceae             |                   |            |                                             |           |           |
| Argemone mexicana L.     | Cardo santo       | BCS (CVA, thrombosis) | Mata; Agreste; and Sertão                 | 0.24      |           |
| Passifloraceae           |                   |            |                                             |           |           |
| Turnera subulata Smith. | Chanana           | URS (urinary tract infection) | Sertão                                      | 0.17      |           |
| Pedaliaceae              |                   |            |                                             |           |           |
| Sesamum orientale L.     | Gergelim preto    | BCS (thrombosis, CVA); MSS (bone pain, joint pain, rheumatism, bone calcium); UDS (numbness); DIS (intestinal regulation); ENM (menopause, appetite suppressant, weight loss) | Mata; Agreste; Sertão | 1.24      |           |
| Petiveriaceae            |                   |            |                                             |           |           |
| Petiveria alliacea L.    | Tipi              | MSS (rheumatism) | Mata; Sertão                               | 0.17      |           |
| Phyllanthaceae           |                   |            |                                             |           |           |
| Phyllanthus niruri L.    | Quebra pedra      | URS (kidney stones, kidney problems); DIS (liver, gallstones); EXI (bumps) | Mata; Borborema; Sertão | 0.65      |           |
| Piperaceae               |                   |            |                                             |           |           |
| **Piper nigrum** L. | Pimenta do reino | NES (labyrinthitis); UDS (headache) | Mata; Borborema; Sertão | 0.35 |
| **Poaceae** |
| *Cymbopogon citratus* (DC.) Stapf | Capim santo | NES (tranquilizer, stimulant); DIS (bellyache); BCS (high blood pressure) | Mata; Agreste; Sertão | 0.58 |
| *Zea mays* L. | Milho | URS (kidneys), BCS (jaundice) | Sertão | 0.35 |
| **Polygonaceae** |
| *Polygonum hydropiperoides* Michx. | Erva de bicho | URS (kidneys) | Mata | 0.17 |
| **Rhamnaceae** |
| *Ziziphus joazeiro* Mart. | Juá | SST (dandruff); DIS (gum disease) | Mata; Sertão | 0.35 |
| **Rubiaceae** |
| *Coutarea hexandra* (Jacq.) K. Schum. | Quina quina | ENM (diabetes, blood clotting), RES (sinusitis), MSS (rheumatism), UDS (fever) | Mata; Agreste; Sertão | 0.76 |
| *Genipa americana* L. | Jenipapo | MSS (fracture healing); BCS (increase blood platelets) | Sertão | 0.35 |
| *Guettarda sp.* | Angélica | RSS (menstrual cramps) | Sertão | 0.17 |
| *Morinda citrifolia* L. | Noni | ENM (diabetes, weight loss); NEO (cancer); BCS (blood circulation) | Agreste; Sertão | 1.12 |
fluid retention, hemorrhoids, high blood pressure); DIS (gastritis); RSS (uterus inflammation)

