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SHORT REPORTS

EFFECT OF VARIETY AND AGE ON PHYSICOCHEMICAL PROPERTIES OF STARCH FROM SWEET POTATOES GROWN IN THAILAND

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ABSTRACT

The properties of starches for four varieties of sweet potato (TIS 8250, NORIN 03, POMO POJO 2 and POMO 03-2) harvested three and four months after cultivation were investigated. It was found that variety and age significantly affected the starch content ($p \leqslant 0.05$). In general, sweet potato aged 4 months (94.56 to 96.06%) has higher starch content than those aged 3 months (85.83 to 92.56%). The starch granules from sweet potato aged four months were significantly less swollen and yielded hot pastes of higher stability than those derived from sweet potatoes aged three months. No significant differences of amylose and phosphorus contents was observed ($p \leqslant 0.5$) and the phosphorus was esterified. It is suggested that this property may be the result of associative hydrogen bondings in granules of starches from sweet potatoes that increased the order of crystallite in the granules.

INTRODUCTION

Sweet potatoes (SP) are an important crop in Thailand and also an inexpensive source of carbohydrates. The annual production of SP is more than 120,000 tons[1] and are available primarily as fresh roots. However, because of the length of growing season, the requirement of special storage and handling conditions, marketing of fresh SP is not popular. Production of starch or some shelf stable products could raise the consumption of SP and promote diversification of SP utilization as a valuable raw material for industry.

Starch is the major constituent of SP. Its importance to the properties of SP flour is recognized[2]and has been proposed as a part of flour in baking products.[3] Starch is also a significant raw material for industry.

It is generally recognized that starches from different varieties differ in gelatinization and pasting characteristics[4, 5] and relatively little work has been done on comparison of properties of starches from various SP varieties and harvested time. This study was undertaken to examine the influence of varieties and harvested time (three and four months after cultivation) on the properties of SP starches. The varieties used in this study are TIS 8250, NORIN 03, POMO POJO 2 and POMO 03-2 which are promoted by Office of Agricultural Economics, Ministry of Agriculture & Cooperatives.

MATERIALS AND METHODS

Sweet potatoes

Four varieties of starchy SP, namely TIS 8250, NORIN 03, POMO POJO 2 and POMO 03-2, which was grown by the Office of Agricultural Economics, Ministry of Agriculture & Cooperatives was selected. They were harvested at 3 and 4 months after cultivation.

Isolation of starch

Sweet potato tubers were washed, hand cut into pieces and ground with a Colloid Mill. To prevent discoloration of the SP during grinding, the SP were soaked in 0.075% sodium metabisulfite solution. The slurry were then filtered through a 75 and 200 mesh size screens, respectively. Prime starch were sedimented from the filtrate and the starch was washed twice with tap water. The starch was dried in an oven at 50°C for 6 hr.

Determinations

Moisture, fat, starch and ash contents were determined as given in AOAC methods.[6] Protein and phosphorus contents were determined as given in ISO methods.[7, 8]

Amylose was determined by the method of Juliano[9] using potato amylose M.W. 300,000 (Serva, biochenistry grade) as a standard.

Swelling power and solubility were determined at 10°C interval from 65-95°C by the method described by Leach *et al.*[10]

Shape and size of granules were determined by the method of Mac Master[11] using a Differential Interference Contrast Microscope (Nikon, model UFX-11, Japan).

Pasting characteristics of starch were studied by means of Brabender Visco Amylograph (Brabender OHG Duisburg, model 8004 40, 8012 40, 700 cmg. cartridge, West Germany). Six percent of starch solid in water (450 ml) was heated from ambient temperature to 95°C, kept at this temperature for 30 min, then cooled to 50°C and held at 50°C for 30 min. The following reference consistencies (B.U.) were reported : peak viscosity ; at 95°C ; 30 min after 95°C ; at 50°C ; and 30 min after reaching 50°C.

RESULTS AND DISCUSSION

Chemical Composition

The experimental results recorded in Table 1 revealed that there was no significant difference ($p \leq 0.05$) of protein ($N \times 5.7$), moisture, phosphorus and ash contents of SP

TABLE 1 Chemical composition of sweet potato starches.

