NOTE

NONWHEAT GRAINS AND PRODUCTS

Isolation and Characterization of Starch from Amaranth Flour[1]

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ABSTRACT

A simple procedure for isolation of amaranth starch uses commercial amaranth flour as starting material. Flour is stirred in 0.25% sodium hydroxide solution, and the starch is isolated by screening and centrifugation with water washing. Granules remain well-formed, with a low content of protein and fat. In comparison, a commercial sample had higher protein and fat content, which may account for the existence of the starch "popcorn balls" formed of granules cemented together in a unique spherical shape.

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A simple process was developed for the production of amaranth starch from amaranth flour that is easier than isolation from seeds. Amaranth, an ancient crop of Mexico, Central, and South America, is resistant to drought, hot climate, and pests (Paredes-Lopez et al 1988). The seeds contain ~67% of uniform starch granules. Also, amaranth starch granules are only a micron in diameter and therefore have a very large surface area per unit of weight compared to that of most other starches, which suggests a wide variety of possible applications.

Separating amaranth starch from amaranth protein is somewhat difficult because of the easy binding between the two components. Amaranth starch has been isolated from amaranth seed with a 0.15% sulfur dioxide solution (Yanez and Walker 1986), using a steeping time of 24 hr at 52°C. The preparation of rice starch (Juliano 1984) was described using a 0.25% sodium hydroxide solution for 24 hr at 25°C. Lim et al (1992) showed that oat starch can be obtained from oat flour with sodium hydroxide or calcium hydroxide. Mistry et al (1992) applied the alkali extraction method to corn flour, using a steeping time of 30 min at 55°C.

The main amaranth species are *Amaranthus cruentus, A. caudatus*, and *A. hypochondriacus* (NRC 1984). Saunders and Becker (1984) reported that starch content of amaranth ranges from 48 to 69%, depending on the species. Starch is mainly stored in the perisperm (Okuno and Sakaguchi 1981).

In the present work, a process is used that simplifies the mechanical handling of starch for protein elimination and for isolation of clean starch with acceptable commercial properties.

MATERIALS AND METHODS

Starch Isolation

Commercial grade amaranth flour with 15.0% protein, 64% carbohydrate, 6.0% fat, 12.0% moisture, 10.0% total dietary fiber, and 3.0% ash, as determined by standard methods (AACC 1983), was obtained from Amaranth Resources, Inc.

A slurry of amaranth flour (100 g) in 600 ml of 0.25% sodium hydroxide solution was mixed in a Waring Blendor (Dynamics Corp. of America, New Hartford, CT) for 6 min at 25°C, then filtered through a 200-mesh screen and washed with limited water. The filtrate was centrifuged (300 × *g*, 6 min). The supernatant containing the starch was decanted and centrifuged (1,000 × *g*, 10 min), then the supernatant was discarded. The starch cake surface was washed with sufficient water to remove the cloudy solution on the surface of the starch. Residual starch was then slurried in water (600 ml) and centrifuged (1,000 × *g*, 20 min) to remove any remaining salt. The starch cake was then broken up, dried in an oven at 100°C, and ground with mild shear into a fine powder.

In another preparation, the final wet starch cake was suspended in a 95% ethanol solution and filtered on a cintered glass funnel. Before air could be drawn through the starch cake, the funnel was covered with a latex sheet, which prevented moisture condensation on the starch. The alcohol-impregnated starch was then dried over calcium chloride under vacuum. The product was a fine, white fluffy powder that was allowed to equilibrate in air at 25°C. It contained 0.34% protein and 0.06% fat.

Amylograph

Starch from the ethanol-isolated and air-equilibrated preparation was suspended in distilled water at 10% concentration and measured in a Brabender Viscoamylograph (Fig. 1).

Scanning Electron Micrograph

Scanning electron micrographs were taken with a JEOL JSM-840 scanning electron microscope (Tokyo, Japan). Starch samples were sprinkled on adhesive tapes, attached to specimen studs, and coated with gold-palladium.

RESULTS AND DISCUSSION

Isolation of starch from amaranth flour poses some difficulty because protein and fine fiber can be sedimented with starch as

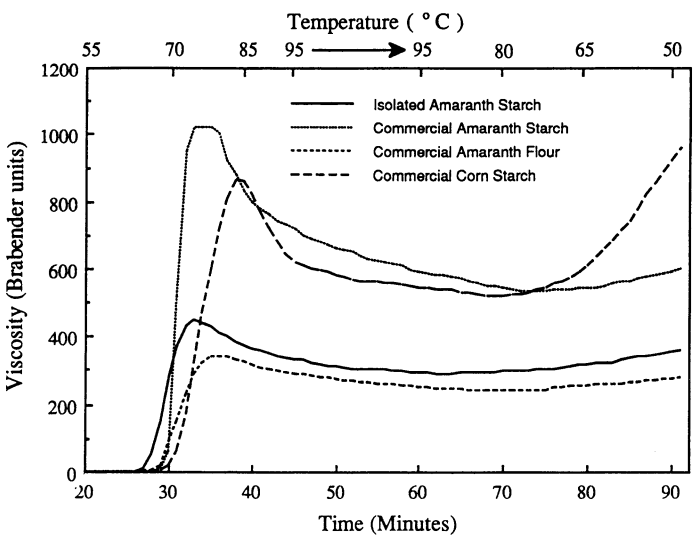

Fig. 1. Viscoamylograph pasting curves for 10% (w/v) slurries of different starches and flours.

