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Physicochemical Properties of Starches of Sweet Potato (*Ipomea batata*) and Red Cocoyam (*Colocasia esculenta*) Cormels

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Abstract: Starches of sweet potato *(Ipomea batata)* and red cocoyam (*Colocasia esculenta*) cormels were extracted by milling and their proximate compositions, physicochemical properties and pasting properties were analyzed. The starch of sweet potato was observed to possess higher percentage values of crude protein, crude fibre and carbohydrates by difference than that of red cocoyam cormels whereas an opposite trend was observed in terms of their percentage ash content and moisture content. Their fat contents were significantly similar ($p < 0.05$). The results of the physicochemical properties, including bulk density, water absorption capacity, amylose and amylopectin contents, swelling power and solubility of the starch samples were significantly different ($p < 0.05$). These properties were found to be influenced by their varying contents of amylose and amylopectin. The results of pasting properties revealed that the paste of sweet potato exhibited higher value of viscosity (405.92 RVU) at lower pasting time (4.37 minutes) than the starch of red cocoyam with paste viscosity of (244.33 RVU) obtained at 4.99 minutes.

Key words: Starch, amylose, amylopectin, pasting properties

INTRODUCTION

Sweet potato and red cocoyam are tropical tubers that store edible material in subterranean roots, corms or tubers (Oke, 1967). They mainly consist of starch, which is the only qualitatively important digestible polysaccharides being regarded a nutritionally superior to low molecular carbohydrate or sugars (Malcolm, 1990). Starch occurs widely in nature and is the most commonly used (Whistler and Paschall, 1965,1967), owing partly to its various native and modified forms and partly to its low relative cost (Whistler *et al.,* 1984).

Starch is an important ingredient in food and non-food industries (such as paper, plastic, adhesive, textile and pharmaceutical industries). Tuber processing is aimed at obtaining products that are stable in terms of longitivity, nutrition and palatability (Greenwill, 1947).

The pasting properties of the starches of corms and cormels of cocoyam (*Colocasia esculenta*) cultivars have been studied, revealing that the starches of both cultivars have better pasting behaviours that their corresponding corms in terms of paste viscosity, retrogradation and paste stability (Oladebeye *et al.,* 2006).

This paper focuses on comparing the proximate compositions, some selected physicochemical properties and pasting behaviours of starches extracted from sweet potato (*Ipomoea batata*) and red cocoyam (*Colocasia esculenta*) cormels with the view to suggesting their possible industrial uses.

MATERIALS AND METHODS

Sample preparation: The tubers of sweet potato (*Ipomea batata*) and red cocoyam cormels (*Colocasia esculenta*) were purchased at Oja-Oba market, Akure, Nigeria. The starches of the tubers were extracted by first washing with water, peeling, slicing, rewashing and grating to obtain the pulp, which was sieved through muslin bag. The filtrate (starch milk) was allowed to stand for sometime for the starch to settle before decanting the supernatant to obtain wet starch cake. The wet starch cakes of the samples were sun dried, ground into fine powder, packaged into transparent polyethylene bags and labelled prior to analysis.

The crude protein, crude fibre, moisture and ash contents of the starch samples were determined using the method of AOAC (1990). The method described by Pearson *et al.* (1981) was used for fat content analysis. Carbohydrate was obtained by difference 100%-(moisture + protein + fat + ash + fibre) %. The pH was measured using the method described by AOAC (1990). The method described by Wang and Kinsella (1976) was used for bulk density determination. The water absorption capacity was determined as reported by Akintayo (1999). The method reported by Song and Jane (2000) was used for amylose and amylopectin contents analysis. The solubility and swelling power were carried out using the methods described by Leech *et al.* (1959). A Rapid Visco-Analyzer (Model: 3-D, Newport Scientific, Australia, 1995) with Thermocline for windows software was used to evaluate of the pasting properties of the starch samples. Viscogram profile/pasting curves show the relationship between time, viscosity and temperature during cooking processes. Test runs were conducted following standard profile 1 which included 1 min of mixing, stirring and warming up to 50°C, 3 min and 42 sec of heating at 12°C/min up to 95°C, 2.5 min of holding at 95°C, 3 min and 48 sec of cooling down to 50°C, at the same rate as the heating (12°C/min) and 2 min holding at 50°C, where the process ended after 13 minutes (Deffenbaugh and Walker, 1989). Starch gelatinization (pasting) curves were recorded on RVA and viscosity was expressed in terms of Rapid Visco Units (RVU), which is equivalent to 10 centipoises.

