Chapter 7

Açaí (*Euterpe oleracea*) and Bacaba (*Oenocarpus bacaba*) as Functional Food

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Abstract

This chapter reviews two oleaginous fruits that are widely consumed by people in the Amazon region: Bacaba (*Oenocarpus bacaba*) and Açaí (*Euter*pe *oleracea*). Besides their food and the folk medicinal uses, studies suggest that substances present in both berries have antioxidative effects, antimicrobial, and therapeutic properties such as hypocholesterolemic and neuroprotection effects. These therapeutic effects are related to phenolic compounds, anthocyanins, and fatty acids, which can prevent serious problems such as coronary heart disease, hypertension, and depression. The use of supercritical fluid technology is described as a technique to obtain the best extracts of bacaba and açaí, as well as their valuable constituents. Indubitably, this technology is a great tool for human health and all with the advantage of presenting nontoxic solvents such as carbon dioxide or water. Açaí and bacaba fruits represent not only food but also a source of compounds that can work in both prevention and treatment of diseases.

Keywords: Amazon, açaí, bacaba, bioactive compounds, antioxidants, functional food

1. Introduction

The Brazilian Amazon represents one of the richest biomes found in the world. It presents many sources of plants, including native ones not yet explored, but that have potential for use. The economic importance that the aromatic plants represent to the Amazon region is

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associated with the application of their vegetable oils and aromas in technological and industrial processes. Because of this, there is a greater investment in such plants extraction sector, causing an expansion of the domestic and international markets.

Because of this biodiversity, there is a wide variety of oleaginous species, as is the case of andiroba (*Carapa guianensis*), tucumã (*Astrocaryum vulgare*), buriti (*Mauritia flexuosa*), palm (*Elaeis guineensis, Jacq*), açaí (*Euterpe oleracea*), and bacaba (*Oenocarpus bacaba*). These species experimentally have a high yield in vegetable oils, with the potential for production of biologically active natural products, the so-called bioactive compounds, which have a high value added. Among these, the fat-soluble vitamins carotenoids (provitamin A), tocopherols (provitamin E and antioxidant), dyes, and flavonoids (anthocyanins, which are dyes with antioxidant effects) can be highlighted.

The characteristics of the Amazon region are conducive to the proliferation of palm trees, among which there are the oleaginous ones that are commercially cultivated with already fully established management technology, as is the case of açaí and bacaba, which can be considered new "superfruits." The consumption of these fruits pulps has been increasing, mainly due to the benefits that are being showed by scientific papers. Açaí, for example, has a high economic potential, mainly due to its use in the preparation of açaí beverages, which are exported all over the world as an energetic drink [1].

Besides the folk use as a drink, studies suggest that substances present in both berries have therapeutic properties such as hypocholesterolemic and neuroprotection effects. These therapeutic effects are related to fatty acids, which can prevent serious problems such as coronary heart disease, hypertension, and depression [2, 3]. The presence of phenolic compounds in their composition also gives them properties such as antimicrobial and antioxidant effects [4, 5].

Another group of compounds with significant presence in açaí and bacaba is anthocyanins. Anthocyanins are plant-derived compounds belonging to the flavonoids subgroup of phenolic compounds. Besides antioxidative properties, anthocyanins are the focus of studies for application on humans against diseases such as cancer and Alzheimer's [6–8].

Among the various methods of obtaining natural extracts, the process of supercritical fluid extraction has become appropriate and of great interest to the food industry, pharmaceutical, and cosmetic technology. It provides the obtainment of products free of residual solvents and with superior quality, while preserving the organoleptic properties of the material. The most used solvent in the supercritical technology is carbon dioxide (CO_2), which is inert, nontoxic, has a high solubility, and allows performing low-temperature processes, which are perfect for the extraction of thermosensible compounds, as is the case of, for example, anthocyanins.

2. Açaí and bacaba as functional food

The food industry has high expectations in food products that meet the consumers' demand for a healthy lifestyle. In this context, functional food plays a specific role, which is not only to

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satisfy hunger but also to provide humans the necessary nutrients. It also prevents nutrition-related diseases and increases their physical and mental well-being [9].

