Antioxidant capacity and other bioactivities of the freeze-dried Amazonian palm berry, Euterpe oleraceae mart. (acai).

Agric Food Chem. 2006 Nov 1;54(22):8604-10.
Schauss AG, Wu X, Prior RL, Ou B, Huang D, Owens J, Agarwal A, Jensen GS, Hart AN, Shanbrom E.
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The fruit of Euterpe oleraceae, commonly known as acai, has been demonstrated to exhibit significantly high antioxidant capacity in vitro, especially for superoxide and peroxyl scavenging, and, therefore, may have possible health benefits. In this study, the antioxidant capacities of freeze-dried acai fruit pulp/skin powder (OptiAcai) were evaluated by different assays with various free radical sources. It was found to have exceptional activity against superoxide in the superoxide scavenging (SOD) assay, the highest of any food reported to date against the peroxyl radical as measured by the oxygen radical absorbance capacity assay with fluorescein as the fluorescent probe (ORACFL), and mild activity against both the peroxynitrite and hydroxyl radical by the peroxynitrite averting capacity (NORAC) and hydroxyl radical averting capacity (HORAC) assays, respectively. The SOD of acai was 1614 units/g, an extremely high scavenging capacity for O2*-, by far the highest of any fruit or vegetable tested to date. Total phenolics were also tested as comparison. In the total antioxidant (TAO) assay, antioxidants in acai were differentiated into "slow-acting" and "fast-acting" components. An assay measuring inhibition of reactive oxygen species (ROS) formation in freshly purified human neutrophils showed that antioxidants in acai are able to enter human cells in a fully functional form and to perform an oxygen quenching function at very low doses. Furthermore, other bioactivities related to anti-inflammation and immune functions were also investigated. Acai was found to be a potential cyclooxygenase (COX)-1 and COX-2 inhibitor. It also showed a weak effect on lipopolysaccharide (LPS)-induced nitric oxide but no effect on either lymphocyte proliferation and phagocytic capacity.

Pharmacokinetics of anthocyanins and antioxidant effects after the consumption of anthocyanin-rich acai juice and pulp (Euterpe oleracea Mart.) in human healthy volunteers.

J Agric Food Chem. 2008 Sep 10;56(17):7796-802. Epub 2008 Aug 12.
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The acai berry is the fruit of the acai palm and is traditionally consumed in Brazil but has gained popularity abroad as a food and functional ingredient, yet little information exists on its health effect in humans. This study was performed as an acute four-way crossover clinical trial with acai pulp and clarified acai juice compared to applesauce and a non-

antioxidant beverage as controls. Healthy volunteers (12) were dosed at 7 mL/kg of body weight after a washout phase and overnight fast, and plasma was repeatedly sampled over 12 h and urine over 24 h after consumption. Noncompartmental pharmacokinetic analysis of total anthocyanins quantified as cyanidin-3-O-glucoside showed Cmax values of 2321 and 1138 ng/L at t max times of 2.2 and 2.0 h, and AUC last values of 8568 and 3314 ng h L(-1) for pulp and juice, respectively. Nonlinear mixed effect modeling identified dose volume as a significant predictor of relative oral bioavailability in a negative nonlinear relationship for acai pulp and juice. Plasma antioxidant capacity was significantly increased by the acai pulp and applesauce. Individual increases in plasma antioxidant capacity of up to 2.3- and 3-fold for acai juice and pulp, respectively were observed. The antioxidant capacity in urine, generation of reactive oxygen species, and uric acid concentrations in plasma were not significantly altered by the treatments. Results demonstrate the absorption and antioxidant effects of anthocyanins in acai in plasma in an acute human consumption trial.

Frozen fruit pulp of Euterpe oleraceae Mart. (Acai) prevents hydrogen peroxide-induced damage in the cerebral cortex, cerebellum, and hippocampus of rats.

