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Review Article

Psychopharmacology of Brazilian Native Plants Focusing on Mood: A Bibliographical Survey Followed by a Systematic Review

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Abstract

Given the difficulty of treating some psychiatric and neurodegenerative conditions, Brazil's rich biodiversity provides an optimal scenario for exploring therapeutic alternatives based on bioactive compounds from natural products. 30 non-scientific books were consulted to identify plants popularly used for any purposes related to feelings of well-being. Native species with four or more citations in different books were considered as most popular species, and underwent a systematic review in PubMed, LILACS and Periódicos CAPES databases, including articles in the area of psychopharmacology published up to December 2023, written in Portuguese, English or Spanish. The major use of the 27 native species identified in the survey was as stimulant or calmative, mainly through aqueous extractions of leaves and barks. The systematic review includes 568 articles on the psychopharmacological effects of 23 of the original 27 native species identified, from which 28 articles corresponds to clinical stage. Although most of the studies reviewed support the popular use attributed to some species, it is noteworthy that the vast majority relate to preliminary studies, especially on *in vitro* antioxidant activity, and that clinical studies are still very scarce. In this sense, this review may serve not only as a guide to the effects popularly and scientifically attributed to Brazilian flora products, but also to encourage future research and the development of alternative therapies against psychological stress.

Keywords: Brazilian flora; Non-scientific literature, Adaptogens; Psychopharmacology; Stress; Systematic review.

Introduction

Brazil is one of the most biodiverse countries in the world, as it is estimated that thousands of plant species are distributed along its six phytogeographic domains, being almost half of them endemic (Brazil Flora Group, 2022). This high level of biodiversity makes Brazilian flora an optimal scenario for the investigation of bioactive natural products. However, most plant-derived medicines currently approved focus on other disorders than the ones affecting the central nervous system. For instance, from 71 species in the List of Medicinal Plants of Interest to the Unified Health System in Brazil, only three are indicated for central nervous system disorders, all of them for anxiety (Silva et al., 2022).

It is estimated that one in eight people have some mental disorder in the worldwide population, with anxiety and depressive disorders being the most common problems (World Health Organization, 2022). Mental disorders are caused, among other factors, by physical and mental stress, and mechanisms that counteract some kind of stress are among the main focus of search for their therapies. Adaptogens are natural substances that provide organic resistance through an increase in its capacity to respond to stress by interacting with biomarkers such as corticosteroids and antioxidant enzymes (Mendes and Carlini, 2007). Adaptogens can improve not only physical resistance, but also mental performance, by counteracting stress with an nonspecific pharmacological mechanism (Panossian et al., 2021).

Since psychological stress affects emotional well-being and triggers neuroinflammatory and neuroendocrine responses, which can result in neuropsychiatric conditions (Salim, 2016), the psychological effects of adaptogens are an important matter of study, in respect of subjective feelings of well-being, such as happiness, tranquility, mood and motivation. This study focused on a literature review of Brazilian plants with popular use for general well-being and delightful moments, aiming to find the most common species used for this purpose and scientific studies that could provide support for these folk use and possible mechanisms involved.

Methodology

Survey about popular use

Non-scientific literature was consulted in order to find out plants popularly used for any purposes related to feelings of well-being, classified into six categories defined in Table 1. The list of related terms was updated every time that a new term and use were found during the survey. The literature consulted was composed of a total of 30 books, from which 27 were written in Portuguese, two in English and one in Spanish (Supplementary data 1).

The species with relevant use were included in a database designed for this study, containing its part, recommendation, preparation, posology and the source of the information. Spelling errors on books were identified and corrected manually, while synonyms were grouped under the scientific names currently accepted, according to Rio de Janeiro Botanical Garden (2023), Missouri Botanical Garden (2023), and IPNI (2023) databases. Species with four or more citations in different books were maintained as most popular species, and their origin and phytogeographic domains were determined according to the Rio de Janeiro Botanical Garden (2023) database. Threatened species were considered according to the Official List of Threatened Brazilian Flora Species (Ministério do Meio Ambiente, 2022). Only native or endemic species were selected for the systematic review of scientific literature.

Category	Description	Terms
Energy	Provide physical and mental boosts, enhance attention, mood and motivation; Physiological activation and sensory stimulation; arousal	Energy, energizer, restorative, vitalizing, rejuvenator, anti-ageing, brain stimulant, memory booster, exciting, uplifting, revitalizing Increases concentration, focus and cognitive function Prevents exhaustion, tiredness, weakness, asthenia, atonia, fatigue, lethargy, somnolence, drowsiness, indisposition and debility Helps with lack of attention, memory or energy Biomarkers: adrenaline, adenosine, ATP, acetylcholine/cholinergic transmission
Relaxation	Release the stress and anxiety accumulated in their hectic day to day lives;	Relaxing, calmative, tranquilizing, soothing, easeful, relaxation, sedative

	emotional state of low tension, absence of arousal	Possess restful properties and acts as a stress reliever, avoid anxiety, boredom, hysteria, nervousness, inquietude, uneasiness, insomnia and nervous breakdown Unwind, peaceful mind, restful sleep, central nervous system depression Biomarkers: cortisol/corticosterone
Happiness	Feelings of calm, satisfaction and contentment; In tune with the world around us, including pleasure, meaning and commitment	Pleasant, delightful, enjoyable, brings happiness Avoids loneliness and unhappiness, antidepressant Biomarkers: serotonin, positive mood
Euphoria/ Pleasure	Initiate a feeling or state of intense excitement and happiness; Associated with reward, containing liking and wanting	Pleasure and reward system Euphoria, excitement, joyousness, ecstasy, delight Biomarkers: dopamine, endorphins
Love/ Social bonding	Sensing a feeling of bonding and coherence; Familiar love, self-love, selfless love, enduring love; Involvement/attachment to families, other people, and activities, commitment to social norms and institutions	Love, helps with insight, introspection and self-examination Self-love, warmth, bonding Biomarkers: oxytocin
Arousal	Arousal, sensory alertness, desire, sexual wellness, romance	Aphrodisiac, sexual wellness, impotence Biomarkers: androgens, testosterone

Table 1: Mood states categories and possible psychopharmacological effects related.

Scientific evidence

Scientific literature was searched in PubMed, CAPES and LILACS databases. The search process was done using the scientific binomial name and identified synonyms of each plant selected previously as key-words, and we included studies published up to December 2023. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guideline was followed for the systematic review of the identified articles (Page et al., 2021).

Relevant studies were selected based on its title and abstract, when supporting the popular use or with potential central nervous system effect related to the present project. Studies were excluded if written in a language other than English, Spanish or Portuguese, or if the full text could not be obtained. Only experimental studies with plant extracts investigating its popular use were included: reviews and case-control studies or experiments with isolated compounds or plant mixtures were excluded from this review. Articles in which the scientific names of the species were not explicitly mentioned were also excluded.

The articles selected were fully read in order to confirm its validity to this review's purposes, which resulted in an inclusion of 568 studies (Figure 1).

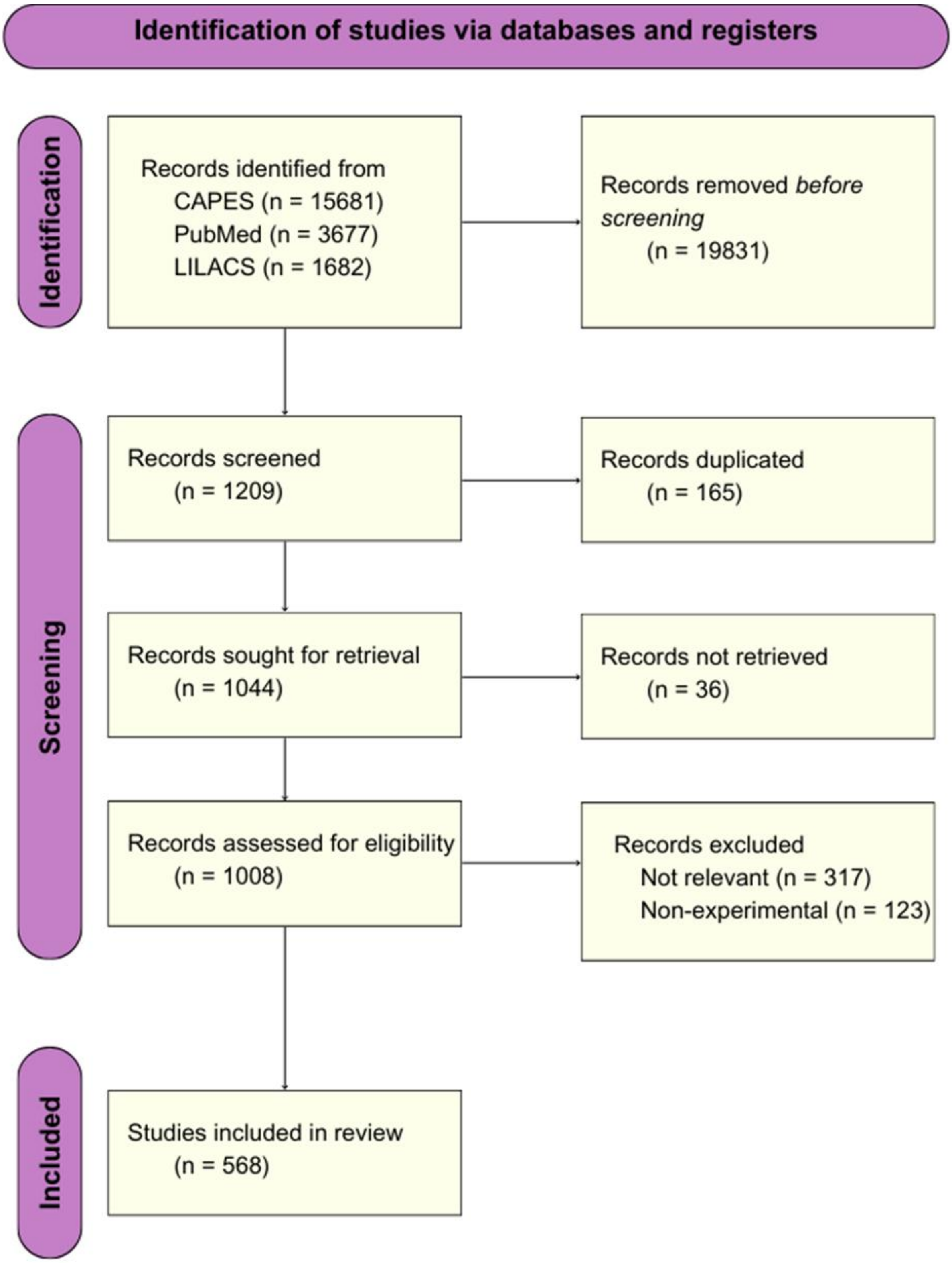

Figure 1: PRISMA flow diagram for new reviews which included searches of databases.

Results

The non-scientific literature survey identified 115 species cited in at least four books, being twenty-seven species native to Brazil (Table 2). Most species were cited in the books by their correct botanical name, but there are several cases of synonyms or invalid names, in which we had to change for the most accepted name. An example is the species "casca-de-anta", cited as *Drimys granadensis*, that we considered as *Drimys brasiliensis* subsp. *Brasiliensis*, according to the Rio de Janeiro Botanical Garden (2023). Another particular case is one of the species known as "catuaba" and cited as *Erythroxylum catuaba* in the survey, which was renamed to *Protium catuaba*, according to the synonym available in IPNI (2023).

From the 27 native species, five are endemic in Brazil (Rio de Janeiro Botanical Garden, 2023): *Aniba canelilla* (Kunth) Mez (Lauraceae), *Drimys brasiliensis* Miers subsp. *brasiliensis* (Winteraceae), *Himatanthus bracteatus* (A. DC.) Woodson (Apocynaceae), *Passiflora alata* Curtis (Passifloraceae) and *Protium catuaba* (Soares da Cunha) Daly & P.Fine (Burseraceae). Among the selected species, two are threatened: *Anemopaegma arvense* (Vell.) Stellfeld ex de Souza is considered endangered, while *P. catuaba* is considered vulnerable (Ministério do Meio Ambiente, 2022).

We did not find experimental studies with *D. brasiliensis* subsp. *brasiliensis*, *Himatanthus bracteatus*, *Protium catuaba* and *Pluchea sagittalis* related to psychopharmacological effects. The other 23 species resulted in at least one study investigating such effects, which added up to 568 relevant studies for the systematic review. In some cases, however, we only found studies when searching by the species synonyms, as occurred to three of them: *A. arvense*, found by *Anemopaegma mirandum*; *Aristolochia labiata*, by *Aristolochia brasiliensis*; and *P. catuaba*, by *Erythroxylum catuaba*. The 540 pre-clinical studies reviewed are shown in Table 3, while the 28 clinical trials are better presented in Table 4.

