REVISÃO

A review of six medicinal and aromatic plants and their health benefits

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Abstract

Brazil has a large biodiversity of plants with nutritional and biological properties that are important for human nutrition. The objective of this study is to review the use of plants in nutrition and the presence of bioactive compounds that bring health benefits, referencing research with six different native and exotic plant species (“açaí”, “cinnamon”, “guarana”, “hibiscus”, “jambu” and “yerba mate”). Numerous studies on the aforementioned plants have been carried out to evaluate and confirm their effects and benefits. Clinical and metabolic studies have shown that the consumption of these plants, especially their extracts, can prevent or treat several diseases such as Alzheimer's, cancer, obesity, diabetes, cardiovascular disease, atherosclerosis, hepatic and cardiovascular fibrosis. The use of extracts from these plants in foods improves some quality characteristics such as oxidative stability, nutritional value, hygienic-sanitary and sensory properties, in addition to the foods becoming functional with antioxidant properties. This review indicates that these plants have the potential to be used as ingredients in formulations of various foods and should be considered important for future studies with the investigation of their effects on these foods.

Keywords: *Euterpe oleraceae* Martius. *Cinnamomum zeylanicum* Blume. *Paullinia cupana* Kunth. *Hibiscus sabdariffa* DC. *Spilanthes oleraceae* L. *Ilex paraguariensis* A.St.-Hil.

Introduction

Plants have been an integral part of our culture since antiquity and are cited in literature as wonders of nature. They have nutritional and biological properties and have been used in food preparation by different cultures for centuries. These edible, medicinal and aromatic plants are part of various cuisines in Asia, Europe and in the Middle East. Plants are important sources of nutritional and bioactive compounds, such as a high amount of antioxidants[1-3].

A variety of pharmacological effects are obtained with the use of plants with bioactive properties, either as pure compounds or as standardized extracts, combined with other sources of bioactive compounds, which are far from being exhausted[4,5].

There are several plant species that have been shown to be important sources of bioactive substances, and therefore studies to assess their potential against chronic diseases have been conducted in various parts of the world[6-8].

It is known that the valuation of a natural plant extract can be based on the concentration of the target compounds and their bioactivity, in addition to providing health benefits[9-11].

Many chemical constituents found in plants, commonly called phytochemicals, such as polyphenols, terpenes and carotenoids, have been described as potential antioxidants, prevention and reduction of diseases[12-14].

Consumers are increasingly interested in foods that can reduce the risk of disease, thus benefiting their health and well-being. By using plants with bioactive properties, either as pure compounds or as standardized extracts, combined with other sources of bioactive compounds, a variety of beneficial effects on health and nutrition are obtained, which should be increasingly studied[1-3].

This review of these six different plant species is justified by the nutritional, medicinal and economic importance that these plants represent in several areas of knowledge. Each of these species has distinct biochemical characteristics, with potential benefits for human health, in addition to playing important roles in gastronomy, local culture where they are inserted and the globalization of functional foods.

Research into these native and exotic plants opens new possibilities in the field of biotechnology, functional foods and phytotherapy, highlighting their potential for innovation in products that meet a growing demand for healthy and sustainable alternatives.

In this review study, we will discuss the importance of plants with bioactive compounds that bring health benefits, referencing research with 6 different plant species (“açaí”, “cinnamon”, “guarana”, “hibiscus”, “jambu” and “yerba mate”) which prove the benefits of these plants when consumed *in natura* or in the form of extracts.

Search methodology

The objective of this study was to carry out bibliographic surveys related to the use of six aromatic and medicinal plants, such as treatment or health prevention, in addition to the presence of bioactive compounds and what has been studied in the last 20 years.

This survey was done through electronic scientific databases, including Science Direct, Scopus and others. The scientific names of the relevant species mentioned in this article were used as keywords for the searches: *Euterpe oleraceae* Martius., *Cinnamomum zeylanicum* Blume, *Paullinia cupana* Kunth, *Hibiscus sabdariffa* DC., *Spilanthes oleraceae* L. and *Ilex paraguariensis* A.St.-Hil.