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TABLE I
Properties of the Amaranth Samples

Sample	Property (dry basis)			
	Protein, %	Fat, %	Color	Texture
Amaranth starch	0.34	0.06	White	Fine
Commercial amaranth starch	2.58	0.43	Lt. yellow	Coarse
Commercial amaranth flour	15.0	6.0	Yellow	Coarse

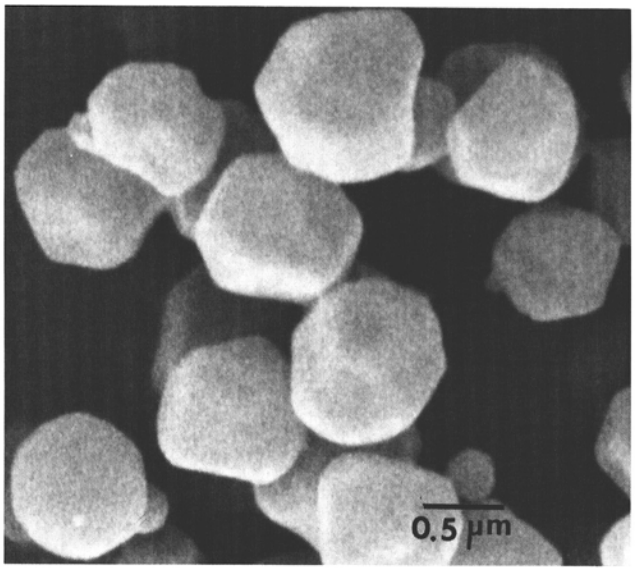

Fig. 2. Scanning electron micrograph of amaranth starch from flour (20,000X).

a brown layer. In the present work, low-speed centrifugation was used to precipitate protein and fine fiber from a starch slurry. Other workers have suggested scraping the gluten from the starch several times (Yanez et al 1986, Perez et al 1993). However, an initial low-gravity centrifugation separated the major amount of protein, so that when the supernatant was centrifuged at higher gravity, starch settled with only mild contamination of the starch cake top. This could be rather easily removed by a mild wash with water to give a starch recovery of 50.3%. Some of the properties of the isolated starch, along with those of commercial amaranth starch and flour, are shown in Table I.

Pasting properties of amaranth starch are also shown in Table I. The peak viscosity (Fig. 1) of the 10% commercial amaranth starch dispersion was more than 1,000 BU (probably due to the high protein content), but it decreased by 600 BU on raising the temperature to 77°C and during the holding period at 95°C. The starch granules may have separated from the observed popcorn ball structure.

An electron photomicrograph of the starch granules is shown in Figure 2. In a commercial preparation of high-protein content, these polygonal granules of commercial amaranth starch are cemented together and formed into popcorn balls of a unique spherical shape; this was also seen in impure rice starch. The electron microphotographs of the commercial amaranth starch at magnification of 5,000× is shown in Figure 3. The higher protein and fat content may account for the existence of popcorn ball morphology.

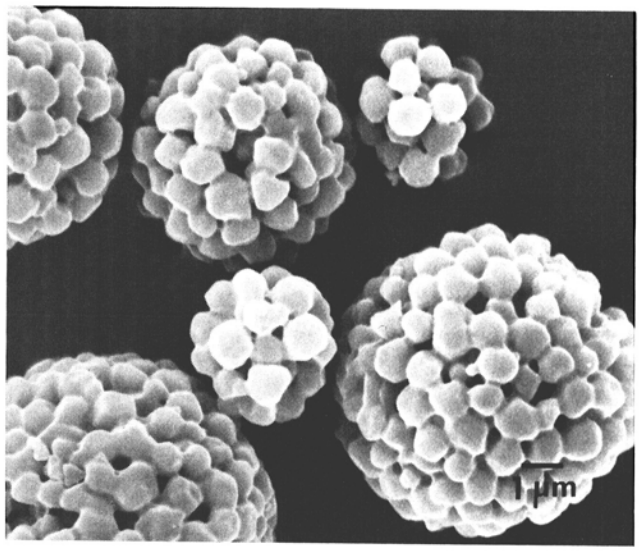

Fig. 3. Scanning electron micrograph of amaranth starch granules reveals "popcorn" balls formed of granules cemented together in a unique spherical shape. (5,000X).

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