Scientific name (family)	**Synonyms**	**Popular name**	**Phytogeographic domains**	**Parts**	**Mode of use**	**Popular use**
Anacardium occidentale L. (Anacardiaceae)		Cajueiro, cajuzeiro	Amazon Rainforest, Caatinga, Central Brazilian Savanna, Atlantic Rainforest, Pampa, Pantanal	Bark, flowers, fruits, leaves, nuts	Cooking, decoction, juice, maceration	Aphrodisiac (Almeida, 1993; Alzugaray and Alzugaray, 2000; Bontempo, 1992; Cruz, 1965, Stasi and Hiruma-Lima, 2002; Moreira, 1978)
				Bark, peduncle	Cooking, decoction	Asthenia (Alzugaray and Alzugaray, 2000; Bontempo, 1992; Corrêa et al., 1998; Cruz, 1965, Stasi and Hiruma-Lima, 2002; Moreira, 1978)
				Bark	Cooking, decoction	Weakness (Alzugaray and Alzugaray, 2000; Bontempo, 1992; Cruz, 1965)
				Flowers, fruits, leaves, nuts	Juice, maceration	Exciting, stimulant (Almeida, 1993; Di Stasi and Hiruma-Lima, 2002)
				Bark, flowers, fruits, leaves	Cooking, decoction	Atonia (Cruz, 1965, Stasi and Hiruma-Lima, 2002)
				Peduncle		Central nervous system depressant (Corrêa et al., 1998)
				Nuts	Juice	Memory fortifying (Almeida, 1993)
				Bark	Cooking	Impotence (Cruz, 1965)
Anemopaegma arvense (Vell.) Stellfeld ex de Souza	*Anemopaegma mirandum*, *Bignonia arvensis*,	Catuaba, tatuaba, catuaba-verdadeira, verga-	Amazon Rainforest, Central Brazilian Savanna, Atlantic	Aerial parts, bark, leaves, rhizome, roots	Alcoholic preparations, decoction, tea, tincture, wine	Aphrodisiac (Albuquerque et al., 2018; Almeida, 1993; Almeida et al., 1998; Alzugaray and Alzugaray, 2000; Corrêa et al., 1998; Lorenzi and Matos, 2002; Moreira, 1978)

(Bignoniaceae)	*Bignonia miranda*	teso	Rainforest	Aerial parts, bark, roots	Alcoholic preparations, decoction, tea, tincture, wine	Memory (Albuquerque et al., 2018; Almeida, 1993; Alzugaray and Alzugaray, 2000; Lorenzi and Matos, 2002)
				Aerial parts, bark, roots	Alcoholic preparations, decoction, tea, tincture, wine	Stimulant (Albuquerque et al., 2018; Almeida, 1993; Lorenz i and Matos, 2002; Moreira, 1978)
				Bark, rhizome, roots	Decoction, tea, wine	Asthenia (Alzugaray and Alzugaray, 2000; Corrêa et al., 1998; Lorenzi and Matos, 2002)
				Bark, roots	Decoction, tea, tincture, wine	Energetic (Almeida, 1993; Alzugaray and Alzugaray, 2000; Lorenzi and Matos, 2002)
				Bark, roots	Decoction, tea, wine	Impotence (Matos, 1999, Balbachas, 1956; Lorenzi and Matos, 2002)
				Bark, roots	Decoction, tea, tincture, wine	Nervousness (Almeida, 1993; Alzugaray and Alzugaray, 2000; Lorenzi and Matos, 2002)
				Bark, rhizome, roots	Tea, wine	Anxiety (Corrêa et al,. 1998; Lorenzi and Matos, 2002)
				Bark, roots	Decoction, tea, wine	Insomnia (Alzugaray and Alzugaray, 2000; Lorenzi and Matos, 2002)
				Bark, roots	Decoction, tincture	Neurasthenia (Almeida, 1993; Lorenzi and Matos, 2002)
				Bark	Decoction, tincture	Agitated sleep, intimate weakness (Almeida, 1993)
				Bark, roots	Decoction	To raise up the nervous system (Balbach, 1969)
				Bark		Weakness (Matos, 1999)
Aniba canelilla (Kunth) Mez (Lauraceae)		Casca preciosa, folha preciosa	Amazon Rainforest, Central Brazilian Savanna, Atlantic Rainforest	Bark, leaves	Infusion, tea	Exciting, stimulant (Almeida, 1993; Balbach, 1969; Berg, 1982, Lorenzi and Matos, 2002)
				Bark, leaves	Tea	Nervous exhaustion (Berg, 1982, Lorenzi and Matos, 2002)
				Bark, leaves, seeds	Essential oil	Nervous tension (Albuquerque et al., 2018)
Aristolochia cymbifera Mart. & Zucc. (Aristolochiaceae)		Papo-de-peru, jarrinha, mil-homens	Central Brazilian Savanna, Atlantic Rainforest	Roots	Decoction	Hysteria (Almeida, 1993; Balbach, 1969; Balbachas, 1956; Cruz, 1965)
				Roots	Decoction	Sedative (Almeida, 1993; Balbach, 1969; Balbachas, 1956; Lorenzi and Matos, 2002)
						Weakness (Bontempo, 1992; Cruz, 1965)
						Stimulant (Cruz, 1965)

Aristolochia labiata Willd. (Aristolochiaceae)	*Aristolochia brasiliensis*	Papo-de-peru, angelicó, jarrinha, mil-homens	Caatinga, Central Brazilian Savanna, Atlantic Rainforest	Roots	Decoction	Sedative (Almeida, 1993; Balbach, 1969; Lorenzi and Matos, 2002)
				Roots	Decoction	Hysteria (Almeida, 1993; Balbach, 1969)
				Leaves, roots, stems		Anxiety (Corrêa et al., 1998)
Drimys brasiliensis Miers (Winteraceae)	*Drimys chilensis, Drimys winteri*	Casca-de-anta, para-tudo, casca-d'anta	Caatinga, Central Brazilian Savanna, Atlantic Rainforest	Bark	Bath, decoction	Stimulant (Almeida, 1993; Balbach, 1969; Balmé, 1982)
				Bark	Decoction	General weakness (Almeida, 1993; Balbach, 1969)
				Bark	Bath	Tiredness (Balmé, 1982)
Drimys brasiliensis Miers subsp. *brasiliensis* (Winteraceae)	*Drymis granadensis*[1]	Casca-de-anta, para-tudo, casca-d'anta	Central Brazilian Savanna	Bark	Decoction	General weakness (Balbachas, 1956; Bontempo, 1992; Cruz, 1965)
				Bark, leaves		Stimulant (Saint-Hilaire, 2009)
Erythrina crista-galli L. (Fabaceae)		Mulungu, flor-de-coral	Central Brazilian Savanna, Atlantic Rainforest, Pampa, Pantanal	Bark	Bath, decoction	Calmative (Almeida, 1993; Alzugaray and Alzugaray, 2000; Balbach, 1969; Balbachas, 1956)
				Bark	Bath	Insomnia (Almeida, 1993)
Erythrina mulungu Mart. (Fabaceae)		Mulungu	Central Brazilian Savanna	Bark	Bath, tea	Insomnia (Almeida, 1993; Balbach, 1969; Balbachas, 1956; Corrêa et al., 1998; Lorenzi and Matos, 2002)
				Bark	Bath, tea	Calmative (Almeida, 1993; Cruz, 1965; Lorenzi and Matos, 2002)
				Bark	Bath, tea	Anxiety (Corrêa et al., 1998; Lorenzi and Matos, 2002)
				Bark	Bath, tea	Psychomotor agitation (Corrêa et al., 1998; Lorenzi and Matos, 2002)
				Bark	Tea	Hysteria, nervous tension, sedative (Lorenzi and Matos, 2002)
						Nervous agitation (Cruz, 1965)
Erythroxylum coca Lam. (Erythroxylaceae)		Coca	Amazon Rainforest	Leaves	Elixir, infusion	Brain stimulant (Alzugaray and Alzugaray, 2000; Moreira, 1978)
				Leaves	Elixir, wine	Exhaustion (Alzugaray and Alzugaray, 2000; Balmé, 1982)
						Nervous manifestation, recover organic losses, tiredness, vital energy (Cruz, 1965)
						Antifatigue, calmative, restorative of central nervous system (Alzugaray and Alzugaray, 2000)
Himatanthus	*Plumeria lancifolia*	Agoniada	Atlantic Rainforest	Leaves	Infusion	Hysteria (Balbach, 1969; Balbachas, 1956)

bracteatus (A. DC.) Woodson (Apocynaceae)				Bark		Anxiety (Corrêa et al, 1998)
				Bark	Cooking	General weakness (Cruz, 1965)
Hymenaea courbaril L. (Fabaceae)		Jatobá	Amazon Rainforest, Caatinga, Central Brazilian Savanna, Atlantic Rainforest, Pantanal	Bark, resin, sap	Cooking, wine	Fortifier (Bontempo, 1992; Cruz, 1965; Di-Stasi and Hiruma-Lima, 2002; Lorenzi and Matos, 2002)
				Bark, fruits, resin	Cooking	Weakness (Bontempo, 1992; Matos, 1999)
						Nervousness (Cabral-Born, 2009)
						Fatigue, sedative (Lorenzi and Matos, 2002)
Ilex paraguariensis A.St.-Hil. (Aquifoliaceae)		Erva-mate, mate	Caatinga, Central Brazilian Savanna, Atlantic Rainforest, Pampa	Leaves	Infusion	Stimulant (Alzugaray and Alzugaray, 2000; Bontempo, 1992; Lorenzi and Matos, 2002; Simões et al., 1986)
					Infusion	Vitalizing (Alzugaray and Alzugaray, 2000; Cruz, 1965)
				Leaves	Infusion	Muscular and mental fatigue (Lorenzi and Matos, 2002)
						Provides strength and energy, fatigue resistance (Cruz, 1965)
					Infusion	Tiredness (Alzugaray and Alzugaray, 2000)
Indigofera suffruticosa Mill. (Fabaceae)	*Indigofera anil*	Anil, anileiro	Amazon Rainforest, Caatinga, Central Brazilian Savanna, Atlantic Rainforest, Pampa	Leaves, roots	Infusion	Sedative (Almeida, 1993; Alzugaray and Alzugaray, 2000; Balbach, 1969; Balbachas, 1956)
Lippia alba (Mill.) N.E.Br. ex Britton & P.Wilson (Verbenaceae)	*Lantana alba*, *Lippia citrata*, *Lippia geminata*	Erva-cidreira, falsa-melissa, erva-cidreira-brasileira, erva-cidreira-de-arbusto	Amazon Rainforest, Caatinga, Central Brazilian Savanna, Atlantic Rainforest, Pampa, Pantanal	Leaves, roots	Alcoholic extracts, bath, compress, decoction, infusion, syrup, tea	Sedative (Albuquerque et al., 2018; Gutiérrez et al., 2010; Haragushi and Carvalho, 2010; Lorenzi and Matos, 2002; Matos, 1999)
				Leaves, roots	Alcoholic extracts, bath, boiling, compress, decoction, infusion, tea	Calmative (Cabral-Born, 2009; Di Stasi and Hiruma-Lima, 2002; Gutiérrez et al., 2010; Junior et al., 2013; Lorenzi and Matos, 2002)
				Leaves, roots	Infusion	Insomnia (Almeida, 1993; Di Stasi and Hiruma-Lima, 2002; Haragushi and Carvalho, 2010)
				Leaves, roots	Tea	Hysteria (Almeida, 1993; Balbach, 1969; Balbachas, 1956)

