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ARAÇÁ-ROXO (*Psidium myrtoides* O. Berg): COMPOSITION, ETHNOMEDICINAL, PHARMACOLOGICAL, AND PHYTOCHEMICAL PROPERTIES – A REVIEW

ARAÇÁ-ROXO (*Psidium myrtoides* O. BERG): COMPOSIÇÃO, PROPRIEDADES ETNOMEDICINAIS, FARMACOLÓGICAS E FITOQUÍMICAS – UMA REVISÃO

ARAÇÁ MORADO (*Psidium myrtoides* O. BERG): COMPOSICIÓN, PROPIEDADES ETNOMEDICINALES, FARMACOLÓGICAS Y FITOQUÍMICAS – UNA REVISIÓN

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Abstract

Psidium myrtoides O. Berg, commonly known as araçá-roxo, is a native brazilian fruit, which belongs to the Myrtaceae family, that gained increasing attention due to its bioactive potential and rich phytochemical profile. Recent studies suggest that araçá-roxo has antioxidant, anti-inflammatory, and chemopreventive compounds that make it a promising target for the development of natural and complementary treatments. This review aimed to compile and analyze scientific evidence available between 2009 and 2025 concerning botanical characteristics, geographical distribution, nutritional composition, phytochemical profile, biological activities, ethnomedicinal uses, or toxicological data related to *Psidium myrtoides*. The analyzed studies indicate that the fruit and the leaf of *P. myrtoides* are rich in phenolic compounds, flavonoids, anthocyanins (predominantly cyanidin-3-O-glucoside), and essential oils, with β-caryophyllene and limonene as major constituents. These compounds are associated with notable antioxidant activity, in addition to anti-inflammatory, antimicrobial, chemopreventive, antidiabetic, antihypertensive, anti-obesity, and potential neuroprotective effects reported in experimental models. Chemical profile and bioactive variations are influenced by factors such as plant part, geographic origin, and seasonality. Although the available results are promising and indicate low cytotoxicity in experimental models, the evidence remains largely limited to in vitro

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Pages: 1-21

and preclinical studies. Current findings provide a consistent scientific basis for continued investigation and technological exploration of *Psidium myrtoides*.

Keywords: *Psidium myrtoides;* pharmacological properties; Myrtaceae

Resumo

Psidium myrtoides O. Berg, comumente conhecido como araçá-roxo, é um fruto nativo brasileiro pertencente à família Myrtaceae, que tem recebido crescente atenção devido ao seu potencial bioativo e ao seu rico perfil fitoquímico. Estudos recentes sugerem que o araçá-roxo possui compostos antioxidantes, anti-inflamatórios e quimiopreventivos, tornando-o um alvo promissor para o desenvolvimento de tratamentos naturais e complementares. Esta revisão teve como objetivo compilar e analisar evidências científicas disponíveis entre 2009 e 2025 referentes às características botânicas, distribuição geográfica, composição nutricional, perfil fitoquímico, atividades biológicas, usos etnomedicinais e dados toxicológicos relacionados a *Psidium myrtoides*. Os estudos analisados indicam que o fruto e as folhas de *P. myrtoides* são ricos em compostos fenólicos, flavonoides, antocianinas (predominantemente cianidina-3-O-glicosídeo) e óleos essenciais, tendo como principais constituintes o β-cariofileno e o limoneno. Esses compostos estão associados a uma notável atividade antioxidante, além de efeitos anti-inflamatórios, antimicrobianos, quimiopreventivos, antidiabéticos, anti-hipertensivos, antiobesidade e potenciais efeitos neuroprotetores relatados em modelos experimentais. O perfil químico e as variações dos compostos bioativos são influenciados por fatores como a parte da planta, a origem geográfica e a sazonalidade. Embora os resultados disponíveis sejam promissores e indiquem baixa citotoxicidade em modelos experimentais, as evidências ainda se restringem, em grande parte, a estudos in vitro e pré-clínicos. Os achados atuais fornecem uma base científica consistente para a continuidade das investigações e exploração tecnológica de *Psidium myrtoides*.
Palavras-chave: *Psidium myrtoides*; propriedades farmacológicas; Myrtaceae

Resumen

Psidium myrtoides O. Berg, comúnmente conocido como araçá morado, es un fruto nativo brasileño perteneciente a la familia Myrtaceae, que ha recibido creciente atención debido a su potencial bioactivo y su rico perfil fitoquímico. Estudios recientes sugieren que el araçá morado posee compuestos antioxidantes, antiinflamatorios y quimiopreventivos, lo que lo convierte en un objetivo prometedor para el desarrollo de tratamientos naturales y complementarios. Esta revisión tuvo como objetivo compilar y analizar la evidencia científica disponible entre 2009 y 2025 sobre las características botánicas, distribución geográfica, composición nutricional, perfil fitoquímico, actividades biológicas, usos etnomedicinales y datos toxicológicos relacionados con Psidium myrtoides. Los estudios analizados indican que el fruto y las hojas de P. myrtoides son ricos en compuestos fenólicos, flavonoides, antocianinas (predominantemente cianidina-3-O-glucósido) y aceites esenciales, siendo el β-cariofileno y el limoneno los principales constituyentes. Estos compuestos están asociados con una notable actividad antioxidante, además de efectos antiinflamatorios, antimicrobianos, quimiopreventivos, antidiabéticos, antihipertensivos, antiobesidad y potenciales efectos neuroprotectores reportados en modelos experimentales. El perfil químico y las variaciones de los compuestos bioactivos están influenciados por factores como la parte de la planta, el origen geográfico y la estacionalidad. Aunque los resultados disponibles son prometedores e indican baja citotoxicidad en modelos experimentales, la evidencia sigue estando mayormente limitada a estudios in vitro y preclínicos. Los hallazgos actuales proporcionan una base científica consistente para continuar con la investigación y la exploración tecnológica de Psidium myrtoides.
Palabras clave: Psidium myrtoides; propiedades farmacológicas; Myrtaceae

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1. Introdução

Brazil, due to its extensive territorial area and wide climatic heterogeneity, is internationally recognized for its remarkable biodiversity, which includes a wide variety of fruit and plant species with substantial biological potential (Valli, Bolzani, 2019). This biological richness spans multiple botanical families, among which *Myrtaceae* stands out as one of the most representative and economically relevant. The diversity and abundance of bioactive compounds identified in fruits belonging to this family have driven increasing interest and demand across several sectors, particularly pharmacology, the food industry, and cosmetics, thereby highlighting the strategic importance of these plant resources for the national economy (Macedo et al., 2021; Proença et al., 2022; Dias et al., 2024; Farias et al., 2024).

