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Review Article

The Confrontation between Ethnopharmacology and Pharmacological Tests of Medicinal Plants Associated with Mental and Neurological Disorders

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For neurological disorders, pharmacological tests have shown promising results in the reduction of side effects when using plants with known therapeutic effects in the treatment of some types of dementia. Therefore, the goals of this study are to gather data about the major medicinal plants used in the nervous system as described in ethnopharmacological surveys from South America and Brazil and to compare this data with the results from pharmacological tests on the active principles of those same plants found in the scientific literature. After collecting the data about each plant, their respective popular indication was compared with the results found through pharmacological tests. The discrepancy rate between the effects observed by ethnopharmacological and pharmacological methods in this study is greater than 50%. In conclusion, despite the importance of ethnopharmacological data, it is important to make comparisons with pharmacological tests for the same plants, since the pharmacological studies, although few, have shown a high rate of discrepancy in the results.

1. Introduction

The knowledge of medicinal plants for therapeutic purposes originated from indigenous tribal cultures [1–4] or ancient civilizations such as those once found in Iran, India, or China [1–3, 5–7] and was passed from generation to generation mostly by means of oral tradition. Presently, knowledge is commonly limited to a village and rural areas or by families isolated from urban centers [8]. Most likely, original information of plants used for therapeutic purpose underwent modifications through time. This was due to their discovery by trial and error over many generations and the oral transmission of information rather than through writing.

A previous study associated culturally propagated therapeutic effects of different medicinal plants obtained by ethnopharmacological/ethnobotanical means with those found in laboratory tests, showing approximately 66% discrepancy in the results [9]. Trading and distribution mistakes [10], similarity of plant names for different species [11], presence of impurities during preparation from other plants, insects, and mushrooms [12], and unexpected reactions and interactions with the active compounds [13] are all examples of commonly encountered problems in the therapeutic use of medicinal plants.

It is not suggested that the medicinal use of plants should be banned, decreased, or hampered. However, there is a need for each procedure to be evaluated by government agencies, institutions, and specialists who understand the therapeutic use of biodiversity in societies with an increasing interest in alternative treatments [6, 14, 15] or in populations with limited or no access to other types of therapeutic resources. Medicinal plant-based therapy may offer benefits,

like decreased side effects [16–18], higher autonomy for individuals in caring for their own health [3], reduced or nonexistent costs, and easy access for social groups located in inaccessible areas or away from urban centers and for people in poor urban areas with limited or no access to a healthcare system [6, 14, 15, 19, 20]. Indeed, those groups rely on alternative therapeutic methods for their health care, especially those derived from local medicinal plants, which is a major issue in countries with higher income gaps.

Many ethnopharmacological surveys were performed in countries and regions representing the greatest biodiversity to identify plants used, with the aim of preserving the cultural heritage of the plant therapy [1–3, 5–7, 21, 22] and acquiring new active compounds for the pharmaceutical industry [8]. Brazil presents the largest biodiversity on the planet [23] and has a large amount of unexplored resources available for ethnopharmacological and herbal studies given that only 16% of Brazil's medicinal plants or just 8% of Brazilian national flora [24] has been evaluated for therapeutic potential [25]. This country represents around 47% of all territories of the South American continent.

Countries in South America present important data about medicinal plants, because of their specific locations in the Andean region, close/into the Amazon Forest [8] or the pampas. Indeed, the use of some medicinal plants was first found in the population in the Andes Ridge, in the pampas, Patagonia [10], or Brazilian's savanna (cerrado) [9]. Probably because of the large population or size, most of the studies in South America are found in Brazil, while ethnopharmacological studies are incipient in other countries in this continent [8, 10].

However, quality or reliability of medicinal plant effects cannot be ensured if ethnobotanical studies do not provide laboratory verification of the effects when prescribing compounds derived from those medicinal plants. Healthcare professionals and patients should note that studies about the correspondence or discrepancy between ethnopharmacological knowledge and laboratory tests for the same plant are lacking [9] and must be done for each class of drug.

There is a growing evidence from in vitro, animal, and clinical studies reporting that medicinal plants might be beneficial for treating various mental and neurological disorders including Alzheimer disease, depression, anxiety, and insomnia [363–366]. For neurological disorders, in particular, pharmacological tests have shown promising results in the reduction of side effects when using plants with known therapeutic effects in the treatment of some types of dementia [18, 22, 367–372]. Medicinal plants have been sought as an alternative therapy [18, 373–375] owing to the inefficacy of some industrial medications on certain diseases, such as degenerative ones. Examples are the use of *Melissa officinalis, Salvia officinalis, Ginkgo biloba,* and *Huperzia serrata* for treating the symptoms of Alzheimer disease [18, 373–375].

The problem is that, especially in developing and/or populated countries, people rely on medicinal plants as primary healthcare [376]. The situation is true for mental and neurological disorders. Patient complaints associated directly or indirectly with neurological or neuropsychiatric disorders, such as headache, insomnia, amnesia, anxiety, or depression, are very common [146, 298, 377, 378], and the use of medicinal plants for these purposes is very frequent in populated countries such as Brazil, India, and China [1–3, 5–7, 22] but without support of adequate pharmacological tests.

Considering the errors in the use and sale of alternative medicines as a whole, we hypothesize that the same errors could happen with plants that act directly on the nervous system. Therefore, the goal of this study is to gather data about the major medicinal plants used in the neural system, as described in ethnopharmacological surveys from South America like in Brazil and compare this data with the results from pharmacological tests on the active principles of those same plants found in the scientific literature. Specifically, this study intends to present reliable data for the use of medicinal plants in primary healthcare and assisting conventional treatments of neurological disorders.

2. Materials and Methods

This study was done through literature review of ethnopharmacological surveys on the medicinal plants used by groups in South America (with emphasis on Brazil) found in academic databases (MEDLINE, LILACS, Scopus, SciELO, Google Academic, and Elsevier). The terms searched were ethnobotanical studies, medicinal plants, ethnopharmacology, neural system, South America, and Brazil. The search was restricted to the most recent and classical articles/books written in Portuguese, English, or Spanish. After collecting the data about each plant, their respective popular indication was compared with the results found through pharmacological tests.

For the first phase, 55 ethnobotanical survey articles were selected and then the most commonly used plants by the population for treating neural system disorders were identified. A table was prepared with data regarding family, scientific name, part of the plant utilized, preparation method, indications, and comparison with pharmacological tests.

In the second phase, 181 articles in which pharmacological tests had been performed with the chosen plants were selected. Unfortunately, scientific tests for the proposed indication or toxicity for all the plants could not be found.

Statistical analysis was done using central tendency measures such as modal frequency.

