Journal of Food Health and Bioenvironmental Science (May - August 2022), 15(2): 19-25

Journal of Food Health and Bioenvironmental Science

Journal homepage : http://jfhb.dusit.ac.th/

Effects of Different Particle Size Distribution and Insoluble Dietary Fiber Content from Pomelo by-Products on the Quality Characteristics of Rice Noodle Products

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Article info

Article history:
Received : 29 April 2022
Revised : 16 July 2022
Accepted : 2 August 2022

Keywords:
Pomelo, By-products, Insoluble dietary fiber, Functional properties, Rice noodles

Abstract

Rice noodles are a widely consumed food in Asia, including in Thailand. Nevertheless, this popular food is high in carbohydrates, but low in dietary fiber. Pomelo by-products (PBP) are a highly insoluble dietary fiber (IDF) source that has been investigated for fiber-fortified rice noodles with health benefits. This study was conducted to prove the effects of IDF in PBP at different levels (10 and 12.5%) of the rice flour and different particle size distributions (180 and 150 µm) on the moisture content, water activity, cooking weight, cooking loss, textural and sensory evaluation. The addition of IDF-PBP to rice noodles was found to have significant ($p<0.05$) effects on the colors of a*, *b**, while cooking weights were increased in all samples. Cooking loss and tensile strength also decreased as compared to the control. The moisture content and water activity of rice noodles were between 8.66-9.14% and 0.32-0.36, respectively. When considering the addition of IDF-PBP at 10 and 12.5%, the findings revealed that the sample was not significantly different ($p>0.05$) in the cooking weight. However, when the particle size was reduced, the cooking weight increased. Cooking loss decreased when IDF-PBP was increased, and the particle size was reduced. The texture of the particle size distribution was 180 and 150 µm at levels 10% in tensile strength and showed not significant difference ($p>0.05$) as compared to the control rice noodles. Rice noodles with 10% IDF-PBP particle size distribution 150 µm showed the highest overall acceptability in sensory evaluation. The results revealed that adding IDF-PBP to rice noodles increased the total dietary fiber content at 9.44% and the insoluble dietary fiber content at 8.71% as compared to the control rice noodles. Based on the results, the addition of IDF-PBP to rice noodles can lead consumers to conclude that the product is healthy.

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Introduction

Noodles are a type of food processed from rice and a traditional oriental food that is widely produced in Thailand and other parts of Southeast Asia. The main ingredient of noodles is rice flour or rice flour mixed with other components, such as tapioca flour or modified starch. Thus, rice noodles are high in carbohydrates and calories, but low in dietary fiber (DE) (Wandee et al., 2015). Therefore, the industry involved in the development of noodles is interested in developing value-added products of daily nutritional food. Several studies have been carried out recently to improve the nutritional properties of rice noodles by adding supplements such as kimchi (Kim et al. 2017), pomelo (Reshmi et al., 2020), germinated brown rice (Chung et al., 2012) and canna starch (Wandee et al., 2015). Citrus fruits are nutritious and rich in essential minerals, vitamins and dietary fiber. In addition, most of these by-products, such as the bark, seeds and pulp, are wasted or underused in the orange juice industry. The weight of fresh fruit is 50%, but findings indicate that there are useful compounds that can be extracted as dietary fiber. Studies have reported that extracted dietary fiber from citrus albedo, flavors, pulp and seeds (Pichaiyongvongdee et al., 2021; Chau & Huang, 2003; Elif et al., 2017). Pichaiyongvongdee et al. (2021) found that pomelo pulp powder prepared from pomelo juice by-products has a total dietary fiber content (TDF) of 92.04% with insoluble dietary fiber (IDF) at 91.93%, which is more than dietary fiber from citrus fruit peels (orange, grapefruit, lemon, gonggan, and ponkan). According to findings, the content of total dietary fiber (TDF) was 61.79-64.07%, and insoluble dietary fiber (IDF) was 48.49-50.32% (Lei et al., 2015).

