

Some wild fruits from amazon biodiversity: composition, bioactive compounds, and characteristics

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Article history:

Received: 28 November 2020

Received in revised form: 23 January 2021

Accepted: 2 April 2021

Available Online: 15 August 2021

Keywords:

Legal Amazon,
Functional properties,
Exotic fruits,
Nutritional characteristics,
Phenolic compounds

DOI:

Abstract

Brazil is one of the countries that share a part of the Amazon region that has been called Legal Amazon. Amazon forest offers the most extraordinary biodiversity of flora and fauna on the planet and, on its surface, can cohabit 50% of the total existing living species. According to some botanists, it would contain about 16-20% of the species that exist today. This region has native fruits with antioxidants and antiproliferative activities already reported by some authors. Consumption of these fruits would be an alternative because they are good sources of nutritional constituents, such as minerals, fibre, vitamins, water, and caloric content. However, the number of scientific studies related to their health benefits is still low. *Eugenia stipitata*, *Myrciaria dubia* H. B. K. (McVough), *Endopleura uchi* (Huber) Cuatrecasas, *Eugenia punicifolia* (Kunth) D.C and *Garcinia madruno*. Among the main compounds reported are the most interesting groups: phenolic compounds, unsaturated fatty acids, carotenoids, phytosterols, and tocopherols, flavonoids, vitamin B, vitamin A, and vitamin C, and carotenoids. The main beneficial effect of the Amazon fruits is the antioxidant effect; other functional properties as medicinal, antimicrobial, antimutagenic, antigenotoxic, antigenotoxic, and anti-inflammatory, antinociceptive, antidiabetic, and gastroprotective, are also reported. Therefore, these fruits can be considered a valuable source of functional foods due to their phytochemical compositions and their corresponding antioxidant activities.

1. Introduction

Statistics show that more than 820 million people worldwide suffer from a lack of food that meets the nutritional requirements necessary for healthy living (FAO *et al.* 2019). Among the factors that generate this problem are the inequality of income distribution and the difficulty of accessibility to food, which causes a significant portion of the world population to be in a state of food insecurity (FAO, 2020).

The consumption of fruits is an alternative to enrich the diet because they are sources of nutritional constituents, such as minerals, fibre, vitamins, water, and caloric content (Andrade Jr and Andrade, 2014). However, native fruits from South America still do not have sufficient studies related to their health benefits compared to fruits from Europe and North America (Rufino *et al.* 2010; Gironés-Vilaplana *et al.*, 2014). Brazil is the second centre in the rank for tropical fruit worldwide, concentrating just in the Brazilian Amazon

approximately 40% of edible fruit-producing species. The majority is obtained through the extraction (EMBRAPA, 2016).

The Amazon rainforest reflects a rich diversity of flora and fauna, serving as a refuge to about 20% of all known species (Ministry of the Environment, 2019) This biome's endemic fruits are consumed in large quantities by most native populations, and access to these products happens quickly in local markets (Matos *et al.*, 2019). These fruits are generally recognized as 'exotic fruits' because they have unusual characteristics such as shape, colour, and flavour (Chang *et al.*, 2019). The wide availability of different bioactive and therapeutic compounds, in addition to the wide variety of species in the Amazon Biome, has attracted worldwide attention from researchers and food industries to those seeking alternatives for a healthy lifestyle (Lima Yamaguchi *et al.*, 2015).

Within this scenario, this review seeks to bring

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information about some fruits from Amazon Forest with high technological and pharmaceutical potential, highlighting aspects of their composition, bioactive compounds, and therapeutic properties, but which are not so well known by the scientific community. For this purpose, the literature data on the aspects already mentioned of Amazonian fruits published between 1993 and 2020 on digital platforms such as ScienceDirect, ResearchGate, SciELO, Scopus, EMBRAPA, and Google Scholar were grouped, with the primary material collected through a search in English, Spanish and Portuguese.

2. Main characteristics of the fruits from the Amazon biome

2.1 Araçá-boi (*Eugenia stipitata*)

From the *Myrtaceae* family, the araçá-boi (*Eugenia stipitata*) is a fruit of climacteric behaviour, found in the western Amazon, Ecuador, and Guyana. Trees from this fruit develop in deep and fertile soil, the fruiting occurs three times a year, and the harvest can occur 38 days after the flowering process (Neves *et al.*, 2015; Avila-Sosa *et al.*, 2019). With a globular berry shape measuring about 12 cm in diameter, the fruit can weigh up to 300 g and has a velvety and thin skin, canary yellow colour, ranging from 4 to 10 seeds per unit, and succulent and acid pulp (Baldini *et al.*, 2017; Bohry *et al.*, 2019).

Many of the fruit species that belong to the *Myrtaceae* family are used as natural medicines by the local population. This healing art is traditionally transmitted from generation to generation, and it is used to treat inflammatory conditions, intestinal disorders, high blood pressure, and diabetes (Reynertson *et al.*, 2008; Leite-Legatti *et al.*, 2012; Malta *et al.*, 2012; Neri-Numa *et al.*, 2013).

The araçá-boi tends to show moisture higher than 90% and a lipid content lower than 0.3%, thus characterizing an ideal non-caloric fruit for the production of juices and jams. Carbohydrates stand out as the main component, representing about 50% of dry weight, with fructose as the primary sugar found. The soluble solids content is around 4.5°Bx; the acid flavour is derived from the low pH of 2.5. The protein content reported in the literature is low, and the percentage of minerals (Neves *et al.*, 2015; Negri *et al.*, 2016; Avila-Sosa *et al.*, 2019; Berni *et al.*, 2019).

With its acid flavour, the fresh consumption of this fruit is low. Still, its industrial processing has been explored to enrich the final products due to its beneficial health components (Neves *et al.*, 2015). An example of this is that papaya jam production with araçá-boi

obtained wide sensory acceptance among tasters (Viana *et al.*, 2012). Likewise, supplementation of apple nectar with araçá-boi pulp increased the product's antioxidant activity (Baldini *et al.*, 2017).

Many bioactive compounds (Table 1) are present in the araçá-boi, and among these, carotenoids as all-trans- β -carotene, lutein, and esters such as palmitic acids, can be highlight (Garzón *et al.*, 2012; Berni *et al.*, 2019). The reported content of phenolic compounds and Vitamin C is high. However, the ripening decreases such compounds' concentration (Neves *et al.*, 2015). The highest antioxidant capacity in the fruit occurs in its unripe state, and the tendency to fall as it matured (Garzón *et al.*, 2012; Cuellar *et al.*, 2013). Besides that, antimutagenic and antigenotoxic activity was found (Neri-Numa *et al.*, 2013). *In vivo* studies have determined the anti-inflammatory effects of *E. stipitata* extract, a result related to phenolic compounds in its composition (Soares *et al.*, 2019).

2.2 Camu-camu (*Myrciaria dubia* H. B. K. (McVough))

Popularly known as camu-camu, caçari, or araçá-d'água, the *Myrciaria dubia* H. B. K. (McVough) is a small tree that belongs to the *Myrtaceae* family. It is present over practically the entire Amazon region. The trees have an average height, not exceeding 3 m, and are found in the non-domesticated state, mainly on the riverbanks and lakes with dark-colored water (INPA, 2012). The trees produce rounded fruits with an average mass ranging from 2.2 to 13.5 g, flat and shiny exterior, diameter ranging from 1.0 to 3.8 cm, and containing three to four seeds per fruit unit. When in the ripening state, its color varies from dark red to purple, fruiting between November to March (Chagas *et al.*, 2012; Langley *et al.*, 2015; Neves *et al.*, 2017).

In some Peru regions, camu-camu is widely used in traditional medicine to treat respiratory diseases, cataracts, depression, flu, gingivitis, infertility, migraine, osteoporosis, and malaria (Castro *et al.*, 2018). Yazawa *et al.*, (2011) proposed in their study that the fruit seed extract has potential as a source of betulinic acid, which as a functional food, prevents diseases linked to the immune system, in addition to having antimicrobial and anti-diabetic properties (Myoda *et al.*, 2010; Fujita *et al.*, 2013).

The fruits are useful minerals (Table 2) because they contain sodium, potassium, calcium, zinc, magnesium, manganese, and copper. They also have small amounts of pectin and starch in their composition. The pulps have different types of fatty acids, mainly stearic, linoleic, and oleic. Highlighted sugars are glucose and fructose, and they also have various kinds of amino acids with an

Table 1. Chemical, nutritional and bioactive composition of Araçá-boi (*Eugenia stipitata*)

