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Short Review

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Phenolic compounds and biological potential of *Eugenia uniflora* L.: A short review

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Abstract

Eugenia uniflora L. (Myrtaceae) is native to Brazil and it is known as pitanga. In traditional medicine, this species is used to treat cough, skin allergies and asthma. Different parts of this plant displayed insecticidal, antimicrobial, and antioxidant activities. The main phenolic compounds found in the extracts of this species are flavonoids and tannins, which display relevant biological activities. This review shows recent phytochemical studies on *E. uniflora*, emphasizing the phenolic compounds, including a description of methods of extraction of these metabolites. Besides, the diversified biological activities and the potential of this plant for the food industry are reported. The pharmacological and nutraceutical potential attributed to *E. uniflora* justify the growing scientific interest in this species.

Eugenia uniflora

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Highlights

- More demand for natural antioxidants motivates research about phenolic compounds.
- *Eugenia uniflora* can be used as a functional ingredient by the food industry.
- Distinct applications of *E. uniflora* spire us to continue the studies on this plant.

CONTENTS

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1. Introduction

The genus *Eugenia* is one of the most important within the Myrtaceae family, which has about 2000 species widespread from Southern Mexico to Argentina, and a small number of species in Africa. Many of these species present highlighted nutritional values and commercial applications, due to the occurrence of bioactive compounds (Saval *et al.*, 2023; Santoso *et al.*, 2021).

Eugenia uniflora L. is native to Brazil and it is known as pitanga. It is the most studied species from the *Eugenia* genus, regarding the essential oil composition and bioactivity. Considering the economic context, pitanga is a promising fruit to be exploited by agroindustry due to its diversified use, exemplified by juices, jellies, ice creams, and fruit compotes, besides its fresh consumption (Luciano *et al.*, 2021a; Santoso *et al.*, 2021; Vargas *et al.*, 2019). In addition, *E. uniflora* leaf essential oil is extensively used to produce a range of personal care products due to its astringent characteristics, added to the peculiar and pleasant aroma (Tobal and Rodrigues, 2019).

In Brazilian folk medicine, the leaves of the pitanga are used in the form of teas prepared as an infusion or decoction. Traditional applications include the treatment of hypercholesterolemia, as a digestive, hepatoprotective, diuretic, antihypertensive, anti-inflammatory, and antimicrobial (Bagatini *et al.*, 2023; Silva *et al.*, 2023). The occurrence of new or rare *E. uniflora* secondary metabolites in other plants, especially polyphenolic compounds and volatile terpenoids, is an awakening for research into new activities and applications.

Due to the importance of *E. uniflora* in different areas, this work aimed to present a short review of the published studies on methods of extraction and isolation of compounds present in extracts of the leaves and fruits of *E. uniflora*, as well as some biological activities of this species reported between 2018 and 2024.

2. Methodology

Data relating to *E. uniflora* L. and bioactive potential were obtained through PubMed and Google Scholar and published in the last 6 years. The following exclusion criteria were adopted: 1) article whose full text was not accessible in the database; 2) publications that did not include the term "*Eugenia uniflora*" and the specific bioactivity in the abstract or title; 3) articles which are not written in English; and 4) articles in which the phytochemicals used in the biological activity assays were not isolated from that species but were acquired from industries. In this short review, 48 publications were included.

3. Extraction and isolation techniques

The extraction of phenolic compounds, glycosylated flavonoids, and tannins from the fruits and leaves of *E. uniflora* has been carried out using conventional and non-conventional extraction techniques, the first being the most used. Generally, for the extraction of phenolic compounds, water and organic solvents (ethanol, methanol, acetone, and n-butanol) are used. It is often necessary to mix the solvents to increase efficiency (Sobeh *et al.*, 2019).

