

Chapter

Application of the Theory of Signatures to Validate the Use of Medicinal Plants in the Riverside Area of the Cities of Mazagão and Macapá, State of Amapá, Amazonia, Brazil

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Abstract

The Theory of signatures can explain how traditional knowledge was formed or perpetuated to the present day. Based on the optical characteristics of plants, the appearance of a particular plant resembles some organ in the human body, indicating that this plant can be used in treating and curing diseases associated with this organ in which the plant resembles. Therefore, this chapter aimed to analyze the relationship of plants with organoleptic optical properties with the use attributed by traditional communities and pharmacological validation through scientific literature. The plants were selected through ethnobotanical research in a riverside region in Amapá State. Photographic records were made to compare the part of the plant with the organ of the human body. After botanical identification, they were subjected to a review of scientific literature to prove the applications of traditional uses. *Results:* The plant species *Arrabidaea chica*, *Astrocaryum murumuru*, *Bauhinia splendens*, *Costus spicatus*, *Croton urucurana*, *Eleutherine bulbosa*, *Melissa officinalis*, *Phlebodium decumanum*, *Phyllanthus amarus* and *Zingiber officinale* were identified. *Conclusions:* The species *Costus spicatus*, *Croton urucurana*, *Melissa officinalis*, *Phyllanthus amarus*, and *Zingiber officinale* have had their main traditional uses proven through registered scientific studies, corroborating the existence of a relationship between the morphological aspects of plants and the indication of use in traditional Amazonian medicine.

Keywords: traditional medicine, ethnobotany, medicinal plants, plant morphology, autochthonous resources

1. Introduction

The cultivation and management of medicinal plants date back to the most remote times of humanity, with records dating back to 4000 BC [1]. In Brazil, the use of medicinal plants by indigenous communities has always occurred. With the arrival of Portuguese doctors, who were unable to bring medicines used in Europe, the knowledge of medicinal plants was used in conventional medicine [2]. With the arrival of people of African descent in Brazil, more knowledge was used in Brazilian culture since these people used plants and herbs in rituals and to cure diseases. Thus, there was a union of knowledge between indigenous, Europeans, and Africans, which contributed to the great diversity of traditional knowledge in Brazil [3].

Ethnobotanical studies focus on exploring the processes and justifications for the traditional use of medicinal plants [4, 5]. Multidisciplinary research is emerging to investigate secular knowledge and how it was formed, some of these studies use organoleptic properties, such as smell, taste, and optics [6].

The Theory of Signatures, which emerged in the Middle Ages, with the physician and alchemist Paracelsus, who preached *similia similibus curantur* (“*similar, similar cure*”) [7], can explain how traditional knowledge was formed or perpetuated to the present day. The Theory is based on the optical characteristics of plants: the appearance of a particular part of the plant resembles some organ of the human body, indicating that this plant can be used in the treatment and cure of diseases associated with this organ in which the plant resembles. It can be attributed to the General Theory of Representations (Semiotics), where the construction of the meanings of each element of human nature occurs, generally related to the image that the element transmits [8].

Even today, researchers from different parts of the world analyze the contributions of the Theory of signatures to traditional populations. Leonti et al. [6] expose that the Theory of signatures is an essential mnemonic device for the indigenous people of southern Veracruz, Mexico. Bennett [9] also supports the idea that the Theory of signatures is a mnemonic device. Populations with low schooling used to pass on the knowledge of medicinal plants acquired clearly and practically to the next generations, being an instrument to facilitate memorization. However, ethnobotanical research in the Amazon is still focused on the defining aspect, with no record of investigations of organoleptic properties.

The State of Amapá, located in the Brazilian Amazon, is considered the most preserved state in Brazil, in which 70% of its area is home to Conservation Units, Indigenous Lands, and Quilombolas [10]. The rainy period occurs from January to June, and the drought period from July to December [11]. The vegetation, according to IBGE [12], is classified as Alluvial Dense Rainforest. According to Rabelo [13], there is a Várzea Forest in the region with daily floods due to tidal variation.