Components	Part of the plant	References
Moisture	Pulp and waste	Baldini <i>et al.</i> (2017); Barros <i>et al.</i> (2017); Berni <i>et al.</i> (2019)
Soluble solids (°Bx)	Pulp and waste	Baldini <i>et al.</i> (2017); Barros <i>et al.</i> (2017); Bohry <i>et al.</i> (2019)
pH	Pulp and waste	Baldini <i>et al.</i> (2017); Barros <i>et al.</i> (2017); Bohry <i>et al.</i> (2019)
Total titratable acidity	Pulp and waste	Baldini <i>et al.</i> (2017); Barros <i>et al.</i> (2017); Bohry <i>et al.</i> (2019)
Ashs	Pulp	Baldini <i>et al.</i> (2017); Berni <i>et al.</i> (2019)
Lipids	Pulp	Baldini <i>et al.</i> (2017); Berni <i>et al.</i> (2019)
Proteins	Pulp	Baldini <i>et al.</i> (2017); Berni <i>et al.</i> (2019)
Total fibers	Pulp	Baldini <i>et al.</i> (2017);
Soluble fibers	Pulp	Baldini <i>et al.</i> (2017); Berni <i>et al.</i> (2019)
Insoluble fibers	Pulp	Baldini <i>et al.</i> (2017); Berni <i>et al.</i> (2019)
Digestible carbohydrates	Pulp	Baldini <i>et al.</i> (2017);
Carbohydrates	Pulp	Berni <i>et al.</i> (2019)
Color	Pulp, peel	Bohry <i>et al.</i> (2019)
Vitamin C	Pulp	Neves <i>et al.</i> (2015)
<i>Carotenoids</i>		
all-trans- β -carotene	Pulp	Berni <i>et al.</i> (2019)
all-trans- α -carotene	Pulp	Berni <i>et al.</i> (2019)
β -cryptoxanthin	Pulp	Berni <i>et al.</i> (2019)
cis- β -carotene	Pulp	Berni <i>et al.</i> (2019)
Violaxanthin	Pulp	Berni <i>et al.</i> (2019)
Lutein	Pulp	Berni <i>et al.</i> (2019)
Zeaxanthin	Pulp	Berni <i>et al.</i> (2019)
all-trans- γ -carotene	Pulp	Berni <i>et al.</i> (2019)
cis- γ -carotene	Pulp	Berni <i>et al.</i> (2019)
all-trans-lycopene	Pulp	Berni <i>et al.</i> (2019)
Retinol activity equivalents	Pulp	Berni <i>et al.</i> (2019)
<i>Minerals</i>		
K	Pulp	Leterme <i>et al.</i> (2006)
P	Pulp	Leterme <i>et al.</i> (2006)
S	Pulp	Leterme <i>et al.</i> (2006)
Ca	Pulp	Leterme <i>et al.</i> (2006)
Mg	Pulp	Leterme <i>et al.</i> (2006)
Cl	Pulp	Leterme <i>et al.</i> (2006)
Na	Pulp	Leterme <i>et al.</i> (2006)
Co	Pulp	Leterme <i>et al.</i> (2006)
Cu	Pulp	Leterme <i>et al.</i> (2006)
Fe	Pulp	Leterme <i>et al.</i> (2006)
Zn	Pulp	Leterme <i>et al.</i> (2006)
Mn	Pulp	Leterme <i>et al.</i> (2006)
Cr	Pulp	Leterme <i>et al.</i> (2006)
Se	Pulp	Leterme <i>et al.</i> (2006)
Ni	Pulp	Leterme <i>et al.</i> (2006)
<i>Phenolic compounds</i>		
Vanillic acid-O-hexoside	Waste	Soares <i>et al.</i> (2019)
Ellagic acid	Waste	Soares <i>et al.</i> (2019)
Coumaric acid	Waste	Soares <i>et al.</i> (2019)
Acid-Ohexoside	Waste	Soares <i>et al.</i> (2019)
Catechin	Waste	Soares <i>et al.</i> (2019)
Epicatechin	Waste	Soares <i>et al.</i> (2019)
Gallocatechin-gallate	Waste	Soares <i>et al.</i> (2019)
Dihydroquercetin glucoside	Waste	Soares <i>et al.</i> (2019)
Naringin hydrate	Waste	Soares <i>et al.</i> (2019)
Eriodictyol	Waste	Soares <i>et al.</i> (2019)
Tellimagrandin II	Waste	Soares <i>et al.</i> (2019)
Pterocaryanin C	Waste	Soares <i>et al.</i> (2019)
Casuarictin	Waste	Soares <i>et al.</i> (2019)
Potentillin	Waste	Soares <i>et al.</i> (2019)

Table 2. Chemical, nutritional and bioactive composition of Camu-camu (*Myrciaria dubia* H. B. K. (McVough)).

Components	Part of plant	References
Moisture	Pulp	Alves <i>et al.</i> (2002); Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Carbohydrate	Pulp	Alves <i>et al.</i> (2002); Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Monosaccharides	Pulp	Alves <i>et al.</i> (2002); Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Protein	Pulp	Alves <i>et al.</i> (2002); Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Ashs	Pulp	Alves <i>et al.</i> (2002); Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Crude fiber	Pulp	Alves <i>et al.</i> (2002); Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Lipids	Pulp	Alves <i>et al.</i> (2002); Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Total soluble solids (°Bx)	Pulp	Alves <i>et al.</i> (2002); Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Total titrable acidity	Pulp	Alves <i>et al.</i> (2002); Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
pH	Pulp	Alves <i>et al.</i> (2002); Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Starch	Pulp	Alves <i>et al.</i> (2002); Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Pectin	Pulp	Alves <i>et al.</i> (2002); Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Citric acid cycle intermediates	Pulp	Alves <i>et al.</i> (2002); Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
<i>Polyphenols</i>		
Polyphenols	Pulp, peel	Fracassetti <i>et al.</i> (2013); Fujita <i>et al.</i> (2013)
Ellagic acid and derivatives	Leaves	Ueda <i>et al.</i> (2004)
1-methylmalate	Fruit juice	Akachi <i>et al.</i> (2010)
C-glycosidic ellagitannins	Peel, seed	Kaneshima <i>et al.</i> (2016)
Betulinic acid	Seed	Yazawa <i>et al.</i> (2011)
<i>Essential Aminoacids</i>		
Phenylalanine	Pulp	Zapata and Dufour (1993)
Threonine	Pulp	Zapata and Dufour (1993)
Valine	Pulp	Zapata and Dufour (1993)
Leucine	Pulp	Zapata and Dufour (1993)
Isoleucine	Pulp	Zapata and Dufour (1993)
Lysine	Pulp	Zapata and Dufour (1993)
Histidine	Pulp	Zapata and Dufour (1993)
Methionine	Pulp	Zapata and Dufour (1993)
<i>Essential Fatty Acids</i>		
Stearic	Pulp	Justi <i>et al.</i> (2000)
Linoleic	Pulp	Justi <i>et al.</i> (2000)
Oleic	Pulp	Justi <i>et al.</i> (2000)
γ-linolenic	Pulp	Justi <i>et al.</i> (2000)
α-linolenic	Pulp	Justi <i>et al.</i> (2000)
Tricosanoic	Pulp	Justi <i>et al.</i> (2000)
Eicosadienoic	Pulp	Justi <i>et al.</i> (2000)
<i>Vitamins</i>		
Vitamin C	Pulp	Alves <i>et al.</i> (2002); Castro <i>et al.</i> (2015); Zapata and Dufour (1993); Rodrigues and Marx (2006); Rufino <i>et al.</i> (2010); Chirinos <i>et al.</i> (2010)
Niacin	Pulp	Zapata and Dufour (1993)
Riboflavin	Pulp	Zapata and Dufour (1993)
Thiamine	Pulp	Zapata and Dufour (1993)
Vitamin A	Pulp	Zanatta and Mercadante (2007); Zapata and Dufour (1993)
Vitamin B12	Pulp	Zapata and Dufour (1993)

Table 2 (Cont.). Chemical, nutritional and bioactive composition of Camu-camu (*Myrciaria dubia* H. B. K. (McVough)).

Components	Part of plant	References
<i>Minerals</i>		
K	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
PO ₄	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
SO ₄	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Ca	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Mg	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Cl	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Na	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Co	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Cu	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Fe	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Zn	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Al	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Mn	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
B	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Br	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Cr	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Mo	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
Se	Pulp	Justi <i>et al.</i> (2000); Zapata and Dufour (1993)
<i>Carotenoids</i>		
Neoxanthin	Pulp	Zanatta and Mercadante (2007)
cis-neoxanthin	Pulp	Zanatta and Mercadante (2007)
Violaxanthin(all-trans*+ cis)	Pulp	Zanatta and Mercadante (2007)
Luteoxanthin	Pulp	Zanatta and Mercadante (2007)
Flavoxanthin*+mixture	Pulp	Zanatta and Mercadante (2007)
5,6-epoxy-lutein	Pulp	Zanatta and Mercadante (2007)
5,8-epoxy-zeaxanthin	Pulp	Zanatta and Mercadante (2007)
5,6-epoxy-zeaxanthin	Pulp	Zanatta and Mercadante (2007)
All-trans-lutein	Pulp	Zanatta and Mercadante (2007)
Zeaxanthin	Pulp	Zanatta and Mercadante (2007)
Sintaxanthin	Pulp	Zanatta and Mercadante (2007)
b-Cryptoxanthin(all-trans*+ cis)	Pulp	Zanatta and Mercadante (2007)
5,8-Epoxy-b-carotene	Pulp	Zanatta and Mercadante (2007)
β-carotene	Pulp	Zanatta and Mercadante (2007)

emphasis on valine, serine, glutamate, and leucine. Among the organic acids, there is an expressive presence of critical acid when the fruit is not fully ripe and malic acid when it ripened. Camu-camu has significant amounts of B vitamins, vitamin A and vitamin C content 60 times higher than that found in oranges, which according to RDC n° 269 of 2005 (Brazil, 2005), this quantity are 66 times higher than the recommended daily intake (Justi *et al.*, 2000; Alves *et al.*, 2002; Rodrigues and Marx, 2006; Akter *et al.*, 2011; Hernández *et al.*, 2011; Castro, Cobos, Maddox *et al.*, 2015; Castro, Maddox, Cobos *et al.*, 2015).

The amount of bioactive compounds changes as the fruit ripens. Carotenoids, flavonoids, anthocyanins, and vitamin C are in higher concentrations before harvest (Avila-Sosa *et al.*, 2019). All-trans-lutein is the carotenoid in greater abundance (Zanatta, 2007). Among

the polyphenol compounds are anthocyanins, total phenolics, flavonols, and flavonoids (Zanatta *et al.*, 2005; Reynertson *et al.*, 2008; Chirinos *et al.*, 2010; Goncalves *et al.*, 2010; Myoda *et al.*, 2010; Rufino *et al.*, 2010). Camu-camu shows a high antioxidant capacity (Akter *et al.*, 2011; Avila-Sosa *et al.*, 2019) and antimicrobial and antigenotoxic characteristics (Chirinos *et al.*, 2010; Da Silva *et al.*, 2012; Fujita *et al.*, 2013).