3. Results

Data on South American medicinal plants that act on the nervous system was summarized by family, scientific name, part of the plant utilized, preparation method, indications, and comparison with pharmacological tests (Table 1). The most cited families were Lamiaceae (24/138), Asteraceae (16/138), and Verbenaceae (6/138), representing 33.7% of the medicinal plants analyzed (Figure 1).

The most common indications, according to ethnopharmacological surveys, were calmative/sedative (72/167), analgesic (39/167), and headache (35/167), representing 86,2% of all indications (Figure 2).

Ethnobotanical surveys revealed that the leaves (70/160) and the whole plant (13/160) amounted to 51.7% of all plant

Table 1: Family names, forms of preparation, used part of the plants, medicinal effects cited by population, the pharmacological effects tested for cited plants with the references, and the divergence between the cited effects by population and pharmacological tests.

Family Scientific name/common name	Forms of preparation/used part	Medicinal effects cited by population	Pharmacological tests	Divergences
Acanthaceae				
Hygrophila tyttha Leonard/Tame-male	Infusion/Part air plant	Calmative [26]	Anxiolytic effect, anticonvulsant and sedative [26]	No
Justicia pectoralis Jacq./Anador	Decoction/Leaf	Headache [27]	Anxiolytic and depressor Neural Central System [28], analgesic and anti-inflammatory [29], estrogenic, progestagenic and anti-inflammatory effects [30], antioxidant [31]	No
Alismataceae				
Echinodorus grandiflorus (Cham. & Schltdl.) Mich./Hat leatherback	Decoction/Leaf	Analgesic [21]	Anti-inflammatory and analgesic [32, 33], diuretic [33], antihypertensive [34, 35]	No
Amaranthaceae				
Alternanthera paronychioides St-Hil./Anador	Not found/Leaf, stalk	Analgesic [36]	Antioxidant [37]	Yes
Apiaceae				
Apium graveolens L./Celery	Not found/Complete plant	Calmative [36]	Vasorelaxant and antihypertensive [38]	Yes
Coriandrum sativum L./Coriander	Infusion/Seed	Headache [39]	Antioxidant [40], anti-inflammatory [41], antibacterial [42], anxiolytic, sedative and muscle relaxant [43], antifungal [44], hypoglycemic, hypolipidemic and hepatoprotective [45], analgesic [46]	No
Pimpinella anisum L./Fennel	Infusion/Seed	Calmative [7, 27, 39, 47–49]	Antibacterial [50], neuroprotective and anticonvulsant [51], antiviral and immunostimulating [52], antioxidant [53], anticancer [54]	No
*Foeniculum vulgare*Mill./Fennel	Decoction/Stalk	Headache and calmative [13, 36, 55–60]	Antimicrobial [61], diuretic [62], antihelminthic [63], antioxidant [64], anxiolytic [65]	No
Aquifoliaceae				
Ilex paraguariensis/Erva Mate	Infusion/leaves, branches	Stimulant [66]	Stimulant [66]	No
Araliaceae				
Didymopanax macrocarpum (C. & S.) Seem./ Five leaves	Compress, bathe/Leaf	Analgesic [67]	Not found	Not found
Hedera helix/Hiedra	Cataplasm/Leaf	Analgesic, neuritis, neuralgia [68]	Expectorant and antitussive [69], mucolytic and bronchodilator [70], anti-inflammatory [71]	No
Aristolochiaceae				
Aristolochia esperanzae O. Kuntze./Papo de peru, cipo-millhomem	Decoction/Complete plant	Analgesic [67]	Antiophidic activity [72], antimicrobial [73]	Yes
Aristolochia gilbertii Hook/Milhomem	Infusion/Root	Headache [7]	Not found	Not found

Table 1: Continued.

Family Scientific name/common name	Forms of preparation/used part	Medicinal effects cited by population	Pharmacological tests	Divergences
Aristolochia melastoma Manso ex. Duchtra/Capitãozinho	Decoction/Root, leaf	Sedative [67]	Not found	Not found
Asteraceae				
Achillea millefolium L./Ponta-alívio	Decoction/Complete plant	Calmative, analgesic [21, 36, 47, 57, 74, 75]	Immunostimulating [76]	Yes
Achyrocline satureioides D.C./Macela	Infusion/Flower	Sedative, calmative, headache [56, 67, 75, 77, 78]	Anticancer [79], calmative effect, anti-inflammatory and antispasmodic [80], antiviral [81]	No
Artemisia absinthium L./Losna	Decoction/Leaf	Analgesic [21, 82]	Anticancer [83], antifungal [84], antibacterial [85], antileishmanial [86]	Yes
Artemisia camphorata Vill./Camphor	Infusion/Leaves	Calmative [58] antiepileptic [87]	Not found	Not found
Artemisia vulgaris L./Artemisia	Not found	Headache [88]	Antifungal [89]	Yes
Chamomilla recutita (L.) Rauschter/Camomile	Infusion/Flower	Calmative, sedative [36, 39, 48, 57, 90–92]	Antibacterial and anti-inflammatory [92, 93], gastroprotection [94], antihyperglycemic and antioxidant [95]	Yes
Chrysanthemum parthenium Bernhadi/Artemisia	Decoction, infusion/Leaves	Calmative [78]	Not found	Not found
Cynara scolymus L./Artichoke	Not found	Calmative [74]	Diuretic [96], prolonged satiety sensation and hypoglycemic [97], antioxidant [98]	Yes
Lactuca sativa L./Lettuce	In nature, infusion/Leaves, root	Calmative, sedative [74, 99]	Antioxidant [100]	Yes
Matricaria chamomilla L./Camomile	Infusion/Leaves	Calmative [56, 75, 78, 101, 102]	Antibacterial and antioxidant [103]	Yes
Mikania hirsutissima DC./Cipó-cabeludo	Not found	Calmative [67, 104]	Antiophidic activity and antidiarrheal [105]	Yes
Solidago chilensis Meyen/Arnica	Compress/Complete plant	Analgesic [106]	Anti-inflammatory [107]	Yes
Spilanthes oleracea/Anestesiol	Not found	Anesthetic [108]	Peptic antiulcer and contraception [109]	Yes
Tanacetum sp./Macelinha	Decoction/Complete plant	Analgesic [23]	Not found	Not found
Tanacetum vulgare L./Catinga-de-mulata	Decoction, maceration/Leaves	Analgesic [23]	Antibacterial and antifungal [110], antiviral [111], cytotoxic [112], treatment of infections caused by *Trypanosoma cruzi* and *Leishmania amazonensis* [113], immunomodulatory [114], antihelminthic [115]	Yes
Vernonia cf. *condensata* Baker./Boldo do chile	Infusion/Bark	Calmative [57]	Antitumor and anti-inflammatory [116], antioxidant [117]	Yes
Bignoniaceae				
Anemopaegma arvense/Catuaba	Infusion, decoction/Root, bark, leaves	Nervous exhaustion [118]	Increased weight and testicular parenchyma [119], antifungal [120]	Yes
Bombacaceae				
Eriotheca candolleana (K. Schum.)/Catuaba	Infusion/Root	Nervous exhaustion [121]	Not found	Not found
Boraginaceae				
Cordia verbenacea DC./Maria preta	Bathe/Leaves	Analgesic [49]	Antimicrobial [122], anti-inflammatory [123]	No

Table 1: Continued.