Dietary fiber is plant carbohydrate polymers that are not digested with digestive enzymes by humans. Dietary fiber can be divided into 2 types, insoluble dietary fiber (IDF), and soluble dietary fiber (SDF). IDF includes lignin, cellulose, and hemicellulose and SDF includes pectin, gum, and mucilage. Each type of fiber has different physiological effects (Dhingra et al., 2012). IDF is related to reducing intestinal transit time with improved drainage due to bulking capacity, thereby supporting the growth of intestinal microflora with good effects on diarrhea, constipation and irritable bowel syndrome. SDF is associated with reduced cholesterol levels in the blood, delayed gastric emptying, blood glucose control and lower serum cholesterol levels. Li & Komarek (2017); Kim et al. (2017) reported in previous studies that most of the dietary fiber residue from kimchi is composed of the insoluble dietary fiber used as an ingredient in common wheat noodles. In addition, IDF has been used as an ingredient in pasta and cakes. Therefore, it can be used as an ingredient in healthy food. According to the Thai Recommended Daily Intake (Thai RDI) nutrition experts recommend that people consume at least 25 grams of fiber per day for adults for optimal health. In general, the Thai rice noodles available on the market usually contain fiber at 3g/100g and it is recommended that the level of fiber foods be increased. Therefore, IDF from pomelo by-products could be used as a functional food material.

However, dietary fiber addition influenced the noodle microstructure and the quality of texture and sensory, which limited the consumption of dietary fiber. The findings of Reshmi et al. (2020) showed that adding dietary fiber from pomelo fruit segment in noodle affected the texture and cooking loss. Kim et al. (2017) found that adding insoluble dietary fiber from kimchi had an effect of increasing cooking loss and a decrease of sensory, if added in high quantity. There are also studies on the particle size of dietary fiber to improve the product. It was found that the change in particle size of bran had a negative effect on bread quality in terms of increased water holding capacity, and better hydration properties. At the same time, Zhang et al. (2019) study on the effect of IDF wheat bran particle size in noodles showed that the particle size of rice bran influenced cooking loss, texture, and water distribution.

The main objective of this study was to investigate the quality of rice noodles by using different particle size distributions and varying the ratios of insoluble dietary fiber (IDF) from pomelo by-products (PBP). Firstly, we made IDF-PBP and then evaluated the cooking quality, color, cooking weight, cooking loss, texture and sensory evaluation of rice noodles.

Materials and methods

1. Samples and chemicals

The albeo of pomelo by-products were collected from Nakhon Pathum Province. Rice flour was obtained from Choheng rice vermicelli factory company limited (Nakhon Pathom). Tapioca flour was obtained from Thai made flour factory Bangkok Co., Ltd. (Bangkok). All the chemicals and reagents used were of analytical grade.

2. Preparation of insoluble dietary fiber from pomelo by-products (IDF- PBP)

IDF was produced by pomelo pulp according to the method of Pichaiyongvongdee et al. (2021) with minor method modification like the cleaning process and different particle size distribution of powder. Firstly, the fresh pomelo pulp was cleaned with 0.01N NaOH solution at 37°C (pomelo pulp : NaOH solution, 1:10, w/v) for 10 min, followed by washing with distilled water and then the treated sample was soaked with 40% ethanol for 30 min. Bitterness reduction was by constant soaking with distilled water at pH 7.0 for 60 min. All the samples were dried in a tray dryer (Memmert 400, Germany) at 70°C until their moisture content was less than 10%, and recorded as IDF. The milled samples were ground in a blender (Model A 327 R7; Molineux; France) and sieved to two different particle sizes distribution : labeled as 150 μm and 180 μm. The chemical composition per 100 g dry of IDF- PBP appeared as follows: total dietary fiber (TDF) was 92.04%, insoluble dietary fiber (IDF) was 91.93% and soluble dietary fiber (SDF) was 0.11% (Pichaiyongvongdee et al., 2021). IDF-PBP was blended into rice flour at 2 substitution levels (10% and 12.5%) for further tests.

3. Preparation of dried rice noodles

The rice noodles for the experiment were developed by mixing IDF-PBP with different particle size distribution (180 μm, A and 150 μm, B) and were blended into rice flour at 2 substitution levels at 10% and 12.5% of rice flour and coded as 0 (control), A10, A12.5, B10 and B12.5, respectively and shown in Table 1. Other elements like 14% tapioca starch and 22% rice flour and ingredients were mixed with 64% distilled water (modified method from Anukulwattana, 1969) The dough was incubated for 60 min at room temperature for uniform hydration and equilibrium. Each 100 ml suspension was combined and then spread on a stainless steel tray (25 x31x1.5 cm) and steamed in a steamer at 100°C for 5 min to complete gelatinization. Then the dough was cut into 5 mm-wide strands with a noodle cutter and dried in a tray dry at 70°C for 60 min to reduce the moisture content to below 10%. Finally, all rice noodle strands were packed in plastic bags and stored at room temperature until the experiment.

