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CHARACTERIZATIONOF STARCHES FROM RED COCOYAM (*Colocasia esculenta*) and WHITE COCOYAM (*Colocasia antiquorum*) CORMELS

K . N. Awokoya[a*], B.A. Moronkola[b] and O.O. Tovide[b]

[a]Department of Chemical Sciences,Olabisi Onabanjo University,P.M.B 2002, Ago Iwoye, Nigeria.

*Corresponding E-mail address: awokoyakehinde@yahoo.com

ABSTRACT

Starches of red cocoyam (*Colocasia esculenta*) and white cocoyam (*Colocasia antiquorium*) were isolated and their proximate compositions, physicochemical properties and pasting properties were analysed. Ash, moisture and amylose contents of red cocoyam were found to be higher than that of white cocoyam and their protein contents were significantly similar. No pronounced difference was observed between the X- ray pattern of red cocoyam and white cocoyam starch samples, and the samples gave the characteristic B pattern of tuber starches. Scanning electron microscopy revealed that starch granules has shell and ellipsoid shapes with heterogeneous sizes.The range of granules were 20 to 150 μm in width and 30 to 180 μm in height. Studies on the functional properties also revealed that both swelling capacity and solubility increased with temperature increase.

Key words: Cocoyam starch; amylose; Physicochemical properties.

1. INTRODUCTION

Starch is one of the most used food ingredients worldwide due to its diverse functionalities, year-round availability, and low cost(Thomas *et al*.,1999). The source of starch varies all over the world and it depends on the tradition and prevalent climatic conditions. The main sources of starch are cereal grain (corn, wheat,and rice (tapioca and sweet potato), and tubers (potato and cocoyam). This diversity of sources of starch is reflected in their properties and functionalties. (Wurzburg,1986). The high carbohydrate content of cocoyam and its degree of availability makes it a very good source of starch for both domestic and industrial uses in tropical Africa.

Starch is an important ingredient in food and non-food industries (such as paper, plastic, adhesive, textile, agrochemical and pharmaceutical industries). 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).

The objective of this research focuses on comparing the proximate compositions, some selected physicochemical properties and pasting behaviours of starches extracted from red cocoyam (*Colocasia esculenta*) and white cocoyam (*Colocasia antiquorium*) cormels with the view to suggesting their possible industrial uses.

2. MATERIALS AND METHODS

2.1 MATERIALS

The tubers of red cocoyam (*Colocasia esculenta*) and white cocoyam (*Colocasia antiquorum*) cormels were purchased from a local market in Ogun State, Nigeria.

All reagents used in this work were of analytical grade.

2.2 STARCH EXTRACTION FROM COCOYAM

The method employed for starch isolation is outlined in Fig. 1.

Peeled cocoyam (15Kg) was washed thoroughly and used for starch extraction.The starch obtained was air dried for 48h at 30^{0}C, after which it was ground to fine powder using a mortar and pestle, and then sieved.

2.3 PROXIMATE ANALYSIS

Standard Association of Official Analytical Chemistry methods AOAC (1984), were adopted for estimating moisture, ash, protein and amylose content.

PHYSICOCHEMICAL PROPERTIES

3.1 WIDE-ANGLE X-RAY DIFFRACTION OF STARCH GRANULES

X-ray diffraction measurement of the powder samples were performed on the MD–10 minidiffractometer at Center for Energy Research and Development (CERD), Obafemi Awolowo University Ile – Ife, Nigeria.

The powder sample was ground manually, sieved and loaded in glass capillaries (sample cuvette) of 0.3mm diameter. A photon wavelength of 1.54Å was used. The scanning region of the diffraction angle (2θ) was from 16^0 to 70^0.

3.2 STARCH GRANULE MORPHOLOGY

To determine the granule morphology of the red and white cocoyam starches, each starch granule were taken and dusted onto a carbon sticker, then coated with gold using a sputter coater (Balzers Union, FL- 9496) for 30 min. Images were recorded using INCAPentaFET × 3 SEM fitted with Oxford ISIS EDS.

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3.3 EFFECT OF TEMPERATURE ON SWELLING POWER AND SOLUBILITY

Effect of temperature on swelling power and solubility was evaluated using the method of Leach. McCowen and Scoch (Leach et al., 1959). 1.0g of starch sample was accurately weighed and quantitatively transferred into a clean dried test tube and weighed (W_1). The starch was then dispersed in 10ml of distilled water.