Articles in English, Spanish and Portuguese from 2003 onwards were selected according to their importance for this review study. For this research, 128 scientific articles were selected that presented results on consumption habits, populations that use them, benefits and socio-environmental impacts of the plant species mentioned. In addition, traditional use in food, the part(s) of the plant used, the preparation method(s) and the form of administration in vivo and in vitro were also taken into consideration for this review.

Data analysis and context

Açaí – *Euterpe oleraceae* Martius.

Açaí (*Euterpe oleracea* Martius.) is known as a “superfood” due to its high concentrations of nutrients and other health-benefiting properties[15]. Superfoods are classified as foods rich in bioactive phytochemicals. These compounds occur naturally in plants and provide color, flavor, and odor to foods[16].

Açaí, a fruit native to Brazil, has high concentrations of bioactive compounds and is consumed in different regions of the country[17,18]. Its production increased by more than 55% from 2018 to 2022, and exceeded 1.690.000 tons in 2022, being exported to the world by Brazil[19,20].

Açaí pulp is mainly consumed by the Brazilian population in the North and Northeast regions of the country. However, there has been an increase in demand for açaí pulp in recent years in national and international markets, and fruit has aroused the interest of investors and researchers. This is mainly due to the high antioxidant capacity of açaí provided by its high anthocyanin and tocopherol contents[21-23].

To make açaí more accessible to consumers around the world, açaí berries are processed soon after harvest. They are frozen, freeze-dried, or turned into pulp or powder to preserve their nutritional value and extend their shelf life. Frozen açaí pulp is a common form of açaí that retains most of its nutritional benefits. Frozen açaí is a convenient option for consuming this fruit outside of the Amazon rainforest[24].

Polyphenols are the predominant chemical constituents of açaí, notably anthocyanins and flavonoids, which justify its classification as a functional food which helps in preventing several degenerative diseases[9,25,26].

Açaí berries are rich in anthocyanins, a flavonoid that gives the fruit its dark purple color. These compounds have antioxidant properties that help neutralize free radicals and reactive species, strengthening the body's defense system and promoting health. Free radicals are naturally formed in the body, but when produced in excess, they can attack cell membranes and nuclei, leading to oxidative damage to lipids, proteins, and

nucleic acids. Antioxidants are crucial to controlling this process, since excessive free radicals and reactive species have been linked to several health problems[27,28].

Studies have shown that the consumption of foods rich in polyphenols, especially those of the flavonoid class, has been associated with a low risk of developing several diseases due to the antioxidant properties present in the food. Açaí is one of the fruits that has been gaining prominence, as it has significant amounts of a group of flavonoids. The main anthocyanins found in açaí are cyanidin-3-glycoside and cyanidin-3-rutinoside[21,23,29].

Although data on the antioxidant potential of açaí species are conflicting, some studies in the literature report that anthocyanins are the compounds which most contribute to the antioxidant power of açaí, being present in higher concentrations than those found in several fruits, such as blueberries, cranberries, plums and raspberries. Some studies consider that açaí has a lower concentration of total phenolics (13.9 mg/g GAE) than other dark fruits[22,30,31].

The way you consume açaí has a direct impact on its health benefits. Consuming this fruit in its pure form preserves and enhances its positive effects. For those looking to maximize the benefits of açaí, it is recommended to opt for the most natural way of consuming it possible[24,27,28].

Cinnamon – *Cinnamomum zeylanicum* Blume

In Brazil, the two main varieties of cinnamon sold are Chinese Cinnamon (*Cinnamomum cassia* (L.) J. Presl) and Ceylon Cinnamon (*Cinnamomum zeylanicum* Blume), also known as true cinnamon. Of these, *C. cassia* is the most widely found and consumed, mainly due to its lower production cost and greater availability. However, there are significant differences between these two varieties, both in terms of chemical composition and health effects[32].

Chinese cinnamon (*C. cassia*) is known to contain relatively high levels of coumarin, a compound that, in large quantities, can be toxic to the liver and cause liver damage. In addition, coumarin has anticoagulant properties. Regarding the flavor of this species, it is more pungent and stronger, and the aroma is more intense compared to the species *C. zeylanicum*[32-34].

The species *C. cassia* can help regulate blood sugar and is traditionally used to control glucose levels in people with type 2 diabetes, in addition to having anti-inflammatory and antioxidant properties[34,35].

