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Plants indicated by Brazilian Indians to Central Nervous System disturbances: A bibliographical approach

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disturbances: A bibliographical approach

Abstract

Brazil possesses great biological and cultural diversity, above all in view of the great number of indigenous ethnic groups, 218, that inhabit the five main biomas in Brazil. The purpose of this review is to analyze the relationship between chemical constituents of species utilized by several Brazilian Indians and the uses/indications made by them. Ethnopharmacological surveys by various researchers as from the decade of the seventies were researched. The 34 publications selected, carried out with 26 indigenous ethnic groups, showed a total of 307 species utilized for 67 different diseases or effects possibly related to the Central Nervous System (CNS). Such plants belong to 85 taxonomic families, mostly Fabaceae, Asteraceae, Rubiaceae, Poaceae, Apocynaceae, Bignoniaceae, Euphorbiaceae, and Solanaceae. The chemical constitution of these plants was researched as from the Pubmed and Web of Science and the information obtained was crossed with different indigenous uses, grouped in 12 categories according to similarities between their expected effects on the CNS: analgesics, to counteract fever, tonics and/or adaptogens, hallucinogens, anxiolytics, anticonvulsants, head illnesses, hypnotics, stimulants, weight control, memory enhancers, and others. Some phytochemical classes were observed to be more common among plants utilized for certain purposes: flavonoids (analgesia, fever, anxiety, hypnotic, weight control and as a stimulant), alkaloids (hallucinogens, head illnesses and as stimulant), essential oils (fever and anxiety), lignans (hallucinogen), tannins (anxiety), triterpenes and saponins

(hypnotic). These data suggest that these phytochemical classes possibly possess a greater number of chemical constituents that perform the effects described or that, in some way, assist in determining the use of the plant by the Indians.

Key Words: ethnopharmacology; Central Nervous System; plants; phytochemistry; Indians; Brazil; flavonoids; alkaloids.

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Introduction

Estimates show there are at least 5 thousand indigenous peoples in the world today – a total of some 350 million persons. Of these, 218 groups inhabit the Brazilian territory – a total of some 370 thousand persons, approximately 0.2% of the total population of Brazil ^[1]. These ethnic groups occupy regions with a great variety of plant forms, mainly in the Amazon forest, the caatinga semi-arid lands, the cerrado brushlands, and the Atlantic rain forest. The indigenous population in Brazil, however, was once much greater. It is difficult to affirm how many Indians there were in Brazil before colonization by Portugal in 1500 – an estimated 5 million. Three centuries subsequent to this contact with Europeans, this number was reduced to 1 million. The population was decimated by wars, epidemics, and, above all, by processes of enslaving that occurred in Brazil as from the sixteenth century ^[2].

At least three peculiarities should be an incentive to ethnopharmacological research among indigenous ethnic groups in Brazil: a) the considerable number of ethnic groups (218) with many that still hold to cultural tradition; b) because the country includes the greatest number of angiosperms - some 55,000-60,000 species ^[3]; and c) the vast dimensions of the territory – 8,547,403.5 km² – which renders medical care by government services in locations farther from urban centers difficult; being this situation more severe in the case of the indigenous areas. This factor, though, is propitious to holding to indigenous local medicine, the object of this ethnopharmacological study.

In spite of the numerous advantages cited above, few ethnopharmacological studies have been carried out among the Brazilian Indians up to the present time. Existing studies have in the majority, been by foreign researchers such as Richard Evans

Schultes, Ghilleen Prance, and Willian Balée, among others. These studies with rare exceptions ^[4,5], specifically analyzed the plants with possible indication for neurological diseases or that had an effect on the Central Nervous System (CNS).

A knowledge of hallucinogenic plants that Indians of the Americas use in their rites, and of other properties of potions prepared from distinct plant species, have been common to man for thousands of years. Different chemical classes of natural products gave rise to pharmaco substances of distinct therapeutic categories. There are various examples of drugs utilized therapeutically whose application derives from indigenous knowledge; curare-type drugs, plaque blockers, among others ^[6]. Indigenous culture is also rich in hallucinogenic preparations and "poisons" ^[7]. Although in some cases, there is a high correlation between the active principle and indigenous use, such as in the case of the alkaloids and the hallucinogenic effect, or of cardioactive glycosides and its tonic effect on the cardiac muscles, this chemical constitutive effect is rarely observed in other uses. The present review has endeavored to draw plant species with possible indications for the CNS from studies in ethnopharmacology carried out among the Indians in Brazil. These indications/uses were classified at a second stage in order to attempt to establish a correlation between these categories and the chemical compounds of the species to which they belong based on phytochemical studies present in scientific literature.

Methodology

A bibliographical survey of ethnopharmacological publications

The following materials were consulted for studies in ethnopharmacology among Brazilian indigenous ethnic groups: the PubMed Data Base ^[8] on publications of scientific articles; Data Base of Theses and Dissertations from Brazilian universities through CAPES ^[9] and USP ^[10]; and also the NUPAUB-USP Database ^[11] publication data base (Nucleus for Support to Research on Human Populations in Brazilian Humid Areas - University of São Paulo). Moreover it was consulted the books from the CEBRID library (Brazilian Center for Information on Psychotropic Drugs), and from a private collection.

Thirty-four publications were selected as from this study: 20 scientific articles, 2 thesis (doctorate), 3 dissertations (Master's degree), 3 books, 3 chapters from a book, and 3 others.

Among those selected publications, some refer to indigenous ethnic groups whose geographical distribution comprises other countries in South America. Examples of this include the Yanomami that occupy a region of Amazonia in both Brazilian and Venezuelan territory and the Tiriyo that inhabit the Brazilian Amazon region and part of Suriname. Forty (40), 18.5%, of the 218 indigenous peoples listed in this study, inhabits also in other countries in South America ^[1]. All of the therapeutic plants of the ethnic groups whose geographical distribution exceeds Brazilian territory were included in this article, even those that do not occur in Brazil spontaneously. This criterion for inclusion was based on the fact that there is traffic of plant resources between these ethnic group settlements, as described by Chagon ^[12] concerning Yanomami peoples.

Plant species that the ethnic group under consideration had cited for diseases or for other uses reminiscent of possible action/effects on the CNS were drawn from these 34 publications.

The scientific names of some plant species cited in older publications (the seventies) had to be up-dated by consulting the Missouri Botanical Gardens data base ^[13], in cases in which they had fallen into disuse.

Uses cited for each plant were classified according to the similarity between possible effects/action, as for instance: plants for headache, earache, and other types of pain were grouped under the category "analgesic".

Research on the chemical constituents of the plants selected

A bibliographical survey was carried out initially on the PUBMED data base ^[8] and Web of Science ^[14], utilizing the scientific names of each plant. Results of this search were subjected to a screening (through titles and abstracts) to ascertain whether the articles contained chemical constituents of the species in question and to discard false results. More complete papers were utilized when a specific species had studies showing these same chemical constituents. Pharmacological studies that confirmed the effects described by the Indians for the plant in question were also selected during the analysis of the results of the search.

Some limitations must be considered in spite of the careful survey. For instance, use of a scientific name as a key word will not bring results if the orthography of the scientific name published has been subject to alteration. It was not possible to check on all the botanic synonyms in the survey, given the large number of plants. Another limitation: some journals do not offer access to the entire text - not even the abstract was available in some cases. It was not possible to check on the chemical constitution of these plants, except where the printed editions were available in the libraries consulted (University of São Paulo and Federal University of São Paulo). Finally, a number of studies with

Brazilian plants are presented at Brazilian congresses and other regional events and they are not consulted since their abstracts are of difficult access.

An attempt was made to establish a correlation between the said categories of use and specific chemical classes as from the data obtained in this bibliographical survey. The correlation between the presence of phytochemical classes and the therapeutic use made by the Indians was regarded as positive in cases where a reasonable part of the plants with that use possessed the phytochemical class in question.

Results and Discussion

The importance of natural products in human therapeutics has been acknowledged since time immemorial. The chemical repertoire of plants is incredibly vast, probably somewhere well above 100,000 potentially active substances, of which only a minute proportion has been investigated by pharmaceutical laboratories ^[15].

Ethnopharmacological information on the use of medicinal plants, especially by Indians and traditional communities, are a valuable tool for a choice of plants to be studied.

Unfortunately, these studies have as yet not focused as they should have on fungi and animals indicated in these same ethnopharmacological studies.

The 34 publications analyzed in this revision referred to information from 26 ethnic groups, namely: Araraibo, Asurini, Baniwa, Deni, Fulni ô, Guajajara, Jamamadi, Kaapor, Krahô, Kubeo, Kuikuro, Maku, Makuna, Pankararu, Pareci, Pataxó, Paumari, Tembê, Terena, Ticuna, Tiriyo, Tukano, Xokleng, Xukuru, Yanomami, and Yawalapiti, as can be observed in Table 1.

In addition, the said publications supply information concerning the Indians in a generic way – those that belong to the Karib language, those that inhabit the Brazilian Amazon, the south of Brazil, the Brazilian coast, and the Upper Xingu regions. Another three ethnic groups – Bará-Maku, Surara, and Waiká, although included in Table 1, according to the nomenclature cited in their respective publications, are not included in the map in Fig. (1), for they belong to the Yanomami ethnic group.

The map shows that the 26 ethnic groups inhabit four of the Brazilian biomas: the Amazon forest, the caatinga semi-arid lands, the cerrado brushlands, and the Atlantic rain forest which, provides considerable biological diversity to the plants listed in this review.

Table 1 shows the 307 plants that are recorded in this study, as from the ethnopharmacological literature from 26 Brazilian ethnic groups. Of the 307 species, only one is not an angiosperm: *Adiantum serratodentatum* Humb. & Bonpl. ex Willd. (püyari epü), namely a fern from the Pteridaceae family. The species belong to 85 taxonomic families, mostly Fabaceae (49 species recorded), Asteraceae (17), Rubiaceae (14), Poaceae (11), Apocynaceae (9), Bignoniaceae (9), Euphorbiaceae (9), Solanaceae (8), Cyperaceae (7), Lamiaceae (7), Piperaceae (7), Rutaceae (7), Verbenaceae (7), and Moraceae (7). The Fabaceae, Euphorbiaceae, Asteraceae, Bignoniaceae, and Rubiaceae families are also among the most cited in an ethnopharmacological survey carried out among the Krahô Indians that, like the present study, analyzed the plants with possible action on the CNS ^[5].

The 307 plants are used to treat 67 different complaints and/or ailments which is suggestive that they may, in some way, be active on the CNS: these uses were further grouped into 12 categories according to similarities between their expected effects on the CNS, as can be seen in Table 2. They are: analgesics, to counteract fever,

tonics/adaptogens, hallucinogens, anxiolytics, anticonvulsants, head illnesses, hypnotics/sedatives, stimulants, weight control, memory enhancers, and others (no defined effect). For example, category **1 - analgesics** concerns 18 uses (arthritis; analgesic; body ache; chest pain; pain in the anus; muscle pain; pain in the backbone; pain in the sole of the foot; pain in the ribs; ear ache; pain in the lower womb; rheumatic pain; headache; toothache; pain; lower extremity pain, otitis, painful joints) and comprehended a total of 132 plants employed to alleviate these several kinds of pain. On some occasions, the same species was cited for more than one use; for example, some plants indicated for fever are also utilized for headaches, since the use "fever with headache" was recurrent. Some pathologies, such as rheumatism and arthritis were included under the category analgesics, because they were indicated to counteract pain resulting from these diseases.

Fig. (2) shows the number of plants indicated for each one of the 12 categories, where six of these (marked by an asterisk), seem to exert possible psychoactive action/effects: hallucinogens, anxiolytics, head illnesses, stimulants, hypnotics, and memory enhancers.

A bibliographic survey with the plants from this survey showed that, of the 307 plants listed, 135 have been the subject of some type of scientific study (from the phytochemical point of view) available on the PubMed or Web of Science data base.

The 172 others have not yet been studied from that point of view, or, these studies are to be found in theses and other articles of difficult access. The majority of plants whose chemical constitution has not yet been studied belong to the therapeutics of the Tiriyo, the Yawalapiti, and the Pareci Indians. These ethnic groups inhabit the Amazon forest and cerrado brushland biomas - Fig. (1). The dearth of studies of the plants utilized by them may be indicative of greater isolation of their cultures, based on plants of the

region, probably little explored. Several of the plants utilized by the Pareci were not included in this survey, for they were identified only as far as genus ^[27]. A lack of identification in some cases may have occurred through the non-availability of adequate material (fertile branches); moreover, some of these plants could be possibly new species.