Family Scientific name/common name	Forms of preparation/used part	Medicinal effects cited by population	Pharmacological tests	Divergences
Brassicaceae				
Coronopus didymus (L.) Smith/Mastruz	Maceration/Leaves	Analgesic [49]	Healing [124], anti-inflammatory [125]	No
Bromeliaceae				
Tillandsia usneoides (L.) L/Barba de velho	Not found	Antiepileptic [49]	Abortion [126], antiviral [127]	Yes
Buddlejaceae				
Buddleja brasiliensis Jacq./Verbasco	Infusion, cataplasm/Part air plant	Calmative [67]	Low potential hemolytic [128]	Yes
Burseraceae				
Commiphora myrrha (T. Nees) Engl/Myrrh	Infusion/Leaves	Calmative [49]	Antioxidant [117], analgesic [129]	Yes
Caesalpiniaceae				
Bauhinia forficata Link./Pata de vaca	Decoction/Leaves	Analgesic [23]	Antioxidant and increased liver glycogen [130], antimutagenic [131]	Yes
Bauhinia rutilans Spruce ex. Benth/Escada-de-macaco	Infusion/Part air plant	Analgesic [99]	Not found	Not found
Canellaceae				
Capsicodendron dinissi Occhioni/Pepper	Not found	Migraine [104]	Not found	Not found
Capparaceae				
Cleome spinosa Jacq./Mussambê	Infusion/Complete plant	Headache [132]	Cytotoxic [49], antioxidant [133], anti-inflammatory and antinociceptive [134]	No
Caprifoliaceae				
Sambucus nigra L./Elderberry	Decoction/Leaves	Analgesic [23, 49]	Anti-inflammatory and antioxidant [134], parasiticidal [135]	No
Chenopodiaceae				
Chenopodium ambrosioides L./Yerba Santa Maria	Maceration, infusion/Leaves, bark, seed	Analgesic, calmative [23, 48, 57]	Antitumor [79], hypotensive [136], antipyretic and anxiolytic [137]	Yes
Compositaceae				
Baccharis trimera (Less) D.C./Gorse	Infusion/Leaves	Headache [138]	Antiulcer and antioxidant [139], anti-inflammatory [140], anti-inflammatory and analgesic [141]	No
Vernonia condensata B./Boldo	Infusion, decoction/Leaves	Calmative [138]	Antioxidant [117], analgesic [142]	Yes
Cucurbitaceae				
Cayaponia tayuya (Vell.) Cogn./Taiuia	Infusion, decoction/Root	Neuralgia [67]	Hepatotoxic [142], anti-inflammatory [143]	Yes
Dilleniaceae				
Davilla rugosa Poir./Vine cabloco	Bathe/Root	Sedative [67]	Antioxidant [144], antiulcer [145]	Yes
Euphorbiaceae				
Jatropha curcas L./Pião-bravo	Infusion/Seed	Headache [102, 132]	Acetylcholinesterase inhibitor [146], antibacterial, antioxidant and antitumor [147, 148], cytotoxic [149]	Yes
Ricinus communis L./Castor beans	Infusion/Leaves	Headache [77, 87]	Antimicrobial and anticancer [150], antimicrobial [151]	Yes

Table 1: Continued.

Family Scientific name/common name	Forms of preparation/used part	Medicinal effects cited by population	Pharmacological tests	Divergences
Fabaceae				
Caesalpinia ferrea Mart. ex. Tul./Pau ferro	Not found	Analgesic [57]	Nutritional supplementation of iron, zinc and manganese [152] anti-inflammatory and healing [153], antihyperglycemic [154], antimicrobial [155]	No
Cajanus flavus De Candolle/Andu beans	Infusion/Leaves	Headache [99]	Not found	Not found
Erythrina falcata Benth/Surina, mulungu	Not found	Sedative and antiepileptic [67, 104]	Depressant CNS [156]	No
Indigofera anil/Anil	Not found	Sedative [107]	Not found	Not found
Indigofera suffruticosa Mill./Anileira	Decoction, infusion/Complete plant	Sedative [67]	Anti-inflammatory [157], lectin activity [158], antiepileptic [159], antiparasitic [160]	Yes
Pterodon emarginatus/Sucupira	Infusion/leaves, fruit	Headache [120]	Antimicrobial [161–163], analgesic and anti-inflammatory [164]; antileishmanial, anticancer, hypoglycemic [165]	No
Ginkgoaceae				
Ginkgobiloba/Ginco	Decoction, infusion/Leaves	Vasodilator, brain dysfunction, dizziness and concentration and memory [160]	Treatment of Alzheimer disease [166], prevention of dementia [167], antioxidant, vasodilator, stimulant of SNC [168]	No
Geraniaceae				
Pelargonium graveolens L'Her/ Mauve smelling	Not found	Sedative [87]	Anxiolytic and antidepressant [159], antibacterial [169], hypoglycemic and antioxidant [170]	No
Mimosa pudica L./Dormideira	Infusion/Complete plant	Sedative [99]	Reduction of fertility [171], hepatotoxic [172], lipid-lowering [173], anxiolytic and antipyretic [137], antiophidic [174]	No
Iridaceae				
Calydorea sp./Jabotitana	Decoction/Rhizome	Analgesic [23]	Not found	Not found
Labiatae				
Agastache mexicana Kunth/Toronjil	Not found	Sedative [102]	Antihypertensive [175], vasorelaxant [176], anti-inflammatory and antinociceptive [177], antinociceptive [178], anxiolytic [179]	No
Lavandula latifolia/Lavanda	Oil	Stimulant [68]	Anxiolytic [180], antifungal [181], antioxidant [182]	Yes
Origanum vulgare/oregano	Infusion/Leaf	Sedative [68]	Antimicrobial [183] proapoptotic effect and cytotoxic [184], antiurolithic [185]	Yes
Lamiaceae				
Coleus barbatus Benth./Falso-boldo	Tisane mate/Leaf	Headache, calmative [56]	Hepatoprotective [186]	Yes
Cunila microcephala Benth./Hortelã-miúdo, hortelã-pimenta, poejo	Decoction/Complete plant	Analgesic [23, 58]	Anti-inflammatory and antioxidant [187]	No
Hyptis suaveolens Poit./Samba-coité	Tea/Leaf	Headache [188]	Hypoglycemic and antioxidant [189], hepatoprotective and antioxidant [190], gastroprotective activity [191], neuroprotective and antioxidant [192], antifungal [193]	Yes
Lavandula officinalis Chaix & Kitt/Alfazema	Tea/Leaf, stalk	Calmative [49]	Antimicrobial [194], antioxidant [195], sedative and hypnotic [196]	No

Table 1: Continued.

