

Effects of Partial Replacement of Rice Flour with Various Starches on the Physicochemical and Sensory Properties of “Sen Lek” Noodle

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ABSTRACT

This research was conducted to investigate the effects of partial replacement of rice flour with 5 to 20 % three different starches (potato, corn and cassava) on the chemical and the physical properties of both raw mixed flour and Sen Lek products. Sensory properties of the products were also evaluated. The results indicated that values of protein, amylose, water absorption index (WAI), solid loss as well as the viscosity changes by RVA of the raw mixed rice flour were affected by the level and the types of starch in the mixes. Sen Lek prepared from rice flour containing various starches had higher values of cooking yield and cooking loss than those prepared from pure rice flour (the control). Besides, the products added with starch contained higher carbohydrate but lower protein and fat as the starch content in the raw mixes flour increased. All noodle products, except the one prepared from the mix containing 20% cassava starch, were considerably more elastic than the control. Incorporation of various starches in Sen Lek preparations increased the extensibility and the stickiness values of the cooked products. The sensory evaluation showed that all noodles gave fairly good quality of which three noodle samples replacing with 5% potato starch, 20% corn starch and 10% cassava starch had the highest acceptance scores within each starch group. However, no significant difference was observed on the texture and the acceptance score between those three noodle samples and the control.

Key word: rice noodle, sen lek, rice flour

INTRODUCTION

Rice noodle is one of the products made from rice flour. It is favorably consumed as a main dish or snack by people in south East Asia, Thailand in particular. Through rapid expansion of the noodle's market, locally and internationally, does increase its value. The drawback of the product's qualities still exists due to the instability of the proper quality of raw material, especially rice, and the variation in the production technology. Very few studies have been reported on the desirable rice

qualities for rice noodle production (Kohlwey *et al.*, 1995; Li and Luh, 1980; Bhattacharya *et al.*, 1999). To achieve such quality, a number of rice noodle factories practically added some other native starches or modified starches to replace a portion of rice flour. However, the prevailing of the science data to support the necessary application of those starches to improve the noodle quality is limited. Hence, the physicochemical properties of rice flour mixed with various starches and the qualities of rice noodle were investigated.

MATERIALS AND METHODS

Raw material

A single lot of rice flour was purchased from a rice noodle factory in the form of rice cake with 40% moisture content. The cake was beaten into small pieces, dried in a hot-air oven at 45°C for 16 hours and ground with Pin Mill. The flour obtained was kept in the closed plastic bags until the experiment began. Potato starch was obtained from the Winner Group Ltd., while corn starch (Friend ship) and cassava starch (Pha Mung Korn) were purchased from a local supermarket. These three types of native starch are normally used in rice noodle factories.

Flour preparation

Each type of starch was mixed with the rice flour at 5, 10, 15 and 20% of total dry weight. Chemical and physical properties of the flours were analyzed for moisture, protein and ash contents according to AOAC (1990), amylose content by Juliano (1971), water absorption index (WAI) and solid loss by modified Anderson *et al.* (1969). The viscosity of the flours was also measured by using a Rapid Visco Analyser (RVA).

Noodle preparation : Sen lek

Forty percent of the flour was prepared and let stand for 1 hr at room temperature. Seventy grams of the slurry were poured into 22×28 cm stainless steel tray, steamed for 5 minutes and cooled down to room temperature, resulted in a gelatinized noodle sheet about 1 mm thick. The sheet then was removed from the tray, placed onto the racks and dried on a perforated tray at 150°C for 10 minutes before cooling and cutting to obtain small strips about 0.5 mm wide. The noodles were further dried in a hot-air oven at 45°C until the moisture content decreased to 10-12%.

Physical properties of noodle

Cooking yield and cooking loss

Sen Lek noodles were determined for cooking yield and cooking loss. Noodles of 10 g were cut into 5 cm length and were added to a beaker containing about 150 ml of boiling distilled water on a hot plate. The beaker was covered with a watch-glass, cooked for 10 min and stirred slightly with a glass rod. The cooked noodles were filtered through a stainless steel screen and washed with 20 ml distilled water. After draining for 5 min, the noodles were weighed and the cooking yield was calculated. For cooking loss, the combined filtrate and washing were poured into 200 ml volumetric flask, adjusted to the volume with distilled water. Ten millimeter of the solution was pipetted into a tared aluminum dish, evaporated until dried and dried at 105°C to constant weight. The solid loss during cooking was calculated.