Due to the high coumarin content, excessive consumption of *C. cassia* can lead to liver damage, especially in sensitive people or children. In addition, people taking anticoagulant medications should avoid large amounts of this species, as it contains coumarin, which has anticoagulant properties[32,33].

Ceylon cinnamon (*C. zeylanicum*) contains less coumarin than *C. cassia*, making it a safer option for regular consumption. This species is rich in antioxidants, especially phenolic compounds such as cinnamic acid and cinnamaldehyde, which provide anti-inflammatory and antimicrobial properties. *C. zeylanicum* has a milder, sweeter flavor with a delicate aroma, and is considered to be of superior quality in gastronomy[33,36].

Like *C. cassia*, *C. zeylanicum* can also help regulate blood sugar, but with a lower risk of adverse effects. Its antioxidant properties help fight free radicals, contributing to the prevention of chronic diseases[32,33,35].

There has been an increase in studies of the therapeutic properties of plants that may present an alternative therapeutic resource in recent years. One of these plants researched over time due to its significant biological properties is *Cinnamomum zeylanicum* Blume, commonly known as cinnamon. Various parts of the plant such as its bark, leaves, flowers, fruits and roots have medicinal and culinary applications. The chemical composition of materials obtained from different parts of a *C. zeylanicum* plant show considerable variation, resulting in different pharmacological effects. Cinnamon has great economic value and is widely used in various areas such as the pharmaceutical, food, cosmetics and beverage industries[32-34].

C. zeylanicum is known as “cinnamon”, “India cinnamon”, “Ceylon cinnamon”, being generally called “true cinnamon”, and it is a plant native to some regions of India and Sri Lanka. The parts (bark, leaves, flowers and others) of cinnamon are bioactive compound sources which have antimicrobial, antioxidant, insecticidal activity, and are also used as flavoring agents in foods[35-37].

The biological activity of cinnamon regarding its analgesic, antiseptic, anticancer, antispasmodic, coagulant, neuroprotective, hepatoprotective, gastroprotective, cardioprotective and antimicrobial potential, as well as its action in reducing and controlling the serum levels of fats in the blood have already been reported in literature. Several studies have shown additional evidence of the antimicrobial potential of this plant against gram-positive and gram-negative fungi and bacteria[32,38,39].

Cinnamon has several medicinal and pharmacological properties that are effective in controlling human diseases like diabetes, Alzheimer’s disease, cancer, arthritis, heart disease, indigestion, and tooth decay, etc.[40].

Alzheimer's disease is a progressive neurodegenerative condition that leads to death, characterized by memory loss, severe behavioral abnormalities, and cognitive impairments. Although there is no cure, it is possible to slow the progression of the disease through different therapeutic approaches. Inhibiting cholinesterases, such as acetylcholinesterase and butyrylcholinesterase, is one such strategy, helping to preserve cognitive function. Another approach is inhibiting the aggregation of beta-amyloid peptides, whose accumulation in the brain contributes to neurodegeneration and dementia. In addition, monoamine oxidase inhibitors can alleviate symptoms associated with the disease, such as depression and psychosis. Phytochemicals present in plants such as cinnamon have shown potential to inhibit these enzymes and processes, offering a possible route to the development of treatments that slow the progression of Alzheimer's[33].

Traditional uses of the species for medicinal purposes include the treatment of vaginitis, inflammation, neuralgia, wounds, diabetes, leucorrhoea and rheumatism. Cinnamon bark is one of the oldest herbal medicines cited in articles as an anti-inflammatory to fight pain, enteralgias, bronchitis and rheumatism. The chemical composition of cinnamon comprises type A procyanidins, dimeric, trimeric and oligomeric proanthocyanidins, camphene, sabinene, myrcene, fenchone, nerol, bornyl and cinnamyl acetates, geranial, cinnamaldehyde and eugenol. Biological activities which have already been reported for the species include analgesic, antipyretic, antifungal, anti-inflammatory, antimicrobial, antidiabetic and antioxidant effects[34,37].

