Consensus of the medicinal use of *Copaifera langsdorffii* Desf. in different phytophysiognomies

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ABSTRACT

The present study had as its objective to carry out an ethnobotanical survey of Copaíba in Cerradão, Carrasco, Wetland and Caatinga phytophysiognomies in the Chapada do Araripe, Northeast, Brazil, with a standardized form. Semi-structured interviews and the snowball technique were used. Usage diversity, plant part consensus and level of fidelity were analyzed to verify the consensus of the usage categories, plant part and indicated diseases. In the study, 61 therapeutic indications were cited for Cerradão (38), Caatinga (33), Pantanal (20) and Carrasco (15), with wound healing, rheumatic arthritis, bone pain, back problems and throat inflammation being the most cited.Despite Cerradão and Caatinga registering a greater number of therapeutic indications, their general level of fidelity was low, ranging from 3.57 to 25 and 4.35 to 26.09, respectively. Of the 13 registered categories, musculoskeletal and skin disorders were the categories with the highest usage diversity values among the studied phytophysiognomies. The data obtained for *Copaifera langsdorffii* Desf. emphasize its therapeutic potential and the need for studies that evaluate the species as a source of biologically active natural products, thus serving as a basis for future studies.

Keywords: Copaíba, Informant consensus, Therapeutic Uses, Different biomes, Ethnobotany

INTRODUCTION

The systematic search for substances with medicinal potential has been performed using several approaches, allowing the selection of plants that represent an effective alternative for obtaining new bioactive compounds and consequently new medicines (Nascimento et al. 2014; Verma and Shukla 2015). Traditional knowledge as a strategy for selecting plants and their therapeutic treatments opens up several options for data analysis by ordering species and prioritizing a set of plants for further study (Araújo et al. 2008; Brito et al. 2015).

It should be taken into account that over time the knowledge and use of medicinal plants by traditional communities can be lost, as can be seen in Reyes-García et al. (2013) in an analysis of a subsample of people interviewed twice, which indicated that under rapidly changing socioeconomic, political, and environmental conditions, cultural loss can occur within a single generation, and not only during the transmission process (Reyes-Garcia et al. 2013), since one generation forgets to pass on knowledge to the next generation (Aunger 2000; Casagrande 2002; Reyes-García et al. 2009;

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Gomez-Baggethun et al. 2010). Reyes-Garcia et al. (2013) suggests that contemporary indigenous societies may be abandoning their traditional knowledge because they perceive that this form of knowledge does not prepare them well to deal with the new socioeconomic and cultural conditions they currently face.

On the other hand, investigations on medicinal plants and their uses have been the subject of studies in different geographical regions. Ethnobiological studies carried out in different plant formations in Brazil are promising instruments for the discovery of new drugs, since Brazil has high biodiversity and endemism associated with a considerable wealth of knowledge regarding its flora (Kong et al. 2009; Alves and Nascimento 2010).

Some species have a wide distribution, meaning that they can be found in different regions and vegetation types. Knowing that factors such as cultural, chemosensory aspects, environmental resource availability, accessibility and effectiveness have been reported as important in the selection of medicinal plants and their uses in medical systems over time (Phillips and Gentry 1993; Stepp and Moerman 2001; Geck et al. 2017; Albuquerque and Alves 2018; Ferreira Júnior and Albuquerque 2018), the therapeutic indications of a species can be expected to vary in different ecosystems. Moreover, the use of a given species by communities from different phytophysiognomies to treat specific diseases is associated with their chemical composition (Endara and Coley 2011), which can vary for the same species when analyzed in different ecosystems. This qualitative and quantitative variation in plant secondary metabolism can be influenced by ecogeographical variations (for example, variations between ecosystems) such as light intensity, water and carbon-nitrogen availability (Herms and Mattson 1992; Barone and Coley 2002).

Copaifera langsdorffii Desf., which can be found from Northeast Argentina to Venezuela (Almeida et al. 1998; Lorenzi 2000), shows a wide distribution and can, for example, be highlighted. In Brazil *C. langsdorffii* naturally extends to the Northeast, North, Midwest, Southeast and South regions, and can be found in different phytophysiognomies, such as Campo Rupestre, Cerrado (lato sensu), Ciliary or Gallery Forest, Terra Firme Forest, Semideciduous Seasonal Forest and Rainforest, as well as in anthropized areas (Costa 2018).

In the Chapada do Araripe region, *C. langsdorffii* can be found in Cerradão, Carrasco and Wetland phytophysiognomies (Ribeiro et al. 2014; Saraiva et al. 2015; Santos et al. 2022a; Santos et al. 2022b). This species has great medicinal potential, indicated for the treatment of several diseases (Santos et al. 2022c). Differences in chemical composition as a function of geographic location have been reported for different species, including *C. langsdorffii* (Almeida et al. 2014; Oliveira et al. 2017). In a review of *C. langsdorffii,* Santos et al. (2022c) found that there is variation between different Brazilian regions, both in relation to diseases, body systems, parts used, preparation and form of administration, as well as in relation to chemical composition. This shows the great variability in the use of *C. langsdorffii* and the specificities of each region.

Given that each region and vegetation formation has its specific characteristics and, consequently, culture, different behaviors may influence the type of therapeutic indications, as well as the used parts, forms of preparation, etc. Thus, the present study was carried out to verify the number of therapeutic indications in different phytophysiognomies (Cerradão, Carrasco, Wetland and Caatinga) and to evaluate the usage agreement/informant's knowledge on therapeutic indications in communities from the different environments. This information is of paramount importance as it indicates which pathology the species has the greatest treatment consensus among the informants, thus guiding targeted and more in-depth studies for *C. langsdorffii.*

MATERIAL AND METHODS

Study area

The research was carried out in the Chapada do Araripe, in rural communities inserted in different vegetation types, such as Cerradão (A: Barreiro Grande 39W 33' 38"; 7S 27' 14", B: Manoel Coco 39W 33' 32"; 7S 12' 02", C: Zabelê 39W 35' 09"; 7S 10' 24"), Carrasco (D: Minguiriba 39W 33' 47"; 7S 15' 35"), Wetland (E: Guaribas 39W 30' 06"; 7S 17' 29") and Caatinga (F: Baixio das Palmeiras 39W 23' 02"; 7S 16' 48", G: Baixio do Muquén 39W 23' 10"; 7S 16' 26", H: Baixio da Chapada 39W 23' 27"; 7S 16' 36"), located in the municipality of Crato, Ceará, Brazil (Figure 1).

In the different phytophysiognomies of the Chapada do Araripe, municipality of Crato, Ceará, meet a total of 429 families, being 103 (24%) families in Wetland, 107 (25%) in Carrasco, 109 (25,4%) in Cerradão and 110 (25,6%) in Caatinga (Table 1). However, only those who actually used *C. langsdorffii* present in the study areas were interviewed, not considering those who used commercial samples.

The places studied have electricity, the water is from rain accumulated in cisterns or from artisanal wells and there is a Catholic chapel and primary schools. Regarding the educational level, most of them did not finish elementary school and

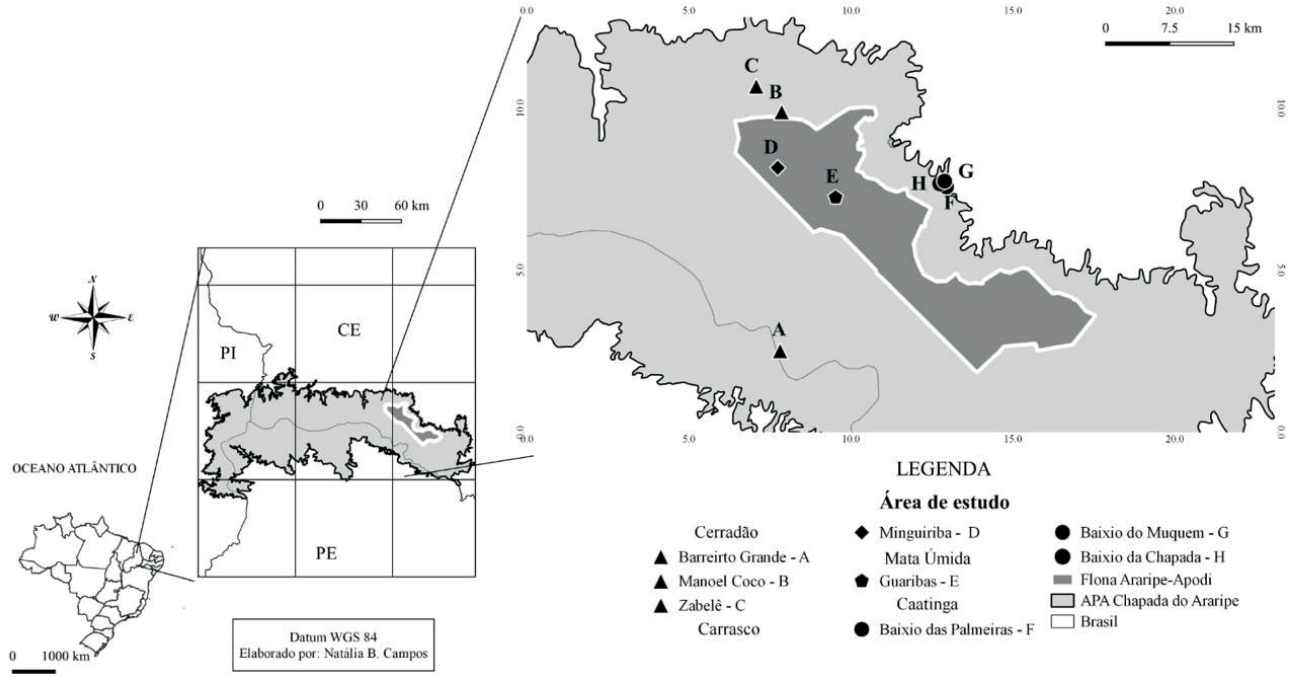

Figure 1. Geographic location of the study areas in Chapada do Araripe, Ceará, Brazil.