In fruits, the percolation technique with ethanol/water was used to isolate the sesquiterpenoids Eugenilone A− N (Chen *et al.*, 2023), while hydrolysable tannins, carotenoids, iridoids, anthocyanins, and flavonoids were isolated by maceration with acetone, methanol/water and HCl/methanol (Biazotto *et al.*, 2019; Rodrigues *et al.*, 2020). Combined techniques showed promise in obtaining phenolic compounds in *E. uniflora* fruits. An example is the maceration with sonication using pure or mixtures of solvents such as methanol, ethanol, water (Migues *et al.*, 2018; Ramalho *et al.*, 2019; Santos *et al.*, 2021), hexane, and ethyl acetate (Rashmi and Negi, 2022) in obtaining anthocyanins, tannins, flavonoids and phenolic acids.

Conventional extraction is the most used due to ease of use and low cost. However, unconventional extraction techniques have environmentally important advantages, such as shorter extraction time and amount of solvent, high yield and better reproducibility. Unconventional extraction techniques such as supercritical CO_2 have been used to extract different metabolites from leaves (Bezerra *et al.*, 2020; Canabarro *et al.*, 2020). Souza *et al.* (2022) described a green method combining the extraction assisted by microwave using natural deep eutectic solvent (NADES) composed of choline and lactic acid to isolate bioactive phenolic compounds from the leaves of *E. uniflora*. The low energy consumption associated with the method's reproducibility was highlighted in that study.

Different chromatographic techniques are used for the isolation and purification of phenolic compounds present in the leaves and fruits of *E. uniflora*. Thin-layer chromatography (TLC) analysis using silica gel (Rashmi *et al.*, 2023), column chromatography (CC) performed on silica gel, Sephadex LH-20 and Diaion HP-20 (Chen *et al.*, 2023; Sobeh *et al.*, 2019; Tenório *et al.*, 2024), flash chromatography system Sepacore® X50 with RP-18 column (Sobeh *et al.*, 2019), high-performance liquid chromatography (HPLC) performed on a reversed-phase octadecylsilanized silica gel (ODS) column and with refractive index detector (Biazotto *et al.*, 2019; Rodrigues *et al.*, 2020), and UV/VIS photodiode array detector (Ramalho *et al.*, 2019; Santos *et al.*, 2021).

For the structural elucidation of the isolated substances from *E. uniflora,* the comparison with standard samples of phenolic compounds (gallic acid, vanillic acid, ellagic acid, *p*-coumaric acid, ferulic acid) and flavonoids (kaempferol, resveratrol, quercetin, catechin, epicatechin and rutin), for example, is a conventional method. (Bagatini *et al.*, 2023). Afterwards, the structural elucidation of the isolated metabolites is generally performed using hyphenated techniques. In these cases, the equipment (Gas or liquid chromatograph) used for the isolation of the constituents is coupled to a mass spectrometer that is operated by distinct ionization types (Bagatini *et al.*, 2023; Souza *et al.*, 2022; Tenório *et al.*, 2024). Additionally, FTIR and one- and two-dimensional ^{1}H and ^{13}C NMR spectroscopies are essential techniques also used in the structural elucidation of the isolated metabolites (Rashmi and Negi, 2022).

4. Chemical composition

E. uniflora is a source of secondary metabolites from distinct classes, such as phenolic acids, glycosylated flavonoids and their aglycones, triterpenes, and tannins (**Table 1**). The chemical structure of some compounds isolated from *E. uniflora* is shown in **Fig. 1**. Many studies report the analysis of total phenolics found in extracts, as well as the content of flavonoids present in leaves, seeds or fruits of different varieties or stages of maturation of *E. uniflora* (Lazzarotto *et al.*, 2021; Fidelis *et al.*, 2022; Migues *et al.*, 2018). There are compounds which are commonly found in different parts of *E. uniflora*. However, since the amount of these compounds varies depending on the part of the plant (Bezerra *et al.*, 2020; Borsoi *et al.*, 2022), this evidence can direct the scientific interest for a specific part of *E. uniflora*. Qualitative and