The resultant slurry was heated at 50^0C, 60^0C, 70^0C, 80^0C and 90^0C respectively for 30min in water bath. The mixture was cooled and centrifuged at 500rpm for 15min. Approximately 5mL of the supernatant were dried to a constant weight at 110^0C. The residue obtained after drying the supernatant represented the amount of starch solubilized in water. Swelling power was calculated as g per g of starch on dry weight basis.

The residue obtained from the above experiment (after centrifugal) with water it retained was quantitatively transferred to the clean dried test tube used earlier and weighed (W_2).

$$\text{Swelling of starch} = \frac{W2-W1}{Weight\ of\ starch} \qquad 1$$

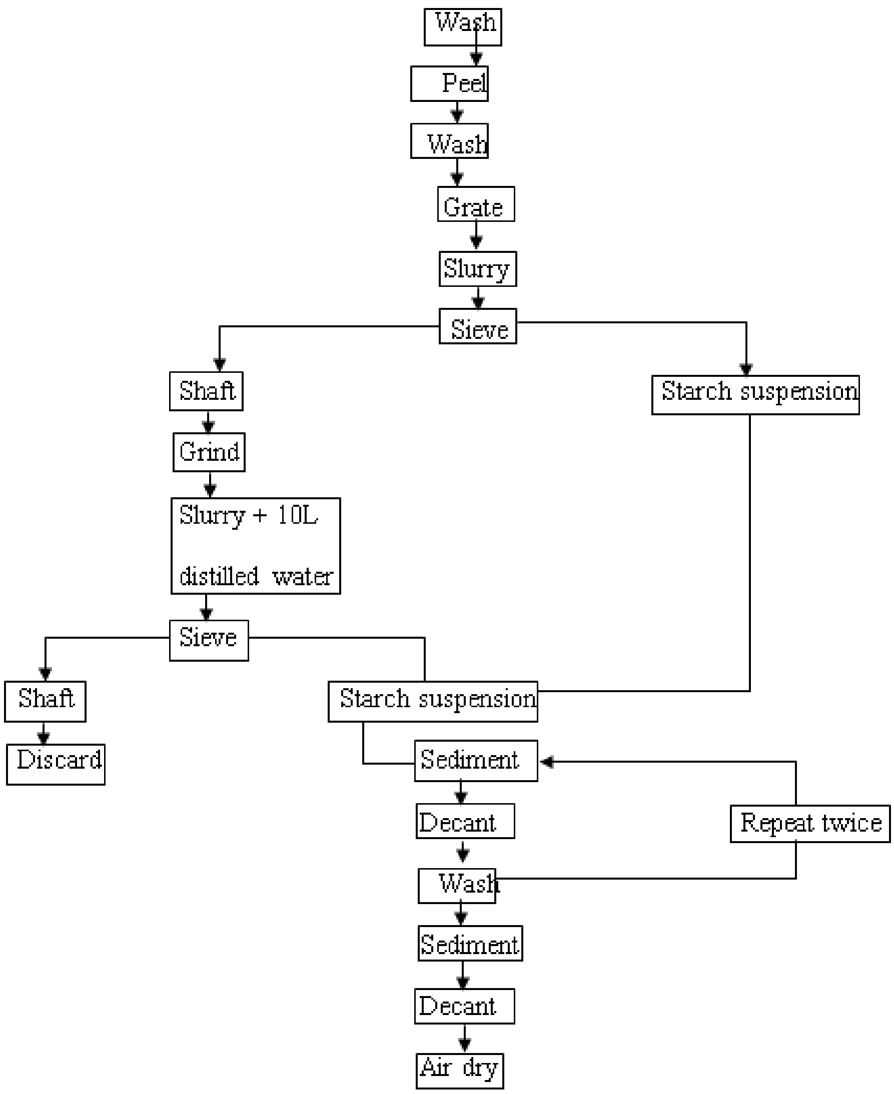


Fig 1: Schematic diagram for extraction of both red and white cocoyam (colocasia antiquorum).

3. RESULTS AND DISCUSSION

3.1 PROXIMATE ANALYSIS

The results of the proximate analysis of red and white cocoyam starch presented in Table 1. Lower moisture content of white cocoyam (9.03±0.04) than that of red cocoyam cormel starch suggests higher microbial resistance by the former than the latter (Marichamy *et al*., 2011). The two starches are significantly similar in terms of protein content while the starch of red cocoyam has higher ash content (2.01±0.03) than that of sweet potato (1.87±0.02). The difference in amylose contents contribute to significant differences in the starch properties and functionality (Thomas and Atwell, 1999).