Among this extensive biodiversity, *Psidium myrtoides* (araçá-roxo) represents a species with considerable bioactive potential that has been comparatively underrepresented in scientific investigations. This fruit, which belongs to the same genus as guajava, has distinct botanical characteristics, but with equally remarkable properties. Recent studies suggest that araçá-roxo contains antioxidant, anti-inflammatory, and chemopreventive compounds that show great potential for applications in the fight against degenerative diseases, such as cancer, and in the prevention of chronic inflammatory processes, which are often associated with several modern pathologies. The presence of bioactive substances, such as flavonoids and tannins, confers therapeutic properties to this fruit, making it a promising target for the development of natural and complementary treatments. In addition, araçá-roxo has demonstrated significant antifungal activity, reinforcing its potential for the treatment of fungal infections and the control of pathogenic microorganisms (Cassiano et al., 2021; Dias et al., 2022; Dias et al., 2018; Franco et al., 2021).

Considering these attributes, *Psidium myrtoides* exhibits considerable potential as a valuable source of raw material for the pharmaceutical, cosmetic, and food industries, while also representing a sustainable alternative within agricultural systems (Salvador et al., 2011; Corrêa, 1984). The increasing scientific and industrial interest in this species underscores the need for more comprehensive and systematic investigations to fully elucidate its therapeutic and technological potential, which may substantially contribute to the development of novel products, processes, and applications.

MATERIAL AND METHODS

Literature Search Strategy

A comprehensive exploratory narrative review was conducted to gather scientific evidence regarding *Psidium myrtoides O. Berg.* The literature search was performed in the electronic databases Google Scholar, PubMed, ScienceDirect, SciELO, and the CAPES Periodicals Portal. The search included articles published between 2009 and 2025, without language restrictions. The following keywords and their combinations were used: “*Psidium myrtoides*”, “araçá-roxo”, “bioactive compounds”, “phytochemistry”, “anthocyanins”, “phenolic compounds”, “antioxidant activity”, “pharmacological activity”, and “essential oils”.

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Eligibility Criteria

Forty five original research articles, reviews, official documents and ethnobotanical studies reporting botanical characteristics, geographical distribution, nutritional composition, phytochemical profile, biological activities, ethnomedicinal uses, or toxicological data related to *P. myrtoides* were considered eligible, using the key words above. Studies focusing exclusively on other Psidium species or lacking a clear identification of *P. myrtoides* were excluded, as *P. guajava* or another specie from the same plant family. Furthermore, studies before 2009 or that not mention *P. myrtoides* in their title.

Study Selection and Data Extraction

After removal of duplicates, titles and abstracts were screened to assess relevance. Full texts of potentially eligible studies were subsequently evaluated. Data extracted included plant part used, geographic origin, extraction methods, identified compounds, analytical techniques, biological assays performed, and main outcomes related to antioxidant, pharmacological, or toxicological effects.

Data Analysis and Synthesis

The selected studies were analyzed qualitatively and organized according to thematic categories, including botanical description, phytochemical composition, ethnomedicinal uses, and biological activities. Differences in chemical composition and biological effects were interpreted considering factors such as plant part, geographic origin, seasonality, and extraction methods. No meta-analysis was performed due to heterogeneity of methodologies and outcomes across studies.

RESULTS

The results of this review are organized to provide an integrated overview of the botanical characteristics, phytochemical composition, and biological activities reported for *Psidium myrtoides*. The findings are presented descriptively, highlighting consistencies and divergences among studies, as well as experimental conclusions supported by the available evidence.

Botanical Characteristics

Psidium myrtoides O. Berg was discovered by Otto Karl Berg (1815–1866) in 185 (Berg, 1857). It is a species belonging to the Myrtaceae family, which can be presented as a tree or shrub, with a height ranging between 3 and 20 meters. The branches are cylindrical, with diameters between 0.8 and 3.5 mm, usually hairless or with only a few visible hairs. The leaves are elliptical or inverted spoon-shaped, measuring 2.5 to 11 cm long by 1 to 4.5 cm wide, with a texture similar to that of paper or thicker and more resistant, like leather. The presence of fine hairs is discreet, located mainly on the central vein on the underside of the leaf. The apex (tip) of the leaf may be elongated and narrow, pointed or slightly rounded, while the base varies between narrow towards the petiole or gently pointed. The margins are whole and slightly facing down. The central vein is slightly recessed on the upper leaf face and prominent on the underside, with 7 to 14 pairs of secondary veins

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clearly visible on both sides, arranged in a curved manner and connected to each other. The vein that surrounds the leaf is about 1 to 2 mm from the edge [13,14].

The fruits are berry-like, with a rounded shape or similar to that of a pear, measuring 9 to 16 mm in length and 5.5 to 14 mm in width, hairless, and red in color when ripe. Each fruit contains 4 to 10 irregularly shaped seeds, measuring 4 to 5 mm in length. The morphological characteristics of this species are important for its identification and differentiation within the genus *Psidium* (Tuler et al., 2017).

Distribution and cultivation

Psidium myrtoides is a species native to Brazil, with an extensive geographic distribution that covers several regions of the country, including states such as Tocantins, Bahia, Ceará, Maranhão, Distrito Federal, Goiás, Espírito Santo, Minas Gerais, Rio de Janeiro, São Paulo, Paraná, and Rio Grande do Sul. This wide geographical distribution reflects the plant's high adaptability to diverse environmental conditions, allowing it to occur across several Brazilian biomes, such as the Cerrado, Caatinga, and Atlantic Forest, each with distinct ecological characteristics (Macedo et al., 2021).

In the Caatinga, a semi-arid biome, *Psidium myrtoides* demonstrated a remarkable adaptation to the drought conditions characteristic of this ecosystem. The plant can survive in arid soils and high-temperature climates, taking advantage of rare rainfall and using its physiological mechanisms to minimize water loss. Their adaptation to these environments involves, among other aspects, the ability to reduce transpiration and a deep root system, which enables access to underground water sources. In the Cerrado, a savanna biome with acidic soil and well-defined drainage, the plant establishes itself in areas of thin cerrado and campo sujo, where its resistance to nutrient scarcity and its adaptation to low-fertility soils are essential for its survival. Its presence in this biome contributes to the complexity of the ecosystem, given its role in vegetation and in providing resources for local fauna (Tuler et al., 2017).

