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Research Note

Influence of Salts on Pasting Characteristics of Cassava (*Manihot esculenta Crantz*)

ABSTRACT

Pasting characteristics and sedimentation volume of cassava flour samples were affected by the presence of sodium chloride, sodium sulphate, and trisodium orthophosphate. Changes observed in sedimentation volume were very pronounced in the case of SHTT samples. While sodium phosphate considerably increased the sedimentation volume, the presence of sodium sulphate showed a suppression. The effect of sodium chloride was found to be marginal in all the flour samples. Paste stability and set back properties were improved in the presence of sodium sulphate and, to a lesser extent, in the presence of sodium chloride. Sodium phosphate, however, showed an opposite effect, consistent with its high pH.

INTRODUCTION

The process of starch gelatinization is influenced by factors such as water content, presence of salts, sugars, organic acids, and glyceryl esters of fatty acids. The mechanism of starch gelatinization has been studied and explained with reference to a few selected starches such as corn, wheat and potato (Oosten, 1982; Evans & Haisman, 1982; Wootton & Bamunuarachchi, 1980; Biliaderis *et al.*, 1986). The above studies, however, essentially report changes in gelatinization temperatures of the starches concerned rather than pasting properties. Recently, Abbas *et al.* (1986) have examined influences of food additives such as sodium chloride and sucrose on pasting characteristics of Tepary Bean Starch.

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Effects of steam hydrothermal treatments (SHTT) on some of the physico-chemical properties of cassava have already been reported from this laboratory (Raja *et al.*, 1987). In the present study, the effects of three inorganic salts, sodium chloride (NaCl), sodium sulphate (Na_2SO_4) and trisodium orthophosphate ($Na_3PO_4 \cdot 12H_2O$) on sedimentation volume (SV) and pasting properties of cassava flour samples have been examined.

MATERIALS AND METHODS

Fresh cassava tubers of seven to eight months maturity, and belonging to the Cultivar Malayan-4 (M-4) were processed to plain dried, SHTT-chips, and starch. While the fresh tubers had a moisture content of 58–60%, the processed chips had a moisture range of 7–10%. Their starch contents on a dry weight basis were 90–92%. All three chemicals mentioned above were supplied by BDH/Merck (India) and were of AR grade. Sodium chloride and sodium sulphate were used at 1,4, and 8% (w/v) concentrations. Sodium phosphate was used at the 0·5 and 1·0% levels. Sedimentation volumes were determined in water as well as in salt solutions of different concentrations. The experimental procedure was the same as already reported (Raja *et al.*, 1987). Pasting characteristics of flour samples were studied using a Brabender Viscograph by the method of Halick & Kelly (1959).

RESULTS AND DISCUSSION

The previous studies (Raja *et al.*, 1987) had revealed that flour samples prepared from SHTT cassava chips show higher sedimentation volumes in water than plain dried flour, as generally observed in the case of pregelatinized cereal flours such as rice (Bhattacharya & Zakiuddin Ali, 1975; Rao *et al.*, 1983). In the present series, the SHTT-induced increases, at all the salt concentrations, were found to be similar to the above. Among the salts tried, sodium phosphate increased the sediment volume to a maximum extent of 30·6% (SHTT-I) at 1·0% concentration while sodium sulphate at 8·0% concentrations suppressed sediment volume by a maximum of 12% (SHTT-I) compared to that in water (Table 1). The effect of sodium chloride was only marginal even at 8·0% concentration. The pasting characteristics of cassava flour samples were also found to be considerably affected by the presence of the above salts. It was observed that both plain-dried and SHTT-samples showed delayed swelling in the presence of sodium sulphate and chloride. The effect of the former was more pronounced. Also, the marginal increase observed in pasting temperature indicated delayed onset of

TABLE 1
Effect of Inorganic Salts on Sedimentation Volume of Cassava Flour (<250 μm particle size)

Sample	*Water*	*Sedimentation volume (ml)*							
		Sodium chloride (%)			*Sodium sulphate (%)*			*Sodium phosphate (%)*	
		1	*4*	*8*	*1*	*4*	*8*	*0·5*	*1·0*
Plain dried flour	27	27	27	27	27	28	29	28	31
SHTT-Sample									
I (5 min)	72	72	72	75	70	69	63	86	95
II (10 min)	81	80	81	84	77	77	71	98	100
III (20 min)	91	90	91	92	85	83	82	98	100

gelatinization; all the samples attained their respective peak viscosity at relatively higher temperatures in solutions of the above two salts (Table 2 and 3) than in water alone. However, in the presence of sodium phosphate, samples showed a tendency for earlier swelling and attainment of peak viscosity. Also, while sodium chloride and sulphate slightly lowered pH, there was a significant shift in pH from 6·5 to 11·6 in the presence of sodium phosphate. The mechanism of inhibition of starch gelatinization and swelling of starch granules in sodium sulphate solution has been explained (Oosten, 1982). Accordingly, the changes in water structure and reduction in 'free' water available for absorption by starch granules have been identified as factors responsible for inhibition of swelling and gelatinization. However, the effect of sodium chloride still remains inadequately explained. Its effect on pasting properties such as peak viscosity has been reported to be markedly dissimilar in corn and wheat starches to that in Waxy Maize Starch (Ganz, 1965). The influence of sodium phosphate in facilitating earlier granule swelling was consistent with its high pH as is generally observed in an alkaline environment (Kim *et al.*, 1985).