Table 1 The ingredient formulation of experimental rice noodles with insoluble dietary fiber-enriched fractions from pomelo by-products

Sample	Ingredients (%)			
	Rice flour	IDF- PBP	Tapioca flour	Distriilled water
control	22.00	0	14.00	64.00
A10 (180 μm)	19.80	2.20	14.00	64.00
A12.5 (150 μm)	19.25	2.75	14.00	64.00
B10 (180 μm)	19.80	2.20	14.00	64.00
B12.5 (150 μm)	19.25	2.75	14.00	64.00

Remark: IDF- PBP: insoluble dietary fiber from pomelo by-products;
A10 : fresh rice noodles with 10% IDF-PBP (180 μm) of the rice flour;
A12.5 : fresh rice noodles with 12.5% IDF-PBP (180 μm) of the rice flour
B10 : fresh rice noodles with 10% IDF-PBP (150 μm) of the rice flour;
B12.5 : fresh rice noodles with 12.5% IDF-PBP (150 μm) of the rice flour

4. Analysis of rice noodles quality

4.1 Chemical composition

Chemical composition was determined according to the AOAC, (2016); moisture content (925.45), fat content (922.06), protein content (981.10), ash content (940.26), total dietary fiber (TDF) content (985.29), insoluble dietary fiber (IDF) content (985.29) and soluble dietary fiber (SDF) content (985.29).

4.2 Color measurement

The color of samples were measured using a Hunter colorimeter (Minolta Camera Co., Osaka, Japan). Data was recorded as *L**, *a** and *b** values. (*L**=black to white); (*a**=green to red) and (*b**=blue to yellow) were recorded.

4.3 Cooking properties

Samples were prepared for cooking weight and cooking loss of rice noodles and measured according to the AACC method (1995). Dried rice noodles were cut into small pieces 5 cm in length about 10 g and boiled in 300 ml water in a beaker for 3 min or until completely cooked, rinsed with distilled water, drained for 15 min, and immediately weighed. Cooking weight was measured from the difference between noodle weights before and after cooking, and expressed as the percentage of g cooked noodle/g dried noodle. Cooking loss was measured by evaporating to dryness the cooking water and rinse water in a pre-weighed glass beaker in a hot-air oven at 105°C for 12 h, and was expressed as the percentage of solid loss during cooking.

4.4 Textural analysis

Samples prepared for textural analysis consisted of dried rice noodles boiled in 300 ml water in a beaker for 3 min or until completely cooked, rinsed with distilled water and drained for 15 min. The cooked noodles were measured for texture properties using Manual of TAXT plus Texture Analyzer (Stable Micro System Ltd., U.K.). The tensile strength of noodle settings were pre-tested at a speed of 1 mm/s, test speed 3 mm/s, post-test 10 mm/s, strain at 40% and trigger force, 5.0 g. (Wandee et al., 2015). The force of each sample at fracture, indicating the tensile strength, were recorded data.

4.5 Sensory evaluation

Samples prepared for sensory evaluation used a similar method as for textural analysis. The cooked noodles containing 5 types of noodles (including the control) were put on a plastic tray and served to the panelists. A total of 50 panelists were recruited from Suan Dusit University. All the panelists were University students in the Department of Food Technology. Before formal evaluation, the panelists were trained to obtain objective results for the sensory descriptors. The panelists evaluated the freshly cooked noodles using a 9 point-hedonic scale (1=disliked extremely, 9 =liked extremely). The attributes evaluated were whiteness, smoothness, springiness, flavor, taste and overall acceptability. The research questionnaire was examined for accuracy, appropriateness and obtained approval by the Ethical Review Subcommittee for Human Research and Development Institute, Suan Dusit University, COA.NO: SDU-RDI 2020-011.

4.6 Statistical analysis

The data were performed in triplicate as means± standard deviation (SD), using a one-way ANOVA analysis of variance and using a T-test (Independent test) for 2 samples with SPSS Statistic Version 20.0 (SPSS Inc., Chicago, IL, USA). Data were considered statistically significant at $p<0.05$ by Duncan's Multiple Range Test.

Results and discussion

1. Moisture content and water activity

Concerning the chemical properties of dried rice noodle products with the addition of different particle size distributions and content of IDF-PBP, the control raw dried noodles were placed in a dry tray at 70°C for 60 minutes to reduce the moisture content, as presented in Table 2. The moisture content and water activity of the sample noodles varied between 8.66-9.50% and 0.32-0.36, respectively. Moisture content is very important for the quality of food and can control the growth of microorganisms. Larrauri (1999) reported that dried food should have a moisture content lower than 10% and water activity value less than 0.6 to prevent microbial growth.