quantitative profiles of secondary metabolites are influenced by parameters such as storage time, extraction method and solvent. Depending on these external factors and plant physiology, the type and content of metabolites during pitanga's maturation certainly change. It was observed that the anthocyanin content increased, while flavonoid and tannin contents decreased in fruits of red, red-orange, and purple biotypes from *E. uniflora* harvested in Brazil (Chaves *et al.*, 2018). Bellaver *et al.* (2024) evaluated the impact of drying at different temperatures on the retention of phenolic compounds and carotenoids in the pulp of *E. uniflora.* The results indicated the degradation of those compounds, highlighting the importance of optimizing the drying process and maximizing the fruit's nutraceutical value.

Santos *et al.* (2021) reported differences between the content of myricetin, quercetin, and lutein in distinct samples of fruits from the purple variety. This illustrates the variability in the constituents of the fruits belonging to the same plant and highlights the importance of collecting a sample that represents the whole specimen.

Table 1. Chemical composition of *E. uniflora.*

Plant part	Compound class	Compound	Reference
Fruits	Sesquiterpenes	Eugenilones A-N	Chen *et al.*, 2023
Pulp, seeds, and leaves	Phenolic acid	Gallic acid	Borsoi *et al.*, 2022; Tenório *et al.*, 2024
Seeds	Phenolic acids	Protocatechuic acid	Bagatini *et al.*, 2023
		Daucic acid	
		Salicylic acid	
Leaves	Phenolic acids	Quinic acid	Oliveira *et al.*, 2018
		4-hydroxybenzoic acid	
		4-p-coumaroylquinic acid	
		Chlorogenic acid	
Leaves, pulp, and fruits	Phenolic acids	p-Coumaric acid	Borsoi *et al.*, 2022; Rashmi and Neghi, 2022
Leaves and pulp	Phenolic acids	Ellagic acid	Bagatini *et al.*, 2023; Borsoi *et al.*, 2022
		Vanillic acid	Rashmi and Neghi, 2022
		Caffeic acid	
Fruits	Phenolic acids	Syringic acid	
		Homovanillic acid	
		3-Hydroxybenzoic acid	
		Tannic acid	
Pulp		4-hydroxyphenylacetic acid	Chaves *et al.*, 2018
		Gallic acid 3-*O*-[6'-*O*-acetyl-βd-glucoside]	Sobeh *et al.*, 2019
		Gentisic acid 5-*O*-β-D-glucoside	
Leaves, pulp, and seeds	Flavonoids	Myricitrin	Oliveira *et al.*, 2018;
Leaves	Glycosilated flavonoids	Myricetin-3-*O*-(2''-*O*-galloyl)-α-l-rhamnopyranoside	Oliveira *et al.*, 2018
		Myricetin-3-*O*-(2''-*O*-galloyl)-α-L-rhamnopyranoside hydrate	
Pulp	Hydrolysable tannins	Valoneic acid dilactone	Sobeh *et al.*, 2019
		Sanguiin h1	Bagatini *et al.*, 2023
		Tellimagrandin I	
Leaves	Hydrolysable tannins	Tellimagrandin II	
		Tercatain	
		Heterophylliin a	
		Ellagitannin	Oliveira *et al.*, 2018
Fruits	Hydrolysable tannins	Theogallin	Ramalho *et al.*, 2019
		Eugeniflorin D2	Oliveira *et al.*, 2018
Leaves	Dimmeric tannins	Camptothin	Oliveira *et al.*, 2018
		Gemin/dhippomanin A	
		Oenothein B	Oliveira *et al.*, 2018; Ramalho *et al.*, 2019
Leaves	Flavanone	2"-Galloylastragalin	Bagatini *et al.* 2023
		Isosakuranetin	
		Quercetin	
Leaves, seeds	Flavanols	Kaempferol	Borsoi *et al.*, 2022
		Gallocatechin	Bagatini *et al.*, 2023
		Epigallocatechin	
Leaves, seeds	Glycosilated flavone	Luteolin 7-*O*-glucoside	
Fruits[a]	Glycosilated flavonols	Myricetin-galloyl-hexoside	Migues *et al.*, 2018
		Quercetin galloyl hexoside	
		Quercetin-rhamnoside	
		Quercetin-pentoside	
		Quercetin-hexoside	
	Glycosilated Flavones	Myricetin-pentoside	
		Myricetin-rhamnoside	
	Anthocyanins	Delphinidin-3-hexoside	
		Cyanidin-3-hexoside	
Fruits[b]	Anthocyanins	Malvidin-*O*-galactoside	Migues *et al.*, 2018
		Malvidin-*O*-pentoside	
		Malvidin-*O*-acetylhexoside	
		Petunidin-*O*-galactoside	

