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Research Article

Functional Characteristics of Starches from Indian Sweet Potato Cultivars

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ABSTRACT

In this study, properties of starches extracted from the three Indian varieties of sweet potatoes, Shri-Bhadra, PT-23 and Kanchengad were compared. Varieties have influence on starch properties which helps in selection of the variety according to specific application. The starch yield ranged from 30.96% to 39.26%, in which, Kanchengad starch recorded highest amylose content (36.06%). The sweet potato varieties differed significantly with functional properties. Shri-Bhadra starch possessed superior values with highest water absorption capacity (0.89 ml/g), oil absorption capacity (0.82 ml/g), paste clarity (0.55%), sediment volume (2.15 ml) and bulk density (0.57 g/m^3) among all the compared cultivars. Results obtained revealed that moisture, ash, protein and fat contents showed no significant difference. The study concluded that different varieties varied in starch yield, functional properties and color values but exhibited similar chemical properties.

Key words: *Purple sweet potato varieties; Functional characteristics; Chemical composition*

INTRODUCTION

Starch is the fundamental carbohydrate in plants which is cost-effective and nutritionally significant[21]. It can be obtained from many vegetable sources such as corn, wheat, potato, foxtail, rice, etc[7]. Starch granules consists of linear amylose and branched amylopectin polymers. It has minor amounts of lipid, protein, ash and fiber. Tuber crops such as yam, tapioca and sweet potatoes endure as underexploited sources of starches for the industries worldwide[12]. Most often, starch is extracted from tubers through the process of rasping, sieving and centrifugation[6]. The properties of starch are mainly dependent on its extraction process and highly dependent on the source[11].

Sweet potato (*Ipomea batatas*) is a dicotyledonous plant that belongs to the family of Convolvulaceae[15]. It is essentially the most important root crops worldwide and remarkably easy to manage and cultivate[9].

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According to FAO stat, sweet potato ranks as the third most important starchy food, after cassava and potato in the world. In recent times, sweet potato is gaining focus in research due to its unique nutritional and functional properties[23]. Starch is one of the prime components in the root of sweet potato, which is predominantly used as a food ingredient into bakery products, extruded products, ketchup, instant soups, custards, puddings, etc[24]. Depending on the color of the peel and flesh, sweet potato can be classified into white, yellow, orange and purple one[4]. So far, most studies have focused on starches from white, yellow and orange sweet potatoes[13]. Purple sweet potato, a peculiar cultivar of sweet potato, contains huge amount of starch and anthocyanins[17]. However, studies on starch isolated from purple sweet potato are very minimal. Few studies have manifested that the structural, physicochemical and functional properties of starch are closely associated to the genotype and growing condition of purple sweet potato[18]. However, whether the structural, physicochemical or functional properties of starch reverted by the variety of purple sweet potato is still unexplained.

In the present investigation, the properties of starches from three purple sweet potato varieties, Shri Bhadra, PT-23 and Kanchengad were determined and compared accordingly.

MATERIAL AND METHODS

2.1.Materials:

Three kinds of purple sweet potatoes of *Shri-Bhadra*, *PT-23* and *Kanchengad* varieties were used in this study. These materials were obtained from Central Tuber Crop Research Institute, Trivandrum, India. All the chemicals and reagents were of analytical grade.

2.2.Starch Isolation:

Starch isolation was carried out according to the method of Senanayake *et al.*[16]. Sweet potatoes were sorted and washed thoroughly. The cleaned tubers were then diced and reduced in size using meat grinder. The ground tubers were then homogenized with water (1:3 w/v) and filtered using muslin cloth. The residue was repeatedly homogenized and filtered for 3 times. The suspension was allowed to settle without disturbance throught the night. The supernatant was then discarded and the settled starch was washed thoroughly with water about 3 times. The purified starch was then dried at 50°C for 24 h, pulverised and packed for analysis.