| Uncaria sp. | Unha de gato | UDS (inflammation); RSS (cysts, nodule, myoma, polycysts, uterus inflammation); MSS (bone inflammation) | Mata; Agreste; Sertão | 0.77 |
|-------------|--------------|------------------------------------------------------------------------------------------------|-----------------------|------|
| Rutaceae    |              |                                                                                               |                       |      |
| *Citrus aurantium* L. | Laranja | NES (tranquilizer) | Mata; Sertão | 0.17 |
| *Pilocarpus* sp. | Jaborandi | UDS (fever) | Mata | 0.17 |
| Sapotaceae  |              |                                                                                               |                       |      |
| *Sideroxylon obtusifolium* (Roem & Schult.) T.D. Penn. | Quixaba | UDS (inflammation, pain); MSS (spine inflammation); SST (wound healing); URS (kidneys); EXI (bumps) | Mata; Agreste; Borborema; Sertão | 0.93 |
| Selaginellaceae |          |                                                                                               |                       |      |
| *Selaginella convoluta* (Arn.) | Mão fechada | RES (cough, flu) | Sertão | 0.24 |
| Smilacaceae |              |                                                                                               |                       |      |
| *Smilax* sp. | Japecanga | SST (vitiligo); MSS (spine inflammation) | Mata | 0.35 |
| Solanaceae  |              |                                                                                               |                       |      |
| Family          | Genus                          | Species                        | Common Name          | Uses ( Complaints)                                                                 | Region | Value |
|-----------------|--------------------------------|--------------------------------|----------------------|-----------------------------------------------------------------------------------|--------|-------|
| Solanaceae      | Solanum                       | americanum Mill.               | Erva moura           | SST (wound healing)                                                               | Sertão | 0.17  |
|                 |                                | paniculatum L.                 | Jurubeba             | DIS (liver, gastritis); ENM (diabetes); RSS (menstrual cramps)                   | Sertão | 0.58  |
| Theaceae        | Camellia                      | sinensis (L.) Kuntze           | Chá verde/Chá preto  | ENM (cholesterol, diuretic, weight loss, loss of appetite); NES                   | Mata;  | 1.42  |
|                 |                                |                                 |                      | Matas; Agrestes; DIS (inflammation, fever); DIS (bellyache, intestine,           | +-     |       |
|                 |                                |                                 |                      | Borborema; intestinal infection); SES (vision problems); URS (diuretic)         | Sertão |       |
| Verbenaceae     | Lippia                        | alba (Mill.) N.E. Br. ex Britton & P. Wilson | Erva cidreira       | RES (expectoration); BCS (anemia); DIS (indigestion, bellyache); NES             | Mata;  | 0.99  |
|                 |                                |                                 |                      | Matas; Agrestes; (tranquilizer, insomnia); ENM (whet the appetite)               | +-     |       |
| Violaceae       | Pombalia                      | lanata (A. St.-Hil.) Paula-Souza | Papaconha            | RES (expectoration, cough, flu); PAD (worm infection); UDS (fever)               | Mata;  | 0.65  |
|                 |                                |                                 |                      | Borborema; Sertão; UDS (fever)                                                   | +-     |       |
| Vitaceae        | Cissus                        | sp.                            | Parreira             | URS (kidneys); MSS (spine)                                                       | Sertão | 0.35  |
| Zingiberaceae   | Alpinia                       | zerumbet (Pers.) B.L. Burtt & R.M. Sm. | Colônia             | UDS (fever); RES (expectoration)                                                 | Mata;  | 0.35  |
|                 |                                |                                 |                      | Sertão;                                                                  |        |       |
| Plant Name                  | Common Name | Uses                                                                 | Location | Frequency |
|----------------------------|-------------|----------------------------------------------------------------------|----------|-----------|
| *Curcuma longa* L.         | Cúrcuma     | UDS (inflammation); BCS (hepatitis; jaundice); PAD (antibiotic); RES (flu); MSS (bones) | Mata; Sertão | 0.93      |
|                            |             | BCS (high blood pressure, prevent blood clotting); DIS (throat pain, sore throat, stomach); RES (cough, expectoration, flu, hoarseness); ENM (liver fat, cholesterol, weight loss); UDS (pain, inflammation); NES (stimulant); URS (diuretic) | Mata; Agreste; Borborema; Sertão | 1.78      |
| *Zingiber officinale* Roscoe | Gengibre    | RES (cough, flu, tiredness), UDS (pain)                               | Borborema; Sertão | 0.47      |
| *Indeterminated 1*         | Baço        | SST (wound healing)                                                  | Sertão   | 0.17      |
| *Indeterminated 2*         | Caninana    | DIS (diarrhea)                                                       | Borborema | 0.17      |
| *Indeterminated 3*         | Catinga branca | DIS (gastritis, ulcer)                                               | Borborema | 0.24      |
| *Indeterminated 4*         | Cauaçú      | MSS (bone pain, joint pain, rheumatism)                              | Borborema | 0.3       |
| *Indeterminated 5*         | Chocalho de vaqueiro | MSS (joints, rheumatism, spine), UDS (inflammation)              | Sertão   | 0.47      |
| *Indeterminated 6*         | Cipó de cruz | RES (common cold, flu)                                               | Sertão   | 0.47      |
| *Indeterminated 7*         | Espriteira  | RES (common cold, flu)                                               | Agreste  | 0.24      |
| *Indeterminated 8*         | Jalapa      | ENM (diabetes)                                                       | Mata      |            |
| Indeterminated 9 | Junço          | UDS pain) | Sertão | 0.17 |
|-----------------|----------------|-----------|--------|------|
| Indeterminated 10 | Mapirunga      | MSS (rheumatism), UDS (pain) | Agreste | 0.28 |
| Indeterminated 11 | Maria leite    | URS (kidney stones), DIS (gallstone) | Mata    | 0.34 |
| Indeterminated 12 | Pau tenente    | ENM (diabetes, cholesterol), UDS (inflammation) | Mata; Sertão | 0.41 |
| Indeterminated 13 | Pimenta parda  | RES (throat) | Agreste | 0.17 |
| Indeterminated 14 | Porangaba      | ENM (cholesterol, blood clotting, diabetes), DIS (intestine) | Mata; Agreste; Sertão | 0.47 |
| Indeterminated 15 | Quebra faca    | ENM (diabetes, cholesterol), SST (pruritus) | Sertão | 0.41 |
| Indeterminated 16 | Sassafrás      | URS (urinary tract infection, kidneys) | Sertão | 0.24 |
| Indeterminated 17 | Urinana        | URS (urinary tract infection), ENM (retained fat) | Mata | 0.35 |
Table 2. Medicinal plants of high Relative Importance in public markets of different Mesoregions in the state of Paraíba, Northeastern Brazil. N = species native to Brazil. E = exotic species. RI = Relative Importance.