Tensile strength and stickiness

Noodles were soaked in tap water for 10 min, drained, after 10 min they were cooked in boiling distilled water for 2 min then removed and immediately cooled in distilled water. The cooked noodles were drained on a stainless steel screen for 10 minutes. Texture qualities of the cooked noodles including tensile strength, break distance (extensibility) and stickiness were measured on a Texture Analyzer model TA-XT2i Stable Micro System Ltd., Vienna, England., using a Spaghetti Tensile Rig (Code A/SPR) probe and a Pasta Stickiness Rig (Code HDP/PES) probe, respectively.

Chemical properties of noodle

Noodles were determined for moisture, protein, fat and ash contents by the standard methods of AOAC (1990). Carbohydrate content was calculated by the different method 100-(protein + fat + ash content).

Sensory evaluation of noodle

Sensory evaluation of Sen Lek noodles were conducted by using 9 points Hedonic Scale. Twenty

panelists were selected from the Institute of Food Research and Product Development staff. Organoleptic qualities evaluated were appearance, color, shiny and grossy, cohesiveness, flavor, texture and overall acceptance.

Statistical analysis

Data collected from the sensory evaluation were analyzed by the use of ANOVA and mean procedure of SAS (Statistical Analysis System). Duncan's New Multiple Rang Test was used to detect mean differences.

RESULTS AND DISCUSSION

Properties of raw materials

Physical properties such as WAI and solid loss of the mixed rice flour were changed by the levels and the types of starch added in the mixes (Table 1). Rice flour containing 5 to 20% potato, corn and cassava starches had WAI values of 1.29-1.31, 1.25-1.33 and 1.24-1.31%, respectively. As the levels of the cassava starch in the mixes increased, the WAI decreased. Our observation

was in close agreement with the findings of Tiraporn (1990). The cooking losses were relatively high in the samples mixed with corn and cassava starches. The mixes containing potato starch were identical to the pure rice flour (control). Among starch groups, corn starch strongly affected the solid loss of the mixes.

The results from RVA measurement revealed that incorporation of other starches in rice flour affected the rheological behavior on heating and cooling of the flour samples. The mixes with potato and cassava starches gave lower gelatinization temperatures (GT) than the control, while corn starch had no noticeable effect on the GT (Table 2). The mixes with potato starch showed the highest peak viscosity value which implied that this starch can improve swelling and water absorption of the mixes more than the other starches. Final viscosity of the pure rice flour was relatively high, therefore retrogradation easily occurred as compared with the other samples. Among the starch groups, rice flour mixed with cassava starch had the lowest value of the final viscosity resulted in more stickiness of the cooked paste.

Table 1 WAI and solid loss of rice flour and rice flour mixed with various starches.

Sample	WAI*	Solid loss (%)*
Rice flour	1.27	1.63
5% Potato	1.29	1.66
10% Potato	1.30	1.61
15% Potato	1.30	1.65
20% Potato	1.31	1.55
5% Corn	1.33	1.99
10% Corn	1.25	2.02
15% Corn	1.28	2.01
20% Corn	1.28	1.82
5% Cassava	1.31	1.93
10% Cassava	1.28	1.86
15% Cassava	1.29	1.75
20% Cassava	1.24	1.73

* Average are based on three measurements of each sample.

Table 2 Pasting properties of rice flour and rice flour mixed with various starches using Rapid Visco Analyzer (RVA).

Sample	Peak Vis (RVU)	Trough (RVU)	Final Vis (RVU)	Break down (RVU)	Set back (RVU)	Consistency (RVU)	Pasting Temp (°C)
Rice flour	271.08	175.83	359.83	95.25	87.75	184.00	80.75
5% Potato	274.58	137.00	296.58	137.58	22.00	159.58	78.35
10% Potato	298.58	150.08	311.75	148.50	13.17	161.67	77.50
15% Potato	309.67	156.17	312.25	153.50	2.58	156.08	76.70
20% Potato	348.75	178.00	330.58	170.75	-18.17	152.58	73.50
5% Corn	247.50	132.92	280.08	114.58	32.58	147.16	80.75
10% Corn	251.50	138.25	284.92	113.25	33.42	146.67	80.70
15% Corn	237.42	134.92	273.50	102.50	36.08	138.58	80.70
20% Corn	256.62	152.25	301.04	104.37	44.42	148.79	79.15
5% Cassava	256.25	127.00	264.25	129.25	8.00	137.52	79.10
10% Cassava	254.67	127.58	251.00	127.08	-3.67	123.42	78.40
15% Cassava	251.08	124.92	235.50	126.17	-15.58	110.58	76.70
20% Cassava	285.29	155.58	280.33	129.71	-4.98	124.75	75.55

RVU = Rapid Visco Unit

Table 3 showed the chemical composition data of the rice flour and the rice flour mixed with various starches. Increasing amount of starch in the mixes caused a decrease in protein content and an increase in amylose content. Rice flour with 20% corn starch exhibited the highest amylose content (33.40%). However, all samples contain amylose in the range of 30.86 to 33.40% corresponding to the suitable values (27 to 33%) recommended by Niyomvit (1989) for rice noodle manufacturing. There was no change in ash content in all samples.

