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Full Length Research Paper

Assessment of selected cooking characteristics of prime starch and food grade fibre isolated from cassava *(Manihot esculenta)* pulp

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Ease of separation of dietary fibre components of cassava pulp relative to other tropical root crops was the motivation for this study. Food grade fibres were isolated from cassava pulp using simple technique that consist essentially solvent mixture-separation procedure. Assessment of selected cooking proprieties namely paste formation and swelling capacity of the fibre isolates in comparison to the prime starch showed that isolated fibres exhibited variable cooking properties that are collectively independent of fibre size as determined by sieve mesh clearance, contrast to the cooking property of the prime starch. The fibres may find usefulness as carbohydrate food ingredients.

Key words: Cassava pulp, solvent-clearance separation, food fibre, cooking property.

INTRODUCTION

There is increase demand from consumers for baked products with lower caloric density and high levels of dietary fibre (Leveille, 1975). This is due to catalogue of evidences by Trowell et al. (1976), Van Soest and Robertson (1977), and Yamagishi et al. (2003) among others on health benefits of consumption of dietary fibre-rich foods.

Of all the types of roots and tuber crops, cassava (*Manihot esculenta*) roots possess the highest amount of fibres in its pulp. In addition, relative easy of separation of the fibrous components from cassava pulp in comparison to other principal tropical crops namely yam and potato suggest that cassava root may relatively be an economic source of dietary fibre for use in formulation of functional foods.

Cassava is one of the most important root crops in the world, with a production of more than 150 million tons per year with the highest proportion localized to the lowland of the tropics, where Nigeria is a chief producer. Unlike fibres from other foodstuffs (table fruits) in which cooking may be optional for attainment of edibility, cooking is mandatory to enhance edibility of cassava fibres. This is because cooking step creates the physical properties necessary for the development of texture in food products (Caldwell et al., 2000). Characterization of cooking properties of components of cassava pulp may provide information on water-heat interaction of carbohydrate components in cassava pulp which may be crucial in determination of their suitability for use in formulation of foods by processors and ingredient suppliers.

The objective of this study was to isolate food fibres from cassava pulp using simple method of solvent mixture-separation procedure and evaluate their cooking characteristics in terms of paste formation and swelling capacity. To our knowledge this study has not been reported elsewhere.

METHODOLOGY

Materials

Cassava roots of TME 30572 varieties aged 12½ months, at harvest were obtained from Igbira farm in suburb of Federal Polytechnic, Ado-Ekiti, Nigeria. The roots were improved variety (low cyanide and high yield).

Isolation

The classical method of extraction of cassava starch as described by Osunsami (1987) was adopted, in which grated pulp was utilized and the procedure extended in order to isolate food grade fibres

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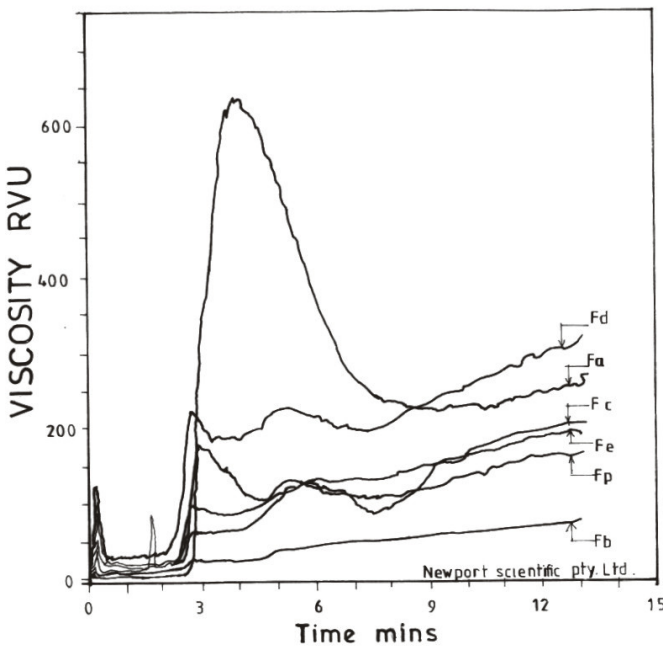

Figure 1. Rapid visco analyser curves of pulp, prime starch and food fibre of cassava. F_P = Cassava pulp; F_a= Prime Starch; F_b = Component obtained using 1 mm mesh size; F_c = Component obtained using 1.5 mm mesh size; F_d= Component obtained using 2.0 mm mesh size; F_e= component obtained using 3.0 mm mesh size.