In Brazil, there are two kinds of functional food: açaí and bacaba (see **Figure 1**), which are oleaginous fruits, present black-violet color, and are from typical palm trees in the Amazon region. They belong to the *Arecaceae* family and when processed with water, form an emulsion. Both are commercially exploited for the production of foods and beverages. The juices of bacaba and açaí are considered tasty and much appreciated by the Amazonian population. In the period between harvests of açaí, from December to April, bacaba has the highest sales potential, in a relay system [10, 11].

The functional quality of bacaba oil was analyzed by Pinto [12] through the determination of atherogenicity index (AI) and thrombogenicity index (TI) proposed by Ulbricht and Southgate [13] and hypocholesterolemic/hypercholesterolemic ratio (h/H) suggested by Santos-Silva et al. [14]. The results of AI, TI, and h/H were satisfactory. Although the values of AI and TI were low, h/H was high in levels that show bacaba oil could be regarded as cardioprotective, suggesting the direct consumption of it in the form of table oil, similar to olive oil, or in encapsulated form as a phytopharmaco. In the same study, bacaba oil was used for coating iron oxide for the synthesis of Fe_3O_4 magnetic nanoparticles (MNP). The results showed that the oil well replaced the oleic acid, with the formation of MNP with morphological and desirable



Figure 1. Bacaba (**a**) and açaí (**b**) berries.

magnetic characteristics. MNP have therapeutic features, being used as drug carriers in the treatment of cancer by magnetic induction, reducing collateral effects to patients.

Açaí, being a source of fibers and rich in antioxidants, has considerable potential for nutritional applications and in the health field as a functional food or dietary supplement [15]. The work conducted by Barbosa et al. [2] evaluated the effect of a diet with daily consumption of açaí pulp in the prevention of oxidative damage by measuring the activity of antioxidant enzymes and the use of protein biomarkers in healthy women. The results showed that the açaí intake increased the activity of catalase, an intracellular enzyme which is also known as hydroperoxidase, able to decompose the hydrogen peroxide (H_2O_2), which is associated with various pathologies connected to oxidative stress; the results also showed an increase in total antioxidant capacity and a reduction in the production of reactive oxygen species. These studies reveal the antioxidant effect of açaí, increasing the understanding of its beneficial health properties.

The antioxidants found in açaí and bacaba are necessary to prevent the formation and oppose the actions of reactive oxygen species (ROS) and reactive nitrogen species (RNS), which are continuously formed in the human body. Mechanisms of free radicals such as these are related to various human diseases, including cancer, atherosclerosis, malaria, rheumatoid arthritis, and neurodegenerative diseases. Many components of the diet such as carotenoids and plant pigments are suggested as important antioxidants; however, the interest in phenolic compounds of plants, particularly flavonoids, is also increasing. Thus, diets based on functional foods rich in antioxidants are important for the maintenance of human health [16–19].

3. Chemical composition of açaí and bacaba

The nutritional properties of Amazonian palm trees are related to the composition of fatty acids and phytochemical compounds, the so-called bioactive compounds. Açaí and bacaba are some of the species of fruits that have become quite attractive, not only for lipid content they present, but also for their composition of bioactive compounds.

The fatty acids present in fruit species such as these are considered one of the most important constituents in living organisms due to their structural role in cell membranes and as metabolic energy sources [20]. Those considered essential to life are known as essential unsaturated fatty acids and must be supplied by food. The main representatives are omega-9 (ω-9), omega-6 (ω-6), and omega-3 (ω-3). Of these groups, the α-linolenic acid (n-3), the linoleic and arachidonic acids (n-6), and the oleic acid (n-9) can be highlighted [21]. The vegetable oils, such as bacaba and açaí, are good sources of these components and fat-soluble vitamins such as vitamins A, D, E, and K [22].

According to Martin et al. [23], the availability of ω-3 and ω-6 fatty acids in the human species depends on the food supply, and moreover, it is important to know what are the sources capable of supplying these needs. **Table 1** shows some sources of monounsaturated and polyunsaturated fatty acids of fruits that come from palm trees and are considered as dietary sources of fatty acids.

Batista et al. [8] obtained the fatty acids profile of lyophilized açaí pulp extracts obtained by extraction with supercritical CO_2, as shown in **Table 2**.