Family Scientific name/common name	Forms of preparation/used part	Medicinal effects cited by population	Pharmacological tests	Divergences
Leonotis nepetifolia (L.) R. Br./Cordão de São Francisco	Infusion, decoction/Leaf, branches	Sedative, headache [132, 138]	Antimicrobial [197], anti-inflammatory [198]	Yes
Melissa officinalisL./Erva-cidreira, melissa	Decoction/Leaf	Calmative, migraine, sedative [23, 36, 55, 58, 59, 87, 89, 90, 101, 102, 138, 199]	Anti-inflammatory [200], calmative [201], antioxidant [202], antigenotoxic and antimutagenic [203], neuroprotective [199, 204]	No
Mentha arvensis L./Hortelã-mentol	Tea/Leaf	Headache [188]	Antibacterial [205], antifungal [206], anti-inflammatory and sedative [207], peptic antiulcer [208]	Yes
Mentha cf. suaveolens Ehrh./Hortelã, hortelã-grande	Decoction, maceration/Leaf	Calmative, Analgesic [23, 199]	Antifungal [209, 210], antioxidant [211], antibacterial [212]	Yes
Mentha piperita L./Hortelã, hortelã-roxo	Decoction/Complete plant	Analgesic [23, 102]	Antifungal [213, 214], antioxidant [211], anthelmintic [215], hypoglycemic and hypolipidemic [216], anticancer [217] analgesic [218]	No
Mentha pulegium L./Poejo	Decoction/Stalk	Calmative, sedative [47, 56, 58, 78]	Antioxidant [211], antimicrobial [219]	Yes
Mentha sp./Hortelã	Decoction/Stalk	Headache, Calmative [36, 47, 49, 55–57]	Anthelmintic [215]	Yes
Mentha spicata L./∗	∗ ∗ ∗	Headache [87]	Hypoglycemic and hypolipidemic [216], antioxidant [220], antiemetic [221]	Yes
Mentha × *villosa* Huds./Hortelã	Tea/Leaf	Headache [188]	Antifungal and antibacterial [222], antimicrobial and antioxidant [223], analgesic and antispasmodic [153]	No
Ocimum basilicum L./Alfavaca	Decoction, maceration/Leaf	Calmative, analgesic [23, 39]	Antidepressant and anticonvulsant [224]	Yes
Ocimum gratissimum L./l Louro	Tea/Leaf	Headache, calmative [49, 87, 188]	Anticonvulsant [225, 226], antifungal [227]	Yes
Ocimum minimum L./Manjericão	Maceration/Leaf	Headache [94]	Antiulcerogenic and antioxidant [35]	Yes
Ocimum selloi Benth./Alfavaca	Infusion, tea/Leaf	Calmative [138]	Antibacterial [219], analgesic and antidiarrheal [220]	Yes
*Origanum majorana*L./Manjerona	Decoction/Stalk	Calmative [56]	Antibacterial [228], antioxidant [49], antimetastatic and antitumor [229], antihyperglycemic and antihyperlipidemic [230]	Yes
Plectranthus barbatus Andr./Boldo	Decoction, maceration/Leaf	Analgesic [23, 57, 60]	Cytotoxic [231], acetylcholinesterase inhibitor [232], antimicrobial [233]	Yes
Plectranthus neochilus Schlechter/Boldo do Chile	Infusion/Leaf	Headache [89]	Analgesic [234]	No
Rosmarinus officinalis L./Alecrim	Decoction/Leaf	Analgesic, calmative [23, 39, 48, 58, 59, 102, 138, 235]	Antibacterial [236], antioxidant [237], antifungal [238], anticancer [239], antidepressant [240], analgesic [241], antioxidant, anti-inflammatory, metal chelation [242], prevention and treatment of dementia [243], neuroprotective [244]	No
Salvia lachnostachys Benth./Melissa	Decoction/Leaf	Somniferous [23, 78]	Anti-inflammatory and analgesic [244]	Yes
Salvia lavandulifolia Vahl./Mariselva	Oil/∗∗	Nervous disorders [245]	Hypoglycemic [245], neuroprotective [246]	No
Salvia officinalis L./Salvia, barcelona	Decoction/Leaf	Calmative, Analgesic [23]	Antibacterial [228], anti-inflammatory [247], antidiarrheal and antispasmodic [185], analgesic and anti-inflammatory [248]	No

Table 1: Continued.

Family Scientific name/common name	Forms of preparation/used part	Medicinal effects cited by population	Pharmacological tests	Divergences
Lauraceae				
Cinnamomum zeylanicum Breyn./Canela	Infusion, maceration/Stalk	Calmative [39]	Antifungal [249] antimicrobial [250], antioxidant [251], antidiabetic [252]	Yes
Nectandra megapotamica (Spreng.) Mez/Canela-preta	Infusion/leaf	Calmative [253]	Anesthetic [254]	Yes
Leguminosae				
Acosmium subelegans (Mohlenbr) Yakovl/Perobinha do campo	* * *	Sedative, epilepsy and nervous exhaustion [255]	Depressant effect SNC and anticonvulsant [255]	No
Hymenaea courbaril L./Jatobá	Infusion, maceration/Bark, fruit	Sedative [132]	Not found.	Not found
Tamarindus indica/Tamarindo	Compress, bathe, infusion/Stalk, leaves, fruit	Treatment of fever, stomach upset, diarrhea, jaundice and as skin cleansers [256], inflammation, urinary tract infection and laxative [257], headache and stress [258]	Antibacterial [256], antihelminthic [257], antioxidant [259], antinociceptive [260], analgesic and anti-inflammatory [261], antihistaminic and antianaphylactic [262], antiulcer [263]	No
Liliaceae				
Allium sativum L./Alho	* * *	Headache [59]	Hypotensive [264], synergism with antibiotics [265], antioxidant [266]	Yes
Malpighiaceae				
Banisteriopsis caapi/Mariri, ayahuasca	Decoction, infusion/vine	Hallucinogen, emotional and cognitive sensory changes, psychoactive [267–269] aid in treatment of abuse of other Psychoactives [270]	Hallucinogen [271] inhibiting the reuptake of serotonin, in addition to inhibiting MAO [272]	No
Galphimia glauca/Amarilla	Maceration/Part air plants	Calmative [273]	Anxiolytic [273]	No
Meliaceae				
Cedrela fissilis/Cedro-rosa	Infusion/Bark	Headache [121]	Not found	Not found
Moraceae				
Cannabis sativa/maconha, marijuana, cânhamo	Oil, inhalation/Leaves, stalk, flowers	Treatment of pain, nausea and vomiting, multiple sclerosis and other neurological disorders, loss of appetite and eating disorders, Insomnia, anxiety and depression, neuroprotective action [274], antiemetic, appetite stimulant [275], clinical and experimental studies in the treatment of dementias [276], schizophrenia, antipsychotic, anxiety [277], antipsychotic [278]	Treatment of pain, nausea and vomiting, multiple sclerosis and other neurological disorders, loss of appetite and eating disorders, Insomnia, anxiety and depression, neuroprotective action [273], antiemetic, appetite stimulant [274], clinical and experimental studies in the treatment of dementias [275], schizophrenia, antipsychotic, anxiety [276], antipsychotic [277], psychoactive [278]	No
Dorstenia brasiliensis Lam./Carapiá	Cataplasm/Rhizome	Anesthetic [67]	Anti-inflammatory [278]	Yes
Myrtaceae				
Eucalyptus globulus Labill./Eucalipto	Infusion, Bathe/Leaf	Headache [48]	Toxic effect [279], antibacterial [280, 281]	Yes
Eugenia uniflora L./Pitangueira	Decoction/Leaf	Calmative [23, 282]	Antimicrobial and antioxidant [283], anti-*Trypanosoma cruzi* [206]	Yes