				Leaves, roots	Alcoholic extracts, bath, compress, infusion, syrup, tea	Anxiety (Albuquerque et al., 2010; Lorenzi and Matos, 2002)
				Leaves	Tea	Lethargy, strengthen brain and nerves (Balbach, 1969; Balbachas, 1956)
				Leaves	Tea	Nervousness (Lorenzi and Matos, 2002; Matos, 1999)
				Leaves, roots	Alcoholic extracts, bath, compress, decoction, infusion, syrup	Tranquilizer (Albuquerque et al., 2018; Gutiérrez et al., 2010)
				Leaves	Infusion	Dizziness (Haragushi and Carvalho, 2010)
				Leaves		Inquietude (Matos, 1999)
				Leaves	Tea	Uneasiness (Lorenzi and Matos; 2002)
Passiflora alata Curtis (Passiflora ceae)		Maracuj azeiro, maracujá -doce	Amazon Rainforest, Central Brazilian Savanna, Atlantic Rainforest, Pampa	Fruits, leaves, roots	Decoction, infusion	Insomnia (Corrêa et al., 1998; Junior et al., 2013; Lorenzi and Matos, 2002)
				Fruits, leaves, roots	Infusion	Anxiety (Corrêa et al., 1998; Junior et al., 2013)
				Leaves	Decoction	Calmative (Lorenzi and Matos, 2002; Simões et al., 1986)
				Fruits, leaves, roots		Central nervous system depressant (Corrêa et al., 1998)
				Leaves	Decoction	Nervousness (Lorenzi and Matos, 2002)
				Leaves		Sedative (Simões et al., 1986)
Passiflora edulis Sims (Passiflora ceae)		Maracuj á, maracujá -azedo	Amazon Rainforest, Caatinga, Central Brazilian Savanna, Atlantic Rainforest, Pampa, Pantanal	Fruits, leaves, roots	Decoction, infusion	Insomnia (Almeida, 1993; Corrêa et al., 1998; Haragushi and Carvalho, 2010; Junior et al., 2013; Lorenzi and Matos, 2002; Matos, 1999)
				Fruits, leaves, roots	Decoction, infusion	Anxiety (Corrêa et al., 1998; Haragushi and Carvalho, 2010; Junior et al., 2013)
				Fruits, leaves	Boiling, decoction	Nervousness (Cabral-Born, 2009; Lorenzi and Matos, 2002; Matos, 1999)
				Leaves	Decoction, infusion	Calmative (Haragushi and Carvalho, 2010; Lorenzi and Matos, 2002)
				Fruits, leaves, roots		Central nervous system depressant (Almeida, 1993; Corrêa et al., 1998)

				Leaves		Hysteria, neurasthenia, sedative (Almeida, 1993)
Passiflora quadrangularis L. (Passifloraceae)		Maracujá-açu	Amazon Rainforest, Caatinga, Central Brazilian Savanna, Atlantic Rainforest, Pampa, Pantanal	Leaves	Infusion	Insomnia (Alzugaray and Alzugaray, 2000; Balbach, 1969; Balbachas, 1956; Cruz, 1965)
				Leaves	Infusion	Neurasthenia (Balbach, 1969; Balbachas, 1956; Cruz, 1965)
				Leaves	Infusion	Calmative (Alzugaray and Alzugaray, 2000; Balbachas, 1956)
				Leaves	Infusion	Nervous breakdown (Balbach, 1969; Balbachas, 1956)
				Leaves	Infusion	Sedative (Alzugaray and Alzugaray, 2000; Cruz, 1965)
						Anaphrodisiac, depression (Balbach, 1969)
Paullinia cupana Kunth (Sapindaceae)	*Paulinia cupana* var. *sorbilis*, *Paullinia sorbilis*	Guaraná, guaranazeiro	Amazon Rainforest	Seeds	Capsule, infusion, powder, syrup, tea	Stimulant (Almeida, 1993; Alzugaray and Alzugaray, 2000; Berg, 1982; Haraguchi and Carvalho, 2010; Junior et al., 2013; Lorenzi and Matos, 2002; Simões et al., 1986)
				Seeds		Asthenia (Almeida, 1993; Corrêa et al., 1998; Cruz, 1965)
				Seeds	Capsule, powder, syrup, tea	Aphrodisiac (Berg, 1982; Junior et al., 2013)
				Seeds	Infusion	Depression (Almeida, 1993; Alzugaray and Alzugaray, 2000)
					Capsule, syrup, tea	Fatigue (Junior et al., 2013; Lorenzi and Matos, 2002)
				Seeds		Indisposition (Corrêa et al., 1998; Matos, 1999)
				Seeds	Capsule, syrup, tea	Physical and mental exhaustion (Corrêa et al., 1998; Junior et al., 2013)
				Seeds		Weakness (Bontempo, 1992; Matos, 1999)
						Atonia, to favor intellectual activity (Almeida, 1993)
						Calmative, general well-being (Cruz, 1965)
				Seeds		Drowsiness (Matos, 1999)
						Early aging, fatigue (Lorenzi and Matos, 2002)
						Invigorating (Bontempo, 1992)
					Capsule, syrup, tea	Somnolence (Junior et al., 2013)
Pluchea sagittalis	*Pluchea quitoc*	Quitoco	Amazon Rainforest,	Leaves, stems	Bath	Hysteria (Balbach, 1969; Balbachas, 1956; Cruz, 1965;

(Lam.) Cabrera (Asteraceae)			Caatinga, Central Brazilian Savanna, Atlantic Rainforest, Pampa			Lorenzi and Matos, 2002)
				Leaves, stems	Bath	Stimulant (Balbach, 1969; Balbachas, 1956)
				Leaves, stems		Anxiety, insomnia (Corrêa et al., 1998)
Protium catuaba (Soares da Cunha) Daly & P.Fine (Burseraceae)	*Erythroxylum catuaba*[2]	Catuaba, tatuaba	Atlantic Rainforest	Bark	Decoction, tincture	Aphrodisiac, stimulant (Almeida, 1993; Bontempo, 1992; Cruz, 1965)
				Bark	Decoction	Impotence (Balbachas, 1956; Bontempo, 1992; Cruz, 1965)
				Bark	Decoction, tincture	Neurasthenia (Almeida, 1993; Cruz, 1965)
				Bark	Decoction, tincture	Agitated sleep, energetic, intimate weakness, nervousness, memory (Almeida, 1993)
						Insomnia, nervous affections, to strengthen the nervous system (Cruz, 1965)
				Bark	Decoction	To raise up the nervous system (Balbach, 1969)
Ptychopetalum olacoides Benth. (Olacaceae)		Marapuama, muirapuama	Amazon Rainforest	Branches, roots, stems	Tea	Impotence (Almeida, 1993; Balbach, 1969; Balbachas, 1956; Lorenzi and Matos, 2002)
				Branches, roots, stems		Asthenia (Almeida, 1993; Balbach, 1969; Corrêa et al., 1998)
				Branches, roots, stems		Weakness (Almeida, 1993; Balbach, 1969; Balbachas, 1956)
				Roots	Alcoholic preparations, dried and ground, tea	Aphrodisiac (Albuquerque et al., 2018; Lorenzi and Matos, 2002)
				Roots	Alcoholic preparations, dried and ground, tea	Antifatigue, debility, improve cognitive function, neurasthenia (Albuquerque et al., 2018)
				Roots, stems		Indisposition (Corrêa et al., 1998)
Schinus terebinthifolia Raddi (Anacardiaceae)	*Schinus antiarthritica*, *Schinus terebinthifolius*, *Schinus terebinthifolius* var. *selloana*	Aroeira, aroeira-mansa, aroeira-vermelha	Caatinga, Central Brazilian Savanna, Atlantic Rainforest, Pampa			Atonia (Balbach, 1969)
						Calmative, impotence (Cruz, 1965)
						Stimulant (Di Stasi and Hiruma-Lima, 2002)

Sonchus oleraceus L. (Asteraceae)	*Sonchus laevis*	Serralha, chicória-brava	Caatinga, Central Brazilian Savanna, Atlantic Rainforest	Leaves	Cooking, decoction	To strengthen nerve/nervous system (Balbach, 1969; Bontempo, 1992; Cruz, 1965)
				Whole plant		Asthenia (Corrêa et al., 1998; Lorenzi and Matos, 2002)
Theobroma cacao L. (Malvaceae)		Cacau, cacaueiro	Amazon Rainforest, Atlantic Rainforest	Seeds		Weakness (Alzugaray and Alzugaray, 2000; Matos, 1999)
				Seeds		Drowsiness (Matos, 1999)
				Seeds		Energetic, stimulant (Lorenzi and Matos, 2002)
						Excitatory of brain functions, exhaustion (Alzugaray and Alzugaray, 2000)
						Nervous exciting (Balmé, 1982)
Turnera diffusa Willd. ex Schult. (Turneraceae)	*Turnera aphrodisiaca*	Damiana	Caatinga, Central Brazilian Savanna, Atlantic Rainforest		Tincture	Aphrodisiac (Alzugaray and Alzugaray, 2000; Moreira, 1978; Thomson, 1978)
					Tincture	Stimulant (Alzugaray and Alzugaray, 2000; Balbach, 1969; Moreira, 1978)
				Leaves	Infusion	Impotence (Balbach 1969; Morgan, 1979)
						Debility, exhaustion, nervousness (Thomson, 1978)
						Neurasthenia (Moreira, 1978)
Xylopia aromatica (Lam.) Mart. (Annonaceae)		Pimenta-dos-negros, pimenta-de-macaco	Amazon Rainforest, Central Brazilian Savanna	Bark, seeds	Pulverized roasted seeds, tincture	Exciting, stimulant (Almeida, 1993; Balbach, 1969; Berg, 1982; Lorenzi and Matos, 2002)
				Bark, seeds	Pulverized roasted seeds, tincture	Aphrodisiac (Berg, 1982; Lorenzi and Matos, 2002)

[1] Uncertain scientific identification, as considered a misapplied name by the used database (Rio de Janeiro Botanical Garden, 2023).
[2] Although an unaccepted scientific name, it was considered a synonym due to the high frequency of its application in popular literature.

Table 2: List of popular plants from non-scientific literature.

Scientific name (family)	Properties	Experimental investigation	Reference
Anacardium occidentale L. (Anacardiaceae)	Antioxidant	ABTS, DPPH, NO and cationic scavenging activity; β-carotene bleaching assay; FIC; ORAC; MDA and ROS levels reduction; increased antioxidant enzymatic activity; reducing power	(Abas et al., 2006; Ajileye et al., 2015; Akomolafe and Asowata-Ayodele, 2022; Andrade et al., 2023, 2011; Anyaegbu et al., 2017; Bini et al., 2023; Broinizi et al., 2007, 2008; Chaikhong et al., 2022; Chaves et al., 2010; Chotphruethipong et al., 2017; Cruz Reina et al., 2022; R. A. Da Silva et al., 2013; De Carvalho et al., 2018; De Lima et al., 2014; Duangjan

			et al., 2019, 2021; Elekofehinti et al., 2016; Encarnação et al., 2016; Gomes et al., 2013; Gordon et al., 2012; Indirayati et al., 2020; Junsathian et al., 2018; Kamath and Rajini, 2007; Kongkachuichai et al., 2015; Lopes et al., 2012; Melo Cavalcante et al., 2003; Melo et al., 2008; Moo-Huchin et al., 2015; Oloruntola, 2021; Oyedemi et al., 2017; Pereira et al., 2015; Porto-Luz et al., 2020; Queiroz et al., 2010, 2011; Quesado Junior et al., 2017; Razab and Abdul-Aziz, 2010; Razali et al., 2008; Ribeiro et al., 2021; Santana Andrade et al., 2022; J. A. S. Santos et al., 2018; Sija et al., 2019; Silva et al., 2021; Soares et al., 2013; Souza et al., 2017; Srichomphu et al., 2022; Sulbarán et al., 2013; Trevisan et al., 2006; Vieira et al., 2011; Zielinski et al., 2014b)
	Neuroprotective	Inhibited $A\beta_{1-42}$ aggregation; protected SK-N-SH cells against H_2O_2	(Junsathian et al., 2018)
		Protected HT22 and Neuro-2a cells against glutamate and H_2O_2-induced toxicity	(Duangjan et al., 2021)
		Inhibited nitric oxide production in stimulated BV-2 cells	(Iwuanyanwu et al., 2023; Olajide et al., 2013)
		Protected HT22 cells against hemozoin-induced damage and hCMED/D3 cells against increased permeability	(Iwuanyanwu et al., 2023)
	Neuromodulation	AChE and BChE inhibition	(Akomolafe and Asowata-Ayodele, 2022; Bini et al., 2023; Srichomphu et al., 2022)
		MAO inhibition	(Akomolafe and Asowata-Ayodele, 2022; Srichomphu et al., 2022; Wattanathorn et al., 2018)
		Reduced GABA-transaminase activity	(Srichomphu et al., 2022)
		Increased neurite length	(Duangjan et al., 2021)
		Increased tyrosine hydroxylase positive neuronal density in *nucleus accumbens*	(Wattanathorn et al., 2018)
	Anti-ageing	Increased *C. elegans* pharynx pumping rate and lifespan	(Duangjan et al., 2019)
	Memory enhancer	Reduced escape latency time and increased retention time on Morris water maze	(Srichomphu et al., 2022)
	Sedative	Reduced spontaneous locomotion	(D. P. B. Da Silva et al., 2018)
	Hypnotic	Reduced latency and increased time of pentobarbital-induced sleep	(Srichomphu et al., 2022)