2.3.Water and Oil absorption capacity:

Water and oil absorption capacity were measured using method of Babu *et al.*,[2]. About 1 g of sample was suspended into each tube containing 5ml of water and oil. The respective suspensions were then mixed well in vortex mixer for a min at room temperature and centrifuged at 3000 x g for 10min. The supernatant was then carefully removed and weighed. Following formula was used to calculate the water and oil absorption capacity:

$$\text{WAC/OAC} = \frac{\text{Mass of water/oil added} - \text{Mass of water/oil removed}}{\text{Mass of starch sample}}$$

2.4.Paste clarity:

Paste Clarity (PC) was measured according to the method of Bhandari & Singhal[3]. Starch (500m, db) was suspended in distilled water (5ml) in a glass-stoppered tube and heated at 95°C for 30min in shaking water-bath. After cooling, the starch clarity was measured on a spectrophotometer at 650nm against water blank.

2.5.Bulk Density:

Bulk density of starch particles were determined following method of Iheagwara[10]. About 10g of starch (dry basis) was weighed and put into 100 mL of graduated cylinder. Bulk density was calculated using the following formula:

$$\text{Bulk density} = \frac{\text{Mass of the starch}}{\text{Volume occcupied by starch}}$$

2.6. Sediment volume:

The method of Tessler[19] was employed. About 1g of starch was mixed with 95ml of distilled water. The pH of the starch slurry was adjusted to pH 7.0 using NaOH/HCl. The slurry was then heated for 15min in boiling water-bath. Total weight was made upto 100g using distilled water. The starch slurry was transferred to a 100ml graduated cylinder and was sealed.

The starch slurry was left to settle at room temperature for 24hrs and the volume of sediment consisting of starch granules was determined.

2.7. Chemical analysis of sweet potato starch

Moisture Content (MC) and Dry Matter (DM) were determined by the method of Adebayo *et al.* Ash, Crude Protein and Crude Fat contents were determined according to AOAC. pH was determined according to the method of Benesi.

2.8. Amylose content:

The amylose content was estimated by following method of Hoover & Ratnayake[8]. 0.2 g of sample was taken in 100ml volumetric flask and dissolved in 8mL of 90% DMSO. The slurry was vigorously mixed for 20min and made up to volume to 25mL. About 1mL of diluted solution was taken out and mixed with deionised water then placed in a water bath at 90°C for 10min. The vials were left to cool at room temperature and then made up to 25mL volume. The diluted solution (1mL) was taken out and mixed with deionised water (40mL) and iodine solution (5mL). The volume of the mixture was adjusted to a final value of 50mL. Then the solution was allowed to stand for at least 15min and read at absorbance of 600nm using UV-VIS spectrophotometer. A standard curve of amylose was plotted to determine amylose content of starch samples.

RESULTS AND DISCUSSION

Starches were isolated from three different varieties of purple sweet potatoes (*Shri-Bhadra*, *PT-23* and *Kanchengad*) and were compared for their starch yield. *Shri-Bhadra* variety yielded the greatest amount of starch (39.26%) followed by Kanchengad (34.72%) and *PT-23* (30.96%). The results given in Table 1 represent the functional properties of sweet potato starches extracted from the three varieties. Water Absorption Capacity (WAC) of sweet potato starches were in the range of 0.61 -0.89 ml/g. WAC is associated to the interactive forces within the starch components, weaker interactive forces leads to higher WAC[14]. It is an important processing parameter that imputes the viscosity of the starches. OAC of sweet potato starch ranged from 0.58-0.82 ml/g but it was higher than the OAC (0.15ml/g) of sweet potato starch as reported by Chibuzo[5]. It could be due to higher hydrophobic tendency than hydrophilic tendency of extracted starches. Paste clarity of starch is due to the influences of the color and shine. The paste clarity was observed to be highest (0.55%) in *Shri-Bhadra* variety and lowest (0.34%) in *PT-23* of sweet potato starch. This might be attributed to a significantly lower content of amylose than other two varieties. The paste clarity of *PT-23* is almost similar to the sweet potato starch of 0.33% as per reports of Salwa *et al.,*[15]. Significant differences were observed in functional properties such as water absorption capacity, oil absorption capacity and paste clarity among the three starches. This could be due to the differences in morphology and genetic structure of the varieties.