Amapá also has a great diversity of traditional populations (indigenous, quilombolas, riverside people, descendants of Africans, and peasants), creating a unique diversity of knowledge about medicinal plants from the Amazon [10].

This chapter aimed to analyze the relationship between plants with organoleptic optical properties, the use attributed by traditional communities, and the validation of the pharmacological effect in scientific literature.

2. Study area

The Amazon stands out for its humid tropical climate [11], favoring its enormous diversity of fauna and flora. As it is a biome that is difficult to access, it has a great diversity of traditional secular knowledge about medicinal plants, passed from generation to generation. The place of study was the region of the District of Fazendinha (0.0217220, N -51.0853921 O) and the riverside area of the Vila Nova River (-0.096039 N -51.268450 O), in the Municipality of Mazagão, State of Amapá, an island in the eastern Amazon, which houses the mouth of the Amazon River (Figure 1).

3. Plant selection

The project was approved by the Ethics Committee of the Federal University of Amapá-UNIFAP under protocol number CAAE - 31830720.0.0000.0003 and review number: 4.073.014.

A list of medicinal plants popularly used in Amapá was built after the compilation of two ethnobotanical studies in the State of Amapá. The list has 130 medicinal plants. After research at the Photo Library of the Virtual Herbarium of the Botanical Garden of Rio de Janeiro (JABOT), ten plants were identified with similar shapes to organs of the human body or physiological functions (Table 1).

The collection of botanical material was carried out in November and December 2020 for identification purposes. The exsiccates were deposited at the Herbário Amapaense of the Institute of Scientific and Technological Research of the State of Amapá to identify botanical species (HAMAB-IEPA) by Dr. Patrick de Castro Cantuária.

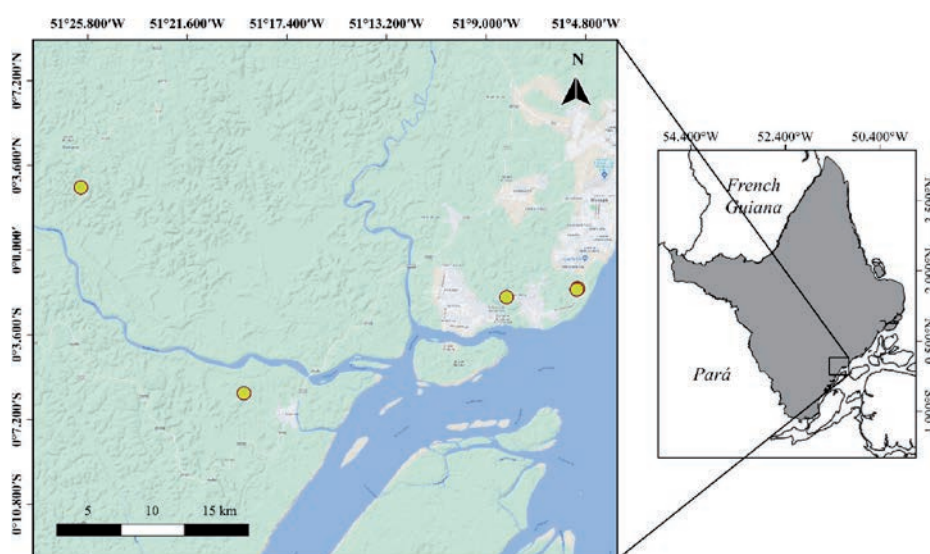


Figure 1.
 Location of the area where the plant species were collected.

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Herbal deposit number	Scientific name	Popular name	Popular indication	Appearance	Imagem planta	Plant image Related organ image
HAMAB 019281	<i>Arrabidaea chica</i>	Pariri	Anemia, diarrhea, wound washing, jaundice	Blood		
HAMAB 019289	<i>Astrocaryum murumuru</i>	Murumuru	Inflammation in the eyes	Eyes		
HAMAB 019282	<i>Bauhinia splendens</i>	Ladder of tortoise	Joint pain, rheumatism, and syphilis	Intestine		
HAMAB 019282	<i>Bauhinia splendens</i>	Ladder of tortoise	Joint pain, rheumatism, and syphilis	Clitoris		
HAMAB 019283	<i>Costus spicatus</i>	Canafiche, canarana	Inflammation in the uterus and ovaries, vaginal discharge, urinary tract infection, and syphilis	Urethra		