In the Atlantic Forest biome, characterized by high biodiversity and constant humidity, *Psidium myrtoides* benefits from more fertile soil conditions and frequent rainfall. This biome, which is home to a vast diversity of species, offers the plant a favorable environment for its growth, with abundant nutrients and a rich interaction with other plant and animal species. The presence of *Psidium myrtoides* in this ecosystem contributes to the maintenance of biodiversity and environmental services, such as the regulation of the water cycle and soil stability. In addition, its adaptation to a wide range of habitats highlights the ecological versatility of the species (Freitas et al., 2021).

Particularly in the state of Espírito Santo, *Psidium myrtoides* is known as "araçaúna" and adapts to a variety of environmental conditions. The plant is found in tableland vegetation, restinga areas and mountainous regions, demonstrating its ability to colonize different types of soil and microclimates. In the restingas, environments subject to salinity and strong temperature variations, the plant shows considerable resistance, taking advantage of the conditions of the coast. In tableland areas, well-drained and more fertile soils provide an ideal environment for the development of *Psidium myrtoides*. In mountainous regions, the species

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establishes itself on steeper terrain, helping to conserve the soil and prevent erosive processes. This ecological flexibility is a clear example of how the species can adapt to different conditions, becoming an important component of local vegetation (Tuler et al., 2017).

The reproductive cycle of *Psidium myrtoides* is another significant aspect of the species. Flowering occurs predominantly between April and December, allowing a prolonged pollination window. This extended flowering period suggests that the plant can benefit from different weather conditions throughout the year, optimizing its chances of reproduction. Fruiting, in turn, occurs from February to December, characterized by a long fruit-maturation period. This phenological strategy is important for maintaining the plant's population, as it ensures seed dispersal throughout the year, increasing the chances of successful germination of new plants (Tuler et al., 2017).

Ethnomedicinal uses

The ethnomedicinal use of plants is an ancestral practice widely spread in various cultures around the world, being an essential part of traditional knowledge transmitted between generations. In Brazil, biodiversity favors a wide variety of species used for therapeutic purposes, especially within the Myrtaceae family, which houses numerous representatives with bioactive potential. A study conducted by Boscolo and Galvão (2026) in traditional communities in the mountainous region of Rio de Janeiro identified the use of several species in this family to treat common diseases, such as flu, colds, bronchitis, stomach pain, and intestinal disorders. According to the authors, the choice of these plants is related to both their local availability and the perceived effectiveness. These popular practices have aroused growing interest in science, as many of the species used empirically contain compounds with recognized anti-inflammatory, antioxidant, and antimicrobial actions, which reinforces the need for studies to validate and value this traditional knowledge.

In traditional medicine, *Psidium myrtoides* leaves are used to treat gastrointestinal diseases, such as diarrhea and dysentery, whose symptoms may be related to *Candida* spp. infections. In addition to its application in the control of these conditions, there are reports of its use due to its anti-inflammatory properties, which can contribute to the reduction of systemic inflammatory processes. Evidence suggests that the bioactive compounds present in this species have antimicrobial and anti-inflammatory potential, which justifies the growing interest in scientific investigation of their therapeutic properties (Macedo et al., 2021).

The compounds present in the leaves of *Psidium myrtoides* are predominantly essential oils, whose chemical composition was characterized by Dias and coauthors (Dias et al., 2021). In this study, the authors analyzed variation in the production of these compounds throughout the seasons, demonstrating that synthesis is more intense during dry periods. Among the main constituents identified, beta-caryophyllene and limonene stand out, substances widely recognized for their bioactive properties, including antimicrobial, anti-inflammatory, and insecticidal activities. In addition, the results suggest that, due to their chemical composition, the essential oils of this species have the potential to replace synthetic

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pesticides in agricultural production, reducing the environmental impact associated with the use of conventional agrochemicals. Thus, the sustainable exploitation of these compounds may represent a viable alternative for integrated pest management, reinforcing the economic and ecological relevance of *P. myrtoides* in agriculture (Vinh-Lam, 2026).

Phytochemical Profile

According to the study by Cassiano and coauthors (Cassiano et al., 2024), the nutritional composition of the araçá-roxo *(Psidium myrtoides*), also known as araçaúna, was detailed for the pulp with peel and for the seeds. The results are presented in Table 1.

Some studies have characterized the araçá-roxo through these techniques of activity and antioxidant characterization. In the study by Ferreira and coauthors (Ferreira et al., 2021), gallic acid, epicatechin, and epigallocatechin were identified as the main bioactive compounds in *P. myrtoides* fruits, known for their high capacity to neutralize free radicals and modulate inflammatory pathways.

Gallic acid, a phenolic acid present in many fruits, exerts its antioxidant mechanism primarily through the donation of hydrogens and electrons to neutralize free radicals, preventing the oxidation of essential biomolecules. Its structure, rich in hydroxyl groups, enables the stabilization of free radicals by resonance, in addition to forming chelates with metal ions that catalyze oxidative reactions, such as iron and copper, reducing the formation of reactive oxygen species. In addition, recent studies show that gallic acid can activate the Nrf2 signaling pathway, promoting the expression of endogenous antioxidant enzymes, such as glutathione peroxidase and superoxide dismutase, amplifying its cellular protective action (Subramanian et al., 2015).

Catechins, especially epicatechin (EC) and epigallocatechin (EGC), are flavonoids that have potent antioxidant activity by direct and indirect mechanisms. Structurally, the presence of multiple hydroxyl groups allows the donation of hydrogen and electrons for the efficient neutralization of free radicals, stabilized by electron resonance. Epigallocatechin has an additional hydroxyl group on the B-ring, which gives it greater antioxidant capacity compared to epicatechin. In addition to direct neutralization, these catechins modulate important cellular pathways, such as the inhibition of nuclear factor kappa B (NF-κB), reducing inflammation, and the activation of the Nrf2 pathway, which stimulates the production of antioxidant enzymes and improves cellular defense against oxidative stress. These integrated mechanisms give catechins an important role in protecting against diseases related to oxidative stress (Lamarão, Fialho, 2009).