2. Color characteristics

Color characteristics of dried noodles with different particle size distributions and content of IDF-PBP are shown in Table 2. Increasing IDF-PBP reduced the $L*$ and increased the $a*$ and $b*$ colors of rice noodles. The results indicated that, as the amount of IDF-PBP increased from 10% to 12.5% at each size, the appearance of the dried noodles grew darker. The darkness of the product was caused by the Mallard reaction between reducing sugars and proteins (Mohamed et al., 2010). At the same time, in reducing the particle size distribution of the IDF-PBP addition in noodles, the L increased and the $a*$ and $b*$ of rice noodles decreased. Pichaiyongvongdee et al. (2021) reported that reducing the particle size distribution of IDF- PBP from 425 µm to 50 µm found that $L*$ increased in lightness, whereas $a*$ and $b*$ decreased as the particle size of the sample was reduced. Therefore, the effects of specific are as increased.

3. Cooking qualities

The cooking weight and cooking loss of noodles are important indicators for assessing overall texture quality and can be used as indicators of the structural integrity of noodles, which is defined as the amount of solids dissolved in water during cooking (Bhattacharya et al., 1999; Zhang et al., 2019). The quality of rice noodles was determined by evaluating cooking properties such as cooking weight and cooking loss, as presented in Table 2.

The addition of IDF-PBP to rice flour for rice noodle production found significant difference ($p<0.05$) in which

Table 2 Effect of IDF- PBP with different particle size distribution and content on chemical properties and functional properties of rice noodles products

Sample	Moisture (%)	water activity	Color			Cooking weight (%)	Cooking loss (%)	Tensile Strength (g force)
			$L*$	$a*$	$b*$			
Control	8.88±0.22[bc]	0.33±0.00[b]	82.52±0.38[a]	0.30±0.05[d]	9.03±0.37[d]	187.42±4.27[c]	6.71±0.11[a]	69.86± 2.73[a]
A10	8.66±0.19[c]	0.32±0.01[b]	73.80±0.47[d]	0.55±0.08[b]	9.85±0.33[b]	217.16±0.29[b]	2.84±0.07[b]	66.53± 1.24[a]
A12.5	9.14±0.09[ab]	0.36±0.01[a]	73.33±0.87[d]	0.60±0.06[a]	9.97±0.26[a]	218.67±0.40[b]	2.58±0.03[c]	47.73± 2.16[b]
B10	8.94±0.02[bc]	0.36±0.00[a]	81.57±0.56[b]	0.42±0.02[c]	9.22±0.13[c]	222.30±0.24[a]	2.42±0.01[cd]	66.62± 3.02[a]
B12.5	9.50±0.10[a]	0.36±0.00[a]	80.92±0.55[c]	0.56±0.03[ab]	9.28±0.15[c]	225.57±0.31[a]	2.40±0.01[d]	46.77± 1.42[b]

Remark: Difference letters in the same column indicate that the values are significant difference ($p < 0.05$)
A10 : rice noodles with 10% IDF-PBP (180 µm) of the rice flour;
A12.5 : rice noodles with 12.5% IDF-PBP (180 µm) of the rice flour
B10 : rice noodles with 10% IDF-PBP (150 µm) of the rice flour;
B12.5 : rice noodles with 12.5% IDF-PBP (150 µm) of the rice flour

cooking loss decreased in all samples and cooking weight increased in all samples in comparison to the control rice noodles.

The cooking weight of noodles fortified with IDF-PBP increased from 187.42% (control) to 225.57% (experimental noodles with IDF- PBP). In addition, it was found that the rice noodles with IDF- PBP small particle size distribution of 150 µm had higher cooking weight. Pichaiyongvongdee et al. (2021) reported that IDF-PBP with a particle size of 150 µm had high insoluble dietary fiber (IDF) at 91.93%. The microstructure of the porous fiber affecting WHC indicates increased water binding capacity. Jian et al. (2019) studied the insoluble dietary fiber (IDF) of wheat bran with different particle size distributions, finding that reducing particle size distribution contributed to a rising tendency for cooking loss from 8.65% to 7.65%.

The effect of adding IDF-PBP to noodles at 10% to 12.5% in the same particle size distribution found no significant differences (p>0.05) due to insufficient volume that changed the cooking weight of the noodles. Ekthamasut (2013) studied the effects of using bambara groundnut flour at three levels (10, 20 and 30%) on noodles and found increased cooking loss.

