ARTIGO ORIGINAL

Assessment of the scientific evidence of the potential use of açaí (Euterpe oleracea, Mart.) in clinical outcomes: analysis with focus on antioxidant and anti-inflammatory action

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Palavras-chave: Frutas, propriedades antioxidantes, propriedades anti-inflamatórias

ABSTRACT

The açaí berry (Euterpe oleracea, Mart.), fruit native to the Amazon region and explored mainly in the region of Pará, gained importance in recent years due to potential health benefits, associated with its phytochemical composition and antioxidant capacity, related to its high content of flavonoids. Among these, anthocyanins are responsible for the anti-inflammatory and antioxidant capacity of this fruit. Experimental studies show that due to its composition, the acai berry has antioxidant activity related to its ability to reduce the reactive oxygen species (ROS) and its potential to inhibit cyclooxygenase 2 (COX-2). Another benefit studied is the analysis of their effectiveness in the anti-inflammatory process, being observed inhibition of araquedônico acid-derived mediators, suggesting that the fruit can act in the chronic inflammatory process. Also it was possible to observe that the fruit may have anti-inflammatory effects in healthy patients. Thus, the supplementation of diets with use of acai berry could attenuate inflammation process and oxidative stress, today with more consistent evidence derived primarily from in vitro studies. However, there is still need for further studies to prove the action of this fruit in the mechanisms involved in these processes, isolation of specific compounds and determining their optimal dosage.

Keywords: Fruits, Antioxidants, Anti-inflammatories.

INTRODUCTION

The açaí palm (Euterpe oleracea Mart.), plant native to the Amazon region, is found mainly in the states of the north region of Brazil. Its fruit has become symbol of the State of Pará in the northern region, this being its main operator, followed by the States of Maranhão, Amapá, Acre and Rondônia (1, 2). Its socioeconomic importance occurs due to the abundance of the fruit in the region, having this full utilization. Its seed is used for crafts and organic fertilizer, its stem provides the palm and its leaves are used to cover roofs of local residences. In addition, their stems can be intended for the manufacture of cellulose (2).

Despite the açaí harvesting occur throughout the year, the best organoleptic, nutritional and antioxidant qualities are obtained when the product is harvested in the months of august to december. The harvest from january to july, due the climatic characteristics, provides nutritional quality product apparently bottom (3).

In Brazil, it's fairly widespread consumption

of the plant, being traditionally the pulp of the fruit of the açaí consumed in the form of juice. In addition to this form, there are also several applications in cooking through its use in pies, jams and liqueurs(4).

According to the current legislation, the juice from the açaí berry is classified under: açaí thick or special (type A) - pulp extracted with the addition of water and features after being filtered more than 14 total solids, with very dense appearance. The açaí berry medium or regular (type B) - pulp extracted with the addition of water and after being filtered from 11 to 14 of total solids, having moderately dense appearance and the açaí berry slim or popular (type C) - pulp extracted with the addition of water and after being filtered from 8 to 11 of total solids, and thus the appearance little dense(5).

Although the vast majority of consumption is derived from the diluted juices, those possessing low content of açaí (4 to 5%), there is a small number, but significant, on the market for the consumption of the juice with high content of açaí (40%), designed for dissemination in various media of potential health benefits attributed to fruit(6).

The açaí also has been receiving prominence in other producing regions of the country such as Rio de Janeiro, São Paulo, Brasília, Goias and Northeast region. However, due to its high cost due to additional steps in the production chain and marketing, the most consumed in these regions is the açaí berry slim, which is usually mixed with other products, which alters their taste, odor and caloric value. Currently, with the increased consumption in Brazil, an incipient phase of exportation of the product, which reaches North American and European markets (especially Italy), which is sent in the form of frozen pulp(2).