| Species                  | Origin | RI | Species            | Origin | RI |
|--------------------------|--------|----|--------------------|--------|----|
| Punica granatum          | E      | 2  | Abarema cochliacarpos | N      | 1.22 |
| Zingiber officinale      | E      | 1.78 | Miconia albicans  | N      | 1.21 |
| Myracrodruon urundeuva   | N      | 1.69 | Illicium verum    | E      | 1.18 |
| Rosmarinus officinalis   | E      | 1.67 | Syzygium aromaticum | E      | 1.18 |
| Cinnamomum sp.           | E      | 1.64 | Anacardium occidentale | N    | 1.17 |
| Foeniculum vulgare       | E      | 1.59 | Matricaria chamomilla | E | 1.17 |
| Pimpinella anisum        | E      | 1.59 | Equisetum giganteum | N      | 1.17 |
| Ptredon emarginatus      | N      | 1.54 | Monteverdia ilicifolia | N | 1.13 |
| Cnidoscolus urens        | N      | 1.51 | Peumus boldus      | E      | 1.13 |
| Hymenaea courbaril       | N      | 1.42 | Senna sp.          | N      | 1.12 |
| Camellia sinensis        | E      | 1.42 | Morinda citrifolia | E      | 1.12 |
| Lavandula angustifolia   | E      | 1.4  | Allium sp.        | E      | 1.07 |
| Anethum graveolens       | E      | 1.37 | Allium sativum    | E      | 1.06 |
| Hibiscus sp.             | E      | 1.37 | Coriandrum sativum | E      | 1.06 |
| Libidibia ferrea         | N      | 1.29 | Eucalyptus globulus | E      | 1.06 |
| Sesamum orientale        | E      | 1.24 | Origanum sp.      | E      | 1.04 |

During the study period 88 species were unavailable at least once at least at one of the traders interveiwed (Table 3). The Mata was the mesoregion where the highest number of species was absent at some point during the year, while the Borborema was the region with least seasonal absence of species.
Table 3. Percentage of informants that reported the absence of some species during the interview period for each studied mesoregion. Blank cells indicate that the species was not recorded in the mesoregion at any time of the year.

