

Potato french fries coated with modified tapioca starch mix

(Jejari ubi kentang bersalut campuran kanji ubi kayu terubahsuai)

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Key words: tapioca starch, modified, coating, potato, french fries

Abstrak

Kanji ubi kayu (*Manihot esculenta*) diikat silang dengan menggunakan 0.3 g (kekuatan tinggi) dan 0.2 g (kekuatan rendah) fosforus oksiklorida dalam keadaan pH (11.0–11.2) dan suhu (30 °C) terkawal. Ciri-ciri pes, kestabilan sejuk beku-pencairan dan sisa fosforus serta fosfat residu kanji terubahsuai tersebut telah ditentukan. Kanji terubahsuai itu digunakan di dalam campuran salutan untuk jejari kentang goreng. Jaringan jejari kentang goreng yang dihasilkan dengan menggunakan campuran salutan yang mengandungi kanji ubi kayu terubahsuai kekuatan tinggi didapati tidak mempunyai perbezaan yang ketara ($p \leq 0.05$) dari segi kekerasan, kejelekitan, kebergetahan, keliatan, kepekatan dan keanjalan berbanding dengan jejari kentang goreng yang bersalut dengan campuran kanji komersial yang disarankan.

Abstract

The tapioca starch (*Manihot esculenta*) was cross-linked with 0.3 g (higher strength) and 0.2 g (lower strength) phosphorus oxychloride under controlled pH (11.0–11.2) and temperature (30 °C). Pasting characteristics, freeze-thaw stability and residual phosphorus as well as phosphate of the prepared modified starches were determined. The modified tapioca starches were used as coating mixes for potato french fries. The texture of french fries obtained by using a coating mix containing modified tapioca starch of higher strength was found not significantly different ($p \leq 0.05$) from that coated with a recommended commercial starch in terms of hardness, cohesiveness, gumminess, chewiness, adhesiveness and springiness.

Introduction

The global consumption of french fries is in the increase. This is mainly due to today's fast paced life-style leading to an increase in fast food consumption. In 1999, 573 442 t of frozen french fries were exported for a value of US\$566 million, an increase of 22% over 1998. The forecast for the year 2000 was 590 000 t. The Netherlands is the leading exporter of frozen fries followed by Canada

and the USA (Vandenberg and Burafuta 2000).

In 1996, the total frozen french fries market in Malaysia was US\$11 million and more than 80% of the market (US\$9 million) was imported from the USA (Anon. 1996). Almost every major fast food restaurant used frozen fries from the USA.

The quality of french fries very much depends on texture, flavour, taste, colour and

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ease of cooking. Good quality french fries are crispy on the outer surface and tender in the interior portion. They may not be clumpy, sticky, limpy and oily. One of the ways to overcome these problems is to use starch coating.

Currently, very limited studies on french fries are being conducted as this industry is believed to be an established one. However, a few studies are still on-going to further improve the french fries especially in terms of crispness or to create new innovative products. A study by Aguilar et al. (1997) revealed that blanching for 30–45 min at 60–65 °C improves the texture of french fries. They are firmer, more chewy, more cohesive, less limpy and oily. Lima and Singh (1995) measured the textural properties of french fries in canola oil and reported that the bending strength is related to frying time but not frying temperature. Khatijah (1999) studied the use of enzymically prepared high amylose starch mix to improve the quality of french fries. The high amylose starch was found to improve the crispness of the coated french fries.

This study was part of a comprehensive effort to utilise starches from local sources. Its main objective was to improve the texture of french fries by using coating mixes of laboratory prepared modified tapioca starches.

Materials and methods

The tapioca starch was obtained from a processing factory. The potato was commercially obtained from the Klang valley. All chemicals used for analytical purposes were of analytical grade. The

ingredients for french fries processing were commercially purchased from a grocery store.

