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BIOAVAILABLE COMPOUNDS AND THE BIOLOGICAL POTENTIALS OF AÇAÍ (EUTERPE OLERACEA MART.): A REVIEW

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Abstract: This work investigates the bioavailable compounds in açaí, its nutritional composition and biological potential. Its methodology is an integrative review. The results demonstrate the benefits that açaí promotes in the body, especially due to its antioxidant capacity. Acai has an anti-inflammatory, immunomodulatory effect, reduces the lipid profile and has anticancer action. In addition, it has a chemical composition rich in phenolic compounds, lipids, vitamin E and minerals.
Keywords: Açaí; bioavailability; functional food; antioxidant.

INTRODUCTION

The açaí scientific name Euterpe oleracea Mart., is an endemic fruit of the Amazon region and is widely consumed in the state of Pará, its largest producer. In cooking, the pulp of this food is used in the formulation of ice cream, mousses, in the accompaniment of savory dishes and among other options (TORMA, 2016).

In general, the açaí pulp is consumed in natura and can be added to other ingredients such as pieces of fruit and some cereals. Used before physical activity due to its high energy value. In this sense, açaí has a high nutritional value as it is a food that has a high content of fiber, lipids and minerals (LINHARES, 2019).

It is also known that this fruit exhibits significant antioxidant activity, as it is composed of phenolic compounds, including anthocyanins, which attribute certain benefits to human health to açaí, such as reducing the development of cardiovascular diseases (CEDRIM, 2018).

Information about the bioavailability of açaí nutrients for the body is scarce, however, they are essential for the knowledge of how much of the fact that the intake of this food can nutritionally meet human needs and help in the prevention of chronic diseases. Considering that, bioavailability suggests that not everything that is ingested is efficiently absorbed by the body (MARCO, 2008).

Thus, this article aims to gather information regarding the bioavailability of the chemical composition of açaí as well as its therapeutic benefits.

MATERIAL AND METHODS

The present review of the scientific literature uses the integrative method for its construction. Therefore, the research needed to be divided into four stages:

The first stage of the research encompasses the delimitation of a theme, objectives and topics to be addressed; The second stage required a bibliographic survey, using the following descriptors: purple açaí; Euterpe oleracea Mart; chemical composition of açaí; bioavailability; functional food; acai vitamins; essential elements in açaí; vitamin E in acai; Vitamin B in Acai; recommended vitamin intake. Languages: English and Portuguese. There was no specific dating, but the most relevant works for the purpose of this review were mostly published between the years 2000 and 2019. Research medium used: Scientific Electronic Library Online (SCIELO); Academic Google; institutional repository of: University of São Paulo; Federal University of Pará; Federal University of Rio Grande do Sul; Federal University of Ceara; Federal University of Santa Catarina and Federal University of Minas Gerais.

For the third stage, the articles that make up the contribution were evaluated by thorough reading to identify information relevant to the topic, having as exclusion criteria: non-identification of authorship and repeated or inaccurate information; in all, the bibliographic research gathered 67 works, of which 43 were selected for providing more complete information on the topic. Finally, in the fourth stage, the article was edited.

AÇAÍ (*EUTERPE OLERACEA* MART.)

The species Euterpe *oleracea* Mart., popularly known as açaí (açaizeiro fruit), whose scientific name means elegance of the forest (*Euterpe*) and smells like wine (*oleracea*), belongs to the Arecaceae family, being predominantly present in tropical and subtropical regions (OLIVEIRA et al., 2000).

The açaizeiro fruit has a globular appearance, with a diameter between 1 and 2 centimeters, weighing approximately 1.5 grams, with a purple or green color, which will depend on the type of maturation, also presenting annual fruiting and flowering (CEDRIM et al., 2018).

The plant species is endemic to the Amazon region, being found in states such as Pará, Maranhão, Mato Grosso, Tocantins and Amapá. It must be noted that the state of Pará is the main exporter, producer and consumer of the fruit. Its consumption involves the extraction of the pulp for food consumption *in nature* or as a main ingredient or not in the formulation of desserts and culinary dishes (TORMA, 2016; CABRAL, 2020).

Açaí has a high energy value, being composed of significant amounts of lipids, proteins, dietary fibers, fatty acids, phenolic compounds and certain essential minerals, such as magnesium, sodium, calcium, in addition to having vitamins such as E, B1 and B2. Its nutritional value is directly related to characteristics such as type of maturation, variety, climatic condition and place of cultivation (OLIVEIRA et al., 2015; LINHARES, 2019).