Variety/Age	Starch\1* (%)	Amylose\1NS (%)	Moisture^{NS} (%)	Protein\1NS (%)	Fat\1* (%)	Phosphorus/1ns (mg/g)	Ash\1NS (%)
Age 3 Months							
TIS 8250	85.83^{C}	35.18	13.05	0.10	0.07^{CD}	0.041	0.96
NORIN 03	87.16^{C}	40.01	12.85	0.09	0.09^{BC}	0.039	0.87
POMO POJO 2	88.18^{C}	38.86	13.05	0.06	0.10^{B}	0.036	0.74
POMO 03-2	92.56^{B}	36.55	13.48	0.08	0.07^{CD}	0.013	0.75
AVERAGE	88.43	37.65	13.11	0.08	0.08	0.032	0.83
Age 4 Months							
TIS 8250	94.56^{AB}	37.05	12.63	0.04	0.22^{A}	0.031	0.74
NORIN 03	95.88^{A}	38.02	12.05	0.06	0.01^{E}	0.040	1.29
POMO POJO 2	94.96^{AB}	36.63	12.88	0.05	trace^{E}	0.021	0.91
POMO 03-2	96.06^{A}	39.06	12.70	0.05	0.06^{D}	0.132	0.82
AVERAGE	95.37	37.69	12.57	0.05	0.07	0.131	0.94

\1 base on dry weight

NS not significantly difference ($p \leqslant 0.05$)

* average values with the same superscript mean no significantly difference ($p \leqslant 0.05$)

starches from the four varieties aged 3 and 4 months.

Variety and age of SP had interaction effect on the starch and fat contents. In general, SP aged 4 months (94.56 to 96.06%) had higher starch content than those aged 3 months (85.83 to 92.56%). The fat content of starches from SP aged 3 months ranged from 0.07 to 0.10% and was about 0.01 to 0.22% from SP aged 4 months.

The amylose contents of the starches were 37.65% and 37.69% for SP aged 3 and 4 months, respectively. The results were higher than those obtained by Wang and Lin[12] who found that the amylose percentage was 20.3% ; but were quite comparable to those given by Madamba *et al*[13], who reported that amylose contents of SP were ranged from 29.68 to 32.40%. However, no significant difference of amylose contents of the starches from different varieties and ages was observed ($p \leqslant 0.05$).

Starch Granules

Starch granules of the SP are generally round, oval and polygonal with an average size of 5.51 to 13.88 micron (Table 2). The largest starch granules of SP were smaller than the average size of tapioca and potato starch granules.[14] No significant difference of granule sizes of the starches was observed. ($p \leqslant 0.05$.).

Pasting Properties of Starches

Typical pasting pattern of starches derived from different varieties of SP aged 3 and 4 months were shown in Fig.1 and 2, respectively. The detailed viscogram indices and the initial pasting temperature of each sample were reported in Table 2.

Although values of hot and cold paste viscosities among varieties within the group were similar, the stability of hot pastes from starches of SP aged 4 month was better than that from SP aged 3 months, as evident from the data in Table 2. Since difference in the paste stability of starch during cooking reflect the strengthening of the swollen granules, this suggested that starches from SP aged 4 months have more closely associative forces than those from SP aged 3 months.

Pasting pattern curves as shown in Fig.1 and 2 resemble the curve obtained with tapioca starch. Hovever, SP starches showed better cooking stability than tapioca starch.

Swelling Power and Solubility

Swelling power and solubility of SP starches are shown in Table 3. For the temperature range from 65 to 95° C, the swelling power of starches from SP aged 4 months are significantly lower than that from SP aged 3 months ($p \leqslant 0.05$).

Concurrent with the swelling of starch granules, dissolution of small linear molecules from the granules occurs. In the temperature range from 85° to 95° which is the high melting region, the solubility of starches aged 3 months was higher than that of the starches aged 4 months.