Table 1. Socio-cultural data of respondents, including the number of respondents in each community studied.

	Total residences per community	Number of people who responded by community
Communities		
A: Barreiro Grande	13	04
B: Manoel Coco	52	10
C: Zabelê	44	14
D: Minguiriba	107	08
E: Guaribas	103	15
F: Baixio das Palmeiras	13	06
G: Baixio do Muquén	42	07
H: Baixio da Chapada	55	10
Sex		
Women	-	47
Men	-	27
Age		
20 to 33 years	-	04
40 to 56	-	31
> 60 years	-	39
Education		
Illiterate	-	20
Incomplete Elementary School	-	37
Complete primary education	-	02
Incomplete high school	-	03
Complete high school	-	09
Complete Higher Education	-	03

SUBTITLE: A a C: Cerradão; D: Carrasco; E: Wetland; F a H: Caatinga

people over 60 years old are mostly illiterate (Table 1). The main activity of the residents is subsistence agriculture, mainly of corn, beans and cassava, followed by other practices, such as handling and selling the faveira legume (*Dimorphandra gardneriana* Tul.) to the pharmaceutical industry, pequi fruit (*Caryocar coriaceum* Wittm.) for trade and poultry farming.

Located within the Caatinga domain in Northeast Brazil, the Chapada do Araripe has a tabular surface with an altitude ranging from 700 to 1000 m, and encompasses the states of Ceará, Pernambuco and Piauí. The vegetation in this area is composed of phytophysiognomies from Cerrado, Cerradão, Carrasco, Rainforest and Hypoxerophillic Caatinga (Souza and Oliveira 2006). Red-yellow latosols, litolic neossols and red-yellow argisols are the predominant soils, which due to this mosaic, present varied phytophysiognomies and characterize different environmental gradients throughout the Chapada area (Souza and Oliveira 2006; IPECE 2016; MMA 2011). Latosols are present at the top of the Chapada, these being deep soils with low fertility and Cerrado, Cerradão and Carrasco vegetation covers. Neossols cover the slope and declive areas, being very shallow and stony soils with low fertility, presenting transitions from a rainforest vegetation to a hypoxerophillic caatinga. Finally, argisols are located in middle to low parts of the Chapada, where these are shallow soils that have high fertility and vegetation constituted by subperennial vegetation and hypoxerophillic caatinga (Souza and Oliveira 2006). The typology of the superior part of the Chapada do Araripe reflects a rainwater permeability that acts as an infiltration and supply zone for underground aquifers, which reappear as several springs, streams and rivers in the middle and lower parts of this plateau (Silva and Linhares 2011). The Chapada do Araripe is protected by an Environmental Protection Area (APA da Chapada do Araripe) and part of its territory is also protected by the Araripe National Forest and the Araripe Geological Park (Costa et al. 2004).

The climate is Hot Tropical Humid, presenting little thermal variation, with an average annual temperature between 24 and 26 ºC (Cavalcanti and Lopes 1994; Costa et al. 2004). The region has two distinct seasons; a rainy season concentrated between the months of January and April and a long dry season lasting about seven months, with critical scarcity between July and September. Despite this, the region does not present accentuated characteristics of water deficit, due to the resurgence of infiltrated water throughout the area of the top (Loiola et al. 2015). The Chapada do Araripe, depending on atmospheric and sea conditions, receives an average of 1,043 mm of rain per year, resulting in an average of 700-1000 mm/year. Its topography directly influences climatic conditions, interacting with air masses and providing a mild climate in relation to the other surrounding semi-arid regions, causing direct interference to the local flora (Costa et al. 2004).

Data Collection

Ethnobotanical survey

The ethnobotanical study was carried out from January 2019 to February 2020, through semi-structured interviews (Albuquerque et al. 2010), using a standardized form, with residents of different phytophysiognomies (Cerradão, Carrasco, Wetland and Caatinga) of the Chapada do Araripe, Ceará, Brazil.

Of the total of 429 families, only those who actually used Copaíba (*C. langsdorffii*) present in the study areas were interviewed, disregarding those who used commercial samples. 74 (17,2%) people were interviewed 28 (37,8%) Cerradão, 23 (31,1%) Caatinga, 15 (20,3%) Wetland and eight (10,8%) Carrasco, being 47 female and 27 male, with ages ranging from 21 to 97 years (Table 1). All the families in the communities were approached, making a complete census, with the heads of the families being interviewed (Table 1). At the beginning of the interviews the research objectives were explained, at which point the interviewees were presented with an Informed Consent Form (ICF). After this step, people were then free to voluntarily accept (or refuse) to participate in the research. Then, the participants listed the diseases, part used, preparation, administration, collection time, storage type, storage conditions (temperature), storage time and dosage/route of administration of the species *C. langsdorffii*.

For the interviewees to recognize *C. langsdorffii*, visual stimuli were used, such as photographs (Martin 2001; Garcia 2006) of leaves, flowers, fruits, resin and trunk (Blanckaert et al. 2007). The quality of the images was guaranteed using a professional camera with 24.1 megapixels and an EF-S 18-55mm IS II compact zoom lens and 4x optical zoom for different subjects. *C. langsdorffii* is known in the Chapada do Araripe region by more than one common name (copaíba, podoia and pau d'oleo) as reported by the forester; thus, these names were also reported in the interviews, as a way for the interviewees to recognize the species. It is worth mentioning that some families did not know or never used *C. langsdorffii*.

The research was submitted to the Ethics Committee of the Regional University of Cariri, approved with opinion number 3.183.176, and to the National System for the Management of Genetic Heritage and Associated Traditional Knowledge

(Sistema Nacional de Gestão do Patrimônio Genético e do Conhecimento Tradicional Associado; SISGEN), under registration number AF4C8BB.

Botanical material collection and identification

Copaifera langsdorffii reproductive branches (flower or fruit) were collected from the four study areas (Cerradão, Carrasco, Wetland and Caatinga) and taken to the Plant Ecology Laboratory of the Regional University of Cariri. The collected material was packaged in plastic bags and treated according to standard herborization techniques (Mori et al. 1989), being subsequently identified and incorporated into the Herbarium Caririense Dárdano de Andrade-Lima collection from the Regional University of Cariri (HCDAL/URCA) registered as *N° 14.312 (Cerradão), N° 14.313 (Carrasco), N° 14.314 (*Wetland) and N° 14.315 (Caatinga). Identification occurred through specialized bibliography and comparison with herbarium exsiccates. The Angiosperm Phylogeny Group IV (APG 2016) was adopted as the classification system. The list of Brazilian flora species was consulted to review the scientific name of the species (Flora do Brasil 2018). Authorization for botanical material collection was provided by the Biodiversity Authorization and Information System (Sistema de Autorização e Informação em Biodiversidade; SISBIO) of the Brazilian Institute for the Environment and Renewable Resources (Instituto Brasileiro do Meio Ambiente e dos Recursos Renováveis; IBAMA), registered under number 67422-1.

Classification of therapeutic indications

Therapeutic indications for *C. langsdorfii*, were grouped into 13 body systems categories based on the International Classification of Primary Care (ICPC-2) proposed by the International Classifications Committee (Wonca 2000): Circulatory System (K); Digestive System (D); Endocrine, Metabolic and Nutritional System (T); Female Genital System (X); Male Genital System (Y); General and Unspecified System (A); Muscle - Skeletal (L); Neurological System (N); Ear System (H); Skin System (S); Psychological System (P); Respiratory System (R); and Urology System (U).

Data analysis

Usage diversity value (UD)

The usage diversity index value measures the importance of the usage categories and how they contribute to the total usage values:

$$UD = Ucx/Uct$$

Calculated through the number of citations for each usage category (Ucx), divided by the number of citations for all usage categories (Uct) (Bys; Balslev, 2001 adapted by Oliveira et al. (2014).

Level of fidelity (FL)

Determines the informant's consensus on each therapeutic indication mentioned for the species under study:

$$FL\ (\%) = (Np/N) \times 100$$

This index is calculated by dividing Np which corresponds to the number of reported uses for a given species for a particular disease, by N which is the total number of respondents who cited the given species (Friedman et al., 1986 adapted by Oliveira et al. 2014).