J Med Food. 2009 Oct;12(5):1084-8.
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Oxidative stress is implicated in several human illnesses, including neurological disorders such as Parkinson's and Alzheimer's diseases. Acai is largely consumed in Brazil and contains high levels of antioxidant compounds. This work aims to study the antioxidant activity of acai frozen fruit pulp in the cerebral cortex, hippocampus, and cerebellum of rats treated with the oxidizing agent hydrogen peroxide (H(2)O(2)). Pretreatment of tissue with acai decreased H(2)O(2)-induced damage of both lipids and proteins in all tissues tested. This fruit was also able to reduce the activities of the antioxidant enzymes superoxide dismutase and catalase to basal levels. We observed a negative correlation between the polyphenol content of acai and the levels of lipid ($r = -0.689$; $P <or= .05$) and protein damage ($r = -0.569$; $P <or= .05$), suggesting the participation of polyphenols in the observed antioxidant activity. These data suggest that acai has a positive contribution in the development of age-related neurodegenerative diseases.

Correlation between antioxidant activity and bioactive compounds of açaí (Euterpe oleracea Mart) comercial pulps

Arch Latinoam Nutr. 2008 Jun;58(2):187-92.
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The purpose of this work was to analyze commercial açaí pulp and to correlate the contribution of vitamin C, total carotenoids and phenolic compounds with the antioxidant

activity of there products besides the examination of the standard related to the quality of the obtained products. Analysis were made with regard to pH, acidity total, soluble solids, sugars, color, water activity, vitamin C, total anthocyanins, total carotenoids, antioxidant activity and phenolic compounds. All parameters analyzed showed significative difference among the marks not added with preservatives and sucrose. The açaí fruit can be considered a fair source of vitamin C and good source of natural antioxidants. In regard to the correlation with the antioxidant activity only the total anthocyanins and the total carotenoids presented positive and significative correlation.

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.

J Agric Food Chem. 2008 Sep 24;56(18):8326-33. Epub 2008 Aug 22.
Jensen GS, Wu X, Patterson KM, Barnes J, Carter SG, Scherwitz L, Beaman R, Endres JR, Schauss AG.
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This study investigated the in vitro and in vivo antioxidant and anti-inflammatory properties of a juice blend (JB), MonaVie Active, containing a mixture of fruits and berries with known antioxidant activity, including acai, a palm fruit, as the predominant ingredient. The phytochemical antioxidants in the JB are primarily in the form of anthocyanins, predominantly cyanidin 3-rutoside, cyanidin 3-diglycoside, and cyanidin 3-glucoside. The cell-based antioxidant protection of erythrocytes (CAP-e) assay demonstrated that antioxidants in the JB penetrated and protected cells from oxidative damage ($p < 0.001$), whereas polymorphonuclear cells showed reduced formation of reactive oxygen species ($p < 0.003$) and reduced migration toward three different pro-inflammatory chemoattractants: fmlp ($p < 0.001$), leukotriene B4 ($p < 0.05$), and IL-8 ($p < 0.03$). A randomized, double-blinded, placebo-controlled, crossover trial with 12 healthy subjects examined the JB's antioxidant activity in vivo. Blood samples at baseline, 1 h, and 2 h following consumption of the JB or placebo were tested for antioxidant capacity using several antioxidant assays and the TBARS assay, a measure of lipid peroxidation. A within subject comparison showed an increase in serum antioxidants at 1 h ($p < 0.03$) and 2 h ($p < 0.015$), as well as inhibition of lipid peroxidation at 2 h ($p < 0.01$) postconsumption.

Comparison of chemical and cell-based antioxidant methods for evaluation of foods and natural products: generating multifaceted data by parallel testing using erythrocytes and polymorphonuclear cells.

J Agric Food Chem. 2008 Sep 24;56(18):8319-25. Epub 2008 Aug 22.
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The objective of this study was to compare three tests frequently used for evaluation of antioxidant potential in natural products: (1) oxygen radical absorbance assay (ORAC), (2) cell-based antioxidant protection in an erythrocyte model (CAP-e), and (3) reactive oxygen species formation in polymorphonuclear cells (ROS PMN). The methods were applied to four natural products, all containing antioxidants capable of entering and protecting cells in the CAP-e assay. The magnitude of this effect was not directly correlated to the ORAC value of each product. Furthermore, the products showed different effects in the ROS PMN assay. Acai provided strong inhibition of ROS formation, indicating anti-inflammatory properties. In contrast, Immunel and EpiCor mildly enhanced ROS formation, suggesting activation of the innate immune response. HA Joint Formula showed a complex, nonlinear dose-response in the ROS PMN assay. This illustrates that complex natural products may have similar antioxidant properties but different effects on human cells. Cell-based antioxidant protection is addressed best in the CAP-e assay, since some natural products contain compounds that may provoke cellular signaling in other cell types. The PMN cell type is a useful model for assessment of overall anti-inflammatory versus immune supportive properties of a product. The sequential use of the three methods serves to bridge analytical and biological testing methods.

