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Feasibility Studies of Using Banana Starch as a Substitute for Cross - Linked Starch in Food Industry

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ABSTRACT: Banana starch was isolated from two varieties, 'Alukehel' and 'Monthan', and the swelling power, solubility pattern at different temperatures, and viscosity changes at 8 and 10% concentrations (w/v) were studied. The banana starch showed fairly restricted swelling power and solubility pattern. Both properties showed a trend of two stage pattern over the temperature range 50-90 C and suggest the existence of two sets of bonding forces within the granules. The amylograms showed different patterns for the two selected concentrations. The high pasting temperature, low breakdown and setback manifested in the present study indicate the properties of a cross-linked starch.

INTRODUCTION

Starch has a wide range of applications in the food and non-food products. The choice of starch in a particular food product is governed by its physico-chemical properties. Various roots and tubers have been studied in the past as sources of starch (Swinkels, 1985). Banana though generally consumed as a dessert fruit, also contains high content of starch when unripe and could be exploited as a starch source. Its potential acceptance in food preparations is high due to absence of flavour. The present study examines the feasibility of using banana starch isolated from two local cooking banana varieties as a substitute for cross-linked starches.

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MATERIALS AND METHODS

Materials

Two Sri Lankan varieties of cooking banana namely 'Alukehel' and 'Monthan' were used in this study. Bunches 90 – 95 days old, from each variety were obtained from growers in the Kandy District. The crop was grown under rain fed conditions and the cultural practices were according to the recommendations of the Department of Agriculture (1985). Fruits free of injuries and bruises were pressure-cooked at 1.05 kg/cm^2 for five minutes, peeled and then cut into transverse slices of about 0.5 cm thickness. These slices were dipped in 1% (w/v) solution of sodium metabisulfite (pH 3.5) for five minutes and dried at 60 C for 6 hours in a forced draft oven. The dried slices were ground to flour in a Wiley laboratory mill and passed through a sieve with a pore size of 250.

Isolation of starch

The starch was isolated from the flour by the procedure described by Kayisu *et al.*, (1981) and drying of the starch was carried out at 50 C in a cabinet drier. In this method, 50g of the flour was extracted twice with 500 ml of distilled water, the precipitated starch was suspended in water and allowed to settle for 24 hrs. at 4 C. The supernatant was siphoned off and the residue was dried at 50 C in a cabinet drier. The starch cakes were powdered in a Waring Blender and passed through sieve of size 250 (Kahn, 1987).

Composition of starch

Moisture, protein and ash contents of the isolated starch were determined using standard AOAC (14.004, 14.067, 14.006) (1975) procedures. The purity of the isolated starch was determined by the method of Thivend *et al.*, (1972). Lipid content of the starch was determined by the method described by Floch *et al.*, (1957) where the starch was extracted twice with a mixture of chloroform: methanol (2:1 v/v) containing 0.05% $CaCl_2$; and dried in a rotary evaporator.

Functional Properties of Starch

The swelling and solubility patterns were studied by the method described by Leach *et al.*, (1959) at temperature intervals of 10 C from 50–90 C. In this method 2 g of the starch was suspended in 180 ml distilled water and kept in a water bath for 30 minutes. The suspension was then removed and the total weight of the water present was made upto 200 g and centrifuged for 15 minutes at 2200 rpm. The supernate was drawn off by suction and 10 ml aliquot was evaporated and dried for 4 hours at 120 C in a forced draft oven. The percentage of solubles extracted from the starch was calculated. The swelling power was calculated as the weight of the sedimented paste per gram of dry starch.

Brabender viscosity was determined as described by Mazurs *et al.*, (1957). Starch concentrations of 8 and 10% (w/v, on dry basis) were heated in a Brabender amylograph at a rate of 1.5 C rise per minute. The paste was heated to 95 C, maintained at that temperature for one hour, then cooled at a rate of 1.5 C per minute to 50 C and held for one hour. A Brabender visco–amylograph model VA–VE equipped with a 700 cmg cartridge (C.W. Brabender Instruments, West Germany) was used. The cup was rotated at 72 rpm.