Noodle qualities

Evaluations of noodle qualities were based on the amount of cooking yield and cooking loss, tensile strength, break distance value, surface stickiness and a taste panel. The results showed that the cooking yield of the noodles with potato and cassava starches were increased as the quantity of the starches in the mixes increased (Figure 1). All noodles prepared from the starches-mixed rice flour

samples had higher cooking yields than the control. This is probably due to the role of the added starches upon the slightly increased water absorption of the noodle. Noodle prepared from the pure rice flour had the cooking loss value of 6.11%. Incorporation of extra starch into rice flour resulted in increasing the solid loss of such noodles during cooking. Sen Lek with 20% corn starch exhibited the lowest cooking loss value (5.09%). Protein and fat contents of the starch added noodle were significantly decreased as the amount of starch increased. Carbohydrate content, on the other hand, were increased in all noodle samples which added starches. Ash content was slightly changed (Table 4).

Textural properties of Sen Lek

It is generally accepted that the main criterion for assessing the overall quality of cooked pasta is based on the evaluation of texture (Smewing, 1997). In this experiment cooked noodles were tested for

Table 3 Chemical compositions of rice flour and rice flour mixed with various starches.

Sample	Protein ^(a) (%)	Ash ^(a) (%)	Amylose ^(a) (%)
Rice flour	7.41 ^(b)	0.21 ^(b)	30.96 ^(b)
5% Potato	7.15	0.22	30.96
10% Potato	6.56	0.34	30.93
15% Potato	6.38	0.31	31.44
20% Potato	6.20	0.30	31.52
5% Corn	7.09	0.21	31.06
10% Corn	6.77	0.21	32.30
15% Corn	6.40	0.19	32.81
20% Corn	6.18	0.20	33.40
5% Cassava	7.06	0.33	30.86
10% Cassava	6.79	0.31	31.50
15% Cassava	6.26	0.30	31.72
20% Cassava	6.08	0.23	31.83

(a) Values reported on a moisture free basis.

(b) Averages are based on three measurements of each sample.

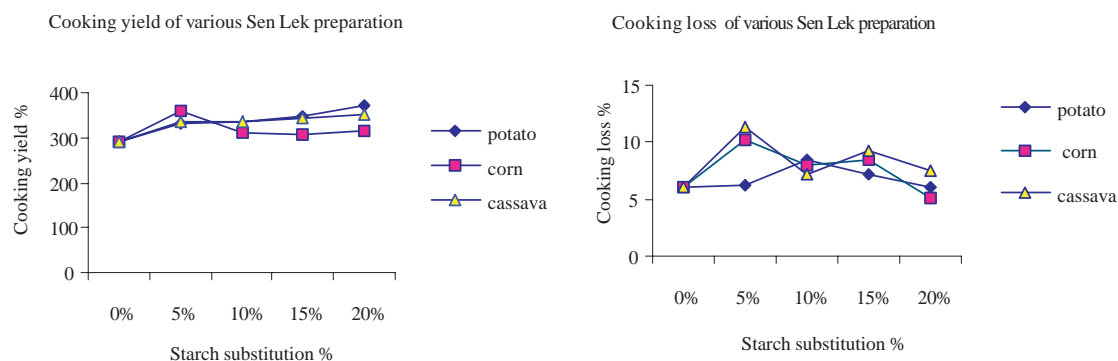


Figure 1 Cooking yield and cooking loss of Sen Lek prepared from rice flour and rice flour mixed with various starches.

tension to assess elasticity and break distance, to imply the extensibility. The results were shown in Table 5. All noodles mixed with starch, except that containing 20% cassava starch, had tensile strength values relatively higher than the control. The noodles with 5% corn, potato and cassava starches had tensile strength values of 45.87, 30.04 and 30.76 gram-force, respectively. While the noodle with 10% potato starch exhibited higher tensile strength

value than those with 10% corn starch and 10% cassava starch. However, adding of starch up to 20% resulted in lowering the tensile strength value of the noodle.

