MODIFIED CASSAVA STARCH IN MALAYSIAN FOOD PRODUCTS

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ABSTRACT

Starch modification widens the possibility of having several different types of food products. Modified starches are more flexible than their native ones and are more appropriate for industrial usage. A few types of modified starches that are suitable for food thickener, batter mix and edible film are studied to increase the economic value of cassava and provide more choice to food manufacturers when selecting their food ingredients.

In the case of food thickener three different types of modified starches are prepared. Two of them are cross-linked hydroxypropylated while the other is cross-linked acetylated. The cross-linked acetylated starch produced has the clearest paste and lower gelatinization temperature than the cross-linked hydroxypropylated starches. The prepared modified starches are then incorporated into tomato sauces. All the three modified starches are found to be capable of producing tomato sauces but of different thickness or degree of viscosity.

For the batter mix the cassava starch is enzymatically prepared and used as an ingredient in a batter mix for deep-fried chicken pieces. The finished product is found to be comparable in terms of texture and sensory attributes with the deep-fried chicken pieces using a commercially available modified starch in the batter mix.

The modified starch for edible film is prepared by initially treating the native cassava starch with enzyme and then with acetic anhydride in alkaline medium. The product is subsequently purified before casting the aqueous solution onto a flat surface plate and drying. The high solubility property of the edible film enables it to be used for food sachets intended to be dissolved in water.

INTRODUCTION

In Malaysia, the total import value of starches (comprising mainly cassava, wheat, maize, potato and sago) in 2000 amounted to RM193,142,246. Cassava starch accounted for about 53% of this value, and its import volume has been growing at an annual growth rate of 16.26% between 1996 and 2000 (Tan *et al.*, 2002).

Since the late 1980s, imports of cassava starch have outstripped corresponding exports (**Figure 1**). Imports have exceeded exports by a maximum volume of more than 195,000 tonnes in 1999, before dropping to about 172,000 tonnes in 2000. Based on rising starch consumption trends in Malaysia, the growth prospects for cassava starch are highly positive.

The growing acceptance of cassava starch in food products due to its various beneficial properties has led to the expansion of related studies conducted in several countries. Cassava starch has a bland flavor that does not mask light flavors such as vanilla, peach and lemon. Its paste, film and gel are clearer than those of other starches; hence, it is suitable for use in certain products such as fruit filling. In addition, its gluten-free nature and easy digestibility have led to its widespread use in baby foods.

In line with the current trend of research, the Food Technology Centre of MARDI has developed a few types of modified cassava starches suitable for food use, including food thickener, batter mix and edible film. The existence of these modified starches is

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intended to increase the economic value of cassava and provide more choice to food manufacturers when selecting their food ingredients.