Continue...

Fruits[a,b]	Anthocyanins	Pelargonidin-*O*-rutinoside	Chaves *et al*., 2018
		Delphinidin-*O*-galactoside	
		Pelargonidin-*O*-glucoside	
		Delphinidin-*O*-glucoside	
		Cyanidin-*O*-galactoside	
		Cyanidin-*O*-glucoside	
Pulp	Anthocyanins	Cyanidin 3-glucosyl-rutinoside	
	Glycosylated flavones	Luteolin 7-*O*-glucuronide	Chaves *et al*., 2018
		Kaempferol-3-*O*-glucuronide	
		Kaempferol-3-*O*-sophoroside	
		Isorhamnetin-3-*O*-glucoside	
		Luteolin-6-C-glucoside	
Pulp	Flavones	Isorhamnetin	Chaves *et al*., 2018
		Rhamnetin	
	Flavonol	Catechin	Chaves *et al*., 2018
	Flavanone glycoside	Eriodictyol-7-*O*-glucoside	
Fruits	Stilbene	Pterostilbene	Rashmi *et al*., 2023
	Naphtoquinone	Juglone	
	Lignan	Syringaresinol	
	Isoflavone	Biochanin A	
	Phenylpropanoid	Estragole	
Pulp	Carotenoids	Rubixanthin	Borsoi *et al.*, 2022
		Lutein	
		B-carotene	
		Violaxanthin	
		Lycopene	
		Zeaxanthin	

Source: Elaborated by the authors.
Note: a: purple variety; b: red variety.

