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FULL LENGTH ARTICLE

Comparative study of the physico-chemical properties of rice and corn starches grown in Indian temperate climate

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Abstract Starches isolated from the rice (Jhelum and Kohsar) and corn (PS-43 and Shalimar-maize) cultivars were studied for their physico-chemical and morphological properties. Physico-chemical properties such as composition, water and oil absorption capacity, swelling power, syneresis, freeze–thaw stability and light transmittance showed significant differences among the starches. Amylose contents of starches separated from the Jhelum and Kohsar rice cultivars and PS-43 and Shalimar-maize corn cultivars were 6.33%, 4.90%, 7.52% and 8.09%, respectively. The granular size varied from 5.2 to 5.9 μm for rice starches and 11.4–12.0 μm for corn starches. Transmittance value of gelatinized pastes from all starches progressively decreased up to the 2nd day during refrigerated storage, except Kohsar rice starch which lost its clarity significantly up to 3rd day of storage. The pasting property revealed peak, breakdown and setback viscosity which were in the range of 2479–3021 cP, 962–1713 cP and 1293–2003 cP respectively.

1. Introduction

Cereals belong to the family Poaceae (formerly Gramineae). They are particularly important to humans because they are staple food crops in many areas of the world (Pomeranz and Munck, 1981). Cereal grains provide about 50% of the daily calories ingested by people throughout the world. The most extensively cultivated grains are wheat, rice, corn or maize, barley, oats, rye and millets. Among the cereals grown in Kashmir province of India, rice and maize are the most important. They are main source of carbohydrate to the Kashmiri people. India is the second largest producer of rice in the world with a production of 143.96 million metric tonnes–MMT (FAO, 2010). India also has the privilege of being the 7th largest producer of maize in the world, with a production of 14.06 MMT (FAO, 2010).

Starch is the major dietary source of carbohydrates and is the most abundant storage polysaccharide in plants. Amylose and amylopectin are two macromolecular components of starch granules (Be Miller, 2007). Isolated starch is used in the food industry to impart functional properties, modify food

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texture, consistency and so on. Not only is the amount of starch important for the texture of a given product, but also the type of starch is critical (Biliaderis, 1991).

Starch from rice is non-allergenic, because of the hypoallergenicity of the associated protein. Rice starch granule being very small in size provides a texture perception similar to that of fat (Champagne, 1996). Corn starch occupies an important place in the preparation of pies, puddings, salad dressings and confections. It is incorporated into cakes, cookies, icings and fillings to increase moisture retention, retard crystal growth of other sugars and to improve tenderness and keeping quality. Recent uses of starch include their use as delivery vehicles that protect pharmaceutically active proteins from digestion (Guan et al., 2000), such as microencapsules for small molecules (Korus et al., 2003) and biodegradable films (Rindlav-Westling et al., 2002).

The present study was undertaken to investigate and compare the physico-chemical properties of newly released indigenous cultivars of rice (Jhelum, Kohsar) and corn (PS-43, Shalimar maize) to predict their promising applications in food and allied industries.

2. Materials and methods

2.1. Materials

The rice (paddy) and the corn (maize) varieties were procured from the Shere Kashmir University of Agricultural Sciences and Technology, Shalimar, Srinagar, India. Rice cultivars viz. Jhelum and Kohsar were dehusked by laboratory dehusker (Ambala Associates, Ambala, India) and then polished using laboratory polisher (Ambala Associates, Ambala, India) and stored at room temperature (20 °C). The corn grains were separated manually from cobs and stored until further use at 20 °C. All reagents used in this study were of analytical grade.

2.2. Methods

2.2.1. Starch isolation

Starch was isolated from the samples by the method of Wani et al. (2010). One kilogram of the sample was soaked in 4 L of distilled water and kept at 4 °C for 12 h. Coats of the seeds were removed by manual abrasion. The cotyledons were pulverized along with water for 5 min in a mixer blender. The slurry obtained was then diluted to ten times (volume/volume) with distilled water and the pH was adjusted to 10 using 0.5 M NaOH. The slurry was continuously mixed on magnetic stirrer for one hour, and then filtered through a 75 μm mesh sieve to separate the fiber. The filtered slurry was then centrifuged at 3000*g* for 30 min at 10 °C (C-24, Remi Industries Mumbai, India). The aqueous phase obtained on centrifugation was collected for the recovery of proteins, whereas the sediment obtained was scraped off from the surface and the lower white portion was washed three times with distilled water and allowed to sediment at refrigerated temperature (4 °C). This sediment was recovered as starch. The starch was dried at 40 °C in a hot air oven (NSW-143, Narang Scientific Works Pvt. Ltd., New Delhi, India).

2.2.2. Composition

Protein (920.87), fat (920.85), crude fiber (978.10), ash (923.03), and moisture (925.10) contents were determined according to standard methods of AOAC (1990).

2.2.3. Amylose content

Apparent amylose content of the starch samples was determined by the method of Williams et al. (1970).

2.2.4. Color

The color of the starch was determined using a color flex spectrocolorimeter (Hunter Lab Colorimeter D-25, Hunter Associates Laboratory, Ruston, USA) after being standardized using Hunter Lab Color standards and their Hunter '*L*' (lightness), '*a*' (redness to greenness) and '*b*' (yellowness to blueness) values were measured.

2.2.5. Water absorption capacity (WAC) and oil absorption capacity (OAC)

Starch (2.5 g dry weight basis db) was mixed with 20 mL distilled water/oil (Dalda-Andheri (E), Mumbai) in a preweighted centrifuge tube and then stirred for 2 min on vortex mixer and allowed it to stand for 30 min at 25 °C, centrifuged at 3000*g* for 10 min at 25 °C (Eppendorf 5810 R, Germany) and the supernatant was decanted. Gain in weight was expressed as water/oil absorption capacity (Sofi et al., 2013).

2.2.6. Swelling & solubility index

Swelling power and solubility of the starches were determined using 2% db (w/v) aqueous suspension of starch at 90 °C according to the method of Nwokocha and Williams (2009).

2.2.7. Bulk density

Bulk density was determined using mass/volume relation according to the method of Wani et al. (2013a,b).

2.2.8. Light transmittance or gel clarity

This was determined by the method of Wani et al. (2010) using an UV-spectrophotometer (U-2900, Hitachi, Tokyo, Japan).

2.2.9. Syneresis

Starch suspensions (2%, w/w db) were heated at 90 °C for 30 min in a water bath (SWB-10L-1-Taiwan) with constant stirring. The starch samples in separate tubes were stored for 1, 2, 3, 4 and 5 days at 4 °C. Syneresis was measured as percentage amount of water released after centrifugation at 3000*g* for 10 min (Eppendorf 5810 R, Germany).

2.2.10. Freeze–thaw stability

Freeze–thaw stability was determined by the method of Hoover and Ratnayake (2002).

2.2.11. Scanning electron microscopy

The starch granules were placed on an adhesive tape attached to a circular aluminum specimen stub. After coating vertically with gold–palladium, the samples were photographed at an accelerator potential of 5 kV using a scanning electron microscope (Hitachi S-300H-Tokyo, Japan).