Lignans and other constituents of the fruits of Euterpe oleracea (Acai) with antioxidant and cytoprotective activities.

J Agric Food Chem. 2008 Sep 10;56(17):7759-64. Epub 2008 Jul 26.
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Using a hydroxyl radical scavenging assay, bioactivity-guided fractionation of a methanol-soluble extract of the fruits of Euterpe oleracea (acai) led to the isolation of 22 compounds of previously known structure. Altogether, 14 of these isolates were found to be active in an in vitro hydroxyl radical scavenging assay and seven of these isolates in a 1,1-diphenyl-2-picrylhydrazyl radical scavenging assay. Dihydroconiferyl alcohol, (+)-lariciresinol, (+)-pinoresinol, (+)-syringaresinol, and protocatechuic acid methyl ester exhibited cytoprotective activity in cultured MCF-7 cells stressed by H2O2. Lignans have not been previously reported as constituents of this species and were found to be representative of the aryltetrahydronaphthalene, dihydrobenzofuran, furofuran, 8-O-4'-neolignan, and tetrahydrofuran structural types.

Chemical composition, antioxidant properties, and thermal stability of a phytochemical enriched oil from Acai (Euterpe oleracea Mart.).

J Agric Food Chem. 2008 Jun 25;56(12):4631-6. Epub 2008 Jun 4.

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Phenolic compounds present in crude oil extracts from acai fruit (Euterpe oleracea) were identified for the first time. The stability of acai oil that contained three concentrations of phenolics was evaluated under short- and long-term storage for lipid oxidation and phenolic retention impacting antioxidant capacity. Similar to acai fruit itself, acai oil isolates contained phenolic acids such as vanillic acid (1,616 +/- 94 mg/kg), syringic acid (1,073 +/- 62 mg/kg), p-hydroxybenzoic acid (892 +/- 52 mg/kg), protocatechuic acid (630 +/- 36 mg/kg), and ferulic acid (101 +/- 5.9 mg/kg) at highly enriched concentrations in relation to acai pulp as well as (+)-catechin (66.7 +/- 4.8 mg/kg) and numerous procyanidin oligomers (3,102 +/- 130 mg/kg). Phenolic acids experienced up to 16% loss after 10 weeks of storage at 20 or 30 degrees C and up to 33% loss at 40 degrees C. Procyanidin oligomers degraded more extensively (23% at 20 degrees C, 39% at 30 degrees C, and 74% at 40 degrees C), in both high- and low-phenolic acai oils. The hydrophilic antioxidant capacity of acai oil isolates with the highest phenolic concentration was 21.5 +/- 1.7 micromol Trolox equivalents/g, and the total soluble phenolic content was 1252 +/- 11 mg gallic acid equivalents/kg, and each decreased by up to 30 and 40%, respectively, during long-term storage. The short-term heating stability at 150 and 170 degrees C for up to 20 min exhibited only minor losses (<10%) in phenolics and antioxidant capacity. Because of its high phenolic content, the phytochemical-enriched acai oil from acai fruit offers a promising alternative to traditional tropical oils for food, supplements, and cosmetic applications.

Absorption and biological activity of phytochemical-rich extracts from açai (Euterpe oleracea Mart.) pulp and oil in vitro.