Classifying of several uses/indications of the plants per category showed that **analgesics** and **to counteract fever** are in the lead in number of species, with 132 and 120 species respectively. The first category was, likewise, the second most cited (48 plants) in another ethnopharmacological survey among the Krahô Indians ^[5]. And, it may have ranked second because the leading category in that ethnic group was tonics, since that the status of “champion runner” is extremely important culturally to that peoples.

In Table 2, the main active principles found in the plants to which are attributed analgesic activity are, by decreasing order of number of citations in articles: flavonoids, alkaloids, triterpenoids, phenolic compounds, and coumarins. If we considered that the flavonoids, coumarins, and phenolic compounds possess phenolic groups in their structure, this group would, by far, be in greatest evidence among the plants utilized as analgesics in this survey. For instance, in the case of *Justicia pectoralis*, one of the species utilized by Yanomani, Pataxó, and other Indians in the Amazon forest, analgesic activity was attributed to the presence of coumarins ^[47]. Coumarin and umbelliferone presented antinociceptive and antiinflammatory activity in animal models ^[47,50].

Tannins, less frequent in plants of the analgesic categories, possess phenolic groups and studies on their antinociceptive activity ^[674].

Researches have shown that the analgesic activity of certain flavonoids depends on their structure. For instance, some authors have demonstrated that glycosylated flavonoids ^[675,676] are more active than the aglicone flavonoids ^[677]. Certain flavonoids, such as

quercetin and flavones are known to inhibit the biosynthesis of prostaglandins by inhibiting the cyclooxygenase enzyme^[678]. Various flavonoids, including rutin and quercetin produced significant antinociception in the acetic acid-, formalin- and capsaicin-induced nociceptive response^[679].

Morphine is the most famous example of an alkaloid with analgesic activity and one of the most powerful, showing that this phytochemical class is also rich in constituents with the said action, especially among the indolic alkaloids^[679,680,681,682]. Alkaloids isolated from *Psychotria colorata* show a marked naloxone-reversible antinociceptive activity in animals^[683].

Some essential oils and terpenoids have been described as possessing antinociceptive activity^[684,685,686].

The second category most indicated, **to counteract fever**, may be justified in view of the high incidence of malaria in the Amazon region, one symptom being running a high temperature. Considering the greater part of the ethnic groups in this review are to be found in the Amazon region, it can be inferred that the great number of species indicated for this category are explained by local therapeutic needs.

The main phytochemical classes of plants employed by the Indians to counteract fever are flavonoids, essential oils, triterpenoids, tannins, and alkaloids. Naphtoquinones, saponins, and coumarins were present in a lesser proportion of plants. Some flavonoids^[687,688] and essential oils^[689] are known to significantly reduce fever. Many antipyretic drugs also act as analgesics and antiinflammatory drugs. Acetylsalicylic acid, derived from salicylic acid isolated from *Salix* sp. is one example^[679]. Many drugs with this threefold effect (analgesic-antipyretic-antiinflammatory), however, exert a peripheric action^[679]. It is therefore logical that the flavonoids have been the constituents most

found among the plants utilized for analgesia such as those against fever, even because, in some cases, the plant was indicated to combat fever with pain in general (Table 1). The hallucinogen category is also one of the most cited, with 25 plants indicated. Many of the plants in this category are utilized for shamanism practices by supposedly altering the perception of the shaman, to facilitate contact with the spiritual world and make for the ritual of cure and its therapeutic function. Tobacco (*Nicotiana tabacum* L.) was included under the category hallucinogen and indicated as psychoactive ^[16]. According to Prance ^[17], it possesses a hallucinogenic effect when blended with the species *Theobroma subincanum* Martius in Buchner (Sterculiaceae). Schultes ^[16] explains that tobacco is definitely psychoactive in any method of use; the enigma remains as to how, under certain conditions and in various methods of use, *Nicotiana* can have strong psychoactive effects in aboriginal societies.

The alkaloids are the main active principles with hallucinogenic activity and were the most frequent constituents among the plants utilized for such a purpose by the Indians. Countless alkaloids present central properties, above all indolic derivatives that occur in several plants utilized by the Indians of the Americas and by the African people as sacred beverages in pagan ceremonies. The structural similarity between the indolic alkaloids and serotonin explains the action of these substances at the level of central serotoninergics, because of their structural analogy to serotonin ^[690,691,692].

The tonics/adaptogens category includes 15 extremely broad uses, adaptogens being characterized because they are generally utilized for prophylactic purpose, or else, to attenuate the physical and psychological deficiencies as a result of aging or of stress ^[693,694]. In the case of this category, there was no phytochemical class in common in the

plants utilized by the Indians: of the 40 plants in the category, only four (10%) possess alkaloids, the constituent most commonly determined. Some of the plants best known as adaptogens are rich in saponins and do not possess alkaloids among their constituents, such as with *Panax ginseng* and *Eleutherococcus senticosus*^[695]. The saponins found in the species *Panax* have proved to possess a great number of actions on the CNS^[696]. However, although the pharmacological effects of the two species cited above are well described as to their saponins, other plants regarded as adaptogens (including *E. senticosus*) possess a very different chemical constitution^[693].

The main constituents employed by the Indians for purposes reminiscent of the anxiolytics are the flavonoids and essential oils. The anxiolytic activity of the flavonoids^[697,698,699], alkaloids^[691,700] and, essential oils^[701] is known. There are also studies showing a hypnotic effect for alkaloids, flavonoids and essential oils^[701,702,703,704]. In fact, the majority of anxiolytic agents become hypnotics when used in high doses. Valerian Kava kava and Passion flower are examples of phytotherapies available commercially that possess an anxiolytic and hypnotic effect^[705]. Some hypnotics and sedatives may also be used as anticonvulsants, as was observed for the flavonoids in *Goodyera schlechtendaliana*^[706] and of *Equisetum arvense*^[707]. Of the nine plants cited as anticonvulsants in this survey, the only phytochemical class identified is that of essential oils, only in the *Scleria hirtella*. Anticonvulsant activity has been reported in literature for this phytochemical class^[708].

In the stimulants category, the more frequent phytochemical classes were the flavonoids and the alkaloids, although few plants were cited for this category. The stimulating effect of caffeine, an alkaloid present in many plants, and of other xanthines has been

well described in literature. Coffee, guarana, and mate tea are examples of plants used as stimulants with a high caffeine content ^[703]. Guarana seeds (*Paullinia cupana*) were already in use for their tonic and stimulating properties by Brazilian Indians before the discovery of the country ^[709] (Henman, 1986). In fact, guarana is still in use by the Indians living in Amazonia, as verified in this review (Table 1).

The category "weight control" includes both plants utilized for slimming or to reduce the appetite (anorectic drugs), and those to gain weight or stimulate the appetite. These are, therefore, "contrary" uses. Plants are used to gain weight, among the Indians, where the standards of beauty in these cultures differ from "western" values where a slim frame is viewed as an aesthetically ideal form. As to chemical constitution of the plants in the weight control category, the flavonoids are the only class identified in two of the 6 plants (33%), used to lose weight. Stimulating drugs commonly have an anorectic effect as with the amphetamines. Guarana and Ma Huang (*Ephedra sinica*) are examples of stimulating plants used to augment the metabolism and burn energy ^[703]. Amphetaminic drugs possess different side effects and may induce dependence, for which reason, the search for alternative drugs for slimming and weight control continues, especially among medicinal plants.

The Brazilian Indians indicated only two plants for improved memory (*Ficus anthelmintica* and *Tabernaemontana heterophylla*), in contrast to the Schultes survey carried out among the Indians in the Columbian Amazonia where several plants were cited for this purpose ^[28]. The two plants in evidence for this category in this review do not possess phytochemical studies, which renders any correlation unfeasible. There are a reasonable number of studies, almost all of them with animals, indicating the potential

of several Brazilian plants to improve cognitive processes ^[710,711,712,713]. The chemical constituents involved with the pharmacological activity are mostly cholinergic agonists or anticholinesterases. However, in the case of *Ginkgo biloba*, one of the plants most used for the treatment of dementia and other cognitive problems, the active principles are flavonoids and diterpene lactones ^[705].

In addition, the antioxidating effect of many plants may contribute to an alleged therapeutic effect in some categories. Neurodegenerative diseases are known to present damage wrought by oxidative processes ^[714,715] as a characteristic. In the measure in which they may prevent or lessen damage as a result of the oxidative process, antioxidants could also contribute to the adaptogen property of some plants ^[716]. Flavonoids, tannins, and polyphenols are classes rich in antioxidating substances ^[717].

One strong limitation to analyze the data found in this review resides in the interpretation of the researcher concerning the uses indicated by the cultures involved in each one of the 34 ethnopharmacological surveys. To correlate one term in ethnomedicine with one in official medicine is not always an easy task: for some terms, researchers must resort to a type of "translation" compared to a type of "ethnopharmacological puzzle" - one of the greatest challenges to researchers who carry out ethnopharmacological surveys, above all in the absence of professionals in the medical area to follow up on field studies, who might contribute to establish this correlation. One example of this is the use "to increase the breasts", found in one of the publications in this review for the species *Anacardium giganteum* and *Spondias lutea*, included in the category **others** for their possible action on the CNS. These two species might have been included under the category **illnesses of the head**, for they might well

be of neuroleptic potential, since the dopaminergic blockers augment the levels of prolactin, leading to an augmented volume to the mamma.

This survey has endeavored to correlate the presence of several phytochemical classes with therapeutic use of these plants by Brazilian Indians. Although an attempt to establish this correlation has been much hampered by a lack of phytochemical studies with many of the species, it was possible, in some cases, to detect a predominance of certain phytochemical groups in some categories. It is impossible to generalize that these groups are, therefore, capable of such biological activity, even because the pharmacological effect was investigated only in very few plants in the survey. It is possible to suppose, however, that these phytochemical classes are richer in constituents capable of the respective pharmacological activity, probably with similar chemical groups. This positive correlation seems to have occurred with the flavonoids (analgesia, fever, anxiety, hypnosis, weight control, and as a stimulant), alkaloids (hallucinogen, head illness and stimulating action), essential oils (fever and anxiety), lignans (hallucinogen), tannins (anxiety), triterpenes and saponins (hypnotics).

The presence of certain chemical groups in the plants utilized by the Indians in some way may contribute to their choice of use of each species, even if by observation of plant organoleptic properties ^[718,719]. These choices could take place through "clues" such as color, odor, or other characteristics that are observable in plants (presence of latex, capacity for fermentation, sensitivity to the touch, etc.) in the same way as with the theory of signatures ^[720].

Among the 307 plants included in this survey, that are utilized by Brazilian Indians, with possible effects on the CNS, few have ever been proven pharmacologically, as seen below: analgesic activity (*Justicia pectoralis*, *Neurolaena lobata*, *Hedyosmum brasiliense*, *Phyllanthus orbiculatus*, *Ocimum basilicum*, *Miconia rubiginosa*, *Virola michelli*, *Petiveria alliacea*, *Uncaria guianensis*, *Physalis angulata*, *Urera baccifera*, *Lantana trifolia*, *Alpinia zerumbet*, and *Zingiber officinalis*) [47,159,185,405,609,721,722,723,724,725,726,727,728,728,730], hypothermic (*Chaptalia nutans*) [609], possibly *Solanum mauritianum* against fever and pain [731], anxiolytic/hypnotic/sedative (*Lipia alba* and *Passiflora edulis*) [619,732], and tonic/adaptogen (*Ptychopetalum olacoides*) [733]. In the case of the hallucinogens *Tanaecium nocturnum*, *Anadenanthera peregrina*, Ayahuasca (*Banisteriopsis caapi* and *Psychotria viridis*), those of the genera *Virola* in general, or the other plants of this category, the effect may be confirmed by simple statements by users [273,734,735,736]. The analgesic category included the greater number of plants of proven effect. Antinociceptive activity is relatively easy to find in plants indicative of a certain non-specificity. It is important, however to view the results with caution, where experiments that are not well outlined may represent a false-positive result, through inexperience on the part of investigators on measuring and interpreting results [737].