In another study, Silva and coauthors (Silva et al., 2021) showed that the fruits were bioactively characterized and significant levels of total phenolics (74.64% in the pulp and 116.48% in the peel), anthocyanins (pulp: 8.72% and peel: 71.65%), flavonoids (7.98% pulp and 25.075 in the peel) and carotenoids (0.13% in the pulp and 0.52% in the peel), expressed in mg per 100 g of fruit, were found.

The functional relevance of this fruit was reinforced in the study by Gomes and coauthors (Gomes et al., 2024), which showed a remarkable antioxidant capacity of the species. High values of antioxidant activity were found in the assays with DPPH

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(3,069.81 mg of LAA/100 g and 2,996.95 mg of LAA/100 g) and ABTS (1,061.11 mg of LAA/100 g and 777.71 mg of LAA/100 g), indicating an expressive superiority when compared to the species *P. cattleianum*. In addition, the authors highlighted the significant presence of anthocyanins, total phenolic compounds, and water-soluble tannins, compounds directly related to the antioxidant activity and therapeutic potential of the fruits.

Corroborating these findings, Dias and coauthors (Dias et al., 2022) observed that both ripe and immature fruits of *P. myrtoides* had higher antioxidant capacity compared to other species of the genus *Psidium*. This finding suggests that the species has a promising functional profile, regardless of the stage of maturation, which expands its possibilities of use in feeding and in the formulation of functional or nutraceutical products.

In this same study, Dias and coauthors (2022) also investigated the essential oils extracted from the leaves of *Psidium myrtoides*, expanding the understanding of the functional potential of the species beyond the fruits. The phytochemical analysis revealed that the major compounds present in these oils were β-caryophyllene and limonene, two terpenes widely recognized for their biological properties. In another study by Silva et al. (2021), the essential oils extracted from the leaves of *Psidium myrtoides* in different states of Brazil showed a significant variation in their chemical profiles and can be classified into three distinct groups based on the main compounds identified. The oils collected in several regions of the country showed a predominance of mono- and sesquiterpenes, compounds widely recognized for their aromatic and therapeutic properties. The terpene structures found in oils include acyclic types, p-mentane, pinane, caryophylane, germacrano, eleman, cadinane, and bisabolan, which are common features in many plants in the Myrtaceae family. The first chemical profile, from the Federal District, was predominantly composed of E-caryophyllene, caryophyllene oxide, α-humulene and myrcene, compounds known for their anti-inflammatory and antioxidant properties. The second profile, originating in the state of Ceará, was dominated by 1,8-cineole, α-eudesmol, α-pinene, elemol and γ-eudesmol, substances with proven antimicrobial and anti-inflammatory activity.

Finally, the third profile, represented by samples from the states of Goiás and Espírito Santo, was characterized mainly by E-caryophyllene, α-humulene, α-bisabolol, α-copaene, and caryophyllene oxide, terpenes widely studied for their therapeutic properties, particularly for their calming and analgesic effects. These variations in chemical profiles demonstrate the richness and diversity of *Psidium myrtoides* and suggest that the composition of the essential oil can be influenced by both geographical and climatic factors, evidencing the adaptability of the plant to different environmental conditions.

β-caryophyllene is a natural sesquiterpene whose main molecular mechanism of action is its ability to act as a selective cannabinoid receptor type 2 (CB2) agonist, which distinguishes it from other terpenoid compounds. By binding to this receptor, which is highly expressed in immune cells and peripheral tissues, β-caryophyllene exerts anti-inflammatory and antioxidant effects, without eliciting the psychotropic effects related to the CB1 receptor (Baradaran et al., 2022).

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Macedo and coauthors (2021) investigated the variation in the yield of *Psidium myrtoides* essential oil throughout the year, highlighting notable seasonal differences. The study revealed that the highest oil yield was obtained during the dry season, with values ranging between 0.96% and 1.02%. This higher oil production in the dry season can be attributed to environmental factors, such as reduced water availability, which can lead to higher concentrations of volatile compounds in the plant's leaves.

On the other hand, during the rainy seasons, yields decreased significantly, ranging from 0.36% to 0.48%, indicating a negative correlation between oil yield and rainfall. The amount of oil in the leaves seems to be inversely proportional to the amount of rainfall, suggesting that climatic conditions directly influence the production of essential oil, possibly due to the dilution of volatile compounds in periods of high humidity. In addition, the month of November was highlighted as the ideal period for harvest, as it had the highest oil content, reaching 0.27 mL/100 g of fresh leaves. These results suggest that the seasonal behavior of the volatile compounds in the leaves of *Psidium myrtoides* can be strategically used for the production of essential oil. In terms of composition, oxygenated compounds, such as mono- and sesquiterpenes, decreased throughout the year, especially between May and November. Simultaneously, sesquiterpene hydrocarbons, such as 1,8-cineole, showed a significant increase in this period, which may be related to the plant's adaptation to seasonal variations. 1,8-cineole, for example, had a lower concentration in March, a period in which it coincides with the ripening process of Psidium species, suggesting that the development of leaves and fruits can interfere with the production of certain bioactive compounds.

In addition, *P. myrtoides* also stands out as a source of bioactive compounds, especially due to its expressive antioxidant capacity, which can contribute significantly to the prevention of oxidative damage in cells and, consequently, to the promotion of human health. This potential was evidenced in the study conducted by Monroy et al. (2025), in which a modern and efficient technique of supercritical extraction with carbon dioxide in purple araçá flour was used. This method allowed the obtaining of extracts highly concentrated in antioxidant compounds, presenting relevant results under several parameters analyzed. Among them, the contents of phenolic compounds stand out, which reached values of 33.06 ± 2.26 mg of gallic acid equivalents per gram of extract (mg EAG/g), and of total monomeric anthocyanins, with 3.91 ± 2.10 mg of cyanidin-3-glucoside equivalents per gram of extract (mg C3G/g). The antioxidant activity was evaluated by different methods, and by the ORAC (Oxygen Radical Absorption Capacity) assay, the value found was 415.13 ± 13.66 µmol of trolox equivalents per gram of extract (µmol TE/g), while by the FRAP (Iron Reducing Power) method, the value was even more expressive: 747.16 ± 18.49 µmol TE/g. In addition, cyanidin-3-glucoside was identified as the main antioxidant compound present, representing 4.83% of the total mass of the extract (w/w). These findings reinforce the functional potential of the purple macaw.