J Agric Food Chem. 2008 May 28;56(10):3593-600. Epub 2008 Apr 29.
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Polyphenolic extracts from various fruits and vegetables have been shown to exert growth inhibitory effects in cell culture studies. Whereas individual polyphenolic compounds have been extensively evaluated, understanding of the biological activity of polyphenolic extracts from natural sources is limited and critical to the understanding of their potential effects on the human body. This study investigated the absorption and antiproliferative effects of phytochemical extracts from acai pulp and a polyphenolic-enriched acai oil obtained from the fruit pulp of the acai berry (Euterpe oleracea Mart.). Chemical composition, antioxidant properties, and polyphenolic absorption of phytochemical fractions in a Caco-2 monolayer were determined, along with their cytotoxicity in HT-29 human colon adenocarcinoma cells. Standardized extracts were characterized by their predominance of hydroxybenzoic acids, monomeric flavan-3-ols, and procyanidin dimers and trimers. Polyphenolic mixtures (0-12 microg of gallic acid equiv/mL) from both acai pulp and acai oil extracts inhibited cell proliferation by up to

90.7%, which was accompanied by an increase of up to 2.1-fold in reactive oxygen species. Absorption experiments using a Caco-2 intestinal cell monolayer demonstrated that phenolic acids such as p-hydroxybenzoic, vanillic, syringic, and ferulic acids, in the presence of DMSO, were readily transported from the apical to the basolateral side along with monomeric flavanols such as (+)-catechin and (-)-epicatechin. Results from this study provide further evidence for the bioactive properties of acai polyphenolics and offer new insight on their composition and cellular absorption.

Antioxidant, mutagenic, and antimutagenic activity of frozen fruits.

J Med Food. 2008 Mar;11(1):144-51.
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Many studies have focused on the effect of fresh fruits on the risk of developing cancer and other diseases involved with reactive species and free radicals. The intake of frozen fruits has spread widely in the last years, but, until now, their biological activity is not completely known. In this study, 23 samples of frozen fruits were analyzed for their nutritional composition, total polyphenols, total carotenoids, and vitamin C content. Antioxidant, mutagenic, and antimutagenic effects were also evaluated. Antioxidant assays included 2,2-diphenyl-1-picrylhydrazyl radical (DPPH(.)) scavenging activity and determination of superoxide dismutase (SOD)- and catalase (CAT)-like activities. Mutagenic and antimutagenic evaluations were performed in eukaryotic cells of Saccharomyces cerevisiae yeast. Most samples (74%) showed antioxidant activity similar to vitamin C in the DPPH(.) assay, and this activity was positively correlated ($r = 0.366$; $P <or= .01$) with carotenoid contents. All samples showed CAT-like activity. SOD-like activity was detected in 56% of samples assayed. Only four fruits (acai, cashew apple, kiwi fruit, and strawberry) showed mutagenic activity when tested in high (5%, 10%, and 15% [wt/vol]) concentrations. Twelve samples presented antimutagenic effects against hydrogen peroxide, and this effect was positively correlated with CAT-like activity ($r = 0.400$; $P <or= .01$). Evaluation of polyphenols, carotenoids, and ascorbic acid showed considerable levels of these compounds in frozen fruits, even after freezing. These data suggest that frozen fruits contribute to the prevention of biological damages.

Total oxidant scavenging capacity of Euterpe oleracea Mart. (açaí) seeds and identification of their polyphenolic compounds.

J Agric Food Chem. 2006 Jun 14;54(12):4162-7.
Rodrigues RB, Lichtenthäler R, Zimmermann BF, Papagiannopoulos M, Fabricius H, Marx F, Maia JG, Almeida O.
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The antioxidant capacity of methanol and ethanol seed extracts from Euterpe oleracea Mart. (açaí) against the reactive oxygen species (ROS) peroxyl radicals, peroxynitrite, and hydroxyl radicals was studied with the total oxidant scavenging capacity (TOSC)

assay in a modified and automated version. Cold methanol digestion was the most efficient extraction method with respect to the antioxidant capacity. The extracts exhibit good antioxidant capacity against peroxyl radicals, similar to the capacity of the pulp. The antioxidant capacity against peroxynitrite and hydroxyl radicals is even higher. The main antioxidants identified by HPLC-MS and HPLC-CEAD are five different procyanidins (di- through pentamers); furthermore, protocatechuic acid and epicatechin were identified as minor compounds. Determination of TOSC values of HPLC seed extract fractions indicates that the procyanidins contribute substantially to the overall antioxidant capacity. In addition, however, other compounds that have not yet been identified are responsible for a large part of the observed antioxidant capacity.