		No effect on pentobarbital-induced sleep	(D. P. B. Da Silva et al., 2018)
	Anxiolytic	Increased time spent and entries on elevated plus maze open arms	(Srichomphu et al., 2022)
	Antidepressant	No effect on forced swim test	(Srichomphu et al., 2022)
	Aphrodisiac	Reverted stress-induced sexual behavior impairment; increased testosterone serum	(Wattanathorn et al., 2018)
	Antistress	Reduced corticosterone levels	(Wattanathorn et al., 2018)
Anemopaegma arvense (Vell.) Stellfeld ex de Souza (Bignoniaceae)	Neuroprotective	Protected SH-SY5Y against rotenone-induced toxicity	(De Andrade et al., 2008)
Aniba canelilla (Kunth) Mez (Lauraceae)	Antioxidant	ABTS and DPPH scavenging activity	(Cruz et al., 2023; J. K. R. Da Silva et al., 2007; Martins et al., 2016)
	Neuromodulation	AChE inhibition	(N. N. S. Silva et al., 2014)
	Memory enhancing	Reverted scopolamine-induced damage on Morris water maze	(De Campos et al., 2023)
Aristolochia cymbifera Mart. & Zucc. (Aristolochiaceae)	Antioxidant	DPPH scavenging activity	(Alviano et al., 2008)
Aristolochia labiata Willd. (Aristolochiaceae)	Antioxidant	DPPH scavenging activity; inhibition of linoleic acid oxidation; reducing power	(Thirugnanasampandan et al., 2008)
Drimys brasiliensis Miers (Winteraceae)	Antioxidant	ABTS and DPPH scavenging activity; reducing power; ORAC	(Barrientos et al., 2023; Bridi et al., 2019; Fonseca Gomes et al., 2013)
	Neuromodulator	AChE and BChE inhibition	(Barrientos et al., 2023)
Erythrina crista-galli L. (Fabaceae)	Antioxidant	DPPH scavenging activity	(Deviani et al., 2022)
Erythrina mulungu Mart. (Fabaceae)	Neuromodulator	Nicotinic receptor blockade	(Setti-Perdigão et al., 2013)
	Sedative	Reduced entries on elevated plus maze arms and locomotor activity on open field test; no effects on rotarod test	(Vasconcelos et al., 2010)
	Anxiolytic	Reduced avoidance latency on elevated T-maze	(Flausino, et al., 2007; Onusic et al., 2003, 2002)
		Increased time spent in the light compartment on light-dark transition	(Flausino, Jr. et al., 2007; Onusic et al., 2003, 2002)
		No effect on elevated plus maze	(Flausino, Jr. et al., 2007)
	Antidepressant	No effect in immobility time on forced swim test	(Ribeiro et al., 2006)
Erythroxylum	Antioxidant	DPPH scavenging activity; ORAC	(Gamarra Ochoa et al., 2018; Poblete

coca Lam. (Erythroxylaceae)			et al., 2009)
Hymenaea courbaril L. (Fabaceae)	Antioxidant	ABTS, DPPH and superoxide scavenging activity; reducing power	(G. P. Bezerra et al., 2013; Cassol et al., 2019; Everton et al., 2021; Mello-Peixoto et al., 2013; Menezes Filho et al., 2020; Pereira Santos et al., 2020; Ruth et al., 2021; Scaramussa et al., 2024; Spera et al., 2019; Suzuki et al., 2008)
Ilex paraguariensis A.St.-Hil. (Aquifoliaceae)	Antioxidant	ABTS, DPPH and cationic scavenging activity; ORAC; FIC; increased antioxidant enzymatic activity; MDA and ROS levels reduction; increased survival against malonic and methylmalonic acids; inhibition of liposomal oxidation; β-carotene bleaching assay; reducing power	(Akbarmehr et al., 2023; Al Khoury et al., 2022; Anesini et al., 2006; Baeza et al., 2018; Bassani et al., 2014; Bastos et al., 2007, 2006; Berté et al., 2011; Bixby et al., 2005; Bracesco et al., 2003; C. Branco et al., 2013; C. D. S. Branco et al., 2013; Bravo et al., 2007, 2014; Campos et al., 1996; Carini et al., 1999; Chandra and Gonzalez De Mejia, 2004; Chen et al., 2017; Cittadini et al., 2015; Cogoi et al., 2023; Colpo et al., 2016, 2017, 2007; Contreras-Esquivel et al., 2022; Correa et al., 2019; Dabulici et al., 2020; De Gois et al., 2016; Dudonné et al., 2009; Efing et al., 2009; Erol et al., 2009; Fantinelli et al., 2016; Farias et al., 2021; Fernandes et al., 2016, 2017; Filip et al., 2000; Flieger et al., 2021; Gorjanović et al., 2012; Gremski et al., 2019; Hartwig et al., 2012; Kaezer, 2013; Konieczynski et al., 2017; Leonard et al., 2010; Lima et al., 2014; Lopes et al., 2021; López Córdoba et al., 2013; López-Córdoba et al., 2014; M. L. Machado et al., 2021; Mateos et al., 2018; Mateus et al., 2023; Mello and Kubota, 2014; Menini et al., 2007; Mesquita et al., 2021; Milioli et al., 2007; Miranda et al., 2017; Niraula et al., 2018; Oh et al., 2016; Pagliosa et al., 2010; Peralta et al., 2013; Pereira, 2015; Piovezan-Borges et al., 2016; Portela et al., 2019; Rakeli Simão Boyarski et al., 2020; Ranilla et al., 2010; Reis et al., 2014; Riachi et al., 2018; Rivelli, 2011; Rivelli et al., 2011; Rząsa-Duran et al., 2022; Saldanha, 2005, 2012; Santa-Helena et al., 2022; Santos et al., 2000, 2015; J. S. Santos et al., 2018; Santos et al., 2020; Sari et al., 2007; Schinella et al., 2000; Schubert et al., 2007; Souza et al., 2015; Souza, 2009; Tamagno et al., 2022; Teselkin et al., 2021, 2022; Tlili and Sarikurkcu, 2020; Valduga et al., 2016; Vieira et al., 2011; Vieitez et al., 2018; Zielinski et al., 2014b,

			2014b)
	Neuromodulation	Effect upon AChE dependent on brain region	(Bortoli et al., 2018; C. Branco et al., 2013; M. L. Machado et al., 2021; Ramallo et al., 2015; Santos et al., 2015; Vanin Dos Santos Lima et al., 2022)
		No effect on MAO inhibition	(Reis et al., 2014)
		Antidepressant effect dependent on NMDA receptors and nitric oxide	(Ludka et al., 2016)
		Reduced normetanephrine levels increased by stress	(Romana-Souza et al., 2015)
	Neuroprotection	Inhibition of amyloid β-structures aggregation	(Cogoi et al., 2023)
		Reduced lipid peroxides in telencephalon, and increased in midbrain and cerebellum	(Miranda et al., 2017)
		Protected hippocampal and cortical slices against glutamate-induced toxicity	(Ludka et al., 2016)
		Increased myelination, gray matter count and density in brain of lung adenocarcinoma-bearing mice; no effects on brain lipid peroxides	(Cittadini et al., 2019a, 2019b)
		Prevented dopaminergic neuronal death and increased axonal length and branching	(Bernardi et al., 2019)
		Reduced stress-induced cellular damage in cortex, hippocampus and striatum	(De Lima et al., 2019)
	Locomotion	Reduced MPTP-induced hypolocomotion and reserpine-induced catalepsy	(Milioli et al., 2007)
		Reverted locomotor alterations induced by methylmalonic and malonic acids exposure	(Portela et al., 2019)
		Delayed $A\beta_{1-42}$-induced paralysis	(M. L. Machado et al., 2021)
		Prevented motor alteration in stressed rats on open field test	(De Lima et al., 2019)
	Memory enhancer	Aqueous extract prevented scopolamine-induced memory impairment on step-down avoidance task, but hydroethanolic extract induced impairment	(Santos et al., 2015)
		Reduced haloperidol-induced memory dysfunction on Morris water maze	(Colpo et al., 2007)
		Decreased investigation time on social recognition test; increased latency on step-down inhibitory avoidance task; increased latency on Morris water maze only with	(Prediger et al., 2008)

		high doses (250 mg/kg)	
	Anxiolytic	Reduced burying behavior on marble burying test; increased time and entries on elevated plus maze open arms	(Mesquita et al., 2021)
		Increased time spent and number of entries on elevated plus maze open arms; increased number of entries into open field central zone	(Santos et al., 2015)
		No effect on elevated plus maze parameters	(Reis et al., 2014)
		Increased number of entries on elevated plus maze closed arms, while reducing time spent	(De Lima et al., 2019)
	Antidepressant	Reduced immobility time on forced swim test	(Reis et al., 2014)
		Reduced immobility time on tail suspension test	(Ludka et al., 2016)
	Anti-ageing	Extended lifespan	(Lanzetti et al., 2013; Lima et al., 2014; M. L. Machado et al., 2021; Niraula et al., 2018)
		Reduced lifespan in high doses (50 mg/mL)	(Niraula et al., 2018)
	Energetic	No effect on physical performance during exercise	(Saldanha, 2012)
		Increased energy expenditure by VCO_2/VCO_2 ratio	(Choi et al., 2017)
	Antistress	Increased survival against environmental stresses induced by starvation, paraquat and desiccation	(Niraula et al., 2018)
Indigofera suffruticosa Mill. (Fabaceae)	Antioxidant	DPPH scavenging activity	(Arriaga et al., 2013)
	Neuromodulation	Increased glycine and reduced glutamic acid concentration in serum, without affecting tyrosine, phenylalanine or tryptophan	(Bu Wong et al., 1999)
Lippia alba (Mill.) N.E.Br. ex Britton & P.Wilson (Verbenaceae)	Antioxidant	ABTS, DPPH and cationic scavenging activity; ORAC; inhibition of linoleic acid oxidation; MDA levels reduction; increased antioxidant enzymatic activity; β-carotene bleaching assay; reducing power	(Azambuja et al., 2011; Barros et al., 2022; Celis et al., 2007; Chies et al., 2013; Da Silva Port's et al., 2013; Farias et al., 2019; Finamor et al., 2023; Hay et al., 2018; Jaramillo-Colorado et al., 2020; Joshi et al., 2018; L. et al., 2017; Morais et al., 2013, 2009; Nunes et al., 2018; Parodi et al., 2012; Puertas-Mejía et al., 2002; Ramos et al., 2003; Rodríguez-Sevilla et al., 2014a, 2014b; Santos Filho et al., 2023; Stashenko et al., 2014, 2004; Teixeira De Oliveira et al., 2018; Varón et al., 2007)
	Neuromodulatio	AChE inhibition	(Morais et al., 2013)

	n	No effect on AChE levels	(Salbego et al., 2014)
		Anxiolytic activity dependent of $GABA_A$ and $5\text{-}HT_{3a/b}$	(Nonato et al., 2023)
		Dendritogenesis	(Velásquez et al., 2023)
		Diazepam potentiation dependent of GABAergic system	(Heldwein et al., 2014)
	Sedative	Decreased time spent and increased number of falls on rotarod	(Zétola et al., 2002)
		Reduced rearing on open field test, number of entries and time on elevated plus maze open arms; reduced time on rotarod	(Vale et al., 1999)
		Reduced locomotion	(Nonato et al., 2023)
		Induced immobilization in *Drosophila melanogaster*	(L. V. F. Da Silva et al., 2018)
		Induced deep anesthesia and death in *Neohelice granulata*	(Souza et al., 2018)
		Anesthesia induction	(Heldwein et al., 2014; Kampke et al., 2018; Postay et al., 2021; Toni et al., 2015)
	Hypnotic	Increased time and reduced latency on pentobarbital-induced sleep	(Zétola et al., 2002)
		Increased ketamine-induced sleeping time	(Fauth et al., 2002)
	Anxiolytic	Increased permanence in the light compartment on light-dark test	(Nonato et al., 2023)
		Increased time of entries on elevated plus maze open arms	(Vale et al., 1999)
		Reduced avoidance latency on elevated T-maze	(Hatano et al., 2012)
		Potentiate diazepam reduction of anesthesia time induction	(Heldwein et al., 2012)
		Increased number of entries in the upper zone on novel tank test	(Junior et al., 2018)
	Antistress	Reduced cortisol levels	(De Freitas Souza et al., 2018; Junior et al., 2018)
		Increased cortisol levels	(Becker et al., 2016)
		No effect on cortisol levels	(Toni et al., 2015)
Passiflora alata Curtis (Passifloraceae)	Antioxidant	ABTS and DPPH scavenging activity; β-carotene bleaching assay; ORAC; MDA levels reduction; reducing power	(Colomeu et al., 2014; Doyama et al., 2005; Lugato et al., 2014; Muniz et al., 2023; Ożarowski et al., 2019; Reis et al., 2020; Rudnicki et al., 2007; Santana and Mancini-Filho, 2015; Vasic et al., 2012; Viera et al., 2022)
	Memory enhancer	No effect on memory acquisition in step-down inhibitory avoidance task	(Barbosa et al., 2008)
	Sedative	Reduced entries on elevated plus	(Romanini et al., 2006)