RESULTS AND DISCUSSION

Table 1 contains the results of proximate compositions of the starches of sweet potato (*Ipomea batata)* and red cocoyam cormels (*Colocasia esculenta*). Lower moisture content of sweet potato (8.72±0.03%) than that of red cocoyam cormel starch suggests higher microbial resistance by the former than the latter. In terms of percentage crude protein, crude fibre and carbohydrates by difference, the starch of sweet potato exhibits higher values than the starch of red cocoyam cormels. Sweet potato has been identified as a significant source of dietary fibre (Collins and Walter, 1982) and evidence suggesting that increased fibre consumption may contribute to the reduction in the incidence of certain diseases such as diabetes, coronary heart disease, colon cancer and various digestive disorders has been reported (Augustin *et al.,* 1978). The two starches are significantly similar ($p < 0.05$) in terms of fat content while the starch of red cocoyam has higher ash content (1.98±0.02%) than that of sweet potato (1.64±0.01).

From Table 2, the bulk density of the granules of sweet potato starch (0.76±0.01) is slightly higher than that of red cocoyam cormel starch (0.74±0.01). Bulk density is a function of particle size; particle size is inversely proportional to bulk density. Higher value bulk density of sweet potato suggests its suitability as drug binder and disintegrant in pharmaceuticals. Likewise, the starch of sweet potato is outstanding in terms of water absorption capacity and amylose content compared to the starch of red cocoyam cormels. The differences in amylose and amylopectin contents contribute to significant differences in the starch properties and functionality (Thomas and Atwell, 1999). The swelling power obtained in red cocoyam starch (10.78±0.04g/g) is higher than that of sweet potato (10.23±0.02). The same trend is observed for the values of solubility (%) obtained for the two starches. Tester and Karkalas, (1996) and Zeleznak and Hoseney (1987) have reported that the amylose acts both as diluents and inhibitor of swelling, especially in the presence of lipids which can form insoluble complexes with some of the amylose during swelling and gelatinization. The starch molecules are held