AÇAÍ AS A FUNCTIONAL FOOD

There is no definition of functional food, however, FUFOSE (Functional Food Science in Europe) FAIR-95-0572 defines functional food as one that has physical benefits at a physiological level and that helps in the prevention of chronic diseases, in addition, the ingredient considered functional must be present in the food and have its effects reached in the amounts in which it is ingested in a regular diet.

Another possibility of definition suggests that foods have functionality when the functional ingredient is contained in the food at the time of ingestion, or their functionality may still be reached when they are formulated with the aim of enhancing their beneficial properties, in any case they must be non-toxic and do not aim to treat or cure pathologies, their consumption must aim to reduce the risk of developing chronic diseases. Functional foods must contain terpenoids, nitrogen compounds, phenolic metabolites, fatty acids, prebiotics and probiotics (LOBO, VELASQUE, 2016).

In this sense, açaí is considered a functional food due to its antioxidant characteristics, being rich in phenolic compounds mainly in relation to the expressive amount of anthocyanins and its nutritional value. Açaí presents in its composition carbohydrates, fibers, vitamins, proteins, minerals and fatty acids (PORTINHO et al., 2012).

It exhibits numerous therapeutic benefits regarding pathologies that are triggered by oxidative stress, manifests anti-inflammatory potential, improves the lipid profile and reduces markers that are associated with risk factors of the metabolic syndrome, which are cardiovascular diseases (Portinho et al., 2012; Cedrim, 2018).

CHEMICAL COMPOSITION

The açaí berry exhibits various compounds in its composition, which change according to the region to which they belong, as well as extrinsic factors. Thus, the substances with the highest occurrence in the species will be cited.

ANTHOCYANINS

They are part of the group of phenolic compounds and are responsible for the reddish color characteristics of the fruit. Because they are present in greater amounts in açaí, they are related to its high antioxidant activity. Its main representatives are cyanidin-3-glucoside, cyanidin-3-rutinoside, perlagonidine-3-glucoside, cyanidin-3-sambioside, peonidine-3-glucoside, peonidine-3-rutinoside (OLIVEIRA et al., 2015).

They have a C6C3C6 carbon skeleton based on 2-phenylbenzopyrone (flavylium salt), which generate different molecules that vary in relation to the amount of hydroxyl and methoxy groups and sugar binding sites present in the molecule (TORMA, 2016).

Antioxidant compounds fight oxidative processes that are mainly triggered by free radicals, resulting in a reduction in oxidative stress, which implies less damage to DNA and other macromolecules that can facilitate the onset of chronic pathologies (CEDRIM, 2018).

TOO MANY PHENOLIC COMPOUNDS

Açaí has a high amount of phenolic compounds, these compounds are considered exogenous antioxidants and have the ability to inhibit the formation of reactive species, managing to act in the formation of stable products. They provide protection against lipid oxidation and cellular proteins, promoting the maintenance of membrane structure and function (TORMA, 2016). The predominant phenolic compounds in açaí are gallic acid, benzoic acid, catechin and flavonoids: orientin and homoorientin (GALORI et al., 2004; RIBEIRO et al., 2010).

FOOD FIBERS

Dietary fibers can be divided into soluble and insoluble, soluble fibers are related to reducing cholesterol levels and glucose tolerance. Insoluble fibers act by reducing intestinal constipation, act in minimizing problems related to hemorrhoids and varicose veins. In addition, both help in weight control and provide greater satiety when added to a balanced diet (OLIVEIRA et al., 2015).

The soluble fibers that are available in açaí have the ability to reduce the levels of fat in the human body, decreasing the levels of cholesterol and toxins. This is because açaí seeds have insulin crystals, which strengthens the intestinal microbiota, which has specific bacteria inside that consume this polysaccharide (LOBO, VELASQUE, 2016).

FATTY ACIDS

Fatty acids are present in açaí, such as oleic acid (Omega 9), palmitic and linoleic acid (Omega 6). Oleic and linoleic acids are classified as unsaturated and act (when consumed in large amounts) by reducing HDL (high-density lipoproteins) levels and increasing the oxidation sensitivity of LDL (low-density lipoproteins) (YUYAMA et al., 2011). ; OLIVEIRA et al., 2015).

They are also responsible for controlling blood pressure and influence blood viscosity as well as platelet functions (BEZERRA et al., 2016). Palmitic acid (saturated fatty acid) is in a lower proportion when compared to Omega 6, and its presence is related to insulin resistance (SANTOS, 2014).