Herbal deposit number	Scientific name	Popular name	Popular indication	Appearance	Imagem planta	Plant image Related organ image
HAMAB 019288	<i>Croton urucurana</i>	Christ's blood	Hemorrhage, wound healing, antitumor, and diarrhea.	Blood		
HAMAB 019284	<i>Eleutherine bulbosa</i>	Marupá, marupázinho	Verminous healing of skin wounds	Hemorrhoid		
HAMAB 019285	<i>Melissa officinalis</i>	Cidreira, cidreira herb, Lemon balm	Headache, digestive problems, anxiety, and nervousness	Heart		
HAMAB 019286	<i>Phlebodium decumanum</i>	Guaribinha	Cough, hoarseness, and bronchitis	Guariba monkey		
HAMAB 019287	<i>Phyllanthus amarus</i>	breaking stone	Urinary tract pain (urinary tract infection)	little Rock		

Herbal deposit number	Scientific name	Popular name	Popular indication	Appearance	Imagem planta	Plant image Related organ image
HAMAB 019290	<i>Zingiber officinale</i>	Ginger	Gastrointestinal system, anticancer, anti-cough, anti-inflammatory.	Stomach		

Table 1.
List of plant species identified with the macroscopic characteristics of the parts used and the correlations with parts of the human body.

According to Fidalgo and Bononi [14], the samples were processed in the field and identified with their vernacular names, with labels containing the collection number and specific information for each sample. Photographic records of the species were made, and the geographical coordinates of the area with the Global Positioning System (GPS) apparatus were recorded.

4. Obtaining photographic records

The photographic records were taken from September to December 2020 to record the flowers of the Amazonian Spring. The collections took place in Macapá, in the district of Fazendinha, and the municipality of Mazagão, in the riverside area of the Vila Nova River, with the help of a specialist in traditional medicinal plants.

5. Bibliographic research

The scientific support for the traditional use of the identified plant species was based on searches on three platforms: Web of Science, CAPES Journals, and Google Scholar (articles published between 1945 and 2021). The word pharmacology and scientific name of the identified species were used in the searches. The articles that describe some pharmacological actions of the species were selected. In vivo, in vitro, and clinical studies articles were included. The data were tabulated in Excel spreadsheets, analyzed, and divided into categories.

6. Theory of signatures and plants from Amazon

Arrabidaea chica plant, popularly known as “Pariri” or “Crajirú” in the eastern Amazon region, is used by traditional populations as body paint, sunscreen, mosquito repellent, in wound healing, intestinal colic, skin conditions, blood disorders, and leukemias [3]. Its leaf tea is red as blood and is widely used for anemia [15].

Astrocaryum murumuru is a palm widely used in the Amazon. Its fruit tea is used for inflammation in the eyes [15], and its fruit butter is also used in the cosmetics industry for the manufacture of creams, soaps, and shampoos [16]. The fruit of the palm tree “Murumuru,” when cut in half, looks like eyes, as shown in **Table 1**.

Bauhinia splendens, known as “Ladder of tortoise” or “Herb of Jabuti,” is commonly used for joint pain, rheumatism, and syphilis. The bark of its stem is also used against pathogenic bacteria [17], and its leaves are used for vaginal infections [18]. It can be noted that its flower has a shape that resembles the clitoris and its tangled stem that resembles the large intestine, being used to cure diseases in both organs (**Table 1**).

Costus spicatus is popularly known in the Amazon as “Canafiche.” In other regions of the country, it is known as “Cana do Pântano” or “Cana-do-Brejo.” It is popularly used for pain and inflammation, relief of urinary tract infection, and expulsion of kidney stones. Its anti-inflammatory, antimicrobial, and diuretic action has already been scientifically proven [19, 20]. The shape of its stem resembles the human urethra.