Pharmacological activities
Anti-inflammatory and antioxidant activity

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Chronic inflammation plays a central role in the development and progression of several chronic non-communicable diseases, such as obesity, type 2 diabetes, cardiovascular disease, and certain cancers. This type of inflammation is characterized by a persistent, low-intensity immune response, unlike acute inflammation, which is punctual and protective. One of the main triggers of chronic inflammation is the excessive accumulation of adipose tissue, especially visceral adipose tissue, which starts to act as an endocrine organ, secreting pro-inflammatory cytokines, such as tumor necrosis factor alpha (TNF-α), interleukin-6 (IL-6), and C-reactive protein (CRP). These signaling molecules promote a systemic inflammatory environment and contribute to the increase of oxidative stress, favoring the imbalance between the production of reactive oxygen species (ROS) and the antioxidant capacity of the body. This chronic pro-oxidative state can compromise cellular function, affect insulin sensitivity, and lead to endothelial dysfunction, and is therefore a determining factor for the emergence and worsening of NCDs (Cominetti et al., 2017).

The modulation of inflammation by bioactive compounds has been widely studied, especially in the context of chronic non-communicable diseases. Proinflammatory cytokines such as interleukin-6 (IL-6) and tumor necrosis factor alpha (TNF-α), whose expression is regulated by the nuclear factor kappa B (NF-κB) signaling pathway, can be inhibited by the regular intake of bioactive compounds present in foods of plant origin, such as polyphenols, flavonoids, and carotenoids (Bello, Faller, 2016).

These compounds have antioxidant action, acting in an antagonistic way to oxidative stress by neutralizing reactive oxygen species (ROS) and nitrogen (ERN), either through the donation of electrons or by the formation of stable complexes with these reactive molecules. In addition, evidence suggests that bioactive compounds can activate signaling pathways with anti-inflammatory and cytoprotective effects, such as the nuclear factor 2-related erythroid factor 2 (Nrf2) pathway, which induces endogenous antioxidant enzymes, and the p53 gene pathway, which regulates apoptosis and DNA repair. Other mechanisms may also be involved, such as the inhibition of the expression of pro-inflammatory enzymes, such as cyclooxygenase-2 (COX-2) and inducible nitric oxide synthase (iNOS). Thus, bioactive compounds play an important role in maintaining redox homeostasis and preventing chronic low-grade inflammation, with potential application in the prevention and control of NCDs (Bello, Faller, 2016).

In the study conducted by Cassiano and coauthors [6], the analysis of the induction of the enzyme quinone reductase (also known as NAD(P)H:quinone oxidoreductase 1 – NQO1) was carried out, which plays a key role in the process of cellular detoxification, being involved in the neutralization of reactive quinones and protection against oxidative stress. This enzyme is widely recognized as a marker of chemopreventive activity, since its expression is induced by compounds with antioxidant and anticancer potential. The authors investigated the effect of araçá-roxo extract (*Psidium myrtoides*) on modulating NQO1 expression in experimental models, observing a significant increase in the activity of this enzyme after treatment with the extract.

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Pages: 1-21

Antimicrobial activity

The growing concern about antimicrobial resistance has driven the search for new therapeutic agents, especially those of natural origin, that can act effectively against pathogenic microorganisms (Sirwan et al., 2024). This phenomenon, characterized by the ability of microorganisms to resist drugs commonly used to treat infections, was responsible for about 1.27 million deaths in 2019, according to data from the World Health Organization.

Microorganisms such as bacteria, viruses, fungi, and protozoa are widely distributed in the environment, including the human body, and perform different functions. While some are beneficial and contribute to the decomposition of organic matter and ecological balance, others are associated with diseases, with a significant impact on human, animal, and plant health (Hamad et al., 2025).

Given this scenario, antimicrobials remain fundamental for infection control. However, the indiscriminate and prolonged use of these compounds has favored the emergence of resistant strains, which reinforces the importance of developing alternative strategies, such as the use of natural products with antimicrobial potential (Hamad et al., 2025).

Several studies have investigated the antimicrobial potential of parts of *Psidium myrtoides*. In the study conducted by Dias and coauthors (Dias et al., 2024), the antifungal activity of the plant's leaf extracts was evaluated, focusing on the inhibition of Colletotrichum gloeosporioides, an important plant pathogen associated with losses in agricultural production. The results were promising, demonstrating a significant inhibition of approximately 70% of the fungal activity, suggesting that compounds present in the leaves of the araçá-roxo have relevant antifungal action. In addition, Macedo and coauthors (Macedo et al., 2021) investigated the antifungal activity of *P. myrtoides* extracts against yeasts of the genus Candida, microorganisms of clinical interest due to their pathogenic potential in humans. The authors reported a considerable inhibitory effect, indicating that the secondary metabolites present in the plant may have pharmacological properties with potential applications in the health area.

Anticancer activity

In the Brazilian context, estimates for the 2023-2025 triennium indicate that about 704 thousand new cases of cancer will be diagnosed per year, 483 thousand of which, when non-melanoma skin cancer is excluded. The latter, however, remains the most common type, with 220 thousand new cases estimated, followed by breast (74 thousand), prostate (72 thousand), colon and rectum (46 thousand), and lung (32 thousand) cancers. The differences in incidence are also reflected between the sexes: while prostate cancer leads among men (except for non-melanoma skin cancer), female breast cancer is the most frequent among women. These data highlight the need for specific prevention, early diagnosis, and control strategies, considering both regional particularities and gender differences (Ong et al., 2023).

Conventional cancer treatments, such as surgery, chemotherapy, radiotherapy, and hormone therapy, are widely used in the clinical management of different tumor types, including breast and prostate cancers — both of which are highly prevalent (Ong et al., 2023). While effective in many cases, these treatments are often

REMUNOM
ISSN 2178-6925

Received: 13/04/2026 - **Accepted:** 27/05/2026
Vol: 13.11
DOI: 10.66104/b8zzw386
Pages: 1-21

associated with significant side effects, which negatively impact patients' quality of life. In chemotherapy, for example, systemic toxicity is observed, with manifestations such as nausea, fatigue, immunosuppression, and alopecia. Hormonal therapy, on the other hand, common in the treatment of prostate and breast cancer with positive hormone receptors, can cause metabolic disorders, sexual dysfunctions, osteoporosis, and vasomotor symptoms. In light of this scenario, it is essential to seek complementary or adjuvant therapeutic alternatives with lower toxicity and greater potential for antitumor activity. In this context, fruit extracts rich in bioactive compounds — such as polyphenols, flavonoids, and carotenoids — have attracted growing interest because they exhibit antioxidant, anti-inflammatory, and modulatory properties of cellular pathways related to tumor cell proliferation and apoptosis (Cominetti, Horst, 2017).