In recent years, the fruit gained importance due to the potential health benefits, associated with its phytochemical composition and antioxidant capacity (4). In addition, the açaí berry has been used in dietary supplements, since it contains high energy value and a wide range of nutrients, including proteins, lipids, vitamins and polyphenols(7). The present study has as objective check for evidence that the anti-inflammatory and antioxidant action of açaí can mitigate oxidative stress and inflammatory process and analyze the dosages used in in vitro and in vivo studies available in the literature.

METHODOLOGY

It is a systematic review focusing on articles related to the topic Euterpe oleracea, Mart. For both, employed the Boolean technique with the words AND, NOT and OR and the following descriptors of health: Disease prevention, Cardiovascular diseases, açaí, Euterpe oleracea mart., Atherosclerosise, and their corresponding in Portuguese.

The trace was conducted by means of the manual search with visits to integrated system for libraries and consultations the electronic means of scientific reliability as SCIELO (Scientific Electronic Library Online), LILACS (Latin American literature and Caribbean Center on health sciences) and PUBMED. Selected articles published over the past 13 years and that anticipated the objectives determined in the present research.

DISCUSSION

a. Composition and chemical-nutritional aspects

The degree of maturity of the açaí berry is important for the biological activity of its pigments. The Green pulp presents fewer phenolic pigments, anthocyanins and antioxidant activity in relation to the ripe pulp, which has the maximum amount of these pigments(8).

The açaí berry is considered high-calorie food, this is due to the presence of high amount of fatty acids (oleic, linoleic and Palmitic), with 60% of monounsaturated and polyunsaturated of 13%(1, 2), characterizing a desirable profile of lipids with potential cardiovascular benefit(9). In relation to proteins, their content is higher than milk (3,50%) and egg (12,49%), and the amino acid profile is similar to that found in the egg farm(2).

The pulp is also rich in minerals, including calcium and potassium and vitamins, especially vitamin E, admittedly with antioxidant potential and with action to combat free radicals(10), Although it has not yet been demonstrated in isolation effect in reducing cardiovascular events(11). Contrary to popular belief, the fruit cannot be regarded as significant additional source of iron(1, 2). In relation to fibers, the fruit presents high amount the same, mostly insoluble fibers(12).

The açaí berry also contains flavonoids, those responsible for action potential antioxidant and anti-inflammatory properties of fruit(13-15). This is due to the presence of phenolic compounds that desencadeam a reduction in the production of reactive oxygen species (Ros), thus protecting the oxidative damage in vitro cell and providing anti-inflammatory signaling, leading to reduced production of free radicals by polymorphonuclear cells(16). Anthocyanins are natural pigments belonging to this group of flavonoid compounds, having scientific evidence experimental laboratory contribution in reducing cholesterol levels and endothelial inflammatory activity(17-21).

So, in this particular aspect we can conclude that

açaí is recognized due to its high chemical compounds content of antioxidant activity, particularly total total anthocyanins and phenolics(22). However, the evidence of its beneficial effect are currently derived from laboratory experimentation, there is no unequivocal evidence to date of the potential in clinical patient cohort.

b. Anthocyanins

The reddish purple color typical of açaí is derived from its high anthocyanin content. Anthocyanins and phenolics showed positive and significant correlation with antioxidant activity of açaí(23). Its pulp is tested at trial against radical hydroxyl (OH•), Alkoxyl (ROO•) and hydrogen peroxide (H2O2) had an impact on attenuation of oxidative stress derived of these compounds(24).

The major anthocyanins found in Acai pulp are represented by cyanidin-3-glucoside, cyanidin-3-rutinoside, pelargonidin-3-glucoside, cyanidin-3-sambubioside, peonidin-3-Glucoside and peonidin-3-rutinoside(4). Through the isolation of anthocyanin cyanidin-3-Glucoside and cyanidin-3-rutinoside in freeze-dried samples of acai berry, it was possible to demonstrate the high degree of presence of these compounds in the fruit(25).