Fruits that come from palm trees	Part of the fruit analyzed	(C12:0) lauric (%)	(C14:0) myristic (%)	(C16:0) palmitic (%)	(C18:1) oleic (%)	(C18:2) linoleic (%)	(C18:3) linolenic (%)
Babaçu (*Orbignya phalerata* Martius)[1]	Kernel	44.0	17.0	8.0	14.0	2.0	–
Buriti (*Mauritia flexuosa L.f.*)[2]	Mesocarp	–	–	18.0	73.5	2.7	2.1
Dendê (palm) (*Elaeis olifera*)[3]	Endocarp	47.9	16.1	8.4	16.2	2.7	Traces
Pupunha (*Bactris gasipaes*)[4]	Mesocarp	–	–	35.20	51.7	4.9	1.2
Tucumã (*Astrocaryum vulgare*)[5]	Epicarp + mesocarp	–	0.10	24.6	65.1	2.6	0.2
Bacaba (*Oenocarpus bacaba*)[6]	Mesocarp	0.18	0.59	32.27	40.82	9.78	1.93
Bacaba (*Oenocarpus bacaba*)[7]	Mesocarp	–	–	30.6	47.3	20.6	–
Patauá (*Jessenia bataua*)[5]	Mesocarp	–	0.10	13.3	76.7	3.9	0.1
Açaí (*Euterpe oleracea*)[3]	Mesocarp	–	–	25.9	54.9	11.5	1.1

Sources: [1]Lima et al. [24], [2]Tavares et al. [25], [3]Rogez. [26], [4]Yuyama et al. [27], [5]Rodrigues et al. [28], [6]Montúfar et al. [29], [7]Santos et al. [30].

Table 1. Content of the main fatty acids present in palm tree fruits consumed in the human diet.

Foods rich in fatty acids, such as bacaba and açaí, can play an important role in human food base, because the linolenic, linoleic, and oleic acids present in these raw materials are considered functional and exhibit inflammation-reducing and immunity-increasing properties in the human body, as demonstrated by Wallace et al. [31], Schwab and Serhan [32], Serhan et al. [33], and Calder [34].

In addition to fatty acids, various bioactive compounds can be found in these fruits. Yamaguchi et al. [1] report that about 90 substances have been found in açaí, of which approximately 31% consist of flavonoids, followed by 23% of phenolic compounds, 11% of lignoids, and 9% of anthocyanins. These are compounds that are correlated with high biological activity.

Content of fatty acids in % g/100mg									
Fatty	**50°C**	**50°C**	**50°C**	**60°C**	**60°C**	**60°C**	**70°C**	**70°C**	**70°C**
Acid	**150 bar**	**220 bar**	**350 bar**	**190 bar**	**270 bar**	**420 bar**	**220 bar**	**320 bar**	**490 bar**
C8:0	0.69	1.26	0.83	0.77	1.58	0.40	0.33	2.27	0.02
C10:0		0.03	0.02	0.02	0.04	0.03	–	–	–
C12:0	0.07	0.17	0.17	0.13	0.19	0.25	0.07	0.33	0.14
C13:0	–	–	–	–	–	–	0.02	0.21	–
C14:0	0.13	0.24	0.16	0.19	0.21	0.30	0.13	0.42	0.18
C15:0	–	–	–	–	–	–	–	–	–
C16:0	28.15	30.91	23.47	26.29	29.20	28.58	25.41	90.86	27.81
C16:1	4.95	0.03	5.49	6.14	7.08	6.83	4.16	0.08	5.81
C17:0	–	0.04	0.14	0.03	–	–	0.05	0.19	0.03
C18:0	1.05	1.25	1.02	0.80	1.14	1.16	1.43	5.35	1.33
C18:1	64.86	65.81	52.73	50.78	60.42	62.41	55.71	0.23	64.65
C18:2	–	–	15.54	14.80	–	–	12.59	–	–
C18:3	–	–	–	–	–	–	–	–	–
C20:0	0.08	–	–	–	0.10	–	–	–	–
C22:0	–	0.22	0.38	–	–	–	0.04	–	–
SFA	30.18	34.15	26.22	28.25	32.48	30.74	27.53	99.67	29.53
MUFA	69.81	65.84	58.23	56.93	67.51	69.25	59.87	0.31	70.46
PUFA	–	–	15.54	14.80	–		12.59	–	–
S/U	0.43	0.52	0.35	0.39	0.48	0.44	0.38	321.52	0.42