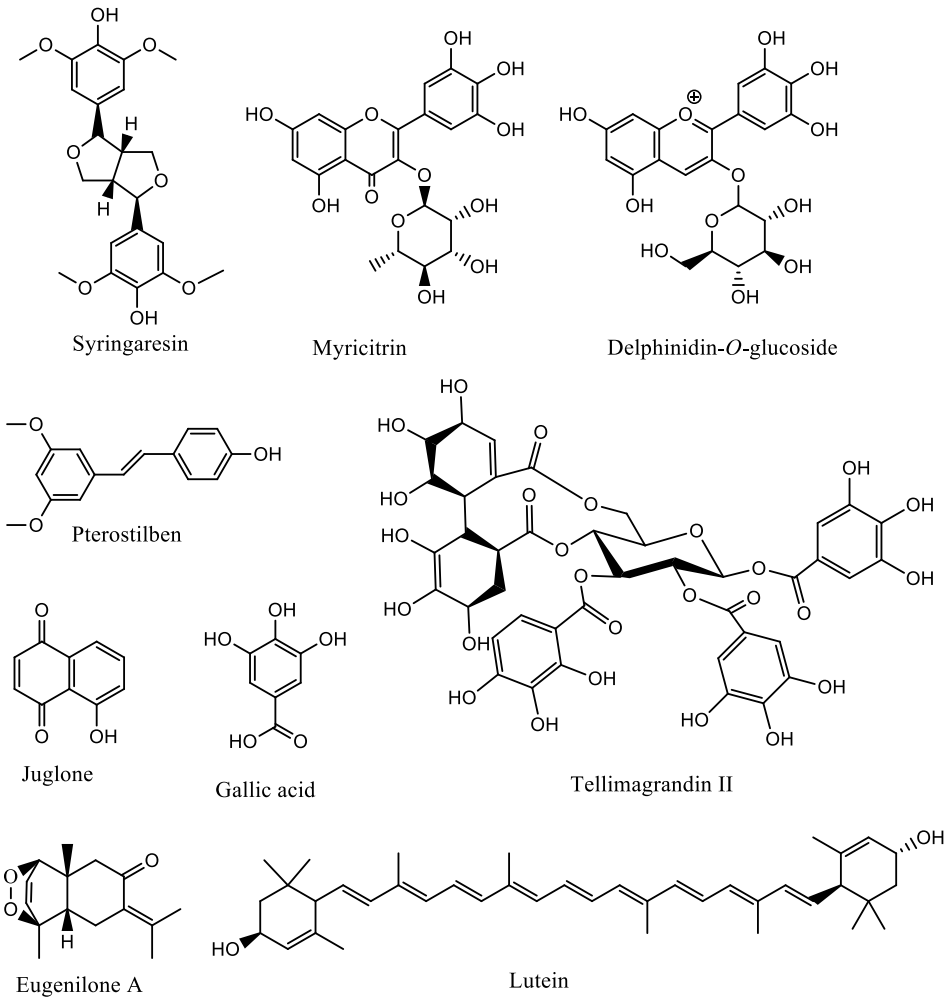

Figure 1. Chemical structures of metabolites isolated from *E. uniflora*.
Source: Elaborated by the authors.

5. Bioactivity of extracts and isolated substances of *E. uniflora*

The fruits and leaves of *E. uniflora* are used for the treatment of different symptoms and diseases, such as fever, bronchitis, digestive disorders, gout, and hypertension (Chen *et al.*, 2023; Fidelis *et al.*, 2022; Souza *et al.*, 2018). Many published studies support the traditional use of *E. uniflora*, as described in the sequence.

Virulence attributes, such as adhesion and biofilm formation, were tested in cultures of nine *Candida* species in the presence and absence of an *E. uniflora* leaf extract. The results were statistically significant for both *C. albicans* and non-*albicans Candida* isolates (Souza *et al.,* 2018). *Pseudomonas aeruginosa* is an important pathogen for human health, with a great capacity to develop antibiotic resistance. It was chosen to conduct tests with an ethanolic extract of *E. uniflora* leaves. The results obtained describe the interaction of components of the extract with commercial antibiotics. For ciprofloxacin, amikacin and colistin. The presence of the extract does not alter the antibiotic activity. However, with piperacycline or ceftazidime, the extract of *E. uniflora* induced synergistic effects increasing antibiotic activity (Bobadilla *et al.*, 2018).

A crude methanolic extract of *E. uniflora* leaves was evaluated against *Helycobacter pylori* and presented MIC of 128 mg/mL. The composition of the extract was studied by determining total phenolic compounds (19.31%) and total tannins (16.13%) in milligram equivalents of gallic acid per gram of extract, total flavonoids (2.86%) and using FT-ICR-ESI-MS demonstrating the presence of monomeric saccharides, dimers and trimers, ellagic acid, ellagitannin, galloyl-derivatives, and myricetin and as main compounds. (Monteiro *et al.*, 2019).

Serratia liquefaciens is a relevant bacterium because of its ability to form a biofilm that facilitates infection. An extract containing phenolics from *E. uniflora* fruit pulp in sub-inhibitory concentrations for S. liquefaciens significantly reduced biofilm formation by the microorganism (Rodrigues *et al.*, 2020). An ethanolic extract from the pulp of the pitanga was tested against the colorectal bacteria *Streptococcus bovis*, *Enterococcus faecalis*, *E. coli*, and *S. enterica*, demonstrating a significant reduction in the infectious potential of these microorganisms (Indrawati *et al.*, 2019).