Modified tapioca starch

The modified tapioca starches with two different strengths of cross linking were prepared separately by using 50% native tapioca starch suspension (as is basis) containing sodium sulphate. The pH of the mixture was adjusted to 11.0–11.2 with sodium hydroxide before the addition of 0.3 g (higher strength) and 0.2 g (lower strength) phosphorus oxychloride (POCl₃) (Figure 1). The mixture was stirred for 30 min at 30 °C. The pH of the mixture was then lowered to 6.0 with hydrochloric acid. The mixture was dewatered, washed and centrifuged before oven dried at 50–60 °C. The product was then ground and sieved using 125 mm sieve.

Starch pasting characteristic

The starch pasting characteristic was measured using a Brabender amylograph (700 cm g and at 75 rpm). A starch suspension containing 45 g starch (as is basis) in 450 mL water at pH 7.0 was studied. The cycle involved a heating period from 30 °C to 95 °C, holding period at 95 °C for 30 min followed by a cooling period to 50 °C.

Freeze-thaw

The freeze-thaw cycle of gelatinized starch was determined as described by Wu and Seib (1990). The starch paste (6% d.b., pH 6.5) which had undergone the heating-cooling cycle in the amylograph was used in the determination. The cooked starches in

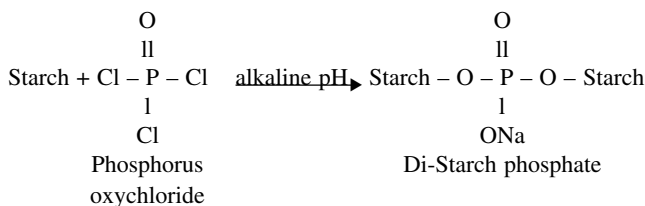


Figure 1. Cross linking of starch with phosphorus oxychloride

sealed tubes were held first at 4 °C for 24 h and then subjected to freeze-thaw cycles (-18 °C for 48 h and thawed at 30 °C in a water-bath for 2 h).

Phosphorus

The residual phosphorus and phosphate content of the modified starch was determined according to Smith and Caruso (1964).

French fries

The potatoes were washed, deskinning and cut into strips (1 x 1 cm² by 6–8 cm in length). They were then dipped into 0.5% sodium aluminium pyrophosphate for 1 min and partially dried in an oven. The coating mixes consisting of wheat flour, salt, commercially recommended starch as control or developed modified starches as tests and water were applied onto the potato strips. The excess coating was removed before the fries were parfried in palm olein at about 150 °C for 1–3 min. They were then packed into plastic bags, frozen in a blast freezer and stored in a freezer until further usage. The french fries were finished fried at about 150 °C prior to analysis or consumption.

Texture profile analysis

The texture of french fries was determined by using a Stevens Fernel (model QTS25) texture analyser. The products were cooled to room temperature prior to the determination. The texture profile analysis (TPA) curve was obtained by using a single blade shear cell. Two consecutive compressions (8 mm) at 1.7 mm/s were carried out. Six random replicates of french fries from each treatment were analysed. Three readings (0.5 cm from the ends and the middle part) from each fry were taken. The parameters recorded from the force versus deformation curves were hardness, cohesiveness, gumminess, chewiness, adhesiveness and springiness (Bourne 1982).

Statistical method

Analysis of variance using one-way ANOVA with multiple range tests was applied to the results. The significance was established at $p \leq 0.05$.

Results and discussion

Pasting characteristics

The pasting characteristics of the laboratory prepared modified tapioca starches (T1 & T2) differed from that of a recommended commercial starch (Com.) (*Figure 2*). The recommended commercial starch did not show any response on heating as it was not a cross-linked starch but a blend of high amylose corn starch and tapioca dextrin. Both the prepared starches (T1 & T2) had gelatinization temperatures of 57.0 °C and 57.5 °C (*Table 1*). The modified tapioca starch of higher strength (T1) had a pasting peak of 1 580 Brabender units (B.U.) at 24 min while that of lower strength (T2) 1 520 B.U. at 24 min. T2 with the absolute set-back value of 520 B.U. was more stable than T1 (absolute set-back value of 880 B.U.). Stability or set-back value is the viscosity difference between peak viscosity and the viscosity after 30 min holding at 95 °C (Wu and Seib 1990). The lower the absolute value of stability, the more stable the starch paste was to shearing exerted by the agitator in the Brabender amylograph.