C8:0 (caprylic acid); C10:0 (capric acid); C12:0 (lauric acid); C13:0 (tridecanoic acid); C14:0 (myristic acid); C15:0 (pentadecanoic acid); C16:0 (palmitic acid); C16:1 (palmitoleic acid); C17:0 (margaric acid); C18:0 (stearic acid); C18:1 (oleic acid); C18:2 (linoleic acid); C18:3 (linolenic acid); C20:0 (arachidic acid); C22:0 (behenic acid); SFA (saturated fatty acids); MUFA (monounsaturated fatty acids); PUFA (polyunsaturated fatty acids).

Table 2. Content of fatty acids in açaí pulp extracts obtained by extraction with supercritical CO_2.

Of these components, anthocyanins have received great attention due to their potential benefits in preventing chronic diseases, including cancer and Alzheimer [8]. They are glycosides of anthocyanins and have, at their core, the flavylium cation. They belong to the group of flavonoids and subgroup of phenolic compounds. These compounds are responsible for defining the color of a variety of vegetables, including purple color in açaí [1]. They are hydrophilic, stable at acid pH, sensitive to light exposure, elevated temperatures, and presence of O_2.

To obtain bioactive substances such as anthocyanins, different extraction techniques have been developed with the aim of reducing the extraction time and the solvent consumption, increasing the extraction yield and improving the quality of the extracts. Among these

techniques are included: ultrasound assisted extraction, microwave assisted extraction, supercritical fluid extraction, and accelerated solvent extraction [35].

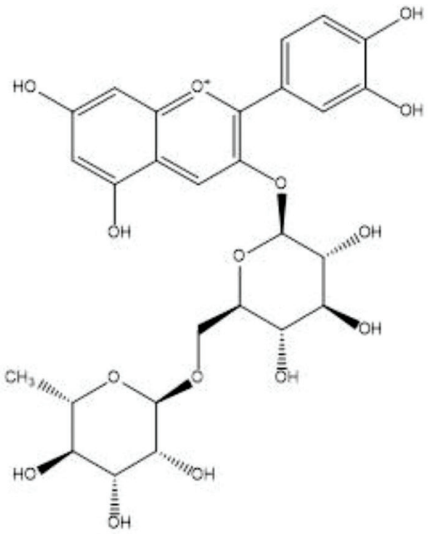
The choice of a method for extracting anthocyanins depends largely on the purpose of extraction and the nature of the constituent molecules of these compounds [36]. Therefore, as these pigments are very soluble in water, they are easily extracted by polar solvents. Their extraction typically involves the use of aqueous acidified solutions of ethanol, methanol, or acetone [37]. However, these solvents have also used limitations such as lower extraction efficiency compared to other solvents, as well as a lower durability of their extracts [38, 39].