Table 1: Continued.

Family Scientific name/common name	Forms of preparation/used part	Medicinal effects cited by population	Pharmacological tests	Divergences
Orchidaceae				
Vanilla planifolia Jack. ex Andrews/Baunilha	* * *	Calmative [67]	Not found	Not found
Oxalidaceae				
Averrhoa Carambola L./Carambola	Infusion/Leaf	Analgesic [99]	Analgesic [284]	No
Papaveraceae				
Papaver somniferum/Planta do ópio	* * *	Analgesic and sedative [68]	Not found	Not found
Passifloraceae				
Passiflora alata Curtis/Maracujá	Fruit	Calmative [55, 59, 77, 90]	Sedative [285]	No
Passiflora caerulea L./Maracujá	Infusion/Part air plant	Sedative and calmative [91, 286]	Anxiolytic [287]	No
Passiflora edulis Sims./Maracujá	Tea/Leaf	Calmative and insomnia [39, 48, 74, 77, 78, 90, 99, 257]	Anxiolytic [288]	No
Passiflora miersii Mart./Maracujazinho	Infusion/Leaf	Calmative and antidepressant [67]	Not found	Not found
Pedaliaceae				
Sesamum orientale L./Gergelim	Seed/Juice	Anticonvulsant [99]	Hypoglycemic [289]	Yes
Phytolaccaceae				
Petiveria alliacea L./Guiné, tira capeta	Decoction/Complete plant	Analgesic [23, 74, 99, 290]	Antimicrobial [291], antinociceptive, sedative, anticonvulsant and depressant [292]	Yes
Piperaceae				
Pothomorphe umbellata Miq./Pariparoba	Infusion/Leaf	Headache [121]	Antioxidant [293], antitumor [294], antihelminthic [295]	Yes
Poaceae				
*Cymbopogon citratus*Stapf./Capim santo, capim limão	Decoction/Leaf	Calmative, analgesic and sedative [7, 23, 27, 36, 39, 47–49, 55–58, 74, 77, 78, 88–90, 99, 101, 102, 138, 296]	Anxiolytic, sedative and anticonvulsant [297]	No
Polygalaceae				
Polygala paniculata L./Arnica	Decoction/Complete plant	Analgesic [23]	Analgesic and antidermatogenic [298], antinociceptive and gastric cytoprotective activity [299]	No
Polygonaceae				
Homalocladium platycladum Bailey/Carquejinha	Decoction/Stalk	Analgesic [23]	Antibacterial [300], analgesic, anti-inflammatory [301]	No
Rosaceae				
Rosa centifolia L./Rosa branca	Decoction/Leaf, flower	Analgesic [23]	Anti-inflammatory and antiarthritic [302], antioxidant [303], antiulcer and cytoprotective [304]	No
Sanguisorba minor Scop./Pimpinela	Tea/Leaf, flower	Calmative [102]	Inhibitory action of acetylcholinesterase [305]	Yes
Rubiaceae				
Coffea arabica L./Café	Cataplasm/Leaf	Headache [101]	Antioxidant [306], antioxidant and stimulant [307]	Yes

Table 1: Continued.

Family Scientific name/common name	Forms of preparation/used part	Medicinal effects cited by population	Pharmacological tests	Divergences
Cinchona officinalis L./∗	Decoction/Bark	Analgesic [23]	Not found	Not found
Psychotria viridis/chacrona, ayahuasca	Infusion/Leaves	Hallucinogen, emotional and cognitive sensory changes, psychoactive [267–269] aid in treatment of abuse of other Psychoactives [268]	Hallucinogen [308]	
Alibertia sp./Marmelo	Decoction, infusion/Root, fruit	Calmative [118]	Not found	Not found
Rutaceae (5)				
Casimiroa edulis Llave & Lex./Zapote blanco	∗ ∗ ∗	Sedative [102]	Vasodilator [309, 310], anticoagulants and antimicrobial [310], anxiolytic [311], anxiolytic and antidepressant [312]	No
Citrus aurantium L./Laranja	Decoction/Bark	Headache and calmative [36, 48, 56, 59, 78, 90, 194]	Low toxicity [313], anxiolytic [314, 315]	Yes
Citrus limon (L.) Burm. f./Limão-galego,	∗ ∗ ∗	Calmative and sedative [90, 194]	Neuroprotective activity and anticonvulsant [316]	Yes
*Citrus sinensis (*L.*)* Osbeck	Infusion/Leaf	Calmative, analgesic and sedative [23, 27, 49, 74, 99, 138]	Antioxidant, antithyroid and antihyperglycemic [317]	Yes
Ruta graveolens L./Arruda	Decoction, maceration/Leaf	Calmative and headache [23, 39, 48, 57, 60, 102]	Antimicrobial [318], antioxidant [319], antitumor [320], antinociceptive, anti-inflammatory and antipyretic [321]	Yes
Solanaceae				
Atropa belladonna L./Beladona	Decoction/Leaf	Calmative [23]	Healing [322]	Yes
Cestrum sendtnerianum Mart./Guiné-do-campo	Infusion, Decoction/Leaf	Sedative [67]	Not found	Not found
Solanum americanum Mill./Maria-pretinha	Decoction/Leaf, Stalk	Sedative, Analgesic [45, 67]	Antifungal [323], antioxidant and anticancer [324]	Yes
Solanum cernuum Vell/Pata de mono	∗ ∗ ∗	Calmative [87]	Antiulcerogenic [325]	Yes
Umbelliferae				
Anethum graveolens/Eneldo	∗ ∗ ∗	Sedative [68]	Antifungal [326], anticonvulsant [327], anti *Helicabator pylori* [328], decreased fertility rate [329], participates in the regulation of Diabetes Mellitus [330]	Yes
Coriandrum sativum/Cilantro	Infusion/Leaf, fruit	Stimulant [68]	Antioxidant [40], sedative and muscle relaxant [43], antibacterial [331], antiarthritic [332], anti-inflamatory [41], antifungal [333], hypoglycemic and hypolipidemic [334]	Yes
Petroselinum hortense/Salsa da horta	∗ ∗ ∗	Sedative [107]	Diuretic and hypotensive [335]	Yes
Urticaceae				
Urera baccifera (L.)/Urtiga	Leaf	Analgesic [36]	Antioxidant [336], anti-inflamatory [337]	No
Verbenaceae (6)				
Aloysia citrodora Palau/Erva luíza	∗ ∗ ∗	Calmative [74, 286]	Not found.	Not found