Freeze-thaw stability

In the freeze-thaw tests slight syneresis was observed in both the modified starch pastes (*Figure 3*). Syneresis did not occur in the initial stages. The modified starch of lower strength was stable for eight freeze-thaw cycles while that of higher strength for sixteen cycles. The amount of water separation increased steeply at the initial syneresis stage and lessened thereafter. The recommended commercial starch did not form gel after heating and hence the inability to measure the percentage of water separation.

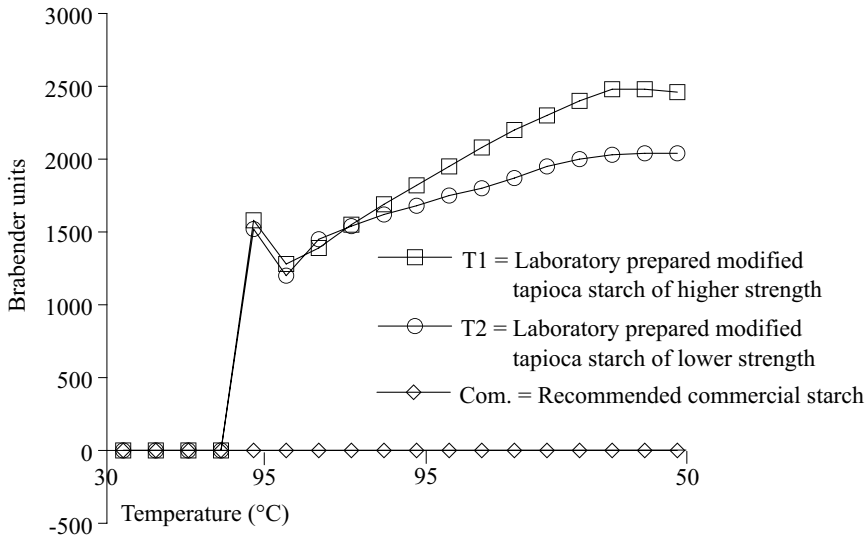


Figure 2. Pasting characteristics of the recommended commercial starch and laboratory prepared modified tapioca starches at a concentration of 45 g in 500 mL suspension and pH 7.0

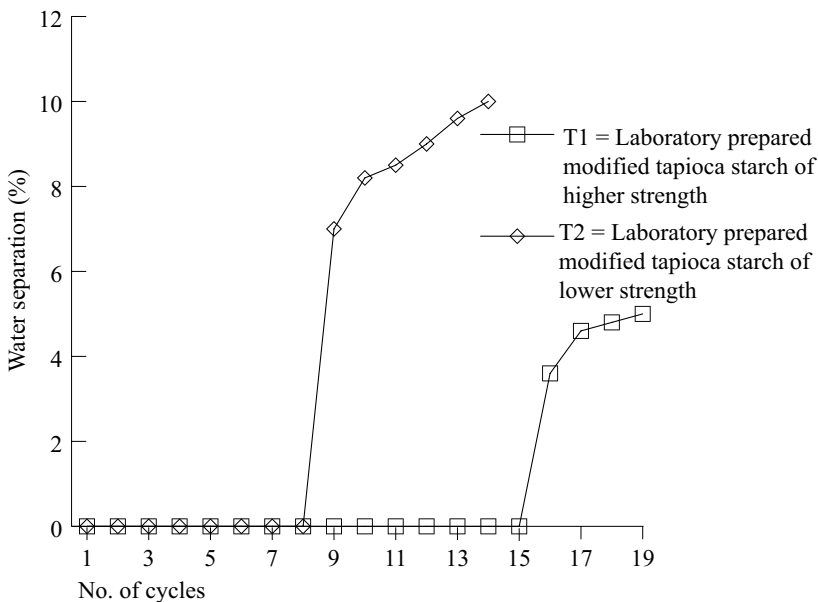


Figure 3. Freeze-thaw stability of modified tapioca starch pastes (10% starch in water)