| Species                  | Mata (N = 13) | Agreste (N = 10) | Borborema (N = 4) | Sertão (N = 8) |
|--------------------------|---------------|------------------|-------------------|--------------|
|                          | 1° 2° 3° 4°   | 1° 2° 3° 4°      | 1° 2° 3° 4°       | 1° 2° 3° 4°  |
| Abarema cochliacarpos    | 7.69          | -                | -                 | 12.5         |
|                          | -             | 30 20 20 10      | -                 | -            |
| Agave sp.                | -             | -                | -                 | -            |
| Ageratum conyzoides      | -             | 10               | -                 | -            |
| Allium sp.               | 7.69          | 15.38 7.69       | -                 | 25 12.5 25   |
| Aloe vera                | 7.69          | 15.38 7.69       | 25                 | -            |
| Alpinia zerumbet         | 15.38 7.69    | -                | -                 | 12.5         |
| Amburana cearensis       | 15.38 7.69    | 15.38 10 30      | -                 | -            |
| Anacardium occidentale   | -             | 7.69             | 10 10             | 12.5 12.5    |
| Anadenanthera colubrina  | 15.38 - 7.69  | 10 -             | -                 | -            |
| Anemopaegma sp.          | 7.69 7.69     | -                | -                 | 12.5         |
| Anethum graveolens       | 23.07         | -                | -                 | 12.5 12.5    |
| Annona muricata          | 7.69 15.38    | -                | -                 | -            |
| Baccharis sp.            | 15.38 7.69 15.38 | -   | -                   | 12.5         |
| Bahuinia sp.
| 7.69 7.69 | - | 10 | 25 | 25 | 12.5 | 12.5 |
| Berholletia excelsa      | -             | 7.69             | -                 | -            |
| Boerhavia coccinea       | -             | 7.69             | -                 | 12.5 12.5    |
| Brassica sp.             | -             | -                | 10 10             | 12.5 12.5    |
| Camellia sinensis        | 7.69          | -                | 10 20             | 12.5 12.5    |
| Caryocar sp.             | -             | -                | 12.5              | 12.5         |
| Plant Name                  | -  | -  | -  | -  | -  | 12.5 | 12.5 |
|-----------------------------|----|----|----|----|----|------|------|
| *Cenostigma pyramidale*    |    |    |    |    |    | 12.5 | 12.5 |
| *Centella sp.*             |    |    |    |    |    | 12.5 | 12.5 |
| *Cissus sp.*               |    |    |    |    |    | 12.5 | -    |
| *Chorisia glaziovii*       |    |    |    |    |    | 12.5 | 12.5 |
| *Cissampelos sympodialis*  |    |    |    |    |    | 12.5 | -    |
| *Cnidoscolus urens*        |    | 7.69| 10 | 10 |    | 12.5 | -    |
| *Cnidoscolus quercifolius* |    | 10 | 25 | 25 | 25 | -    | -    |
| *Cocos nucifera*           |    |    |    |    |    | 12.5 | -    |
| *Combretum fruticosum*     |    |    |    |    |    | 12.5 | -    |
| *Copernicia prunifera*     |    |    |    |    |    | 12.5 | -    |
| *Croton sp.*               |    | 10 |    |    |    | -    | -    |
| *Cymbopogon citratus*      |    | 10 | 25 | 25 | 25 | -    | -    |
| *Cynophalla flexuosa*      |    |    |    |    |    | 12.5 | 12.5 |
| *Erythrina velutina*       | 15.38| - | - | - | - | - | 12.5 |
| *Eucalyptus globulus*      |    |    |    |    |    | -    | -    |
| *Foeniculum vulgare*       | 38.46 | 7.69 | - | - | 25 | 50 | 12.5 |
| *Glycyrrhiza glabra*       |    |    |    |    | 7.69 | -    | -    |
| *Helianthus annuus*        |    |    |    |    | 10 | 25 | -    |
| *Hibiscus sp.*             | 7.69| - | - | - | 10 | - | 12.5 |
| *Hymenaea courbaril*       | 23.07 | 7.69 | 7.69 | - | - | 25 | -    |
| *Illicium verum*           | 15.38 | 7.69 | 7.69 | - | 30 | 10 | -    |
| *Lavandula angustifolia*   | 7.69| 7.69 | - | - | 10 | 25 | 12.5 |
| *Libidibia ferrea*         | 15.38 | 7.69 | - | 20 | 10 | 10 | - |
| *Licania rigida*           | 15.38 | 15.4 | - | - | 25 | - | 12.5 |
| *Lippia alba*              | 7.69| 7.69 | - | - | - | - | 12.5 |
| *Luffa operculata*         | 7.69| - | - | 10 | 10 | - | 12.5 |

