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Original Research Article

Chemical and nutritional analysis of seeds from purple and white açaí (*Euterpe oleracea* Mart.)

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ABSTRACT

Seeds from the purple and the white fruit produced by the Amazonian palm, *Euterpe oleracea* Mart., commonly called "açai", were analyzed by solid state ^{1}H-decoupled ^{13}C CPMAS and MAS NMR, solution NMR and LC–MS/MS. The goal was to distinguish the seeds from each colored fruit and determine their spectra for the first time. The seeds of each variety contained primarily glycosidic carbons, due to their cellulose and hemicellulose content. They also contained carbons due to C═O, C═C, as well as aliphatic carbons. The insoluble fiber found in açaí pulp is distinguishable from the seed of the fruit by its unique solid state ^{1}H-decoupled ^{13}C CPMAS NMR spectra. The seed also contains fats (0.22–0.33%) not previously reported. The seed contains a mixture of saturated and unsaturated fats. There are also 3.38–4.70% total methanolic extractables, with no detectable cyanidin 3-*O*-glucoside or cyanidin 3-*O*-rutinoside, unlike the pulp which contains both cyanidins. When the NMR spectra of the white and purple açaí seeds are compared, it was possible to observe differences between these two açaí varieties, as well as differences between the composition of pulp of the fruit and its seed.

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1. Introduction

Açaí (pronounced ah-sigh-ee) is the common name given to three species of palm trees: *Euterpe edulis* Mart., *E. oleracea* Mart. and *E. precatoria* Mart. (Schauss et al., 2006a; Kang et al., 2012). *E. edulis* is a primary source of heart-of-palm, a popular garnish in salads, while *E. oleracea* and *E. precatoria* are known for the fruit pulp, which has been reported to have the highest hydroxyl radical and superoxide anion scavenging capacity *in vitro* of any fruit, vegetable or nut, as well as pronounced anti-inflammatory activity due to a class of flavones that display both antioxidant and anti-inflammatory bioactivities (Kang et al., 2012; Odendaal and Schauss, 2014; Schauss et al., 2006b; Dupureur et al., 2012).

The dark purple fruits of *E. oleracea* and *E. precatoria* are important sources of nutrition for vast populations that inhabit the Amazon. They contain unsaturated fats (Schauss et al., 2006a; Luo et al., 2012), anthocyanins (Schauss et al., 2006a; Dupureur et al., 2012), non-anthocyanin flavonoids (Dias et al., 2013), vitamins, minerals (Schauss et al., 2006a; Smith et al., 2012a) and dietary fiber (Schauss et al., 2006b; Smith et al., 2012b). The fruit can also appear to be a greenish to yellow color when ripe and display a crème-colored mesocarp, commonly referred to as "white açaí" (Smith et al., 2012a,b). However, relying on the color of the fruit is not the best way to determine which variety of açaí to consume

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(Strudwick and Sobel, 1988; de Oliveira et al., 2000) since there are at least 29 reported genotypes of white açaí (Sanchez and de Oliveira, 2000).

Açaí fruit contains a single light brown seed that accounts for about 85–90% of the diameter of the fruit (1–2 cm) and up to 90% of its weight (0.7–1.9 g). The seeds are covered with a layer of fiber under a thin edible violet pulp (Strudwick and Sobel, 1988; de Oliveira et al., 2000). Initial studies of the seeds reported that they contained cellulose and hemicellulose fiber, protein, minerals, lipids and a limited number of polyphenols (Rodriguez et al., 2006). Also, Aguiar and de Mendonça (2002, 2003) have reported on the morphological and anatomical properties of germinating seeds of *E. precatoria*.

It has been estimated that in the city of Belém, Pará, Brazil, near the mouth of the Amazon River, ~100,000–120,000 tons of açaí fruit is processed annually for domestic consumption and export, which generates ~300 tons of organic waste from the seeds each day (Rogez, 2000; Martins et al., 2009). Only a small portion of the seed waste product is used as feed for pigs, or left to decompose into a potting soil destined for home gardens and as a fertilizer used by plantations (Rodriguez et al., 2006). A small cottage industry has evolved that polishes the seed to create jewelry (bracelets, necklaces, etc.) (Rogez, 2000). However, most seeds simply become organic waste, whose disposal can be expensive for local governments.

Recently, the seed of açaí has received particular attention for its purported bioactivities *in vivo* (de Moura et al., 2011), hence characterization of the seed was performed.

Since açaí seeds have not been approved for human consumption, nor been subject to toxicological studies, it would be useful to distinguish between the composition of açaí pulp found in dietary supplements and beverages (Smith et al., 2012b) and its seed. The objective of this study was to further our understanding of the chemistry of açaí seeds, and provide methods to distinguish the seed from the pulp of the fruit.