Chemical structure of cyanidin-3-Glucoside(26)

The anti-inflammatory capability of anthocyanins is derived from different mechanisms. Among these, is demonstrated inhibition of nuclear factor Kappa β activation (NF-kβ), inflammatory response and inhibition of apoptosis of endothelial cells induced by human CD40 factor. In addition, it was demonstrated even inhibiting the production of nitric oxide (NO), the increase of the expression of the enzyme nitric oxide synthase (iNOS) and induced a reduction in plasma monocyte chemoattractant protein concentration of monocytes 1 (MCP-1)(27), effecting a possible link between effects of açaí and beneficial properties in human endothelial function. Was demonstrated positive correlation derived protective polyphenols of açaí in human umbilical vascular endothelial cells on inflammatory stress induced by inhibition of gene expression of adhesion molecules and activation of NF-kβ(28).

The açaí berry is also source of phytosterols, showing (78%) sitosterols, stigmasterol (6.5%), campesterol (6%) and avenasterol (6,5%)(29). The concentration of phytosterols found average was in the fruit in prior analysis was 15 mg for every 100 g of fruit, mainly the β-sitosterol(30).

In experimental study conducted in order to investigate protective action of açaí against genotoxicity in vivo induced by doxorubicin (DXR), a powerful group of liposomal anticancer, this demonstrated protective effects of açaí pulp observed in acute and subacute both treatments, derived from the fruit pulp before administration of DXR. The result of the chemical analysis confirmed the presence of carotenoids, anthocyanins, phenolic compounds and flavonoids in fruit pulp. In general, subacute treatment (adminstrado more prolonged before toxic damage induction) provided a greater effectiveness in protecting against DNA damage induced by DXR(31). Such evidence may suggest the bases several lines of research.

It is important however to note that features derived from the form of processing can have direct influence on nutritional composition. Progressive damage has been shown to açaí fruit after their harvest, favoring the microbial contamination and degradation of anthocyanin(32). Thus, in field analysis, such aspects should be guarded.

c. Evidence in experimental models

In a study conducted to determine concentrations of total phenolics, total flavonoids and ascorbic acid in comparison using frozen fruit pulps, the antioxidant capacity in the disabling of the alkoxy radical (ROO•), hydrogen peroxide (H2O2) and hydroxyl (OH •), the açaí berry was the fruit that showed better ability of reducing the EROs(24). In addition, study aiming to correlate the level of these elements (including total anthocyanins and phenolics of açaí pulp) to its potential benefit in reducing oxidative stress, showed significant correlation between the level of these compounds and antioxidant activity of pulps analyzed(23).

The supplementation of diet with açaí berry pulp not only acts as an antioxidant, but can also modulate the production of EROs by neutrophils and enhance oxidant balance liver antioxidant for the induction of mRNA expression of antioxidant enzymes in the oxidative stress. The properties of the pulp of açaí in vivo and in physiological conditions seem to involve beneficial effects related to antioxidant defense system and partial rollback of the deleterious effects on the liver caused by diabetes in this animal model(33).

In another experiment performed, adding 5 of freeze-dried açaí ration provided a reduction in the number of invasive tumours colon (p=0,005) and

the reduction of the multiplication of these tumors (p=0,001). In addition, it was possible to observe a reduction in the proliferation of tumor cells of Ki-67 (p=0,003) and net growth index (p=0,001). Therefore, the results of this study indicate that the addition of açaí berry can reduce the development of chemically induced colon carcinogenesis in rats(34).

Due to its high content of polyphenols, freeze dried açaí pulp was exploited by its protective effect in rat microglial cells. The fractions extracted with methanol (MeOH) ethanol (EtOH) and were particularly rich in anthocyanins, whereas the fraction extracted using acetone (ACE) was rich in other phenolic compounds. The açaí berry resulted in significant decrease in production of nitrite (p<0,05), accompanied by reduction of expression of inducible nitric oxide synthase (iNOS), besides significant reduction dependent on the concentration of cyclo-oxygenase-2 (COX-2), enabled by p38mitogen-activated protein kinase (p38 MAPK), tumor necrosis factor α (TNFα), and NF-kβ. The present study suggests that ultimately the acai berry can potentially interfere favorably in motor and cognitive functions(35).