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| Plant                          | - | - | - | - | - | - | - | 12.5 | -  |
|-------------------------------|---|---|---|---|---|---|---|-----|----|
| Maytenus rigida               |   |   |   |   |   |   |   |     |    |
| Mentha sp.                    |   |   |   | 25| 25| 25|   |     |    |
| Miconia albicans              |   | 7.69| 7.69| 10|   |   |   |   |    |
| Monteverdia ilicifolia        |   | 7.69| 10|   |   |   |   |   | 12.5|
| Morus sp.                     | 7.69| 7.69|   |   |   |   |   |    |    |
| Musa x paradisiaca            |   |   |   | 12.5| 12.5|   |   |   |    |
| Myracrodruon urundeuva        |   |   | 30| 10| 20|   |   |   |    |
| Persea americana              |   |   |   |   |   |   |   | 12.5|    |
| Phyllanthus niruri            | 23.07| 15.4| 30.77| 10|   | 10|   | 25|    |
| Pimpinella anisum             |   |   | 7.69|   |   |   |   |   |    |
| Pombalia lanata               |   |   | 23.08|   |   |   |   | 12.5| 25|
| Ptredon emarginatus           | 7.69| 7.69| 7.69| 10| 10| 20| 10| 25|    |
| Punica granatum               | 7.69|   | 10|   |   |   |   |   | 25  |
| Rosmarinus officinalis        |   | 7.69| 10|   |   |   |   |   | 12.5|
| Salvia hispánica              | 7.69|   | 10|   |   |   |   | 25|    |
| Sambucus australis            | 7.69|   | 10| 10| 10|   | 25| 25|    |
| Schnapsis brasiliensis        |   |   | 10| 10| 10|   |   | 12.5| 12.5|
| Senna sp.                     | 7.69| 7.69| 10| 10|   |   |   |   |    |
| Sesamum orientale             |   |   | 10|   |   | 25| 25| 25| 12.5|
| Sideroxylon obtusifolium      |   |   | 10| 10| 10|   | 25|   |    |
| Solanum americanum            |   |   |   | 12.5|   |   |   |    |    |
| Symphytum officinale          |   |   |   |   |   |   | 12.5| 12.5|
| Syzygium cumini               |   |   |   |   |   |   | 12.5|   |    |
| Tamarindus indica             | 7.69| 7.69|   |   |   |   |   | 12.5| 12.5|
| Taraxacum officinale          |   |   |   | 25| 25| 25| 12.5| 12.5|
Valeriana sp. - 7.69 -

Wilbrandia sp. - - - 7.69 - - - - - - -

Ximenia americana - - - - - - - - 25 - - - -

Zingiber officinale - - 7.69 - - - - - - - - - - 12.5 -

Ziziphus joazeiro - - - 7.69 - - - - - - - - - - 12.5 -

Discussion

The medicinal plant species traded in the public markets of Paraíba were shared among the mesoregions, except for the Sertão, which had a more specific group of plants for sale. Climatic and seasonal variations did not seem to greatly influence plant availability throughout the year, considering that traders in general keep a stock of dry plants to ensure the supply of most species. Overall, leaves, bark, and seeds were the most frequently traded plant parts, with the bark predominating in the Agreste mesoregion, while leaves were the most traded plant structure in the remaining mesoregions.

The highest Relative Importance values were recorded for *Punica granatum*, *Zingiber officinale*, and *Myracrodruon urundeuva*. Although these species were recorded in all studied mesoregions and kept a relatively frequent availability in the trading locations during the research, previous studies involving some of the studied municipalities did not record these species in the market. In Guarabira, *P. granatum* was not previously recorded among the main species, and *Z. officinale* and *M. urundeuva* were also not recorded in a previous study conducted in the market of Patos [24], even though *M. urundeuva* occurs naturally in the region [42,43]. These data may indicate that over the past decade changes have occurred in plant availability or in the local importance of medicinal plants traded in these markets. It is worth mentioning that these species have been commonly documented in markets of nearby regions, such as in Pernambuco, although *P. granatum* and *Z. officinale* usually presented relatively low RI values compared to what was observed in our study [10,18,23].
In most cases the medicinal use of leaves, bark, and seeds (Figure 3) was recorded, similarly to several other studies [7,30,44]. Previously a greater use of leaves and herbaceous plants in wetter regions, such as the Atlantic Forest has been commonly registered [4,45,46], while in drier regions, such as the Caatinga, a predominance of the use of barks and woody plants has been shown [3,47], highlighting a relationship with the loss of foliage in the vegetation during the drier periods [16]. This apparent correspondence between the most used plant parts and the environment can also be seen in other studies conducted in dry [6,8,48] and wetter environments [33,20]. However, in this study, it was not possible to establish a similar relationship between the environment and the most traded plant parts, and the Agreste was the only drier region where the bark was the main plant structure traded. The leaves were the main plant part in the remaining mesoregions, even in drier areas, where a more significant bark trade would have been expected. A possible explanation for that is the dynamism of medicinal plant trade, which involves not only the local plant species in the studied markets but also species from other regions and even imported from other countries, since, as observed here, most species with high Relative Importance were exotic.