VITAMINS

Açaí has in its composition vitamins B1 and B2 and vitamins E and C (LORENZI et al., 2006). Vitamin C or ascorbic acid acts as an exogenous antioxidant. Vitamins B1 and B2 are water-soluble and assist cells in converting carbohydrates into energy and in the production of red blood cells (RUBERT et al., 2017). Vitamin E protects lipids from oxidation (MACHADO, 2010).

MINERALS

The minerals sodium (Na), magnesium (Mg), manganese (Mn), calcium (Ca), potassium (K) and iron (Fe) are found in açaí. They exert different functions, Na is related to cardiac function and muscle contraction. K acts in the maintenance of blood pressure and water balance. Ca plays a role in insulin secretion and blood vessel relaxation (SANTOS, 2014; TORMA, 2016; MINIGHIN, 2019).

Mg is a macromineral responsible for cell signaling and energy production, Mn plays a role in wound healing and bone development (MINIGHIN, 2019). Fe facilitates the transport of oxygen to tissues, serves as a catalyst in oxidation and acts in the destruction of infectious organisms (GERMANO and CANNIATTI-BRAZACA, 2002).

PROTEINS

Proteins are responsible for metabolic functions such as the production of antibodies in the immune system, when they are in the form of lipoproteins, they act in the transport of cholesterol and fat-soluble vitamins. In addition, both minerals and vitamins need to be linked to protein carriers for their transport (CARRAZZA, 1988; MARCO, 2008).

BIOAVAILABILITY

According to Marco (2008), bioavailability is defined as a certain amount of nutrient present in a food that, when ingested, can actually be (be accessible) used by the body. This definition includes the mechanisms of absorption and transport of nutrients and their transformation into compounds with biological potential.

In foods, when evaluating the bioavailability of minerals, one must take into account how efficient the absorption of the same was in the intestinal lumen path to the blood, evaluating how these minerals present themselves, as they may be in a form in which they will not be used despite being absorbed (BENITO, MILLER, 1998; MARCO, 2008).

In summary, açaí presents in its composition anthocyanins and other phenolic compounds, minerals, vitamins, dietary fibers and fatty acids, with emphasis on Omega 6 and 9 (OLIVEIRA et al., 2015).

Minerals (Ca, Mg, K and Mn) are bioavailable and accessible in açaí when considering the daily intake of 200 g or 300 ml of fresh pulp. Regarding the levels of Fe (depending on the region where the açaí is collected and produced), this element is found in insignificant levels or in high concentrations (however in a state unavailable to be absorbed). Thus, açaí is not a source of iron (SANTOS, 2014; MINIGHIN, 2019).

Vitamin C present in açaí would be able to maintain Fe in the ferrous state, which is more soluble, facilitating its absorption by the intestinal tract, as it would act as a reducing agent, but ascorbic acid is found in insufficient amounts in this food, not having ability to interfere with Fe absorption. One possibility to improve its use would be the consumption with citrus fruits such as oranges or the addition of lemon drops in the pulp when consumed (MARCO, 2008).

It must be noted that açaí has an amount around 14 mg/100 g to 30 mg/100 g of ascorbic acid. This content indicates that, when compared to the recommended daily intake of vitamin C by the RDA (Recommended Dietary Allowance), which would be 75 mg/day and 95 mg/day for adult women and men, respectively, açaí does not interfere with the absorption of Fe, as already mentioned, has a considerable amount of this vitamin in its composition, however, the intake of 200 g of the fruit pulp would still not be able to supply the recommended (Scherer et al., 2008; SANTOS, 2014; AQUINO, 2019).

The vitamin E (α-tocoferol and α-tocotrienol) must be ingested in amounts of 11-15mg/day for men and 15mg/day for women, açaí has an average of 45mg/100g of this vitamin in its composition, which makes it a source of vitamin E, given that in healthy individuals they are normally well absorbed (MOURÃO et al., 2005; PADOVANI et al., 2006; COSTA, 2013).

According to Rubert et al., (2017) men and women must ingest a relatively small amount of vitamin B1 (1.1 mg/day to 1.2 mg/day) and B2 (1.3 mg/day to 1.1 mg/day), açaí shows an average value of 0.25mg/100g and according to the TACO (Brazilian Food Composition Table) of 0.04mg/100g. Therefore, the fruit exhibits a considerable amount of these vitamins, considering that they are normally present in very low amounts in most foods (SANTOS, 2007; VANNUCCHI; CUNHA, 2009).