3.2 SWELLING POWER AND SOLUBILITY

Result of the effect of temperature on swelling power and solubility presented in Figure 2 and 3, respectively.The results indicate that both swelling power and solubility were temperature dependent, and values increased with increase in temperature for both starches (Kaith *et al*., 2010). It is also reasonable that as the temperature of the medium increases, starch molecules become more thermodynamically activated, and the resulting increase in granular mobility enhances penetration of water which facilitates improved swelling capacities. Similar observations have been reported earlier for starches of rice (Liu *et al*., 1999).

3.3 WIDE-ANGLE X-RAY DIFFRACTION OF STARCH GRANULES.

The wide angle X-ray diffraction of red cocoyam and white cocoyam starches is presented in Figure 4, and 5 respectively.

The diffractogram of the native starch is the B-type, typical of tuber starches. Generally, tuber starches have been shown to exhibit a 'B' type X-ray pattern having diffraction peaks at 5.5-5.6^0 14.1^0,16.0^0, 17.0^0, 19.7^0, and 24^0 2θangles. 'A' type starches mainly cereals exhibit reflections at 15.3^0, 17.0^0, 18.0^0, 20.0^0 and 23.4^0 2θangles (Buleon et al.,1998).

All the samples gave the characteristic 'B' pattern of cocoyam starch with strong peaks at 16.13^0, 16.28^0, 16.35^0, 17.22^0, 17.43^0, 17.44^0 and 19.880, 2θ.

No pronounced difference was observed between the X-ray pattern of the red and white cocoyam starches.

3.4 GRANULE MORPHOLOGY

Scanning electron microscopy was used to investigate the granule morphology of the red and white cocoyam starches (Figure 6). Studies revealed that the native cocoyam starch has shell and ellipsoid shapes with sizes ranging from 20 to 150 μm in width and 30 to 180 μm in height.

Table 1: Proximate compositionof the starch samples

Sample	% M. C	% Ash	% Protein	% Amylose content
Red cocoyam cormel	10.02±0.08	2.01±0.03	0.64±0.02	84.08±0.06
White cocoyam cormel	9.03±0.04	1.87±0.02	0.65±0.01	83.06±0.04

Means within columns with different letter are significantly different {$p< 0.05$}

All values are means of triplicate determinations + or – standard deviation.

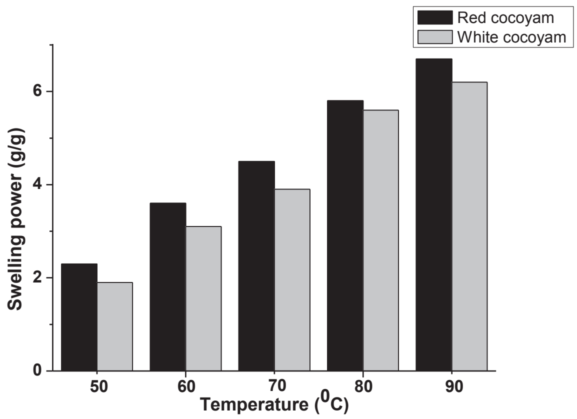


Fig 2: Effect of temperature on swelling power of red and white starch cocoyam.

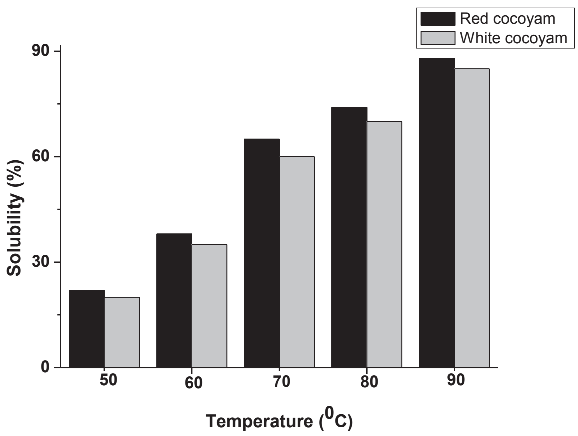


Fig 3: Effect of temperature on solubility of red and white starch cocoyam.