Table 1: Continued.

Family Scientific name/common name	Forms of preparation/used part	Medicinal effects cited by population	Pharmacological tests	Divergences
Aloysia triphylla Royle/Cidrão	**/Leaf	Sedative [55, 235]	Treatment of intestinal disorders [338], anti *Trypanosoma Cruzi* [339], anti-*Helicobacter pylori* [328], antibacterial [340], spasmolytic and anti-inflammatory [341], antinociceptive [244]	Yes
Lantana camara L./Camará	Infusion, Decoction/Leaf	Headache [132]	Antibacterial [342], antioxidant [343], anxiolytic [344]	Yes
Lippia alba (Mill.) N.E. Br./Erva-cidreira	Leaf/Infusion	Headache and calmative [39, 49, 55, 58–61, 75, 77, 94, 97]	Antimicrobial [345], antispasmodic [346], anxiolytic [347], anesthetic [348]	No
Lippia gracillis Schauer/Alecrim da serra	Infusion/Leaf	Headache [132]	Antimicrobial [349], antitumor [350], anti-inflammatory and healing [351]	Yes
*Verbena cf. minutifolia Phil./**	Decoction/Complete plant	Analgesic [23]	Not found	Not found
Violaceae				
Viola odorata L./	***	Sedative [87]	Antitumoral [352], antioxidant and antibacterial [353], antimicrobial [354], vasodilator and antidyslipidemic [355]	Yes
Zingiberaceae				
Alpinia zerumbet (Pers.) Burtt & Smith/Colônia	Decoction/Leaf	Calmative [39, 48, 49, 101]	Hypotensive [356], vasodilator [357], antioxidant [358]	Yes
Zingiber officinale Rosc./Gengibre	Decoction/root	Analgesic and headache [23, 57, 78]	Antioxidant [359], antihyperglycemic [360], antibacterial [361], androgenic [362]	Yes
Costus brasiliensis Schum./Cana-de-macaco	Not found	Calmative [67]	Not found	Not found

*It is the popular name that was quoted. **It was not mentioned how to prepare. ***It is the portion used or how to prepare that was quoted.

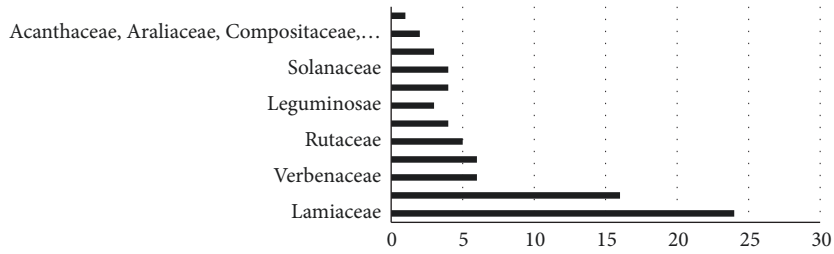


Figure 1: The cited families of medicinal plants according to popular knowledge.

parts most commonly used, but, in 18% of the studied plants, there were no citations about the used part for making medicines (Figure 3).

The most common preparation methods provided in the surveys were infusion (59/167) and decoction (49/167), representing 63.7% of all the methods (Figure 4).

Common effects attributed to the plants in the ethnopharmacological surveys were antioxidant (42/401), anti-inflammatory (31/401), antibacterial (20/401), and antimicrobial (17/401), totaling 31.9% (Figure 5).

Comparison between ethnopharmacological data and pharmaceutical tests for the same plants and compounds found differences in 52.9% (73/138) of the cases and similarities in 30.4% (42/138) (Figure 6). No pharmacological tests were found for 16.9% (23/138) of the plants mentioned in the ethnopharmacological surveys (Table 1).

Table 1 shows a list of the medicinal plants analyzed in this study. The pharmacological effects including "anticonvulsant" and "anxiolytic" were considered to correspond to "calmative" in medicinal effects cited by population since both effects are attributed to the same action in the neural system, that is, inhibitory action. Furthermore, the pharmacological effect "anti-inflammatory" was also considered to correspond to "analgesic" in medicinal effects cited by

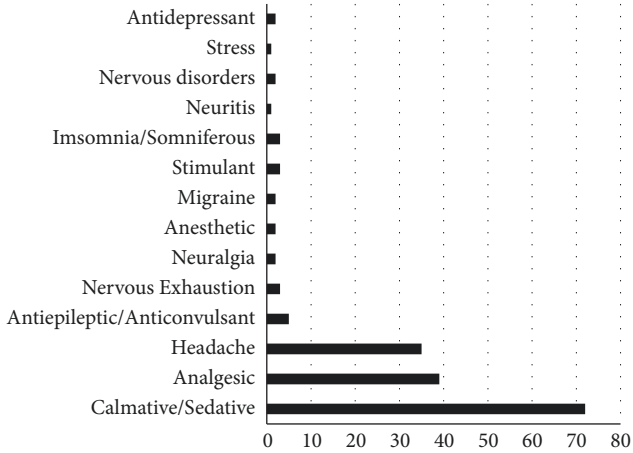


Figure 2: The indications for use of the medicinal plants according to popular knowledge.