It was impossible to establish a relationship between the unavailability of any species during some period and the mesoregion, given that when one species was unavailable in one trade location (market stand), it could usually be found in other locations of the same market. While there might be a relationship between plant habit and availability, given most species that showed some period of unavailability are herbaceous, similar to other studies [10], most species are sold dried, giving the traders the possibility to simply acquire and stock the material avoid a lack of the product [20], although at times traders simply might not have the financial resources to stock material.

In some cases, the informants stated that *Foeniculum vulgare*, according to them, cultivated in the Brejo and Curimataú areas (Agreste Mesoregion), was not available during
some periods. A possible explanation for species unavailability in some cases could be traced to the recent sale of the whole stock by a trader, or the lack of interest by the trader in stocking a particular product given the low demand.

It was also possible to note the incorporation of a new species into the plant trade during our study: In the first stage of the interviews, *Miconia albicans* was only found in a few places of the Mata and Sertão mesoregions, and then a fast spread of this species in the market was observed. Although being a native species and, according to some informants, common in woody areas of both the Atlantic Forest and the Caatinga, its medicinal use was not well known until recently. According to the traders, the recent increase in the trade of this species occurred due to its recent promotion treat pain and muscular and rheumatic diseases on the internet and television, which led increasing consumer demand. Previous ethnobotanical studies did record this species, but made no reference to its medicinal use [49–51]. Previous records of its medicinal exist from Mexico [52], and five different species of *Miconia* have been reported as medicinal plants in Bolivia [5]. Similar cases have also been reported for *Hibiscus* sp., *Camellia sinensis*, and *Zingiber officinale*, species that began to be traded less than a decade ago, according to the informants, also influenced by the media and the internet.

The greater use of medicinal plants to treat diseases of the digestive and respiratory systems has often been reported in ethnobotanical studies [3,14,15,21], and explained by the fact that these diseases are most commonly affecting the population [3,15]. The emphasis on endocrine, nutritional, and metabolic diseases might partly be explained due to plant use for weight loss (Table 1), which, according to the traders, is also a consequence of the growing interest of customers in using plants that aid in losing weight and keeping a good shape. This has been related to the current habits of society, which tends to be sedentary and ingest highly caloric foods, becoming obese, and social media and television promoting the sale of medicinal plants for losing weight [53–56].
The four mesoregions shared 35 species. The one-way ANOSIM multivariate analysis demonstrated significant similarity between the mesoregions, except for the Sertão, which showed a significant differences from all remaining mesoregions.

The difference between the Sertão and the remaining mesoregions could also be observed in the Principal Coordinates Analysis. Interestingly, the Agreste Mesoregion, geographically located in a transition area between the Atlantic Forest and the Caatinga, fell in the center of the graph, sharing its limits with all remaining mesoregions. This leads us to suggest that the Agreste mesoregion represents a type of "biocultural ecotone" or “cultotone,” resembling the concept of ecotone, understood not only as a transition area for vegetation, but of knowledge and practice in the use of medicinal plants in relation to the remaining mesoregions.

Considering the relatively small territory of the state of Paraíba (56,585 km²) [35], it may be inferred that there is a permutation of knowledge and traded species between the different regions. Although a study with similarity analysis between different phytophysiognomies in the states of Paraíba and Pernambuco has not found similarity between the studied phytophysiognomies [57], it is worth noting that, in addition to the possibility of permutation of native species of different phytophysiognomies, the use of exotic species is a factor that collaborates for a greater sharing of species, even in so different areas as the Atlantic Forest and the Caatinga.