Anti-inflammatory and antihyperglycemic activities are linked to traditional uses of the leaves from *E. uniflora* and were evaluated in the crude methanolic extract, isolating and identifying several phenolic compounds. The extract showed strong antioxidant activity in HaCaT cells, reducing ROS and p38 phosphorylation, and increasing GSH levels (Sobeh *et al.*, 2019). The *in vivo* anti-inflammatory activity was evaluated by the considerable reduction in paw edema caused by carrageenan, in addition to the reduction in acid-induced writing and the increase in latency time in the hot plate test, and reduction in rectal temperature in rats after intraperitoneal injection of Brewer's yeast (Sobeh *et al.*, 2019). Antidiabetic activity was demonstrated in rats with streptozotocin-induced diabetes, strongly reducing serum glucose and lipid peroxidation levels and, at the same time, increasing serum insulin concentration (Sobeh *et al.*, 2019).

The fraction obtained with ethyl acetate extract of *E. uniflora* leaves showed a high concentration of phenolic compounds, identifying gallic acid (5.29%), ellagic acid (1.28%) and myricitrin (8.64%) as being the major compounds. This fraction showed anti-inflammatory activity with a significant reduction in paw edema and the number of abdominal contortions induced by acetic acid, and an antinociceptive effect at all doses tested, suggesting the participation of opioid receptors (Candeia *et al.*, 2022).

A recent discovery of novel secondary metabolites in *E. uniflora* occurred in studies of fruits and thus may become important in food production. They are sesquiterpenes with rearranged skeletons called Eugenilones A-H, some of which have moderate anti-inflammatory activity determined in a model using zebrafish (Chen *et al.*, 2022). Between the so-called Eugenilones A-N, two of which (A and E) showed significant anti-inflammatory activity by inhibiting the production of cellular factors such as NO and TFN—alpha (Chen *et al.*, 2023).

Counting on phenolic compounds with strong antioxidant activities, an ethanolic extract of *E. uniflora* and fractions showed promising results in hepatoprotection models (Syama *et al.*, 2020). At doses of up to 2.0 g/kg administered to rats, no toxic effects could be observed. By the other side, the most active fraction of the extract (500 mg/kg) showed antitoxic effects comparable to silymarin (100 mg/kg) in the model of rat intoxication with CCl_4 at the highest dose tested, in the same way that impaired normal bilirubin and alkaline phosphatase levels were restored. The histological study showed the normalization of liver tissues after treatment with the active fraction (Syama *et al.*, 2020).

Cytotoxic activities have been found in different *E. uniflora* extracts from leaves, seeds, fruit pulp, essential oils, and isolated substances. As an example, the cytotoxic potential of an *E. uniflora* leaf extract was studied *in vitro* against dengue virus replication in the Huh7it-1 cell line, showing an IC_{50} of 19.8 µg/mL (Dewi *et al.*, 2019). Furthermore, phenolic compounds from this plant, such as myricetin, cyanidin -3-*O*-glucoside, and galloylastragalin, were evaluated by in silico analysis of toxicity assessment and against the MDM2 and Bcl-xL proteins, which are responsible for promoting cancer cell growth and malignancy. Galloylastragalin showed potent inhibition of those proteins. All the compounds assayed were potentially non-hepatotoxic, non-mutagenic, non-carcinogenic, and non-cytotoxic (Kar *et al.*, 2024), which stimulates further evaluation of the anticancer properties of *E. uniflora*.

Extracts from the seeds and pulp of the *E. uniflora* fruit were tested to determine antitumor activities, cytotoxic potential and inhibitory capacity for α-amylase and α-glucosidase. The extracts were not cytotoxic to peripheral blood mononuclear cells. The seed extract decreased the cell viability of melanoma cells within 24 hours of exposure. At a concentration of 5 µg/mL, the seed extract inhibited α-amylase (7.73%) and α-glucosidase (15.34%) (Borsoi *et al.*, 2022).