Although there were no significant difference in amylose and phosphorus contents, it is apparent from the swelling power, solubility and viscograms data that SP aged 4 months have strengthened starch granules, therefore the cooking stability of the starches is increased. Either this property is the result of some internal cross-linkages between starch chains,

TABLE 2 Granule size and viscographic indices of starches

Variety/Age	Granule Size (NS) (Micron)	Pasting Temp. (°C)	Viscosity (B.U.)					
			95°C*	peak*	After 30 min at 95°C*	peak viscosity to 95°C 30 min	50°C	After 30 min at 50°C*
Age 3 Months								
TIS 8250	11.16 ± 1.00	70-74	400^{D}	585^{AB}	260^{E}	325	350^{E}	345^{E}
NORIN 03	9.87 ± 0.80	73-78	410^{CD}	495^{CDE}	285^{D}	210	375^{D}	365^{D}
POMO POJO 2	9.42 ± 3.91	71-75	390^{D}	545^{BC}	250^{E}	295	315^{F}	300^{E}
POMO 03-2	7.01 ± 1.19	68-72	340^{E}	540^{BCD}	220^{F}	320	280^{G}	255^{F}
Age 4 Months								
TIS 8250	11.41 ± 1.27	70-75	415^{CD}	480^{DE}	345^{BC}	135	450^{C}	450^{C}
NORIN 03	8.92 ± 0.88	74-80	430^{C}	460^{E}	315^{C}	145	460^{C}	470^{C}
POMO POJO 2	12.67 ± 1.21	70-75	460^{B}	550^{BC}	360^{B}	195	500^{B}	520^{B}
POMO 03-2	9.99 ± 0.82	68-73	510^{A}	615^{A}	415^{A}	200	570^{A}	585^{A}

NS means no significant difference ($p \leqslant 0.05$)

B.U. means Brabender unit

* average values with the same superscript mean no significantly difference ($p \leqslant 0.05$)

TABLE 3 Swelling power and solubility

Solubility (%)

Variety	Age (month)	Temperature (°C)			
		65	75	85	95
TIS 8250	3	9.091	12.930	30.303	32.727
	4	12.040	20.485	28.444	29.899
NORIN 03	3	0	19.934	32.617	51.543
	4	2.416	23.798	25.369	27.785
POMO POJO 2	3	0	20.940	27.785	34.228
	4	4.429	22.550	27.584	32.939
POMO 03-2	3	13.360	15.402	45.021	>50
	4	8.108	17.230	24.896	29.189

Swelling power

Variety	Age (month)	Temperature (°C)			
		65	75	85	95
TIS 8250	3	4.337	23.980	42.600	53.316
	4	3.061	30.102	34.439	45.153
NORIN 03	3	2.449	22.448	34.948	61.837
	4	1.939	26.020	29.847	45.510
POMO POJO 2	3	4.032	29.486	40.322	52.419
	4	3.931	28.125	31.401	42.943
POMO 03-2	3	9.848	26.516	51.515	54.546
	4	5.961	25.252	30.051	40.050

