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Isolation and characterization of starch from babassu mesocarp

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ABSTRACT

Despite being rich in starch, babassu mesocarp, a by-product of babassu oil extraction, has only been explored as animal food and biomass. This work aimed to isolate starch from babassu mesocarp by either steeping alkaline (AS) or steeping in water (WS) and to characterize these starches. Compared with the WS method, the AS method provided purer starch (99%) in larger yield (85%), however caused larger loss of total phenolic compounds. The AS starch contained agglomerated starch granules with polymodal particle size distribution, higher swelling power and better solubility as compared to WS starch. The lower amylose content and the higher amylopectin content in the AS starch translated into larger crystallinity and thermal stability. The starches isolate from babassu mesorcap were yellowish or reddish as a result of the presence of phenolic compounds. These starches displayed antioxidant activity. Thus, these starches could be applied as food ingredients or in bioactive film.

1. Introduction

Babassu (*Orbignya* sp.) is a native palm that grows in the northern and northeastern states of Brazil. It is possible to extract oil from babassu kernel, which corresponds to 7% of the babassu fruit weight on average (Soler, 2007; Teixeira, 2008). The kernel oil is the main product obtained from babassu; it has been applied in the oleochemical, cosmetic, biofuel, and food industries (Zylbersztajn et al., 2000). Other babassu fruit parts (epicarp, mesocarp, and endocarp) have considerable potential for coal, tar, fuel gas, starch, and alcohol production (Teixeira, 2008). Babassu mesocarp is a by-product of babassu oil extraction; it is generated during separation of babassu kernel. Drying and milling of babassu mesocarp gives flour, a product that is widely marketed in the state of Maranhão (Brazil). As a substitute for cassava flour, babassu mesocarp flour serves as food for humans and animals (Carneiro et al. 2009). This flour contains 60% starch, but its composition varies as a function of its origin (Cinelli, López, Castilho, Freire, & Castro, 2014). Despite the traditional use of babassu mesocarp flour, the properties of this starch remains little explored.

Starch is an important plant polysaccharide. It constitutes a highly available, inexpensive resource that displays interesting physicochemical properties like biocompatibility, biodegradability, and non-toxicity (Yuliana, Huynh, Ho, Truong, & Ju, 2012). For these reasons, starch has been applied not only in the food industry, but also in the pharmaceutical, biomedical, and polymer industries (Afolabi, Olu-Owolabi, Adebowale, Lawal, & Akintayo, 2012).

Isolation techniques are necessary to obtain pure starch from plant sources. Because most isolation methods affect the properties of the final material, identifying the most suitable isolation technique in terms of starch purity, yield, and properties is essential (Correia & Beirão-da-Costa, 2012).

Commercial starch isolation involves milling or grating, fiber separation, starch suspension in water, centrifugation, purification, dehydration, and drying (Agama-Acevedo et al., 2014; Santos et al. 2013). Some types of starch require additional extraction stages, and countless methods for starch isolation exist. Hence, investigating the best starch isolation procedure for each material is crucial.

Alkaline, acid, or enzymatic methods aid starch release when starch is associated with proteins and fibers. Belhadi, Djabali, Souilah, Yousfi, and Nadjemi (2013) verified that starch isolation from sorghum by the alkaline method and the acid method provides higher extraction yield and purer starch, respectively. In the case of Portuguese chestnut, the alkaline method gives superior starch extraction yield as compared with the enzymatic method (Correia & Beirão-da-Costa, 2012). The properties of pea starch also depend on the employed isolation method (dry milling and acid,

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alkaline, or enzymatic extraction). The pea starch isolated by the alkaline method has higher peak viscosity and higher To, Tp, Tc, and endothermic enthalpy than starch isolated by other methods (Sun, Chu, Xiong, & Si, 2015). Palácios-Fonseca et al. (2013) observed that the method (acid or alkaline) used to isolate starch from corn influences the amylose content, crystallinity, and enthalpy of the starch granules—the alkaline method produces starch granules with low protein and fat content and has increased enthalpy.

Considering that babassu mesocarp remains unexplored in terms of starch isolation, this work aimed to evaluate the effect of different isolation methods including aqueous steeping and alkaline steeping on the physicochemical, functional, and structural properties of babassu mesocarp starch.

2. Material and methods

2.1. Material

Babassu mesocarp flour was provided by the industry "Coopaesp" (Esperantinópolis - Maranhão). This material originated during separation of babassu kernel, used for oil extraction. The babassu mesocarp flour was transported and stored in the laboratory at 10 °C. Sodium hydroxide P.A. was acquired from Sigma–Aldrich (St. Louis, EUA).