The flavonoids and phenolic acids present in araçá-roxo also exert selective cytotoxic effects on tumor cells, which can interfere with the cell cycle and increase the sensitivity of cancer cells to chemotherapeutic agents, contributing to combined therapeutic strategies. Carotenoids, on the other hand, in addition to their antioxidant activity, have been associated with the regulation of gene expression and the modulation of immunity, relevant aspects in the tumor microenvironment (Dharmawansa, 2020).

In the study by Cassiano and coauthors (Cassiano et al., 2024), these chemopreventive activities of *P. myrtoides* were demonstrated through the action of quinone reductase activation. chemopreventive drugs, through the activation activating quinone reductase. This phase II enzyme is involved in the detoxification of potentially carcinogenic compounds, favoring their excretion and reducing oxidative damage to DNA. The induction of quinone reductase indicates an important cellular mechanism in the protection against tumor initiation, suggesting that the compounds present in araçá-roxo act as modulators of carcinogenesis.

Thus, the diversified phytochemical profile of *Psidium myrtoides* supports its potential as a functional agent in the context of nutritional oncology, especially as an adjuvant in therapies against hormone-dependent cancers, such as prostate and breast cancers.

Antidiabetic activity

Diabetes mellitus represents one of the greatest global challenges in public health due to its continuous growth and the associated high morbidity and mortality rates. In 2021, it was estimated that 529 million people were living with diabetes worldwide, corresponding to an age-standardized prevalence of 6.1% (Brasil, 2023). This data highlights the magnitude of the diabetes epidemic, justifying the interest in bioactive compounds with the potential to modulate glucose metabolism.

In this context, *Psidium myrtoides* has stood out due to its expressive content of anthocyanins, especially Cyanidin-3-O-glucoside, associated with the inhibitory activity of α-glucosidase and α-amylase in in vitro studies (Deepa et al., 2023; Gakidou et al., 2025). This enzymatic inhibition slows down the digestion of complex carbohydrates and the subsequent release of glucose, contributing to the reduction of postprandial glycemia — a mechanism comparable to that of antidiabetic drugs such as carbohydrase inhibitors.

REMUNOM
ISSN 2178-6925

Received: 13/04/2026 - **Accepted:** 27/05/2026
Vol: 13.11
DOI: 10.66104/b8zzw386
Pages: 1-21

Antihypertensive activity

Systemic arterial hypertension is one of the most prevalent chronic conditions in Brazil and strongly contributes to the burden of cardiovascular diseases. Recent data from Vigitel 2023 indicate that approximately 27.9% of the adult population of Brazilian capitals reported a medical diagnosis of hypertension, the highest prevalence ever recorded in the historical (Oumeddour et al., 2024). This scenario reinforces the importance of investigating bioactive compounds with a potential blood pressure-modulating effect.

The anthocyanin cyanidin-3-O-glucoside (C3G) has been widely recognized for its cardioprotective effects and antihypertensive potential, acting by multiple biomolecular mechanisms. According to Tang and coauthors [36], C3G has a direct impact on vascular function by modulating the bioactivity of nitric oxide (NO), resulting in improved endothelium-dependent vasodilation. The authors also highlight that cyanidin reduces vascular inflammation, attenuates oxidative stress, and positively interferes with metabolic pathways associated with endothelial integrity, contributing to the reduction of arterial stiffness. In addition, Tang and coauthors (Kowalczyk et al., 2011) demonstrate that C3G can modulate key components involved in the progression of cardiovascular dysfunctions, promoting systemic effects that favor blood pressure control. These findings reinforce the relevance of anthocyanins as nutraceutical agents with the ability to influence central molecular targets in the pathophysiology of hypertension.

Anti-obesity action

Obesity is one of the most relevant public health problems today, with continuous growth on a global scale. According to recent estimates by the World Health Organization, more than 1 billion people are living with obesity in the world, including approximately 650 million adults, and the prevalence continues to increase in all age groups and regions (Wei et al., 2011). In Brazil, data from Vigitel 2023 indicate that the prevalence of obesity among adults reached 22.8%, with an upward trend over the last decade (Oumeddour, 2024). This scenario reinforces the need to identify complementary, safe, and affordable strategies for the prevention and management of obesity, including the investigation of bioactive compounds from natural foods with the potential to modulate energy metabolism.

*Psidium myrtoide*s stands out for its phytochemical profile rich in phenolic compounds, notably anthocyanins such as Cyanidin-3-O-glucoside (C3G), as well as flavonoids and other polyphenols detected in recent phytochemical analyses. Data from studies on C3G demonstrate that it exerts anti-obesity effects by several mechanisms: it regulates lipid and fatty acid metabolism through the activation of pathways such as AMPK, reduces lipogenesis, increases fatty acid oxidation, and decreases lipid accumulation in hepatocytes and adipocytes, resulting in lower weight gain and lower adiposity in animal models of high-fat diets. There is also evidence that C3G modulates the expression of genes involved in adipogenesis and fat storage, stimulates thermogenesis via brown adipose tissue activation, and regulates adipokines, inflammation, and insulin sensitivity (Ziaopeng et al., 2024; Tousif et al., 2022).

REMUNOM
ISSN 2178-6925

Received: 13/04/2026 - **Accepted:** 27/05/2026
Vol: 13.11
DOI: 10.66104/b8zzw386
Pages: 1-21

Neuroprotective effects

The search for safe neuroprotective agents has emphasized dietary compounds with antioxidant, anti-inflammatory, and modulating action on glia and synaptic pathways. Among these, anthocyanins—and especially cyanidin-3-O-glucoside (C3G)—have been consistently associated with neuronal protection by multiple mechanisms: reduction of oxidative stress via activation of the Nrf2 pathway and increase of antioxidant defenses, suppression of neuroinflammation by modulation of the microglial phenotype and inhibition of pro-inflammatory cascades, mitochondrial protection and prevention of neuronal apoptosis, in addition to effects on pathological protein aggregation and promotion of autophagy and β-amyloid clearance in Alzheimer's models (recent reviews and experimental studies). There is also evidence that C3G influences synaptic signaling pathways (e.g., ERK/CREB/BDNF) and modulates the gut-brain axis, mechanisms that contribute to cognitive preservation in animal models (Vilmar et al., 2025; Sobral et al., 2015).