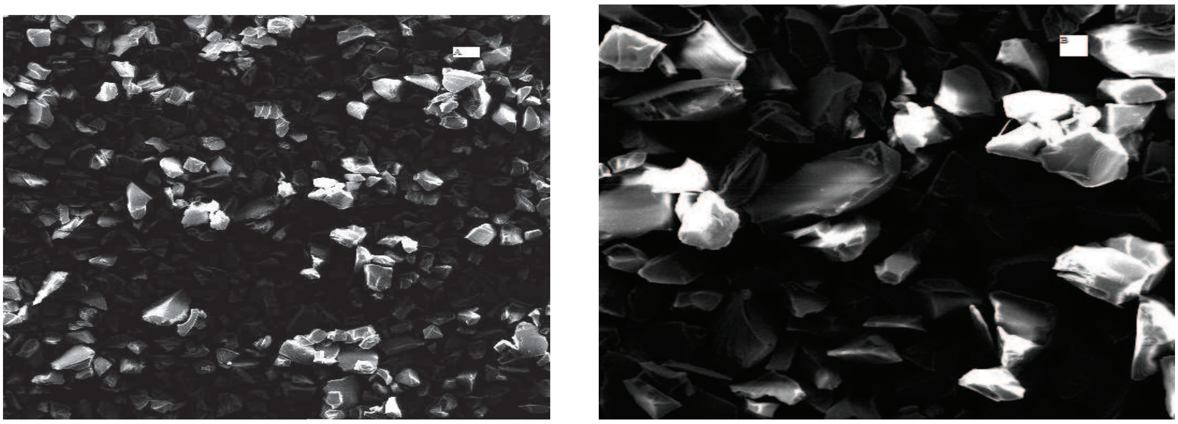
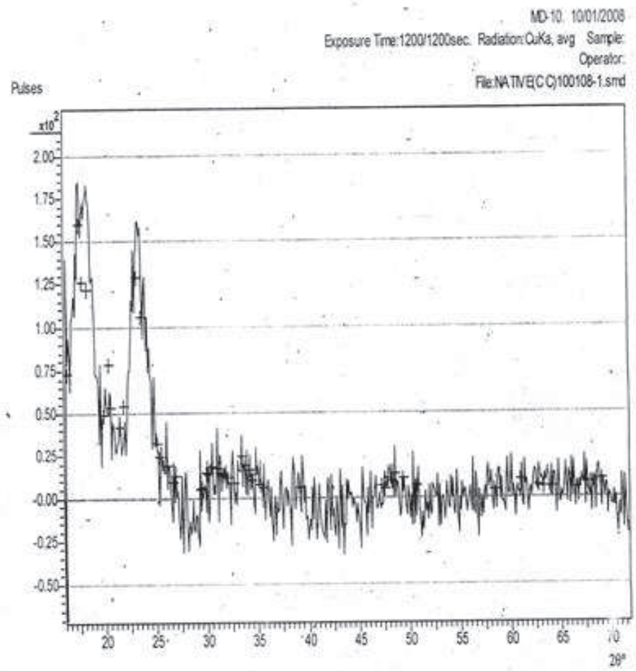
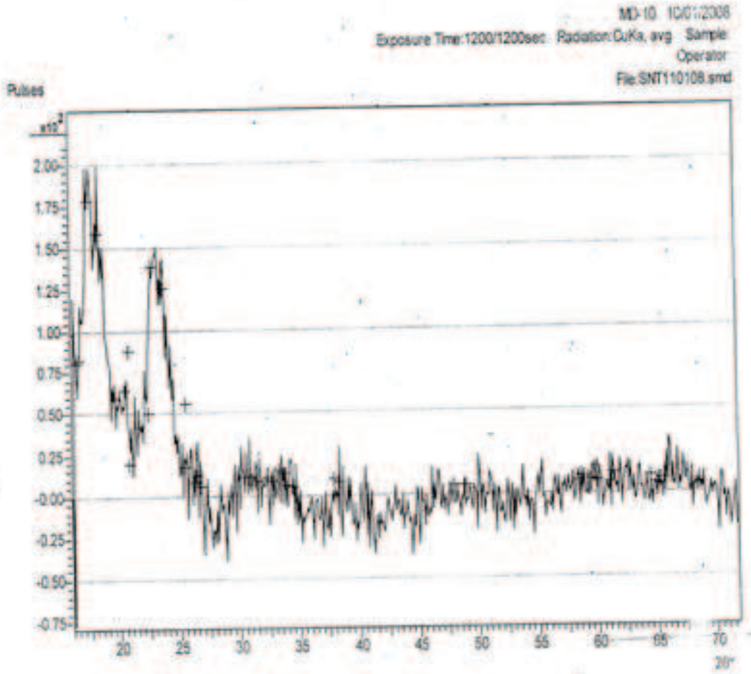


Fig. 6 **(A)** The scanning electron micrographs of red cocoyam starch. **(B)** white cocoyam starch.