References	Application	Anthocyanins quantification
Finco et al. [40]	Characterization and analysis of total phenolic compounds and total flavonoids of bacaba extract (*Oenocarpus bacaba* Mart.) by HPLC-DAD-MS	The total content of monomeric anthocyanin was evaluated by a differential pH method described by Sellappan et al. [41]. The anthocyanin cyanidin-3-glucoside was used as pattern
Gouvêa et al. [42]	Isolation of anthocyanins patterns (cyanidin-3-O-glucoside and cyanidin-3-O-rutinoside) of lyophilized açaí (*Euterpe oleracea* Mart.) by HPLC	The isolation of anthocyanins was carried out by HPLC. The anthocyanin identification in the lyophilized açaí was done by mass spectrometry. They used the anthocyanins patterns: cyanidin-3-*O*-glucoside and cyanidin-3-*O*-rutinoside
Santos et al. [43]	This study evaluated the encapsulation of anthocyanin extract obtained from jabuticaba (*Myrciaria cauliflora*) using supercritical CO_2 as solvent and ethanol as co-solvent	In the extraction of jabuticaba anthocyanin, supercritical CO_2 was used together with the co-solvent ethanol in certain conditions of pressure, temperature, and flow ratio
Paes et al. [44]	Extraction of anthocyanins and phenolic compounds of blueberry (*Vaccinium myrtillus* L.) using supercritical CO_2 and water and ethanol as co-solvents	HPLC and mass spectrometry. Pelargonidin was used as pattern for the identification of anthocyanins
Neves et al. [45]	The objective of this study was to follow the physicochemical and functional alterations of açaí and bacaba pulps processed by hand	For the determination of total anthocyanins, the method of Francis [46] was used
Novello et al. [47]	This study aimed to evaluate the influence of organic solvents on the extraction of anthocyanins from açaí. The anthocyanins, the fatty acids profile, and the antioxidant activity of the extract were analyzed by HPLC	The anthocyanins were determined by spectrophotometry using differential pH method described by Giusti and Wrolstad [48]. The identification and quantification of anthocyanins of lyophilized açaí extract were performed by HPLC-DAD. The identified anthocyanins were cyanidin-3-*O*-glucoside and cyanidin-3-*O*-rutinoside
Batista et al. [8]	This study determined the phenolic compounds and anthocyanins of lyophilized açaí pulp after extraction with supercritical CO_2	The anthocyanins were determined by UV-visible spectrophotometry using the Folin-Ciocalteu reagent, according to the method described by Singleton and Rossi [49]

Table 3. Overview of anthocyanin extraction applications.

The main anthocyanins found in açaí are cyanidin-3-*O*-glucoside and cyanidin-3-*O*-rutinoside. In bacaba, it is cyanidin-3-glucoside. This information is presented in **Table 3**, as well as an overview of some anthocyanin extraction applications of açaí, bacaba, and other raw materials. Their chemical structures are presented in **Figure 2**.

(a) Cyanidin-3-O-rutinoside



(b) Cyanidin-3-glucoside

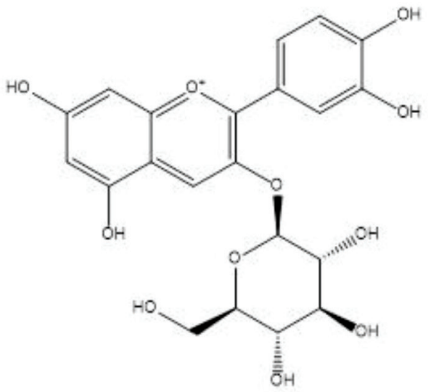


Figure 2. Chemical structures of the main anthocyanins found in açaí and bacaba (**a**): 2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-3-chromeniumyl6-*O*-(6-deoxy-α-L-mannopyranosyl)-β-D-glucopyranoside; (**b**): 2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-3-chromeniumyl β-D-glucopyranoside [nomenclatures according to IUPAC].

In addition to anthocyanins, other bioactive compounds have been identified in açaí and bacaba. Pacheco-Palencia et al. [50] analyzed two species of açaí and identified several flavones, including homoorientin, orientin, deoxyhexose taxifolin, and isovitexin; flavanol derivatives, including (+)—catechin, (−)—epicatechin, procyanidin dimers and trimers, and phenolic acids such as protocatechuic, p-hydroxybenzoic, vanillic, syringic, and ferulic. Phenolic compounds are also reported to be potentially protective against cardiovascular disease and cancer [51]. Also, large amounts of phenolic compounds such as phenolic acids, flavanols, and flavonols can be found, which act as cofactors to improve the biological action of anthocyanins [52].

Santos et al. [53] evaluated the content of bioactive compounds and total antioxidant capacity of native fruits of the Amazon palm trees, including the species *O. bacaba*. Their results showed a high content of total polyphenols, presence of carotenoids, higher levels of anthocyanins, and antioxidant capacity in the bacaba extracts. In the study of Finco et al. [40], the phenolic classes: C-glycoside, flavonoid, C-hexoside, C-glycosylflavone, isorhamnetin hexoside, quercetin hexoside, quercetin diglycoside, quercetin glycoside, and isorhamnetin glycoside, were identified.