The fruit is not consumed because of the high acidity in its natural form, except for the indigenous people. This happens due to the high content of L-ascorbic acid and phenolic acid, which affect its palatability (Langley *et al.*, 2015). Although there is evidence of its beneficial effect on health, fruit juice still has high sensory rejection rates (Vidigal *et al.*, 2011). However, these acidic characteristics have been explored for yogurt production, obtaining high acceptability (Aguilar and Do

Amaral, 2015).

The camu-camu can be considered a food additive since their lyophilized aqueous extract increases the final product's antioxidant activity when added to milk products. This higher antioxidant activity decreased the necessity of preservatives in this type of food (Gaglio *et al.*, 2019; Fidelis *et al.*, 2020). The camu-camu yogurt containing its seed extract obtained an acceptance rate of 84%, demonstrating that the camu-camu seed extract can be a potential ingredient for addition to dairy products (Fidelis *et al.*, 2020). Thus, this type of food is suitable in a series of new approaches to make them naturally healthy, using natural extracts in the production of dairy foods (Zikiou and Zidoune, 2019).

2.3 Uxi (*Endopleura uchi* (Huber) Cuatrecasas)

Popularly known as uchi, uxi, axuá, uchi-pucu, uxi-amarelo, uxi-liso, and uxi-ordinário (Sá *et al.*, 2015), *Endopleura uchi* (Huber) Cuatrecasas is a botanical species belonging to the Humiriaceae family and is present throughout the Brazilian Amazon basin. Developing on dry land, the fruit trees of *Endopleura uchi* (Huber) Cuatrecasas can reach 30 m in height, with trunks of rigid reddish wood, commonly used in construction. After the end of the rainy season, flowering begins between June and July. The ripening of the fruits occurs between December to July (Marx *et al.*, 2002). The fruits have the shape of an oblong-ellipsoid drupe, diameter varying from 5 to 7 cm, rough yellow-orange skin, weighing about 60 g, and the pulp is the only edible portion (Neves *et al.*, 2015; Lima *et al.*, 2020).

Tea from the bark of the uxizeiro tree trunk is used by the inhabitants of the Amazon region to treat diabetes, arthritis, rheumatism, cholesterol control, and to treat menstrual disorders (Oliveira *et al.*, 2017). Infusion of *E. uchi* peel has antidiabetic activity due to a high content of phenolic compounds, specifically bergenin and its derivatives (De Abreu *et al.*, 2008). Bergenin acts as an inhibitor of α -glucosidase (AGIs), an enzyme that acts in the catabolism of carbohydrates to reduce the postprandial peaks of glucose and insulin (Silva and Teixeira, 2015).

Endopleura uchi peel extracts showed a better option for diabetes treatment compared to other plants that have already been studied for this, such as *Cecropia obtusifolia*, *Malmea depressa*, *Acosmium panamense*, and *Spergularia rubra* (Vinhos *et al.*, 2011). Kumar *et al.* (2012) tested the type 2 antidiabetic activity of bergenin in diabetic rats. The results obtained allowed the authors to conclude that bergenin has significant antidiabetic, hypolipidemic, and antioxidant activity in type 2 diabetic rats.

Regarding antibacterial activity, *Pseudomonas aeruginosa* showed a high sensitivity for the infusion of *E. uchi* peel. However, *Bacillus cereus* and *Micrococcus luteus* showed greater sensitivity to the *E. uchi* hydroethanolic extract (Silva and Teixeira, 2015). Politi *et al.* (2012) reported that *E. uchi* infusion extracts could have an inhibition potential against *S. aureus*. The antibacterial activity of *E. uchi* may be associated with the presence of phenolic compounds. It is also possible that there are other bioactive compounds in the extracts, which interfere with the real antimicrobial potential, such as tannins and organic acids (Silva *et al.*, 2009; Taveira *et al.*, 2010).

Among other benefits of *E. uchi* is the ability to act in the inhibition of pancreatic lipase (Yun, 2010; Sukhdev and Singh, 2013) and the formation of lipoproteins (Klop *et al.*, 2013); thus becoming a potential for preventing obesity and hyperlipidemia (Hyacienth *et al.*, 2019). This ability to inhibit pancreatic lipase may be directly related to the content of polyphenols, especially flavonoids, which can have an essential role in preventing obesity and also preventing serum lipoproteins oxidation (Oliveira *et al.*, 2017). Phenolic compounds interact with specific amino acids at the lipase catalytic active site, forming stable complexes, inactivating the enzyme (Pereira *et al.*, 2011; Souza *et al.*, 2011, Shikov *et al.*, 2012, Lunagariya *et al.*, 2014).

As for the proximal composition (Table 3), the uxi has a moisture content of less than 50% in all fruit portions. The pulp shows high levels of total lipids, emphasizing the presence of linoleic and α -linolenic acids, and its peel similarly has significant levels of palmitic acid and oleic acid (Berto *et al.*, 2015). Among the mineral compounds in the whole fruit, magnesium is present in high concentrations, which is an essential constituent of bones and teeth, which offers the population easy access to a resource that brings permanent benefits to the health and quality of life of those who consume (Elige *et al.*, 2012; Berto *et al.*, 2015). Fractions of sugars are relatively low, with the highest concentration being fructose. Similarly, organic acids are also present in low amounts. The crude protein fraction is low, which differs from the total dietary fiber, which achieves a surprising concentration for fruits, emphasizing pectin (Marx *et al.*, 2002).

The content of ascorbic acid present in the fruit is evident. However, it is worth noting that the storage time deteriorates the ascorbic acid. This deteriorating behavior with storage is opposite to what occurs with the total phenolic content (Marx *et al.*, 2002; Neves *et al.*, 2015), where bergenia is the more abundant compound

Table 3. Chemical, nutritional and bioactive composition of Uxi (*Endopleura uchi* (Huber) Cuatrecasas).

Components	Part of plant	References
Moisture	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Raw protein	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Lipid fraction	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Acid content	Pulp	Marx et al. (2002)
Soluble solids (°Brix)	Pulp and peel	Neves et al. (2015)
Soluble sugars	Pulp and peel	Neves et al. (2015)
Titrateable acidity	Pulp and peel	Neves et al. (2015)
<i>Carbohydrates</i>		
Available carbohydrates	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Glucose	Pulp	Marx et al. (2002)
Fructose	Pulp	Marx et al. (2002)
Saccharose	Pulp	Marx et al. (2002)
Starch	Pulp	Marx et al. (2002)
Pectin	Pulp	Marx et al. (2002)
<i>Organic acids</i>		
Citric acid	Pulp	Marx et al. (2002)
Maleic acid	Pulp	Marx et al. (2002)
<i>Fatty acids</i>		
Myristic acid	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Palmitic acid	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Palmitoleic acid	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Stearic acid	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Oleic acid	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Linoleic acid	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Linolenic acid	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Eicosanoic acid	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Fatty acids related compounds	Extract	Lima et al. (2020)
<i>Amino acids</i>		
Glutamic acid	Pulp	Marx et al. (2002)
Leucine	Pulp	Marx et al. (2002)
Valine	Pulp	Marx et al. (2002)
Phenylalanine	Pulp	Marx et al. (2002)
Serine	Pulp	Marx et al. (2002)
Tyrosin	Pulp	Marx et al. (2002)
Alanine	Pulp	Marx et al. (2002)
Threonine	Pulp	Marx et al. (2002)
Proline	Pulp	Marx et al. (2002)
Isoleucine	Pulp	Marx et al. (2002)
Lysine	Pulp	Marx et al. (2002)
Aspartic acid	Pulp	Marx et al. (2002)
Asparagine	Pulp	Marx et al. (2002)
Glycine	Pulp	Marx et al. (2002)
Glutamine	Pulp	Marx et al. (2002)
Arginine	Pulp	Marx et al. (2002)
Histidine	Pulp	Marx et al. (2002)
Methionine	Pulp	Marx et al. (2002)
γ -Aminobutyric acid	Pulp	Marx et al. (2002)
α -Aminoadipic acid	Pulp	Marx et al. (2002)
Amino acid related compounds	Extract	Lima et al. (2020)
<i>Biogenic amines</i>		
Ornithine	Pulp	Marx et al. (2002)
Taurine	Pulp	Marx et al. (2002)
Ethanolamine	Pulp	Marx et al. (2002)
<i>Vitamins</i>		
Ascorbic acid	Pulp and peel	Marx et al. (2002); Neves et al. (2015)
α -Tocopherol	Pulp	Marx et al. (2002)

Table 3 (Cont.). Chemical, nutritional and bioactive composition of Uxi (*Endopleura uchi* (Huber) Cuatrecasas).