2θ°	d	I int	I max	I rel	I corr	FWHM
16.28	5.44286	-151	-10.2	-3.3	-3.5	0.1973
17.43	5.08686	4606	78.4	100.0	100.0	0.78497
18.29	4.85122	490	39.9	10.6	10.2	0.1645
17.81	4.98140	3197	45.1	69.4	68.2	0.94723
19.88	4.46551	-124	-34.7	-2.7	-2.4	0.047804
20.34	4.36688	-273	-5.8	-5.9	-5.3	0.62496
20.60	4.31075	-873	-30.1	-19.0	-16.8	0.38826
21.45	4.14180	-614	-42.2	-13.3	-11.5	0.19421

FIG. 4



	2θ°	d	I int	Imax	Irel	Icorr	FWHM
	16.35	5.42150	17	7.6	0.2	0.3	.028587
	16.54	5.36040	480	10.3	6.4	7.4	0.62506
	17.44	5.08446	6787	105.4	90.0	100.0	0.66055
	18.31	4.84437	5692	86.7	75.5	80.6	0.67715
	19.56	4.53908	-514	-14.0	-6.8	-6.9	0.4899
	20.40	4.35311	-136	-9.7	-1.8	-1.8	0.18657
	20.80	4.27009	5729	14.1	76.0	74.3	5.4501
	21.52	4.12843	-19	-32.2	-0.3	-0.2	0.0080153
	20.73	4.28511	-769	-53.7	-10.2	-10.0	0.19137
	22.39	3.97053	-425	-23.8	-5.6	-5.3	0.23801
	22.72	3.91370	3177	90.4	42.1	39.2	0.46945
	25.42	3.50372	6368	7.2	84.4	74.4	12.026
	23.65	3.76127	5873	77.8	77.9	71.0	1.0093
	25.36	3.51149	687	18.8	9.1	8.0	0.46925

FIG. 5

4. CONCLUSION

The interest concerns investigations on relatively cheap but under-explored starch resources.

The starch of red cocoyam has higher priority standing as alternative binders and disintegrants in table formulation than the starch of white cocoyam cormel owing to their appreciable high values of swelling power and solubility.

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REFERENCES

Association of Official Analytical Chemists (AOAC) 1984. Official Methods of Analysis. 15th Edition, Washington D.C.

Buleon, A., Colona, P., Planchot, V and Ball, S. 1998. Starch granules: Structure and biosynthesis, 23, 85 – 112.

Balbir Singh Kaith, Rajeev Jindal, Hemant Mittal and Kiran Kumar. Temperature, pH and electric stimulus responsive hydrogels from Gum ghatti and polyacrylamide-synthesis, characterization and swelling studies. Der Chemica Sinica, 2010, 1(2): 44 -54.

Liu, H., Corke, H. Physical properties of crosslinked and acetylated normal and waxy rice starch.Starch/Stärke. 1999, 51, 249 – 252.

Leach, H. W., McCowen, L. D., Scoch, T. J.(1959). Structure of Starch granule. Cereal Chem. 36, 534 – 544.

Marichamy, G., Shanker, S., Saradha, S.A., Nazar .R and Badhul Haq,M.A European Journal of Experimental Biology, 2011, 1(2): 47 -55.

Oladebeye, A.O., A.A.Oshodi and A.A. Oladebeye, 2006. Comparative Studies on the Pasting Properties of Starches of Corms and Cormels of Two Cocoyam (Colocasia esculenta).Chem. Tech. j., 2: 260-264.

Thomas, D. J., Atwell, W.A. Starches; Eagan Press: St. Paul, MN, 1999.

Wurzburg, O.B. Modified Starches: Properties and Uses; CRC Press: Boca Raton, FL, 1986; pp 3-40.