Guarana – *Paullinia cupana* Kunth

Guarana (*Paullinia cupana* Kunth., Sapindaceae) is a species native to Brazil of great economic and social importance. It is an evergreen shrub native to the Amazon region, which was domesticated in the Amazon due to its caffeine-rich seeds. Brazil is the only guarana producer in the world, meeting both national and

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international demand. Guarana seeds have been roasted and used for hundreds of years by indigenous tribes for their stimulant, aphrodisiac and healing properties[5,7,41].

In 2022, guarana production in Brazil was 2.460 tons. In the same year, the production value was R$ 45.779.00. Its average production yield per hectare, in the same year, was 237 kg, with the state of Bahia being the largest producer of guarana in Brazil[20].

The fruit is a dehiscent capsule and a dark brown seed partially encased in an air is visible when it opens. Its ripe fruit color can vary from yellow-orange, yellowish-red to vibrant bright red[42].

Guarana seeds have several pharmacological functions, such as antimicrobial, antioxidant, anticancer, stimulant and cognitive functions, in addition to liver protection and weight loss. Many of these actions are likely due to the high methylxanthine and tannin contents in its seeds[43-45].

Due to the high potential of guarana, in addition to its medicinal characteristics and profitability, it has become an important raw material for the cosmetics and soft drinks industries. Approximately 70% of production is used in producing soft drinks and energy drinks[10].

The guarana plant is associated with a wide variety of pharmacological actions, including anticarcinogenic, antiproliferative, antimicrobial, antioxidant, energetic cytoprotective, thermogenic, antidepressant, and anxiolytic activities, as well as reducing oxidative effects and metabolic disorders[43-45].

Guarana seeds are used by dissolving the ground roasted seed powder in water, without or in combination with other herbal medicines. Nowadays, guarana is commercially exploited by the beverage, cosmetic and pharmaceutical industries[5].

Although there is a lot of interest in studying the caffeine in guarana, including its benefits and consequences, the most diverse pharmacological effects of guarana are associated with the tannins present in the plant's seeds, which represent about 16% of the seed composition[5,46].

Guarana is widely used in the food industry in the form of syrups, extracts and distillates, mainly as a flavoring agent and as a source of caffeine by industries. The greatest economic value of guarana is currently in manufacturing beverages. The American Beverage Company (Ambev) alone uses 70% of all guarana seeds produced annually. The remainder of the production (30%) is destined for the pharmaceutical industry and export, mainly to Japan and the United States[5,10].

The seeds are the commercially useful part of the plant due to the large amounts of caffeine, theobromine and theophylline, in addition to the high concentration of tannins and other compounds such as saponins, polysaccharides, proteins and fatty acids[47,48].

Hibiscus – *Hibiscus sabdariffa* DC.

The Hibiscus genus (*Hibiscus sabdariffa* L.) stands out among plant diversity. Hibiscus (*H. sabdariffa* L.) belongs to the Malvaceae family, and is an important medicinal plant originally from India, Sudan and Malaysia, being later introduced in Africa, Southeast Asia and Central America. It is a shrub that is around 3 m tall, cultivated due to the interest in its leaves, calyces and seeds, which are used to prepare drinks with culinary and medicinal purposes[2,49].

The fleshy calyces (sepals), thick red cup-shaped, are commercially important for producing beverages, juices, jellies and syrups in the food industry. In addition, these calyces are a good source of natural food coloring due to their high pigment content. Despite its wide consumption as a beverage and use in the food industry, hibiscus is also used in nutraceuticals, cosmetics and pharmaceuticals[50,51].

Hibiscus is considered a plant with diuretic properties for gastrointestinal treatment, liver infections, fever and hypertension in traditional medicine. Hibiscus is a functional food in Asian countries and the economic interest is in dehydrated calyces used worldwide in the production of teas, foods, preservatives and antioxidants[12,52,53].

It has traditionally been used effectively against hypertension, inflammation and liver disorders. Studies have shown that *H. sabdariffa* has multi-effects with antitumor, antioxidant and anti-hyperlipidemia activities. In addition, hibiscus extract has been reported to inhibit LDL (low density lipoprotein) oxidation and lower serum triacylglycerides and cholesterol. The extract from this plant can also reduce the formation of foam cells and inhibit the proliferation and migration of vascular smooth muscle cells, suggesting an anti-atherosclerotic effect of hibiscus[54-56].