Components	Part of plant	References
<i>Minerals</i>		
Mn	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Zn	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Cu	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Fe	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Mg	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
Na	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
P	Pulp, seed and peel	Marx et al. (2002); Berto et al. (2015)
<i>Bioactive compounds</i>		
Phenolic Acid	Extract	Lima et al. (2020)
Total Phenolic Compounds	Tree bark extract, pulp and peel	Neves et al. (2015); Silva and Teixeira (2015); De Oliveira et al. (2017); Lima et al. (2020)
Flavonoids	Extract	Lima et al. (2020)
Chalcones	Extract	Lima et al. (2020)
Coumarins	Extract	Lima et al. (2020)
Others phenolic compounds	Extract	Lima et al. (2020)
Terpenoids	Extract	Lima et al. (2020)
Total flavonoids content	Tree bark extract	De Oliveira et al. (2017)
<i>Antioxidant activity</i>		
AChE and BuChE inhibitory activity	Tree bark extract	Silva and Teixeira (2015)
Antibacterial activity	Tree bark extract	Silva and Teixeira (2015)
α -Glucosidase inhibitory activity	Tree bark extract	Silva and Teixeira (2015)

(Nunomura et al., 2009; Silva and Teixeira, 2015). The pulp and peel of the uxi showed great antioxidant potential, but similar to what occurs with vitamin C the storage time decreases this potential (Neves et al., 2015; Hyacienth et al., 2019). The principal carotenoid found in the uxi pulp is trans- β -carotene, which guarantees its potential as a functional food (Lima et al., 2020). It can also be considered a vitamin E source, as it has an amount higher than the daily intake recommended according to RDC n° 269 of 2005 (Brasil, 2005).

2.4 Pedra-ume caá (*Eugenia punicifolia* (Kunth) D.C.)

Eugenia punicifolia (Kunth) D.C. belongs to the *Myrtaceae* family and is popularly known as pedra-ume-caá, pedra-ume, murta, or muta. It is a shrub widely distributed in the Amazon region and the savanna biome (Périco et al., 2019). Pedra-ume caá (*Eugenia punicifolia*) is a fruit species used as an alternative source of functional food. The fruits are similar to a small cherry with sweet pulp, which presents different colors according to ripening stages (Ramos et al., 2019). The flowering season is from June to March, and fruiting can occur all year round (Souza and Lorenzi, 2008).

The species is characterized by a cylindrical stem, with bark in irregular plaques that expose the yellow-colored epidermis with light spots. The leaves are elliptical (approximately 6 cm long and 2 cm wide), opposite, and petiolate. Its numerous flowers are arranged in white panicles. The wood of this plant, when dry, is red and very resistant, being used in posts and rafters (Brito et al., 2014).

Eugenia punicifolia is one of the traditional medicinal plants unexplored by pharmacists in Brazil. Traditionally used by the local community, this species was registered by the French naturalist August de Saint-Hilaire on his travels to Brazilian territories from 1816 to 1822 (Brandão et al., 2012). Besides that, *Eugenia punicifolia* has agricultural and industrial importance due to its traditional medicinal applications as multiple biological activities, such as antioxidants (Cunha et al., 2016), antimicrobial (Santos et al. 2018), anti-inflammatory (Costa et al., 2016; Lazarini et al., 2016), antinociceptive and gastroprotective (Basting et al., 2014), cytotoxic (Sousa et al., 2015) and insecticidal activities (Gonzalez et al., 2014). The leaves of this medicinal plant are popularly used in aqueous decoctions or infusions as a natural therapeutic agent for the treatment of inflammations, fever, and flu, diabetes, and in alcoholic infusions for the treatment of wounds and infectious diseases (Oliveira et al., 2005; Leite et al., 2010; Chaves and Barros, 2012; Perico et al., 2019). In addition to being a source of phenolic, flavonoid, essential oils (Linalool, β -caryophyllene, and α -terpineol), coumarin, tannin, and galotanin (Basting et al., 2014; Galeno et al., 2014; Cunha et al., 2016; De Albuquerque et al., 2019).

Phytochemical studies carried out on the pulp and seed of the *Eugenia punicifolia* fruit demonstrated the occurrence of sucrose, α -D-glucopyranose, β -D-glucopyranose, linoleic acid, gallic acid, shikimic acid, β -glucogallic acid, 3'-rhamnoside myricetin, ellagic acid, quercetin 3-O-rhamnoside and kaempferol 7-O-

rhamnoside (Ramos *et al.*, 2019). From a pharmacological point of view, studies using crude extracts of this genus have shown its anti-inflammatory, analgesic, antifungal, antipyretic, hypotensive, antidiabetic, and antioxidant activities (Donepudi *et al.*, 2012; Basting *et al.*, 2014; Tenfen *et al.*, 2016). Besides, the exotic flavor, juiciness, high acidity, and unique sensory characteristics of the fruit make it suitable for the production of juices, nectars, jams, and jellies (Lizcano *et al.*, 2010; Calvi *et al.*, 2017).

2.5 Madroño (*Garcinia madruno*)

Garcinia madruno is a species native to Central and South America, traditionally known as madroño, charichuelo, cozoiba, naranjita, ocoró, satro, and belongs to the Clusiaceae family (Lim, 2012). It is a tropical fruit tree commonly grown in the Amazon region and easily found in its natural habitat, the Eastern Amazon, and in dry forests with sandy soils. Its trees are 6 to 12 m high, with a dense green crown, and the fruiting occurs in summer. This plant produces yellow fruit with one to three seeds, covered by a white pulp. The fruit is used as food and has a characteristic acidic flavor (Chávez Cury *et al.*, 2012).

Garcinia madruno is widely used in the healing of skin infections and wounds due to its anti-inflammatory characteristics (Baggett *et al.*, 2005). Also, it is a supplement to the diet of the local population due to the presence of proteins, lipids, carbohydrates, and minerals (Ca, Mg, Na, K, P, Fe, Zn, Cu, Mn) (Chávez Cury *et al.*, 2012).

One of the reasons that aroused interest in *Garcinia madruno* is due to the presence of bioactive compounds previously identified in its leaves and fruits, such as vitamin A, vitamin C, total phenolic content, antioxidant activity, glyceryl palmitate, polyisoprenylated benzophenones, hydroxycitric acid, and biflavonoids (Osorio *et al.*, 2013; Carrillo-Hormaza *et al.*, 2016; Ramirez *et al.*, 2019). In general, polyisoprenylated benzophenones show broad biological activity with antibacterial, antifungal, anti-inflammatory, and antioxidant properties (Kumar *et al.*, 2013).

Garcinia madruno stands out for producing a high content of biflavonoids (6-11%), establishing itself as a species of relevance because most fruits do not reach 8% (Tabares-Guevara *et al.*, 2017; Sabogal-Guáqueta *et al.*, 2018). Biflavonoids call attention compared to the other chemical groups in *Garcinia* due to their bioactive potential. Some studies show that these compounds can inhibit the lipid peroxidation of human LDL and stabilize the DPPH radical (Osorio *et al.*, 2009; Osorio *et al.*, 2013). Studies show that biflavonoids generally have a

high level of antioxidant activity and relevant pharmacological activities, such as antimicrobial, antiallergic, anti-inflammatory, hepatoprotective antiviral (Ferreira *et al.*, 2012; Carrillo-Hormaza *et al.*, 2019; Ramirez *et al.*, 2019). However, although the functionality of biflavonoids is positively related to their antioxidant capacity, there is no evidence or studies that clarify the structural differences between biflavonoids with antioxidant activity (Carrillo-Hormaza *et al.*, 2016).

3. Future perspectives

Given the vast bioavailability of Amazonian fruits, many are still unknown or little explored by the scientific community. However, several authors have been paying attention to this availability and have started investigating bioactive compounds' quantification in these exotic fruits. Information about the composition of exotic fruits from the Amazon is still scarce. Many of their bioactive compounds still need to be fully identified and characterized (phenolic acids, flavonoids, biflavonoids, anthocyanins, among others). Thus, more research must be carried out to determine the complete profile of the bioactive compounds.

Given the presence of essential phytochemicals in Amazonian fruits and their association with biological properties, these fruits' possible applications as functional ingredients of food products should be examined. Another point that needs to be explored more is the medicinal application of leaf extracts, fruit peels, and seeds in pharmacology and cosmetology. Finally, the use and enhancement of by-products (peel and seeds) produced during the processing of these fruits should be investigated once they can be a new source of value-added ingredients. This can also help solve some environmental issues about the sustainable management of these materials.

Conflict of interest

The authors declare no conflicts of interest.

Acknowledgments

The authors thank the Coordination for the Improvement of Higher Education Personnel (CAPES, Brazil), for the financial support offered through scholarships and the National Council for Scientific and Technological Development (CNPq, Brazil).

References

Aguiar, J.P. and Do Amaral, F. (2015). Camu-camu (*Myrciaria dubia* HBK): yogurt processing, formulation, and sensory assessment. *American*