RESULTS AND DISCUSSION

Isolation and composition of starch

The flour of starch yield averaged 68.8 and 64.9% for 'Alukehel' and 'Monthan', respectively. The yield obtained in the present study was higher than that reported by Kayisu *et al.*, (1981) for variety 'Valery'. The difference may be due to varietal differences and maturity state. The composition of starch from banana flour is shown in Table 1. The amount of starch from variety 'Alukehel' was slightly higher than that from variety 'Monthan'. The higher ash content of variety 'Monthan' is partly responsible to this slight difference. The starch content obtained in this study is low when compared to the value of 99.5% reported by Kayisu *et al.*, (1981) for variety 'Valery', but comparable to that obtained by Shantha and Siddappa (1970) from variety 'Maduranga'. The lipid content of the starch was found to be lower than that of cereal starches (0.6), but comparable to that of cassava starch (0.1) (Swinkels, 1985).

Table 1. The yield and composition of Banana starch (% as received basis).

COMPONENT	VARIETY	
	ALUKEHEL	MONTHAN
Yield	68.80 ± 4.80 [a]	64.90 ± 3.20
Moisture	7.02 ± 0.53	7.00 ± 0.41
Starch	90.20 ± 1.71	87.40 ± 0.81
Protein	0.28 ± 0.05	0.31 ± 0.04
Lipid	0.16 ± 0.05	0.17 ± 0.01
Ash	0.56 ± 0.05	0.86 ± 0.07

[a]Mean ± SD of eight samples.

The ash content of both varieties were much higher than that of 0.05% recorded by Lii *et al.*, (1982).

Swelling and solubility pattern

The patterns of swelling and solubilization of a starch are governed by various bonding forces in the molecule (Leach *et al.*, 1959). The overall results of the present study indicate that the banana starch has a fairly restricted swelling power. The swelling pattern showed a trend of two stage swelling, with an initial gelatinization, followed by a period of restricted swelling and finally a second rapid swelling (Figure 1). The trend was prominent in variety 'Monthan' whereas variety 'Alukehel' showed a slower increase above 60 C. This behaviour may be due to two sets of bonding forces which relax at different temperature levels. Solubilization also shows a pronounced two stage pattern (Figure 2) and confirms the existence of the two sets of bonding forces within the granules. The data also provides a comparison of the solubilization of banana starch at equal levels of swelling (Figure 3). Variety 'Alukehel' exhibited a higher degree of solubility than that of variety 'Monthan' at equal levels of swelling. The increase in solubility with the increase in temperature was pronounced in variety 'Alukehel' compared to variety 'Monthan'. The values obtained in the present study agree with those of Kayisu *et al.*, (1981) for variety 'Valery' but are much lower than those reported by Lii *et al.*, (1982). The swelling pattern of banana starch is similar to that of milo starch but differs from that of potato which shows a very rapid unrestricted swelling at relatively low temperature (Leach *et al.*, 1959).

Brabender visco amylograph

The amylographs showed different patterns at the two selected concentrations (Figure 4). The amylographs of the two varieties also differed at these starch concentrations. Both varieties have relatively high pasting temperatures compared to potato and cassava starches which lie in the range of 60 - 70 C (Swinkels, 1985). In both varieties peak was obtained only beyond 95 C. The starch showed little break down on heating at 95 C for a period of 60 minutes. Generally, when a native starch solution is heated, the viscosity increases at first, and drops upon continued heating due to the collapse and disintegration of the

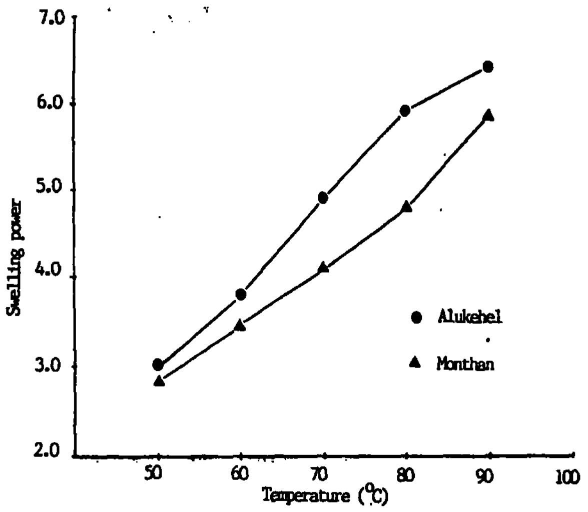

Fig. 1. Effect of varying temperature on the swelling power of Banana starch.