H. sabdariffa is a rich source of flavonoids and its anticancer potential has attracted the interest of researchers. Kaulika, Febriansah[57] reported the cytotoxic potential of hibiscus in T47D breast cancer cells. Hibiscus petals contain flavonoids which may have antioxidant functions that play an important role in the pathophysiology of cancer. The authors concluded that hibiscus has potential as a chemopreventive agent based on its molecular fit and cytotoxic activity against T47D breast cancer cells.

Hibiscus flowers have a high anti-inflammatory effect. This effect was confirmed by using extracts from its flowers using a cellular modeling system. The polyphenol content in hibiscus works as an anti-inflammatory agent, improving antioxidant conditions and regulating the expression of cyclooxygenase-2. This also increases anti-inflammatory cytokine expression (IL-10) and therefore decreases pro-inflammatory cytokine expression (IL-6 and TNF-α)[58].

According to Ojulari *et al.*[59], the bioactive compounds derived from *H. sabdariffa* are effective against obesity, with a relevant decline in body weight, suppression of adipogenesis and inhibition of lipid accumulation. Hibiscus extract inhibited α-amylase activity, which therefore blocked sugar and starch absorption, which may aid in weight loss.

Sepal decoctions and infusions, and occasionally hibiscus leaves, are used in at least 10 countries in treating hypertension and hyperlipidemia with no reported adverse events or side effects[60].

Jambu – *Spilanthes oleraceae* L.

Acmella oleracea (L.) R. K. Jansen (sin. Spilanthes acmella var. oleraceae (L.) C. B. Clarke ex Hook. F.), also known as *Spilanthes oleracea* L., is part of the Asteraceae family, first discovered in Peru. It is currently found in tropical and subtropical regions of the world, especially in northern Brazil, where it is known as jambu[6,61,62].

It is an important medicinal plant traditionally used for its analgesic and anti-inflammatory properties, but also for being antipyretic, anticonvulsant, antidiarrheal, antidiuretic, antiseptic, antifungal, antiprotozoal, an insecticide, in addition to being used for culinary purposes[13,62,63].

These properties are due to its endogenous content of bioactive compounds, such as sterols, coumarins, flavonoids, saponins, terpenoids, polysaccharides and especially alkylamides[13].

Among the alkylamides, spilanthol (E, E, Z)-2,6,8-decatrienoic acid N-isobutylamide) is considered the most potent bioactive compound found in jambu. This compound is mainly found in its flowers, leaves, stems, and roots[13,63,64].

Many studies have been conducted with this species to produce and extract spilanthol due to its pharmacological and medicinal importance based on typical effects of alkylamides, such as analgesic, neuroprotective, antioxidant, antimutagenic, anticancer, anti-inflammatory, antimicrobial, antilarvicidal and insecticidal activities[65,66].

Yerba Mate – *Ilex paraguariensis* A.St.-Hil.

Yerba mate (*Ilex paraguariensis* A.St.-Hil., Aquifoliaceae) is a plant widely consumed in South America, especially in Brazil, Argentina, Paraguay and Uruguay. Its use extends across several local cultures, each with its own traditions and preparation methods, resulting in different forms of consumption that, in turn, can influence the availability of the plant's bioactive compounds[67,68].

Mate (maté in Spanish) is an infusion made from the yerba mate plant (*I. paraguariensis*), which has been culturally consumed daily as a beverage in the regions of origin, with some reports estimating consumption of more than 1 L day^{-1}. For this reason, many studies, including human trials, are based on this traditional volume of consumption[14,69,70].

Yerba mate production in Brazil reached 618.601 tons in 2022, with a production value of R$ 846.541,00. The average production yield per hectare in the same year was 8.421 kg, with the state of Paraná being the largest producer of yerba mate in Brazil[20].

In southern Brazil, yerba mate is traditionally consumed in the form of chimarrão. This drink is prepared by adding hot (not boiling) water to ground yerba mate. Chimarrão is more than just a drink; it is a symbol of hospitality and friendship. Sharing chimarrão in conversation circles is a common practice, representing a moment of social interaction[71-73].