Plant part consensus value (PPC)

This index measures the degree of agreement between the informants regarding the plant part used:

$$PPC = Px/Pt$$

Where: Px is the number of times a particular plant part was mentioned; Pt corresponds to the total number of parts (Bys and Balslev 2001 adapted by Oliveira et al. (2014).

RESULTS AND DISCUSSION

Medicinal indications for copaíba (*Copaifera langsdorffii*)

Different *C. langsdorffii* structures (oil-resin, leaf, seed and bark and stem bast) were indicated to treat 61 health problems in Cerradão (38 therapeutic indications), Caatinga (33), Wetland (20) and Carrasco (15) phytophysiognomies, with cicatrizing (21 citations) being the most commonly mentioned, followed by rheumatic arthritis (17), bone pain (15), back problems (15) and throat inflammation (13) (Table 2). These health problems are among the most recurrent in ethnobiological studies that address this species (Ribeiro et al. 2014; Fagundes et al. 2017; Macêdo et al. 2018).

The set of medicinal plants that make up the medical arsenal of a given culture is the result of a long process of cultural validation, which is always dynamic (Stepp and Moerman 2001; Palmer 2004). These investigations have thus contributed to the understanding of the factors that modulate the selection of medicinal plants in medical systems over time, such as resource availability in the environment and its effectiveness, which have been reported as important in the selection of medicinal plants (Stepp and Moerman 2001). Regarding the variation in the number of uses of *C. langsdorffii* in

different phytophysiognomies, it is probably related to the availability of the resource in the environment, causing communities to prefer to use other plants that are available close to these communities and that can alleviate the same symptoms as the species under study. In addition, different ecosystems seem to have different vocations from a pharmacological point of view (Albuquerque et al. 2012).

Furthermore, we cannot ignore the role of culture in human perception of environmental resources. In particular, we assume that culture acts by attributing meanings to what we perceive through our senses, so that something mentioned as unpleasant by one culture may be pleasant and desired by another (Albuquerque and Alves 2018). Thus, culture generally provides the meaning and context for the expression of innate behaviors in the contact of humans with different tastes and smells (Shepard 2004), acting as a filter for innate responses. For example, plants with a strongly bitter taste are mainly indicated for the treatment of gastrointestinal diseases by the Tzeltal Mayans of Mexico, due to their wide cultural acceptance (Brett 1998). Furthermore, there are certain foods that are extremely tasty for certain cultural groups, while for others they can be disgusting (Albuquerque and Alves 2018).

Health problems such as rheumatoid arthritis, bone pain, throat inflammation, bumps and back problems were cited in all studied physiognomies. Whereas, other diseases were restricted to a certain phytophysiognomy, with 15 therapeutic indications being cited only in the Cerradão (asthma, bronchitis, throat cancer, uterine cancer, prostate, sprains, insomnia, mycosis, anxiety, sunburn, sinusitis, worms, hypertension, earache and loss of appetite), 10 being indicated only in the Caatinga (stroke, muscle pain, herniated disc, poor circulation, osteoporosis, xiphoid process dislocation, insect bite, tendonitis, tumor and skin burn), 4 in the Carrasco (painful veins, pregnancy stretch marks, vaginal inflammation and diarrhea) and 4 in the Wetland (diabetes, laxative, gastric ulcer and general infection) (Table 4). This variation observed between the phytophysiognomies may be related to the number of informants who know *C. langsdorffii* to treat their health problems, having been recorded that in the Cerradão and Caatinga a greater number of people know and use this species as medicinal and, consequently, a greater number of diseases in general was registered in these areas and also a greater number of exclusive diseases, compared to the areas of Carrasco and Wetland. Real perceptions of reality are difficult to access, as they are abstract and influenced by several factors, such as age, gender, income and biological and evolutionary aspects (Albuquerque and Alves 2018). And such factors may be related to variations in the uses of *C. langsdorffii* in the different phytophysiognomies of the Chapada do Araripe.

Table 2. Ethnobotanical Survey of Copaíba (*Copaifera langsdorffii*, Fabaceae) in Chapada do Araripe, Northeast, Brazil.

Therapeutic Indications / Communities	Part Used	Preparation	Administration	Collection Time	Storage type	Storage conditions (temperature)	Storage time	Dosage / Route of administration
Rheumatoid arthritis (17) / A (2); B (3); C (1); D (3); E (2); F (3); G; H (3)	Oil-resin (16), leaf (1), Stalk stem (1)	Mix with water (2), mix with coffee (1), heat the oil (2), soak (1), decoction (1)	Massage (15), oral intake (5)	Half day (1), any time (5), afternoon (1)	Glass container (8), plastic (9)	Environment (13), refrigeration (1)	Undefined (5), 1 month (1), 2 years (1), more than 4 years (1)	Topic (14), oral (11) 1 time a day (3); 2 times a day; 2 times a day, until it heals (2); 3 times a day, until it heals; 2 times a day, for 5 days, until it heals; 2 times a day, for 8 days (2); 1 teaspoon, 2 or 3 times a day, until cured; 2 or 3 times a day, until it heals; 6 drops, 2 times a day, for 3 to 4 days
Arthrosis (5) / B (2); F (2); G (1); H (1)	Oil-resin (4), leaf (1)	Warms up the oil (1), decoction (1)	Massage (4), oral intake (1)	Any Time (2)	Plastic container (3), glass (2)	Environment (4)	2 years (1)	Topic (3), oral (3) 1 time a day (3); 2 times a day, for 8 days (2); 3 times a day (1)
Asthma (1) / B (1)	Oil-resin (1)	Mix with tea (1) or coffee (1)	Oral ingestion (1)	Morning (1), any time (1)	Glass container (1), plastic (1)	Environment (1)	Undetermined (1)	Oral (1) 1 time a day (1)

Continue...

Table 2. *Continuation.*

Therapeutic Indications / Communities	Part Used	Preparation	Administration	Collection Time	Storage type	Storage conditions (temperature)	Storage time	Dosage / Route of administration
Stroke (1) / F (1)	Oil-resin (1)	Mix with coffee (1)	Oral ingestion (1)	-	Plastic container (1)	Environment (1)	Undetermined (1)	Oral (1) 3 drops (1). 1 time a day (1)
Bronchitis (1) / C (1)	Oil-resin (1)	Mix with water (1)	Oral ingestion (1)	Morning (1)	Plastic container (1)	Refrigeration (1)	1 year (1)	Oral (1) 10 drops (1). 3 times a day (1). For 8 days (1)
Cancer (6) / B(1); E(2); F (2); H (1)	Oil-resin (5), Stalk stem (1)	Soak (1), mix the oil with water (3), coffee or tea (1)	Oral ingestion (6)	Any time (3), morning (1)	Plastic container (3), glass (2)	Environment (3), refrigeration (1)	-	Oral (6) Oil: 5 ml, 2 times a day, for 15 to 45 days; Stalk stem: 3 drops, 3 times a day, for 6 months
Throat cancer (1) / B(1)	Oil-resin (1)	Drinking pure (1)	Oral ingestion (1)	Morning (1)	Glass container (1), plastic (1)	Environment (1)	Undetermined (1)	Oral (1) Once a day (1). 3 to 4 days (1)
Uterine cancer (1) / B(1)	Oil-resin (1)	Drinking pure (1)	Oral ingestion (1)	Morning (1)	Glass container (1), plastic (1)	Environment (1)	Undetermined (1)	Oral (1) Once a day (1). 3 to 4 days (1)
Healing (wound and cut) (21) / B (2); C (4); E (10); F (3); G(1); H(1)	Oil-resin (19), Stalk stem (1), seed oil (1)	Soak (1), toast and cook the seed and remove the oil (1), mix with some tea (1)	Poultice (18), massage (1), oral intake (2)	Any time (2), morning (4)	Plastic container (9), glass (12)	Environment (18), refrigeration (3)	2 months (1), more than 1 year (3), more than 6 months (2), undetermined (4), 3 to 4 years (1), more than 4 years (1)	Topic (19), oral (2) 1 time (2); 1 time a day, for 3 days; 3 drops, 2 to 3 times a day; 2 times a day (5); 2 times a day, until it heals (5); 2 to 3 times a day, for 8 days; 2 to 3 times a day; 3 times a day (2)
Diabetes (1) / E(1)	Oil-resin (1)	-	Oral ingestion (1)	-	Glass container (1)	Environment (1)	-	Oral (1) 5 to 6 drops, 2 to 3 times a day
Diarrhea (2) / D (2)	Leaf (2)	Decoction (2)	Oral ingestion (2)	Any Time (2)	-	-	-	Oral (2) 2 times a day, for 3 days; Several times a day, until it heals.
Bellyache (6) / D (4); E(2)	Leaf (4), Stalk stem (1), Oil-resin (1)	Decoction (4), sauce (1), mix with water (1)	Oral ingestion (6)	Any Time (6)	Plastic container (2)	Environment (1)	-	Oral (6) 1 time; 2 times a day, for 3 days; several times a day, until it heals (2); 3 drops, 2 times a day, for 5 days; 2 times a day for 5 days
Headache (4) / A (1); D (2); F(1)	Leaf (1), Oil-resin (3)	Decoction (1), mix the oil with water (1), tea (1) or coffee (1)	Oral ingestion (3), massage (1)	Any time (3)	Plastic container (2), glass (2)	Environment (3)	2 years	Topic (1); Oral (3) 1 time a day; 4 drops, 1 time a day; 3 times a day, until it heals; 3 drops, twice a day, until cured
Toothache (3) / B (2); H(1)	Oil-resin (3)	Mixing with water (1), Mixing with coffee (1)	Massage outside the tooth (1), poultice (2), Oral water intake (2)	Any time (1)	Plastic container (2), glass (1)	Environment (2)	Undetermined (2), cannot save (1)	Topic (2), oral (2) 9 drops, 3 times a day; 1 time

Continue...