Specifically with regard to *Psidium myrtoides* (araçá-roxo), phytochemical studies show that the fruit has a profile rich in phenolics and anthocyanins, with emphasis on the presence of cyanidin-3-O-glucoside among the main pigments identified by HPLC/LC-MS in infusions and extracts (phytochemical analyses of native Brazilian fruits). Given the accumulation of preclinical evidence on the neuroprotective activity of C3G and anthocyanin-rich fruit extracts, the phytochemical profile of *P. myrtoides* provides biochemical plausibility for neuroprotective effects: fruit anthocyanins can act as antioxidants and microglial modulators, preserve mitochondrial function, reduce protein aggregation, and favor synaptic plasticity and neurotrophic pathways (Sobral et al., 2015).

Clinical and toxicological studies

In the literature, there are no clinical studies on the in vivo actions of *Psidium myrtoides*. However, there are some similar species, such as *Psidium guajava* (Hasnat eyt al., 2024. In it, the clinical efficacy of oil extracted from *Psidium guajava* (PG) in the treatment of childhood rotaviral enteritis was evaluated through a randomized clinical trial. The study included 62 children diagnosed with enteritis caused by human rotavirus, who were randomly allocated into two groups: the intervention group, treated with Psidium guajava oil, and the control group, treated with the traditional decoction known as Gegen Qinlian.

Clinical endpoints included the time required for diarrhea cessation, serum sodium (Na^+) levels, stool sodium and glucose concentrations, as well as the negative conversion rate of human rotavirus antigen (HRV) in fecal samples.

The results showed that the recovery rate within three days was significantly higher in the PG-treated group (87.1%) compared to the control group (58.1%), with a statistically significant difference ($P < 0.05$). In addition, the mean time to diarrhea cessation was significantly shorter in the PG group (25.1 ± 9.5 hours) than in the control group (38.7 ± 15.2 hours; $P < 0.01$). A significant reduction in sodium and glucose concentrations in the feces of PG-treated patients was also observed, in contrast to the non-significant reduction observed in the control group ($P < 0.05$). The rate of negative HRV antigen in feces was also higher in the group treated with

REMUNOM
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Received: 13/04/2026 - **Accepted:** 27/05/2026
Vol: 13.11
DOI: 10.66104/b8zzw386
Pages: 1-21

PG (87.1%) than in the control group (58.1%), with a statistically relevant difference ($P < 0.05$).

Regarding its toxicological capacity, according to a study by Gomes and coauthors (2024), *Psidium myrtoides* demonstrated the absence of cytotoxicity, even at high concentrations (12.5mg/ml in 48 hours). This characteristic is directly related to the presence of antioxidant compounds in its composition, such as flavonoids, anthocyanins, and tannins, which act to neutralize free radicals and protect cells. The absence of relevant toxic effects suggests that the bioactive constituents of the plant are not only safe to use but can also contribute positively to the maintenance of cellular health. Thus, *P. myrtoides* emerges as a promising alternative in the development of new natural therapies, especially in the context of inflammatory, degenerative diseases and even in supporting the treatment of some types of cancer, where safety and antioxidant activity are crucial factors.

Thus, it is pertinent to carry out clinical investigations involving *Psidium myrtoides* since in vivo studies of other species have demonstrated effectiveness against pathological conditions, in addition to in vitro studies with *P. myrtoides* have promising results regarding its biological properties. The evaluation of the effects of this species in human models can contribute significantly to the validation of its therapeutic potential, especially considering the growing demand for herbal alternatives based on scientific evidence. Thus, the translation of laboratory findings to the clinical context represents an essential step towards deepening knowledge about the possible benefits of this native plant.



Figure 1. Fruits and leaves of Araçá-roxo (*Psidium myrtoides* O. Berg).

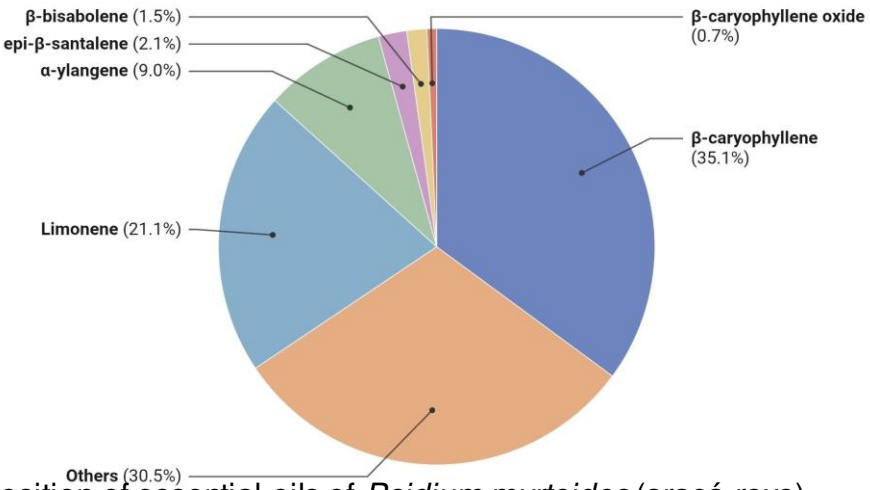


Figure 2. Composition of essential oils of *Psidium myrtoides* (araçá-roxo).