Diverse study conducted in experimental model also suggests oil of Euterpe oleracea on inflammatory response, due to inhibition of arachidonic acid-derived mediators. With this, the açaí berry can potentially have a beneficial role in chronic inflammatory processes (36).

Wine consumption of açaí in experimental model mitigated atherosclerosis through effects involving reduction of synthesis and absorption of sterols, reduction of oxidative modification of lipoproteins and improves endothelial function(30). Costa et al. (2012) revealed that chronic treatment with açaí seed extract prevents the development of arterial hypertension and endothelial dysfunction. These effects are associated with the synthesis, antioxidant action, and the inhibitory effect on the levels of matrix metalloproteinase-2 (MMP-2). In this way, the açaí berry works in reducing oxidative stress and levels of MMP-2(37).

d. Research in humans

In a study conducted in vitro and in vivo, in order to investigate the anti-inflammatory and antioxidant properties of a patented juice containing açaí as the predominant ingredient, along with smaller amounts of other fruits. Ingestion of this demonstrated substantial juice antioxidant capacity to protect cells from oxidative damage in vitro. In addition, resulted in significant reduction in plasma lipid peroxidation in the 2 hours period, in vivo, being possible to observe an increase in plasma antioxidant capacity. About anti-inflammatory capability, it was possible to observe significant statistic reduction of three pro-inflammatory article-chemotactic formyl-metionyl-leucyl-phenylalanine (FMLP), Leukotriene B4, interleukin 8. However, it is speculated whether the fruit may or may not have anti-inflammatory effects for healthy patients(38).

In randomized were observed healthy subjects aged 18-50 years and no smoking. The subjects were divided into 2 groups, was offered 400 ml of fruit juice. Ingestion of juice containing açaí and cranberry compound, rich in ascorbic acid and anthocyanins increased the concentration of ascorbic acid in plasma, stabilized pró-antioxidante balance in healthy nonsmokers, but did not reduce the oxidative stress markers(39).

In another protocol developed in humans, the plasma antioxidant capacity was significantly increased after the 7mlkg consumption of the juice and pulp of açaí. Individual increases in plasma antioxidant capacity of 2,3 to 3 times were observed for the consumption of juice and pulp of açaí¸ respectively. The antioxidant capacity in the urine, the generation of ROS and uric acid concentrations in plasma were not significantly altered by the treatments. The results demonstrate the absorption and effects of antioxidant anthocyanins in plasma due to the consumption of açaí in humans(26).

Pilot study noted 10 adults with overweight (IMC ≥ 25 kg/m2 e ≤ 30 kg/m2), who consumed 100g of pulp of açaí twice a day for 1 month. Proved to be reduction in fasting glucose and insulin levels after treatment of 30 days (both p<0,02). It was possible to observe significant statistical reduction in total cholesterol levels, as well as a reduction in LDL-c and the relationship between total cholesterol and HDL-c, as well as moderate their postprandial plasma glucose reduction after standard meal consumption. The consumption of açaí pulp demonstrated so reduction in levels of disease risk metabolic markers in overweight adults(40).

Pilot study with humans with chronic joint disease which participants ingested 120 ml of fruit juice containing predominantly patented the pulp of açaí (Euterpe oleracea Mart.) and other fruit concentrates during 12 weeks. Was associated with a significant reduction of pain, improved range of motion and realisation of physical activity daily. Plasma antioxidants were monitored, being possible to see improvement within 2 weeks and who remained increased throughout the 12 weeks. The inflammatory marker C-reactive protein (CRP) was reduced by 12 weeks, but this change

did not reach statistical significance. Lipid peroxidation reduced slightly until the end of the experiment. With this, it was possible to observe the significant association between increased antioxidant capacity, improves range of motion and reduction of chronic pain(41).

CONCLUSION

Currently the açaí berry has been receiving prominence due to its high content of flavonoids. Among these, anthocyanins are responsible for the anti-inflammatory and antioxidant capacity of this fruit. Studies are being conducted in order to assess whether the consumption of açaí can mitigate oxidative stress and inflammatory process.