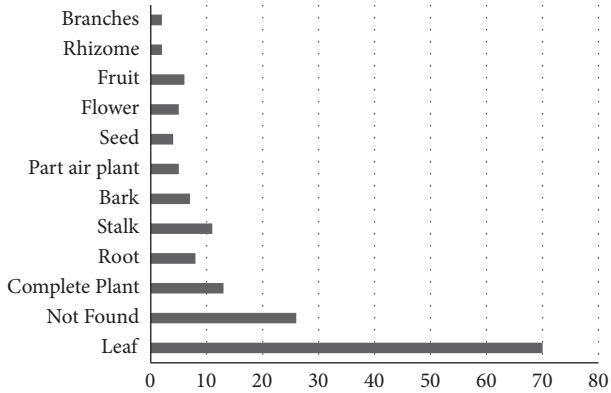


Figure 3: Part of plants used for indications according to the popular knowledge.

population since anti-inflammatory agents are effective in treating pain diseases.

4. Discussion

The most frequent indications of medicinal plant use for neural system disorders in our survey (i.e., calmative, analgesic, headache, and insomnia) are associated with the most common occurrences seen in medical practice [7, 36, 47, 55, 68, 77, 104, 132, 235, 258] (Figure 2).

The plant families analyzed (Lamiaceae and Asteraceae) are in accordance with general ethnobotanical studies [4, 7, 379–382] (Figure 1), as well as the most utilized plant parts (leaves) [1, 7, 379, 383, 384], and preparation methods (infusion and decoction) [7, 253, 379, 383, 384] (Figure 4).

Despite that, the frequency of effects observed by most pharmacological tests does not coincide with those reported for the same plants when analyzed by ethnopharmacological means, (i.e., antioxidant, anti-inflammatory, antibacterial, and antimicrobial), demonstrating a high discrepancy between proven and popularly mentioned effects (Figure 6).

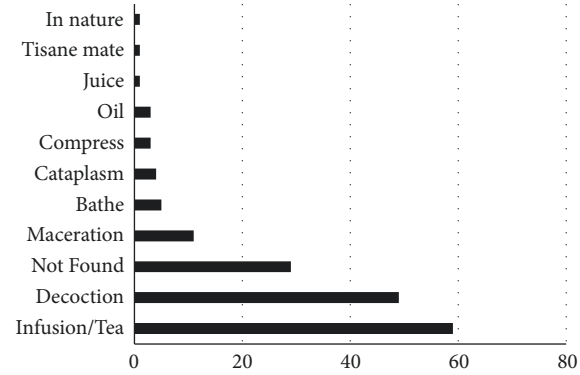


Figure 4: Preparation methods cited by population for medicinal plants.

It is important to remember that results of pharmacological tests were not found for all the plants mentioned in the ethnopharmacological studies, although those represent a small minority (16.9%) (Figure 5).

The discrepancy rate between the effects observed by ethnopharmacological and pharmacological methods in this study is in agreement with a previous study [9] and, in both cases, a disagreement of over 50% was found. This data indicates the need for better control in the use of medicinal plants as a whole, especially in countries with a large proportion of economically backward population where such therapy is most common, such as China, India, and Brazil. However, there are possibilities that scientific studies are not enough or they are missing to corroborate the ethnopharmacological activities.

Tables like the one produced in this study can be used as a basis for the indication of medications for health professionals working in the neural area who choose to substitute alternative therapies with conventional methods. The tables can be used to maintain the patient's health and help make these treatments more accessible to people of all economic levels [385], bring medical practice closer to the care of cultural groups [386], and expand the idea of wholeness in healthcare.

Performing pharmacological tests in the medicinal plants mentioned in ethnopharmacological studies will help avoid prescription errors based only on popular knowledge, which, despite the importance, exhibits extensive methodological shortcomings from its propagation through generations (see Introduction). Although the pharmacological tests cannot solve problems related to contamination during preparation and/or mistakes when identifying plants by unskilled people, performing those tests would decrease the problems caused by adverse effects and wrong prescriptions.

Neurological disorders present complex etiologies often with aggravating social influences, requiring special care when making prescriptions; many critically ill patients are secluded from society and require medical monitoring and medications derived from modern pharmaceutical technology since indications for complex etiologies like dementias were not addressed in the ethnopharmacological articles analyzed in this study.