A specific extract for phenolic compounds from fresh purple pitanga was obtained by homogenizing the seedless fruits with ethanol in an ULTRA-TURRAX® mixer. The extract was studied using a Parkinson's disease model in which memory impairments are induced by intranasal 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine (MPTP) administration in rats. The results of the analyses demonstrated a neuroprotective effect for the fruit phenolic extract, which contains a total phenolic of around 96.5 mg of chlorogenic acid equivalent/mL (Savall *et al.*, 2023).

The aqueous extract and fraction obtained in acetyl acetate of the leaves from *E. uniflora* were evaluated in vitro and in vivo assays for their antiophidic action. Both samples inhibited the enzymatic action of *B. leucurus* and *B. brazili* venoms at low concentrations. In addition, the extract and fraction also demonstrated *in vivo* antiphonic activity by reducing oedema in the first 0.5 h after treatment (Daniele-Silva *et al.*, 2024).

The relevant and diversified biological properties of *E. uniflora* illustrated here stimulate the continuation of research about this species' therapeutic potential, which can lead to the development of new psychotherapies.

6. Food applications

The pitanga tree is well adapted to the Brazilian climate, which allows its cultivation in almost all parts of the country. Due to its ability to thrive in different climatic and soil conditions, the pitanga tree has spread and is currently cultivated in several regions of the world, including South America, Central America, the Caribbean, Florida (where it is the most popular *Eugenia* species), Hawaii, Mexico, China, India, Sri Lanka, Madagascar, South Africa, Israel, and Mediterranean countries (Bezerra *et al.*, 2018; Engela *et al.*, 2021; Griffis *et al.*, 2018). Its high plasticity supports diversified production and stimulates commercial exploitation in different regions of the world.

A part of the human consumption of *E. uniflora in nature, it* was also investigated as a promising ingredient for many food applications. Adding bioactive compounds from plants in films could reduce the need for food preservatives. The application of pitanga leaf extract to cassava starch/chitosan films exhibited antifungal activity against *Aspergillus flavus* and *A. parasiticus* (Chakravartula *et al.*, 2020). The second layer of gelatin-based film application promoted antimicrobial effects against *S. aureus* and *L. monocytogenes*. Furthermore, the addition of phenolic compounds from *E. uniflora* produced an active film with high antioxidant activity. The bilayer technique allowed for the use of lower concentrations of additives without affecting the water vapor permeability characteristics (Luciano *et al.*, 2021a). On the other hand, when the extract was used with a single-layer technique, negative impacts were observed on the physical properties of films derived from cassava starch and chitosan. Gas permeability, including O_2 and CO_2, was elevated compared to the control film (Iaccheri *et al.*, 2023).

The incorporation of a water-in-oil-in-water (W/O/W) emulsion containing hydroalcoholic extract from pitanga leaves into gelatin and/or chitosan films resulted in a film with higher phenolic compounds and antioxidant capacity, able to suppress the growth of *S. aureus*. (Tessaro *et al.*, 2021a; 2021b). The addition of soybean straw crystalline nanocelluloses and the W/O/W emulsion produced a flexible material with high water vapor barriers (Tessaro *et al.*, 2021a). In both uses, a film with excellent UV/Vis light barrier properties was achieved, which could be ideal for packaging lipid-rich foods.

