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Characterization of some properties of starches isolated from *Xanthosoma sagittifolium* (*tannia*) and *Colocassia esculenta* (*taro*)

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Abstract

In this study, moisture, ash, amylose, phosphorous content, and the gelatinization profiles of starches isolated from *Colocasia esculenta* (*taro*), and *Xanthosoma sagitifolium* (*tannia*) storage organs were evaluated. The gelatinization profile and the changes in the heat flow or enthalpy during the gelatinization process were evaluated by DSC methodology. The phosphorous and amylose content were also analyzed by a colorimetric method. The results show that the amylose content of the starch isolated from *Xanthosoma sagittifolium* is higher than those shown by *Colocasia esculenta* and *Manihot esculenta* Crantz starches. The phosphorous content was higher in *Xanthosoma sagittifolium* than *Colocasia esculenta* or the commercial *Manihot esculenta* C. starches. The gelatinization profile range is wider in *Manihot esculenta C.* than the other two starches. Differences in these parameters may affect the functional properties of the products formulated with these starches. The most significant relationship between parameters was found between the amylose and gelatinization profile and enthalpic change and ash.

Keywords: Aroid's starches; Starch properties; Starches from *Xanthosoma sagittifolium* and *Colocassia esculenta*

1. Introduction

Most tropical plants produce underground storage organs classified as roots or modified stems or tubers, examples of plants that produce tubers as storage organs are *Xanthosoma sagittifolium* (tannia, yautia, ocumo criollo) and *Colocasia esculenta* (taro, ocumo chino). The tubers of this tropical plants belonging to the family *Araceae*, store a high starch concentration that ranges between 22 and 40% (Agbor Egbe & Rickard, 1990; Delpeuch, Favier, & Charbonniere, 1978; INN, 1999; Montaldo, 1992; Treche & Guion, 1980a,b), and for this reason, they are considered carbohydrate foods (Swinkels, 1985). They are not extensively commercialized at present, but are mostly grown in domestic gardens or 'conucos' in South America.

Improvements in agronomic techniques and utilization of modern genetic techniques may allow these tubers to be cultured and commercialized extensively. In addition, these tubers are widely consumed in tropical areas and may resolve starvation problems elsewhere.

However, they have a short shelf life because of their high moisture content. One of the best ways to preserve them may be by processing them to obtain flour and/or starches. Starches obtained from theses tubers have never been commercialized because their properties are unknown. Since the transformation into starch will decrease losses after the tubers have been harvested, value added processes such as wet milling may be useful in order to obtain starches from these tubers. It is, therefore, clear that a significant amount of work remains to be done on the functional characteristics of flours and native, as well as modified tropical starches if they are ever to become competitive with commercial starches such as corn, wheat, and potato (Satin, 1999). Before consideration is given to tubers as potential

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sources of starch to produce foods, it is necessary to characterize their chemical composition, physical, physicochemical, and functional properties.

Limitations for the use of this research are dependent upon agricultural developments of these crops. There are numerous factors that are related to these limitations such as: lack of interest in these cultures; especially crops of *Xanthosoma sagittifolium* and *Colocasia esculenta*, the climate and growing condition requirements of these crops, and unavailable information related to these crops.

The aim of this study is to characterize and compare the native starches isolated from *Xanthosoma sagittifolium* and *Colocasia esculenta*.

2. Material and methods

2.1. Material

2.1.1. Samples

Three batches of clean tubers of *Xanthosoma sagittifolium* and *Colocasia esculenta* were obtained from a local market. Commercial *Manihot esculenta* Crantz, starch obtained from Alfonzo Rivas C.A, Cagua, Venezuela was used as control.

Starches of *Xanthosoma sagittifolium* and *Colocasia esculenta*, were obtained from three different batches of the tubers, following the method described by Pérez, Bahnasey, and Breene (1993), with some modification. The cleaned tubers were peeled, weighed, sliced and ground for 2 min at high speed in a waring blender with small volumes of distilled water. The homogenate was passed through an 80-mesh sieve. This grinding and screening operation was repeated four more times. The resulting slurry was passed consecutively through a 200- and 270-mesh sieve and centrifuged at 1500 rpm for 20 min. After removing the mucilaginous layer, the sediment was washed several times by suspension in distilled water and centrifuging until it appeared to be free of non-starch material. The sediment was then dried in an oven at 45 °C. The *Xanthosoma sagittifolium* and *Colocasia esculenta* dried starches were blended, passed through a 60-mesh sieve, and stored at room temperature in sealed plastic bags.

2.2. Methods

2.2.1. Chemical properties

Starches isolated from the three batches of each kind of tuber were analyzed for moisture, ash, crude protein ($N\times$ 6.25%) fatty material, crude fiber and total sugar contents as a percentage (w/w), following methods described in AOAC (2000), AACC (2000), and Whistler (1964). Phosphorous content, as a percentage (w/w), was determined following the photometric method as described by AOAC (2000). The amylose content was determined using the colorimetric method described by McGrance, Cornell, and Rix (1998). The standard curve was established using pure potato amylose: A0512 Sigma Type III.

Yield of the starch obtained from each batch was calculated using the equation = % yield = (wt of starch isolated/wt of edible portion of the tuber) $\times$ 100. Purity was calculated from the difference between 100 and percent of moisture, crude protein, fatty material and ash content following the equation: % purity = (100 − [% moisture + % crude protein + % fatty materials + % ash + % total sugars]).

2.2.2. Rheological properties

2.2.2.1. Brabender viscoamylograph analyses. Pasting properties were determined with the Brabender viscoamylograph (7% of concentration) by the method described in AACC (2000), and the breakdown, setback, and consistency indices were calculated from the corresponding plots. Values were expressed in Brabender Units (BU) following parameters as were described by Mazur, Schoch, and Kite (1957) and Merca and Juliano (1981).

2.2.2.2. Differential scanning calorimetry (DSC) analyses. DSC analyses were performed on a Perkin Elmer, Norwalk Differential Scanning Calorimeter Mod. DSC-4 following the procedure described by Pérez, Breene, and Bahnassey (1998a). A 200 mg (db) starch of known moisture content was weighed accurately; water was added and thoroughly mixed with the appropriate quantity of distilled water to give a starch:water ratio of 1:2. Measured portion of each sample was withdrawn and dispensed into weighed DSC sample pans. Each sample pan was hermetically sealed and stored for 1 h before testing. A sample pan was placed in the DSC sample cell and a sealed pan filled with 50 μl of water was placed in the reference cell. Temperature was raised from 25 to 160 °C at a rate of 15 °C/min and kept at this temperature for 2 min. The temperature was then decreased from 160 to 25 °C at the rate of 5 °C/min. Enthalpic data were collected during the cycle. The gelatinization profile analyzed by this method describes the change of enthalpy for the sample for the first, middle, and end points of the peak over the isotherm region. Thermal transition was defined in terms of T_o (onset) T_p (peak) and T_e (endpoint gelatinization temperature). Enthalpy value ($\Delta H/g$) was calculated from the endotherm plots (Biliaderis, 1983; Davis, 1998; Pérez et al., 1998a).

2.3. Microscopy

2.3.1. Scanning electron microscopy

Granular shape and size and distribution granular were studied by scanning electron microscopy (SEM). Starch was sprinkled onto double-sided adhesive tapes, attached to circular specimen stubs, coated with 200 A of pt/palladium using a Hitachi E 102 Ion Sputter, examined at 20.0 kV, and photographed in a Hitachi S 2400 scanning electron microscope. Starch granule diameter range was estimated