There is no doubt that the models of chemical structure versus biological activity are very useful to provide biochemical understanding of the biological activity of natural products [738,739]. The molecular structure is important, mainly, owing to the lipophilicity and steric hindrance factors, but it is in the interaction between chemical groups of the active principles and proteins / enzymes of the body that the key for a good effect most probably resides [740]. A search for a new drug by binding-receptor interaction often comes up against the incapacity of the pharmaco to transpose the

hemato-encephalic barrier when the therapeutic agent is to act on the CNS ^[741]. In addition, the chance of finding a biologically active substance by mere trial and error is lower when the molecules tested come from plants in popular use for any specific disease. Hence the importance of ethnopharmacological studies that will offer guidance for the study of these "more promising" plants. The discovery of new drugs must, therefore, be regarded as a complex and interdisciplinary search in biology, ethnopharmacology, ethnobotanics, chemistry, pharmacology, and clinical sciences.

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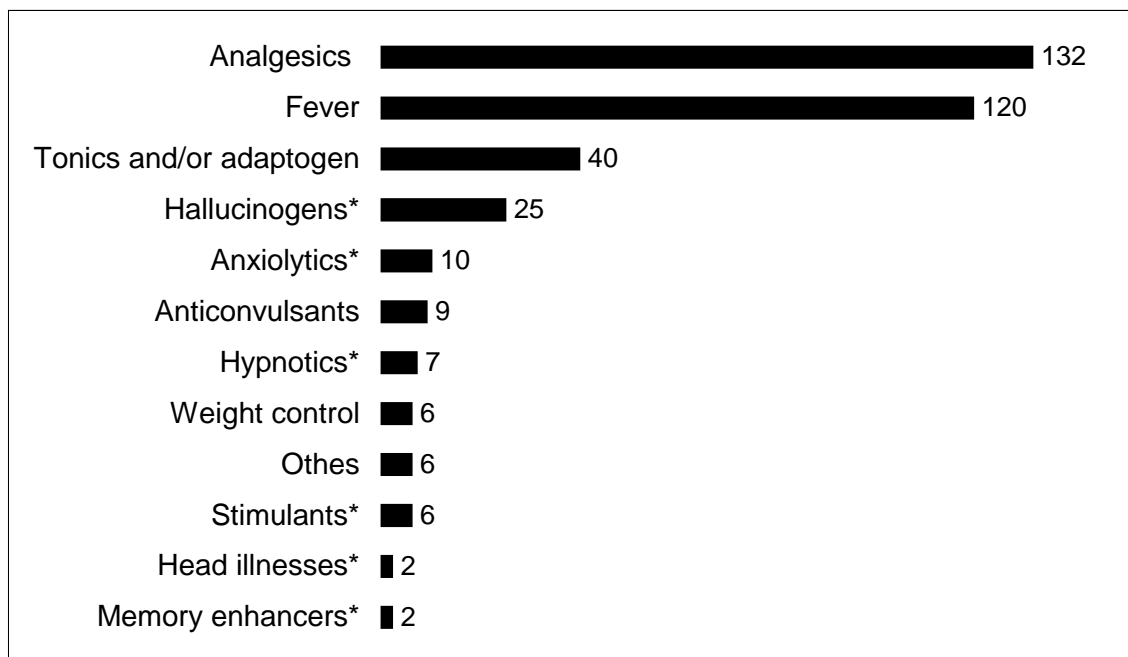
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Figure 1: Map of South America showing the geographic location on Brazilian territory of each one of the 26 indigenous ethnic groups analyzed in this study (*apud* Brock University Map Library ^[482]). 1- Araraibo, 2- Asurini, 3- Baniwa, 4- Deni, 5- Fulni ô, 6- Guajajara, 7- Jamamadi, 8- Kaapor, 9- Krahô, 10- Kubeo, 11- Kuikuro, 12- Maku, 13- Makuna, 14- Pankararu, 15- Pataxó, 16- Pareci, 17- Paumari, 18- Tembê, 19- Terena, 20- Ticuna, 21- Tiriyo, 22- Tukano, 23- Xokleng, 24- Xukuru, 25- Yanomami, and 26- Yawalapiti.

Figure 2



*possible psychoactive effects

Table 1: Three hundred and seven (307) plant species indicated by the Brazilian Indians during ethnopharmacological surveys, with possible effects on the Central Nervous System, and their main chemical constituents found in the scientific literature.

Family (n° species) Species (vernacular name)	Use (as described in the literature)	Parts and form of use	Indigenous ethnic group using plant species	Chemical composition
Acanthaceae (3)				
<i>Justicia pectoralis</i> Jacq.	Inebriating snuff	No data available	Waiká (Yanomami) [16,17]	coumarin, flavonoids, lignans, 3-phenilpropionic acid [47,48,49,50,51]
<i>Justicia</i> cf. <i>pectoralis</i> Jacq. (anador)	Toothache, body ache, rheumatic pain	Leaves	Pataxó [18]	coumarin, flavonoids, lignans, 3-phenilpropionic acid [47,48,49,50,51]
<i>Justicia pectoralis</i> Jacq. var. <i>stenophylla</i> Leonard (mashi-hiri)	Additive (<i>Virola theiodora</i>)	Leaves - snuff	Waiká (Yanomami) and others [16,19]	coumarin, flavonoids, lignans, 3-phenilpropionic acid [47,48,49,50,51]
<i>Ruellia</i> aff. <i>malacosperma</i> Greenm. (mo-ru-a-chi)	Fever	A poultice of crushed leaves applied to the head	Ticuna [20]	no phytochemical data
<i>Ruellia geminiflora</i> Kunth (kana arokö)	Epileptiform convulsions	Whole plant – decoction (bath)	Tiriyó [21]	no phytochemical data

Amaranthaceae (2)				
<i>Alternanthera dentata</i> (Moench) Stuchlik ex R.E. Fr. (erva-de-penicilina)	Fever, headache	Leaves	Xokleng ^[22]	no phytochemical data
<i>Cyathula prostrata</i> (L.) Blume Blume (öpömötögö)	Fever	Leaves – decoction (bath)	Tiriyó ^[21]	Steroids ^[52]
Amaryllidaceae (1)				
<i>Curculigo scorzonerifolia</i> (Lam.) Baker (maripa-imö)	Fever	Roots – decoction (rubbing and massage)	Tiriyó ^[21]	no phytochemical data
Anacardiaceae (6)				
<i>Anacardium giganteum</i> W. Hancock ex Engl. (oroi)	Estimulante para o crescimento dos seios	Liquid extract from roots – <i>in natura</i> (ingested or topical)	Tiriyó ^[21]	alkyl and arylalkyl-1,3-diols, tannins, flavonoids, terpenes, saponins, anagigantic acid ^[53,54,55]
<i>Anacardium occidentale</i> L. (cajueiro)	Lower extremity pain	Bark	Pataxó ^[18]	anacardic acid, phenolic compounds, triterpenoids, flavonoids, essential oils, tannins, lactones ^[56,57,58,59,60,61,62,63,64,65,66]
<i>Mangifera indica</i> L. (manga)	fever	Leaves	Pataxó ^[18]	flavonoids, terpenes, carotenoids ^[67,68,69,70,71,72,73,74,75]
<i>Mangifera indica</i> L. (manga)	Pain in the backbone	Leaves - decoction	Xukuru ^[23]	flavonoids, terpenes, carotenoids ^[67,68,69,70,71,72,73,74,75]
<i>Schinus</i>	Fever, body	Leaves	Pataxó ^[18]	flavonoids, terpenes, triterpenes, saponins, tannins ^[76,77,78]

<i>terebinthifolius</i> Raddi (aroeira)	ache			
<i>Spondias lutea</i> L. (mope)	Estimulante para o crescimento dos seios	Liquid extract from roots – <i>in natura</i> (ingested and topical)	Tiriyó ^[21]	tannins, flavonoids, alcohols, aldehydes, terpenic compounds ^[54,79,80]
<i>Spondias mombin</i> L.	pain	Bark - decoction	Ticuna ^[20]	essential oils, phenolic acids, furanone, tannins ^[80,81,82,83,84,85]
<i>Spondias mombin</i> L.	fever	Leaves – infusion (for bathing head and body)	Yanomami ^[24]	essential oils, phenolic acids, furanone, tannins ^[80,81,82,83,84,85]
Annonaceae (3)				
<i>Annona hypoglauca</i> Mart. (arimina-imö)	Muscle pain	Leaves – decoction (bath and ablutions)	Tiriyó ^[21]	No phytochemical data
<i>Duguetia duckei</i> R.E. Fr. (pakira-txuwi)	Fever	Bark – decoction (bath)	Tiriyó ^[21]	No phytochemical data
<i>Xylopia nitida</i> Dunal (envira)	fever	Bark	Asurini ^[25]	essential oils ^[86]
Apiaceae (1)				
<i>Pimpinella anisum</i> L. (erva-doce)	Fever, chest pain	Leaves	Pataxó ^[18]	flavonoids, essential oil, coumarins ^[87,88,89,90,91,92,93,94,95,96,97]
Apocynaceae (9)				
<i>Aspidosperma discolor</i> A DC.	fever	Bark	Pataxó ^[18]	Alkaloids ^[98,99,100,101]

(coronei, pau- quina)				
<i>Aspidosperma nitidum</i> Benth. ex Müll. Arg.	Toothache	Bark - chewed	Waimiri- Atroari ^[26]	No phytochemical data
<i>Himatanthus bracteatus</i> (A. DC.) Woodson (a-nà- roó)	fever	Leaves	Makuna ^[20]	No phytochemical data
<i>Himatanthus lancifolius</i> (Müll. Arg.) Woodson (janaúba)	Fever, toothache	Bark, resin	Pataxó ^[18]	alkaloids, iridoids ^[102,103,104,105]
<i>Mandevilla illustris</i> (Vell.) Woodson	Headache	Whole plant	Pareci ^[27]	Steroids ^[106,107,108,109]
<i>Mesechites trifidus</i> (Jacq.) Müll. Arg. (epuku-imö)	Headache, pain	Stem – infusion (bath)	Tiriyó ^[21]	No phytochemical data
<i>Parahancornia amapa</i> (Huber) Ducke	General debility	Latex of the bark	Indians living in Brazilian Amazon ^[28]	Triterpenoids ^[110]
<i>Tabernaemontana heterophylla</i> Vahl	Old people who are slow and forgetful	Leaves – tea	Tukano and other Indians living in Brazilian Amazon ^[20, 28]	No phytochemical data
<i>Tabernaemontana sananho</i> Ruiz &	calmative		Indians living in	No phytochemical data

Pav.			Brazilian Amazon ^[20]	
<i>Tabernaemontana sananho</i> Ruiz & Pav.	Rheumatic pain	Leaves and bark	Ticuna ^[20]	No phytochemical data
<i>Tabernaemontana sananho</i> Ruiz & Pav.	fever		Indians living in Brazilian Amazon ^[20]	No phytochemical data
Areceaceae (1)				
<i>Mauritia minor</i> Burret	To strengthening those who are weak and who no longer are interested in life because of age	Fruit - beverage	Indians living in Brazilian Amazon ^[28]	No phytochemical data
Aristolochiaceae (1)				
<i>Aristolochia medicinalis</i> R.E. Schult. (loo-to-mê)	Periodic attacks of an epileptic-like nature	Root – infusion	Kubeo ^[20]	No phytochemical data
Asclepiadaceae (1)				
<i>Asclepias curassavica</i> L.	toothache	Latex	Ticuna ^[20]	Cardenolides, terpenes , flavonoid glycosides ^[111,112,113,114,115]
Aspleniaceae (1)				

<i>Asplenium formosum</i> Willd. (avenca-mirim)	Toothache	Whole plant – decoction	Xukuru ^[23]	No phytochemical data
Asteraceae (17)				
<i>Acanthospermum hispidum</i> DC. (pica-de-Minas)	Chest pain	Leaves	Pataxó ^[18]	sesquiterpene lactones, diterpene galactoside ^[116,117,118,119]
<i>Achillea millefolium</i> L. (novalgina)	fever	Leaves – decoction	Indians living in the South of Brazil ^[29]	sesquiterpenoid, terpenoids flavonoids aglycones, essential oil, betaines ^[120,121,122,123,124,125,126,127,128,129]
<i>Achyrocline satureioides</i> (Lam.) DC. (marcela-galego)	Fever, body ache	Whole plant	Pataxó ^[18]	flavonoids ^[130,131] , essential oils ^[132]
<i>Achyrocline satureioides</i> (Lam.) DC. (poty ju)	tonic	Flowers, leaves, roots – decoction	Indians living in the South of Brazil ^[29]	flavonoids ^[130,131] , essential oils ^[132]
<i>Artemisia vulgaris</i> L. (artemisia)	Body ache	Leaves	Pataxó ^[18]	coumarin; flavonoids; eudesmane acids, sesquiterpene lactones, cyanogenic glucoside ^[133,134,135,136,137,138,139,140]
<i>Baccharis cylindrica</i> (Less.) DC. (carqueja)	Lower extremity pain	Bark	Pataxó ^[18]	No phytochemical data
<i>Baccharis uncinella</i> DC.(vassoura-do-campo)	Calmative	Leaves and flowers – Decoction (ingested)	Xokleng ^[22]	Essencial oils ^[141]
<i>Chaptalia nutans</i>	fever	Whole plant –	Tiriyó ^[21]	coumarins ^[142,143,144]