Table 2. *Continuation.*

Therapeutic Indications / Communities	Part Used	Preparation	Administration	Collection Time	Storage type	Storage conditions (temperature)	Storage time	Dosage / Route of administration
Earache (3) / A (1); B (2)	Oil-resin (3)	Dissolves the resin with water and coa (1)	Poultice (3)	Any time (2)	Glass container (2), plastic (1)	Environment (2)	Undetermined (2), cannot save (1)	Topic (3) 2 drops, 1 time; Drip 2 drops in the ear, 2 times a day, until it heals; 4 drops in the ear, 3 times a day, until it heals
General pain (7) / B(1); C (4); F(1); H (1)	Oil-resin (5), Stalk stem (1), leaf (1)	Soak (1), decoction (2), warm the oil (1)	Oral ingestion (3), massage (4)	Any time (1)	Plastic container (2), glass (2)	Environment (2)	Cannot save (1)	Oral (3), topical (4) 3 times a day, indefinitely; 2 times a day; 3 times a day, until it heals
Pain in the legs (5) /A (3); C (1); F(1)	Oil-resin (4), Stalk stem (1)	Warm oil (1), cooking (1)	Massage (4), Oral ingestion (2)	Any time (2)	Glass container (3), plastic (1), plastic bag (1)	Environment (1)	Undetermined (2), 1 year (1)	Topic (4), oral (2) 2 or 3 times a day, until it heals; 3 times a day for 1 month
Urinary pain (3) / A (1); C(1); H (1)	Leaf (2), Oil-resin (1)	Decoction (2), mix the oil with water (1)	Oral ingestion (3)	Any time (1)	Plastic container (1)	Environment (1)	Undetermined (1)	Oral (3) Half an American glass, 3 times a day, until it heals; 3 times a day; 3 drops, 1 time
Muscular pain (1) / H(1)	Oil-resin (1)	-	Massage (1)	-	Plastic container (1)	Environment (1)	-	Topic (1) 3 times a day (1)
Joint pain (10) / A (1); B (1); C (3); E (1); G (1); H (3)	Oil-resin (10)	Mix with water (2), coffee (2), warm the oil (8)	Oral ingestion (2), poultice (1), massage (5)	Any time (1)	Glass container (5), plastic (4)	Environment (7)	Undetermined (1), 1 year (1)	Oral (1), topic (7) 2 or 3 (3) times a day, until it heals (3); 3 drops; 2 times a day, until it heals; 2 times a day; Once a day
Pain in the veins (1) / D (1)	Oil-resin (1)	-	Massage (1)	-	Glass container (1)	Environment (1)	Undetermined (1)	Topic (1)
Body ache (1) / E(1)	Oil-resin (1)	Mix oil with water (1)	Oral ingestion (1)	Morning (1)	Plastic container (1), glass (1)	-	3 to 4 years (1)	Oral (1) Child: 3 drops; Adult: 4 or 5 drops, once a day
Stomach ache (4) / E (3); G (1)	Stalk stem (1), Oil-resin (3)	Soak (1), mix the oil with water (1)	Oral ingestion (4)	Any time (2)	Plastic container (3), glass (1)	Environment (4)	More than 6 months (1)	Oral (4) 3 drops, 2 times a day, for 5 days; 2 times a day, for 5 days; 20 to 25 drops, 2 times a day, until cured; 3 drops, 2 times a day
Bone pain (15) / A (1); B (5); C(1); D (3); E (4); H(1)	Oil-resin (13), leaf (1), Stem bark (1)	Dissolves the resin in the coffee (1), heats the resin and passes it on the spot (1), decoction (2), with sauce (1)	Oral ingestion (3), massage (13)	Half day (1), any time (5), afternoon (1)	Glass container (8), plastic (5), yard (1)	Environment (7), refrigeration (1)	Undetermined (2), more than 1 (1), 2 (1) years, 1 month (1), if you spend too much time curdling (1), you cannot save (1)	Oral (3), topical (13) 3 times a day, indefinitely; 2 times a day, for 8 days (2); 2 small pieces of the peel in half a glass of water, 1 time, until cured; 2 times a day, for a week (2); 2 times a day, until it heals; 2 times a day; 1 time a day, indefinitely; 3 times a day, until it heals (2)
Sprains (1) / A(1)	Oil-resin (1)	Heat resin on fire and strain (1)	Massage (1)	-	Plastic container (1)	-	-	Topic (1) 2 times a day (1), for 1 week (1)

Continue...

Table 2. *Continuation.*

Therapeutic Indications / Communities	Part Used	Preparation	Administration	Collection Time	Storage type	Storage conditions (temperature)	Storage time	Dosage / Route of administration
Migraine (2) / B(1); D (1)	Leaf (1), Oil-resin (1)	Decoction (1)	Oral ingestion (1), Massage (1)	Any time (2)	Glass container (1), plastic (1)	Environment (1)	2 years (1)	Oral (1), topic (1) 1 time a day; 3 times a day, until it heals
Stretch mark of pregnant woman (1) / D(1)	Seed oil (1)	Roast the seed and extract the oil (1)	Massage (1)	Any time (1)	Plastic container (1), aluminum (1), pot (1)	Environment (1)	Undetermined (1)	Topic (1) Several times a day (1)
Gastritis (6) / C (2); E(2); F(1); H(1)	Oil-resin (4), Stalk stem (1), leaf (1)	Soak (1), decoction (1), mix the oil with water (3)	Oral ingestion (6)	Any time (3)	Glass container (3), plastic bag (1), plastic container (3)	Environment (4)	1 year (1), undetermined (1)	Oral (6) 1 time a day; 1 time; 3 drops, 2 times a day, for 5 days; 2 times a day, for 5 days; 5 ml, 2 times a day, for 3 days; 1 drop, once a day
Flu (5) / D (1); E (3); H(1)	Oil-resin (5)	With honey (1), with coffee (1)	Oral ingestion (4), inhalation (1)	-	Plastic container (3), glass (3)	Environment (4)	Undetermined (1)	Oral (4), Inhalation (1) 4 drops, 1 time a day; 10 drops, 2 to 3 (2) times a day, until cured; 1 to 2 drops, 2 (2) times a day
Hemorrhoid (6) / B (4); F (2)	Oil-resin (6)	Put it in the sun to find out (1)	Poultice (5), Oral ingestion (2)	Morning (1)	Glass container (4), plastic (2)	Environment (5)	Undetermined (3)	Topic (5), oral (2) 2 to 3 times a day; 1 tablespoon; 1 time a day (2)
Herniated disc (1) / G (1)	Oil-resin (1)	-	Massagem (1)	-	Plastic container (1)	Environment (1)	-	Topic (1) 3 times a day (1)
Tonsils hypertrophy (2) / E(1); H(1)	Oil-resin (2)	Warm the oil (1)	Oral ingestion (1), Massage (1)	-	Glass container (2), plastic (1)	Environment (2)	Undetermined (1)	Oral (1), topic (1) 1 to 2 drops, 2 times a day; 3 times a day
Swelling (7) / A(1); D(3); F(1); H (2)	Oil-resin (6), Seed (1)	Heat the resin on the fire (2), Roast the seed and cook to extract an oil (1)	Massage (5), Poultice (2)	Any time (2)	Plastic container (4), glass (5), pot (2), aluminum (2), can (2)	Environment (4), refrigeration (1)	Undetermined (3)	Topic (7) 2 times a day, for a week; 3 times a day, until it heals (2); 2 times a day, for 1 month; 2 times a day
Infection in general (2) / E (2)	Oil-resin (2)	-	Oral ingestion (2)	-	Plastic container (2), glass (2)	Environment (2)	Undetermined (1)	Oral (2) 10 drops, 2 to 3 times a day, until cured; 1 to 2 drops, 2 times a day
Inflamed throat (13) / B(1); D(1); E (5); F (2); G (2); H(2)	Leaf (1), Oil-resin (11), Stalk stem (1)	Decoction (1), mix the oil with water (3), soak (1), warm the oil (1)	Oral ingestion (10), massage (4), gargle (1)	Any time (2)	Glass container (6), plastic (4)	Environment (10)	More than 6 months (oil) (1), undetermined (1), more than 4 years (1), Cannot save (1)	Oral (11), topic (4) 1 spoon, 2 times a day, for 3 days; 1 American cup, 1 time a day, until cured; 10 drops, 2 to 3 times a day, until cured; 2 times a day, until it heals; 10 to 15 drops, 2 times a day, until cured; 3 times a day; 1 to 2 drops, 2 times a day; 2 drops, 1 time a day, for 2 days; 2 drops, 2 times a day, for 3 days; 3 drops, 3 times a day (4)

Continue...