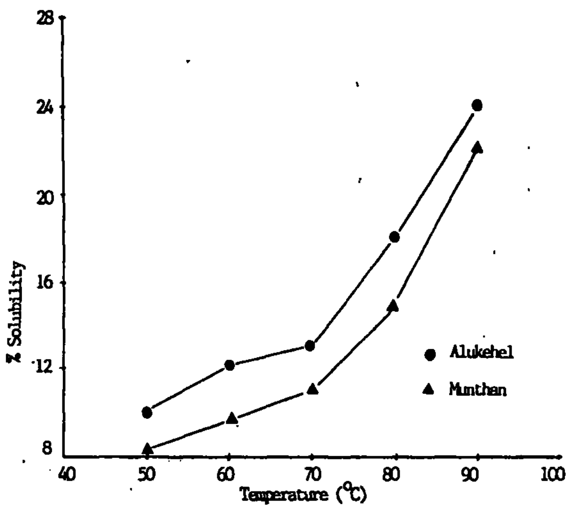

Fig. 2. Effect of varying temperature on the solubility of banana starch.

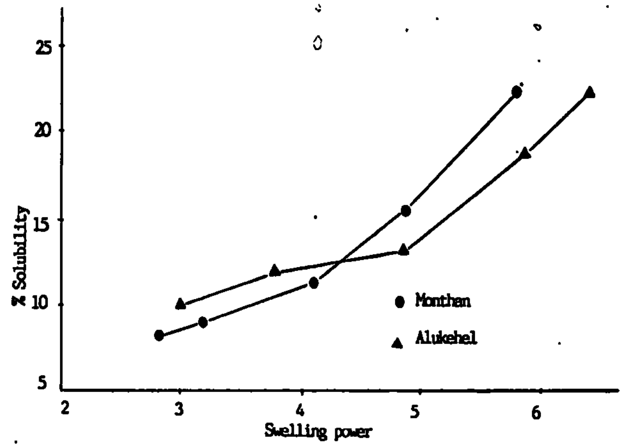

Fig. 3. Effect of swelling power on the solubility of banana starch.

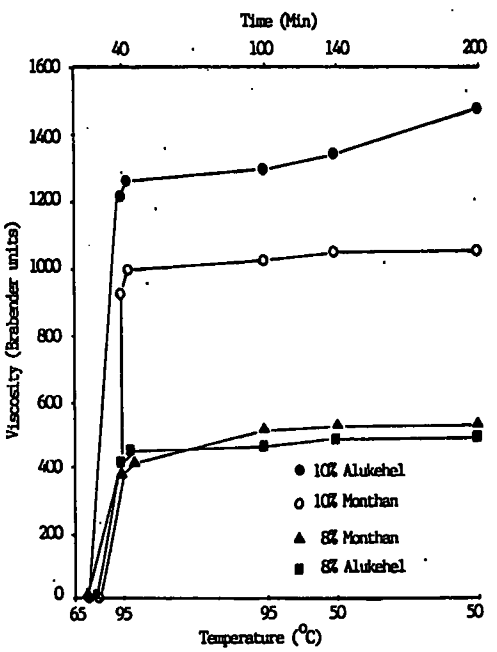

Fig. 4. Brabender viscoamylograms of banana starch.

hydrogen bonds holding the granules (Wurzburg, 1982). During the period of cooling to 50 C and holding at 50 C, retrogradation of the starch molecules cause the increase in viscosity.

The results of the present study shows that the relatively high pasting temperature, reduced swelling, stability of the swollen granule against mechanical fragmentation, and absence of retrogradation referred to as low setback differentiates the banana starch from native starches. The viscosity pattern of starches is generally classified into four main types (Schoch and Maywald, 1968), namely high swelling, moderate swelling, restricted swelling and highly restricted swelling. Based on this classification, the banana starch could be considered as a restricted swelling type. The Brabender amylogram of the banana starch confirms the properties of cross-linked starches, which increases its potential use in the food industry as a substitute for chemically modified cross-linked starches.

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