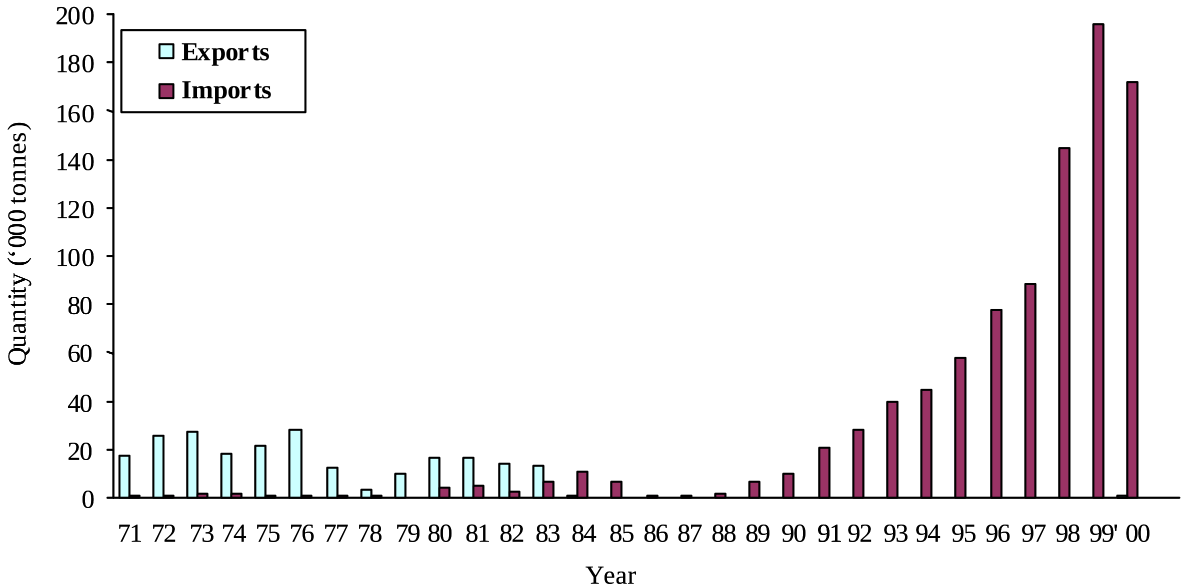

Figure 1. Cassava starch exports from and imports to Malaysia over the period of 1971-2000.
Source: *Department of Statistics, Malaysia.*

Food Thickener

Preparation of Modified Cassava Starches

Two types of cross-linked hydroxypropyl cassava starches (TA and TB) were prepared as shown in **Figure 2**. In the preparation of TB, the starch was reacted in a closed glass reaction vessel attached to a motorized vacuum pump. The vacuum pump was allowed to function at regular intervals. In addition, a cross-linked acetylated cassava starch (TC) was produced as shown in **Figure 3.**

Table 1 shows that the light transmittance values of the pastes, i.e. 6.5% for TA, 12.2% for TB and 23.7% for TC, were greater than that of the commercial starch (4.27 %) indicating greater clarity of the three modified starches. TC was found to be the clearest. This finding is in line with studies by Craig *et al.* (1989) who found that cross-linking would reduce the clarity of the starch paste, and by Wu and Seib (1990) who indicated that acetylation gave better clarity. Among the three modified cassava starches, TB had the lowest phosphorus content of 6.7 mg/100 g. Generally, phosphorus content affects the pasting characteristic of the starch. The pasting characteristic of TC was found to be similar to that of the commercial product (Com), while TA and TB had similar pasting curves (**Figure 4**).