Table 2. *Continuation.*

Therapeutic Indications / Communities	Part Used	Preparation	Administration	Collection Time	Storage type	Storage conditions (temperature)	Storage time	Dosage / Route of administration
Inflammation in general (4) / B(2); E (2)	Oil-resin (3), Stem bark (1)	Mixing with honey (1), decoction (1)	Oral ingestion (3), massage (2)	-	Plastic container (2), glass (1)	Environment (2)	More than 6 months (1), undetermined (1)	Oral (3), topical (2) 2 times a day (2); 2 times a day, until it heals; 1 to 2 drops, 2 times a day
Vaginal inflammation (2) / D (2)	Stalk stem (2)	Cooking (1), decoction (1)	Bathe (2)	Any time (1)	-	-	-	Topic (2) 1 time a day (night) (2)
Insomnia (1) / C (1)	Leaf (1)	Decoction (1)	Oral ingestion (1)	-	-	-	-	Oral (1)
Laxative / Constipation (1) / E(1)	Oil-resin (1)	-	Oral ingestion (1)		Glass container (1), plastic (1)	Environment (1)	Undetermined (1)	Oral (1) 10 to 15 drops, 2 times a day
Bad circulation (1) / F(1)	Oil-resin (1)	Warm the oil (1)	Massage (1)	-	Glass container (1), plastic (1)	Environment (1)	-	Topic (1) 3 times a day (1). For 1 month (1)
Indigestion (3) / B (2); D(1)	Leaf (1), Oil-resin (2)	Decoction (1), mix with water (2), coffee (1) or tea (1)	Oral ingestion (3)	Any time (1)	Plastic (2), Glass (2)	Refrigeration (1), environment (1)	1 month (1), undetermined (1)	Oral (3) 15 drops; 5 drops; 2 times a day for 3 days
Ringworm (1) / C(1)	Oil-resin (1)	Mix with some tea (1)	Oral ingestion (1)	-	Backyard (1)	-	-	Oral (1) 5 (1) to 9 (1) drops. Once a day (1). Until cure (1)
Nervousness (2) / B(1); C(1)	Leaf (1), Stem bark (1)	Decoction (2), sauce (1)	Oral ingestion (2)	Morning (1), any time (1)	Backyard (1)	-	-	Oral (2) 2 small pieces of the peel in half a glass of water (1). Until cure (1)
Osteoporosis (1) / H(1)	Oil-resin (1)	-	Massage (1)	-	Glass container (1), plastic (1)	Environment (1)	Undetermined (1)	Topic (1) Once a day
Beat (6) / A(1); D(2); E(1); F(1); H(1)	Oil-resin (5), seed oil (1)	Dissolve the resin with coffee (1), roast the cooking seed and add the oil (1)	Oral ingestion (1), Massage (3), poultice (2)	Any time (2)	Plastic container (4), glass (2), aluminum (2), pot or can (2)	Environment (4)	Undetermined (3)	Oral (1), topic (5) 2 times a day, for 1 week; 3 times a day, until it heals (2); 2 times a day, until it heals; Once a day
Open chest (1) / F(1)	Oil-resin (1)	Mix the oil with water (1)	Oral ingestion (1)	-	Plastic container (1)	Environment (1)	Undetermined (1)	Oral (1) 1 time a day (1)
Loss of appetite (6) / C (6)	Seed (2), leaf (3), Stalk stem (1)	Decoction (6)	Oral ingestion (6)	Any time (1)	Glass container (2), yard (1)	Environment (2)	1 year (2)	Oral (6) 1 handful of leaves in half a glass of water (1). 1 time a day (1)
Bug bite (1) / H(1)	Oil-resin (1)		Poultice (1)	-	Glass container (1), plastic (1)	Environment (1)	Undetermined (1)	Topic (1) 1 time a day (1)
High pressure (2) / B (2)	Leaf (2)	Decoction (2)	Oral ingestion (2)	-	-	-	-	Oral (2) 2 to 3 times a day; 1 to 2 times a day

Continue...

Table 2. *Continuation.*

Therapeutic Indications / Communities	Part Used	Preparation	Administration	Collection Time	Storage type	Storage conditions (temperature)	Storage time	Dosage / Route of administration
Spine problems (15) / B(1); C (5); D(2); E (3); G(1); H (3)	Seed (1), Oil-resin (13), leaf (1)	Mix with water (3), decoction (1), Roast the seed and cook to extract an oil (1)	Massage (11), poultice (2), Oral ingestion (3)	Any time (3), late afternoon (1)	Plastic container (8), glass (6), aluminum (2), pot or can (2)	Environment (10)	Undetermined (4), if you keep too much curd (1), more than 1 year (1)	Topic (12), oral (4) 2 to 3 times a day; 2 drops, 1 time a day; 3 times a day, until it heals (5); 2 times a day; 1 time a day, indefinitely (2); 1 time
Kidney problem (3) / A (1); C (1); G (1)	Leaf (2), Oil-resin (1)	Decoction (2)	Oral ingestion (3)	Any time (2)	Glass container (1), bag (1)	Cooling (1), environment (1)	-	Oral (3) Half an American glass, 3 times a day, until it heals; 1 time a day, until it heals; 3 drops, 2 times a day
Prostate (1) /C(1)	Oil-resin (1)	Mix with some tea (1)	Oral ingestion (1)	-	Plastic container (1), glass (1)	Environment (1)	-	Oral (1) 3 drops, 2 times a day
Skin burn (3) / G(1); H (2)	Oil-resin (2)	-	Poultice (2), massage (1)	-	Plastic container (2), glass (1)	Environment (3)	-	Topic (3) 2 times a day (2); 1 time
Sun burn (1) / C(1)	Oil-resin (1)	Passes on the skin (1)	-	-	-	-	-	Topic (1)
Cracked feet (4) / C (3); H(1)	Oil-resin (4)	-	Massage (4)	-	Glass container (3)	Environment (1)	1 year (2)	Topic (4) 1 time (2); 3 times a day (1)
Sinusitis (1) / A(1)	Stalk stem (1)	Decoction (1)	Inhalation through the nose (1)	-	Plastic bag (1)	Environment (1)	1 year (1)	Inhalation (1)
Tendonitis (1) / H(1)	Oil-resin (1)	-	Massage (1)	-	Plastic container (1), glass (1)	Environment (1)	-	Topic (1) 2 times a day (1)
Cough (7) / A (2); B (1); E (2); H (2)	Oil-resin (5), Stalk stem (1), leaf (1)	Dissolve the resin in coffee (2) or tea (1), cooking (1), mix with oil-resin honey (1), leaf decoction (1)	Oral ingestion (7)	Any time (3), morning (1)	Plastic container (1), glass (3)	Environment (4)	Undetermined (2), if too much curd is spent (1)	Oral (7) 3 drops in 1 cup of coffee, 2 times a day; 3 times a day, until it heals (3); 1 time a day, until it heals; 2 times a day, until it heals
Tumor (2) / F(2)	Oil-resin (2)	-	Poultice (1), oral ingestion (1)	-	Plastic container (1)	Environment (1), refrigeration (1)	-	Topic (1), oral (1) 3 times a day; 3 drops, 3 times a day, for 6 months
Gastric ulcer (1) / E(1)	Oil-resin (1)	Mix with tea (1)	Oral ingestion (1)	-	-	Environment (1)		Oral (1) 2 times (1). Until cure (1)
Worm (1) / B(1)	Oil-resin (1)	Mixing with water (1), coffee (1) or tea (1)	Oral ingestion (1)	-	Glass container (1), plastic (1)	Environment (1)	Undetermined (1)	Oral (1) 5 drops (1)

SUBTITLE: A: Barreiro Grande; B: Manoel Coco; C: Zabelê; D: Minguiriba; E: Guaribas; F: Baixio das Palmeiras; G: Baixio do Muquén; H: Baixio da Chapada; AVC: Stroke.

Almeida et al. (2011) found that medicinal plants harvested from the Caatinga exhibited greater antimicrobial activity than plants from the same species that were harvested in the Atlantic Forest. Moreover, plants harvested from the Caatinga generally have greater versatility and greater inhibition of sensitive microorganisms (Albuquerque et al. 2012). Thus, the Caatinga can be a promising environment for bioprospecting research of antimicrobial compounds (Albuquerque et al. 2012). Evidence suggests that medicinal plants from the dry forest are a rich source of drugs in which phenolic compounds, especially tannins, are directly responsible for their therapeutic activity and may be good candidates for bioprospecting efforts (Albuquerque et al. 2012).

