Biochemical Composition in Cassava Root and Physico-chemical Properties of Starch

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Introduction

Cassava (*Manihot esculenta* Crantz) is one of Thailand's major economic field crops. The planting area is about 1.09 million hectares with the root production of 17 million tons a year. More than fiftypercents of the fresh cassava roots are processed for in to starch with a value about 175 million US $. Thailand is the world's largest cassava starch exporter.

Cassava varieties, the time of harvesting as well as the environment all affect the quality of cassava starch such as its viscosity, swelling power, and solubility.

Table 1 Chemical and physical properties of Satuk, Warin, Korat, Chokchai, Surin, Yasotorn, and Srikew soil series in Nakhon Rachasima province.

Soil properties	Satuk	Warin	Korat	Chokchai	Surin	Yasotorn	Srikew
pH	7.8	6.2	4.5	4.6	6.7	5.6	7.1
Organic Matter,%	0.537	0.655	1.442	1.638	2.294	0.721	0.930
Available Phosphorus,ppm.	6.67	15.63	11.88	25.00	10.00	9.00	23.33
Exchangible Potassium,ppm.	113.6	29.8	174.9	118.4	265.9	25.7	120.8
Soil texture	sandy clay loam	loamy sand	loamy sand	clay loam	clay loam	sandy clay loam	sandy loam

Material and Methods

This experiment was conducted in seven different soil series, i.e. Satuk, Warin, Korat, Chokchai, Surin, Yasotorn and Srikew, all in Nakhon Rachasima province, Thailand's major cassava growing area. Six commecial cassava varieties, i.e. Rayong 1, Rayong 60, Rayong 90, Rayong 5, Karsetsart 50, and Rayong 72, were evaluated for their root biochemical composition and the physico-chemical propertied of starch. A split plot in randomized complete block design was employed with the main plot consisting of cassava varieties and the sub-plot of four harvesting times at 6, 8, 10 and 12 months. Cassava was planted at 1 x 1 m, 15-15-15 chemical fertilizer was applied 30 days after planting. Ten kilograms of fresh roots were collected at each harvesting time for starch extracting. The experiment was conducted during 1996 - 1999 in the farmers' fields. The biochemical composition and the physicochemical properties of cassava starch were determined at the Cassava and Starch Technology Research Unit, National Center for Genetic Engineering and Biotechnology, Kasetsart University, and Rayong Field Crops Research Center, Department of Agriculture.

Results and Discussion

The biochemical composition of starch extracted from six varieties planted in the early and late rainy seasons and harvested at 4 different times is shown in Table 2. The Rayong 5 gave lowest phynolic content for both planting seasons. Planting in early rainy season and harvested at 6 as well as 8 months of the late rainy season provided low phynolic content. No significant was detected for the fiber content among varieties when planted in the late rainy season. Harvested at 10 months gave lowest fiber content for both seasons. Over all average of all varieties and harvesting time indicated that planted in the early rainy season shown lower fiber content than the late rainy season. For fat content, the result indicated that among varieties was not significant different when planted in the early rainy season. Rayong 90 showed the lowest fat content when planted in both seasons. Both planting seasons gave no significant different in protein content. At 10 and 12 months harvested showed low protein content. All varieties gave no significant different when planted in early rainy season for cyanine content. Rayong 5 provided low cyanine content for both planting seasons. High cyanine content were found when harvested at 8 - 10 months in the early rainy season as well as 6 and 12 months harvested in the late rainy season.

Table 2 Phenolic content, fiber content, fat content, protein content and cynide content of six cassava varieties and four harvesting peroids when planted on Warin soil series at Nakhon Ratchasima in early (ERS) and late (LRS) rainy season,1996.

Factors	phenolic content (%)		fiber content (%)		fat content (%)		protein content (%)		cyanide content(ppm)	
	ERS	LRS	ERS	LRS	ERS	LRS	ERS	LRS	ERS	LRS
1. Variety										
Rayong 1	0.1233	0.1135	1.756	3.061	0.244	0.162	2.244	3.167	143	103
Rayong 60	0.1225	0.1230	1.917	2.579	0.155	0.167	2.099	2.728	99	139
Rayong 90	0.1215	0.1171	1.488	2.487	0.170	0.140	1.775	2.659	77	115
Rayong 5	0.1121	0.1058	1.625	2.377	0.228	0.182	2.144	2.796	167	82
Kasetsart 50	0.1367	0.1347	1.661	2.292	0.231	0.246	2.506	3.214	95	160
Rayong 72	0.1186	0.1201	1.771	2.166	0.200	0.214	2.300	3.054	73	108
LSD (0.05)	0.0009	0.0029	ns	0.003	ns	0.058	ns	ns	ns	34
2. Harvesting time (month after planting ; MAP)										
6 MAP	0.1090	0.1163	1.830	2.397	0.210	0.159	2.164	3.678	10	147
8 MAP	0.1312	0.0916	1.585	2.834	0.143	0.171	2.129	3.172	206	95
10 MAP	0.1118	0.1267	1.426	2.117	0.222	0.212	2.144	2.495	205	91
12 MAP	0.1378	0.1416	1.972	2.627	0.243	0.198	2.274	2.399	16	139
LSD (0.05)	0.0214	0.0021	0.272	0.324	ns	0.021	ns	0.268	85	2