- Journal of Analytical Chemistry*, 6(5), 377-381. <https://doi.org/10.4236/ajac.2015.65036>
- Akachi, T., Shiina, Y., Kawaguchi, T., Kawagishi, H., Morita, T. and Sugiyama, K. (2010). 1-methylmalate from camu-camu (*Myrciaria dubia*) suppressed D-galactosamine-induced liver injury in rats. *Bioscience, Biotechnology, and Biochemistry*, 74(3), 573-578. <https://doi.org/10.1271/bbb.90775>
- Akter, M.S., Oh, S., Eun, J.B. and Ahmed, M. (2011), Nutritional compositions and health promoting phytochemicals of camu-camu (*Myrciaria dubia*) fruit: A review. *Food Research International*, 44(7), 1728-1732. <https://doi.org/10.1016/j.foodres.2011.03.045>
- Alves, R., Filgueiras, H., Moura, C., Araujo, N. and Almeida, A. (2002). Camu camu (*Myrciaria dubia* Mc Vaugh): a rich natural source of vitamin C. *Proceedings of the Interamerican Society for Tropical Horticulture*, 46(1), 11-13.
- Andrade Júnior, M.C. and Andrade, J.S. (2014). Amazonian fruits: an overview of nutrients, calories and use in metabolic disorders. *Food and Nutrition Sciences*, 5(17), 1692-1703. <https://doi.org/10.4236/fns.2014.517182>
- Avila-Sosa, R., Montero-Rodríguez, A.F., Aguilar-Alonso, P., Vera-López, O., Lazcano-Hernández, M., Morales-Medina, J.C. and Navarro-Cruz, A.R. (2019). Antioxidant properties of Amazonian fruits: a mini review of *in vivo* and *in vitro* studies. *Oxidative Medicine and Cellular Longevity*, 2019, 8204129. <https://doi.org/10.1155/2019/8204129>
- Baggett, S., Protiva, P., Mazzola, E.P., Yang, H., Ressler, E.T., Basile, M.J. and Kennelly, E.J. (2005). Bioactive benzophenones from *Garcinia xanthochymus* fruits. *Journal of Natural Products*, 68(3), 354-360. <https://doi.org/10.1021/np0497595>
- Baldini, T.F., Neri-Numa, I.A., Do Sacramento, C.K., Schmiele, M., Bolini, H.M.A., Pastore, G.M. and Bicas, J.L. (2017). Elaboration and Characterization of Apple Nectars Supplemented with Araçá-boi (*Eugenia stipitata* Mac Vaugh—Myrtaceae). *Beverages*, 3(4), 59. <https://doi.org/10.3390/beverages3040059>
- Barros, R.G.C., Andrade, J.K.S., Denadai, M., Nunes, M.L. and Narain, N. (2017). Evaluation of bioactive compounds potential and antioxidant activity in some Brazilian exotic fruit residues. *Food Research International*, 102, 84-92. <https://doi.org/10.1016/j.foodres.2017.09.082>
- Basting, R.T., Nishijima, C.M., Lopes, J.A., Santos, R.C., Périco, L.L., Laufer, S., Bauer, S., Costa, M.F., Santos, L.C., Rocha, L.R.M., Vilegas, W., Santos, A.R.S., Dos Santos, C. and Hiruma-Lima, C.S. (2014). Antinociceptive, anti-inflammatory and gastroprotective effects of a hydroalcoholic extract from the leaves of *Eugenia punicifolia* (Kunth) DC. in rodents. *Journal of Ethnopharmacology*, 157, 257-267. <https://doi.org/10.1016/j.jep.2014.09.041>
- Berni, P., Campoll, S.S., Negri, T.C., DE Toledo, N.M. and Canniatti-Brazaca, S.G. (2019). Non-Conventional Tropical Fruits: Characterization, Antioxidant Potential and Carotenoid Bioaccessibility. *Plant Foods for Human Nutrition*, 74(1), 141-148. <https://doi.org/10.1007/s11130-018-0710-1>
- Berto, A., Da Silva, A.F., Visentainer, J.V., Matsushita, M. and De Souza, N.E. (2015). Proximate compositions, mineral contents and fatty acid compositions of native Amazonian fruits. *Food Research International*, 77(Part 3), 441-449. <https://doi.org/10.1016/j.foodres.2015.08.018>
- Bohry, D., Berilli, A.P.C.G., Da Silva Berilli, S., De Almeida, R.F. and Zooca, A.A.F. (2019). Characterization and genetic divergence of araçá-boi based on physicochemical and colorimetric traits of fruits. *Revista de Ciências Agrárias Amazonian Journal of Agricultural and Environmental Sciences*, 62, 3004. <https://doi.org/10.22491/rca.2019.3004>
- Brandão, M. G., Pignal, M., Romaniuc, S., Graef, C.F. and Fagg, C.W. (2012). Useful Brazilian plants listed in the field books of the French naturalist Auguste de Saint-Hilaire (1779–1853). *Journal of Ethnopharmacology*, 143(2), 488-500. <https://doi.org/10.1016/j.jep.2012.06.052>
- Brazil. Ministry of Health. National Health Surveillance Agency. (2005). Resolution RDC n° 269, of September 22, 2005. The “Technical regulation on the recommended daily intake (idr) of protein, vitamins and minerals”. ANVISA - National Health Surveillance Agency, of September 23, 2005. Retrieved on August, 25, 2020 from BVMS Website: https://bvms.saude.gov.br/bvs/saudelegis/anvisa/2005/rdc0269_22_09_2005.html.
- Brito, A.U., Chaves, F.C.M., Senra, T.V., Oka, J.M. and Berni, R.F. (2014). Production of fruits of stone-ume-caá according to weather conditions in Manaus-AM. In EMBRAPA Western Amazon-Article in conference proceedings (ALICE). *Brazilian Horticulture*, 31(2), S2373-S2379.
- Calvi, G.P., Aud, F.F., Ferraz, I.D.K., Pritchard, H.W., and Kranner, I. (2017). Analyses of several seed viability markers in individual recalcitrant seeds of *Eugenia stipitata* McVaugh with totipotent germination. *Plant Biology*, 19(1), 6-13. <https://doi.org/10.1111/plb.12466>

- Carrillo-Hormaza, L., Ramírez, A.M., Quintero-Ortiz, C., Cossio, M., Medina, S., Ferreres, F., Gil-Izquierdo, A. and Osorio, E. (2016). Comprehensive characterization and antioxidant activities of the main biflavonoids of *Garcinia madruno*: a novel tropical species for developing functional products. *Journal of Functional Foods*, 27, 503-516. <https://doi.org/10.1016/j.jff.2016.10.001>
- Carrillo-Hormaza, L., Ramírez, A.M. and Osorio, E. (2019). Chemometric classification of *Garcinia madruno* raw material: Impact of the regional origin and ripeness stage of a neotropical exotic species. *Food Chemistry*, 293, 291-298. <https://doi.org/10.1016/j.foodchem.2019.04.118>
- Castro, J.C., Cobos, M., Maddox, J.D., Imán, S.A., Egoavil, A., Torres, J. and Gutierrez, F. (2015). Gene expression and enzyme activities of the D-mannose/L-galactose pathway influence L-ascorbic acid content in *Myrciaria dubia*. *Biologia Plantarum*, 59(4), 783-787. <https://doi.org/10.1007/s10535-015-0540-z>
- Castro, J.C., Maddox, J.D., Cobos, M., Requena, D., Zimic, M., Bombarely, A., Imán, S.A., Cerdeira, L.A. and Medina, A.E. (2015). De novo assembly and functional annotation of *Myrciaria dubia* fruit transcriptome reveals multiple metabolic pathways for L-ascorbic acid biosynthesis. *BMC Genomics*, 16, 997. <https://doi.org/10.1186/s12864-015-2225-6>
- Castro, J.C., Maddox, J.D. and Imá, S.A. (2018). Camu-camu—*Myrciaria dubia* (Kunth) McVaugh. In Rodrigues, S., de Oliveira Silva, E. and de Brito, E.S. (Eds). *Exotic Fruits Reference Guide*, p. 97-105. USA: Academic Press. <https://doi.org/10.1016/B978-0-12-803138-4.00014-9>
- Chagas, E.A., Bacelar-Lima, CG., Carvalho, A. D.S., Ribeiro, M.I.G., Sakazaki, R.T. and Neves, L.C. (2012). Camu-camu propagation (*Myrciaria dubia* (HBK) Mcvaugh). *Agro@ambiente On-line*, 6(1), 67-73. <https://doi.org/10.18227/1982-8470ragro.v6i1.634>
- Chang, S.K., Alasalvar, C. and Shahidi, F. (2019). Superfruits: Phytochemicals, antioxidant efficacies, and health effects—A comprehensive review. *Critical Reviews in Food Science and Nutrition*, 59(10), 1580-1604. <https://doi.org/10.1080/10408398.2017.1422111>
- Chaves, E.M.F. and Barros, R.F.M. (2012). The executioner's diversity and use of medicinal resources in the Serra da Ibiapaba PAC, Piauí, Northeast Brazil. *Brazilian Journal of Medicinal Plants*, 14(3), 476-486. <https://doi.org/10.1590/S1516-05722012000300009>
- Chávez Cury, G., Abela Gisbert, M.D.C., Bravo, J.A., Peñarrieta, J.M. and Rendón Porcel, W.J. (2012). Study of the edible fruit of the plant species *Garcinia madruno*. *Bolivian Journal of Chemistry*, 29(1), 87-93.
- Chirinos, R., Galarza, J., Betalleluz-Pallardel, I., pedreschi, R. and Campos, D. (2010). Antioxidant compounds and antioxidant capacity of Peruvian camu camu (*Myrciaria dubia* (HBK) McVaugh) fruit at different maturity stages. *Food Chemistry*, 120(4), 1019-1024. <https://doi.org/10.1016/j.foodchem.2009.11.041>
- Cuellar, F.A., Ariza, E., Anzola, C. and Restrepo, P. (2013). Research of antioxidant capacity of araza (*Eugenia stipitata* Mc Vaugh) during the ripening. *Revista Colombiana de Química*, 42(2), 21-28.
- Cunha, F.A.B., Waczuk, E.P., Duarte, A.E., Barros, L.M., Elekofehinti, O.O., Matias, E.F.F., Da Costa, J. G.M., Sanmi, A.A., Boligon, A.A., Rocha, J.B.T., Souza, D.O., Posser, T., Coutinho, H.D.M., Franco, J.L. and Kamdem, J.P. (2016). Cytotoxic and antioxidative potentials of ethanolic extract of *Eugenia uniflora* L. (Myrtaceae) leaves on human blood cells. *Biomedicine and Pharmacotherapy*, 84, 614-621. <https://doi.org/10.1016/j.biopha.2016.09.089>
- Da Silva, F.C., Arruda, A., Ledel, A., Dauth, C., Romão, N.F., Viana, R.N., Ferraz, A.B.F., Picada, J.N. and Pereira, P. (2012). Antigenotoxic effect of acute, subacute and chronic treatments with Amazonian camu-camu (*Myrciaria dubia*) juice on mice blood cells. *Food and Chemical Toxicology*, 50(7), 2275-2281. <https://doi.org/10.1016/j.fct.2012.04.021>
- De Abreu, H.A., Lago, I.A.D.S., Souza, G.P., Piló-Veloso, D., Duarte, H.A. and Alcântara, A.F.D.C. (2008). Antioxidant activity of (+)-bergenin—a phytoconstituent isolated from the bark of *Sacoglottis uchi* Huber (Humireaceae). *Organic and Biomolecular Chemistry*, 6(15), 2713-2718. <https://doi.org/10.1039/b804385j>
- De Albuquerque, Y.A.P., Silva, J.R., Maciel, P.M.C. and Saraiva, R.A. (2019). Phytochemical characterization and allelopathic potential of the *Eugenia punicifolia* (Kunth) DC (Myrtaceae) extract on the germination and initial development of *Lactuca sativa* (Asteraceae). In 70th National Botany Congress/36° Northeast Botany Meeting. Vol. 1, p. 177-177. Maceió - Alagoas
- Donepudi, A.C., Aleksunes, L.M., Driscoll, M.V., Seeram, N.P. and Slitt, A.L. (2012). The traditional ayurvedic medicine, *Eugenia jambolana* (Jamun fruit), decreases liver inflammation, injury and fibrosis during cholestasis. *Liver International*, 32(4), 560-573. <https://doi.org/10.1111/j.1478->