Conclusions

The inventory of medicinal plants available in the markets of Paraíba varies little throughout the year. In general, traders seem to keep permanent stocks of the main plants. Traders were also receptive to incorporating new plants into their stocks, which might be explained several factors, such as the influence of the media and the internet, fostering the growing interest of customers in certain species.
It was impossible to establish a relationship between the periods of species absence in some trading locations and the mesoregion where this absence occurred. The absence during certain periods is probably more related to temporary unavailability or the impossibility for the trader to stock the product, or might even be related to environmental changes, which may influence species availability.

The Sertão mesoregion was the only one that showed a significant variation in the inventory of species sold by the traders. It is also interesting that the Agreste mesoregion, geographically located in an intermediate region between the Atlantic Forest and the Caatinga, showed an intermediate similarity pattern with the remaining mesoregions.

Declarations

Ethics approval and consent to participate

The aim of this study was explained to each informant, who was then asked to sign a consent form, as required by the National Health Council and the Research Ethics Committee (Resolution 466/12). This research was approved by the Research Ethics Committee of the State University of Paraíba (Protocol No. 82943618.0.0000.5188). The authors interviewed 35 informants, who were informed of the aim of this scientific research and agreed to sign an informed consent form, according to necessary standards, and as described in the methodology through the protocol number.

Consent for publication

The participants who signed the consent form were aware that this scientific research could be published in the academic milieu.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the
corresponding author on reasonable request.

**Competing interests**

The authors declare that they have no competing interests.

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**Authors’ contributions**

ECF collected and analyzed the data and wrote the manuscript, DDC and RFPL coordinated the field research and the writing of the manuscript, RWB and NYPZ contributed in final write up.

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Figure 1. Map of the State of Paraíba, Brazil, highlighting the studied municipalities, the municipalities where it was impossible to conduct the research, the four mesoregions of the state, and the predominance areas of the biomes.

Figure 2. Percentage of citations for each category of medicinal use in public markets of Paraíba, northeastern Brazil. n = number of informants in the mesoregion. BCS = Blood and cardiovascular system; CUD = Cultural diseases; DIS = Digestive system; ENM = Endocrine system, nutrition, and metabolism; EXI = External injuries; INT = Intoxication; MBD = Mental and behavioral diseases; MSS = Musculoskeletal system; NEO = Neoplasms; NES = Nervous system; PAD = Parasitic diseases; PRP = Pregnancy and parturition; RES = Respiratory system; RSS = Reproductive system and sexual health; SES = Sensory system; SST = Skin and subcutaneous tissue; UDS = Unspecified diseases and symptoms; URS = Urinary system. A: Mata, B: Agreste, C: Borborema, D: Sertão.

Figure 3. Percentage of citations for the plant parts traded for medicinal use in public markets of Paraíba, northeastern Brazil. n = number of informants in the Mesoregion. A: Mata, B: Agreste, C: Borborema, D: Sertão.

Figure 4. Principal Coordinates Analysis (PCoA) showing the similarity between the species indicated by the 35 traders in the four mesoregions. Green = Mata; Yellow = Agreste; Blue = Borborema; Red = Sertão.
Figure 1

Map of the State of Paraíba, Brazil, highlighting the studied municipalities, the municipalities where it was impossible to conduct the research, the four mesoregions of the state, and the predominance areas of the biomes.
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Percentage of citations for each category of medicinal use in public markets of Paraíba, northeastern Brazil. \( n \) = number of informants in the mesoregion. BCS = Blood and cardiovascular system; CUD = Cultural diseases; DIS = Digestive system; ENM = Endocrine system, nutrition, and metabolism; EXI = External injuries; INT = Intoxication; MBD = Mental and behavioral diseases; MSS = Musculoskeletal system; NEO = Neoplasms; NES = Nervous system; PAD = Parasitic diseases; PRP = Pregnancy and parturition; RES = Respiratory system; RSS = Reproductive system and sexual health; SES = Sensory system; SST = Skin and subcutaneous tissue; UDS = Unspecified diseases and symptoms; URS = Urinary system. A: Mata, B: Agreste, C: Borborema, D: Sertão. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.
**Figure 3**

Percentage of citations for the plant parts traded for medicinal use in public markets of Paraíba, northeastern Brazil. \( n = \) number of informants in the Mesoregion. A: Mata, B: Agreste, C: Borborema, D: Sertão.

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