2. Materials and methods

2.1. Samples

Purple "upland" variety of açaí fruit was collected in the municipality of São João de Pirabas, state of Pará, Brazil. White açaí fruit was furnished by an açaí pulp producer in the city of Belém,

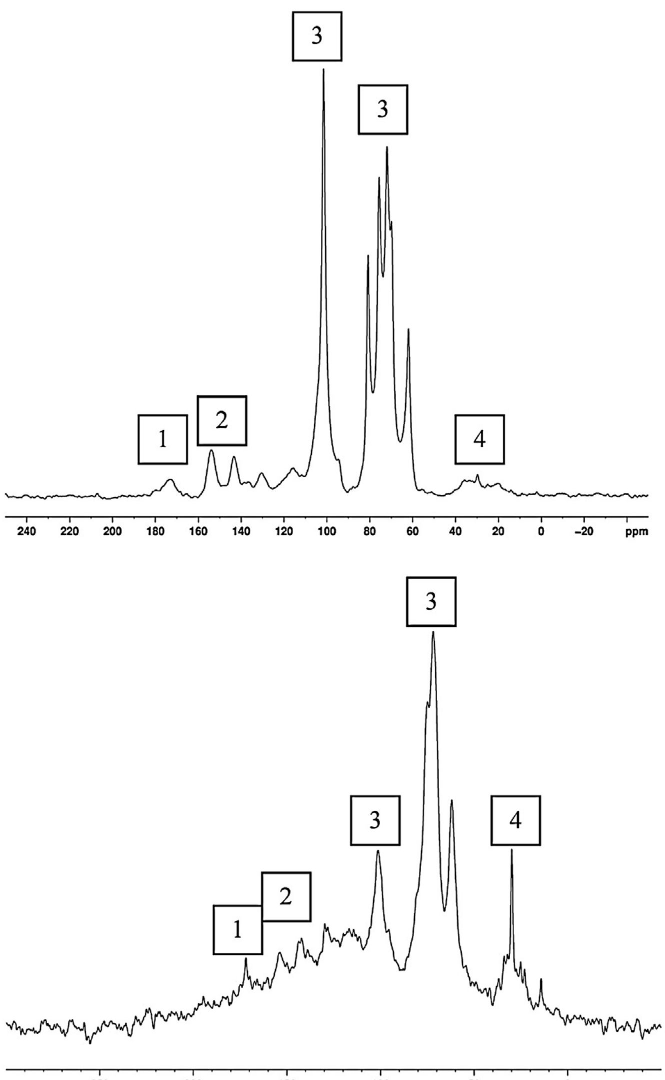

Fig. 1. [1]H-decoupled [13]C CPMAS NMR (top) and MAS NMR (bottom) of seeds from white açaí. Characteristic chemical shift regions are marked by 1 (C=O), 2 (C=C), 3 (glycosidic C–O), and 4 (aliphatic carbons).

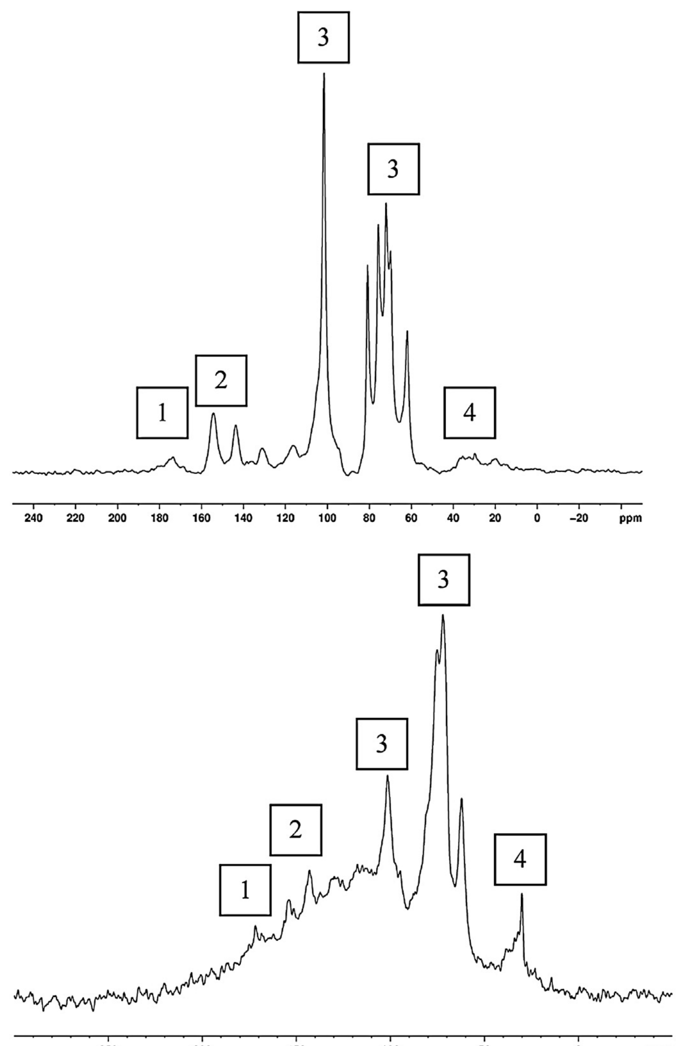

Fig. 2. [1]H-decoupled [13]C CPMAS NMR (top) and MAS NMR (bottom) of seeds from purple açaí. Characteristic chemical shift regions are marked by 1 (C=O), 2 (C=C), 3 (glycosidic C–O), and 4 (aliphatic carbons).