3231.2011.02724.x

- EMBRAPA. Cultivars and Seeds Market. Brasília, DF: Amazônia is the birthplace of native fruits with high commercial potential, 2016. Retrieved on August, 25, 2020 from EMBRAPA Website: <https://www.EMBRAPA.br/busca-de-noticias/-/noticia/14818376/amazonia-e-berco-de-frutas-nativas-de-alto-potencial-comercial>.
- FAO, IFAD, UNICEF, OMS and PMA (2019). The state of food security and nutrition in the world 2019. Protect yourself from the slowdown and weakening of the economy. Retrieved on August, 26, 2020 from FAO Website: <http://www.fao.org/3/ca5162es/ca5162es.pdf>.
- FAO. (2020). Seguridad Alimentaria y Nutricional. Basic concepts. Special Program for Food Security (PESA). Retrieved on August, 25, 2020 from FAO Website: <http://www.fao.org/3/a-at772s.pdf>.
- Ferreira, R.O., Carvalho, M.G.D. and Silva, T.M.S.D. (2012). Occurrence of biflavonoids in Clusiaceae: Chemical and pharmacological aspects. *New Chemistry*, 35(11), 2271-2277. <https://doi.org/10.1590/S0100-40422012001100035>
- Fidelis, M., De Oliveira, S.M., Santos, J.S., Escher, G.B., Rocha, R.S., Cruz, A.G. and Shahidi, F. (2020). From byproduct to a functional ingredient: Camu-camu (*Myrciaria dubia*) seed extract as an antioxidant agent in a yogurt model. *Journal of Dairy Science*, 103(2), 1131-1140. <https://doi.org/10.3168/jds.2019-17173>
- Fracassetti, D., Costa, C., Moulay, L. and Tomás-Barberán, F.A. (2013). Ellagic acid derivatives, ellagitannins, proanthocyanidins and other phenolics, vitamin C and antioxidant capacity of two powder products from camu-camu fruit (*Myrciaria dubia*). *Food Chemistry*, 139(1-4), 578-588. <https://doi.org/10.1016/j.foodchem.2013.01.121>
- Fujita, A., Borges, K., Correia, R., De Melo Franco, B.D.G. and Genovese, M.I. (2013). Impact of spouted bed drying on bioactive compounds, antimicrobial and antioxidant activities of commercial frozen pulp of camu-camu (*Myrciaria dubia* Mc. Vaugh). *Food Research International*, 54(1), 495-500. <https://doi.org/10.1016/j.foodres.2013.07.025>
- Gaglio, R., Gentile, C., Bonanno, A., Vintaloro, L., Perrone, A., Mazza, F., Barbaccia, P., Settanni, L. and Di Grigoli, A. (2019). Effect of saffron addition on the microbiological, physicochemical, antioxidant and sensory characteristics of yoghurt. *International Journal of Dairy Technology*, 72(2), 208-217. <https://doi.org/10.1111/1471-0307.12569>
- Galeno, D.M.L., Carvalho, R.P., De Araújo Boleti, A.P., Lima, A.S., De Almeida, P.D.O., Pacheco, C.C., De Souza, T.P. and Lima, E.S. (2014). Extract from *Eugenia punicifolia* is an antioxidant and inhibits enzymes related to metabolic syndrome. *Applied Biochemistry and Biotechnology*, 172(1), 311-324. <https://doi.org/10.1007/s12010-013-0520-8>
- Garzón, G.A., Narváez-Cuenca, C.E., Kopec, R.E., Barry, A.M., Riedl, K.M. and Schwartz, S.J. (2012). Determination of carotenoids, total phenolic content, and antioxidant activity of Arazá (*Eugenia stipitata* McVaugh), an Amazonian fruit. *Journal of Agricultural and Food Chemistry*, 60(18), 4709-4717. <https://doi.org/10.1021/jf205347f>
- Gironés-Vilaplana, A., Baenas, N., Villaño, D., Speisky, H., García-Viguera, C. and Moreno, D.A. (2014). Evaluation of Latin-American fruits rich in phytochemicals with biological effects. *Journal of Functional Foods*, 7, 599-608. <https://doi.org/10.1016/j.jff.2013.12.025>
- Goncalves, A.E.S.S., Lajolo, F.M. and Genovese, M.I. (2010). Chemical composition and antioxidant/antidiabetic potential of Brazilian native fruits and commercial frozen pulps. *Journal of Agricultural and Food Chemistry*, 58(8), 4666-4667. <https://doi.org/10.1021/jf903875u>
- Gonzalez, M.S., Lima, B.G., Oliveira, A.F., Nunes, D.D., Fernandes, C.P., Santos, M.G., Tietbohl, L.A.C., Mello, C.B., Rocha, L. and Feder, D. (2014). Effects of essential oil from leaves of *Eugenia sulcata* on the development of agricultural pest insects. *Brazilian Journal of Pharmacognosy*, 24(4), 413-418. <https://doi.org/10.1016/j.bjp.2014.05.003>
- Hernández, M.S., Carrillo, M., Barrera, J. and Fernández-Trujillo, J.P. (2011). Camu-camu (*Myrciaria dubia* Kunth McVaugh). In Postharvest biology and technology of tropical and subtropical fruits, p. 352-375. USA: Woodhead Publishing. <https://doi.org/10.1533/9780857092762.352>
- INPA. (2012). Cultivation of Camu-camu. Retrieved on August, 26, 2020 from INPA Website: <https://www.inpa.gov.br/cpca/areas/camu-camu.html>.
- Justi, K.C.J., Visentainer, J.V., De Souza, N.E. and Matsushita, M. (2000). Nutritional composition and vitamin C stability in stored camu-camu (*Myrciaria dubia*) pulp. *Archivos Latinoamericanos de Nutrición*, 50(4), 405-408.
- Kaneshima, T., Myoda, T., Nakata, M., Fujimori, T., Toeda, K. and Nishizawa, M. (2016). Antioxidant activity of C-Glycosidic ellagitannins from the seeds and peel of camu-camu (*Myrciaria dubia*). *LWT-Food Science and Technology*, 69, 76-81. <https://doi.org/10.1016/j.lwt.2016.01.024>