		maze closed arms and spontaneous locomotor activity in open field test	
		Reduced spontaneous motor activity and antagonized amphetamine-induced hyperlocomotion	(Oga et al., 1984)
		Decreased spontaneous locomotor activity	(Klein et al., 2014)
	Hypnotic	Increased pentobarbital-induced sleeping time	(Oga et al., 1984)
	Anxiolytic	Increased entries in elevated plus maze open arms	(Barbosa et al., 2008)
		Increased time spent in elevated plus maze open arms	(Petry et al., 2001)
		No effects on stress-induced rats in elevated plus maze	(Airton et al., 2022)
	Antidepressant	No effects on forced swim test	(Airton et al., 2022)
Passiflora edulis Sims (Passifloraceae)	Antioxidant	ABTS, DPPH and cationic scavenging activity; β-carotene bleaching assay; ORAC; FIC; MDA levels reduction; increased antioxidant enzymatic activity; xanthine oxidase system's inhibition; reducing power	(Aguillón Osma et al., 2013; Aguillón-Osma et al., 2019; Barbosa Santos et al., 2021; Baseggio et al., 2022; Cahyanti et al., 2021; Cazarin et al., 2014; Cruz et al., 2021; Da Costa et al., 2023; J. K. Da Silva et al., 2013; De Oliveira et al., 2016; De Santana et al., 2017; De Souza et al., 2012; Devaki and Sunitha, 2009; Dos Santos et al., 2022, 2023, 2021; Doungue et al., 2018; Ferreira et al., 2011; Ferreres et al., 2007; Franco et al., 2014; García-Cardona et al., 2021a, 2021b; Guimarães et al., 2020; Gunathilake et al., 2018; Huo et al., 2023; Jorge et al., 2009; Lima et al., 2018; López-Vargas et al., 2013; Lourith and Kanlayavattanakul, 2013; Martins et al., 2015; Montoya Yepes et al., 2021; Moreno et al., 2015; Muntafiah et al., 2022; Naranjo-Durán et al., 2023; Ngibad et al., 2023; D. A. Oliveira et al., 2016; Panelli et al., 2018; Pardo-Jumbo et al., 2017; Pereira et al., 2019; Pham et al., 2020; Pineli et al., 2015; Purohit et al., 2021; Maria Cristina Copello Rotili et al., 2013; Maria Cristina C Rotili et al., 2013; Rudnicki et al., 2007; Sánchez et al., 2010; Santana and Mancini-Filho, 2015; Sie et al., 2023; Sukketsiri et al., 2023; Vagula et al., 2019; Viera et al., 2022; Weber et al., 2021; Wong et al., 2014; Xiong et al., 2019; Yepes et al., 2021; Zeraik et al., 2012)
	Neuromodulation	AChE inhibition	(Dos Santos et al., 2021; Doungue et al., 2018; Lima et al., 2018; Mostefa

			et al., 2023)
		Increased GABA levels on brain tissue	(Otify et al., 2015)
		Antidepressant effect dependent on DA/5-HT transmission	(Ayres et al., 2017)
	Neuroprotection	Increased $A\beta_{1-40}$ and reduced $A\beta_{1-42}$ levels and $AlCl_3$ hippocampal neurodegeneration	(Doungue et al., 2018)
		Reduced neurodegeneration induced by acetylcholine and glutamate	(Cao et al., 2022)
	Locomotion	No effect on rotarod	(Figueiredo et al., 2016; Maluf et al., 1991)
		No effect on wire or chimney test	(Coleta et al., 2006)
	Memory enhancing	No effect on memory acquisition in step-down inhibitory avoidance task	(Barbosa et al., 2008)
		Reverted $AlCl_3$-induced impairment on Morris water maze	(Doungue et al., 2018; Mostefa et al., 2023)
		Reduced number of errors and increased visit score and time in illuminated arm on arm radial maze	(Mostefa et al., 2023)
		Inhibited chemotaxic memory loss induced by $A\beta_{1-42}$ expression	(Cao et al., 2022)
	Sedative	Reduced head-dipping and rearing on elevated plus maze	(Li et al., 2011)
		Reduced locomotor activity on open field test	(Ayres et al., 2015, p. 201; Deng et al., 2010; Figueiredo et al., 2016; Klein et al., 2014)
	Hypnotic	Increased pentobarbital sleeping-time	(Maluf et al., 1991)
		No effect on thiopental-induced sleep	(Ayres et al., 2015)
		Reduced latency and increased duration on ethyl ether-induced sleep	(Sena et al., 2009)
	Anxiolytic	Increased entries in elevated plus maze open arms	(Ayres et al., 2015; Barbosa et al., 2008; Coleta et al., 2006; Deng et al., 2010; Li et al., 2011; Otify et al., 2015; Petry et al., 2001)
		Increased time spent in elevated plus maze open arms	(Coleta et al., 2006; Figueiredo et al., 2016; Otify et al., 2015; Petry et al., 2001)
		Reduced burying behavior on marble burying test	(Coleta et al., 2006)
		Increased number of transitions and time in the light compartment on light-dark procedure	(Sena et al., 2009)
	Antidepressant	Reduced immobility time on forced	(Jovelina Samara Ferreira Alves et al.,

		swim test	2020; Jovelina S. F. Alves et al., 2020; Ayres et al., 2017, 2015; Wang et al., 2013)
		Reduced immobility time on tail suspension test	(Wang et al., 2013)
	Anti-ageing	Extended lifespan	(Cao et al., 2022)
	Antistress	Reduced $AlCl_3$-induced aggressiveness	(Doungue et al., 2018)
Passiflora quadrangularis L. (Passifloraceae)	Antioxidant	DPPH scavenging activity; reducing power	(Guevara et al., 2019; Ramaiya et al., 2021, 2014)
	Hypnotic	Increased ethyl ether-induced hypnosis	(Echeverry et al., 2018; Gazola et al., 2018, 2015)
	Anxiolytic	Increased time spent on elevated plus maze open arms, reduced freezing time on open field test and number and time of head dips on holeboard test	(De Castro et al., 2007)
Paullinia cupana Kunth (Sapindaceae)	Antioxidant	ABTS, DPPH scavenging activity; FIC; TRAP; xanthine oxidase system's inhibition; increased antioxidant enzymatic activity; MDA and ROS levels reduction; reducing power	(Bittencourt et al., 2014; Boasquívis et al., 2018; Da Silva Bittencourt et al., 2020; Dabulici et al., 2020; Ferrari, 2002; K. N. Machado et al., 2021; Majhenič et al., 2007; Martins, 2010; Mattei et al., 1998; Mingori et al., 2017; Peixoto et al., 2017; Portella et al., 2013; Roggia et al., 2020; Sereia et al., 2019; Veloso et al., 2017; Yamaguti-Sasaki et al., 2007; Zamberlan et al., 2020)
	Neuroprotection	Protected SH-SY5Y cells against rotenone-induced toxicity	(De Oliveira et al., 2011)
		Protected neural cells against vincristine-induced damage	(Veloso et al., 2017)
		Protected BV-2 cells against H_2O_2-induced toxicity	(Roggia et al., 2020)
		Reduced methylmercury-induced mortality on SH-SY5Y cells	(Algarve et al., 2019)
		Increased lifespan	(Arantes et al., 2018; Peixoto et al., 2017)
		Protected SH-SY5Y cells against glyoxal, methylglyoxal and acrolein-induced toxicity	(Bittencourt et al., 2014)
		Reduced $A\beta_{1-42}$ aggregation	(Bittencourt et al., 2014; Zamberlan et al., 2020)
		Prevented ASH neurons against polyQ-induced death	(Boasquívis et al., 2018)
	Neuromodulation	AChE inhibition	(Ruchel et al., 2017; Sereia et al., 2019; Zamberlan et al., 2020)
		Anxiolytic effect dependent on 5-HT/DA/Glu systems	(Rangel et al., 2013)
		Antidepressant effect partially	(Campos et al., 2005)

		dependent on adenosinergic transmission	
		Panicolytic effect dependent on DA/5-HT transmission	(Roncon et al., 2011)
	Locomotion	Reverted acrolein-induced reduction of exploratory behavior on open field test	(Da Silva Bittencourt et al., 2020)
		Only high doses (100 mg/kg) increased locomotion frequency on open field test	(Campos et al., 2005)
		No effect on reverting locomotor impairments by aging	(Mingori et al., 2017)
		Reduced $A\beta_{1-42}$-induced motor impairments in *C. elegans*	(Boasquívis et al., 2018; Zamberlan et al., 2020)
		No effect on spontaneous locomotor activity	(Mattei et al., 1998; Otobone et al., 2007)
	Memory enhancer	Reverted recognition index impairment in hyperlipidemic rats on object recognition task	(Ruchel et al., 2017)
		Reduced espace latency in normal and in scopolamine-induced amnesic rats on Morris water maze	(Otobone et al., 2005)
		No effect on discrimination index in novel object recognition task	(Mingori et al., 2017)
		Reverted scopolamine-induced amnesia on passive avoidance	(Espinola et al., 1997)
		No effect on number of errors or time on Lashley III maze, or on active avoidance test	(Espinola et al., 1997)
	Hypnotic	No effect on pentobarbital-induced sleep	(Mattei et al., 1998)
	Anxiolytic	No effect on elevated plus maze	(Otobone et al., 2007; Ruchel et al., 2017)
		Increased espace latency on elevated T-maze	(Rangel et al., 2013; Roncon et al., 2011)
		Decreased inhibitory avoidance latency on elevated T-maze	(Rangel et al., 2013)
		Reverted acrolein-induced anxiety on open field test	(Da Silva Bittencourt et al., 2020)
	Antidepressant	Reduced immobility time on forced swim test	(Campos et al., 2005; Otobone et al., 2007)
	Anti-ageing	Extended lifespan	(Zamberlan et al., 2020)
		No effect on lifespan	(Espinola et al., 1997)
	Aphrodisiac	Increased testosterone levels in serum	(Leite et al., 2011)
	Energetic	Increased time in water on forced swim test	(Espinola et al., 1997)
		Reduced methylmercury-induced	(Algarve et al., 2019)

		sleepiness and increased daily activity	
Ptychopetalum olacoides Benth. (Olacaceae)	Antioxidant	ABTS, DPPH and superoxide scavenging activity; MDA levels reduction; increased antioxidant enzymatic activity	(De Vargas et al., 2016; Siqueira et al., 2007)
	Neuroprotective	Reverted oxygen and glucose deprivation damage in hippocampus	(Siqueira et al., 2004)
		Reverted $A\beta_{1-42}$ deposition and hippocampal neuronal death, and reduced astrocytosis without affecting BDNF levels	(Figueiró et al., 2011)
	Neuromodulator	AChE inhibition in frontal cortex, hippocampus and striatum	(Figueiró et al., 2010; Siqueira et al., 2003)
		Memory effects dependent of 5-$HT1_a$	(Da Silva et al., 2008)
		Antidepressant activity mediated by α2-adrenoceptor	(Paiva et al., 1998)
		Antidepressant activity mediated by D1r/B-NAr, but not 5-HT	(Piato et al., 2009)
	Locomotion	Restored locomotor impairment induced by reserpine on open field test	(Salomão et al., 2011)
		No effect on rotarod	(Da Silva et al., 2002)
	Memory enhancer	Increased latency on step-down inhibitory avoidance	(A. L. Da Silva et al., 2007; Da Silva et al., 2009, 2008, 2004; Figueiró et al., 2011)
		Reverted amnesia induced by scopolamine and MK-801 on step-down inhibitory avoidance	(Da Silva et al., 2009)
		Increased time spent in the light compartment on light-dark procedure in unpredictable chronic mild stress model	(Piato et al., 2010)
		Increased latency on step-down inhibitory avoidance and recognition index after 24h on object recognition test	(A. L. Da Silva et al., 2007)
	Sedative	Decreased locomotion frequency on open field test	(Paiva et al., 1998)
	Anxiolytic	Reduced head dips number and increased latency on holeboard test	(Da Silva et al., 2002)
	Antidepressant	Reduced immobility time on forced swim test and tail suspension test	(Paiva et al., 1998; Piato et al., 2009)
	Antistress	Restore corticosterone levels in unpredictable chronic mild stress model	(Piato et al., 2008)
Schinus terebinthifolia	Antioxidant	ABTS, DPPH and cationic scavenging activity; β-carotene	(Belhoussaine et al., 2022; Bendaoud et al., 2010; Bernardes et al., 2014,