4. Textural analysis

The texture properties could affect evaluation of the overall quality of rice noodles and the sensory evaluation by consumers. The tensile tests used to measure related attributes and elasticity were based on time and force data that can be used to determine fundamental rheological parameters (Ritthiruangdej et al., 2011). Zhang et al. (2019) noted that the addition of IDF should add the appropriate amount and size of the IDF particle size to the noodles. This can affect the hardness and chewiness of the noodles.

The main ingredients used for rice noodles are rice flour (22%) and tapioca starch (14%). Kasemsuwan et al. (1999) reported that rice flour with amylose content between 25-30% is recommended for preparing rice noodles. The amylose content produces acceptable noodle textures, i.e., stickiness, elasticity and strength. The textural parameters of tensile tests are measured and summarized in Table 2. The findings showed that the texture and tensile strength of particle size distribution at 180 µm and 150 µm at 10% of the rice flour were not significantly different (p>0.05) as compared to the control rice noodles. When considering the addition of IDF- PBP at 12.5% of the rice flour, it was found that the sample was significantly different (p>0.05), where by tensile strength was decreased due to the addition of dietary fiber, so the amount of rice flour had to be reduced. This resulted in a decrease in amylose content, which allowed the amylose to be flexible. When the amylose content decreased, the tensile strength of the noodles was reduced. These results correspond with the findings of a study by Ritthiruangdej et al. (2011) who reported that the tensile strength decreased when the banana flour content increased in wheat noodles, thereby the weakening noodle texture. The addition of banana flour, which is gluten-free, in the production of dried noodles diluted the gluten strength and interrupted as well as weakened the structure of the noodles.

Pan & Jiecheng (2019) stated that the effect of reducing the starch content in the mixture results in a reduced viscosity and gel hardness of the starch system as well as the reduced chewiness and tensile strength of the cooked noodles.

5. Sensory evaluation

The attributes evaluated were whiteness, smoothness, springiness, flavor and taste. Table 3 shows the significant differences (p<0.05) in the sensory attributes of cooked fresh noodles made by adding IDF-PBP to rice flour at different volumes and particle size distributions. Significant decreases in smoothness, flavor, and taste were discovered when IDF-PBP was added at 12.5 g/100 g in rice flour (p<0.05). Furthermore, when IDF-PBP with

Table 3 Sensory evaluation of freshly cooked noodles after addition of IDF-PBP with different volume and particle size distribution in rice flour.

Sample	Color (Whiteness)	Smoothness	Springiness	Mouthfeel	Taste	Overall Acceptability
Control	8.03±1.10^{a}	8.03±0.89^{a}	7.30 ±0.75^{a}	6.70±0.75^{a}	7.07±0.58^{ab}	7.33±0.66^{a}
A10	7.03±1.07^{b}	6.43±0.50^{b}	7.03±0.85^{ab}	5.70±0.60^{b}	6.93±0.78^{ab}	6.13±0.82^{b}
A12.5	6.57±0.82^{c}	5.57±0.90^{c}	6.83±0.75^{b}	4.63±0.85^{c}	6.87±0.57^{ab}	5.30±0.92^{c}
B10	7.83±0.79^{a}	7.77±0.86^{a}	7.13±0.78^{ab}	6.57±0.90^{a}	7.10±0.48^{a}	7.03±0.72^{a}
B12.5	7.23±0.63^{b}	6.57±0.86^{b}	6.97±0.72^{ab}	5.90±0.76^{b}	6.73±0.64^{b}	6.43±0.63^{b}

Remark: Difference letters in the same column indicate that the values are significant difference (p<0.05)
A10 : rice noodles with 10% IDF-PBP (180 µm) of the rice flour;
A12.5 : rice noodles with 12.5% IDF-PBP (180 µm) of the rice flour
B10 : rice noodles with 10% IDF-PBP (150 µm) of the rice flour;
B12.5 : rice noodles with 12.5% IDF-PBP (150 µm) of the rice flour

small particle size distribution (150 µm) was added, the scores were higher than large particle size distribution (180 µm). Thus, sensory testing, showed that rice noodles with 10% of the rice flour replaced with pomelo pulp dietary fiber powder of particle size distribution of 150 µm had the highest sensory score among the attributes used to measure the intensity of whiteness (7.83), smoothness (7.77), springiness (7.13), flavor (6.57), taste (7.10) and overall acceptability (7.03). At the same time, overall acceptability showed a positive correlation with whiteness, smoothness, springiness, flavor and taste in sensory results, even though the tensile strength of all the samples in TPA showed no significant differences (p>0.05) from the control and rice noodles with 10% IDF- PBP particle size distribution at 150 µm. According to the findings, the sensory scores for the preference of springiness was affected by the cooked weight and cooked loss. Therefore, rice flour mixed with IDF-PBP at 10.0 g/100 g and a particle size distribution of 150 µm, was considered to potentially produce fresh noodles with high dietary fiber content.