- Klop, B., Elte, J.W.F. and Cabezas, M.C. (2013). Dyslipidemia in obesity: mechanisms and potential targets. *Nutrients*, 5(4), 1218-1240. <https://doi.org/10.3390/nu5041218>
- Kumar, R., Patel, D.K., Prasad, S.K., Laloo, D., Krishnamurthy, S. and Hemalatha, S. (2012). Type 2 antidiabetic activity of bergenin from the roots of *Caesalpinia digyna* Rottler. *Fitoterapia*, 83(2), 395-401. <https://doi.org/10.1016/j.fitote.2011.12.008>
- Kumar, S., Sharma, S. and Chattopadhyay, S.K. (2013). The potential health benefit of polyisoprenylated benzophenones from *Garcinia* and related genera: Ethnobotanical and therapeutic importance. *Fitoterapia*, 89, 86-125. <https://doi.org/10.1016/j.fitote.2013.05.010>
- Langley, P.C., Pergolizzi Jr, J.V., Taylor Jr, R. and Ridgway, C. (2015). Antioxidant and associated capacities of Camu camu (*Myrciaria dubia*): a systematic review. *The Journal of Alternative and Complementary Medicine*, 21(1), 8-14. <https://doi.org/10.1089/acm.2014.0130>
- Lazarini, J.G., Franchin, M., Infante, J., Paschoal, J.A.R., Freires, I.A., De Alencar, S.M. and Rosalen, P.L. (2016). Anti-inflammatory activity and polyphenolic profile of the hydroalcoholic seed extract of *Eugenia leitonii*, an unexplored Brazilian native fruit. *Journal of Functional Foods*, 26, 249-257. <https://doi.org/10.1016/j.jff.2016.08.001>
- Leite, P.E.C., De Almeida, K.B., Lagrota-Candido, J., Trindade, P., Da Silva, R.F., Ribeiro, M.G.L., Lima-Araújo, K.G., Santos, W.C. and Quirico-Santos, T. (2010). Anti-inflammatory activity of *Eugenia punicifolia* extract on muscular lesion of mdx dystrophic mice. *Journal of Cellular Biochemistry*, 111(6), 1652-1660. <https://doi.org/10.1002/jcb.22906>
- Leite-Legatti, A.V., Batista, Â.G., Dragano, N.R.V., Marques, A.C., Malta, L.G., Riccio, M.F., Erbelin, M.N., Machado, A.R.T., Carvalho-Silva, L.B., Ruiz, A.L.T.G., De Carvalho, J.E., Pastore, G.M. and Júnior, M. R.M. (2012). Jaboticaba peel: Antioxidant compounds, antiproliferative and antimutagenic activities. *Food Research International*, 49(1), 596-603. <https://doi.org/10.1016/j.foodres.2012.07.044>
- Leterme, P., Buldgen, A., Estrada, F. and Londoño, A.M. (2006). Mineral content of tropical fruits and unconventional foods of the Andes and the rain forest of Colombia. *Food Chemistry*, 95(4), 644-652. <https://doi.org/10.1016/j.foodchem.2005.02.003>
- Lim, T.K. (2012). *Garcinia madruno*. In *Edible Medicinal and Non-Medicinal Plants*, p. 76-79. Dordrecht, Netherlands: Springer. https://doi.org/10.1007/978-94-007-1764-0_13
- Lima Yamaguchi, K.K., Pereira, L.F.R., Lamarão, C.V., Lima, E.S. and da Veiga-Junior, V.F. (2015). Amazon acai: Chemistry and biological activities: A review. *Food Chemistry*, 179, 137-151. <https://doi.org/10.1016/j.foodchem.2015.01.055>
- Lima, L.G.B., Montenegro, J., Abreu, J.P.D., Santos, M.C.B., Nascimento, T.P.D., Santos, M.D.S., Ferreira, A.G., Cameron, L.C., Ferreira, M.S.L. and Teodoro, A.J. (2020). Metabolite Profiling by UPLC-MSE, NMR, and Antioxidant Properties of Amazonian Fruits: Mamey Apple (*Mammea Americana*), Camapu (*Physalis Angulata*), and Uxi (*Endopleura Uchi*). *Molecules*, 25(2), 342. <https://doi.org/10.3390/molecules25020342>
- Lizcano, L.J., Bakkali, F., Ruiz-Larrea, M.B. and Ruiz-Sanz, J.I. (2010). Antioxidant activity and polyphenol content of aqueous extracts from Colombian Amazonian plants with medicinal use. *Food Chemistry*, 119(4), 1566-1570. <https://doi.org/10.1016/j.foodchem.2009.09.043>
- Lunagariya, N.A., Patel, N.K., Jagtap, S.C. and Bhutani, K.K. (2014). Inhibitors of pancreatic lipase: State of the art clinical perspectives. *EXCLI Journal*, 13, 897-921.
- Malta, L.G., Ghiraldini, F.G., Reis, R., Do Vale Oliveira, M., Silva, L.B. and Pastore, G.M. (2012). *In vivo* analysis of antigenotoxic and antimutagenic properties of two Brazilian Cerrado fruits and the identification of phenolic phytochemicals. *Food Research International*, 49(1), 604-611. <https://doi.org/10.1016/j.foodres.2012.07.055>
- Marx, F., Andrade, E.A., Maria das Graças, B.Z. and Maia, J.S. (2002). Studies of edible Amazonian plants. Part 5: Chemical characterisation of Amazonian *Endopleura uchi* fruits. *European Food Research and Technology*, 214(4), 331-334. <https://doi.org/10.1007/s00217-001-0477-7>
- Matos, K.A.N., Lima, D.P., Barbosa, A.P.P., Mercadante, A.Z. and Chiste, R.C. (2019). Peels of tucumã (*Astrocaryum vulgare*) and peach palm (*Bactris gasipaes*) are by-products classified as very high carotenoid sources. *Food Chemistry*, 272, 216-221. <https://doi.org/10.1016/j.foodchem.2018.08.053>
- Ministry of the Environment. (2019) Brazilian Biodiversity. [online publication]. Retrieved on August, 26, 2020 from MMA Website: <https://www.mma.gov.br/biodiversidade/biodiversidade-brasileira>.
- Myoda, T., Fujimura, S., Park, B., Nagashima, T., Nakagawa, J. and Nishizawa, M. (2010). Antioxidative and antimicrobial potential of residues of camu-camu juice production. *Journal of Food, Agriculture and Environment*, 8(2), 304-307.

- Negri, T.C., Berni, P.R.A. and Brazaca, S.G.C. (2016). Nutritional value of native and exotic fruits from Brazil. *Biosaúde*, 18, 82-96.
- Neri-Numa, I.A., Carvalho-Silva, L.B., Morales, J.P., Malta, L.G., Muramoto, M.T., Ferreira, J.E.M. and Pastore, G.M. (2013). Evaluation of the antioxidant, antiproliferative and antimutagenic potential of araçá-boi fruit (*Eugenia stipitata* Mc Vaugh—Myrtaceae) of the Brazilian Amazon Forest. *Food Research International*, 50(1), 70-76. <https://doi.org/10.1016/j.foodres.2012.09.032>
- Neves, L.C., de Campos, A.J., Colombo, R.C., Roberto, S.R. and Cisneros-Zevallos, L. (2017). Days after anthesis and postharvest behavior define maturity, harvesting time and nutraceutical content of camu-camu fruit. *Scientia Horticulturae*, 224, 37-47. <https://doi.org/10.1016/j.scienta.2017.04.031>
- Neves, L.C., Tosin, J.M., Benedette, R.M. and Cisneros-Zevallos, L. (2015). Post-harvest nutraceutical behaviour during ripening and senescence of 8 highly perishable fruit species from the Northern Brazilian Amazon region. *Food Chemistry*, 174, 188-196. <https://doi.org/10.1016/j.foodchem.2014.10.111>
- Nunomura, R., Oliveira, V.G., Da Silva, S.L. and Nunomura, S.M. (2009). Characterization of bergenin in *Endopleura uchi* bark and its anti-inflammatory activity. *Journal of the Brazilian Chemical Society*, 20(6), 1060-1064. <https://doi.org/10.1590/S0103-50532009000600009>
- Oliveira, G.R., Simão, A.A., Pereira, L.L., Rocha, F.D., Raposo, N.R., De Oliveira, V.I., Pereira, T.V., Do Carmo, H.P., Oliveira, T.C., De Sousa, O.V., De Araujo, A.L.A. and Yamamoto, C.H. (2017). Stem bark extracts of *Endopleura uchi* (Huber) Cuatrec: Inhibition of pancreatic lipase and antioxidant activity. *Journal of Medicinal Plants Research*, 11(30), 472-479. <https://doi.org/10.5897/JMPR2016.6271>
- Oliveira, R.N., Dias, I.J. and Câmara, C.A. (2005). Comparative study of the essential oil of *Eugenia punicifolia* (HBK) DC. from different locations in Pernambuco. *Brazilian Journal of Pharmacognosy*, 15(1), 39-43. <https://doi.org/10.1590/S0102-695X2005000100009>
- Osorio, E., Montoya, G. and Bastida, J. (2009). Phytochemical characterization of a biflavonoid fraction from *Garcinia madruno*: inhibition of human LDL oxidation and its free radical scavenging mechanism. *Vitae*, 16(3), 369-377.
- Osorio, E., Londoño, J. and Bastida, J. (2013). Low-density lipoprotein (LDL)-antioxidant biflavonoids from *Garcinia madruno*. *Molecules*, 18(5), 6092-6100. <https://doi.org/10.3390/molecules18056092>
- Pereira, C.A., Corrêa, A.D., Pereira, L.L.S., Chagas, P.M.B., Santos, C.D. and de Souza, S.P. (2011). Inhibition of digestive enzymes by commercial powder extracts of *Hoodia gordonii* used to treat obesity. *Brazilian Journal of Biosciences*, 9(3), 265-269.
- Périco, L.L., Rodrigues, V.P., Ohara, R., Nunes, V.V.A., Da Rocha, L.R.M., VilegaS, W., Dos Santos, C., Hiruma-Lima, C.A. (2019). Can the gastric healing effect of *Eugenia punicifolia* be the same in male and female rats? *Journal of Ethnopharmacology*, 235, 268-278. <https://doi.org/10.1016/j.jep.2019.02.012>
- Politi, F.A., de Mello, J.C., Migliato, K.F., Nepomuceno, A.L., Moreira, R.R. and Pietro, R.C. (2011). Antimicrobial, cytotoxic and antioxidant activities and determination of the total tannin content of bark extracts *Endopleura uchi*. *International Journal of Molecular Sciences*, 12(4), 2757-2768. <https://doi.org/10.3390/ijms12042757>
- Ramirez, C., Gil, J.H., Marín-Loaiza, J.C., Rojano, B. and Durango, D. (2019). Chemical constituents and antioxidant activity of *Garcinia madruno* (Kunth) Hammel. *Journal of King Saud University-Science*, 31(4), 1283-1289. <https://doi.org/10.1016/j.jksus.2018.07.017>
- Ramos, A.S., Mar, J.M., Da Silva, L.S., Acho, L.D., Silva, B.J.P., Lima, E.S., Campelo, P.H., Sanches, E.A., Bezerra, J.A., Chaves, F.C.M., Campos, F.R. and Machado, M.B. (2019). Pedra-ume caá fruit: an Amazon cherry rich in phenolic compounds with antiglycant and antioxidant properties. *Food Research International*, 123, 674-683. <https://doi.org/10.1016/j.foodres.2019.05.042>
- Reynertson, K.A., Yang, H., Jiang, B., Basile, M.J. and Kennelly, E.J. (2008). Quantitative analysis of antiradical phenolic constituents from fourteen edible Myrtaceae fruits. *Food Chemistry*, 109(4), 883-890. <https://doi.org/10.1016/j.foodchem.2008.01.021>
- Rodrigues, R.B. and Marx, F. (2006). Camu camu [*Myrciaria dúbia* (HBK) Mc Vaugh]: a promising fruit from the Amazon Basin. *Nutrition Vienna*, 30(9), 376.
- Rufino, M.S.M., Alves, R.E., Brito, E.S., Perez-Jimenez, J., Saura-Calixto, F. and Mancinifilho, J. (2010). Bioactive compounds and antioxidant capacities of 18 non-traditional tropical fruits from Brazil. *Food Chemistry*, 121(4), 996-10002. <https://doi.org/10.1016/j.foodchem.2010.01.037>
- Sá, B.M., Lima, C.S., Silva, U.D.A., Carvalho, H.O., Fernandes, C.P., Resque, R.L., De Oliveira, T.T. and