REMUNOM
ISSN 2178-6925

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Vol: 13.11
DOI: 10.66104/b8zzw386
Pages: 1-21

Table 1. Nutritional composition of araçá-roxo (*Psidium myrtoides*) and other species of the same genus

Species / Part	Energy (kcal/100 g)	Carbohydrates (g/100 g)	Proteins (g/100 g)	Lipids (g/100 g)	Reference
Psidium myrtoide (Pulp)	50	11.5	0.7	0.2	Cassiano et al., 2024
Psidium myrtoides (Seed)	55.2	10.3	0.6	3.5	Cassiano et al., 2024
Psidium myrtoides (Total)	143.62	23.66	1.04	4.98	Sharifi-Rad et al., 2023
Psidium guajava (Pulp)	68–95	10–14	0.9–2.6	-	Silva et al., 2021; Ferreira et al., 2021; Mesquita et al., 2017
Psidium cattleianum (Pulp)	40–60	8–12	1.19	0.37	Dias et al., 2022; Sharifi-Rad et al., 2023
Other *Psidium* species (summary)	116.46	18.40	1.85	3.94	Proença et al., 2022 ; Silva et al., 2021; Sharifi-Rad et al., 2023

Table 2. Reported pharmacological activities for *Psidium myrtoides* (araçá-roxo)

Pharmacological activity	Evidence	Compounds	Reference
Antioxidant	DPPH, ABTS, FRAP, ORAC assays (in vitro)	Total anthocyanins; Cyanidin-3-O-glucoside; Flavonoids	Gomes et al., 2024
Inflammatory	Cell models (in vitro)	Flavonoids; Anthocyanins	Cassiano et al., 2024
Antimicrobial	In vitro tests against bacteria and fungi	Flavonoids; Tannins; Anthocyanins	Dias et al., 2022; Macedo et al., 2021
Chemopreventive	Induction of NQO1 (in vitro)	Anthocyanins, including cyanidin-3-O-glucoside	Cassiano et al., 2024
Antidiabetic	Inhibition of α-glucosidase and α-amylase (in vitro)	Cyanidin-3-O-glucoside; Other anthocyanins	Deepa et al., 2023
Antihypertensive	Vasodilation, EO reduction	Anthocyanins (especially cyanidin-3-O-glucoside)	Kowalczyk et al., 2024
Anti-obesity	AMPK modulation,	Cyandin-3-O-glycoside	Ziaopeng et al., 2025; Tousif et al., 2022

REMUNOM
ISSN 2178-6925

Received: 13/04/2026 - **Accepted:** 27/05/2026
Vol: 13.11
DOI: 10.66104/b8zzw386
Pages: 1-21

Neuroprotection	BDNF Increase and Other Markers	Cyandin-3-O-glycoside	Sobral et al., 2015

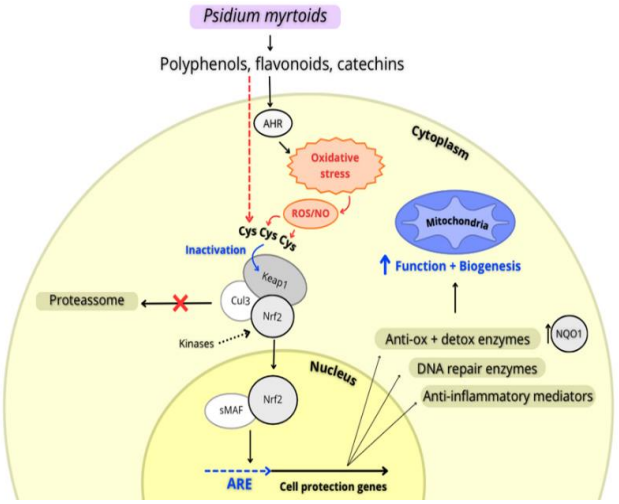


Figure 3. Bioactive compounds of *Psidium myrtoides* (araçá-roxo) and their intracellular interaction.

DISCUSSION

This review presented a synthesis of the available evidence on *Psidium myrtoides*, including its phytochemical composition, traditional uses, and antioxidant bioactivity. The main finding was the consistent association between the high content of phenolic compounds and the antioxidant activity observed across different experimental systems. These results reinforce the role of polyphenol-rich native fruits as potential modulators of oxidative stress and inflammatory processes associated with chronic non-communicable diseases (Francomano et al., 2019).

In contrast to the consistency observed in antioxidant activity, the literature still shows heterogeneity in the phytochemical profiles of the species, particularly regarding secondary metabolite composition and essential oil profiles. This variability is likely related to factors such as edaphoclimatic conditions, ripening stage, plant tissue analyzed, and extraction methodologies, which have also been described for other species within the genus *Psidium*.

The high antioxidant capacity reported for araçá-roxo can be attributed to the presence of phenolic compounds and flavonoids, including catechins and anthocyanins, molecules known to act both through direct scavenging of reactive species and through modulation of cellular pathways involved in antioxidant defense. Among these pathways, the activation of cytoprotective mechanisms associated with the endogenous antioxidant system is particularly relevant [25,51].

Furthermore, the differential distribution of bioactive compounds among pulp, peel, and leaves suggests the potential for integral use of the plant as a source of bioactive molecules. This aspect is relevant from both technological and functional perspectives, since plant by-products often present higher concentrations of phenolic compounds.

REMUNOM
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Vol: 13.11
DOI: 10.66104/b8zzw386
Pages: 1-21

The presence of terpenes in extracts and essential oils of the species broadens the spectrum of reported biological activities, including anti-inflammatory and antimicrobial effects, indicating potential synergy among different classes of secondary metabolites. This behavior is consistent with findings reported for other species of the Myrtaceae family.

The results discussed here are also aligned with the growing scientific interest in Brazilian native fruits as sources of bioactive compounds, particularly those rich in anthocyanins and other polyphenols. In this context, araçá-roxo stands out as a still underexplored species with a chemical profile compatible with relevant biological activities (Dias et al., 2024).

Despite these findings, some limitations must be considered. The number of studies specifically investigating *Psidium myrtoides* remains limited, and most of the available evidence derives from in vitro experimental models, with a lack of in vivo studies and absence of clinical trials. Additionally, the lack of standardization in extraction methods and phenolic compound quantification makes direct comparisons across studies difficult.

Future perspectives include the need for studies investigating the bioavailability, metabolism, and biological effects of araçá-roxo phenolic compounds in in vivo models and humans, as well as the standardization of phytochemical characterization protocols. Advancing these steps is essential for translating experimental findings into applications in nutrition, functional foods, and health.

CONCLUSION

In view of the above, the present review is an important stimulus to the continuity and expansion of scientific investigations on *Psidium myrtoides*, especially regarding its phytochemical composition and potential biological actions. Considering the bioactive compounds present in the species, such as polyphenols and other natural antioxidants, it becomes evident the need to deepen knowledge of their mechanisms of action across different experimental models, including in vitro and in vivo studies and clinical trials. The relevance of this plant as a promising alternative in the therapeutic context is also highlighted, especially in the treatment of complex pathologies, contributing significantly to the development of safer, more effective, and accessible therapeutic strategies for the population.

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Vol: 13.11
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