Croton urucurana, popularly known as “Blood Tree,” “Blood of Christ,” or “Dragon Blood,” is a tree whose bark is cut, releasing a viscous red sap similar to blood. This sap is used in traditional medicine as hemostatic, wound healer, analgesic, anti-inflammatory, and anti-rheumatic agent [21].

Eleutherine bulbosa, popularly known as “Marupá,” is a tropical herb. Its red bulbs resemble hemorrhoids and are traditionally used for pain and regularization of menstruation, intestinal disorders, and deworming [22].

The *Melissa officinalis* plant, the famous “Lemongrass,” well known among medicinal plants, is popularly used for headaches, nervousness, anxiolytics, and heart problems. Its leaf is shaped like a heart [23].

Phlebodium decumanum is known in the eastern Amazon as “Guaribinha,” as its root is the same as the guariba monkey (*Alouatta guariba*). Its root tea is used for “guariba cough,” as long periods of cough are known in the eastern Amazon, in addition to hoarseness and bronchitis.

Phyllanthus amarus, popularly known as “Quebra-Pedra,” as its name suggests, is widely used for the genitourinary system, for kidney stones and gallstones, also used for stomach problems, colic, hepatitis, hypertension, jaundice, Analgesic, antidiabetic, anti-inflammatory, and many other uses, varying from country to country [24]. Its small leaves and seeds resemble small stones, reminiscent of kidney stones.

The rhizomes of the plant *Zingiber officinale* (ginger), depending on its evolution, sometimes are identical to the stomach and one of its most significant benefits is for digestive problems. Studies show that the Chinese have used ginger for more than 2000 years for gastric problems and nausea, being a popular therapy for seasickness [23]. Ginger is a plant that has been extensively studied because of its various uses, anticancer, anti-inflammatory, antitussive, anticoagulant effects, cardiovascular effects, and the gastrointestinal system [25].

7. Vegetable species with a reddish color

It is noted that reddish-colored plants are popularly used for blood disorders. Leonti et al. [6] report in their studies that decoction teas or reddish plant seeds are used to treat bleeding and menstrual problems. It is observed that in addition to Pariri tea (*Arrabidaea chica*) and blood tree (*Croton urucurana*), the flowers of the Escada de Jabuti (*Bauhinia splendens*), used to treat vaginal infections by Indigenous people, also present a reddish color [18].

8. Astringent plant species

Remedies for the gastrointestinal system, such as diarrhea, vomiting, stomach pains, and hemorrhoids, are generally astringent (bark and root), as is the case with the stem of the species Escada de Jabuti (*Bauhinia splendens*), from the root (bulb) of the Marupá plant (*Eleutherine bulbosa*) and Ginger root (*Zingiber officinale*). Leonti et al. [6] demonstrated that the Popoloca indigenous people also use bark and roots to treat diarrhea and dysentery.

9. Names of plant species

Some plant species already have their uses identified by their names, as is the case of the stone-breaking plant (*Phyllanthus amarus*), used for kidney stones, the blood tree plant (*Croton urucurana*), used for blood disorders, and the Guaribinha plant (*Phlebodium decumanum*), used for the well-known “guariba cough” (intense cough) in the Amazon.

10. Formats of plant species

The popular Lemongrass has already been studied by Dafni and Lev [26]. Its leaves, which resemble the heart, are used for heart problems, depression, and insomnia. Murumuru is still a poorly studied palm, with many descriptive studies. The Canafiche plant, which has a urethral appearance, is widely used for urinary infections and kidney stones. As it is a diuretic plant, it is widely used for the urinary system [27].

11. Popular culture and medicinal plants

Posey [28] reports that beliefs and knowledge can sometimes seem contradictory to Western sciences. However, these contradictions are the primary cultural principles to be investigated to understand how traditional populations see the natural world and how these communities classify nature, both in the natural world and the symbolic and social world.