(L.) Pol. (txawarokö)		decoction (bath)		
<i>Complaya trilobata</i> (L.) Strother (malmequer)	Fever, body ache, Rheumatic pain		Pataxó ^[18]	No phytochemical data
<i>Conyza floribunda</i> Kunth (maremrepumpö)	Fever	Whole plant – decoction (bath)	Tiriyó ^[21]	flavonoids, tannins, sesquiterpene lactones and saponins ^[145,146]
<i>Helianthus annuus</i> L. (girassol)	fever	Seed	Pataxó ^[18]	diterpenes, triterpenes, lactones, sterols, flavonoids, coumarins, carotenoids, essential oils ^[147,148,149,150,151,152]
<i>Lactuca sativa</i> L. (alface)	insomnia	Leaves –tea	Terena ^[30]	phenolic acids, triterpenoids, saponins, flavonoids ^[153,154,155,156]
<i>Mikania divaricata</i> Poepp. (aimara ipifö)	Fever	Leaves – infusion (bath)	Tiriyó ^[21]	No phytochemical data
<i>Neurolaena lobata</i> (L.) R. Br. ex Cass.	Fever, headache	Leaves – warm water – crushed - headwash	Ticuna ^[20]	Sesquiterpene lactones, pyrrolizidine alkaloids, flavonoids ^[157,158,159,160,161,162,163,164,165]
<i>Piptocarpha rotundifolia</i> (Less.) Baker (paratudo)	to stimulate appetite, tonic, Rheumatic pain	Tea	Terena ^[30]	No phytochemical data
<i>Porophyllum ruderale</i> (Jacq.) Cass. (arrudinho)	Body ache	Whole plant	Pataxó ^[18]	Terpenoids, essential oils, polyacetylene compounds ^[166,167,168,169,170]
<i>Porophyllum ruderale</i> (Jacq.) Cass. (amescla)	toothache	Leaves	Pataxó ^[18]	Terpenoids, essential oils, polyacetylene compounds ^[166,167,168,169,170]
<i>Tagetes erecta</i> L.	fever	Leaves	Ticuna ^[20]	fatty acids, essential oils ^[171,172,173,174,175]
<i>Wulffia baccata</i>	fever	Leaves – decoction	Tiriyó ^[21]	essential oils, triterpenes ^[176,177]

(L.) Kuntze (werekeru arötöpiru)		(bath)		
Bignoniaceae (9)				
<i>Arrabidaea brachypoda</i> (DC.) Bureau	Painful joints	Whole plant– cataplasm	Pareci ^[27]	Flavonoids ^[178]
<i>Arrabidaea trailii</i> Sprague (tapanapi)	Fever	Leaves – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Callichlamys latifolia</i> (Rich.) K. Schum.	Fever	Bark – infusion – imbibed	Waimiri- Atroari ^[26]	no phytochemical data
<i>Jacaranda copaia</i> (Aubl.) D. Don (marimari)	Fever	Leaves – decoction (bath)	Tiriyó ^[21]	triterpenes ^[179]
<i>Mansoa standleyi</i> (Steyerm.) A.H. Gentry	Fever, headache	Leaves – crushed	Ticuna ^[20]	no phytochemical data
<i>Memora flavida</i> (DC.) Bureau & K. Schum. (kuraiwêmö)	Tonic	Bark, roots and sap from stem – <i>in natura</i> (ingested)	Tiriyó ^[21]	no phytochemical data
<i>Schlegelia macrophylla</i> Ducke	When they refuse to eat and lose appetite	Leaves – tea	Ticuna ^[20,28]	no phytochemical data
<i>Schlegelia roseiflora</i> Ducke	Tonic	Root	Ticuna ^[20]	no phytochemical data
<i>Tanaecium nocturnum</i> (Barb.	Drowsiness and inability to	Bark of the roots - Snuff	Paumari ^[4,16,17,31]	no phytochemical data

Rodr.) Bureau & K. Schum. (koribo)	concentrate			
Boraginaceae (1)				
<i>Cordia trichotoma</i> (Vell.) Arrab. ex Steud. (louro-domato)	fever	Leaves – decoction (ingested)	Xokleng ^[22]	essential oil, phenylpropanoid ^[180,181,182]
Burseraceae (3)				
<i>Crepidospermum goudotianum</i> (Tul.) Triana & Planch. (kuituku)	Fever	Leaves – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Protium pallidum</i> Cuatrec. (breu)	Toothache	Resin	Kaapor and Tembé ^[25]	no phytochemical data
<i>Protium paraense</i> Cuatrec. (breu)	Headache	Resin	Asurini ^[25]	no phytochemical data
Campanulaceae (1)				
<i>Centropogon surinamensis</i> (L.) C. Presl (tukuinetö)	Otitis, ear ache	Liquid extract from leaves – <i>in natura</i> (topical)	Tiriyó ^[21]	no phytochemical data
Cannaceae (1)				
<i>Canna indica</i> L. (pariri)	Body ache	Roots	Pataxó ^[18]	tannins ^[183]

Capparaceae (2)				
<i>Crateva benthamii</i> Eichler	Tonic	Roots	Indians living in Brazilian Amazon ^[20]	Pentacyclic triterpenoid ^[184]
<i>Crateva benthamii</i> Eichler	Rheumatic pain	Leaves (externally)	Indians living in Brazilian Amazon ^[20]	Pentacyclic triterpenoid ^[184]
<i>Crateva tapia</i> L.	Tonic		Indians living in Brazilian Amazon ^[20]	no phytochemical data
<i>Crateva tapia</i> L.	Rheumatic pain	Sap (externally)	Indians living in Brazilian Amazon ^[20]	no phytochemical data
Caprifoliaceae (1)				
<i>Sambucus australis</i> Cham. & Schltdl. (sabugueiro)	Fever, headache	Leaves	Pataxó ^[18]	no phytochemical data
Cecropiaceae (1)				
<i>Coussapoa intermedia</i> Miq.	fever	Fruit – infusion – imbibed over a period of three days	Ticuna ^[20]	no phytochemical data

Chloranthaceae (1)				
<i>Hedyosmum brasiliense</i> Miq.	Rheumatic pain	Flowers and leaves – tincture	Indians living in Brazilian Amazon ^[20]	Sesquiterpene lactone ^[185]
Chrysobalanaceae (2)				
<i>Licania heteromorpha</i> Benth.	toothache	Bark – decoction – chewed	Maku ^[20]	flavonoids, triterpenoids ^[186,187,188]
<i>Licania humilis</i> Cham. & Schltdl. (akukuti)	To see far (shamanism)	Fruit – chewed and smeared over body and head	Yawalapiti ^[32]	no phytochemical data
Clusiaceae (3)				
<i>Kielmeyera coriacea</i> Mart. & Zucc. (pau-santo)	fever	Bark (tea)	Terena ^[30]	xanthenes, phenolic acids, coumarins, triterpenes ^[189,190,191,192,193,194,195,196,197,198,199,200]
<i>Kielmeyera rugosa</i> Choisy	Tonic	Bark (bath)	Pareci ^[27]	coumarins, xanthenes, triterpenoids ^[190,197,199,201,202,203,204,205]
<i>Vismia tomentosa</i> Ruiz & Pav.	Elderly who suffer difficulty in understanding instructions and physical degeneration	Leaves – tea (chronic)	Makuna ^[28]	no phytochemical data
Cochlospermaceae				

(2)				
<i>Cochlospermum orinocense</i> (Kunth) Steud.	fever	Bark – tea	Ticuna ^[20]	no phytochemical data
<i>Cochlospermum regium</i> (Mart.) Pilger	Headache		Krahô ^[5]	no phytochemical data
Combretaceae (1)				
<i>Terminalia catappa</i> L. (amendoeiro)	fever	Bark or leaves	Pataxó and other Indians living in Brazilian Amazon ^[18,20]	triterpenoids, flavonoids, tannins ^[206,207,208,209,210,211,212,213]
Commelinaceae (2)				
<i>Connellyia virginica</i> L. (tokoro pömoi)	Tonic	Whole plant – decoction (bath and ablutions)	Tiriyó ^[21]	no phytochemical data
<i>Dichorisandra affinis</i> Mart. (püreu-imö)	Antidote against curare	Leaves – infusion (ablutions)	Tiriyó ^[21]	no phytochemical data
Convolvulaceae (4)				
<i>Ipomoea batatas</i> (L.) Lam. (batata-	toothache	Leaves	Pataxó ^[18]	anthocyanins, phenolics compounds ^[214,215]

doce)				
<i>Ipomoea schomburgkii</i> Choisy (kuriya xentü)	Tonic	Roots – decoction (baths)	Tiriyó ^[21]	no phytochemical data
<i>Ipomoea wrightii</i> A.Gray	Body ache	Whole plant – bath	Pareci ^[27]	no phytochemical data
<i>Operculina alata</i> (Ham.) Urb. (batata-de-purga)	Toothache, tonic	Exudate	Pataxó ^[18]	no phytochemical data
Curcubitaceae (2)				
<i>Gurania pachypoda</i> Harms	headache	Leaves - crushed	Ticuna ^[20]	no phytochemical data
<i>Luffa operculata</i> (L.) Cogn. (makana)	Fever	Fruit	Paumari ^[33]	diterpenoids, saponins, cucurbitacin glucosides, dammarane-type triterpene ^[216,217,218,219,220,221]
Cyperaceae (7)				
<i>Bulbostylis junciformis</i> (Kunth) C.B. Clarke (kumeu)	Fever	Leaves and colmo – decoction (bath and ablutions)	Tiriyó ^[21]	no phytochemical data
<i>Bulbostylis lanata</i> (Kunth) C.B. Clarke (kumu-imö)	Fever, headache	Whole plant – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Cyperus articulatus</i> L. (haro kiki)	Fever	Rhizoma – infusion (ingested)	Yanomami ^[24]	Amino acid, flavonoids, saponins, sesquiterpenic lactones, ketones, tannins, essential oils ^[222,223,224,225,226,227,228,229,230,231,232,233,234]

		and for bathing the head)		
<i>Cyperus flavus</i> J. Presl & C. Presl (kumeu)	Fever	Whole plant – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Rhynchospora barbata</i> (Vahl) Kunth (xaura-imö)	Fever	Leaves and stem – decoction and smoke (bath and smoke)	Tiriyó ^[21]	no phytochemical data
<i>Rhynchospora nervosa</i> (Vahl) Boeck. (tüpanapotüke)	Fever	Whole plant – infusion (bath and ablutions)	Tiriyó ^[21]	no phytochemical data
<i>Scleria hirtella</i> Sw. (kumeu, kumeumö)	Epileptiform seizures in children	Leaves and colmo – decoction (bath and ablutions)	Tiriyó ^[21]	essential oil ^[235]
Ebenaceae (1)				
<i>Diospyros guianensis</i> (Aubl.) Gürke (ömöriyatöimö)	Tonic	Leaves – infusion (baths and ablutions)	Tiriyó ^[21]	no phytochemical data
Elaeocarpaceae (1)				
<i>Sloanea rufa</i> Planch. ex Benth. (töfa-imö)	Pain in the lower womb	Fruit – decoction (bath)	Tiriyó ^[21]	no phytochemical data
Eriocaulaceae (1)				