- Carvalho, J.C.T. (2015). Subchronic toxicity evaluation of the hydroethanolic extract from *Endopleura uchi* (Huber) Cuatrec in Wistar rats. *African Journal of Pharmacy and Pharmacology*, 9 (8), 223-229. <https://doi.org/10.5897/AJPP2014.4220>
- Sabogal-Guáqueta, A.M., Carrillo-Hormaza, L., Osorio, E. and Cardona-Gómez, G.P. (2018). Effects of biflavonoids from *Garcinia madruno* on a triple transgenic mouse model of Alzheimer's disease. *Pharmacological Research*, 129, 128-138. <https://doi.org/10.1016/j.phrs.2017.12.002>
- Santos, J.F.S., Rocha, J.E., Bezerra, C.F., Do Nascimento Silva, M.K., De Matos, Y.M.L.S., De Freitas, T.S., Dos Santos, A.T.L., Da Cruz, R.P., Machado, A.J.T., Rodrigues, T.H.S., De Brito, E.S., Sales, D.L., Almeida, W.O., Da Costa, J.G.M., Coutinho, H.D.M. and Morais-Braga, M.F.B. (2018). Chemical composition, antifungal activity and potential antivirulence evaluation of the *Eugenia uniflora* essential oil against *Candida* spp. *Food Chemistry*, 261, 233-239. <https://doi.org/10.1016/j.foodchem.2018.04.015>
- Shikov, A.N., Pozharitskaya, O.N., Makarova, M.N., Kovaleva, M.A., Laakso, I., Dorman, H.D., Hiltunen, R., Makarov, V.G. and Galambosi, B. (2012). Effect of *Bergenia crassifolia* L. extracts on weight gain and feeding behavior of rats with high-caloric diet-induced obesity. *Phytomedicine*, 19(14), 1250-1255. <https://doi.org/10.1016/j.phymed.2012.09.019>
- Silva, L.R. and Teixeira, R. (2015). Phenolic profile and biological potential of *Endopleura uchi* extracts. *Asian Pacific Journal of Tropical Medicine*, 8(11), 889-897. <https://doi.org/10.1016/j.apjtm.2015.10.013>
- Silva, S.L.D., Oliveira, V.G.D., Yano, T. and Nunomura, R.D.C.S. (2009). Antimicrobial activity of bergenin from *Endopleura uchi* (Huber) Cuatrec. *Acta amazônica*, 39(1), 187-191. <https://doi.org/10.1590/S0044-59672009000100019>
- Soares, J.C., Rosalen, P.L., Lazarini, J.G., Massarioli, A.P., Da Silva, C.F., Nani, B.D. and De Alencar, S.M. (2019). Comprehensive characterization of bioactive phenols from new Brazilian superfruits by LC-ESI-QTOF-MS, and their ROS and RNS scavenging effects and anti-inflammatory activity. *Food Chemistry*, 281, 178-188. <https://doi.org/10.1016/j.foodchem.2018.12.106>
- Sousa, R.M.F., De Morais, S.A., Vieira, R.B., Napolitano, D.R., Guzman, V.B., Moraes, T.S., Cunha, L.C. S., Martins, C.H.G., Chang, R., Aquino, F.J.T., Do Nascimento, E.A. and De Oliveira, A. (2015). Chemical composition, cytotoxic, and antibacterial activity of the essential oil from *Eugenia calycina* Cambess. leaves against oral bacteria. *Industrial Crops and Products*, 65, 71-78. <https://doi.org/10.1016/j.indcrop.2014.11.050>
- Souza, S.P.D., Pereira, L.L., Souza, A.A. and Santos, C.D.D. (2011). Inhibition of pancreatic lipase by extracts of *Baccharis trimera* (Less.) DC., Asteraceae: evaluation of antinutrients and effect on glycosidases. *Revista Brasileira de Farmacognosia*, 21(3), 450-455. <https://doi.org/10.1590/S0102-695X2011005000049>
- Souza, V.C. and Lorenzi, H. (2008). Systematic botany: Illustrated guide for identifying families of native and exotic phanerogams in Brazil in APG II. 2nd ed. Nova Odessa, Brazil: Instituto Plantarum,
- Sukhdev, S. and Singh, K.S. (2013). Therapeutic role of phytomedicines on obesity: importance of herbal pancreatic lipase inhibitors. *International Research Journal of Medical Sciences*, 1(9), 15-26.
- Tabares-Guevara, J.H., Lara-Guzmán, O.J., Londoño-Londoño, J.A., Sierra, J.A., León-Varela, Y.M., Álvarez-Quintero, R.M., Osorio, E.J. and Ramirez-Pineda, J.R. (2017). Natural Biflavonoids Modulate Macrophage–Oxidized LDL Interaction *In Vitro* and Promote Atheroprotection *In Vivo*. *Frontiers in Immunology*, 8, 923. <https://doi.org/10.3389/fimmu.2017.00923>
- Taveira, M., Silva, L.R., Vale-Silva, L.A., Pinto, E., Valentao, P., Ferreres, F., Pinho, P.G. and Andrade, P.B. (2010). Lycopersicon esculentum seeds: an industrial byproduct as an antimicrobial agent. *Journal of Agricultural and Food Chemistry*, 58(17), 9529-9536. <https://doi.org/10.1021/jf102215g>
- Tenfen, A., Siebert, D.A., Yamanaka, C.N., Mendes de Córdova, C.M., Scharf, D.R., Simionatto, E.L. and Alberton, M.D. (2016). Chemical composition and evaluation of the antimicrobial activity of the essential oil from leaves of *Eugenia platysema*. *Natural Product Research*, 30(17), 2007-2011. <https://doi.org/10.1080/14786419.2015.1107056>
- Ueda, H., Kuroiwa, E., Tachibana, Y., Kawanishi, K., Ayala, F. and Moriyasu, M. (2004). Aldose reductase inhibitors from the leaves of *Myrciaria dubia* (HB and K.) McVaugh. *Phytomedicine*, 11(7-8), 652-656. <https://doi.org/10.1016/j.phymed.2003.12.002>
- Viana, E.S., Jesus, J.L., Reis, R.C., Fonseca, M.D. and Sacramento, C.K. (2012). Physicochemical and sensory characterization of papaya jam with araçá-boi. *Brazilian Journal of Orchardring*, 34(4), 1154-1164. <https://doi.org/10.1590/S0100-29452012000400024>
- Vidigal, M.C., Minim, V.P., Carvalho, N.B., Milagres, M.P. and Gonçalves, A.C. (2011). Effect of a health claim on consumer acceptance of exotic Brazilian fruit juices: Açai (*Euterpe oleracea* Mart.), Camu-

camu (*Myrciaria dubia*), Caja (*Spondias lutea* L.) and Umbu (*Spondias tuberosa* Arruda). *Food Research International*, 44(7), 1988-1996. <https://doi.org/10.1016/j.foodres.2010.11.028>

Vinholes, J., Grosso, C., Andrade, P.B., Gil-Izquierdo, A., Valentão, P., de Pinho, P.G. and Ferreres, F. (2011). *In vitro* studies to assess the antidiabetic, anti-cholinesterase and antioxidant potential of *Spergularia rubra*. *Food Chemistry*, 129(2), 454-462. <https://doi.org/10.1016/j.foodchem.2011.04.098>

Yazawa, K., Suga, K., Honma, A., Shirosaki, M. and Koyama, T. (2011). Anti-inflammatory effects of seeds of the tropical fruit camu-camu (*Myrciaria dubia*). *Journal of Nutritional Science and Vitaminology*, 57(1), 104-107. <https://doi.org/10.3177/jnsv.57.104>

Yun, J.W. (2010). Possible anti-obesity therapeutics from nature—A review. *Phytochemistry*, 71(14-15), 1625-1641. <https://doi.org/10.1016/j.phytochem.2010.07.011>

Zanatta, C.F. and Mercadante, A.Z. (2007). Carotenoid composition from the Brazilian tropical fruit camu-camu (*Myrciaria dubia*). *Food Chemistry*, 101(4), 1526-1532. <https://doi.org/10.1016/j.foodchem.2006.04.004>

Zapata, S.M. and Dufour, J.P. (1993). Camu - camu *Myrciaria dubia* (HBK) McVaugh: Composição química da fruta. *Journal of the Science of Food and Agriculture*, 61(3), 349-351. <https://doi.org/10.1002/jsfa.2740610310>

Zikiou, A. and Zidoune, M.N. (2019). Enzymatic extract from flowers of Algerian spontaneous *Cynara cardunculus*: Milk-clotting properties and use in the manufacture of a Camembert-type cheese. *International Journal of Dairy Technology*, 72(1), 89-99. <https://doi.org/10.1111/1471-0307.12563>