In regions such as Mato Grosso do Sul and some parts of São Paulo, yerba mate is consumed as tereré, a cold drink. In this form of consumption, yerba mate is prepared in the same way as chimarrão, but the water used is cold and sometimes the water is flavored with fruit juices or herbs. Tereré is associated with a warmer climate and is popular among rural workers and young people. Like chimarrão, tereré also has a strong social component, being shared in groups as a sign of friendship and hospitality[68,72,74].

Like green tea and coffee, yerba mate is rich in bioactive compounds, including polyphenols (such as chlorogenic acid), xanthines (caffeine, theobromine) and saponins. These compounds have antioxidant,

stimulant and anti-inflammatory properties, contributing to the health benefits associated with yerba mate consumption[14,72-74].

According to Bracesco *et al.*[71], the well-known traditional preparations of aqueous mate infusions are drinks of four main types:

- *Chimarrão*: Extract in hot water of dried and crushed green mate leaves;
- Cooked maté: Green mate made as herbal tea, a common commercial product;
- Tererê: Extract in cold water of dried and crushed green mate leaves;
- Mate tea: Leaves dried (roasted) and prepared as herbal tea.

Like green tea and coffee, mate has alkaloids, methylxanthine, caffeine and theobromine, and its consumption is traditionally due to its stimulant properties[14,71].

In addition to the main yerba mate consumption types mentioned above, the leaves have other diverse industrial applications, such as soluble extracts for beverages, dye, food preservatives and raw material for hygiene and cosmetic products[69,70].

Several works emphasize the complexity of the chemical composition of yerba mate. There are 2 compounds with the highest concentration among the main active compounds found in the leaves and branches of the plant, they are polyphenols (chlorogenic acid) and xanthines (caffeine, theobromine and theophylline). In addition to these compounds, there are also puric alkaloids (caffeic acid, 3,4-dicapheoylquinic acid, 3,5-dicapheoylquinic acid), flavonoids (quercetin, kaempferol and rutin), amino acids, minerals (P, Fe and Ca), vitamins (A, B1, B2, C and E), as well as cellulose, dextrin, saccharin and gums[70,75-77].

The infusion of yerba mate with hot water tends to extract bioactive compounds more efficiently, especially polyphenols and xanthines. The high temperature facilitates the release of these compounds, making chimarrão a drink rich in antioxidants and caffeine. Due to the greater extraction of caffeine, chimarrão has a more stimulating effect[71-74].

In tererê, the extraction of bioactive compounds is less efficient due to the cold temperature of the water used. This can result in a lower concentration of antioxidants and caffeine in the drink. However, this form of consumption still retains a significant amount of compounds, providing health benefits. Tereré tends to be more refreshing and less stimulating compared to chimarrão, due to the lower amount of caffeine extracted[68,72-74].

Analyzes of the compounds present in *I. paraguariensis* confer several properties of therapeutic value and make it recommendable as a hypocholesterolemic, hepatoprotective, antioxidant, diuretic, digestive, nervous system stimulant, anti-inflammatory, antirheumatic and lipolytic agent, in addition to being indicated in asthenia cases and being an adjunct for treating overweight [75-77].

Numerous studies on these plants have been conducted to evaluate and confirm the effects and benefits cited in this study. Some of the main health benefits from the consumption of these plants are described in **TABLE 1**.

TABLE 1: Evidence of the effectiveness of *Euterpe oleraceae* Martius., *Cinnamomum zeylanicum* Blume, *Paullinia cupana* Kunth, *Hibiscus sabdariffa* DC., *Spilanthes oleraceae* L. and *Ilex paraguariensis* A.St.-Hil. plants for health benefits.