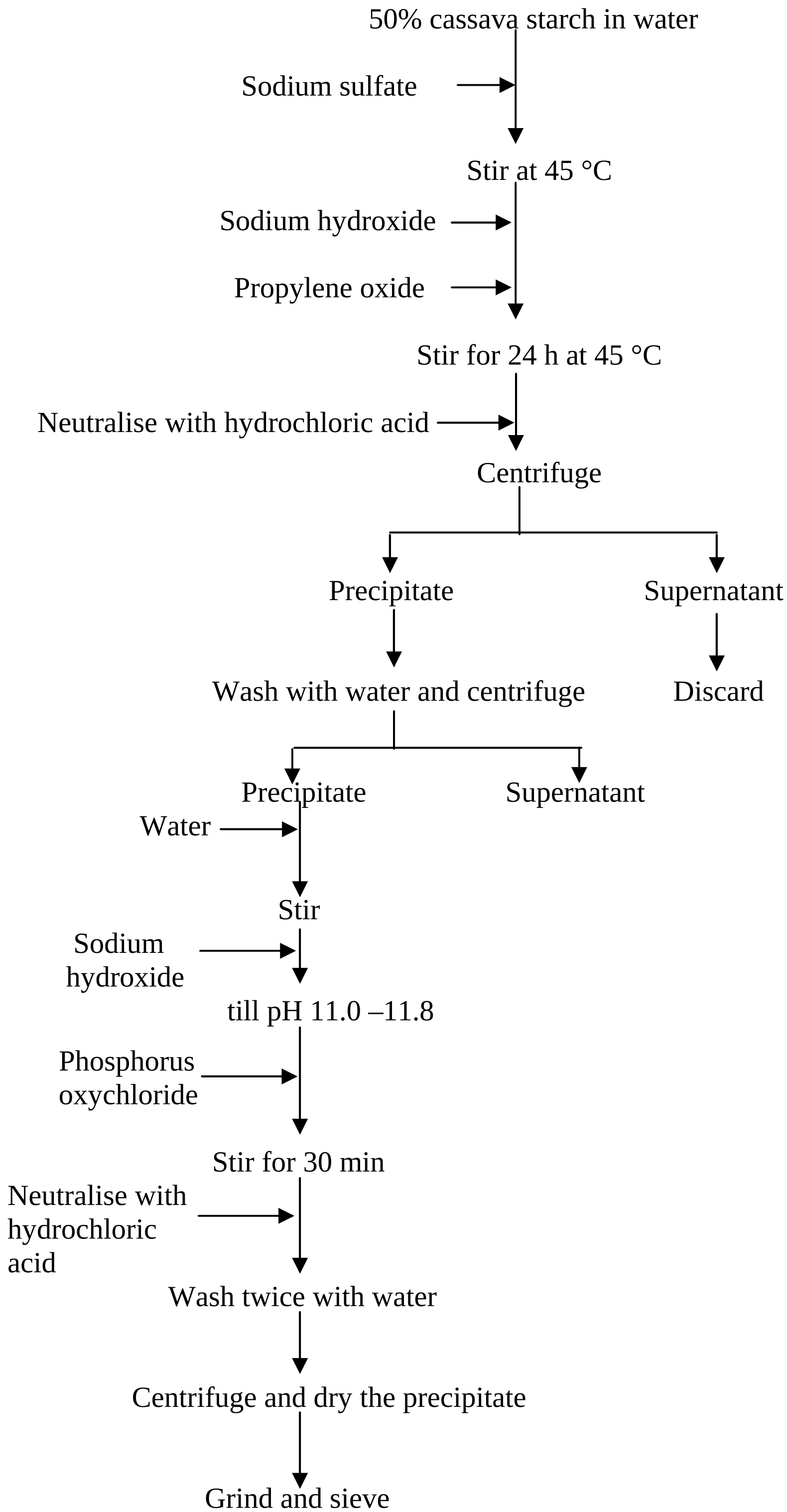

Figure 2: Preparation of cross-linked hydroxypropyl cassava starch.