It is clear that noodles replacement with potato, corn and cassava starches were considerably more extensible than the control. However, the values were exhibited variations upon the types and the amounts of starch used. Addition of starch also

Table 4 Nutritional value of Sen Lek prepared from rice flour and rice flour mixed with various starches.

Sample	Protein ^(a) (%)	Ash ^(a) (%)	Fat ^(a) (%)	Carbohydrate ^(a) (%)
Rice flour	7.20	0.24	0.84	91.72 ^(b)
5% Potato	6.95	0.32	0.75	91.98
10% Potato	6.52	0.33	0.82	92.33
15% Potato	5.93	0.31	0.76	93.00
20% Potato	5.51	0.27	0.56	93.66
5% Corn	6.72	0.25	0.71	92.32
10% Corn	6.18	0.23	0.78	92.81
15% Corn	6.22	0.23	0.70	92.85
20% Corn	5.64	0.21	0.66	93.49
5% Cassava	6.56	0.31	0.84	92.29
10% Cassava	6.59	0.29	0.83	92.29
15% Cassava	6.02	0.31	0.80	92.87
20% Cassava	5.67	0.29	0.80	93.24

^(a) Values reported on the moisture free basis.

^(b) Calculated values, (%) carbohydrate = (100 – Protein-Ash-Fat)

Table 5 Textural characteristics of various Sen Lek from a tensile test cell.

Sample	Max force \pm SD*(g)	Distances \pm SD*(mm)
Rice flour	29.84 \pm 3.36	24.48 \pm 2.99
5% Potato	35.34 \pm 4.34	29.65 \pm 3.09
10% Potato	46.99 \pm 6.88	29.05 \pm 3.14
15% Potato	42.59 \pm 6.32	30.76 \pm 3.97
20% Potato	33.13 \pm 5.85	26.88 \pm 2.99
5% Corn	45.87 \pm 4.30	34.75 \pm 4.11
10% Corn	43.20 \pm 6.91	31.06 \pm 2.42
15% Corn	40.90 \pm 5.56	27.05 \pm 2.67
20% Corn	36.84 \pm 4.54	26.21 \pm 2.93
5% Cassava	30.76 \pm 5.03	27.67 \pm 3.34
10% Cassava	33.83 \pm 2.93	34.60 \pm 2.33
15% Cassava	31.24 \pm 2.48	35.15 \pm 1.51
20% Cassava	26.40 \pm 3.44	31.60 \pm 3.24

* Averages are based on 10 measurements of each sample.

affected the stickiness of the cooked noodles as shown in Figure 2. At 20% cassava starch, the noodle possessed the highest value of stickiness, while the lowest value belonged to the sample

containing 20% corn starch. The stickiness of the cooked noodles added with cassava starch was increased as the amount of starch increased. The results obtained were similar to that reported by

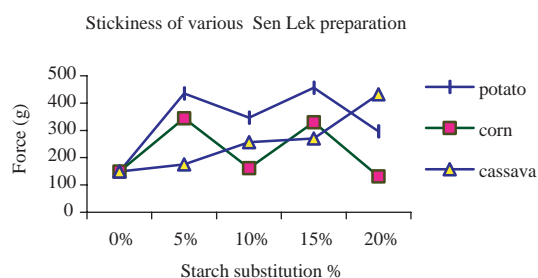


Figure 2 Stickiness of Sen Lek prepared from rice flour and rice flour mixed with various starches.

Tiraporn (1990).

Sensory properties

Table 6 showed the results of sensory test of cooked noodles. The noodles with 5 to 20% corn starch and 5- to 20% cassava starch had no significant difference ($p \geq 0.05$) based on texture. While the noodle with 10% potato starch had texture score significantly different from the other samples in the group. All noodle characteristics such as appearance, color, shiny, cohesiveness, flavor, texture and acceptability gained preference scores of 6 to 7, representing slightly like to moderately like. The

noodle samples containing 5% potato starch, 20% corn starch and 10% cassava starch had the highest acceptability scores in each group of the starches. Panelists suggested that the noodle with potato starch gave more elasticity and tougher as the amount of starch increased, while the noodle with cassava starch possessed more extensibility and softer texture than the control noodle. However, at 20% cassava starch, the noodle exhibited undesirable characteristics. In the experiment, texture scores of the noodle prepared from the mixes containing potato, corn and cassava starches significantly correlated with the score of the product acceptability $r=0.952^*$, 0.926^* and 0.941^* ($p<0.05$), respectively. Texture of cooked noodle was the principle characteristics for the panelists to decide the product acceptance (Bhattacharya et al. 1999). In this experiment, it was found that, the panelists could not define any difference on texture and overall acceptability between the control and the sample with the highest acceptability score from each group. However, the noodle with 20% corn starch obtained the highest score in both texture and acceptability. This may be caused by the highest amylose content of the mix flour (Sanchez, 1975).