The Theory of Signatures is seen as primitive and of no relevance to modern society. However, Leonti et al. [6], in their research with the indigenous people of Popoluca, Mexico, demonstrated that a multidisciplinary approach could go beyond expectations and discover new information about how traditional communities classify the world. In this community, a local healer reports that the shape of the plant is used to attribute its use and that healing occurs when it is believed to be in its shape and is, therefore, essential for maintaining local medical traditions.

So far, studies on the correlations between the organic characteristics of plants and human organs in the Amazon are scarce and almost nonexistent. The Theory of Signatures is a mechanism for maintaining local traditions or even for passing on information between generations, perpetuating traditional knowledge to the present day.

12. Pharmacological actions of plant species

Of the 10 plant species described in this study, nine present studies prove their pharmacological effects. For *Astrocaryum murumuru*, no scientific studies have been found that proved its traditional uses. The pharmacological effects of the species *Arrabidaea chica*, *Bauhinia splendens*, *Costus spicatus*, *Croton urucurana*, *Eleutherine bulbosa*, *Melissa officinalis*, *Phlebodium decumanum*, *Phyllanthus amarus*, and *Zingiber officinale* are described in **Table 2**.

The species *Arrabidaea chica* is popularly used for anemia. However, it was demonstrated by Oliveira et al. [29] that this action had not been scientifically proven because, after treatment interruption, there is no significant influence on hematological parameters. Among the other pharmacological actions that have been proven are antihypertensive, diuretic, antioxidant, antitumor, anti-inflammatory, antimicrobial, antiparasitic, healing, and anti-angiogenic activities [30–37].

Bauhinia splendens is popularly used for vaginal infections and against pathogenic diseases. The results by Silva et al. [38] indicated the efficacy of the hydroethanolic extract against *Staphylococcus aureus* and *Salmonella typhimurium*. The analgesic and anti-inflammatory action in mice was also evaluated by Cechinel Filho et al. [39]. Its antinociceptive action was proven in mice by Filho et al. [17]. The data showed that the plant has significant analgesic action in several pain models.

Species	Popular Name	Pharmacological action	Scientific studies
<i>Arrabidaea chica</i>	Pariri	Antianemic	Oliveira et al. [29]
		Antihypertensive	Cartágenes et al. [30]
		Diuretic	Amaral et al. [31]
		Antioxidant	Dos Santos et al. [32]
		Antitumor	Ribeiro et al. [33]
		antimicrobial	Mota [34]
		anti-inflammatory	Oliveira et al. [35]
		Healing	Jorge [36]
		Antiparasitic	Rodrigues et al. [37]
<i>Astrocaryum murumuru</i>	Murumuru	UD*	UD*
<i>Bauhinia splendens</i>	Ladder of jaboti	Antimicrobial	Silva et al. [38]
		anti-inflammatory	Cechinel Filho et al. [39]
		Analgesic	Cechinel Filho et al. [39]
		Antinociceptive	Filho et al. [17]
<i>Costus spicatus</i>	Canafiche, cana do brejo	Antibacterial and antioxidant	Uliana et al. [40]
		Anti-inflammatory	Silva et al. [41]
		Nephroprotective, diuretic, antilithiasis activity	Moreno et al. [27]
		Hemolytic effect	Silva and Parente [42]
		Antinociceptive and anti-inflammatory	Quintans Junior et al. [43].
<i>Croton urucurana</i>	Christ's blood, for Sangue	Antimicrobial and antioxidant	Simionatto et al. [44]
		Antidiarrheal	Gurgel et al. [45]
		Antiulcer	Cordeiro et al. [46]
		Anti-inflammatory and antinociceptive	Cordeiro et al. [46]
<i>Eleutherine bulbosa</i>	Marupá	Antimicrobial	Padhi and Panda [47]
		Antioxidant and probiotic	Munaeni et al. [48]
		Antihypertensive	Bahtiar and Chumala [49]
		Antifungal	Alves et al. [50]
<i>Melissa officinalis</i>	Lemongrass	Antioxidants	Bayat et al. [51]
		Antihyperglycemic	Weidner et al. [52]
		Antihyperlipidemic	
		Antimicrobial	Mimica-Dukic et al. [53]
		Antiepileptic	Bhat et al. [51]
		Antidepressants	Lopéz et al. [54]
		anxiolytic	Cases et al. [55]
		Antinociceptive	Birdane et al. [56]
		Anti-inflammatory	
		Antispasmodic	Sadraei et al. [57]
		Neuroprotective activity	Lopéz et al. [54]; Akhondzadeh et al. [58]
		Cardiovascular effect	Akhondali et al. [59]
		Anticancer	Weidner et al. [60]