Species	Parts of the plant used	Proven health benefits	Publication
Euterpe oleraceae Martius. (Açaí)	Fruit (pulp) and seed extract	Antioxidant capacity; Presence of anthocyanins.	[9,23,25,26]
		Vasodilator; Prevents cardiovascular disease; Atherosclerosis.	[78,79]
		Prevents obesity; Steatosis and liver fibrosis.	[80]
		Antimicrobial properties (*Staphylococcus aureus*); Cytotoxicity against hepatocellular carcinoma cells (HepG2).	[81]
		Antioxidant, anti-inflammatory (NLRP3 inflammasome); Cytotoxic agent against cervical carcinoma.	[30,31]
		Increased gene expression of antioxidant enzymes and lipid metabolism.	[22]
		Activity against seizures and seizure-related oxidative stress.	[82]
		Identification of compounds such as lipids, prenol, isoflavonoids and isoquinolines related to superfoods.	[83]
Cinnamomum zeylanicum Blume (Cinnamon)	Leaves and bark	Antimicrobial activity; Anticancer properties.	[34,38]
		Antioxidant activity; Anti-inflammatory activity; Antimicrobial activity.	[32,35,36,37]
		Phenolic compounds; Alzheimer's disease remediation; Antidiabetic action.	[33,39,40]
		Cardioprotective activity; Antioxidant capacity.	[11]
		Inhibition of aflatoxin B1; Antifungal action against *Aspergillus flavus*; Antioxidant capacity.	[84]
		Improved oxidative stability; Hygienic characteristics of meat.	[85]
Paullinia cupana Kunth (Guarana)	Fruit and seeds (extract)	Phenolic compounds; Antimicrobial activity.	[10,41,86]
		Anxiety control; Panic disorders; Antidepressant agent; Improves cognitive and physical abilities.	[48,87,88]
		Anti-inflammatory effects; Antitumor effects; Antioxidant effects; Antimicrobial effects.	[7,44,46,47,89,90]
		Adjuvant in lowering cholesterol and protecting the liver.	[45,91]
		Neuroprotective activity.	[42,43]
Hibiscus sabdariffa DC.		Antioxidant activity;	[53,58,92,93,94]

Species	Parts of the plant used	Proven health benefits	Publication
	Seeds and calyces (flowers/sepals)	Source of natural pigments (total anthocyanins, cyanidin and delphinidin).	
		Antimicrobial activity against *Escherichia coli, Salmonella enteritidis*, *Staphylococcus aureus* and *Micrococcus luteus*	[50,85]
		Promotes hypoglycemic and hypolipidemic activities; Prevents liver damage in diabetic condition.	[12,52,96]
		Reduction in body weight, total body fat, liver fat; Increase in HDL-C and decrease in alanine aminotransferase.	[55,56,59]
		Inhibition of human colon cancer cells and antioxidant action.	[51]
		Functional foods with antioxidant properties.	[2,60,97]
Spilanthes acmella (L.) Murr. (jambu)	Leaves and inflorescences	Antifungal activity; High content of vitamin C, phenolic compounds and flavonoids; Antioxidant activity.	[6,61,64]
		Anti-inflammatory activity; Analgesic activity; Antipyretic activity; Local anesthetic activity; Inhibitory effect on nitric oxide production; Presence of phenolic compounds and tannins.	[13,98,99,100,101]
		Diuretic activity; Anti-obesity (slimming).	[102,103]
		Aphrodisiac action.	[104]
Ilex paraguariensis A. St.-Hil. (Yerba mate)	Leaves (extract)	Antioxidant activity; Compound of caffeine, rutin and quercetin.	[8,75,76,77,105,106,107]
		Decreased levels of glucose and glycosylated proteins; Reduced lipid peroxidation in liver, kidney and brain tissues; Increase in antioxidant enzymes, reduction in non-protein thiols generated by diabetes; Reduction of peripheral neuropathy.	[14,108-113]
		Anti-inflammatory; Anti-cancer; Chemoprevention.	[114-116]
		Cardioprotective.	[117,118]
		Anti-aging; Improve bone health.	[119,120]
		Application to traumatic brain injury.	[121]
		It improves the oxidative stability; Nutritional value and sensory quality in beef.	[122]

Source: elaborated by the authors.

Traditional use of species

Açaí has been traditionally used and consumed for centuries by riverside and indigenous communities in the Amazon. Since the 2000s, açaí has become popular in international markets due to its high content of

anthocyanins, which provide antioxidant properties. In countries such as the US and Brazil, it is widely consumed in the form of smoothies, ice cream, supplements and beauty products[16,19].

The use of yerba mate is traditional in South American countries, and the Guarani indigenous peoples are the main disseminators of its consumption. Chimarrão (hot infusion) and tereré (cold) are an integral part of the local culture and each country has its own variations in consumption. In Brazil and Argentina, chimarrão is predominant, while in Paraguay, tereré is more common[68].