The available evidence show that supplementation in diets with the use of açaí can mitigate oxidative stress and inflammatory processes, mainly in in vitro studies. However, there is a need for more studies with larger population showing the action of this fruit and its mechanisms involved in these processes and the determination of its optimal dosage. In addition, the changes demonstrated in the initial models of cardiac remodeling and its antioxidant action can raise the hypothesis that their dietary supplementation has potential benefit also in this condition.

REFERENCES

1. Menezes N, Varela P, Furtado A, Couceiro A, Calheiros I, Rosado L, et al. Chromoblastomycosis associated with Fonsecaea pedrosoi in a carpenter handling exotic woods. Dermatology online journal. 2008;14(2):9. Epub 2008/08/14. PubMed PMID: 18700112.
2. Sistema de Produção do Açaí: Composição química do açaí [Internet]. 2006 [cited 27 abr. 2013]. Available from: http://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/Acai/SistemaProducaoAcai_2ed/paginas/composicao.htm.
3. Rogez G, Marvilliers A, Riviere E, Audiere JP, Lloret F, Varret F, et al. A Mixed-Valence Mixed-Spin Prussian-Blue-Like Heptanuclear Complex We are indebted to Prof. P. Day of The Royal Institute of Great Britain for interesting discussions that were at the origin of the work presented in this paper. Angewandte Chemie. 2000;39(16):2885-7. Epub 2000/10/12. PubMed PMID: 11027998.
4. Portinho JAZ, L. M.; Bruck. M. R. Beneficial effects of açaí. International Journal of Nutrology, . 2012;5(1):15-20. Epub jan./abr. 2012.
5. Sistema de Produção do Açaí: Sistema de Produção do Açaí [Internet]. 2006 [cited 24 jun 2013]. Available from: http://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/Acai/SistemaProducaoAcai_2ed/paginas/processamento.htm.
6. Sabbe S, Verbeke W, Deliza R, Matta VM, Van Damme P. Consumer liking of fruit juices with different acai (Euterpe oleracea Mart.) concentrations. Journal of food science. 2009;74(5):S171-6. Epub 2009/08/04. doi: 10.1111/j.1750--3841.2009.01146.x. PubMed PMID: 19646053.
7. Kim YS, Jung H, Zerin T, Song HY. Protein profiling of paraquat-exposed rat lungs following treatment with Acai (Euterpe oleracea Mart.) berry extract. Molecular medicine reports. 2013;7(3):881-6. Epub 2013/01/08. doi: 10.3892/mmr.2013.1259. PubMed PMID: 23291665.
8. APC. C. Avaliação do efeito da extração e da microfiltração do açaí sobre sua composição e atividade antioxidante. [Tese de Mestrado]: Universidade Federal do Rio de Janeiro; 2008.
9. Sposito AC, Caramelli B, Fonseca FA, Bertolami MC, Afiune Neto A, Souza AD, et al. [IV Brazilian Guideline for Dyslipidemia and Atherosclerosis prevention: Department of Atherosclerosis of Brazilian Society of Cardiology. Arquivos brasileiros de cardiologia. 2007;88 Suppl 1:2-19. Epub 2007/05/23. PubMed PMID: 17515982.
10. Turner A, Okubo Y, Teramura S, Niwa Y, Ibaraki K, Kawasaki T, et al. The antioxidant and non-antioxidant contributions of vitamin E in vitamin E blended ultra-high molecular weight polyethylene for total knee replacement. Journal of the mechanical behavior of biomedical materials. 2012. Epub 2013/02/02. doi: 10.1016/j.jmbbm.2012.12.006. PubMed PMID: 23369759.
11. Rembold CM. Review: Vitamin and antioxidant supplements do not prevent adverse cardiovascular events. Annals of internal medicine. 2013;158(12):JC10. Epub 2013/06/20. doi: 10.7326/0003-4819-158-12-201306180-02010. PubMed PMID: 23778922.
12. ESLT M. Influência da sazonalidade sobre a composição química e atividade antioxidante do açaí (Euterpe oleracea Mart.) [Tese de doutorado]: Universidade Federal do Amapá; 2011.
13. Beara IN, Lesjak MM, Jovin ED, Balog KJ, Anackov GT, Orcic DZ, et al. Plantain (Plantago L.) species as novel sources of flavonoid antioxidants. Journal of agricultural and food chemistry. 2009;57(19):9268-73. Epub 2009/09/17. doi: 10.1021/jf902205m. PubMed PMID: 19754195.
14. Leong ACN KY, Tako M, Iwasaki H, Oku H, Tamaki H. Flavonoid glycosides in the shoot system of Okinawa Taumu (Colocasia esculenta S.). Food Chemistry. 2010;119(2):630-5.
15. Li C, Du H, Wang L, Shu Q, Zheng Y, Xu Y, et al. Flavonoid composition and antioxidant activity of tree peony (Paeonia section moutan) yellow flowers. Journal of agricultural and food chemistry. 2009;57(18):8496-503. Epub 2009/08/29. doi: 10.1021/jf902103b. PubMed PMID: 19711909.
16. Kang J LZ, Wu T, Jensen GS, Schauss AG, Wu X. Anti-oxidant capacities of flavonoid compounds isolated from acai pulp (Euterpe oleracea Mart.). Food Chemistry 2010;122:610-7. Epub 2010/03/03.
17. Graf D, Seifert S, Jaudszus A, Bub A, Watzl B. Anthocyanin--Rich Juice Lowers Serum Cholesterol, Leptin, and Resistin and Improves Plasma Fatty Acid Composition in Fischer Rats. PloS one. 2013;8(6):e66690. Epub 2013/07/05. doi: 10.1371/journal.pone.0066690. PubMed PMID: 23825152; PubMed Central PMCID: PMC3688949.