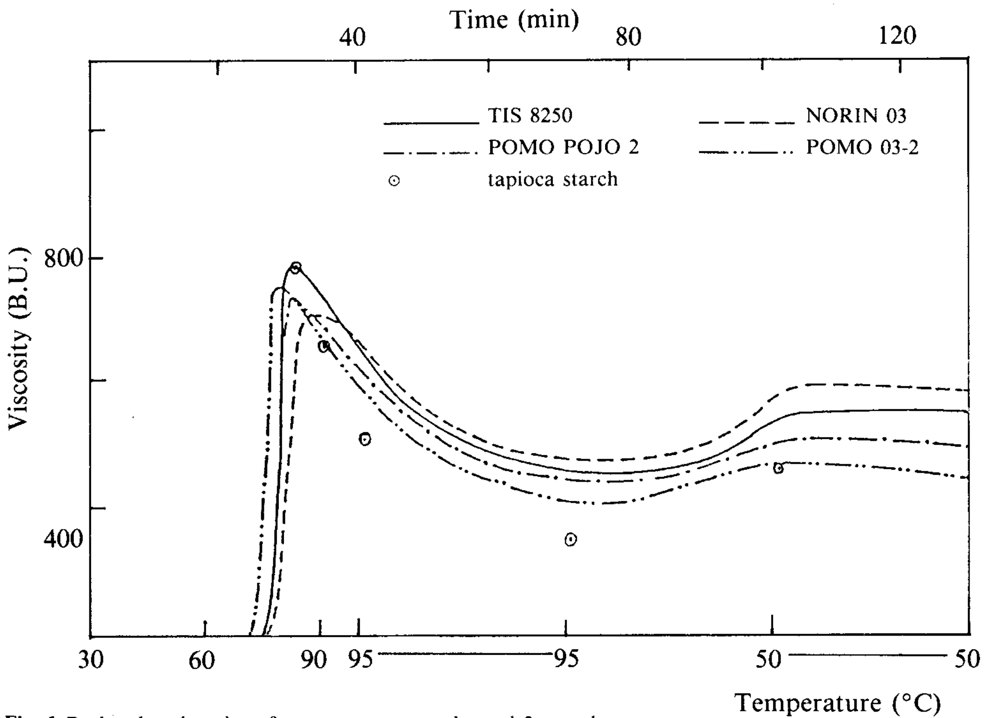

Fig. 1 Brabender viscosity of sweet potato starch aged 3 months.

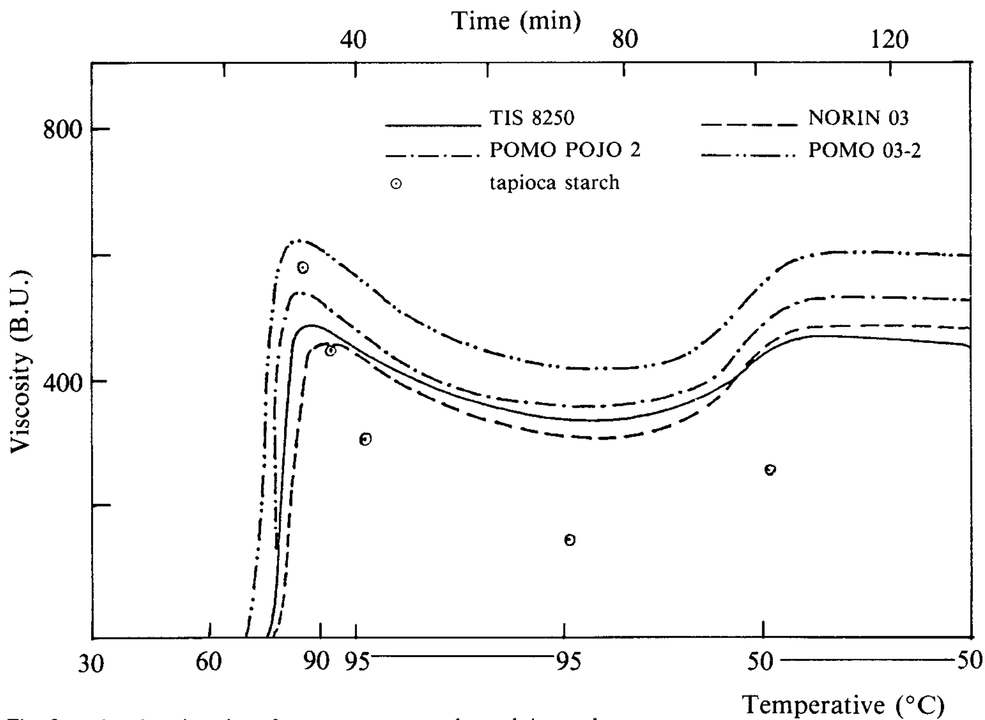

Fig. 2 Brabender viscosity of sweet potato starch aged 4 months.

or it could be due to extensive hydrogen bondings caused by amylose molecules.[15] The phosphorus in the starch granules showed that it was esterified and there were no ionic character with methylene blue.[16] Therefore, the extensive hydrogen bondings can be one reason that increases the order of crystallite in starch granules and results in strengthening the granular structures.

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