4. Methods for obtaining vegetable oils

The economic importance that aromatic plants have in the Amazon region is associated with the application of their vegetable oils and use of their aromas in technological and industrial processes. Because of this, there is a greater investment in such plants extraction sector, causing an expansion of the domestic and international markets.

The soil and climate of the Amazon region are conducive to the proliferation of palm trees, among which there are the oleaginous ones cultivated with commercial purpose. This is the case of açaí and bacaba, whose extraction already constitutes a significant economic activity in the state of Pará-Brazil. There are other native palm trees in the region that provide oleaginous fruits rich in provitamins A and E, yet poorly explored, such as pupunha (*Guilielmaspeciosa*) and tucumã (*Astrocaryumvulgare*). These and other vegetable raw materials present in their composition have a high content of lipids, with significant potential for extraction.

Extraction is a unit operation widely used in the food industry and can be used for the production of coffee, sugar, caffeine extraction, vegetable oils, flavorings, and essential oils [54]. Obtaining these extracts may be accomplished by different methods such as mechanical pressing extraction, solvent extraction, supercritical fluids extraction, or others, depending on their content [55–57].

4.1. Mechanical pressing extraction

The extraction by mechanical pressing is one of the oldest methods of obtaining oil and fats from seed and fruits. For this kind of extraction, the packaged material enters through a feed shaft in the press. The press consists of a basket formed of spaced rectangular steel bars, through blades, whose thickness varies depending on the raw material. In the center of the basket, there is a screw that rotates and moves the material forward, compressing it at the same time. The pressure is regulated via an outlet cone [58, 59].

Souza et al. [60] and Pighinelli et al. [61] report that although the mechanical pressing extraction is less efficient than other methods, it is a more workable system on a small scale, for not being dependent on facilities and safety that are characteristics of the solvent processing, besides being fast, easy to handle and presents low cost of installation and maintenance.

One of the disadvantages of the mechanical pressing method is its low oil yield recovery: even in the most efficient presses, there is still a range of 3–5% of remaining oil in the cake. This residual oil present in the cake can be recovered by a two-step process: pre-extraction (with the screw-press) and solvent extraction, thus maximizing efficiency. Furthermore, the solvent extraction is recommended only in raw materials with <25% of fat content [62–69].

4.2. Solvent extraction

This type of extraction occurs by partitioning a solute between two immiscible or partially miscible phases. The mass transfer occurs from the solutes in the food matrix to the solvent. First, the solute is dissolved in the solvent, then the penetration of the particle solution in the

food surface occurs, and finally the solution is dispersed in the solvent. According to Ghosh [64], solvent extraction can be classified into four types depending on the phase of the matrix: (i) solid-liquid extraction; (ii) liquid-liquid extraction; (iii) vapor extraction; and (iv) supercritical fluids extraction.

The solvent choice is of fundamental importance in the aspects that aim at efficiency, economy, and preservation of the physicochemical and nutritional characteristics of oils. In conventional extraction, some solvents used for obtaining oils from plants are hexane, n-hexane, pentane, ethanol, and petroleum ether [59, 63, 65–70].

In the solvent extraction, there can be a reduction in the product quality because of the several steps necessary to recover the solvent, elevated temperature, long periods of thermal exposure, high oxygen concentration, and extraction of other compounds considered undesirable [63, 71].

4.3. Supercritical fluids extraction

The supercritical fluids (SCFs) extraction is a unit operation by contact that is based on the balance and on the physicochemical properties of the SCFs, being dependent on operating conditions such as temperature, pressure, solvent flow, the material morphology, prior treatment of the porous solid matrix, and the physical properties of the packed bed, such as porosity, distribution and particle size, initial content of solute in the solid matrix, and the fixed bed height [72].

The SCFs present intermediate characteristics between liquids and gases. The diffusion coefficient (DC) of SCFs is high and close to the gases DC, thus increasing the diffusivity when they are in the liquid state, providing a rapid and efficient mass transfer. The density of SCFs is greater than that of a gas, having a higher solvating power due to the high compressibility. Furthermore, they exhibit low viscosity and the absence of surface tension, which promote greater penetration into the solid matrix [73, 74].