The extract of pitanga leaves was able to prevent lipid oxidation in canola oil (Vargas *et al.*, 2019), fresh pork sausages (Luciano *et al.*, 2021b), pork burgers (Lorenzo *et al.*, 2018; Rocchetti *et al.*, 2020) and lamb burgers (Carvalho *et al.*, 2019). The shelf life of these products was improved due to the inhibition of the oxidation process. In meat products, factors such as greater water retention (Luciano *et al.*, 2021b), control of microbial growth (Lorenzo *et al.*, 2018), pH (Carvalho *et al.*, 2019; Lorenzo *et al.*, 2018; Rocchetti *et al.*, 2020), reduction of protein oxidation, and enhancement of red color (Carvalho *et al.*, 2019; Lorenzo *et al.*, 2018) were perceived with the addition of the leaves extract of *E. uniflora* (Luciano *et al.*, 2021b).

The freeze-dried pulp of orange pitanga could also be added to obtain antioxidant properties against lipid and protein oxidation, but the cooking yield and texture characteristics showed significant changes compared to the standard, as well as the low sensory acceptance concerning color in beef patties (Romero *et al.*, 2021).

Pitanga pulp has the potential to be used as an ingredient by the food industry as an innovative, natural option with a health appeal. The addition of pitanga pulp to diet candies (Vergara *et al.*, 2022) and diet jellies (Tobal and Rodrigues, 2019) showed positive physicochemical characteristics, in addition to the maintenance of phenolic compounds after processing. However, anthocyanins, carotenoids and vitamin C levels decreased significantly during storage. Both the dietary and control formulations, with added sucrose, were well accepted sensorially, suggesting the addition of pulp as an alternative to encourage the consumption of native fruits with added phenolic compounds and replace artificial colors and flavorings (Tobal and Rodrigues, 2019; Vergara *et al.*, 2022).

Because the fruit is physically and chemically delicate, its transport to the final consumer is difficult. Generally, pitanga is consumed only by people with a pitanga tree (pitangueira) nearby. This fact stimulates the realization of research aiming at preserving fruit and, consequently, of the species. The above data showed the versatile application of *E. uniflora* and demonstrated the scientific potential of these species, which can stimulate its production and improve its economic value.

7. Concluding remarks

Due to the metabolites from different classes present in *E. uniflora*, promising pharmacological, nutraceutical, and technological potential are attributed to this species, a part of their application in the food industry. The diversified properties of *E. uniflora* stimulate the research of new applications for this plant, which can improve the economic value of this natural resource and its sustainable cultivation.

Authors' contribution

Conceptualization: Cássia Gonçalves Magalhães; Aline Alberti; Jociani Ascari; Domingos Sávio Nunes; **Data curation**: Cássia Gonçalves Magalhães; Aline Alberti; Jociani Ascari; Isabela Maria Macedo Simon Sola; **Formal Analysis**: Cássia Gonçalves Magalhães; Aline Alberti; Jociani Ascari; Domingos Sávio Nunes; **Funding acquisition**: Not applicable; **Investigation**: Cássia Gonçalves Magalhães; Aline Alberti; Jociani Ascari; Domingos Sávio Nunes; **Methodology**: Cássia Gonçalves Magalhães; Aline Alberti; Jociani Ascari; Domingos Sávio Nunes; Isabela Maria Macedo Simon Sola; **Project administration**: Cássia Gonçalves Magalhães; Aline Alberti; Jociani Ascari; Domingos Sávio Nunes; **Resources**: Not applicable; **Software**: Not applicable; **Supervision**: Cássia Gonçalves Magalhães; Domingos Sávio Nunes; **Validation**: Cássia Gonçalves Magalhães; Aline Alberti; Jociani Ascari; Domingos Sávio Nunes; **Visualization**: Cássia Gonçalves Magalhães; Aline Alberti; Jociani Ascari; Domingos Sávio Nunes; Isabela Maria Macedo Simon Sola; **Writing – original draft**: Cássia Gonçalves Magalhães; Aline Alberti; Jociani Ascari; Isabela Maria Macedo Simon Sola; **Writing – review & editing**: Cássia Gonçalves Magalhães; Aline Alberti; Jociani Ascari; Domingos Sávio Nunes.

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Conflict of interest

The authors declare that there is no conflict of interest.

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