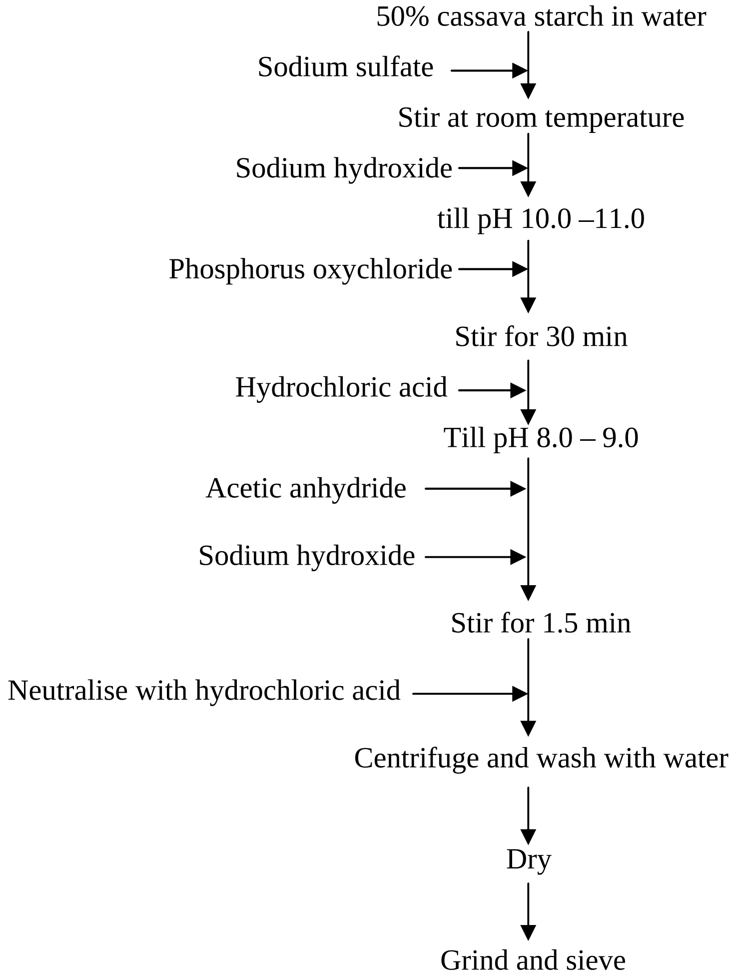

Figure 3: Preparation of cross-linked acetylated cassava starch.

Table 1. Paste clarity and phosphorus content in three modified cassava starches and a commercially available tapioca starch.

Properties	TA[1)]	TB[1)]	TC[1)]	Com.[2)]
Paste clarity (% T_{650nm})	6.55	12.16	23.69	4.27
Phosphorus (mg/100 g)	7.5	6.7	7.3	-[3)]

[1)] TA, TB and TC are modified cassava starches
[2)] Com. = commercially available starch for thickener in sauces
[3)] value not determined

Tomato Sauces Prepared with the Modified Cassava Starches

Figure 5 shows that the viscosity of tomato sauce (SC) containing TC was lowest while that of the commercial cassava starch (Com) was highest. The viscosity curves of tomato sauces SA (containing TA) and SB (containing TB) were also similar to those of commercialy well-known and widely consumed tomato sauces TS1, TS2 and TS3.

The color and pH of the tomato sauces did not show large variation (**Table 2**). The pH of the laboratory-prepared tomato sauces (3.43-3.45) was slightly lower than that of the commercial ones (3.61 –3.72). The total solid content of laboratory-prepared sauces was much higher than that of commercial ones. This could be due to the high amount of tomato paste used.

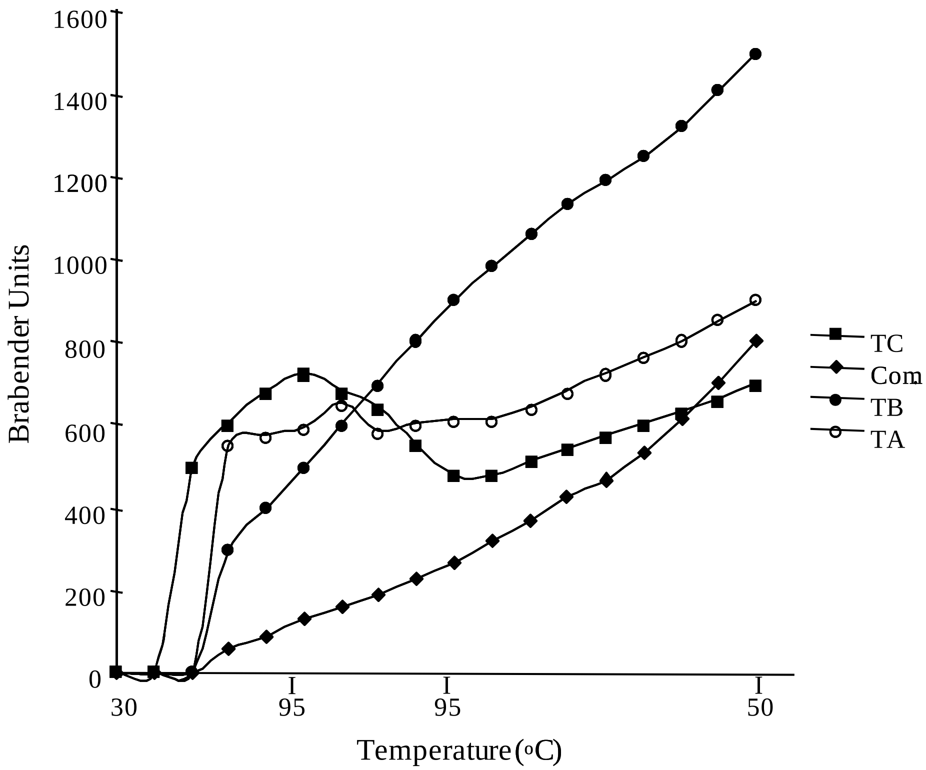

Figure 4. Pasting characteristics of three modified cassava starches and a commercially available starch (6 % d.b.) at pH 6.5.
TA, TB & TC – Modified cassava starches
Com. – Commercially available starch for thickener in sauces