The chemical composition comparison between the control rice noodles and the experiment rice noodles with 10% IDF-PBP (150 µm) of the Rice flour as presented in Table 4. The rice noodles with IDF-PBP showed no significant difference (p>0.05) in terms of moisture and protein content in comparison to the control rice noodles. While fat, total dietary fiber (TDF), insoluble dietary fiber (IDF) and soluble dietary fiber (SDF) showed significant difference (p<0.05). There were differences in the composition, possibly due to the higher percentage of IDF-PBP. Similar observations were reported by Rani et al. (2019) for noodles with multigrain fortification. Furthermore, higher total dietary fiber, particularly the insoluble dietary fiber portion of rice noodles with IDF- PBP might also have been the reason for the relatively high IDF-PBP content of the raw material in which the high insoluble dietary fiber (IDF) was 91.93%. At the same time, the soluble dietary fiber (SDF) of rice noodles with IDF-PBP was lower than the control, because IDF-PBP had low soluble dietary fiber (SDF) at 0.11%. Therefore, rice noodles with IDF-PBP could be classified as a functional food due to its high total dietary fiber. Moreover, insoluble dietary fiber (IDF) is beneficial for health in reducing intestinal transit time and improving drainage due to bulk capacity, thereby supporting the growth of intestinal microflora with good effects on diarrhea, constipation and irritable bowel syndrome. This complies with European Union Commission Regulation (EU) No 1047/ 2012 on 8 November 2012 regarding the list of nutritional claims of more than 6 g of dietary fiber in each 100 g of product (Mora et al., 2013). The addition of dietary fiber to the noodles can lead consumers to conclude that a product is healthy.

Table 4 Chemical properties level in the control rice noodles and rice noodles with IDF- PBP (Dry basis)

Chemical composition	The control rice noodles	rice noodles with IDF- PBP
Moisture (%)[ns]	8.88±0.21	8.94±0.02
Protein (%)[ns]	4.46±0.13	4.56±0.08
Fat (%)	0.85±0.07[b]	1.10±0.08[a]
Ash (%)	0.20±0.00[b]	0.54±0.01[a]
Total dietary fiber (TDF) (%)	5.09[b]	9.44[a]
insoluble dietary fiber (IDF) (%)	3.37±0.26[b]	8.71±0.17[a]
soluble dietary fiber (SDF) (%)	1.72±0.17[a]	0.73±0.01[b]

Remark: Difference letters in the same row indicate that the values have a significant difference (p<0.05)
ns indicates that the values have not significant difference.

Conclusion

The present study investigated separating the insoluble dietary fiber from pomelo by-products (IDF-PBP) for fiber-fortified rice flour and the effects of adding IDF- PBP to rice flour at different levels and particle size distributions. The different levels of IDF- PBP in rice flour found a significant (p<0.05) effect on the cooking weight, which was increased, while cooking loss and tensile strength were decreased in all samples as compared to the control rice noodles. While the different particle size was reduced, the cooking weight increased, and cooking loss decreased. The particle size distribution of IDF-PBP was not significantly different (p>0.05) in terms of tensile strength. Rice noodles with 10% IDF-PBP with a particle size distribution of 150 µm showed the highest overall acceptability in the sensory evaluation as well as cooking weight and tensile strength. The total dietary fiber content (TDF) under these conditions was 9.44 and the insoluble dietary fiber (IDF) content was 8.71% as compared to the control rice noodles. These results suggest that IDF-PBP could be added to rice flour in the preparation of rice noodles. IDF-PBP is a good nutrition source that promotes the broad use of fruit in the human diet for potential health benefits. In addition, it will promote the production of noodles at competitive prices and expand the use of healthy fibers.

Acknowledgments

The research was supported by Suan Dusit University, Bangkok, Thailand and also funded by the National Research Council of Thailand (NRCT) (NO 53811). The author would like to extend appreciation to Assoc. Prof. Dr. Ratiporn Moolsarn for suggestions on the manuscript.

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