from the cassava mash spent (the residue obtained after extraction of starch from cassava grated pulp) based on the following premise: Stirring the grated cassava pulp (spent) slurry in the solvent mixture, components of similar integrity loose and separated as guided by sieve clearance. The Water – 95% Dimethyl sulphoxide (DMSO) (2:5) solvent mixture was used for washing the cassava mash spent through variable (1, 1.5, 2.0, 3.0 mm) mesh size sieves in the order quoted. The starch was separated from cassava pulp mash using muslin cloth prior to separation of the fibres using sieves. Fibres retained by 3 mm sieve were referred to as woody fibre. All the components were thoroughly rinsed using water and dried in air oven at temperature of 45°C for 24 h and package for subsequent analysis.

Analyses

Determination of cooking properties using rapid visco analyser (RVA).

Cooking /pasting properties of pulp, prime starch and food fibres of cassava were characterized using RVA as described by Delcour et al. (2000). 5 g of accurately weighed sample added into water at ratio of 1:2 (w/v). The sample slurry heated from 28 to 150°C at 4°C/min and all experiments were carried out in triplicate. The RVA –3d was operated with 250 g of 9.9% sample-in-water suspensions. The temperature profile included a 2 min isothermal step at 50°C, linear temperature increases to 95°C in 7 min, a holding step (8 min at 95°C), a cooling step (7 min) with a linear temperature decrease to 50°C and a final isothermal step at 50°C. Measurements agreed within 5RVU over the whole profile. Cooking/pasting peaks and associate parameters that are of paramount importance were identified and determined for technological interpretation.

Determination of swelling power

This was determined in accordance with the method described by Leach et al. (1959) with modification for small samples at three temperature (60, 70 and 80°C) regimes.

RESULTS AND DISCUSSION

Several studies had been reported on pasting or cooking properties of cassava starch some of which include works by Beeching et al. (2000), Rickard et al. (1992), Daramola and Osanyinlusi (2006), among others. However, we are not aware of any information on cooking properties of cassava whole pulp and fibre components. The cooking profile of different fractions of cassava pulp as obtained in this study is shown in Figure 1. Cooking characteristics of technological significance as extrapolated from the rapid visco curve (Figure 1) is presented in Table 1.

All the fractions namely pulp (F_p), prime starch (F_a) and food fibres (F_b, F_c, F_d, F_e) exhibited variable cooking attributes. F_p, F_b, F_c, F_d, F_e were characterized with high final viscosity compared to corresponding peak viscosity of each sample. The final viscosity of F_a appeared exceptional to the observation. The high final viscosity of all the samples compared to their respective peak viscosity may be explained in the following terms: (i) The hydration profile of the fibre was not completed during the heating cycle. (ii) The fibres can endure higher heating period and exhibit insulatory characteristics compared to prime starch. The low viscosity of the samples coupled with higher heating period endurance suggests that the fibres may be suitable for use as component for flour-thickened sauces, a product in which contents should remain fluid in the early heating stage for heat penetration to occur.

However, F_p, F_b, F_c, F_d, F_e showed low peak viscosity (46.25-225.42 RVU) relative to F_a that exhibited high (638.83RVU) peak viscosity. The peak viscosity of F_a obtained in this study is similar to earlier report by Richard et al. (1992).

Pasting during cooking is temperature dependent in the viscosity of highly hydrated system (Atwell et al., 1988). Therefore, the results of peak viscosity of the different components can give insight to water absorption potentials of each component. Thus, the low hydration profile of the fibrous fractions suggests resistance of the fibre to water binding/absorption.

Physically, F_b was grainy compared to other fractions that appeared hard gel or stringy. Although, with the second highest (next to F_a) surface area among the fractions, F_b was characterized with the least peak and final viscosity as well as highest cooking temperature (Pt). This could be due to the fact that the component was associated with the highest bond strength within molecular units, in conformity with the assertion of Wang et al. (1993) that extensive and strongly bonded structure exhibits restricted swelling and dispersion. In addition, it

Table 1. Rapid visco analysis*data of pulp, prime starch and food fibre of cassava.