Raddi (Anacardiaceae)		bleaching assay; ORAC; MDA levels reduction; increased antioxidant enzymatic activity; reducing power; increased survival against H_2O_2	2011; Carneiro et al., 2023, 2016; Corradi I. et al., 2018; Costa et al., 2013; Da Silva Dannenberg et al., 2016; Da Silva Nascimento et al., 2023; De Oliveira et al., 2020; Dedvisitsakul and Watla-iad, 2022; Dos Santos Da Rocha et al., 2019; El-Massry et al., 2009; Ennigrou et al., 2018, 2017; Feriani et al., 2021; Guimarães et al., 2023; Horozić et al., 2022; Labre Da Silva et al., 2019; Miranda Dos Santos et al., 2023; Rebelatto et al., 2020; Ribeiro et al., 2015; Rocha et al., 2018; Sassi et al., 2020; Scheid et al., 2018; Sereniki et al., 2016; Silva et al., 2017; Todirascu-Ciornea et al., 2019; Uliana et al., 2016; Velázquez et al., 2003)
	Neuromodulation	Reduced AChE levels	(Todirascu-Ciornea et al., 2019)
	Locomotion	Reverted rotenone-induced impairment in locomotor activity on open field test and motor performance on rotarod	(Sereniki et al., 2016)
	Memory enhancer	Increased arms entries and spontaneous alternation on Y-maze	(Todirascu-Ciornea et al., 2019)
	Anxiolytic	Increased time spent and reduced latency to top on novel tank diving test	(Todirascu-Ciornea et al., 2019)
		No effect on elevated plus maze	(Scheid et al., 2018)
	Antidepressant	Reduced immobility time on forced swim test	(Piccinelli et al., 2015)
Sonchus oleraceus L. (Asteraceae)	Antioxidant	ABTS, DPPH and cationic scavenging activity; ORAC; MDA and ROS levels reduction; reducing power; increased antioxidant enzymatic activity	(Aissani et al., 2022; Al Juhaimi et al., 2017; Alpinar et al., 2009; Disciglio et al., 2017; Elshikh et al., 2023; Li et al., 2015, 2018; Mawalagedera et al., 2016; McDowell et al., 2011; Nouidha et al., 2023; Ou et al., 2014, 2012; Salim et al., 2023; Schaffer et al., 2005; Sergio et al., 2020; Teugwa et al., 2013; Vecchia et al., 2022; Xia et al., 2011; Yin et al., 2007)
	Neuromodulation	AChE inhibition	(Aissani et al., 2022)
	Anti-ageing	Increased longevity, increased expression of anti-ageing genes and decreased expression of senescence genes	(Li et al., 2018)
	Locomotion	Reduced freezing time, and increased travel distance and center zone entries on open field test	(Li et al., 2018)
	Memory enhancer	Reduced latency and path length and increased target crossing in Morris water maze	(Li et al., 2018)

	Anxiolytic	Increased time and entries on elevated plus maze open arms	(Cardoso Vilela et al., 2009)
	Antidepressant	Reduced immobility time on forced swim test and tail suspension test	(Vilela et al., 2010)
Theobroma cacao L. (Malvaceae)	Antioxidant	ABTS, DPPH and cationic scavenging activity; ORAC; FIC; β-carotene bleaching assay; increased antioxidant enzymatic activity; MDA levels reduction; reducing power; inhibition of liposomal oxidation	(Afoakwa et al., 2015; Akoa et al., 2021; Al-Khalaifah et al., 2020; Ariza-Ortega et al., 2021; Arlorio et al., 2008, 2005; Azizah et al., 2010; Baharum et al., 2014; Baldera Ocampo et al., 2021; Belščak et al., 2009; Benítez-Correa et al., 2023; Biapa et al., 2019; Bordiga et al., 2015; Borja Fajardo et al., 2022; Botella-Martínez et al., 2021; Bruna et al., 2010; Budaraga et al., 2019; Cádiz-Gurrea et al., 2017; Caporaso et al., 2018; Carrillo et al., 2014; Chin et al., 2013; Cortez et al., 2023; Crozier et al., 2011; Da Silva Oliveira et al., 2011; Deus et al., 2018; Ebuehi et al., 2019; Feudjio et al., 2019; Gabbay Alves et al., 2019; Gálvez et al., 2013; Ginting et al., 2019; Hasanuddin et al., 2019; Indrianingsih et al., 2021; Ioannone et al., 2015; Jean-Marie et al., 2021; Jenny et al., 2009; Jonfia-Essien et al., 2008; Kosoko et al., 2017; Lavorgna et al., 2021; Lecumberri et al., 2007; Lessa et al., 2018; Llerena et al., 2023; Locatelli et al., 2013; Martínez et al., 2012; Mazor Jolić et al., 2011; Mazzutti et al., 2018; Melo et al., 2021; Mihai et al., 2022; Milbratz de Camargo et al., 2017; Mudenuti et al., 2021; Murcia Artunduaga and Castañeda, 2022; Murillo-Baca et al., 2020; Nguyen et al., 2022b, 2022a, 2021; Oboh et al., 2014; Oracz et al., 2014; Ordoñez et al., 2019; Ortiz S. et al., 2019; Osman et al., 2004; Osukoya et al., 2019; Padilla et al., 2008; Patil et al., 2022; Pico-Hernández et al., 2020; Pierre et al., 2015; Preza et al., 2010; Rachmawaty et al., 2019; Rahayu et al., 2023; Ramírez González et al., 2013; Razola-Díaz et al., 2023; Schinella et al., 2010; Silva et al., 2013; E. N. D. Silva et al., 2014; Siow et al., 2022; Sotelo C. et al., 2015; Sotero et al., 2011; Springer et al., 2023; Suazo et al., 2014; Summa et al., 2006; Umri et al., 2019; Valadez-Carmona et al., 2017; Vargas-Arana et al., 2022; Yahya et al., 2021; Zielinski et al., 2014a; Zzaman et al., 2014a, 2014b, 2013)
	Neuroprotective	Protected SH-SY5Y cells against	(Arlorio et al., 2005)

		ischemic oxidative damage	
	Neuromodulator	Reduced hippocampal vacuoles and increased synaptic connections	(Indla et al., 2023)
	Anxiolytic	No effect on elevated plus maze	(Milbratz de Camargo et al., 2017)
	Aphrodisiac	Increased testosterone and estradiol levels in male *Carassius auratus*, with no effect on females	(Al-Khalaifah et al., 2020)
Turnera diffusa Willd. ex Schult. (Turneraceae)	Antioxidant	ABTS, DPPH and superoxide scavenging activity; FIC; inhibition of linoleic acid oxidation; MDA and ROS levels reduction; reducing power	(Ahmad et al., 2017; Bernardo et al., 2022, 2021, 2017; Bezerra et al., 2011; Garza-Juárez et al., 2011; Ivanišová et al., 2018; Kim et al., 2022; Lucio-Gutiérrez et al., 2012; Palma-Wong et al., 2023; Pérez-Meseguer et al., 2010; Reyes-Becerril et al., 2020; Urbizu-González et al., 2017; Wong-Paz et al., 2015)
	Neuroprotective	Reduced glutamate toxicity against SH-SY5Y cells	(Bernardo et al., 2022, 2017)
		No effect on 6-OHDA toxicity against SH-SY5Y cells	(Bernardo et al., 2022)
		No effects on hippocampal neuronal death rates in aged rats	(A. G. Bezerra et al., 2013)
		High doses (1 mg/mL) have cytotoxic activity on astrocytes	(Bezerra et al., 2016)
	Neuromodulator	Sexual behavior mediated by nitric oxide	(Estrada-Reyes et al., 2009)
		AChE, BChE and MAO-A inhibition	(Bernardo et al., 2017)
	Antistress	No effect on ACTH or corticosterone levels	(Bezerra et al., 2011)
	Aphrodisiac	Enhanced sexual behavior	(Estrada-Reyes et al., 2016, 2013, 2009)
		Enhanced sexual behavior in impotent rats	(Arletti et al., 1999)
		Increased testosterone levels	(El-Demerdash et al., 2019; Tousson et al., 2020)
	Antidepressant	Reduced immobility time on forced swim test	(Ana María et al., 2019)
	Anxiolytic	Increased time and entries on elevated plus maze open arms	(Ana María et al., 2019; Kumar and Sharma, 2005a, 2005b)
		Reduced burying behavior on marble burying test	(Estrada-Reyes et al., 2013)
	Hypnotic	No effect on latency or total pentobarbital-induced sleeping time	(Bezerra et al., 2011)
	Memory enhancer	No effect on scopolamine-induced amnesia on passive avoidance test	(Bezerra et al., 2011)
	Locomotion	No effect on locomotor activity by ambulation or motor coordination	(Ana María et al., 2019; Bezerra et al., 2011)

		by rotarod performance	
		No effect on inverted screen test	(Ana María et al., 2019)
Xylopia aromatica (Lam.) Mart. (Annonaceae)	Antioxidant	ABTS and DPPH scavenging activity	(Jaramillo-Colorado et al., 2020; Novaes et al., 2014)
5-HT: 5-hydroxi-triptamine; ABTS:2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonate); AChE: acetylcholinesterase; BChE: butyrylcholinesterase; DPPH: 2,2-diphenyl-1-picrylhydrazyl; DA: dopamine; FIC: ferrous iron chelating assay; MDA: malondialdehyde; ORAC: oxygen radical absorbance capacity ; ROS: reactive oxygen species.			

Table 3. Pre-clinical studies on psychopharmacological effects of plant extracts.

Scientific name	**Preparation**	**Type of study (sample)**	**Intervention**	**Main results**	**Reference**
Erythrina mulungu	Not specified	Randomized, placebo-controlled, triple-blind, and parallel clinical trial (N=200)	*Erythrina mulungu* (500 mg), *Passiflora incarnata* (500 mg), or Midazolam (15 mg) were administered orally to volunteers who underwent third molar extraction. Anxiety was evaluated through physiological parameters (heart rate, blood pressure, and oxygen saturation) and questionnaire assessment.	Unlike *Passiflora incarnata* and Midazolam, *Erythrina mulungu* showed no significant anxiolytic effect.	(Da Cunha et al., 2021)
Ilex paraguariensis	Instant mate tea dissolved in water	Interventional trial (N=15)	Healthy women received mate tea after an overnight fasting. They had their blood samples collected at baseline, after 1 hour of the first intake, and after 7 days of mate tea intake (5 g of mate tea diluted	Mate tea intake decreased MDA levels after the first administration, and this reduction was maintained after the 7-day protocol. Total antioxidant status and the expression of	(Matsumoto et al., 2009)

			in 500 ml of water daily). Plasma lipid peroxidation (MDA assay), kinetics of the diene conjugation formation, total antioxidant status, and expression of the antioxidant enzymes SOD, CAT, and GPx were evaluated.	antioxidant enzyme genes were observed after the prolonged administration.	
	Aqueous extract	Placebo-controlled trial (N=20)	Participants received *Ilex paraguariensis* aqueous extract (50 g for each 250 ml of water, 'terere' preparation') or water and performed running tests. Participants had their baseline performance evaluated and received 250 ml of the extract or placebo 60 minutes before the test and the remaining 250 ml 30 minutes before the test.	*Ilex paraguariensis* extract decreased the execution time that volunteers spent on running the test, an effect that was not seen in the control group.	(Lima and Chamaa, 2012)
	Soluble yerba mate	Double-blind, randomized, placebo-controlled, crossover study (N=89)	Patients living with HIV/AIDS under antiretroviral therapy received chocolate, placebo chocolate, yerba mate tea, or placebo tea to be consumed for 15 days. After 15 days, participants crossed over to the other experimental arm. The protocol consisted of 4 phases separated	No differences between the treatments (chocolate, yerba mate tea, or placebos) were observed regarding the lipidic and oxidative profile of individuals.	(Souza, 2013)