Ten different preparation methods were reported in the studied vegetation types (Cerradão, Carrasco, Wetland and Caatinga) (Table 2). The Cerradão recorded eight preparation methods, with the preparation by mixing the oil with water, coffee or tea standing out with 33 citations, followed by decoction (25), soaking (three), cooking (two), warm oil (two) and leaving the oil in the sun to amend (one). In the Carrasco, seven preparation methods were recorded, where decoction received the highest number of citations (11), followed by preparing the seed (four), mixing the oil with water, coffee or tea (three), warm oil (two) and cooking (one). In the Wetland, six preparation methods were cited, where the preparation by mixing the oil with water, coffee, tea or honey was the most commonly cited (seven), followed by soaking (five) and seed preparation (one). In the Caatinga, six preparation methods were recorded, where the mixture of oil with water, coffee or tea was the most commonly cited (10), followed by warm oil (nine), soaking (two) and decoction (one). From the preparation methods indicated, mixing the oil with water, coffee or tea was mentioned in all phytophysiognomies. The leaves and trunk bark were indicated for preparations such as decoction, soaking and cooking, while the oil-resin was dissolved with water, coffee, tea and honey, or warmed up before use. To use the seed, its oil needs to be extracted, through a process where it is first roasted and then cooked. There is a preference for the use of teas in communities in different Brazilian regions (Macedo et al. 2016; Ribeiro et al. 2017; Fagundes et al. 2017; Silva et al. 2018), where the choice for this preparation may be associated with the availability of the used part, the plant characteristics and in many cases for being seen by the population as an effective method (Amorozo 2002; Oliveira et al. 2010).

In terms of administration, oral intake, massage and poultices were indicated for *C. langsdorffii* use in Cerradão (55; 32; 12), Caatinga (19; 37; 12), Wetland (30; 14; eight) and Carrasco (13; eight; six) phytophysiognomies and encompassed the largest number of citations (Table 2). Nasal inhalation was recommended only in the Cerrado (one) and Caatinga (one), sit down baths (two) only in the Carrasco, putting the oil on the skin only in the Cerrado (one) and gargling only in the Caatinga (one) (Table 2). The large indication for oral intake is associated with the preference of the communities to use teas and the crude resin to cure their illnesses, while massage and poultices are associated with using the oil-resin to treat rheumatoid arthritis, spine, bones and cicatrizing, which are administered to the external body.

For most interviewees, there was no set time for collecting the used parts of *C. langsdorffii*. Few collected in the morning, midday or afternoon, but not for any specific reason, just for convenience. Regarding the type of storage, they preferred to keep it in a glass or plastic container, with those who cultivated the species in the backyard being rare.

The containers were kept at room temperature, few kept them in the refrigerator, and most of the time the storage time was indefinite and some left it for a month, two years and more than four years. As for the route of administration, it was topical, oral, drops and inhalation, with the first two prevailing and with regard to dosage, no standard was established, there was a lot of variation.

Evidence exists for some of the *C. langsdorffii* therapeutic indications, acquired through bioprospecting, chemical and pharmacological studies, showing important anti-inflammatory activities (Paiva et al. 2003; Paiva et al. 2004; Silva et al. 2009; Gelmini et al. 2013), gastroprotective (Lemos et al. 2015; Motta et al. 2017), antimicrobial (Pieri et al. 2011), antineoplastic (Senedese et al. 2013), diuretic (Paiva et al. 2003; Brancalion et al. 2012), antioxidant (Costa et al. 2015; Carmo et al. 2016; Batista et al. 2016), cicatrizing (Paiva et al. 2002; Masson Meyers et al. 2013) and cytotoxic (Vargas et al. 2015; Lemos et al. 2015; Farias et al. 2019).

Usage diversity value (UD)

Sixty-one health problems grouped into 13 body system categories, with a usage diversity value (UD) ranging from 0.01 to 0.37 (Table 3), were reported in the Cerradão, Carrasco, Wetland and Caatinga phytophysiognomies. From these categories, the Musculoskeletal, Skin, Digestive and Respiratory systems encompassed the largest number of diseases (12; nine; nine; eight) and usage citations (73; 40; 27; 31), respectively, with rheumatic arthritis (17), cicatrizing (21), gastritis and stomachache (six each) and throat inflammation (13) (Table 3) as the most indicated diseases, respectively.

In the Cerradão, 94 citations were recorded for 38 health problems, belonging to 13 body system categories, with a usage diversity value ranging from 0.01 to 0.33 (Table 3). The most cited categories were: Musculoskeletal (UD: 0.33), with seven diseases and 30 usage citations, where the most commonly indicated diseases were bone pain (seven), rheumatoid arthritis (six), back problems (six), leg pain (four), and joint pain (four), which were treated by massaging the oil-resin; Skin (UD: 0.13), with 12 citations for five diseases, where cicatrizing (six) and cracked feet (three) received the highest number of citations, with the oil-resin being administered through poultices; and, General and Unspecific (UD: 0.10), with nine citations for four diseases, where general pain (five) was the most commonly cited, and was treated using different plant parts, such as the oil-resin, leaf and stem bast, administered through oral intake of the decoction or through massaging. The 10 remaining categories obtained usage diversity values ≤ 0.09. The categories, female genital (uterine cancer) and male genital (prostate) were those with the lowest usage diversity value (0.01 each), with one disease and one citation each.

For the Caatinga, 68 citations were cataloged for 33 diseases, distributed across eight body systems, with a usage diversity value ranging from 0.01 to 0.37 (Table 3). Four categories obtained UD values ≤ 0.06 and four UD values ≥ 0.12. The most cited body system categories in this phytophysiognomy were Musculoskeletal (UD: 0.37) and Skin (UD: 0.21). The Musculoskeletal system encompassed 25 citations for 11 health problems, of which, rheumatoid arthritis was the most cited with six citations, with an oil-resin massage being indicated. The Skin category received 14 citations for six health problems, with cicatrizing (five) obtaining the most citations and being treated by the oil-resin poultice.

The Wetland obtained 49 citations for 20 therapeutic indications, grouped across 6 body systems, with a usage diversity value varying from 0.02 to 0.22 (Table 3). From the six registered categories, only the Endocrine, Metabolic and Nutritional category presented a low usage diversity value (UD: 0.02), with one disease (diabetes) and one citation, with the oil-resin being administered through oral ingestion. UD values ≥ 0.14 were observed in the remaining five categories. Of these, the most cited were: Skin (UD: 0.22), with 11 citations for two therapeutic indications, where cicatrizing (10) was the most indicated, treated mainly with an oil-resin poultice; respiratory (UD: 0.22), with 11 citations for four diseases, where throat inflammation (five) was the most cited, with the oil-resin being administered through oral intake and massaging; and, Musculoskeletal (UD: 0.20), encompassing 10 citations for four health problems, with bone pain (four) presenting the highest number of citations, treated through an oil-resin massage.

Table 3. Usage Diversity Value for Copaiba (*Copaifera langsdorffii*) in Chapada do Araripe Nordeste communities, Brazil.

	Cerradão		Carrasco		Wetland		Caatinga	
Category Body systems / Initials (ICPC-2)	**Therapeutic indication and code / number of citations for use**	**UD**	**Therapeutic indication and code / number of citations for use**	**UD**	**Therapeutic indication and code / number of citations for use**	**UD**	**Therapeutic indication and code / number of citations for use**	**UD**
Circulatory (K)	(K96) Hemorrhoid (4), (K85) High pressure (2)	0.07	(K95) Pain in the veins (1)	0.03			(K96) Hemorrhoid (2), (K90) Stroke (1), (K99) Bad circulation (1)	0.06
Digestive (D)	(D82) Toothache (2), (D07) Indigestion (2), (D96) Worm (1), (D99) Gastritis (2)	0.08	(D07) Indigestion (1), (D29) Bellyache (4), (D11) Diarrhea (2)	0.24	(D99) Gastritis (2), (D02) Stomach ache (3), (D29) Bellyache (2), (D12) Laxative / Constipation (1), (D86) Gastric ulcer (1)	0.18	(D82) Toothache (1), (D99) Gastritis (2), (D02) Stomach ache (1)	0.06
Endocrine / Metabolic and Nutritional (T)	(T03) Loss of appetite (6)	0.07			(T89/T90) Diabetes (1)	0.02		
Female Genital (X)	(X75) Uterine cancer (1)	0.01	(X15) Vaginal inflammation (2)	0.07				

Continue...