Sample	PV (RVU)	MV (RVU)	BD (RVU)	FV (RVU)	SV-1 (RVU)	PT (min)	Pt (^oC)	SV-2 (RVU)
F_p	130.83	108.17	22.67	161.25	+53.08	5.73	56.30	-30.42
F_a	638.83	219.75	419.08	249.08	-29.33	3.87	72.00	-389.75
F_b	46.25	43.92	2.33	69.58	+25.67	6.93	66.25	-23.33
F_c	128.92	83.67	45.25	198.25	+114.58	5.47	66.95	-69.33
F_d	225.42	192.92	32.50	306.08	+113.17	5.20	66.80	+80.66
F_e	175.58	125.67	49.92	187.92	+62.25	5.00	68.45	+12.34

*Average of 2 determinations.
F_P = Cassava pulp; F_a= Prime Starch; F_b = Component obtained using 1 mm mesh size; F_c = Component obtained using 1.5 mm mesh size; F_d= Component obtained using 2.0 mm mesh size; F_e= component obtained using 3.0 mm mesh size.
PV = Peak viscosity; MV = Minimum Viscosity; BD = Breakdown viscosity; FV = Final Viscosity; SV-I = Setback viscosity from MV; PT = Pasting time; Pt = Pasting temperature; SV-2 = Setback Viscosity from PV.

Table 2. Swelling power* of pulp, prime starch and food fibre of cassava.

Sample	Temperature (^oC)		
	50	60	70
F_p	4.15	10.96	19.8
F_a	9.85	19.74	33.8
F_b	5.16	11.58	176
F_c	5.10	12.5	19.0
F_d	4.20	10.58	16.0
F_e	4.50	10.14	17.5

*Average of 3 determinations.
F_P = Cassava pulp; F_a= Prime Starch; F_b = Component obtained using 1 mm mesh size; F_c = Component obtained using 1.5 mm mesh size; F_d= Component obtained using 2.0 mm mesh size; F_e= component obtained using 3.0 mm mesh size.

implies that the fraction may contain the least amount of water-soluble fibres. Considering the cooking profile, it is obvious that the cooked characteristics of the various fibre components were not directly proportional to mesh free size of fractions. This suggests that the composition and configuration of biomolecules in the fibre fractions may be different from each other and should be investigated.

All the indices of carbohydrate stability (BV, SV) showed that the fibre fractions resist loss of imbibed water; this may indicate lower tendency to retrograde at variable degree. Retrogradation is a major sensory drawback associated with baked products. Thus it may be useful in bulk filling of foods.

Considering SV-2, sample F_d was associated with the highest positive setback. This connotes that the fibre fraction is endowed with the capacity to hold the highest amount of water. Similar observation manifested in its peak viscosity. Also observed was that fibre modified rheological properties of starch as evident in visco characteristics of the pulp sample (F_p).

Cooking profile of the "woody fibre" component characterized by many peaks and troughs (pattern not shown) during heating in water medium showed that water absorption during heating is not progressive throughout the heating period. This signifies that the amount and rate of water absorbed during heating is negligible. Thus the inordinate rapid viscogram may be a diagnostic feature of "woody fibre".

Generally the peak viscosity time (3.87 min) of F_a was smaller than peak viscosity time (5.00 - 6.93 min) of other fractions and F_p. The converse was observed for the cooking temperature (56.30 - 68.45^oC) of samples F_p, F_b F_c, F_d, F_e. The fibre fraction may be useful as food ingredients with product such as flavourant that require low heating temperature for processing.

Swelling capacity/power

A measure of hydration capacity is a weight measure of swollen starch or similar granules and their occluded water. Often, eating quality of food is related to retention of water in the swollen granules (Richard et al., 1992). The swelling capacity of the preparations (pulp, starch and fibres) at three temperatures regime is shown in Table 2. Generally, swelling power of the samples increase with increase in temperature. However, F_a had the highest swelling power in all the temperature investigated in this study. This observation can be explained in terms of the fact that the prime starch had the least structural compactness. Swelling power in the other samples was not proportional (directly or indirectly) to mesh size passed-through-fibre. This implies that swelling power of the fibre components was not strictly due to the size of the fibre that pass through the mesh size at the range of sieve size employed in this study. Ease of water penetration into fibre could signify the compactness of structural arrangement of the component fractions. The RVA profile (not shown) of the "woody fibre"

made it unreasonable to determine its swelling power and as a result was not evaluated.

Conclusion

Food grade fibres isolated from cassava pulp using simple technique of solvent mixture-separation procedure showed variable cooking property independent of particle size wholly different to cooking properties of the prime starch. The fibre may be useful as carbohydrate food ingredients. The simplicity of the procedure should offer attractive economic benefits superior to labourious and expensive isolation procedure for obtaining food fibres from other starchy crops other than cassava root.

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