Phosphorus

The residual phosphorus and phosphate contents of the prepared modified starches were found to be lower than the permitted levels, i.e. 0.04% phosphorus or 0.11% phosphate, as specified by FAO/WHO and EEC (Trimble 1983; Wurzburg 1986). The

residual phosphorus of T1 was 0.0023% (0.0070% phosphate) while that of T2 was 0.0021% (0.0064% phosphate). As mentioned earlier the control i.e. Com. (recommended commercial starch) was not a cross-linked starch with phosphorus oxychloride but a blend of high amylose

corn starch and tapioca dextrin and hence, the residual phosphate was not determined.

Texture profile analysis

From the texture profile analysis, fries coated with the laboratory prepared modified tapioca starch of higher strength (III) were not significantly different ($p \leq 0.05$) from those coated with the recommended commercial starch (I) in terms of hardness, cohesiveness, gumminess, chewiness, adhesiveness and springiness (Table 2). Fries coated with lower strength modified starch (II) showed similarities with

the recommended starch (I) only in terms of springiness and with those coated with higher strength starch (III) in terms of cohesiveness and springiness. The benefit of starch coated products to achieve the desired texture had been supported by Huang (1995).

Conclusion

This study indicates the possibility of utilising tapioca starch in a coating mix for french fries. It will provide additional choices for food manufacturers in diversifying food products using local raw

Table 1. Pasting characteristics of 6% modified tapioca starches

Modified starches	Tapioca with higher strength (T1)	Tapioca with lower strength (T2)
Gelatinisation temperature (°C)	57.0	57.5
Time taken to gel (min)	18.0	18.5
Peak viscosity (B.U.)	1 580	1 520
Time taken to reach peak viscosity (min)	24.0	24.0
Viscosity at the end of holding period (B.U.)	1 860	1 540
Viscosity at 50 °C	2 460	2 040
Set back (B.U.)	880	520
Consistency (B.U.)	600	500
Breakdown (B.U.)	-880	-520

Set back = viscosity at 50 °C – peak viscosity

Consistency = viscosity at 50 °C – viscosity at the end of holding period

Breakdown = peak viscosity – viscosity at the end of holding period

Table 2. Texture profile analytical values of modified tapioca starch coated potato french fries

Samples	Adhesiveness (g s)	Chewiness (kg mm)	Cohesiveness	Gumminess (kg)	Hardness (kg)	Springiness (mm)
I	24.18 ± 1.22a	2.36 ± 0.38a	0.21 ± 0.01a	0.37 ± 0.05a	1.98 ± 0.06a	5.56 ± 0.04a
II	67.40 ± 2.65b	0.85 ± 0.07b	0.14 ± 0.02b	0.19 ± 0.01b	1.47 ± 0.02b	4.77 ± 0.05a
III	26.66 ± 1.43a	1.89 ± 0.10a	0.18 ± 0.01ab	0.36 ± 0.03a	2.10 ± 0.03a	5.04 ± 0.05a

The values were expressed as mean ± standard deviation (6 replicates with a total of 18 readings)

Means with similar letter within each column are not significantly different at $p \leq 0.05$

I : Coating consisting of a recommended commercial starch

II : Coating consisting of a laboratory prepared modified tapioca starch of lower strength

III : Coating consisting of a laboratory prepared modified tapioca starch of higher strength

Adhesiveness or stickiness: The work required to pull the blade upward

Chewiness: Gumminess x springiness

Cohesiveness: The ratio of work done during the second compression divided by the work done during the first compression

Gumminess: Hardness x cohesiveness

Hardness: The force necessary to deform the french fry

Springiness: The height that the french fry springs back after the first compression to the maximum deformation performed

materials. Value added food products including french fries are in great demand by modern consumers.

The texture of french fries coated with modified tapioca starch (of higher strength) mix was found to be comparable to the texture of those coated with a recommended commercial starch mix. They were crispy, tender and could remain crispy for a longer time compared to the other fries.

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