18. Wang D, Xia M, Yan X, Li D, Wang L, Xu Y, et al. Gut microbiota metabolism of anthocyanin promotes reverse cholesterol transport in mice via repressing miRNA-10b. Circulation research. 2012;111(8):967-81. Epub 2012/07/24. doi: 10.1161/CIRCRESAHA.112.266502. PubMed PMID: 22821931.

19. Qin Y, Xia M, Ma J, Hao Y, Liu J, Mou H, et al. Anthocyanin supplementation improves serum LDL- and HDL-cholesterol concentrations associated with the inhibition of cholesteryl ester transfer protein in dyslipidemic subjects. The American journal of clinical nutrition. 2009;90(3):485-92. Epub 2009/07/31. doi: 10.3945/ajcn.2009.27814. PubMed PMID: 19640950.

20. Han KH, Matsumoto A, Shimada K, Sekikawa M, Fukushima M. Effects of anthocyanin-rich purple potato flakes on antioxidant status in F344 rats fed a cholesterol-rich diet. The British journal of nutrition. 2007;98(5):914-21. Epub 2007/06/15. doi: 10.1017/S0007114507761792. PubMed PMID: 17559701.

21. Xia M, Ling W, Zhu H, Wang Q, Ma J, Hou M, et al. Anthocyanin prevents CD40-activated proinflammatory signaling in endothelial cells by regulating cholesterol distribution. Arteriosclerosis, thrombosis, and vascular biology. 2007;27(3):519-24. Epub 2006/12/13. doi: 10.1161/01.ATV.0000254672.04573.2d. PubMed PMID: 17158355.

22. Pompeu DR, Silva EM, Rogez H. Optimisation of the solvent extraction of phenolic antioxidants from fruits of Euterpe oleracea using Response Surface Methodology. Bioresource technology. 2009;100(23):6076-82. Epub 2009/07/08. doi: 10.1016/j.biortech.2009.03.083. PubMed PMID: 19581082.