			by 15 days washout period each, so the participants underwent the 4 possibilities of intervention. Exercise practice, lipid profile, and lipid oxidation (MDA assay) were evaluated.		
	Yerba mate infusion	Bioavailability study (N=17)	Healthy volunteers had blood samples collected (baseline) and then received yerba mate infusion or water. New blood samples were collected 20, 40, 50, 60, 80, 100, and 120 minutes after intake. The following parameters were assessed in plasma: total polyphenols concentration, antioxidant capacity (FRAP and ABTS methods), uric acid levels, and total protein levels.	Yerba mate increased plasmatic total polyphenols concentration and antioxidant capacity (FRAP and ABTS assays), while no differences were observed in protein and uric acid levels.	(Sánchez Boado et al., 2015)
	Soluble yerba mate	Crossover, placebo-controlled study (N=9)	Healthy male volunteers received a placebo (500 ml of water) and after a 7-day washout period crossed over to the experimental arm and received yerba mate (5g in 500 ml of water). After 1 hour of ingesting a placebo or yerba mate, the resting energy expenditure was	Acute yerba mate intake induced an increased energy expenditure.	(E. P. de Oliveira et al., 2016)

			assessed through indirect calorimetry for 30 minutes.		
	Instant mate tea dissolved in water	Randomized, crossover study (N=12)	Male volunteers were randomized and received mate tea (5 mg/ml, 3 times/day) or water for 11 days. On the 8th day, subjects performed eccentric elbow flexion exercises, and maximal isometric elbow flexion was assessed before and after 0, 24, 48, and 72 hours of training. Blood samples were taken 24, 48, and 72 hours after exercise, and the following parameters were evaluated: total phenolics, GSH, GSSG, GSH: GSSG ratio, and lipid hydroperoxides. After a seventeen-day washout, the volunteers crossed to the other experimental arm.	After eccentric exercise, muscle strength decreased in both groups, but mate tea improved the rate of strength recovery 24 hours after exercise. Mate tea improved plasmatic total phenolic content, although this level decreased 72 hours after exercise. GSH blood levels decreased in the control group 48 and 72 hours after exercise, an effect not seen in the mate tea group. GSSG, GSH: GSSH and lipid hydroperoxides levels were unaffected by mate intake.	(Panza et al., 2016)
	Encapsulated ground green yerba mate leaves	Double-blind repeated-measures crossover placebo-controlled study (N=12)	Healthy women underwent a three-session repeated measure protocol. In the first session, a baseline assessment was performed, including evaluating individual performance and body composition. Before session 2,	It was shown an increase of fatty acid oxidation during exercise in the yerba mate group compared to placebo. Scores for hunger, prospective eating, and desire to eat were reduced in the yerba mate group, whereas measures of	(Alkhatib and Atcheson, 2017)

			the volunteers were randomized to receive yerba mate (4 x 500 mg in capsules) or placebo and after 120 minutes of resting, they were subjected to a cycle ergometer for 30 minutes. On session 3 the volunteers crossed over to the other experimental arm and the protocol was repeated. The following parameters were assessed: fatty acid oxidation, profile of mood state score; and appetite and satiety by a visual analogue scale.	focus, energy, and concentration increased.	
	Powder (leaves mixed with stems)	Double-blind, crossover design (N=11)	Male cyclists received yerba mate (5 g, daily) or placebo for five days and after 1 hour underwent ergometer-based assessments. Before and during tests, blood and respiratory gas samples were taken. Adrenaline concentration and fat utilization were evaluated in plasma.	Yerba mate increased plasmatic adrenaline concentration and fat utilization during a short simulated cycling trial, while respiratory exchange ratios were not impacted.	(Areta et al., 2018)
	Spray-dried aqueous yerba mate extract	Interventional trial (N=14)	Healthy volunteers received capsules of spray-dried yerba mate extract (3 capsules, 3 times/day) and were evaluated at baseline and after	The extract consumption improved the antioxidant capacity after 7 and 60 days. The yerba mate intake also decreased the antioxidant	(Becker et al., 2019)

			7, 30, and 60 days regarding electrocardiogra m, and hematological, urinary, and biochemical tests.	enzyme activity of GSH (after 7 and 60 days), SOD (after 7, 30, and 60 days), CAT (after 7 and 30 days), and paraoxonase-1 (after 7 days). A decrease in lipid hydroperoxides (after 30 and 60 days) and MDA levels (after 7 and 30 days) were observed, while no differences in GPx activity were detected.	
	Instant mate tea dissolved in water	Randomized, crossover study (N=12)	Volunteers received mate tea (5 mg/ml, 3 times/day) or water for 11 days. Starting day 8, three sets of 20 maximal isokinetic eccentric for elbow flexors with one arm were performed and the rate of torque development at 0-50, 0-100, 0-200, and 100-200 ms were evaluated on the following time points: before and at 0, 24, 48, and 72 hours after exercise. Moreover, blood samples were taken before and after 24, 48, and 72 hours of exercise, and creatine kinase, aldolase, total phenols, and GSH:GSSG ratio were measured. After a 17-day washout period, the participants	Mate tea improved the rate of torque development > 50 ms after 48 and 72 hours of eccentric exercise. Mate tea also increased aldolase and total phenols levels, as well as GSH: GSSG ratio, independently of exercise.	(Moura et al., 2020)

			crossed over to the other experimental arm.		
	Tea	Observational study (N=8)	Healthy volunteers consumed a single preparation of mate tea prepared with 4 or 8 g of mate and had their plasmatic antioxidant capacity assessed after 1 and 2 hours (chemiluminescent method based on an ABAP-luminol system).	There was an increase in the antioxidant capacity of the blood plasma of volunteers who received the tea made of 8 g of yerba mate when compared to the baseline evaluation.	(Teselkin et al., 2021)
	Soluble mate tea	Crossover, pilot clinical trial (N=10)	Men volunteers were divided into two groups and received yerba mate or placebo. Then, they were submitted to a one-repetition maximum test after one hour on the bench press and leg press. Muscle strength was evaluated.	Yerba mate did not affect muscle strength in the leg press or bench press exercise when compared to placebo.	(Lobo et al., 2022)
	Kombucha	Sensory descriptive study with consumers (N=105)	Volunteers received green tea, black tea, and yerba-mate kombuchas subsequently in a balanced presentation order. Evoked emotions were evaluated through a check-all-that-apply questionnaire, which consists of a 39-word list with emotion terms.	Awareness that the beverage was yerba-mate kombucha evoked the peaceful, loving, and quiet feelings.	(Dartora et al., 2023)
Lippia alba	Essential oil from leaves	Randomized, placebo-controlled clinical trial	Academic stress levels were measured before and after the	*Lippia alba* essential oil significantly decreased	(Soto Vásquez, 2019)

		(N=38)	evaluation instrument implementation along with essential oil inhalation (30 minutes of dispersion).	academic stress levels assessed through the academic stress inventory.	
	Essential oil from leaves	Randomised, controlled, experimental trial (N=95)	Participants had their anxiety assessed (STAI) before and after the intervention protocol. The protocol consisted of a daily inhalation of the essential oil for 4 weeks.	*Lippia alba* essential oil intervention decreased the STAI scores in the posttest assessment.	(Alvarado Garcia et al., 2021)
Passiflora edulis	Aqueous extract	Cross-over, double-blind study (N=9)	Volunteers received passiflora (lyophilized 10% tea) or a placebo at night and were evaluated for serum biochemical assays, electrocardiogram and electroencephalogram on the following morning. After a 1-week washout period, the volunteers crossed over to the other experimental arm. Hypnotic effects were assessed through a self-report questionnaire.	No significant differences were detected on electrocardiogram or hypnotic effects assessment. Five volunteers presented 'drug rhythm' on electroencephalogram assessment, of which two volunteers presented this pattern also after placebo.	(Maluf et al., 1991)
Paullinia cupana	Powder	Double-blind, placebo-controlled study (N=30)	Guarana (2 x 500mg/day) was administered orally to healthy volunteers in a four-day protocol and cognitive, sleep, and anxiety (STAI) scales parameters were assessed.	It was not observed significant alterations in cognition, sleep, and anxiety upon guarana administration.	(Galduróz and Carlini, 1994)
	Powder	Randomized,	Guarana (2 x	It was not	(Galduróz and

		double-blind, placebo-controlled study (N=45)	500mg/day) was administered orally to healthy elderly volunteers in a 5-month protocol and cognitive, sleep, and anxiety (STAI) scales parameters.	observed any alteration in cognitive, sleep, and anxiety aspects upon guarana administration after 3 and 5 months of guarana intake.	Carlini, 1996)
	Dried ethanolic extracts of guarana, *Panax ginseng*, and guarana/ginseng extracts combination	Double-blind, counterbalanced, placebo-controlled study (N=28)	Participants received a placebo, guarana (75 mg), ginseng (200 mg), and a guarana/ginseng combination (75/200 mg) at different moments, and had their cognitive and mood effects assessed. Patients were evaluated during 5 sessions with a 7-day washout period between them. Cognitive performance and mood were evaluated before and after 1, 2.5, 4, and 6 hours after the treatment (COGDRAS, serial subtraction tasks, and BL-VAS).	Guarana, ginseng, or guarana/ginseng combination improved task performance in the evaluated time points when compared to placebo. Guarana group presented improvements, particularly in attention and sentence verification tasks. Moreover, the ginseng and guarana/ginseng combination improved the speed of attention task performance and the speed of memory task performance, although led to a decrease in accuracy. Finally, guarana and the guarana-ginseng combination improved the performance on the serial subtraction task.	(Kennedy et al., 2004)
	Extract - not specified	Randomized, double-blind, crossover study (N=36)	Breast cancer patients were randomized to receive guarana (75 mg, daily, orally) or placebo during the radiation therapy (28 sessions). Before	No differences were observed between or within the groups at any assessment.	(Da Costa Miranda et al., 2009)

			the 14th session, the patients crossed over to the other experimental arm. Fatigue and depression were assessed (BDI, BFI and CFQ) before the 1st, 14th, and 28th radiation session.		
	Guarana powder	Longitudinal and Intervention Study (N=12)	Healthy volunteers with overweight had blood samples collected in a 12-hour fast and 1h after guarana powder drink consumption (3 g of powder in 300 ml of water). After 15 days of the drink's daily consumption, samples were collected again after a 12-hour fast and after the first hour of drink ingestion. The following parameters were evaluated: resistance of LDL to ex-vivo oxidation, total antioxidant status, ORAC, DNA damage in lymphocytes, and the activity of the antioxidant enzymes SOD, CAT, and GPx.	The lag time of LDL oxidation increased after 1 hour of the drink consumption on day 1 and day 15 of intervention. CAT and GPx increased after guarana ingestion on days 1 and 15 and also increased after the 12-hour fast on day 15 compared to day 1. SOD and total antioxidant status levels were not altered. An ORAC increase was observed 1 h after the drink ingestion on day 1 and day 15, while oxidative damage to DNA was also acutely influenced.	(Yonekura et al., 2016)
	Dry guarana extract	Phase II randomized, double-blind, placebo-controlled crossover trial (N=75)	Breast cancer patients with fatigue after their first cycle of chemotherapy were randomized into guarana (50 mg, twice a day) or placebo groups for 21 days. The patients underwent a 7-	Guarana improved FACT-F, FACT-ES, and BFI index on days 21 and 49, while improved CFQ on day 21 but not on day 49.	(De Oliveira Campos et al., 2011)

			day washout period and then crossed over to the other experimental arm. After 21 days, they were evaluated again regarding fatigue, sleep quality, anxiety, and quality of life questionnaires (CFQ, FACT-F, FACT-ES, BFI, PSQI, and HADS).		
	Standardized dry purified *Paullinia cupana* extract (PC-18)	Phase II, initially uncontrolled, open study (N=40)	The participants were adults diagnosed with cancer under chemotherapy and screened for fatigue (BFI). They received the PC-18 extract twice a day (37.5 mg) for three weeks. After this phase, the participants who showed improvement or stabilization of the BFI index (N = 36) were selected and randomized. The following phase consisted of the administration of a placebo or PC-18 (37.5 mg, twice a day) for 3 additional weeks. Then, the participants were evaluated through BFI and two additional fatigue scales (FACT-F and CFQ), as well as anxiety (HADS) and sleep quality questionnaires (PSQI).	After the initial phase, 36 patients showed an increase or stabilization of BFI scores upon PC-18 intervention. However, three weeks after randomization, no differences were observed between PC-18 or placebo groups in the assessed parameters.	(Del Giglio et al., 2013)
	Commercial	Prospective,	Volunteers were	Guarana showed	(Silvestrini et al.,