Table 3. *Continuation.*

	Cerradão		Carrasco		Wetland		Caatinga	
Category Body systems / Initials (ICPC-2)	**Therapeutic indication and code / number of citations for use**	**UD**	**Therapeutic indication and code / number of citations for use**	**UD**	**Therapeutic indication and code / number of citations for use**	**UD**	**Therapeutic indication and code / number of citations for use**	**UD**
Male Genital (Y)	(Y06) Prostate (1)	0.01						
General and Nonspecific (A)	(A08) Swelling (1), (A79) Cancer (1), (A01) General pain (5), (A29) Inflammation in general (2)	0.10	(A08) Swelling (3)	0.10	(A79) Cancer (2), (A29) Inflammation in general (2), (A29) Body ache (1), (A78) Infection in general (2)	0.14	(A08) Swelling (3), (A79) Cancer (3), (A01) General pain (2)	0.12
Muscle - Skeletal (L)	(L88) Rheumatoid arthritis (6), (L14) Pain in the legs (4), Bone pain (7), (L79) Sprains (1), (L91) Arthrosis (2), (L20) Joint pain (4), (L29) Spine problems (6)	0.33	(L88) Rheumatoid arthritis (3), Bone pain (3), (L29) Spine problems (2)	0.28	(L88) Rheumatoid arthritis (2), Bone pain (4), (L29) Spine problems (3), (L20) Joint pain (1)	0.20	(L88) Rheumatoid arthritis (6), (L14) Pain in the legs (1), Bone pain (1), (L91) Arthrosis (4), (L20) Joint pain (4), (L29) Spine problems (4), (L99) Herniated disc (1), (L18) Muscular pain (1), (L91) Osteoporosis (1), (L87) Tendonitis (1), (L04) Open chest (1)	0.37
Neurological (N)	(N89) Migraine (1), (N01) Headache (1)	0.02	(N89) Migraine (1), (N01) Headache (2)	0.10			(N01) Headache (1)	0.01
Ear (H)	(H01) Earache (3)	0.03	-		-		-	
Skin (S)	(S19) Beat (1), (S18) Healing (6), (S76) Ringworm (1), (S21) Cracked feet (3), (S80) Sun burn (1)	0.13	(S19) Beat (2), (S19) Stretch mark of pregnant woman (1)	0.10	(S19) Beat (1), (S18) Healing (10)	0.22	(S19) Beat (2), (S18) Healing (5), (S21) Cracked feet (1), (S14) Skin burn (3), (S12) Bug bite (marimbondo) (1), (S04) Tumor (2)	0.21
Psychological (P)	(P01) Nervousness (2), (P06) Insomnia (1)	0.03						
Respiratory (R)	(R75) Sinusitis (1), (R05) Cough (3), (R96) Asthma (1), (R92) Throat cancer (1), (R21) Inflamed throat (1), (R78) Bronchitis (1)	0.09	(R21) Inflamed throat (1), (R80) Flu (1)	0.07	(R05) Cough (2), (R21) Inflamed throat (5), (R80) Flu (3), (R90) Tonsils hypertrophy (1)	0.22	(R05) Cough (2), (R21) Inflamed throat (6), (R80) Flu (1), (R90) Tonsils hypertrophy (1)	0.15
Urinary (U)	(U29) Urinary pain (2), (U14) Kidney problem (2)	0.04	-		-		(U29) Urinary pain (1), (U14) Kidney problem (1)	0.03

For the Carrasco, 29 citations for 15 diseases were recorded, across 8 body system categories, with usage diversity values ranging from 0.03 to 0.28 (Table 3). From the registered categories, five obtained UD values ≥ 0.10, while three presented UD values ≤ 0.07. The Musculoskeletal (UD: 0.28) and Digestive (UD: 0.24) systems were the most representative systems, with 3 diseases each and 8 and 7 citations, respectively. The most commonly cited therapeutic indications within these systems were stomachache (four), rheumatoid arthritis (three) and bone pain (three), which were treated by ingesting the leaf decoction or by massaging the oil-resin. The Circulatory system was the body

system category with the lowest UD value in this phytophysiognomy with one disease (pain in the veins) and one usage citation.

The most representative category in the Caatinga, Cerrado, Carrasco and Wetland phytophysiognomies was the Musculoskeletal system, with a usage diversity value equal to 0.37, 0.33, 0.28 and 0.20, respectively, with rheumatic arthritis (17), back problems (15) and bone pain (15), as the most commonly indicated diseases in this system (Table 3). Rheumatism and bone problems are among the diseases for which *C. lansgsdorffii* is used, as reported by Ribeiro et al. (2014), Fagundes et al. (2017), and Macêdo et al. (2018), which affirms these uses in different communities. The vast indication of diseases in this system within the communities may be associated with a limited access to modern medicine and the high cost of pharmaceutical drugs used to treat these health problems, causing populations to select and test plants, as is the case of *C. langsdorffii*, where the oil-resin is widely indicated for such diseases.

The skin category obtained the second highest usage diversity value, with values equal to 0.22 (Wetland), 0.21 (Caatinga), 0.13 (Cerradão) and 0.10 (Carrasco) in the different areas. Cicatrizing (21) received the highest number of citations (Table 3). *C. langsdorffii* has been reported to have cicatrizing properties in other studies (Macêdo et al. 2015; Macêdo et al. 2016; Macêdo et al. 2018), conferring cicatrizing (Paiva et al. 2002; Masson Meyers et al. 2013) and anti-inflammatory properties (Paiva et al. 2003; Paiva et al. 2004; Silva et al. 2009; Gelmini et al. 2013) that have been proven through pharmacological studies.

The Digestive system presented divergences between the phytophysiognomies, in terms of usage diversity (UD), where the Cerradão and Caatinga presented low UD values, 0.08 and 0.06, respectively, for this system, while this category was well represented in the Carrasco and Wetland, with UD values equal to 0.24 and 0.18, respectively (Table 3). Stomachache (six) and gastritis (six) obtained the greatest number of indications. *C. langsdorffii* is highly indicated in ethnobotanical surveys, carried out in Northeast Brazil, for different digestive symptoms (Souza et al. 2014; Macêdo et al. 2015; Saraiva et al. 2015; Silva et al. 2015), where this plant has previously demonstrated a gastroprotective activity (Lemos et al. 2015; Motta et al. 2017), where the compounds responsible for this activity are likely to be kaurenoic acid, quercitrin, afelelin, α-humulene, β-caryophyllene, caryophyllene oxide (Lemos et al. 2015) and galloylquinic acid (Motta et al. 2017), present in different parts of that species.

The respiratory category was another body system category which showed variation when analyzed in different phytophysiognomies (Table 3). In the Cerrado and Carrasco, its usage diversity value was ≤ 0.10, while in the Wetland and Caatinga, its values were 0.22 and 0.15, respectively. Throat inflammation was the most commonly cited disease (13) (Table 3). *C. langsdorffii* is often indicated for this system (throat problems) in different Brazilian regions (Pinto et al. 2013 – Midwest; Baptistel et al. 2014 – Northeast; Franco and Souza 2016 – North; Pereira et al. 2016 – Midwest; Ribeiro et al. 2017 – Midwest; Santos et al. 2019 – Northeast), bronchitis (Guarim-Neto and Morais 2003– Midwest; Moreira and Guarim-Neto 2009 – Midwest; Bitu et al. 2015 – Northeast; Fagundes et al. 2017 – Southeast), colds (Moreira and Guarim-Neto 2009 – Midwest; Santos et al. 2014 – North; Silva et al. 2018 – North; Macêdo et al. 2018 – Northeast) and coughs (Baptistel et al. 2014 – Northeast; Macêdo et al. 2015 – Northeast; Macêdo et al. 2018 – Northeast), also being used less frequently for sinusitis (Conceição et al. 2011 – Northeast) and asthma (Baptistel et al. 2014 – Northeast). Its medicinal properties are likely associated with the presence of sesquiterpenes in its essential oil, such as β-caryophyllene and h-hyalchalene, which confer antimicrobial activity (Alencar et al. 2015).

The categories with the lowest representation in the different phytophysiognomies studied were Circulatory (K), Endocrine, Metabolic and Nutritional (T), Female Genital (X), Male Genital (Y), Neurological (N), Ear (H), Psychological (P) and Urology (U) system, with usage diversity values ≤ 0.10 (Table 3).

Level of fidelity (FL)

The level of fidelity determines the informant's consensus on each therapeutic indication mentioned for the species under study and was calculated for all health problems reported in the Cerradão, Carrasco, Wetland and Caatinga phytophysiognomies (Table 4).

Although the Cerradão and Caatinga phytophysiognomies registered the highest number of therapeutic indications (38 and 33, respectively), their general level of fidelity was lower, varying from 3.57 to 25 and 4.35 to 26.09, respectively. While a fewer number of diseases were indicated in the Wetland and Carrasco (15 and eight, respectively), their level of fidelity was more expressive, ranging from 6.67 to 66.67 and 13 to 50, respectively (Table 4). This difference may be due to the dissemination of knowledge in communities, where a lower number of diseases treated by a given plant in a community is more easily dispersed, reaching a larger number of people, thus having a greater consensus among members from the area. Whereas, in a community where a plant is known to treat various illnesses, this total knowledge will be restricted to a few people,

Table 4. Comparison of the Level of Fidelity (FL) in relation to the medicinal indications of Copaíba (*Copaifera langsdorffii*) in Chapada do Araripe communities, Northeast, Brazil.