2. Batter Mix

Intermediate- and high-amylose cassava starches were used to improve the texture of potato French fries. They were prepared by using an enzyme. A comparison was made between the French fries coated with the laboratory prepared intermediate-and high-amylose cassava starches and a commercially recommended starch. A Stevens QTS25 texture analyser was used to determine the texture profile of the French fries. The French fries coated with the laboratory prepared cassava starches were not significantly different ($p \leq 0.01$) from those coated with the commercially recommended starch in terms of hardness, cohesiveness, gumminess, chewiness, adhesiveness and springiness.

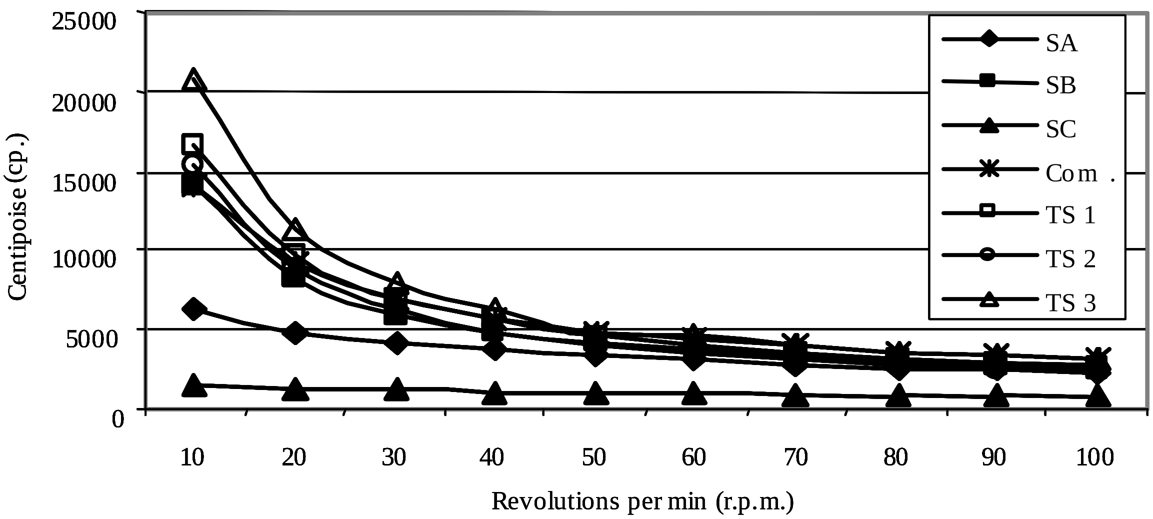

Figure 5. Viscosity of laboratory-prepared and commercial tomato sauces at room temperature.
Note: *SA, SB and SC: Tomato sauces prepared in the laboratory*
TS1, TS2 and TS3: Commercially available tomato sauces

Table 2. Properties of tomato sauces containing the prepared modified cassava starches.

Tomato sauces[1]	Color			pH	Total solids (%)
	L-value	*a*-value	*b*-value		
SA	30.85	15.11	16.05	3.43	82.68
SB	39.95	14.75	16.39	3.45	82.97
SC	28.85	15.73	16.46	3.44	82.90
Com.	28.86	15.87	15.60	3.43	82.71
TS1	24.63	16.49	10.99	3.61	37.09
TS2	25.09	17.27	11.41	3.65	35.43
TS3	25.23	13.93	10.78	3.72	37.09

[1] SA, SB and SC are tomato sauces containing the prepared modified cassava starches, TA, TB and TC
Com. = tomato sauce containing commercially available starch for thickener in sauces
TS_1, TS_2 and TS_3 are commercially available tomato sauces

Coating Starches

The intermediate- and high-amylose cassava starches were prepared by using an enzyme, pullulanase, as described by Khatijah *et al.* (1998). A commercial starch recommended for coating French fries was obtained from the National Starch and Chemical Corporation.