2.2. Babassu starch isolation

Two methods were tested for babassu starch isolation: steeping in alkaline pH (AS) and steeping in water (WS), as represented in Fig. 1. For the AS method, babassu mesocarp flour was soaked in NaOH solution at 0.25% (w/v), at a 1:2 ratio (pH 10.0). The resulting mixture was left to stand at 5 °C for 18 h. For the WS method, babassu mesocarp flour was soaked in distilled water only, at 1:2 ratio, and stored at 5 °C for 18 h. Next, the mixture extracted by the AS or the WS method was milled for 2 min in a food processor (Wallita) operating at maximum power. The milled material was filtered through 80-mesh stainless steel sieves. The material retained in the sieves was reprocessed and sieved again four additional times. This step yielded the liquid fraction and the fiber residue. The fiber residue was dried, milled, and sieved (80 mesh) (Fig. 1). As for the resulting liquid, it was centrifuged at 1500 × g and ambient temperature (25 ± 2 °C) for 10 min. The supernatant was discarded, and the precipitate was re-suspended in water, neutralized with HCl 1 M until pH 7.0 (only in the case of the alkaline method), and centrifuged again, twice. The fraction resulting from the centrifugation procedure was dried in air-circulating oven at 40 °C for 6 h. The dry starch was milled and sieved through 80-mesh sieves. The starch obtained by the AS method (the AS starch), the starch obtained by the WS method (the WS starch), and the corresponding fiber residues were stored in sealed dark flasks at 5 °C.

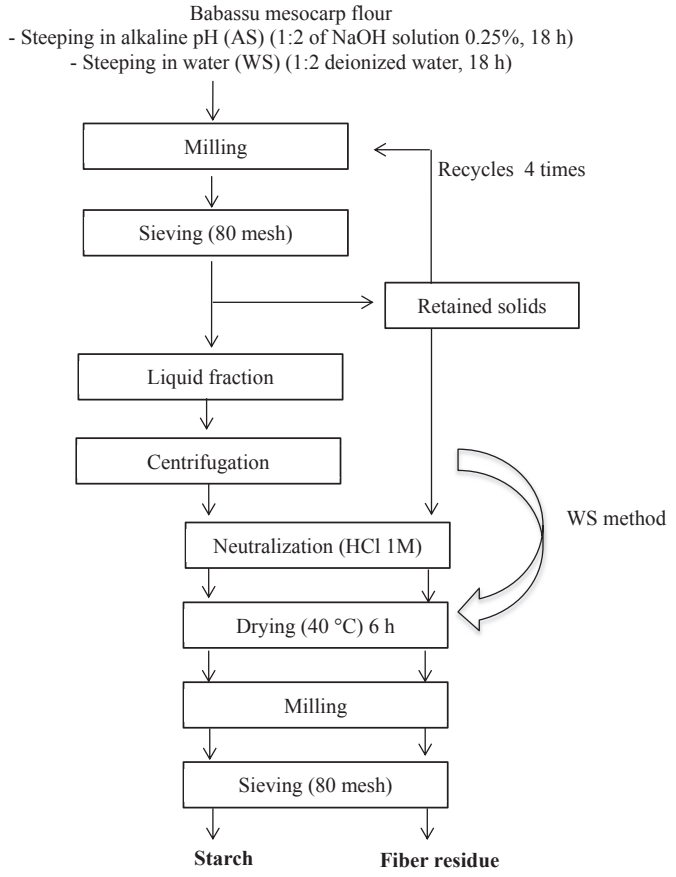

Fig. 1. Procedure employed to isolate babassu starch by steeping in alkaline pH and in water.

2.3. Chemical composition

The moisture, protein, and ash contents of the AS and WS starches and the corresponding fiber residues were obtained according to the methods described by AOAC (1997). The lipid content was determined according to the methodology of Bligh and Dyer (1959). The amylose content was determined by the simplified iodine colorimetric method, according to the methodology proposed by Juliano (1971) and adapted by Martínez and Cuevas, 1989. Holocellulose was estimated with the method described in TAPPI Standard T19m-54 (T19m-54, 1991a). The cellulose content was obtained on the basis of the results achieved for holocellulose (cellulose + hemicellulose). The Klason lignin content was determined by using TAPPI Standard T222 om-22 (T222 om-22, 1991b). All the analyses were accomplished in triplicate. The fibers content was obtained by the sum of soluble and insoluble lignin, hemicellulose and cellulose content.

2.4. Color

The color of the AS and WS starches and the corresponding fiber residues was investigated on a portable colorimeter MiniScan XE (Hunterlab, Riston, Virgínia, EUA) according to the Hunterlab method (Hunterlab, 1997). Color was expressed as color difference (ΔE^*).

To determine the color, the CIElab scale coordinates (L, a, b) were obtained. The lightness parameter L^* ($L^* = 0$ black and $L^* = 100$ white) and the chromaticity parameters a^* ($+a^*$ = red and $-a^*$ = green) and b^* ($+b^*$ = yellow and $-b^*$ = blue) were recorded.

Measurements were conducted in triplicate. ΔE^* was calculated on the basis of Equation (1):

$$\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}, \quad (1)$$

where ΔL^*, Δa^*, and Δb^* are the differences between the L^*, a^*, and b^* parameters of the samples and of the white standard (for which $L^* = 93.49$, $a^* = -0.77$, and $b^* = 1.40$), respectively.

2.5. Antioxidant activity

The antioxidant activity of the AS and WS starches and the corresponding fiber residues was measured by DPPH (Martins,