<i>Syngonanthus oblongus</i> (Körn.) Ruhland	Headache	Whole plant (for bathing head)	Pareci ^[27]	no phytochemical data
Erythroxylaceae (1)				
<i>Erythroxylum coca</i> L. var. <i>ipadu</i> (botô)	stimulant	Leaves chewed	Maku and other Indians living in Brazilian Amazon ^[4,17]	Tropane alkaloids, flavonoids ^[236,237,238,239,240,241,242,243]
Euphorbiaceae (9)				
<u>Croton palanostigma Klotzsch</u>	Fever	-----	Yanomami ^[24,46]	alkaloids, lignans ^[244,245,246,247]
<i>Jathropa gossypifolia</i> C (pinhão-roxo)	Fever, headache	Leaves	Pataxó ^[18]	Diterpenoids, triterpenoids ^[248,249,250,251]
<i>Jatropha curcas</i> L.	Fever	Leaves - crushed	Ticuna ^[20]	triterpenes; phorbol esters, podocarpane diterpenoids; flavones ^[252,253,254,255,256,257,258,259,260,261]
<i>Manihot salicifolia</i> Pohl	Tonic	Leaves and branches (ingested)	Pareci ^[27]	no phytochemical data
<i>Maprounea guianensis</i> Aubl. (paxiximö)	Fever, headache	Leaves – decoction (bath)	Tiriyó ^[21]	triterpenes, phenolic compounds ^[262]
<i>Omphalea diandra</i> L. (warikü)	Toothache	Liquid extract from leaves or stem – <i>in</i>	Tiriyó ^[21]	Alkaloid glycosides, aglycones ^[263,264]

		<i>natura</i> (topical)		
<i>Phyllanthus acuminatus</i> Vahl (chi-hua-che)	headache	Leaves – for bathing the head	Ticuna ^[20]	glycosides, lignans ^[265,266]
<i>Phyllanthus dinizii</i> Huber (arita-imö)	Fever, body ache	Leaves – infusion (bath)	Tiriyó ^[21]	no phytochemical data
<i>Phyllanthus orbiculatus</i> Rich. (aiguapo i dapé)	Body ache	Whole plant	Bani ^[34]	no phytochemical data
Fabaceae – sensu lato (49)				
<i>Alexa grandiflora</i> Ducke (melancieira)	Toothache	Bark	Asurini ^[25]	Pyrrolizidine-3-carboxylic acid ^[267]
<i>Anadenanthera macrocarpa</i> (Benth.) Brenan	hallucinogen		Indians living in Brazilian Amazon ^[35]	Fisetinidol-3-O-beta-D-xylopyranoside (anadanthoside) ^[268,269]
<i>Anadenanthera peregrina</i> (L.) Speg. (yopo)	hallucinogen	Seeds, leaves and cortex – snuff	Yanomami and Indians living in Brazilian Amazon ^[4,12,17]	Alkaloids ^[270,271]
<i>Bauhinia acreana</i> Harms (yapupacinem)	Muscle pain	Bark	Kaapor and Tembé ^[25]	no phytochemical data
<i>Cajanus cajan</i> (L.) Millsp. (andu)	Headache	Leaves	Pataxó ^[18]	Triterpenoids ^[272,273]

<i>Calliandra tenuiflora</i> Benth (karauyarã)	Tonic	Stem – infusion (ingested)	Tiriyó ^[21]	no phytochemical data
<i>Cassia latifolia</i> G. Mey. (pokopoko inetü)	Fever, headache	Leaves – decoction (bath and ablutions)	Tiriyó ^[21]	no phytochemical data
<i>Cassia quinquangulata</i> Rich. (bakadoho' doho)	Fever	Paste from leaves	Paumari ^[33]	naphthopyrone derivative ^[274,275,276]
<i>Clitoria guianensis</i> (Aubl.) Benth. (yawí arokö)	Antidote against curare	Whole plant – decoction (topical, ablutions)	Tiriyó ^[21]	no phytochemical data
<i>Clitoria javitensis</i> (Kunth) Benth. (aiaiya)	Headache	Leaves, flowers, liquid extract from stem or bark – infusion (for baths and ablutions)	Tiriyó ^[21]	no phytochemical data
<i>Copaifera langsdorffii</i> Desf. (pau d'óleo)	Body ache	Fruit or leaves	Pataxó ^[18]	Diterpenoids ^[277,278]
<i>Crotalaria maypurensis</i> Kunth (xauxau)	Fever	Leaves and roots – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Derris floribunda</i> B (Benth.) Ducke (napiyarã)	Headache	Leaves – decoction (baths)	Tiriyó ^[21]	no phytochemical data
<i>Desmodium axilare</i> (Sw.) DC. (aware)	Fever	Whole plant – decoction (bath)	Tiriyó ^[21]	no phytochemical data

imopitökö)				
<i>Desmodium incanum</i> DC. (mata-pasto)	fever	Leaves	Pataxó ^[18]	no phytochemical data
<i>Dialium guianense</i> (Aubl.) Sandwith (jutaípororoca)	Toothache	Seeds	Asurini ^[25]	no phytochemical data
<i>Dioclea elliptica</i> R.H. Maxwell (aruma karau)	Fever	Leaves – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Dioclea erecta</i> Hoehne (mucunan)	To purify and fortify the body	Roots washed with water that is then heated (ingested)	Índios Kuikuro, Yawalapiti and other Indians from Alto Xingu ^[36,37,38]	no phytochemical data
<i>Dioclea glabra</i> Benth. (pömu inetü)	Otitis (pain)	Liquid extract of leaves – <i>in natura</i> (topical)	Tiriyó ^[21]	no phytochemical data
<i>Dioclea latifolia</i> Benth. (mucunan)	To purify and fortify the body	Roots washed with water that is then warmed (ingested)	Índios Kuikuro, Yawalapiti and other Indians from Alto Xingu ^[36,37,38]	no phytochemical data
<i>Dioclea scabra</i> (Rich.) R.H. Maxwell	Fever	Leaves – decoction (bath)	Tiriyó ^[21]	no phytochemical data

<i>Dioclea ucayalina</i> Harms	headache	Leaves on the forehead	Ticuna ^[20]	no phytochemical data
<i>Dipteryx odorata</i> (Aubl.) Willd. (cumaru)	Pain in the ribs, ear ache	Seed oil	Kaapor and Temb� [25,39,40]	flavonoids, essential oils, coumarins, lignans ^[279,280,281,282,283,284]
<i>Discolobium leptophyllum</i> Benth.	Tonic	Roots- decoction (ingested)	Yawalapiti [32]	no phytochemical data
<i>Elizabetha princeps</i> Schomburgk ex Benth.	Adittive (<i>Anadenanthera peregrina</i>)	Bark ashes	Yanomami [12]	no phytochemical data
<i>Elizabetha princeps</i> Schomburgk ex Benth.	Additive (<i>Virola</i> spp.)	Bark ashes – snuff	Waik� (Yanomami) and others [19]	no phytochemical data
<i>Eperua campestris</i> (Ducke) Ducke	Painful joints	Bark (oil)	Indians living in Brazilian Amazon ^[20]	no phytochemical data
<i>Erythrina glauca</i> Willd.	Rheumatic pain, narcotic	Roots – tea	Indians living in Brazilian Amazon ^[20]	alkaloids ^[285]
<i>Lonchocarpus floribundus</i> Benth	tonic	Roots grated, liquid extract smeared on leg previously scarred	Yawalapiti [32]	no phytochemical data
<i>Hymenaea aurea</i> Y.T. Lee & Langenh. (jatob�)	tonic	Bark	Patax� ^[18]	no phytochemical data

<i>Hymenaea courbaril</i> L. (kauru)	Fever	Bark – decoction (bath)	Tiriyó ^[21]	Diterpenoids, terpenes ^[286,287,288,289,290,291,292]
<i>Macrobium bifolium</i> (Aubl.) Pers. (pare)	Fever	Leaves and stem – infusion (bath)	Tiriyó ^[21]	no phytochemical data
<i>Macrobium campestre</i> Huber	Tonic	Bark-decoction	Pareci ^[27]	no phytochemical data
<i>Mimosa hostilis</i> (Mart.) Benth. (maconha-brava, wild marihuana, jurema, yurema)	Hallucinogen	Leaves and seeds - cigarettes are smoked (a substitute for marijuana) or roots – infusion - drink (jurema wine)	Pankararu, Fulni ô, Tukano and others Indians from the Brazilian coast [4,19,31,35]	indole alkaloids, labdane-type diterpenes ^[293,294,295]
<i>Mimosa pudica</i> L. (cipó-dorme- dorme)	insomnia	Leaves and vines – decoction (ingested)	Xokleng ^[22]	tannins, steroids, alkaloids, triterpenes, flavonoids, saponins, bufanolide, mimopudine ^[296,297,298,299,300,301,302,303,304,305,306]
<i>Mimosa tenuiflora</i> (Willd.) Poir. (jurema-preta)	Toothache	Bark- grated in water (mouthwash)	Xukuru ^[23]	saponins, alkaloids, 2-phenoxyvchromones ^[294,307,308,309,310,311]
<i>Mucuna altissima</i> (Jacq.) DC. (tamoko enu)	Headache	Leaves, fruit, liquid extract from stem– infusion (ingested and bath)	Tiriyó ^[21]	no phytochemical data
<i>Periandra pujalu</i> Emmerich & Senna	tonic	Roots crushed in water and boiled (ingested)	Yawalapiti ^[32]	no phytochemical data

<i>Phaseolus linearis</i> Kunth (aware imopitokö)	Fever, headache	Whole plant – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Pithecellobium dinizii</i> Ducke	headache	Caulis flowers crushed to rub on the forehead	Ticuna ^[20]	no phytochemical data
<i>Pterocarpus michelii</i> Britton (iruluma-iriki)	Antídote for <i>Dioclea</i> spp.		Indians from Alto Xingu ^[38]	no phytochemical data
<i>Pterodon emarginatus</i> Vogel	Toothache	Seed oil (topical)	Pareci ^[27]	Diterpenoids, diterpenoids furan ^[312,313,314,315,316]
<i>Schizolobium amazonicum</i> Huber ex Ducke	fever	Leaves – tea	Ticuna ^[20]	Polysaccharides ^[317]
<i>Senna alata</i> (L.) Roxb. (fedegosaõ)	Fever, body ache	Root	Pataxó ^[18]	Flavonoids ^[318,319]
<i>Senna obtusifolia</i> (L.) H.S. Irwin & Barneby (mata-pasto)	fever	Leaves	Pataxó ^[18]	flavonoids, anthraquinones ^[320]
<i>Swartzia recurva</i> Poepp.	Combat physical debilitation resulting from malaria, age or general infirmity	Fruit- decoction	Indians living in Brazilian Amazon ^[28]	no phytochemical data
<i>Tephrosia senna</i> Kunth (senna)	Fever, headache	Leaves	Pataxó ^[18]	no phytochemical data
<i>Tachigalia paniculata</i> Aubl.	stimulant	Leaves – tea	Ticuna ^[20]	indole alkylamines, flavonoids ^[321,322]
<i>Tachigalia</i>	fever	Ants from petiole	Kaapor and	indole alkylamines, flavonoids ^[321,322]

<i>paniculata</i> Aubl. (tachizeiro)			Tembé ^[25]	
<i>Tachigalia paniculata</i> Aubl.	craziness		Kaapor ^[41]	indole alkylamines, flavonoids ^[321,322]
<i>Tachigalia myrmecophila</i> Ducke	fever		Kaapor ^[41]	no phytochemical data
<i>Tachigalia myrmecophila</i> Ducke	To fatten dogs		Kaapor ^[41]	no phytochemical data
<i>Zornia gemella</i> Vogel (arrozinho)	fever	Whole plant	Pataxó ^[18]	no phytochemical data
Flacourtiaceae (3)				
<i>Banara guianensis</i> Aubl. (lantama)	Fever, headache	Whole plant – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Casearia silvestris</i> Sw. (paxixi-imö)	Fever	Whole plant – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Laetia procera</i> (Poepp.) Eichler (pau-jacaré)	General debility	Leaves	Kaapor and Tembé ^[25]	clerodane diterpenes ^[323,324,325,326,327]
Gentianaceae (2)				
<i>Chelonanthus alatus</i> (Aubl.) Pulle	Substitute for <i>Nicotiana tabacum</i>	Leaves	Indians living in Brazilian Amazon ^[20]	no phytochemical data
<i>Coutoubea ramosa</i> Aubl. (mokoko)	Toothache	Liquid extract from leaves – in natura	Tiriyó ^[21]	no phytochemical data

enu-imö)		(topical, poultice)		
Humiriaceae (1)				
<i>Humiriastrum piraparanense</i> Cuatrec.	toothache	Bark – chewed	Makuna ^[20]	no phytochemical data
Lamiaceae (7)				
<i>Hyptis hirsuta</i> Kunth (maruipö)	Pain in the sole of the foot	Stem– decoction (baths and ablutions)	Tiriyó ^[21]	no phytochemical data
<i>Leonotis nepetifolia</i> (L.) R. Br. (bolo-de-frade)	Fever	Leaves	Pataxó ^[18]	no phytochemical data
<i>Melissa officinalis</i> L. (erva-cidreira)	calmative	Tea	Terena ^[30]	flavonoids, essential oils, phenolic acids ^[328,329,330,331,332,333,334,335,336,337]
<i>Ocimum basilicum</i> L. (mangericão)	Fever	Leaves	Pataxó ^[18]	phenolics acids; essential oils, tannins, flavonoids ^[338,339,340,341,342,343,344,345,346,347,348,349,350]
<i>Ocimum basilicum</i> L. (mangericão)	Ear ache	Leaves – decoction (ingested)	Xukuru ^[23]	phenolics acids; essential oils, tannins, flavonoids ^[338,339,340,341,342,343,344,345,346,347,348,349,350]
<i>Ocimum canum</i> Sims (mangericão)	headache	Leaves	Pataxó ^[18]	flavonoids, essential oil ^[351,352,353,354,355,356]
<i>Ocimum micranthum</i> Willd. (huo-ca)	fever	Headwash with water in which leaves have been crushed	Ticuna ^[20]	essential oil ^[357,358,359,360,361]
<i>Plectranthus amboinicus</i> (Lour.)	Ear ache	Leaves – crushed (on the site)	Xukuru ^[23]	diterpenoids, essential oils ^[362,363,364,365]