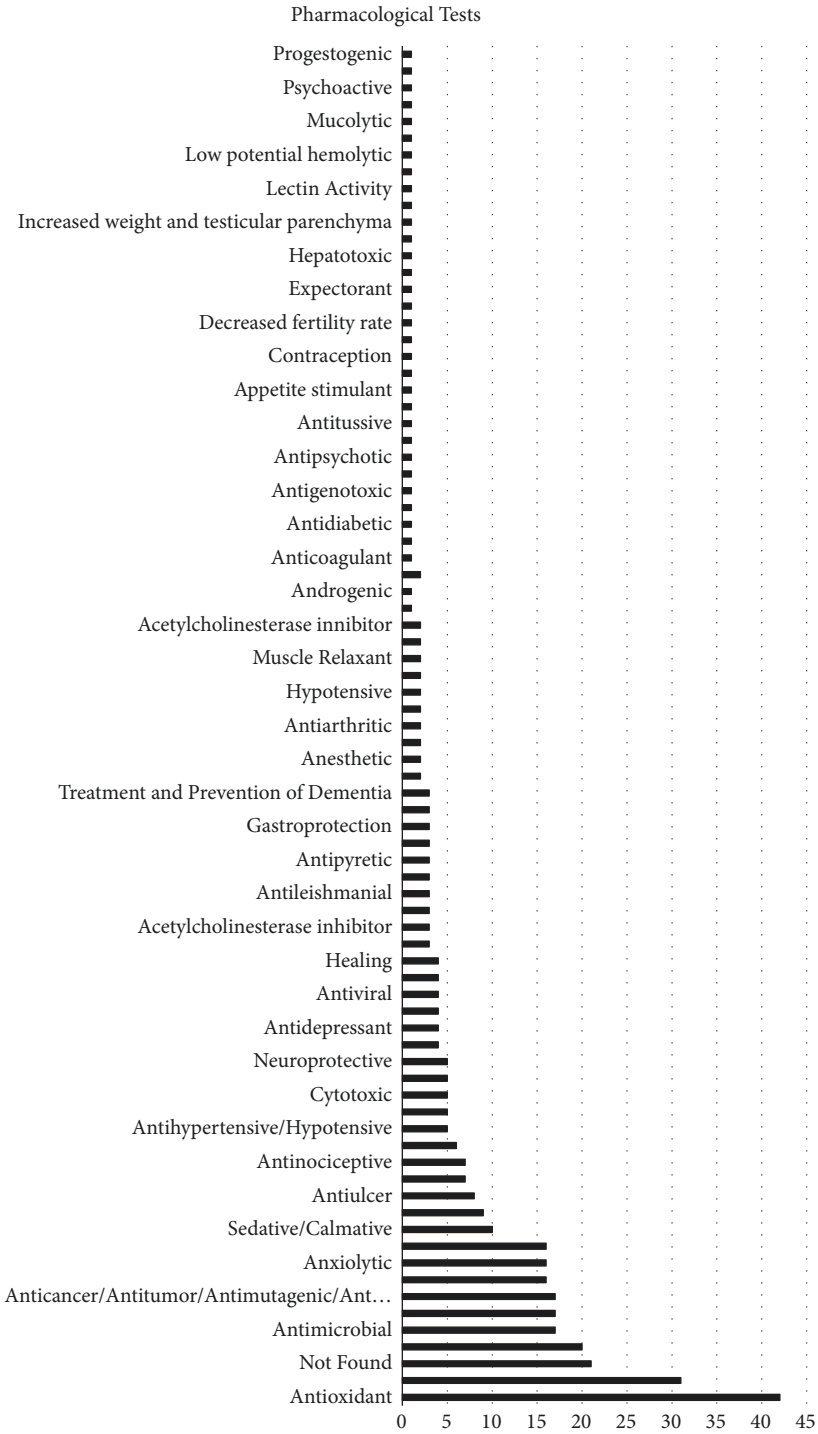


Figure 5: Attributed effects of the medicinal plants according to popular knowledge.

In conclusion, despite the importance of ethnopharmacological data, it is important to make comparisons with pharmacological tests for the same plants, since the pharmacological studies, although few, have shown a high rate of discrepancy in the results, nevertheless, to be important to cite that the scientific studies could not be enough, or are missing, to corroborate the ethnopharmacological activities. Tables containing the plants names and their effects according to pharmacological tests should be consulted by health professionals before prescribing those medications. No medicinal plants were mentioned in ethnopharmacological data for treating complex etiology neural disorders such as dementia, indicating the need for new studies of broader geographical amplitude and pharmaceutical classes all around the world. Emphasis of these studies should occur in developing countries in order to decrease prescription

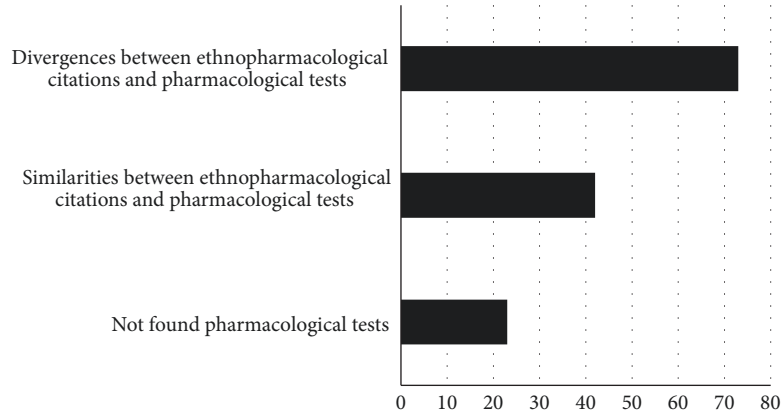


Figure 6: Comparison between ethnopharmacological data and pharmaceutical tests for the same plants and compounds.

errors associated with medicinal plants and increase the coverage of plant-based therapy for the global population while prioritizing people in need.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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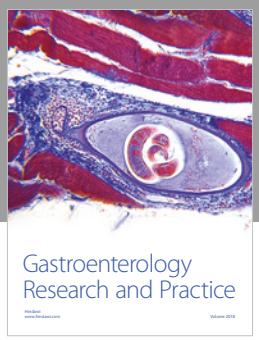
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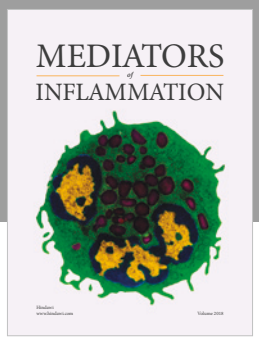
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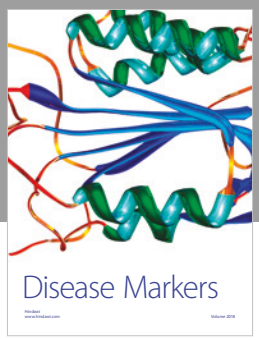
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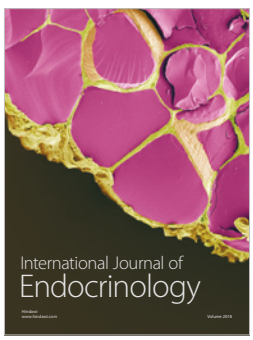






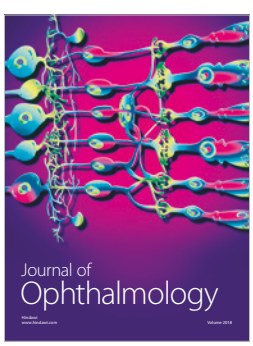


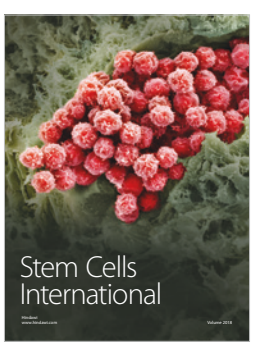


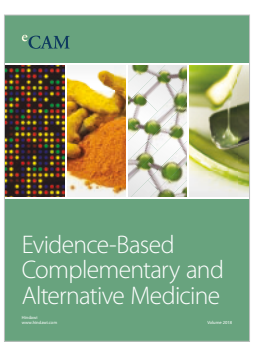






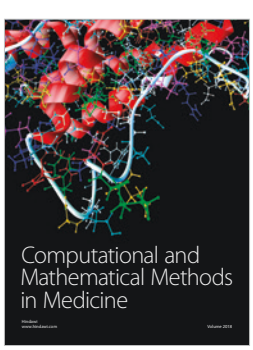


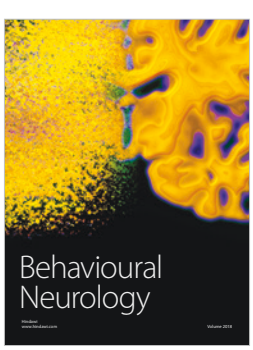




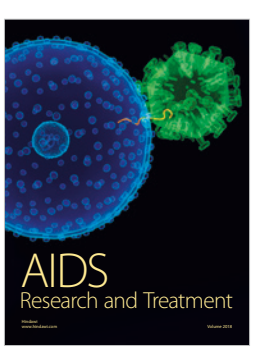


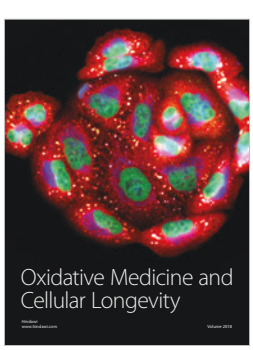












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