The physico-chemical properties of their flour were found to be shown in Table 3. When planted in both seasons the Rayong 72 shown high swelling power as well as harvested at 6 month after planting. Swelling power was reduced when harvested at 10 - 12 months in early rainy season as well as 8 months in late rainy season. Average swelling power of the early rainy season was higher than the late rainy season planting. The Rayong 72 showed high solubility in both planting seasons. Similar result was obtained when harvested at 6 8 months in early rainy season. The highest solubility was observed from the late rainy season planting and harvested at 10 months. Over all average, planted in early rainy season gave higher solubility than the late planting season. The results of peak viscosity showed that Rayong 5 provided high peak viscosity for both planting seasons. The early rainy season planting gave high peak viscosity when harvested at 6 - 8 months. The same trend was observed when harvested at 6 and 12 months in the late rainy season. The early rainy season planting gave higher peak viscosity than the late rainy season planting. The Rayong 1 showed high peak viscosity when planted in the late rainy season planting. The Rayong 5 gave the highest for final viscosity when planted in the early rainy season and the Rayong 1 showed this trend when planted in the late rainy season planting. For both planting seasons, the result informed that harvested at 6 months after planting gave the highest final viscosity. The early rainy season planting gave higher final viscosity than the late rainy season planting.

Table 3 Swelling power, solubility, peak viscosity, and final viscosity of six cassava varieties and four harv esting periods when planted on Warin soil series at Nakhon Ratchasima in the early (ERS) and late (LRS) rainy season,1996.

Factors	Swelling power (%)		Solubility (%)		Final viscosity (RVA)		Final viscosity (RVA)	
	ERS	LRS	ERS	LRS	ERS	LRS	ERS	LRS
1. Variety								
Rayong 1	47.99	41.23	38.0	25.7	408	353	138	156
Rayong 60	54.13	48.01	36.1	29.8	435	349	232	216
Rayong 90	54.19	41.47	34.4	29.0	411	345	228	219
Rayong 5	55.93	46.88	35.2	33.4	449	347	244	204
Kasetsart 50	54.06	46.48	34.2	30.8	426	358	239	215
Rayong 72	62.54	48.81	42.1	33.6	398	324	225	203
LSD (0.05)	5.40	3.62	5.7	3.4	19	15	7	12
2. Harvesting time (months after planting; MAP)								
6 MAP	63.45	48.13	39.6	31.0	432	350	142	244
8 MAP	60.54	41.80	40.0	28.3	430	337	237	215
10 MAP	46.31	45.40	36.1	33.1	405	343	217	205
12 MAP	49.29	45.24	31.0	29.1	416	345	237	203
LSD (0.05)	5.03	3.35	3.6	2.8	16	10	10	10

Conclusion

The results from this study provided information on the biochemical properties of cassava roots of the six principal commercial varieties, and the effect of soil type, planting season, and harvesting time, as well as on physico-chemical characteristics of cassava starch granules and the thermodynamics of starch. Protein and fat content of cassava roots affec t the starch viscosity. Rayong 5 variety, when planted in the early rainy season and harvested at 8 months after planting, was the best cassava variety for the starch industry, due to its low hydrocyanic credentials, and low phenolic acid, fat, protein and fiber content. All soil series provided good starch quality; however, planting Rayong 5 in Chokchai soil resulted in the best starch viscosity.

References

Asoaka M., J.M.V., Blanshard and J.E. Richard. 1992. Effects of cultivars and growth season on the gelatinization properties of cassava (Manihot esculenta Crantz) starch. J. Sci. Food Agric. 59 : 53-58.

CIAT. 1994. Evaluation of the variability of cassava starch functional properties, pp.28-33. *In* Cassava Program Annual Report 1994. Centro Internacional de Agricultura, Tropical, Cali, Colombia.

Cock,J.H. 1985. Cassava : New potential for a neglected crop. Westview Press, Boulder, CO.

Collison, R. 1968. Swelling and gelation of starch. *In* J. A. Radley (ed.) . Starch and its Derivatives. Chapman and Hall Ltd., London, pp. 168-193.

Govindasamy, S., C.G. Oates and H.A. Wang. 1992. Characterization of changes of sago starch components during hydrolysis by a thermostable alpha-amylase. Carbohydrate Polymers 18 : 89-100.

Kawano,K., W.M.G. Fukuda and U. Cenpukdee. 1987. Genetic and environmental effect on dry matter content of cassava root. Crops Sci. 27 : 69-74.

Kim, S.Y., D.P., Wiesenborn, P.H. Orr and L.A. Grant. 1995. Screening potato starch for novel Properties using differential scanning calorimetry. J. Food Sci. 60 : 1060-1065.

Leach, H,w.,L.D.McCowen, and T.J.Schoch. 1959. Structure of the strach granule I.Swelling and solubility patterns of various straches. Anal Chem. 36 : 535-544.

El-Sharkawy M.A. and J.H. Cock. 1987. Response of cassava to water stress. Plant and Soil 100 : 345-360

Morell, M.K., S. Rahman, S.L. Abrahams and R. Appels. 1995. The biochemistry and molecular biology of starch synthesis in cereals. Aust. J. Plant Physiol. 22 : 647-660.

Rogers, D.J. and S. G. Appan. 1971. What's so great about cassava. World Farming 3 (6) : 13-32.

Schoch, T.J. 1964. Swelling power and solubility of granule studies. In R.L. Whistler, R.L.Smith and J.N. BeMiller (eds). Methods in Carbohydrates Chemistry, Volume IV : Starch Academic Press, New York. pp. 106-108.