Cerradão		Carrasco		Wetland		Caatinga	
Therapeutic indications	**FL%**	**Therapeutic indications**	**FL%**	**Therapeutic indications**	**FL%**	**Therapeutic indications**	**FL%**
Bone pain	25.00	Bellyache	50.00	Healing	66.67	Artrite reumática	26.09
Healing	21.43	Swelling	38.00	Inflamed throat	33.33	Inflamed throat	26.09
Artrite reumática	21.43	Artrite reumática	38.00	Bone pain	26.67	Healing	21.74
Loss of apetite	21.43	Bone pain	38.00	Spine problems	20.00	Arthrosis	17.39
Spine problems	21.43	Diarrhea	25.00	Flu	20.00	Spine problems	17.39
General pain	17.86	Headache	25.00	Stomach ache	20.00	Joint pain	17.39
Pain in the legs	14.29	Beat	25.00	Artrite reumática	13.33	Cancer	13.04
Joint pain	14.29	Vaginal inflammation	25.00	Inflammation in general	13.33	Swelling	13.04
Hemorrhoid	14.29	Spine problems	25.00	Cancer	13.33	Skin burn	13.04
Earache	10.71	Migraine	13.00	Cough	13.33	General pain	8.70
Cracked feet	10.71	Indigestion	13.00	Infection in general	13.33	Gastritis	8.70
Cough	10.71	Pain in the veins	13.00	Gastritis	13.33	Hemorrhoid	8.70
Inflammation in general	7.14	Stretch mark of pregnant woman	13.00	Bellyache	13.33	Beat	8.70
Urinary pain	7.14	Flu	13.00	Joint pain	6.67	Tumor	8.70
Nervousness	7.14	Inflamed throat	13.00	Beat	6.67	Cough	8.70
High pressure	7.14			Diabetes	6.67	Stroke	4.35
Gastritis	7.14			Body ache	6.67	Headache	4.35
Kidney problem	7.14			Tonsils hypertrophy	6.67	Pain in the legs	4.35
Toothache	7.14			Laxative / Constipation	6.67	Tendonitis	4.35
Indigestion	7.14			Gastric ulcer	6.67	Bad circulation	4.35
Arthrosis	7.14					Open chest	4.35
Swelling	3.57					Stomach ache	4.35
Beat	3.57					Herniated disc	4.35
Sinusitis	3.57					Kidney problem	4.35
Headache	3.57					Cracked feet	4.35
Asthma	3.57					Toothache	4.35
Cancer	3.57					Urinary pain	4.35
Throat cancer	3.57					Muscular pain	4.35
Uterine cancer	3.57					Bone pain	4.35

Continue...

Table 4. *Continuation.*

Cerradão		Carrasco		Wetland		Caatinga	
Therapeutic indications	FL%	Therapeutic indications	FL%	Therapeutic indications	FL%	Therapeutic indications	FL%
Migraine	3.57					Flu	4.35
Inflamed throat	3.57					Tonsils hypertrophy	4.35
Sprains	3.57					Osteoporosis	4.35
Sun burn	3.57					Bug bite	4.35
Bronchitis	3.57						
Insomnia	3.57						
Ringworm	3.57						
Prostate	3.57						

with only the most common uses being passed on to other members from the community, thus a high probability of reducing knowledge consensus among informants in an area exists.

The most cited therapeutic indications in the Cerradão, Carrasco, Wetland and Caatinga areas were bone pain, stomachache, cicatrizing and rheumatic arthritis/throat inflammation, respectively, with a level of fidelity equal to 25, 50, 66.67, and 26.09%, respectively (Table 4). In general, fidelity levels for the diseases reported were high, showing consensus among the informants. The *C. langsdorffii* effectiveness in treating these health problems may be related to the presence of compounds such as α-humulene, β-caryophyllene, galoylquinic acid, quercitrin, afelelin, kaurenoic acid, caryophyllene oxide, acetoxicopalic acid, agatic acid, hydroxycopic acid and copalic acid, which have proven anti-inflammatory, antibacterial and gastroprotective actions (Paiva et al. 2003; Souza et al. 2011; Lemos et al. 2015; Abraão et al. 2015; Motta et al. 2017).

Health problems such as rheumatic arthritis and back problems showed a high consensus among all the studied phytophysiognomies, with a fidelity level of 38 and 25% in Carrasco, 26.09 and 17.39% in Caatinga, 21.43% in Cerradão and 13.33 and 20% in Wetland areas (Table 4), respectively, these being considered a good and reliable indicator of potential *C. langsdorffii* therapeutic properties.

The lowest level of fidelity value (3.57%) was recorded in the Cerradão area for the following therapeutic indications: swelling, bumps, sinusitis, headache, asthma, cancer, throat cancer, cervical cancer, migraine, throat inflammation, sprains, sunburn, bronchitis, insomnia, mycosis and prostate (Table 4). However, some of these diseases were well represented in the other vegetation types, such as throat inflammation, which despite having a low consensus in the Cerradão, presented robust values in the Wetland (33.33%), Caatinga (26.09%) and Carrasco (13.00%) areas (Table 4).

Plant part consensus value (PPC)

Different *C. langsdorffii* plant parts were reported by community informants to treat their illnesses, such as the resin oil, leaf, stem bast, stem bark and seed (Table 5). The resin oil stands out with greater consensus from all the studied phytophysiognomies, with 0.96, 0.88, 0.71, and 0.45 for the Caatinga, Wetland, Cerrado and Carrasco areas, respectively (Table 5). The stem bast was cited in all the environments, however, it presented a low consensus, with a PPC value ≤ 0.10. The leaf was cited by informants in the Carrasco (PPC: 0.34), Cerradão (PPC: 0.18) and Caatinga (PPC: 0.01) areas, however, it was not indicated in the Wetland. The seed was not cited in the Caatinga, however, it presented a PPC value equal to 0.14 for Carrasco and 0.02 for Cerradão and Wetland areas. The stem bark is used only by Cerradão communities and obtained a low consensus (0.03) (Table 5).

The diversified use of plant structures from the same species is associated with the fact that many symptoms can be treated by any plant part, given they contain similar bioactive properties that are useful to treat the symptoms (Ashraf et al. 2016). It should be noted that in Northeast (Silva et al. 2015; Penido et al. 2016; Santos et al. 2019) and Northern regions (Santos et al. 2014; Mesquita and Tavares-Martins 2018; Silva et al. 2018), a preference for using the stem bark exists, while in the Midwest (Souza and Felfile 2006; Mariano et al. 2015; Pereira

Table 5. Plant part consensus value (PPC) Copaíba (*Copaifera langsdorffii*) in Chapada do Araripe communities, Northeast, Brazil.

Part Used	PPC: Cerradão	PPC: Carrasco	PPC: Wetland	PPC: Caatinga
Oil-resin	0.71	0.45	0.88	0.96
Leaf	0.18	0.34	-	0.01
Stalk stem	0.05	0.07	0.10	0.03
Stem bark	0.03	-	-	-
Seed	0.02	0.14	0.02	-

et al. 2016) and Southeast (Ferrão et al. 2014; Ronchi et al. 2016; Oliveira-Silva et al. 2018) the use of the resin oil stands out. The intensified use of structures such as barks and resin oil, may make the species more vulnerable and cause a reduction in their populations (Santos et al. 2019), thus their collection requires control so as to not harm the conservation of the species.

Human perceptions associated with the use of natural resources need to be thoroughly investigated, as the results from these works can help to understand the selection criteria of certain natural resources by different cultural groups (Albuquerque and Alves 2018). In addition, such factors, in general, do not act in isolation, and it is necessary to understand the forces that act together in the various forms of interaction between people and the biota (Albuquerque and Alves 2018).

CONCLUSION

The research carried out with *C. langsdorffii* in the Cerradão, Carrasco, Wetland and Caatinga phytophysiognomies in the Chapada do Araripe, Northeast Brazil, showed a considerable amount of therapeutic indications, indicating that the informants know and use *C. langsdorffii* to treat diseases that affect different body systems.

C. langsdorffii is indicated to treat rheumatoid arthritis, bone pain, throat inflammation, bumps and back problems in all the studied phytophysiognomies, demonstrating a wide transmission of knowledge between areas for its uses. However, certain disease indications are unique to each ecosystem and may be associated with both a cultural factor from each community, as well as resource availability in the environment and a variation in chemical composition of the species given their different environments.

Therapeutic indications such as rheumatic arthritis and back problems presented a high consensus in Cerradão, Carrasco, Wetland and Caatinga phytophysiognomies, this being considered a good and reliable indicator of potential *C. langsdorffii* therapeutic properties.

The consensus values among the informants showed a high knowledge/usage transmission, regarding *C. langsdorffii*, within the different phytophysiognomies, especially in the Musculoskeletal, Skin, Digestive and Respiratory systems.

The *C. langsdorffii* data obtained in this study highlight its therapeutic potential and the need for studies to evaluate plant species that are used by local communities as a source of biologically active natural products, paving the way for a contribution to the search and development of new drugs.

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AUTHORS' CONTRIBUTIONS

Acquisition and analysis of data: MOS, BVA, FGTM, MJFM, and DAR. Manuscript preparation: MOS. Manuscript editing and review: MOS, JTCJ, MAPS, IRAM, JGMC, and MMAS. All authors read and approved the final manuscript.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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