Spreng (hortelã-da-leaves-grande)				
Lauraceae (5)				
<i>Aniba canelilla</i> (Kunth) Mez	stimulant	Bark	Indians living in Brazilian Amazon ^[20]	essential oils, alkaloids ^[366,367,368,369]
<i>Nectandra amazonum</i> Nees	Fever	Leaves	Pareci ^[27]	Lignans ^[370]
<i>Nectandra pisi</i> Miq.	Fever	Bark – tea	Ticuna ^[20]	no phytochemical data
<i>Ocotea aciphylla</i> (Nees) Mez (airipana)	Narcotic	Leaves – cigarette	Yawalapiti ^[32]	Lignans ^[371,372]
<i>Persea americana</i> Mill. (abacateiro)	Rheumatic pain	Fruit, leaves	Pataxó ^[18]	flavonoids, alkaloids, tannins, saponins, triterpene, essential oil, phenolic acid, furanoic acids, trihydroxyheptadecane derivative ^[373,374,375,376,377,378,379,380,381,382,383,384]
Loganiaceae (2)				
<i>Strychnos guianensis</i> (Aubl.) Mart. (würarimö)	tonic	Stem – infusion (ingested and external, baths)	Tiriyó ^[21]	lignans, alkaloids ^[385,386,387,388,389,390,391]
<i>Strychnos javariensis</i> Krukoff	toothache	Bark – chewed	Ticuna ^[20]	no phytochemical data
Malpighiaceae (2)				

<i>Banisteriopsis caapi</i> (Spruce ex Griseb.) C.V. Morton (caapi, ayahuasca)	hallucinogen	Bark – drink	Indians living in Brazilian Amazon [4,17,35]	indole alkaloids; harmane alkaloids, triterpenoids, long chain alcohols [392,393,394,395,396,397,398,399,400,401,402]
<i>Tetrapteris methystica</i> (caapí-pinima)	hallucinogen	Cortex – infusion (ingested) or prepared as a beverage in cold water	Maku [31]	no phytochemical data
Malvaceae (4)				
<i>Gossypium barbadense</i> L. (algodão)	Chest pain	Leaves	Pataxó [18]	terpenoids [403], phenolic compound [404]
<i>Malachra capitata</i> (L.) L.	fever	Leaves – decoction	Ticuna [20]	no phytochemical data
<i>Pavonia rosacampestris</i> A.St.-Hil	Headache	Whole plant (bath)	Pareci [27]	no phytochemical data
<i>Urena lobata</i> L.	sedative		Indians living in Brazilian Amazon [43]	no phytochemical data
Marcgraviaceae (1)				
<i>Marcgraviastrum elegans</i> de Roon (no-tê-wê-tá)	Elderly find difficult to sleep	Leaves and flowers -tea	Kubeo [20]	no phytochemical data

Melastomataceae (5)				
<i>Comolia microphylla</i> Benth. (txãgarapu)	fever	Whole plant – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Henriettea granulata</i> O. Berg & Triana (pöra)	Irritability and crying in small children	Leaves – infusion (bath)	Tiriyó ^[21]	no phytochemical data
<i>Miconia holosericea</i> (L.) DC (pöra-imö)	Irritability and crying in small children	Leaves – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Miconia rubiginosa</i> (Bonpl.) DC. (pöra-imö)	Irritability and crying in small children	Leaves – decoction (bath)	Tiriyó ^[21]	Triterpenoids ^[405]
<i>Tococa formicaria</i> Mart.	Calmative	Ramifications (bath)	Pareci ^[27]	no phytochemical data
Meliaceae (3)				
<i>Carapa guianensis</i> Aubl. (andiroba)	Fever	Leaves	Indians living in Brazilian Amazon ^[20]	triterpenoids, essential oils, tannins ^[400,406,407,408,409,410,411]
<i>Trichilia macrophylla</i> Benth. (tawariya)	Tonic	Bark and roots – decoction (ingested)	Tiriyó ^[21]	no phytochemical data
<i>Trichilia tocacheana</i> C. DC.	Narcotic	Ingested	Indians living in Brazilian Amazon ^[20]	no phytochemical data

Menispermaceae (6)				
<i>Abuta concolor</i> Poepp. & Endl.	tonic	Root cataplasms	Indians living in Brazilian Amazon ^[20]	Alkaloids ^[412]
<i>Abuta imene</i> (Mart.) Eichler	Tonic for the elderly	Leaves and root – decoction	Indians living in Brazilian Amazon ^[20,28]	Alkaloids ^[413]
<i>Chondrodendron platiphyllum</i> (A. St.-Hil.) Miers (butí)	fever	Leaves	Pataxó ^[18]	alkaloids ^[414]
<i>Chondrodendron platiphyllum</i> (A. St.-Hil.) Miers (abutua)	To stimulate appetite		Indians living in Brazilian Amazon ^[43]	alkaloids ^[414]
<i>Chondrodendron tomentosum</i> Ruiz & Pav.	craziness, fever, dropsy	Root and stem – decoction (ingested)	Indians living in Brazilian Amazon ^[20,28]	curare alkaloids ^[415,416]
<i>Odontocarya tripetala</i> Diels	analgesic	Leaves	Ticuna ^[20]	no phytochemical data
<i>Sciadotenia pachnococca</i> Krukoff & Barneby	tootache	Root bark	Maku ^[33]	no phytochemical data

(tugbiden)				
Monimiaceae (1)				
<i>Siparuna guianensis</i> Aubl. (negramina)	Rheumatic pain	Leaves brewed into tea or juice from the root bark lining	Jamamadi and Pataxó [18,33]	essential oil, oxoaporphine alkaloids, flavonoids [417,418,419,420]
<i>Siparuna guianensis</i> Aubl. (irakö epü)	fever	Leaves – decoction (banho)	Tiriyó [21]	essential oil, oxoaporphine alkaloids, flavonoids [417,418,419,420]
Moraceae (7)				
<i>Brosimum acutifolium</i> Huber (inharé)	Stimulant, tonic	Bark – bottled brew (ingested)	Guajajara [44]	flavonoids, steroids, lignans [421,422,423,424,425,426,427,428,429,430]
<i>Dorstenia asaroides</i> Hook. (munufö ampotü)	Fever	Rhizoma – decoction (bath)	Tiriyó [21]	furanocoumarins [431]
<i>Ficus anthelmintica</i> Mart.	Aphrodisiac, improve memory	Fruit	Indians living in Brazilian Amazon [20]	no phytochemical data
<i>Ficus paraensis</i> (Miq.) Miq.	toothache	Latex	Makuna [20]	no phytochemical data
<i>Ficus paraensis</i> (Miq.) Miq. (madebwa)	Rheumatic pain	Latex	Paumari [33]	no phytochemical data
<i>Helicostylis tomentosa</i> (Poepp. & Endl.) Rusby (takini)	hallucinogen	Sap (bark)	Karib Indians [4]	Essential oils [432]

<i>Maquira calophylla</i> (Poepp. & Endl.) C.C. Berg	narcotic	Fruit – snuff	Indians living in Brazilian Amazon ^[20]	cardiac glycoside (maquiroside), furanocoumarins, coumarins ^[433,434]
<i>Maquira sclerophylla</i> (Ducke) C.C. Berg (rapé-dos-índios)	hallucinogen	Fruit – snuff aspirated	Indians living in Brazilian Amazon ^[16,20,31]	cardiac glycoside ^[435,436,437]
Musaceae (1)				
<i>Musa paradisiaca</i> L. (banana)	Headache	Latex from leaves	Xukuru ^[23]	steroids, triterpenes, tannins ^[438,439,440,441,442]
Myrsinaceae (2)				
<i>Conomorpha</i> cf. <i>obovata</i> (Ruiz Lopez & Pavon) Werdermann	toothache	Root	Bará-Maku (Yanomami) ^[20]	no phytochemical data
<i>Cybianthus subspicatus</i> Benth. ex Miq. (amorimpö panaire)	Dizziness, blurred/darkened vision (epileptic seizure)	Leaves – decoction (baths and ablutions)	Tiriyó ^[21]	no phytochemical data
Myristicaceae (5)				
<i>Virola calophylla</i> (Spruce) Warb. (yakee, paricá, epená, nyakwana)	Hallucinogen	Reddish bark resin	Waiká and Surara (both Yanomami) and others	Neolignans, lignans, alkaloids, flavonoids, steroids ^[443,444,445,446]

			[19,35]	
<i>Virola calophylloidea</i> Markgr. (yakee, paricá, epená, nyakwana)	Hallucinogen	Reddish bark resin	Waiká (Yanomami), Tukano, Araraibo and others [19,35]	flavonoids, neolignans [447,448]
Virola elongata <i>(Benth.) Warb.</i>	Hallucinogen		Surara (Yanomami) [35]	lignans, arylalkanones, acylresorcinols [449,450,451,452,453]
<i>Virola michelii</i> Heckel	Pain		Kaapor [41]	flavones, lignan [454,455]
<i>Virola theiodora</i> (Spruce ex Benth.) Warb. (yakee, paricá, epená, nyakwana)	Hallucinogen	Resin (bark) - snuff aspirated	Tukano, Waiká (Yanomami) and others [4,16,19,31,35,45]	no phytochemical data
Myrtaceae (5)				
<i>Acca sellowiana</i> (O. Berg) Burret (goiabeira)	Body ache	Leaves- decoction	Indians from the South of Brazil [29]	Isoflavonoid [456]
<i>Eugenia cauliflora</i> O. Berg (jabuticaba)	Body ache	Bark, leaves	Pataxó [18]	no phytochemical data
<i>Eugenia uniflora</i> L. (pitanga)	Fever, headache	Leaves	Pataxó [18]	tannins, essential oils, alkaloids, carotenoids [457,458,459,460,461,462,463]
<i>Myrcia multiflora</i> (Lam.) DC. (nono atü)	Antidote against curare	Ramifications, leaves, roots, bark – decoction	Tiriyó [21]	flavonoids, triterpene, ginkgolides [464,465,466,467]

		(topical and ablutions)		
<i>Psidium quineense</i> Sw. (araçá)	Arthritis (pain)	Whole plant	Pataxó ^[18]	no phytochemical data
Nyctaginaceae (1)				
<i>Boerhavia coccinea</i> Mill. (pega-pinto)	Stimulant, tonic	Leaves and roots – decoction (ingested)	Guajajara ^[44]	proanthocyanidins ^[468]
Ochnaceae (1)				
<i>Ouratea castaneifolia</i> (DC.) Engl. (waya-imö)	Epileptiform convulsions	Leaves and fruit – infusion (baths and ablutions)	Tiriyó ^[21]	no phytochemical data
Olacaceae (1)				
<i>Ptychopetalum olacoides</i> Benth.	Tonic, neuromuscular problems, sexual debility, Rheumatic pain	Roots and stem – decoction –tea – internally	Indians living in Brazilian Amazon ^[20]	essential oils, flavonoids ^[469,470,471]
Onagraceae (1)				
<i>Ludwigia nervosa</i> (Poir.) H. Hara (papamã)	Muscle pain	Roots – decoction (ingested and bath)	Tiriyó ^[21]	no phytochemical data
Orchidaceae (3)				
<i>Epidendrum</i>	Body ache	Whole plant (bath)	Pareci ^[27]	no phytochemical data