Hot paste stability and set back properties of cassava were also found to be affected in the presence of the above salts (Fig. 1). This was reflected in the changes in breakdown (P-H) and set back values (C-P) of the gel and correspondingly from the breakdown and set back ratios i.e. H/P and C/P (Table 4). While both sodium chloride and sulphate improved hot paste stability at 95°C during holding for 30 min, sodium phosphate showed earlier breakdown. The set back values were also found to be greater in the presence of sulphate and chloride while sodium phosphate showed a trend to reduce the set back of the paste during cooling. It was also observed that,

TABLE 2

Effect of Incorporation of Salts on Pasting Temperature of Cassava Flour (< 250 μm particle size)

Salt and pH range	*% Concentration*	*Pasting temperature (°C)*			
		Plain dried flour	*SHTT-Samples*		
			I (5 min)	*II (10 min)*	*III (20 min)*
Water					
pH 6·3–6·5	—	72·0	48·0	45·0	42·0
Sodium chloride					
pH 6·00–5·25	1	73·5	46·0	45·5	43·5
	4	78·0	48·0	42·0	40·5
	8	79·5	48·0	43·5	40·5
Sodium sulphate					
pH 6·00–5·25	1	73·5	46·0	45·5	43·5
	4	78·0	49·0	46·5	48·0
	8	84·0	57·0	51·5	51·0
Sodium phosphate					
pH 6·30–11·6	0·5	73·0	43·5	42·0	42·0
	1·0	72·0	43·0	42·0	42·0

TABLE 3

Effect of Inorganic Salts on Paste Temperature at Peak Viscosity Point of Cassava Flour (< 250 μm particle size)

Salt concentration	*Plain dried flour*	*SHTT-Samples*		
		I (5 min)	*II (10 min)*	*III (20 min)*
Water	88·5	88·5	81·0	58·5
Sodium chloride				
1%	91·5	87·0	84·0	60·0
4%	93·0	90·0	84·0	63·0
8%	93·0	91·5	84·0	63·0
Sodium sulphate				
1%	94·0	88·5	84·0	60·0
4%	94·0	94·5	87·0	60·0
8%	95·0	95·0	95·0	60·0
Sodium phosphate				
0·5%	81·0	81·0	58·0	55·5
1·0%	78·5	81·0	58·0	55·5

TABLE 4
Effect of Inorganic Salts on Paste Stability and Set Back Properties of Cassava Flour (<250 μm particle size)

	Breakdown value (P-H), BU				*Set back value (C-P), BU*				*Breakdown ratio H/P*				*Set back ratio C/P*			
	A[a]	*B*[b]	*C*[c]	*D*[d]	*A*	*B*	*C*	*D*	*A*	*B*	*C*	*D*	*A*	*B*	*C*	*D*
Water	290	90	50	70	100(−)	230	250	200	0·55	0·83	0·88	0·80	0·84	1·43	1·58	1·50
Sodium chloride																
1%	250	70	20	50	50(−)	290	320	240	0·62	0·87	0·95	0·86	0·92	1·53	1·76	1·63
4%	200	100	50	60	0	300	300	250	0·70	0·83	0·89	0·85	1·00	1·50	1·65	1·63
8%	210	110	80	60	30	290	300	260	0·70	0·82	0·84	0·86	1·04	1·46	1·60	1·61
Sodium sulphate																
1%	160	40	20	40	20(−)	280	270	290	0·74	0·92	0·97	0·92	0·97	1·57	1·82	1·57
4%	Nil	20	Nil	20	180	320	330	320	1·00	0·92	1·00	0·92	1·33	1·64	2·00	1·64
8%	Nil	20	0	10	140	320	320	320	1·08	0·94	1·00	0·94	1·28	1·88	1·94	1·89
Sodium phosphate																
0·5%	310	310	140	140	240(−)	60(−)	50(−)	0	0·41	0·52	0·66	0·59	0·57	0·91	1·12	1·00
1·0%	300	310	290	200	300(−)	100(−)	110(−)	60(−)	0·37	0·49	0·49	0·52	0·63	0·87	0·81	0·86

[a] A – plain-dried; [b] B—SHTT-I (5 min); [c] C—SHTT-II (10 min); [d] D—SHTT-III (20 min).

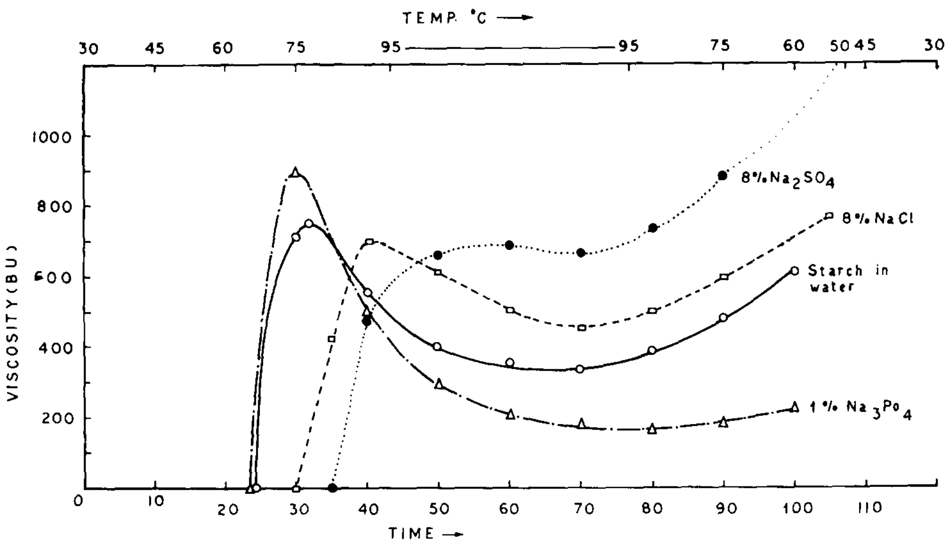

Fig. 1. Viscogram of cassava starch (6%) in salt solution.

between sodium sulphate and chloride, the former was more effective in imparting paste stability and improving set back properties.

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