Table 1: Functional properties of starches from three different sweet potato varieties

Starches	WAC (ml/g)	OAC (ml/g)	Paste Clarity (%)	Bulk-Density (g/m3)	Sediment volume (ml)
Shri Bhadra	**0.89±0.02a**	**0.82±0.25a**	**0.55±0.03a**	**0.57±1.19a**	**2.15±0.09a**
PT-23	**0.61±0.05b**	**0.58±1.03b**	**0.34±1.22b**	**0.51±0.85b**	**1.80±1.00b**
Kanchengad	**0.82±1.01c**	**0.73±0.87c**	**0.47±0.80c**	**0.53±0.64c**	**1.97±0.49c**

Values with different letters within same column differ significantly ($p<0.05$)

Bulk density determines the particle size, which is an indication of porosity of the product. The bulk density of *Shri-Bhadra* starch was found to be higher (0.57 g/m^3) with *PT-23* having the least value (0.51 g/m^3). Similar result was obtained by Iheagwara[10] for native sweet potato starch.

Sediment volume is a measure of starch gelatinization and imparts a clear distinction in wide range of precooked products. It stipulates the changes in starch molecular association during the different modification process. Also, it contemplates the degree of cross linking in starch[25]. The sediment volume of *Shri-Bhadra* (2.15 ml) and *Kanchengad* (1.97 ml) starches were significantly higher compared to *PT-23* (1.80 ml). The sediment volume differed significantly among the starches of different varieties. Iheagwara[10] reported a sediment volume of 1.97ml in native sweet potato starch.

Table 2: Chemical composition of starches from three differentsweet potato varieties

Parameters	Shri Bhadra	PT-23	Kanchengad
Moisture	14.23±1.18a	14.82±2.07b	14.47±0.96a
Dry matter	83.51±0.07a	82.94±1.80b	83.01±2.21c
Ash	0.34±0.06a	0.33±1.47b	0.33±2.60b
Protein	0.12±0.83a	0.11±1.23b	0.11±0.08b
Fat	0.05±0.01a	0.06±0.68b	0.05±0.04a
pH	4.48±0.91a	5.02±0.06b	5.19±0.30c
Amylose	33.05±0.26a	30.47±1.09b	36.06±0.97c

Values with different letters within same row differ significantly ($p<0.05$)

Chemical composition of the sweet potato starches are presented in Table 2. Moisture content was found to be lower (14.23) in *Shri-bhadra* starch and higher in *PT-23* starch (14.82). This was within the range of 10-20% that was on par with the results of Babu & Parimalavalli[1], Babu *et al.,*[2]. Dry matter of starches was in the range of 82.94-83.51 % and this was closer to the report of[1]. Ash content of sweet potato starches ranged from 0.33 to 0.34% and similar value is reported in literature[1,22]. A significant difference was observed in pH (4.48-5.19) of the starch samples and this result is in agreement with Tsakama *et al.,*[22]. Protein content ranged from 0.11% to 0.12%. Fat content was found to be 0.05% for *Shri-Bhadra* starch, 0.05% for Kanchengad starch and highest (0.07%) in PT-23 starches and these results are on par with[20].Amylose content affects the intrinsic quality and application of starch and it was observed to be highest (36.06%) in Kanchengad starch and lowest in PT-23 (30.47%) starches.

CONCLUSION

The highest yield of starch was obtained from the variety '*Shri-Bhadra'*. Results of this study revealed that starch content, functional properties, amylose content of starches were immensely governed by the variety of the sweet potato. However, the starches from these varieties exhibited similar chemical properties. *Shri-bhadra* variety's starch that ranked highest in functional properties could be used as an ideal ingredient in high viscous foods as thickening and binding agent. *Kanchengad* starch that possessed higher amylose content can also be utilized with various food products. This study helps to link novel facts on the properties of starches from different sweet potato varieties.

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