The indigenous peoples of the Amazon, especially the Sateré-Mawé, were the first to cultivate and use guarana, which is known for its stimulating effect due to its high caffeine content. It was also used as an aphrodisiac and to combat fatigue. Guarana was incorporated into the energy drink and soft drink industry in Brazil and globally[5,7,41].

Jambu is widely used in Amazonian cuisine, such as in the traditional dish "tacacá", “pato no tucupi” and “arroz com jambu”. Hibiscus, originally from África, is consumed in medicinal teas and in Brazilian northeastern cuisine, in typical dishes of Maranhão cuisine such as "cuxá" and "arroz de cuxá". Cinnamon has been used for centuries in Ásia and África as a spice and medicine[49,123-125].

Form of exploitation of species

Açaí is largely harvested through sustainable extraction, but there is a growth in monoculture cultivation, especially for export. Some traditional management practices help to preserve the ecosystem, such as the use of agroforestry and consortia[126].

Yerba mate is grown in agroforestry systems and in commercial monocultures. There is a growing demand for organic yerba mate, which promotes sustainable practices. Although guarana is grown in monocultures, there are also initiatives for organic cultivation and sustainable management, especially by traditional communities. Jambu and cinnamon are grown in traditional systems and on small farms, and hibiscus is widely cultivated in África and Southeast Ásia, on a commercial and domestic scale[67,123,125,127].

Socio-environmental impacts of species

The expansion of açaí cultivation has contributed to deforestation in some areas of the Amazon. However, sustainable management in floodplain areas helps maintain biodiversity. The export of açaí has brought significant economic benefits to some communities. Local cooperatives that control the production chain are positive examples[126].

Yerba mate monoculture can result in biodiversity loss. On the other hand, sustainable cultivation in agroforestry systems maintains ecological diversity. Communities that cultivate guarana and yerba mate in family systems tend to receive greater economic returns and maintain traditional practices. The demand for organic and sustainable products has increased these benefits. Overexploitation of jambu and cinnamon can lead to the degradation of forest areas if not managed sustainably. Hibiscus has been promoted in regenerative agriculture systems[67,123,125,127].

Aromatic and medicinal plants are gaining more and more interest as a source of natural bioactive compounds with potential for use not only in the pharmaceutical and cosmetic industry, but also in the food

industry. The essential oils industry is mainly focused on aromatic and medicinal plant extracts, using different conventional and/or innovative techniques with different impacts on the yield, composition and quality of the final product[127].

Medicinal plants are important protective foods, rich in nutrients, vitamins and dietary fiber. They are also the source of several natural bioactive/pharmaceutical compounds that provide various health benefits such as antioxidants, anti-cancer, anti-hypertensive and anti-diabetic properties. Many of these bioactive compounds present in vegetables are terpenoids, carotenoids, phenolics, phytosterols, glucosinolates and others[128].

Conclusions

The six plant species analyzed, açaí, cinnamon, guarana, hibiscus, jambu and yerba mate, demonstrate enormous potential in food, whether as natural products or as ingredients in food formulations. These plants have unique profiles of bioactive compounds, such as polyphenols, flavonoids and caffeine, which provide a range of benefits to human health, including antioxidant, anti-inflammatory and neuroprotective properties.

The integration of these species into functional foods is highly promising, as they not only contribute to the nutritional value of foods, but also improve their sensory characteristics, such as color, aroma and flavor. The use of their extracts or parts, such as fruits, seeds and leaves, has the potential to prevent and treat chronic diseases, such as cardiovascular disease, diabetes and obesity, in addition to promoting general well-being.

The versatility of these plants in different food and industrial applications reinforces their relevance for future research, aiming at the innovation of products that meet the growing demands of consumers for healthier and more functional foods.

Furthermore, the present review can help to guide researchers in choosing plants for future scientific studies based on the data presented. This can generate important information as the basis for possible benefits for the population and thus allow obtaining new consumption alternatives to prevent various diseases.

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Conflict of interest

The authors declare no conflict of interest.

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Contributions

Study design: FLF; MSRO; HMAB

Data curation: FLF; MSRO

Data collection: FLF; MSRO; HMAB

Data analysis: FLF; HMAB

Original manuscript writing: FLF; MSRO; HMAB

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