<i>nocturnum</i> Jacq.				
<i>Oncidium nanum</i> Lindl.	Headache	Whole plant (bath)	Pareci ^[27]	no phytochemical data
<i>Pleurothallis rubens</i> Lindl. (barba-de-São-Sim)	Headache, fever		Xukuru ^[23]	no phytochemical data
Papaveraceae (1)				
<i>Argemone mexicana</i> L. (cardo-santo)	Chest pain	Leaves, seeds	Pataxó ^[18]	phenolics and aliphatic compounds, alkaloids [472,473,474,475,476,477,478,479,480,481]
Passiflorsaceae (4)				
<i>Passiflora alata</i> Curtis (maracujá-açú)	Fever	Leaves, fruit	Pataxó ^[18]	saponins, alkaloids, flavonoids ^[482,483,484,485,486,487,488,489]
<i>Passiflora costata</i> Mast. (tawa)	Headache	Leaves – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Passiflora edulis</i> Sims (maracujá)	Body ache	Leaves, fruit	Pataxó ^[18]	flavonoids, glycosides, alkaloids, triterpenoids, saponins, norterpenoids derivatives, cyanogenic glucosides, carotenoids, 3-Methyl-2-butanone, phenolic compounds ^[490,491,492,493,494,495,496,497]
<i>Passiflora edulis</i> Sims. (maracujá)	calmative	Flowers and leaves – decoction (ingested)	Xokleng ^[22]	flavonoids, glycosides, alkaloids, triterpenoids, saponins, norterpenoids derivatives, cyanogenic glucosides, carotenoids, 3-Methyl-2-butanone, phenolic compounds ^[490,491,492,493,494,495,496,497]
<i>Passiflora laurifolia</i> L.	Induce sleep	Leaves – decoction	Kubeo ^[20]	no phytochemical data

Piperaceae (7)				
<i>Peperomia macrostachya</i> (Vahl) A Dietr. (kona hamaki)	Fever	Leaves – infusion (head and body bathed)	Yanomami [24]	no phytochemical data
<i>Peperomia magnoliifolia</i> (Jacq.) A. Dietr.	Fever	-----	Yanomami [46]	no phytochemical data
<i>Peperomia obtusifolia</i> (L.) A. Dietr.	Rheumatic pain	Leaves crushed	Kubeo [20]	phenolic compounds [498]
<i>Piper arborea</i> Aubl.	Fever		Yanomami [46]	no phytochemical data
<i>Piper arboreum</i> Aubl. (katu mahi)	Fever	Leaves – infusion (head and body bathed)	Yanomami [24]	amides, chromenes, pyridone alkaloids, essential oils [499,500,501,502]
<i>Piper daguanum</i> C. DC.	toothache	Roots – chewed	Ticuna [20]	no phytochemical data
<i>Pothomorphe umbellata</i> (L.) Miq. (capeba)	Fever	Leaves	Pataxó [18]	Tannins, alkaloids, steroids [503,504,505,506]
Phytolaccaceae (1)				
<i>Petiveria alliacea</i> L. (guiné)	Body ache	Liquid smeared on body, guiné roots and tobacco leaves	Terena [30]	flavonoids, coumarins [507,508,509]
Poaceae (11)				

<i>Andropogon leucostachyus</i> Kunth (ói)	Fever	Whole plant – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Axonopus pulcher</i> (Nees) Kuhlm. (ói)	Fever	Whole plant – decoction (bath e ablutions)	Tiriyó ^[21]	no phytochemical data
<i>Cymbopogon citratus</i> (DC.) Stapf (capim-santo)	Fever, headache	Leaves – tea - crushed	Ticuna ^[20]	flavonoids, essential oils, triterpenoids [337,347,510,511,512,513,514,515,516,517,518,519,520,521,522,523,524,525]
<i>Cymbopogon citratus</i> (DC.) Stapf (capim-santo)	calmative	Whole plant – decoction (ingested)	Xukuru ^[23]	flavonoids, essential oils, triterpenoids [337,347,510,511,512,513,514,515,516,517,518,519,520,521,522,523,524,525]
<i>Elionurus adustus</i> (Trin.) Ekman (xaura-imö)	Fever	Whole plant – decoction (bath e ablutions)	Tiriyó ^[21]	no phytochemical data
<i>Eriochrysis cayennensis</i> P. Beauv. (kumeau)	Fever with pain	Whole plant – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Imperata brasiliensis</i> Trin. (sapé)	toothache	Root	Pataxó ^[18]	no phytochemical data
<i>Imperata brasiliensis</i> Trin. (capim-sapé)	Fever	Roots – decoction (ingested)	Xokleng ^[22]	no phytochemical data
<i>Panicum cyanescens</i> Nees ex Trin. (xaura-imö)	Fever	Leaves and roots – decoction (bath)	Tiriyó ^[21]	no phytochemical data

<i>Panicum nervosum</i> Lam. (xaura-imö)	Fever, headache	Whole plant – decoction (ingested and bath)	Tiriyó ^[21]	no phytochemical data
<i>Paspalum serpentinum</i> Hochst. ex Steud. (óí)	Fever	Whole plant – decoction (bath and ablutions)	Tiriyó ^[21]	no phytochemical data
<i>Piresia leptophylla</i> Soderstr. (acanfor- de-remédio)	To combat fatigue	Leaves – decoction(ingested)	Xukuru ^[23]	no phytochemical data
<i>Trachypogon plumosus</i> (Humb. & Bonpl. ex Willd.) Nees (óí)	Fever	Whole plant – decoction (bath and ablutions)	Tiriyó ^[21]	no phytochemical data
Polygalaceae (1)				
<i>Polygala asperuloides</i> Kunth (txawiri)	Headache	Whole plant – decoction (baths)	Tiriyó ^[21]	no phytochemical data
Polypodiaceae (1)				
<i>Polypodium polypodioides</i> (L.) Watt (arekore ayomi)	Fever	Leaves – decoction (bath)	Tiriyó ^[21]	Triterpenoids ^[526]
Proteaceae (3)				
<i>Panopsis rubescens</i>	Fever	Bark- decoction	Tiriyó ^[21]	alkylresorcinols ^[527]

(Pohl) Rusby (txorana)		(bath)		
<i>Panopsis sessilifolia</i> (Rich.) Sandwith (koiyarä)	Fever (children)	Leaves, bark and roots – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Roupala obtusata</i> Klotzsch (ariki arokö)	Epileptiform convulsions	Stem – decoction (baths)	Tiriyó ^[21]	no phytochemical data
Pteridaceae (1)				
<i>Adiantum serratodentatum</i> Humb. & Bonpl. ex Willd. (püyari epü)	Headache	Leaves – decoction (baths and ablutions)	Tiriyó ^[21]	no phytochemical data
Rosaceae (1)				
<i>Rubus brasiliensis</i> Mart. (amora-domato)	To lose weight	Leaves – decoction (ingested)	Xokleng ^[22]	Flavonoids ^[528,529]
Rubiaceae (14)				
<i>Bertiera guianensis</i> Aubl. (Tüpanapopire)	Dizziness and blurred/darkened vision (epileptic seizures)	Leaves – decoction (baths)	Tiriyó ^[21]	no phytochemical data
<i>Borreria verticillata</i> (L.) G. Mey. (João-duru)	Rheumatic pain	Root	Pataxó ^[18]	iridoids, alkaloids ^[530,531,532,533,534]

<i>Coccocypselum guianense</i> (Aubl.) K. Schum. (mami enawetu)	Fever	Whole plant – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Coutarea hexandra</i> (Jacq.) K. Schum. (quina-quina)	Fever	Leaves – decoction (ingested)	Xukuru ^[23]	coumarins, flavonoids ^[535,536,537,538,539,540,541,542,543]
<i>Declieuxia fruticosa</i> (Willd. ex Roem. & Schult.) Kuntze	Pain in legs	Whole plant (bath)	Pareci ^[27]	no phytochemical data
<i>Diodia ocimifolia</i> (Willd. ex Roem. & Schult.) Bremek. (pöröru ella)	Pain in anus	Whole plant – carbonization (smoke)	Tiriyó ^[21]	no phytochemical data
<i>Guettarda viburnoides</i> Cham. & Schltl.	Tonic	Roots grated, liquid extract smeared over arm previously scarred	Yawalapiti ^[36]	no phytochemical data
<i>Palicourea coriacea</i> (Cham.) K. Schum	Pain, fever	Leaves – tea	Pareci ^[27]	no phytochemical data
<i>Perama hirsuta</i> Aubl. (werekeru arötöpiru)	Toothache	Liquid extract from leaves – heated (topical)	Tiriyó ^[21]	no phytochemical data
<i>Psychotria viridis</i> Ruiz & Pav. (yajé)	hallucinogen	Vine	Indians living in Brazilian Amazon ^[17]	Alkaloids ^[399,402,544]
<i>Randia armata</i>	Epileptiform	Leaves – decoction	Tiriyó ^[21]	no phytochemical data

(Sw.) DC. (pörepana)	convulsions	(bath)		
<i>Sipanea pratensis</i> Aubl. (pöreru eya)	Fever, headache	Whole plant – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Tocoyena formosa</i> (Cham. & Schltl.) K. Schum. (waxana-imö)	Fever	Leaves, bark and roots – decoction (bath)	Tiriyó ^[21]	triterpenoids, iridoids, flavonoids ^[545,546,547]
<i>Uncaria guianensis</i> (Aubl.) J.F. Gmel. (piyanaro)	Otitis (pain)	Liquid extract from stem of vine – <i>in natura</i> (topical)	Tiriyó ^[21]	Alkaloids, quinovic acid glycosides ^[548,549,550,551,552,553]
Rutaceae (7)				
<i>Citrus aurantifolia</i> (Christm.) Swingle	Fever	Fruit (juice)	Ticuna ^[20]	essential oils, flavonoids ^[554,555,556,557,558,559,560,561,562]
<i>Galipea jasminiflora</i> (A. St.-Hil.) Engl. (akucikarandu'wa)	fever	Bark	Asurini ^[25]	no phytochemical data
<i>Pilocarpus pennatifolius</i> Lem. (ibirarta-iba)	Sedative		Indians living in Brazilian Amazon ^[43]	no phytochemical data
<i>Ruta graveolens</i> L. (arruda-macho)	Headache, ear ache	Leaves – decoction - liquid extract from leaves dripped into ear	Xukuru ^[23]	alkaloids, coumarins, essential oils, flavonoids ^[563,564,565,566,567,568,569]
<i>Spiranthera</i>	tonic	Roots – decoction	Yawalapiti	coumarins, alkaloids ^[570,571,572]

<i>odoratissima</i> A. St.-Hil.		(steam bath)	[36]	
<i>Zanthoxylum pentandrum</i> (Aubl.) R.A. Howard	toothache	Bark grated and applied as a wad on lips	Yanomami [36]	no phytochemical data
<i>Zanthoxylum rhoifolium</i> Lam. (laranjeira-brava)	fever	-----	Pataxó [18]	alkaloids, essential oils [573,574,575,576]
Sapindaceae (2)				
<i>Paullinia cupana</i> Kunth	stimulant	Seeds	Indians living in Brazilian Amazon [20]	purine alkaloids [577,578,579,580,581]
<i>Talisia cerasina</i> (Benth.) Radlk. (wayanaturi)	Fever (children)	Leaves – decoction (bath)	Tiriyó [21]	no phytochemical data
Sapotaceae (2)				
<i>Micropholis cyrtobotrya</i> (Mart. ex Miq.) Baill. (aware parahta)	Fever	Liquid extract from leaves – infusion (oral and bath)	Tiriyó [21]	no phytochemical data
<i>Micropholis guyanensis</i> (A. DC.) Pierre	Fever	Liquid extract from leaves – infusion (oral and bath)	Tiriyó [21]	no phytochemical data
Schizaeaceae (1)				
<i>Schizaea pennula</i>	Headache	Whole plant (bath)	Pareci [27]	no phytochemical data