Carbon dioxide (CO_2) is widely used as SCF due to having low critical temperature and pressure (73.74 bar and 304.12 K, respectively), besides being: nontoxic, nonflammable, odorless, and easily separated from the extract. Due to its low critical temperature, it is possible to use it to extract reactive and thermosensitive compounds. CO_2 is suitable for extracting apolar compounds, but when polar organic solvents such as ethyl acetate, ethanol, or methanol are added, the polarity is modified, being possible to extract other compounds. These aggregate solvents are called co-solvents [75].

Batista et al. [8] obtained açaí extracts fractions with supercritical CO_2 and analyzed the allelopathic effects of these extracts on two species of invasive plants: *Mimosa pudica* and *Senna obtusifolia*. They observed that depending on the operating conditions of temperature and pressure used, the pattern of phytotoxic responses can change: in some cases, the effect may be stimulatory to seed development. Studies on allelopathy have direct influence on human health, because the use of chemicals such as pesticides, which can cause diseases such as cancer, can be avoided [76–78]. However, other studies must be conducted to isolate the specific metabolites for each role assigned to the açaí.

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Pinto [12] also obtained bacaba extracts fractions with supercritical CO_2 at different conditions of temperature and pressure. In his work, bacaba is mentioned as a rich source of natural antioxidants and dyes. However, there is a need for further studies to elucidate bacaba's behavior in different processes.

4.4. Other extraction methods

The methods of soxhlet, hydrodistillation, solid-liquid, and ultrasound-assisted extraction do not present a performance as good as the one presented by the extraction with supercritical fluids: it has a high selectivity, low or no organic solvent consumption, operates at temperature close to room, no request for subsequent purification steps, and reduces post-processing costs as there is no longer need to eliminate solvent extracts [75, 79, 80].

5. Anthocyanins extraction by SFE

Anthocyanins are the most abundant flavonoid constituents of fruits and vegetables. Their use into food and/or medical fields has proven to be a technological challenge since these compounds have low stability and are susceptible to degradation through factors such as the presence of light, pH, temperatures usually higher than 60–80°C, the presence of sulfite, ascorbic acid, enzymes (such as glycosidases and phenolases), among other factors [43, 81, 82].

In the literature, the recovery of phytochemicals from solid wastes has been reported using conventional and alternative technologies. According to Paes et al. [44], conventional methods are Soxhlet extraction, maceration extraction, extraction by infusion and vapor distillation. Alternative techniques such as supercritical fluid extraction (SFE) and pressurized liquid extraction (PLE) eventually assisted with ultrasound are also reported.

Supercritical fluids processes have proved to be an excellent alternative to extract natural pigments due to the use of environmentally friendly solvents, such as carbon dioxide. According to Vatai et al. [83], extractions with supercritical CO_2 result in non-deteriorated reactions, due to low process temperatures. The CO_2 is readily available, relatively cheap, and accepted as a solvent in the food industry. SFE with CO_2 is an excellent isolation method for natural materials and gives an alternative to replace the nonpolar organic solvents, which can be a source of food contamination.

Supercritical fluid extraction (SFE) using carbon dioxide (CO_2) has been applied for the pretreatment of natural materials, as shown in the works of Paula et al. [84], Ghafoor et al. [85], and Floris et al. [86]. Operating conditions (temperatures varying from 40 to 50°C and pressures above 200 bar) and the use of co-solvents such as ethanol and water were used in their studies as modifiers to obtain the maximum extract yield. According to Seabra et al. [87], even though the choice of the appropriate polar solvent is a key factor for the success of the anthocyanin extraction procedure, its influence on the extract's characteristics is not always clear, due to the diverse structure and composition of plant materials and also the relation material-solvent.

6. Conclusion

Açaí (*Euterpe oleracea*) and bacaba (*Oenocarpus bacaba*) are highly consumed fruits in Amazon that come from common palm trees and have remarkable properties. There are many benefits that help increasing their role in the growing market for nutraceuticals. Their extracts have a range of bioactive and polyphenolic components with antioxidant properties that make them new "superfruits"; however, further studies still need to be conducted in order to elucidate all the roles that these fruits can play. Açaí and bacaba represent not only food, but also a real source of health for humans.

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