Total oxidant scavenging capacities of Euterpe oleracea Mart. (Açaí) fruits.

Int J Food Sci Nutr. 2005 Feb;56(1):53-64.
Lichtenthäler R, Rodrigues RB, Maia JG, Papagiannopoulos M, Fabricius H, Marx F.
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The antioxidant capacities of 11 commercial and non-commercial samples of Euterpe oleracea Mart. (açaí) fruit pulp were studied with the total oxidant scavenging capacity assay in a modified and automated version against three reactive oxygen species. The antioxidant capacities of all purple açaí samples were found to be excellent against peroxyl radicals, good against peroxynitrite and poor against hydroxyl radicals compared with common European fruit and vegetable juices recently analysed. In all cases the correlation between sample concentration and antioxidant capacities was non-linear. The antioxidant capacities against all three reactive oxygen species of the fruit pulp from one white açaí variety were very low. The phenolic compounds in purple açaí fruit pulp were identified by high-performance liquid chromatography-mass spectrometry, and the two major anthocyanins, cyanidin-3-glucoside and cyanidin-3-rutinoside, were quantified by high-performance liquid chromatography-visible spectrometry. The contributions of the anthocyanins to the overall antioxidant capacities of the fruit were estimated to be only approximately 10%. Obviously, compounds not yet identified are responsible for the major part of the antioxidant capacities of the açaí fruit pulp.

Antioxidant activity of dietary fruits, vegetables, and commercial frozen fruit pulps.

J Agric Food Chem. 2005 Apr 20;53(8):2928-35.
Hassimotto NM, Genovese MI, Lajolo FM.
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Fruits, vegetables, and commercial frozen pulps (FP) consumed in the Brazilian diet were analyzed for antioxidant activities using two different methods, one that determines the inhibition of copper-induced peroxidation of liposome and another based on the

inhibition of the co-oxidation of linoleic acid and beta-carotene. The anthocyanin-rich samples showed the highest, concentration-dependent, antioxidant activities in both systems. In the liposome system, at both 10 and 50 microM gallic acid equivalent (GAE) addition levels, the neutral and acidic flavonoids of red cabbage, red lettuce, black bean, mulberry, Gala apple peel, jambolao, acai FP, mulberry FP, and the acidic flavonoids of acerola FP showed the highest antioxidant activities (>85% inhibition). In the beta-carotene bleaching system, the samples cited above plus red guava gave inhibition values >70%. On the other hand, some samples showed pro-oxidant activity in the liposome system coincident with a low antioxidant activity in the beta-carotene system. There was no relationship between total phenolics content, vitamin C, and antioxidant activity, suggesting that the antioxidant activity is a result of a combination of different compounds having synergic and antagonistic effects.

Phytochemical composition and pigment stability of Açai (Euterpe oleracea Mart.).

J Agric Food Chem. 2004 Mar 24;52(6):1539-45.
Del Pozo-Insfran D, Brenes CH, Talcott ST.
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Anthocyanin and polyphenolic compounds present in açai (Euterpe oleracea Mart.) were determined and their respective contribution to the overall antioxidant capacity established. Color stability of açai anthocyanins against hydrogen peroxide (0 and 30 mmol/L) over a range of temperatures (10-30 degrees C) was also determined and compared to common anthocyanin sources. Additionally, stability in a model beverage system was evaluated in the presence of ascorbic acid and naturally occurring polyphenolic cofactors. Cyanidin 3-glucoside (1040 mg/L) was the predominant anthocyanin in açai and correlated to antioxidant content, while 16 other polyphenolics were detected from 4 to 212 mg/L. Red grape anthocyanins were most stable in the presence of hydrogen peroxide, while açai and pigments rich in acylated anthocyanins displayed lower color stability in a temperature-dependent manner. In the presence of ascorbic acid, acylated anthocyanin sources generally had increased color stability. Açai was recognized for its functional properties for use in food and nutraceutical products.