Sw.				
Smilacaceae (1)				
<i>Smilax aequatorialis</i> (Griseb.) A. DC.	Re-establishing virility	Root	Makuna ^[20]	no phytochemical data
Solanaceae (8)				
<i>Brugmansia insignis</i> (Barb. Rodr.) R.E. Schult.	sedative	Leaves	Indians living in Brazilian Amazon ^[20]	no phytochemical data
<i>Brugmansia insignis</i> (Barb. Rodr.) R.E. Schult. and <i>Banisteriopsis caapi</i> (Spruce ex Griseb.) C.V. Morton (Malpighiaceae)	Hallucinogen	Leaves	Indians living in Brazilian Amazon ^[20]	no phytochemical data
<i>Cestrum laevigatum</i> Schtdl. (dama-da-noche)	psychoactive	Leaves – cigarette – substitute for marijuana	Índias from the Brazilian coast ^[31]	no phytochemical data
<i>Nicotiana tabacum</i> L.	psychoactive	Leaves	Indians living in Brazilian Amazon ^[16]	alkaloids, lactones, phenolic compounds ^[582,583,584]
<i>Nicotiana tabacum</i> L.	Body ache	Liquid smeared on body, guiné roots	Terena ^[30]	alkaloids, lactones, phenolic compounds ^[582,583,584]

(fumo) and <i>Petiveria alliacea</i> L. (guiné) (Phytolaccaceae)		and tobacco leaves		
<i>Nicotiana tabacum</i> L. and <i>Theobroma subincanum</i> Martius in Buchner (Sterculiaceae) (shinã)	Hallucinogen	Tobacco leaves and bark ash of various species of cacao - snuff	Jamamadi and Deni ^[17]	alkaloids, lactones, phenolic compounds ^[582,583,584]
<i>Physalis angulata</i> L.	ear ache	Sap	Indians living in Brazilian Amazon ^[20]	steroids, flavonoids, alkaloids ^[585,586,587,588,589,590,591,592,593,594,595]
<i>Physalis angulata</i> L. (fé-de-terra)	fever	Leaves	Pataxó ^[18]	no phytochemical data
<i>Schwenkia americana</i> L. (txãgarapu-imö)	Fever	Whole plant – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Solanum americanum</i> Mill. (erva-moura)	Toothache	Leaves + white rum – decoction (mouthwash)	Xokleng ^[22]	Alkaloids ^[596]
<i>Solanum asperum</i> Rich (mokoko-enu)	Toothache	Liquid extract from leaves – <i>in natura</i> (topical)	Tiriyó ^[21]	Alkaloids ^[597,598]
<i>Solanum mauritianum</i> Scop. (fumo-bravo)	Fever, headache	Leaves on forehead (poultice)	Xokleng ^[22]	Terpenoids ^[599]

Sterculiaceae (2)				
<i>Theobroma subincanum</i> Martius in Buchner	Additive (<i>Virola</i> spp.)	Bark ashes - snuff	Indians living in Brazilian Amazon ^[19]	sterols, purinic alkaloids ^[600,601,602,603]
<i>Waltheria indica</i> L. (malva-branca)	fever	Whole plant	Pataxó ^[18]	Flavonoids ^[604]
Theophrastaceae (1)				
<i>Clavija membranacea</i> Mez	Rheumatic pain	Root - decoction	Ticuna ^[20]	no phytochemical data
Thymelaeaceae (1)				
<i>Schoenobiblus daphnoides</i> Mart. (txawa arokö)	Fever	Liquid extract from bark – <i>in natura</i> (topical)	Tiriyó ^[21]	no phytochemical data
Turneraceae (2)				
<i>Piriqueta cistoides</i> (L.) Griseb. (wüyu-imö)	fever	Whole plant – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Turnera ulmifolia</i> L. (piyuru ampotü)	Headache	Leaves – decoction (baths)	Tiriyó ^[21]	flavonoids, phenolic compounds, alkaloids, essential oils, vernolic acid ^[605,606,607,608]
Urticaceae (1)				
<i>Urera baccifera</i> (L.) Gaudich. ex Wedd.	Pain, arthritis, tonic	Whole plant (including fruit)	Yanomami ^[24]	Flavonoids ^[609,610]

Verbenaceae (7)				
<i>Amasonia angustifolia</i> Mart. & Schauer (würüpö ixömã)	Fever, headache	Leaves – decoction (bath)	Tiriyó ^[21]	no phytochemical data
<i>Amasonia campestris</i> (Aubl.) Moldenke	tonic	Whole plant (bath)	Pareci ^[27]	no phytochemical data
<i>Lantana trifolia</i> L. (maruipö)	Fever, headache	Whole plant – decoction (bath)	Tiriyó ^[21]	essential oil, flavonoids ^[611,612,613]
<i>Lippia alba</i> (Mill.) N.E. Br (cidreira)	To calm	Leaves – decoction (ingested)	Xukuru ^[23]	alkaloids, saponins, sterols, flavonoids, essential oils, prenylated, naphthoquinones, iridoids, terpenoids, phenolic acids [614,615,616,617,618,619,620,621,622,623,624,625,626,627,628,629,630,631,632,633,634]
<i>Lippia alba</i> (Mill.) N.E. Br. (erva-cidreira)	fever	Leaves	Pataxó ^[18]	alkaloids, saponins, sterols, flavonoids, essential oils, prenylated, naphthoquinones, iridoids, terpenoids, phenolic acids [614,615,616,617,618,619,620,621,622,623,624,625,626,627,628,629,630,631,632,633,634]
<i>Stachytarpheta sprucei</i> Moldenke	Fever	Leaves – tea	Pareci ^[27]	no phytochemical data
<i>Stachytarpheta straminea</i> Moldenke	fever	Leaves crushed (for washing)	Ticuna ^[20]	no phytochemical data
<i>Verbena erinoides</i> Lam.	To stimulate appetite		Indians living in Brazilian Amazon ^[43]	no phytochemical data
Violaceae (2)				
<i>Alsodeia guianensis</i> (Aubl.)	Epileptiform convulsions	Leaves and bark – decoction (bath)	Tiriyó ^[21]	no phytochemical data

Eichler. (kana arokö)				
<i>Hybanthus calceolaria</i> (L.) Schulze-Menz (purga-do-campo)	Fever	Whole plant, root	Pataxó ^[18]	no phytochemical data
Vitaceae (1)				
<i>Cissus sulcicaulis</i> (Baker) Planch. (napökö-imö)	Toothache	Liquid extract from stem – <i>in natura</i> (topical and tampon)	Tiriyó ^[21]	no phytochemical data
Vochysiaceae (1)				
<i>Salvertia convallariodora</i> A. St.-Hil	Body ache	Bark (poultice and bath)	Pareci ^[27]	no phytochemical data
Zingiberaceae (3)				
<i>Alpinia zerumbet</i> (Pers.) B.L. Burtt & R.M. Sm. (colônia)	Fever, headache	Leaves	Pataxó ^[18]	essential oils, kava-pyrones, flavonoids, labdane diterpenes [635,636,637,638,639,640,641,642]
<i>Renealmia alpinia</i> (Rottb.) Maas	Headache, general debility	Branch (stem)	Yanomami ^[24]	labdane diterpenoids, terpenes ^[643,644,645,646,647]
<i>Zingiber officinale</i> Roscoe	toothache, rheumatic pain	Rhizoma chewed or whole plant	Ticuna and Yanomami ^[20,24]	phenolic compounds, ketones, aldehydes, phenolic acids, essential oils, diterpenoids, sesquiterpene alcohols [648,649,650,651,652,653,654,655,656,657,658,659,660,661,662,663,664,665,666,667,668,669,670,671,672]

Table 2: Frequency of different phytochemical classes among the plants indicated by the Brazilian Indians, with possible effects on the Central Nervous System (grouped into 12 categories of use).

Categories of use (number of uses cited in the literature)	Number of species	Chemical constituents found in the scientific literature (number of plants that present the chemical constituent listed)
<p>1- Analgesics (18) 1- arthritis (pain); 2- analgesic; 3- body ache; 4- chest pain; 5- pain in the anus; 6- muscle pain; 7- pain in the backbone; 8- pain in the sole of the foot; 9- pain in the ribs; 10- ear ache; 11- pain in the lower womb; 12- rheumatic pain; 13- headache; 14- toothache; 15- pain; 16- lower extremity pain; 17- otitis (pain); 18- painful joints.</p>	132	flavonoids (28); alkaloids (18); essential oil (18); phenolic acids (9); triterpenoid (9); tannins (6); coumarin (5); terpenes (5); diterpenoids (4); steroids (3); glycosides (2); saponins (2); iridoids (2); sesquiterpene lactones (2); lactones (2); labdane diterpenes (2); diterpene galactoside (1); eudesmane acids (1); kava-pyrone (1); ketones (1); lignans (1); aliphatic compounds (1); polyacetylene compounds (1); sesquiterpene alcohols (1); lignan (1); aldehydes (1); anthocyanins (1); cardenolides (1); furanone (1).
<p>2- Fever (3) 1- fever; 2- fever (children); 3- fever with pain.</p>	120	flavonoids (26); essential oil (22); triterpenoid (17); tannins (13); alkaloids (12); saponins (6); coumarins (5); phenolic acids (7); iridoids (4); steroids (5); anthraquinones (2); terpenes (2); polysaccharides (2); sesquiterpene (2); lactones (2); lignans (2); diterpenoids neocucurbitacins (1); furanone (1); furanocoumarin (1); kava-pyrone (1); ketones (1); labdane diterpenes (1); naphthopyrone derivative (1); phenylpropanoid (1); phorbol esters (1); podocarpane diterpenoids (1); sesquiterpenic lactones (1); xanthenes (1); diterpenoids (1); fatty acids (1); alkylresorcinols (1); amides (1); chromenes (1).

<p>3- Tonics and/or adaptogens (15) 1- aphrodisiac; 2- combat physical debilitation resulting from malaria; 3- age or general infirmity; 4- to combat tiredness; 5- drowsiness and inability to concentrate; 6- elderly who suffer difficulty in understanding instructions and physical degeneration; 7- general debility; 8- old people who are slow; 9- tonic; 10- to purify and fortify the body 11- re-establishing virility; 12- to strengthening those who are weak and who no longer are interested in life because of age; 13- tonic for the elderly; 14- neuromuscular problems; 15- sexual debility.</p>	40	alkaloids (4); coumarins (2); triterpenoids (2); flavonoids (1); lignans (1); essential oils (1); clerodane diterpenes (1); xanthones (1); terpenes (1); labdane diterpenoids (1).
<p>4- Hallucinogens (9) 1- hallucinogen; 2- additive (<i>Viola</i> spp.); 3- additive (<i>Viola theiodora</i>); 4- additive (<i>Anadenanthera peregrina</i>); 5- inebriating snuff; 6- narcotic; 7- psychoactive; 8- substitute for <i>Nicotiana tabacum</i>; 9- to see far (shamanism).</p>	25	alkaloids (10); lignans (5); coumarin (3); phenolic acids (3); flavonoids (2); cardiac glycoside (2); steroids (2); diterpenes (1); triterpenoids (1); tannins (1); O-methoxylated-C-glycosylflavones lactones (1); neolignans (1); furanocoumarins (1).
<p>5- Anxiolytics (3) 1- calmative; 2- irritability and crying in small children; 3- to calm.</p>	10	flavonoids (4); essential oils (4); tannins (2); alkaloids (2); triterpenoids (2); saponins (1); sterols (1); naphthoquinones (1); iridoids (1); glycosides (1)
<p>6- Anticonvulsants (4) 1- seizures (children); 2- seizures; 3- periodic attacks of an epileptic-like nature; 4- dizziness and blurred/darkened vision (seizure).</p>	9	essential oil (1).
<p>7- Hypnotics (4) 1- induce sleep; 2- insomnia; 3- sedative; 4- elderly find difficult to sleep.</p>	7	flavonoids (3); triterpenoids (2); saponins (2); phenolic acids (1); essential oils (1); tannins (1); steroids (1); alkaloids (1).

8- Stimulants(1) 1- stimulant.	6	flavonoids (3); alkaloids (2); steroids (1); lignans (1); proanthocyanidins (1); essential oils (1); purine alkaloids (1); indole alkylamines (1).
9- Weight control (4) 1- to fatten dogs; 2- to lose weight; 3- to stimulate appetite; 4- when they refuse to eat and lose appetite	6	flavonoids (2); alkaloids (1).
10- Others (3) 1- antidote against curare; 2- antidote against <i>Dioclea</i> spp.; 3- as stimulant for growth of breasts.	6	flavonoids (4); tannins (3), ginkgolides (1); alkyl and arylalkyl-1,3-diols (1); saponins (1); alcohols (1); aldehydes (1); terpenes (1); triterpene (1).
11- Head illnesses (1) 1- Craziness.	2	curare alkaloids (1).
12- Memory enhancers (2) 1- improve memory; 2- old people who are forgetful.	2	