23. Santos GM, Maia GA, Sousa PH, Costa JM, Figueiredo RW, Prado GM. [Correlation between antioxidant activity and bioactive compounds of acai (Euterpe oleracea Mart) comercial pulps]. Archivos latinoamericanos de nutricion. 2008;58(2):187-92. Epub 2008/10/07. PubMed PMID: 18833997.

24. Vissotto LC RE, Chisté RC, Benassi MT, Mercadante AZ. Correlation, by multivariate statistical analysis, between the scavenging capacity against reactive oxygen species and the bioactive compounds from frozen fruit pulps3. Ciência e Tecnologia de Alimentos. 2013;33(Supl. 1):57-65.

25. Gouvêa ACMS AM, Schulz DF, Pacheco S, Godoy RLO, Cabral LMC. Anthocyanins standards (cyanidin-3-O-glucoside and cyanidin-3-O-rutinoside) isolation from freeze-dried açaí (Euterpe oleraceae Mart.) by HPLC. Ciência e Tecnologia de Alimentos. 2012;32 (1):43-6. Epub jan.-mar. 2012.

26. Mertens-Talcott SU, Rios J, Jilma-Stohlawetz P, Pacheco-Palencia LA, Meibohm B, Talcott ST, et al. Pharmacokinetics of anthocyanins and antioxidant effects after the consumption of anthocyanin-rich acai juice and pulp (Euterpe oleracea Mart.) in human healthy volunteers. Journal of agricultural and food chemistry. 2008;56(17):7796-802. Epub 2008/08/13. doi: 10.1021/jf8007037. PubMed PMID: 18693743.

27. Cardoso LM LJ, Peluzio MCG. Efeitos biológicos das antocianinas no processo aterosclerótico. Revista Colombiana de Ciências Químico Farmacêutica. 2011;40(1):116-38. Epub 2011/05/30.

28. Noratto GD, Angel-Morales G, Talcott ST, Mertens-Talcott SU. Polyphenolics from acai (Euterpe oleracea Mart.) and red muscadine grape (Vitis rotundifolia) protect human umbilical vascular Endothelial cells (HUVEC) from glucose- and lipopolysaccharide (LPS)-induced inflammation and target microRNA-126. Journal of agricultural and food chemistry. 2011;59(14):7999-8012. Epub 2011/06/21. doi: 10.1021/jf201056x. PubMed PMID: 21682256.

29. Pacheco-Palencia LA, Mertens-Talcott S, Talcott ST. Chemical composition, antioxidant properties, and thermal stability of a phytochemical enriched oil from Acai (Euterpe oleracea Mart.). Journal of agricultural and food chemistry. 2008;56(12):4631-6. Epub 2008/06/05. doi: 10.1021/jf800161u. PubMed PMID: 18522407.

30. Feio CA, Izar MC, Ihara SS, Kasmas SH, Martins CM, Feio MN, et al. Euterpe oleracea (acai) modifies sterol metabolism and attenuates experimentally-induced atherosclerosis. Journal of atherosclerosis and thrombosis. 2012;19(3):237-45. Epub 2011/12/06. PubMed PMID: 22139433.

31. Ribeiro JC AL, Aissa AF, Darin JDC, de Rosso VV, Mercadante AZ, Bianchi MLP. Evaluation of the genotoxic and antigenotoxic effects after acute and subacute treatments with açai pulp (Euterpe oleracea Mart.) on mice using the erythrocytes micronucleus test and the comet assay. Mutation research. 2010;695(1-2):22-8. Epub 2009/11/03.

32. Rogez H, Akwie SN, Moura FG, Larondelle Y. Kinetic modeling of anthocyanin degradation and microorganism growth during postharvest storage of acai fruits (Euterpe oleracea). Journal of food science. 2012;77(12):C1300-6. Epub 2012/12/18. doi: 10.1111/j.1750-3841.2012.02996.x. PubMed PMID: 23240969.