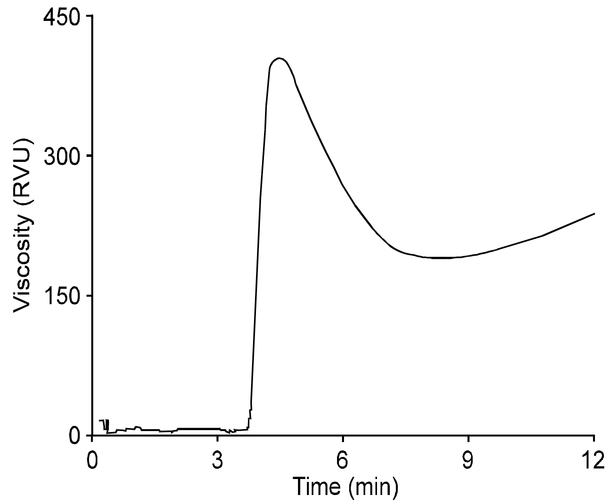

Fig. 1: RVA Pasting Curve of Sweet Potato Starch

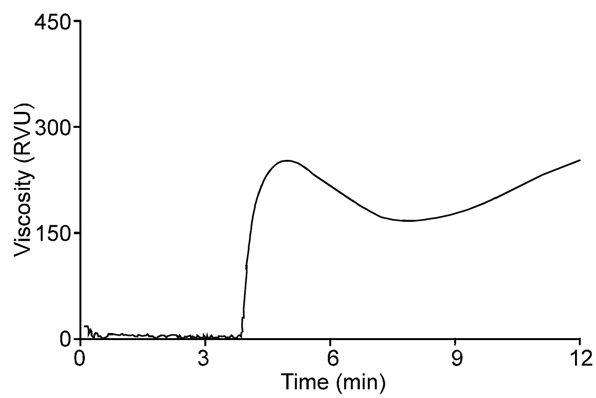

Fig. 2: RVA Pasting Curve of Red Cocoyam Cormels Starch

together by hydrogen bonding in the form of crystalline bundles, called micelles. Thus, swelling power and solubility patterns of starches have been used to provide evidence for associative binding force within the granules (Leach *et al.,* 1959).

In spite of higher pasting time (mins) obtained for the starch of red cocoyam (4.99±0.01), it possesses lower viscosity (244.33±0.01 RVU) than sweet potato starch (405.92±0.01 RVU) (Table 3). The starch paste of sweet potato possesses appreciably higher value of stability at 61.60°C than that of red cocoyam. Retrogradation is an index of texture and acceptability of starch-containing products; it is responsible for staling of bread, a cake not risen well, cream separated, running pastes and glue due to low values of viscosity (Alais *et al.,* 1999). The two starch samples show inverse relationship between their values of retrogradation and paste stability. Figures 1 and 2 show the RVA pasting curves of the starches of sweet potato and red cocoyam cormels.

Table 1: Proximate Compositions of the Starch Samples

Sample	Moisture Content (%)	Crude Protein (%)	Ash Content (%)	Fat Content (%)	Crude Fibre (%)	Carbohydrates by Difference (%)
Sweet Potato	8.72±0.03[a]	1.63±0.01[b]	1.64±0.01[a]	0.39±0.01[a]	0.75±0.02[b]	86.90±0.03[b]
Red Cocoyam Cormels	9.02±0.07[b]	1.41±0.01[a]	1.98±0.02[b]	0.40±0.01[ab]	0.50±0.01[a]	86.69±0.10[a]

Results are the means of triplicate determinations±standard deviation. Means with different superscripts in the same column are significantly different ($p < 0.05$).

Table 2: Selected Physicochemical Properties of the Starch Samples

	Bulk	Water Absorption		Amylose	Amylopectin	Swelling
Sample	Density (g/ml)	Capacity (%)	Content (%)	Content (%)	Power (g/g)	Solubility (%)
Sweet Potato	0.76±0.01[b]	84.91±0.02[b]	19.20±0.02[b]	80.80±0.03[a]	10.23±0.02[a]	8.16±0.02[a]
Red Cocoyam Cormels	0.74±0.01[a]	82.74±0.03[a]	18.93±0.05[a]	81.07±0.04[b]	10.78±0.04[b]	8.65±0.02[b]

Results are the means of triplicate determinations±standard deviation. Means with different superscripts in the same column are significantly different ($p < 0.05$).

Table 3: Pasting Properties of the Starch Samples

Sample	Pasting Time (mins)	Gel. Temp. (0C)	Viscosity (RVU)	Retrogradation (RVU)	Stability (RVU)
Sweet Potato	4.37±0.01[a]	61.60±0.01[b]	405.92±0.01[b]	47.17±0.01[a]	220.33±0.01[b]
Red Cocoyam Cormels	4.99±0.01[b]	61.25±0.01[a]	244.33±0.01[a]	86.83±0.01[b]	86.00±0.01[a]

Results are the means of triplicate determinations±standard deviation. Means with different superscripts in the same column are significantly different ($p < 0.05$).

Conclusion: The protein contribution of sweet potato can be maximized if supplemented with legumes and cereals. The starch of sweet potato has higher priority standing as alternative binders and disintegrants in table formulation than the starch of red cocoyam cormels owing to their appreciably high values of swelling power, bulk density and viscosity.

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