French Fries

The potatoes were washed, deskinned and cut into strips (1x1 cm square by 7-8 cm in length). They were then steamed for 10 min, dipped into 0.5% sodium aluminium pyrophosphate and partially dried in an oven. The various coatings, consisting of wheat flour, salt, dextrin, starches and water, were applied onto the potato strips. The excess coatings were removed before the fries were parfried in palm olein at 160-170°C for 1-3 min. They were then frozen in a blast freezer before packing into plastic bags for storage in a freezer until further usage. The French fries were finished fried at 160-170°C prior to analysis or consumption.

The color of the French fries with coating consisting of a recommended commercial starch (III) was observed to be similar (light yellow) to those with coating consisting of high-amylose starch (II), while those with a coating consisting of intermediate-amylose cassava starch (I) were darker (brownish yellow) in color. The French fries from treatment I were slightly clumpy after frying compared to those from treatment II and III.

Several parameters were obtained from the force versus deformation curves of the texture profile analysis (TPA) **(Table 3)**. The French fries coated with three different coatings were not significantly different ($p \leq 0.01$) in terms of hardness, cohesiveness, gumminess, chewiness, adhesiveness and springiness. They could be considered of similar crispiness as demonstrated by their hardness values.

Table 3. Texture values[1)] of starch-coated French fries.

Samples[2)]	Adhesiveness[3)] (gs)	Chewiness[4)] (kgmm)	Cohesiveness[5)]	Gumminess[6)] (kg)	Hardness[7)] (kg)	Springiness[8)] (mm)
I	2.59±1.92[a]	2.00±0.45[a]	0.33±0.04[a]	0.41±0.10[a]	1.25±0.28[a]	4.94±0.41[a]
II	4.24±1.92[a]	2.23±0.88[a]	0.35±0.06[a]	0.43±0.16[a]	1.26±0.45[a]	5.21±0.65[a]
III	4.34±2.77[a]	1.40±0.39[a]	0.28±0.07[a]	0.28±0.11[a]	1.15±0.81[a]	5.27±0.75[a]

[1)] The values were expressed as mean ± standard deviation
Means with similar superscript within each column are not significantly different at $P \leq 0.01$
[2)] I: Coating consisting of intermediate-amylose tapioca starch
II: Coating consisting of high-amylose tapioca starch
III: Coating consisting of a recommended commercial starch
[3)] Adhesiveness or stickiness : The work required to pull the blade upward
[4)] Chewiness : Gumminous x springiness
[5)] Cohesiveness : The ratio of work done during the second compression divided by the work done during the first compression
[6)] Gumminess: Hardness x cohesiveness
[7)] Hardness: The force necessary to deform the French fry
[8)] Springiness: The height that the French fry springs back after the first compression to the maximum deformation performed

3. Edible Film

Edible films were developed from aqueous solutions of cassava starch. They were prepared by initially converting the native starches into high-amylose starches by using the enzyme pullulanase, and treating the high-amylose starches with acetic anhydride in alkaline medium. The product was then purified before casting the aqueous solution onto a flat surface plate and drying. The films obtained were transparent and clear but a bit fragile. They were highly soluble in cold water and almost completely soluble in hot water **(Table 4)**. The films could be used as food sachets for beverages and dry mixed powder that are intended to be added to hot or cold water prior to use in instant or convenient foods

Table 4: Solubility of edible films in cold and hot water.

Edible films	Solubility (%)[1)]	
	Cold water	Hot water
Cassava	99.1	99.8

[1)] The values are expressed as mean of duplicate samples.

CONCLUSIONS

Modified cassava starch has the potential of being used in various food products. The products developed in this study are intended to be an eye opener to entrepreneurs and hence lead to further development of the cassava industry.

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