33. Guerra JF, Magalhaes CL, Costa DC, Silva ME, Pedrosa ML. Dietary acai modulates ROS production by neutrophils and gene expression of liver antioxidant enzymes in rats. Journal of clinical biochemistry and nutrition. 2011;49(3):188-94. Epub 2011/12/01. doi: 10.3164/jcbn.11-02. PubMed PMID: 22128218; PubMed Central PMCID: PMC3208015.

34. Fragoso MF, Romualdo GR, Ribeiro DA, Barbisan LF. Acai (Euterpe oleracea Mart.) feeding attenuates dimethylhydrazine--induced rat colon carcinogenesis. Food and chemical toxicology : an international journal published for the British Industrial Biological Research Association. 2013;58C:68-76. Epub 2013/04/20. doi: 10.1016/j.fct.2013.04.011. PubMed PMID: 23597449.

35. Poulose SM, Fisher DR, Larson J, Bielinski DF, Rimando AM, Carey AN, et al. Anthocyanin-rich acai (Euterpe oleracea Mart.) fruit pulp fractions attenuate inflammatory stress signaling in mouse brain BV-2 microglial cells. Journal of agricultural and food chemistry. 2012;60(4):1084-93. Epub 2012/01/10. doi: 10.1021/jf203989k. PubMed PMID: 22224493.

36. Favacho HAS OB, Santos KC, Medeiros BJL, Sousa PJC, Perazzo FF, Carvalho JCT. Anti-infl ammatory and antinociceptive activities of Euterpe oleracea oil. Brazilian Journal of Pharmacognosy. 2011;21(1):105-14. Epub 2011/01/24.

37. da Costa CA, de Oliveira PR, de Bem GF, de Cavalho LC, Ognibene DT, da Silva AF, et al. Euterpe oleracea Mart.-derived polyphenols prevent endothelial dysfunction and vascular structural changes in renovascular hypertensive rats: role of oxidative stress. Naunyn-Schmiedeberg's archives of pharmacology. 2012;385(12):1199-209. Epub 2012/10/12. doi: 10.1007/s00210-012-0798-z. PubMed PMID: 23052352.

38. Jensen GS, Wu X, Patterson KM, Barnes J, Carter SG, Scherwitz L, et al. In vitro and in vivo antioxidant and anti--inflammatory capacities of an antioxidant-rich fruit and berry juice blend. Results of a pilot and randomized, double-blinded, placebo-controlled, crossover study. Journal of agricultural and food chemistry. 2008;56(18):8326-33. Epub 2008/08/23. doi: 10.1021/jf8016157. PubMed PMID: 18717569.

39. Ellinger S, Gordon A, Kurten M, Jungfer E, Zimmermann BF, Zur B, et al. Bolus consumption of a specifically designed fruit juice rich in anthocyanins and ascorbic acid did not influence markers of antioxidative defense in healthy humans. Journal of agricultural and food chemistry. 2012;60(45):11292-300. Epub 2012/10/18. doi: 10.1021/jf300719t. PubMed PMID: 23072538.

40. Udani JK, Singh BB, Singh VJ, Barrett ML. Effects of Acai (Euterpe oleracea Mart.) berry preparation on metabolic parameters in a healthy overweight population: a pilot study. Nutrition journal. 2011;10:45. Epub 2011/05/17. doi: 10.1186/1475-2891-10-45. PubMed PMID: 21569436; PubMed Central PMCID: PMC3118329.

41. Jensen GS, Ager DM, Redman KA, Mitzner MA, Benson KF, Schauss AG. Pain reduction and improvement in range of motion after daily consumption of an acai (Euterpe oleracea Mart.) pulp-fortified polyphenolic-rich fruit and berry juice blend. Journal of medicinal food. 2011;14(7-8):702-11. Epub 2011/04/08. doi: 10.1089/jmf.2010.0150. PubMed PMID: 21470042; PubMed Central PMCID: PMC3133683.

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Figura 1: Chemical structures of cyanidin-3-*O*-glucoside (**A**) and cyanidin-3-*O*-rutinoside (**B**)