Species	Popular Name	Pharmacological action	Scientific studies
<i>Phlebodium decumanum</i>	Guaribinha	Anti-inflammatory	Punzón et al. [61]
		Anticancer	Gridling et al. [62]
		Natural supplement	Díaz-Castro et al. [63]
		Antipsoriase	Das et al. [64]
		Antioxidant and anthelmintic	Das et al. [65]
<i>Phyllanthus amarus</i>	Stonebreaker	Gastroprotective	Raphael and Khuttan [66]
		Antiulcer	Shokunbi and Odetola [67]
		Antifungal	Agrawal et al. [68]
		Analgesic	Iranloye et al. [69]
		Anti-inflammatory	Iranloye et al. [69]
		Antinociceptive	Santos et al. [70]
		Antioxidant	Karuna et al. [71]
		Antispasmodic	Ajala et al. [72]
		Antiviral	Ravikumar et al. [73]
		Contraceptive	Rao and Alice [74]
		Diuretic and antihypertensive activity	Srividya and Periwal [75]
		Hepatoprotective activity	Wongnawa et al. [76]
		Hypoglycemic and hypocholesterolemic activities	Mbagwu et al. [77]
		Radioprotective effect	Harikumar and Kuttan [78]
		Antispasmodic	Mans et al. [79]
<i>Zingiber officinale</i>	Ginger	Antithrombotic and anti-inflammatory	Thomson et al. [80]
		Hypoglycemic, hypocholesterolemic, and hypolipidemic activity	Al-Amin et al. [81]
		Anti-inflammatory, antipyretic, and Analgesic	Ojewole [82]
		Gastroprotective action	Bryer [83]
		Radioprotective effect	Jagetia et al. [84]
		Antioxidant	Kim et al. [85]
		Antimicrobial	Ficker et al. [86]
		Anticancer	Shukla and Singh [87]
		Antiarthritic	Funk et al. [88]

*UD: undefined.

Table 2.
 Pharmacological actions of plant species recorded in the ethnobotanical survey.

Costus spicatus is traditionally used for urinary infections. Moreno et al. [27] investigated the nephroprotective and antilithiatic effects, and the study indicated a significant nephroprotective effect. The authors suggest the possible efficacy of traditional use. Other investigations on its pharmacological properties have been studied, such as the antimicrobial, antioxidant, anti-inflammatory, hemolytic, and antinociceptive effects [40–43].

Croton urucurana is traditionally used for bleeding, diarrhea, and wound healing. Gurgel et al. [45] investigated its antidiarrheal action, which presented actions on pathologies associated with diarrhea. Its anti-hemorrhagic effect was tested and the hydroethanolic extract showed a significant effect in inhibiting the hemorrhagic activity of *Bothrops jararaca* venom. It also has analgesic, antiulcer, anti-inflammatory, antinociceptive, antimicrobial, and antioxidant actions [44, 46, 89].

Eleutherine bulbosa, traditionally used for worms and wound healing, has been studied for its antifungal and antimicrobial activity by Alves et al. [50] and Padhi et al. [47], which proved their beneficial actions. Marupá was also investigated for its antihypertensive, antioxidant, and natural probiotic actions [48, 49].