Phenolic compounds are bioavailable in the fruit, however, a small reduction is observed when assessing their accessibility (how much can be absorbed) in the body, which in no way rules out it as an excellent source of antioxidants. In addition, phenolic compounds function as, due to the high content of anthocyanins, neutralizers of neurotoxic effects in the event of an unusual increase in the amount of Mn via oxidative stress, present in açaí (SANTOS, 2014; MINIGHIN, 2019).

Anthocyanins are poorly absorbed by the body, however they are mainly responsible for the antioxidant characteristics of açaí, which makes it a functional food or a super fruit. To explain how they can be so poorly absorbed and, on the other hand, manifest so many health benefits, one must evaluate their course in the human body. Anthocyanins are mostly absorbed in the small intestine, and their effects in the body would be related to the constant release of their metabolites (phenolic acids such as cyanidin-3-glucoside) into the bloodstream, while being absorbed in this organ (CARDOSO, 2018).

Acai fibers are bioavailable, and act by facilitating intestinal transit and reducing cholesterol levels (OLIVEIRA et al., 2015).

Omega 6 and 9 fatty acids are the ones with the highest concentrations in the fruit, making it rich in unsaturated fatty acids. These acids are bioavailable and properly absorbed by the body, reducing the risk of developing chronic diseases, reducing LDL levels and type 2 diabetes (YUYAMA et al., 2011).

Finally, the bioavailability of these nutrients in their active form is not only related to the amount in which they are ingested, but also the specificity of each organism regarding the efficient absorption of these foods, in this case, sex, ethnicity, sports practice and age are some of the factors that will interfere with the proper use of food (SANTOS, 2014).

BIOLOGICAL POTENTIALITIES

The açaí is rich in antioxidant substances, which gives it anti-inflammatory action, the fruit exhibits in more than 50% of its composition a fatty acid profile, which makes it an antihypertensive and cholesterol reducer, in addition to a helper in problems resulting from overweight as it works by decreasing blood glucose levels (RUFINO et al., 2010; UDANI et al., 2011; KANG et al., 2012).

Acai seed extracts also have the ability to preserve kidney morphology and function. In addition to manifesting a vasodilating effect, the study monitored the application of these extracts in hypertensive and diabetic rats (CEDRIM, 2018).

The anticancer property of this fruit can be observed when phenolic extracts reduced leukemic and adenocarcinoma proliferation in the human colon. In addition to inhibiting the cells that are linked to breast cancer (SILVA

et al., 2014). The immunomodulatory effect of açaí is due to the presence of polysaccharides that stimulate T cells and myeloid gamma-delta cells, in research involving human and bovine cells (HOLDERNESS et al., 2011)

The high amount of polyphenols in açaí reduces the risk of obesity, metabolic syndrome and diseases triggered by type 2 diabetes (DEMBINSKA-KIEC et al., 2008). It has a neuroprotective effect, Spada et al., (2009) and Poulose et al., (2012), found that açaí extracts prevent the brain tissue from undergoing oxidative stress, inferring that the fruit can contribute to preventing the progression of diseases. neurodegenerative.

The high amount of anthocyanins present in the fruit makes açaí have anti-aging effects due to its ability to neutralize reactive oxygen species (SOARES et al., 2015). Acai extracts have also been shown to have a nutrigenomic effect on neurons with mitochondrial dysfunction, the extract reduced the effects resulting from oxidative stress and recovered the activity of the mitochondrial complex (MACHADO et al., 2016).

Finally, the administration of 100 to 200 g of açaí per day has been shown to be effective with regard to a balanced diet, in which this dose is able to reduce reactive oxygen species, contributing to a better manifestation of its antioxidant characteristics, better results through inflammation, in addition to observing a reduction in the lipid profile, improving cholesterol. This portion also meets the basic recommendations for a good diet rich in nutrients, especially with regard to the amounts of Ca, K, and Mg minerals, including unsaturated fatty acids (PEREIRA et al., 2012; PALA et al., 2012; PALA et al. al., 2017; BARBOSA, 2015).

CONCLUSION

According to the researched literature, the information found is emphatic in highlighting açaí as an excellent source of antioxidants. They also reveal that the daily consumption of 200 g of fresh pulp provides enough mineral, vitamin E and lipids to beneficially influence human health. Thus, açaí appears as a food with interesting biological potential, linked to oxidative stress and chronic diseases such as the cardiovascular and neurodegenerative ones, and the evident anti-inflammatory activity of this food is also highlighted. As for its functional power, it is observed that it manifests fiber, lipid and mineral content that frame it as such, mainly in relation to phenolic compounds.

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