	preparation	randomized, single-blind, placebo-controlled, crossover study (N=27)	submitted to guarana intake (360 mg x 3) or cornstarch (placebo) in random order for 5 days. Well-being, anxiety, and mood were assessed (PWB, SAS and BL-VAS) at four different time points: pretreatment, treatment 1, washout, and treatment 2.	no significant difference in comparison with placebo.	2013)
	Dry guarana extract	Randomized, double-blind, placebo-controlled phase II study (N=60)	Patients with advanced neck and head cancer with an indication for chemoradiotherapy were randomized and assigned to the guarana or placebo group. Those in the guarana group received guarana (50 mg, twice a day) during the six weeks of chemoradiotherapy treatment. Patients' fatigue and quality of life were evaluated on days 1, 21, 42, and 63 (FACT-F, FACT-HN, EORTC QLQ-30, EORTC QLQ H&N35	Guarana showed improvement in pain, social eating, swallowing, coughing, and weight loss parameters after the first cycle of chemoradiotherapy by FACT-HN35. However, these parameters worsened after the end of the cycles.	(Martins et al., 2017)
	Standardized dry purified *Paullinia cupana* extract (PC-18)	Results of two Double-Blind, Randomised Clinical Trials (N=32, study 1; and N=72, study 2)	In both studies, volunteers were early breast cancer patients who presented an increase in fatigue scores after the first cycle of chemotherapy. Fatigue was assessed using	In both studies, PC-18 did not show a decrease in fatigue scores.	(Sette et al., 2018)

			two questionnaires (CFQ and BFI). **Study 1:** Patients received a placebo or PC-18 (37.5 mg, twice daily) during 3 weeks. Then, the patients had a one-week washout period before crossover to the other experimental arm. Fatigue assessments were performed before and after the first, second, and third cycles of chemotherapy. **Study 2:** Patients received PC-18 (7.5 and 12.5 mg) or placebo orally twice a day and had the fatigue assessed before the first and second chemotherapy cycles and after 21 days of randomization.		
	Powder	Randomized, double-blind, crossover trial (N=27)	Guarana supplementation (125 mg/kg, orally) was administered to volunteers submitted to a maximal-intensity cycling task. Cognitive performance was evaluated before and after exercise (simple reaction time, choice reaction time, immediate word recall test, and BL-VAS), as well as maximal oxygen consumption measurement.	Guarana decreased choice reaction time before and after exercise when compared to placebo, although no significant differences were observed in the other parameters.	(Gurney et al., 2023)
ABTS: 2,2’-azinobis-(3-ethylbenzothiazoline-6-sulfonate); CAT: catalase; FRAP: ferric reducing antioxidant					

power; GPx: glutathione peroxidase; GSH: glutathione; GSSG: glutathione disulfide; MDA: malondialdehyde; ORAC: oxygen radical absorbance capacity; SOD: superoxide dismutase.

Inventories and questionnaires: BDI: Beck depression inventory; BFI: brief fatigue inventory; BL-VAS: Bond-Lader visual analogue scales; CFQ: Chalder fatigue scale; COGDRAS: cognitive drug research computerized assessment system; EORTC QLQ30: european organization for research and treatment of cancer quality of life questionnaire core 30; EORTC QLQ H&N35: european organization for research and treatment of cancer quality of life questionnaire head and neck module; FACT-ES: functional assessment of chronic illness therapy-endocrine symptoms; FACT-F: functional assessment of chronic illness therapy-fatigue; FACT-HN: functional assessment of cancer therapy - head and neck; HADS: hospital anxiety and depression scale; PSQI: Pittsburgh sleep quality index; PWB: psychological well-being scale; SAS: self-rating anxiety state scale; STAI: state-trait anxiety inventory.

Table 4: Clinical studies on psychopharmacological effects of plant extracts.

Discussion

The non-scientific survey about plants popularly used for general well-being and delightful moments identified 115 species cited in at least four books, being 27 natives from Brazil. These species belong to 18 families, the most common was Fabaceae, with four species, followed by Passifloraceae, with three species, and Anacardiaceae, Aristolochiaceae, Asteraceae, Winteraceae, two species each. The plant parts most used were leaves and barks, and the main forms of preparation were aqueous extracts, which comprehends infusions, decoctions, juices and baths. Among the popular uses, the most common were either as a stimulant, to counteract weakness and fatigue, or as calmative, against anxiety, nervousness, and insomnia as well.

Search in scientific databases revealed 568 studies after the inclusion and exclusion criteria. The most studied effect was the antioxidant activity, found in all but two species reviewed – *A. arvense* and *E. mulungu* –, with positive results observed in a great variety of methods, mainly radical scavenging and stimulation of antioxidant enzymes, such as superoxide dismutase, catalase and glutathione peroxidase. Antioxidant capacity is usually attributed to secondary metabolites, such as flavonoids, present in many vegetal species that act as reactive oxygen species scavengers (Dias et al., 2021). Different degrees of antioxidant effect were found for the same plant depending on the parts used and the extraction method. Antioxidant potential is a property very exploited in plants with economic importance, especially in agriculture and food industries, which may explain the considerable volume of studies with some particular species – such as *A. occidentale*, *T. cacao*, *P. cupana*, *I. paraguariensis*, and *Passiflora* spp. –, which comprehends up to 78 % of articles in this present review. Although an antioxidant effect regarding botanical compounds is highly unspecific, the capacity of neutralizing reactive oxygen species could be used to prevent the onset of some neuropsychiatric disorders, in particular neurodegenerative ones, as oxidative stress causes cellular death by mitochondrial damage and DNA mutation (Guo et al., 2013).

We also found studies evaluating the effects of extracts in different neurotransmitter systems. The cholinergic system was the most studied, with half of the mentioned plants investigated as their anticholinesterase activity. It is known that anticholinesterase drugs are used for the treatment of Alzheimer’s disease and other dementias, promoting cognitive and mood improvement (Balázs et al., 2021). In fact, several species found in the survey are used for memory deficits and the scientific search confirmed the potential of Brazilian flora specimens on learning and memory enhancement. *A. occidentale*, *I. paraguariensis*, *P. cupana*, *P. olacoides* and *S. oleraceus* administration improved rodents’ performance on Morris water maze or inhibitory step-down avoidance. *A. canelilla* and *P. edulis* extracts reverted memory impairment caused by scopolamine and $AlCl_3$, respectively. *I. paraguariensis* and *P. cupana* improved memory in both healthy and amnesic conditions.

Other disorders were also objects of studies, such as anxiety and depression, evaluated for *P. olacoides*, *L. alba* and *P. edulis*, for instance, attributing serotonergic and dopaminergic regulatory effects to these species. The studies indirectly supported some uses observed in the survey, as relaxing, energetic and arousal mood improvement. For example, a calmative activity attributed to *L. alba* was supported by the hypnotic effect and cortisol reduction after extract administration; sedative effect was also found in *Passiflora* spp. and *E. mulungu*, species used for insomnia treatment, along with *L. alba*.

The species *I. paraguariensis* and *P. cupana* are used for their stimulant and energetic properties and were evaluated in correlate tests. Studies showed that *T. diffusa* and *A. occidentale* not only improved, but also reverted impairments in sexual behavior, reproducing the aphrodisiac effects alleged by population. *P. cupana* and *T. cacao* could also present some aphrodisiac effects, as its administration increased seric testosterone levels.

On the other hand, some popular uses could not be supported by scientific studies due to its difficulty in translating into pharmacological properties. *Aristolochia* spp., for example, had an indication for hysterical affections, and no study investigating this kind of property was found. Although hysteria is an outdated term, sedative and anxiolytic effects addressed by popular use are enough to justify studies seeking a relaxing activity to these plants.

Considering all the studies reviewed, only a small part of them focused on mood, most of them using animal models to investigate depression and anxiety. Accordingly, the survey and the systematic review couldn't find results for most of the relevant terms related to delightful moments, such as mood states related to love and social bonding or more subjective emotions of nervousness, happiness or joy, for example. One study addressed emotional wellbeing after the use of *I. paraguariensis*: participants reported peaceful, loving and quiet emotions after mate consumption, but the individuals were told the beverage's composition, which may have influenced on the individuals feedback because this plant is often used in their daily life, above any evoked delightful emotions (Dartora et al., 2023).

We identified 28 clinical studies with the selected species. The search initially retrieved 31 clinical studies; however one was excluded due to methodological issues and two proved to be different publications related to the same studies. Thus, the potential of five species were evaluated in clinical studies: *E. mulungu, I. paraguariensis, L. alba, P. edulis,* and *P. cupana*. Withal, the species with more clinical studies reported are *I. paraguariensis* and *P. cupana*. Focusing on mood, *I. paraguariensis* showed improvement performance on exercise recovery (Panza et al., 2016), while *P. cupana* presented conflicting results regarding fatigue scores in oncological patients and cognitive performance tasks on attention and memory (Galduróz and Carlini, 1994, 1996; Kennedy et al., 2004). Two studies using *L. alba* supported its anxiolytic (Alvarado Garcia et al., 2021) and antistress uses (Soto Vásquez, 2019). The anxiolytic and hypnotic effects of *E. mulungu* (Da Cunha et al., 2021) and *P. edulis* (Maluf et al., 1991) were also evaluated, but these clinical studies did not confirm the investigated effects. Thus, except for these two species with negative results, the clinical trials corroborate the pre-clinical results and the effects attributed in folk medicine.

Overall, although a few studies showed a therapeutic or mood effect in human volunteers, due to conflicting and scarce evidence, more double-blind, randomized, placebo controlled trials with representative sample sizes are required, because only six studies followed robust clinical design. It is worth highlighting that only studies that followed the criteria of inclusion were discussed in this review.

There are some limitations of this study which must be discussed. We observed some divergence about the geographical distribution and accepted scientific names depending on the source consulted. We adopted the Rio de Janeiro Botanical Garden (2023) database as the main reference to classify a species as native and endemic, but the occurrence and current correct name are not always the same in all databases.

One of the major limitations in this study was correctly attributing the names described in the non-scientific literature to the actual scientific nomenclature. As already mentioned, *P. catuaba* and *Drymis* spp. were species reviewed by names other than the ones found in the survey – *E. catuaba*, *D. winteri* and *D. granadensis*. Although its synonyms were also included on the scientific review, it's possible that the botanical material employed in some studies does not correspond to the species cited. Unfortunately, the incorrect identification of species and the use of incorrect botanical material are issues that are still present.

Another common problem observed in the survey was the existence of two or more species known by the same popular name; sometimes species belonging to the same family and genus, but also observed for species very distant taxonomically. The survey found two species of *Erythrina* with popular name of "mulungu", *E. crista-galli* and *E. mulungu*, both used as anxiolytics; however a different species is usually employed in experimental studies, *E. velutina*, which have studies exploring anticholinesterase (Santos et al., 2012), hypnotic (Ozawa et al., 2008) and anxiolytic (Raupp et al., 2008) activities. It is worth noting that *E. velutina* is the species normally sold in herbal preparations.

This review tried to avoid such complications by making the lack of scientific name an exclusion criterion, but a major impact of dubious identification still persists, as reflected in the results from *Protium catuaba* studies. The proposed synonym that retrieved results, *Erythroxylum catuaba*, is believed to be a *nomen nudum*, originating from an incorrect identification of *Trichilia* sp. (Ducke, 1966). There is, indeed, a great number of species known as "catuaba", such as *Erythroxylum vaccinifolium* and *Anemopaegma arvense*, this one recognised as true "catuaba". For this reason, the incorrect identification of *E. catuaba* could be easily replicated along phytotherapeutic products and non-scientific publications, as its popular use converged to aphrodisiac effects and was often intertwined between species due to ecological distribution and lack of quality control in pharmaceutical process (Marques, 1998). Thus, taxonomic studies are as important as pharmacological investigation, as its support and application is extremely necessary to solve some of these limitations.

Conclusion

The biodiversity of the Brazilian flora provides an enormous opportunity to study alternative therapeutics, by the effects of natural products on psychiatric and neurodegenerative disorders. In this context, this survey identified 27 native species with popular uses for general well-being and delightful moments and several indications were supported by scientific studies. It is noticeable, though, that the major part of these results only explored an antioxidant activity, and just a small fraction of the studies investigated an effect in a clinical trial. In this sense, the present review not only presents the actual popular and scientific evidence of psychopharmacological effects in Brazilian flora, but may serve as an indicator of where future investigations in psychological stress therapeutics must focus, on both pre-clinical and, specially, clinical research.

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