The herb *Melissa officinalis*, known as lemon balm, has heart-shaped leaves that are used as a tranquilizer, anxiolytic, and antidepressant. Cases et al. [55] carried out a clinical study in stressed volunteers with mild to moderate anxiety disorders with hydroethanolic extract of *M. officinalis* leaves, and after 15 days, the manifestations of anxiety decreased by 18%, and insomnia decreased by 42%. Akhondzadeh et al. [58] evaluated the efficacy of *M. officinalis* extract in patients with mild to moderate Alzheimer's disease. After four months of treatment, the extract produced a significantly better effect than placebo and positively affected patients' agitation. The pharmacological effects of *M. officinalis* have also been tested as an antidepressant, antiepileptic, antispasmodic, anti-inflammatory, antinociceptive, antioxidant, hypoglycemic, hypolipidemic, antimicrobial, anticancer, neuroprotective, and cardiovascular effect [51–54, 56–60, 90].

Phlebodium decumanum is traditionally indicated for severe cough. Its anti-inflammatory action was evaluated in the study by Punzon et al. [61], in which the extract showed inhibitory activity on the production of tumor necrosis factor. Guaribinha has also been investigated for its antipsoriatic, anticancer, natural supplementation, antioxidant, and anthelmintic actions [62–65].

Phyllanthus amarus was evaluated for its diuretic, hypotensive, and hypoglycemic effects in the study by Srividya and Periwal [75] in humans, where the urine volume and urine sodium concentration increased in 24 hours, a decrease in blood pressure in hypertensive women also occurred. The blood glucose level was significantly reduced. *P. amarus* was also evaluated for its antifungal, analgesic, anticancer, antiulcer, gastroprotective, anti-inflammatory, antinociceptive, antioxidant, antispasmodic, antiviral, contraceptive, aphrodisiac activity, hepatoprotective activity, hypoglycemic and hypocholesterolemic activity, radioprotective effects and antidiarrheal and anti-amnesia effects were proven [66–74, 76–79, 91–94].

Zingiber officinale was investigated for its gastroprotective activity. The study by Bryer [83] provided evidence on the use of ginger in the treatment of vomiting and nausea during pregnancy. The study by O'Mahony et al. [95] evaluated the bactericidal activity of ginger, being effective against *Helicobacter pylori*, which can cause peptic ulcers and the development of gastric and colon cancer [96]. The plant was also investigated for its anti-inflammatory, antithrombotic, hypoglycemic, hypocholesterolemic and hypolipidemic activity, antipyretic, analgesic, radioprotective, antioxidant, antimicrobial, anticancer, and antiarthritic effects [80–82, 84–88].

13. Conclusion

Ten plant species were identified that show organoleptic correlation of optics of some part of the plant with a human organ: *Arrabidaea chica*, *Astrocaryum murumuru*, *Bauhinia splendens*, *Costus spicatus*, *Croton urucurana*, *Eleutherine bulbosa*, *Melissa*

officinalis, *Phlebodium decumanum*, *Phyllanthus amarus*, and *Zingiber officinale*. The best-known plants, *Arrabidaea chica*, *Melissa officinalis*, *Phyllanthus amarus*, and *Zingiber officinale*, have more studies that prove their traditional applications. *Astrocaryum murumuru* does not present any published study record on its pharmacological actions attributed to popular medicine, demonstrating the need for more pharmacological research on the Amazonian plant biome.

Costus spicatus, *Croton urucurana*, *Melissa officinalis*, *Phyllanthus amarus*, and *Zingiber officinale* present their main traditional uses proven through scientific studies, corroborating the existence of a relationship between the morphological aspects of plants and the indication of use in traditional Brazilian medicine.

Finally, this study demonstrates the need for a multidisciplinary investigation to ascertain whether the Theory of signatures is used in traditional Brazilian medicine, whether in medicinal plants or as a device for memorizing medicinal plants and transferring traditional knowledge. The Amazon is one of the most biodiverse biomes globally and has a unique diversity of traditional knowledge that is being lost. Because of this factor, there is a need to investigate and document the knowledge and how it has been passed on from generation to generation for centuries.

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Author's contributions

E.B.F. performed the fieldwork and wrote the manuscript on the results obtained. L.A.J., R.C.R.K., P.F.S., A.P.S.R., and A.S.A.B. performed the fieldwork. J.C.T.C. coordinated and supervised the research project and contributed significantly to design and revision of the manuscript.

Declaration of competing interest

The authors declare that they do not have any conflict of interest.

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