Table 6 Sensory scores of Sen Lek prepared from rice flour and rice flour mixed with various starches.

Sample	Appearance	Color	Shiny	Cohesiveness	Flavor	Texture	Acceptability
5% Potato	6.95 ^{ab}	6.83 ^b	6.57 ^{ab}	6.48 ^a	6.48 ^a	6.76 ^a	6.76 ^a
10% Potato	6.57 ^b	6.48 ^c	6.24 ^b	6.50 ^b	6.40 ^a	6.14 ^b	6.00 ^b
15% Potato	7.10 ^a	7.10 ^{ab}	6.33 ^b	6.57 ^b	6.67 ^a	6.86 ^a	6.71 ^a
20% Potato	6.86 ^{ab}	7.29 ^a	6.86 ^a	6.62 ^b	6.50 ^a	6.60 ^{ab}	6.33 ^{ab}
5% Corn	6.15 ^b	6.55 ^b	6.05 ^c	6.43 ^a	6.95 ^a	6.43 ^a	6.28 ^a
10% Corn	6.10 ^{ab}	6.70 ^{ab}	6.35 ^{ab}	6.75 ^a	6.70 ^a	6.58 ^a	6.58 ^a
15% Corn	6.15 ^b	6.85 ^a	6.20 ^{bc}	6.75 ^a	6.70 ^a	6.45 ^a	6.45 ^a
20% Corn	7.00 ^a	6.95 ^a	6.50 ^a	6.75 ^a	6.55 ^a	6.75 ^a	6.70 ^a
5% Cassava	6.91 ^a	6.61 ^a	6.59 ^a	6.95 ^a	6.59 ^a	6.41 ^a	6.73 ^a
10% Cassava	6.45 ^{bc}	6.14 ^b	6.18 ^{bc}	6.55 ^{ab}	6.27 ^b	6.64 ^a	6.80 ^a
15% Cassava	6.82 ^{ab}	6.64 ^a	6.50 ^{ab}	6.36 ^b	6.14 ^b	6.59 ^a	6.70 ^a
20% Cassava	6.27 ^c	6.59 ^a	6.00 ^c	5.47 ^c	6.00 ^b	6.05 ^a	6.02 ^b

In a column, means followed by the same superscript are not significantly different ($P \geq 0.05$) by DMRT

Table 7 Sensory Scores of Sen Lek prepared from rice flour and rice flour mixed with various starches.

Sample	Appearance	Color	Shiny	Cohesiveness	Flavor	Texture	Acceptability
Rice flour	6.45 ^a	6.40 ^{bc}	6.52 ^b	6.20 ^b	5.90 ^b	6.40 ^a	6.20 ^a
5% Potato	6.38 ^b	6.73 ^{ab}	6.25 ^b	5.85 ^b	6.25 ^{ab}	6.20 ^a	6.00 ^a
20% Corn	6.90 ^a	7.10 ^a	7.00 ^a	6.88 ^a	6.65 ^a	6.58 ^a	6.65 ^a
10% Cassava	6.08 ^b	6.15 ^c	6.18 ^b	6.00 ^b	6.20 ^{ab}	6.53 ^a	6.03 ^a

In a column, means followed by the same superscript are not significantly different ($P \geq 0.05$) by DMRT

CONCLUSIONS

Rice quality had a marked influence on the properties and characteristics of rice noodles. Partial replacement of rice flour with potato, corn or cassava starches at 5 to 20 % by wt affected cooking yield, cooking loss, textural properties and sensory qualities of the noodles.

The products had various characteristics upon the type/ amount of starches added. Potato starch provided noodle with tougher and harder texture as compared with corn starch. Cassava starch, on the other hand, gave noodle with transparent, soft texture and sticky, especially at 20% level. However, all noodles showed fairly good quality, wherein, noodle with 5% potato starch, 20% corn starch and 10% cassava starch had the highest acceptant score in each starch group. No significant difference was observed among those three noodles and the control. Hence, the type/ amount of starches used in this experiment had a minimal affect acceptability of the products. Therefore, the addition of such starches to rice flour in noodle production is not necessary if suitable rice's quality is used as raw material.

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