

Physical, Chemical, Textural and Sensory Properties of Dried Wheat Noodles Supplemented with Unripe Banana Flour

Pitiporn Ritthiruangdej^{1,2*}, Sompit Parnbankled¹, Sawitri Donchedee¹ and Rungtiwa Wongsagonsup¹

ABSTRACT

Unripe banana flour is a starchy food that contains a high proportion of indigestible compounds such as resistant starch, and non-starch polysaccharides, which are included in the dietary fiber content. The objective of this study was to use unripe banana flour as an ingredient to make dried noodle products of high nutritional quality with low carbohydrate digestibility and rich in resistant starch. The effect of wheat flour substitution with unripe banana flour was investigated in terms of the physicochemical, textural, cooking and sensory qualities of dried noodles. Five additional dried noodles were prepared by substituting wheat with 10, 20, 30, 40, and 50% banana flour. The optimal ratio of noodle from banana flour was investigated using sensory qualities in comparison with the control (100% wheat flour). The results of noodle formula development indicated that as the amount of banana flour increased, the stickiness of the noodles decreased and the appearance became darker. The optimum formula consisted of 20.45% banana flour, 47.72% wheat flour, 20.45% water, 2.04% salt, 1.02% sodium carbonate, 6.82% egg powder, 0.14% polyphosphate and 1.36% propylene glycol. Banana flour was used to replace 30% of the total wheat flour in the formula. Uncooked dried noodles were composed of 13.7% protein, 0.12% fat and 4.8% dietary fiber (including 2.8% resistant starch). The optimal cooking time and cooking loss were 14.5 min and 11.15%, respectively. The tensile strength and breaking length of cooked noodles were 16.4 g and 67.2 mm, respectively. The results of consumer evaluation showed that the overall liking of uncooked and cooked dried noodles were at the moderate level. The present study indicated that unripe banana flour is a potential source of fiber when substituted for wheat flour in dried noodle products. The incorporation of 30% unripe banana flour in the noodle ingredients significantly increased their total dietary fiber and resistant starch content.

Keywords: dried noodles, unripe banana flour, resistant starch, supplement

INTRODUCTION

Noodle products are a staple food in many parts of Asia. Asian noodles made from wheat may be divided into two general classes based on the ingredients used: white salted noodles

(WSN) made from flour, sodium chloride and water, and yellow alkaline noodles (YAN) made from flour, alkaline salts (such as sodium and potassium carbonate) and water (Asenstorfer *et al.*, 2006). The type of salt, properties of the flour and the manufacturing process lead to a wide array of

¹ Food Technology Program, Mahidol University, Kanchanaburi Campus, Kanchanaburi 71150, Thailand.

² Present address: Department of Product Development, Faculty of Agro-Industry, Kasetsart University, Bangkok 10900, Thailand.

* Corresponding author, e-mail: pitiporn@gmail.com

noodle types (Martin *et al.*, 2008). Traditional noodles are claimed to lack other essential nutritional components such as dietary fiber, vitamins and minerals, which are lost during wheat flour refinement. Thus, noodle products which represent a major end-use of wheat, are suitable for enhancing health after incorporating sources of fiber and essential nutrients (Choo and Aziz, 2010). The development of new products is a strategic area of the food industry. Consumers are demanding foods that show two main properties, with the first dealing with the traditional nutritional aspects of the food, whereas, as a second feature, additional health benefits are expected from its regular ingestion. These kinds of food products are often called nutraceutical foods. In a rapidly changing world, with altered food habits and stressful lifestyles, it is more and more recognized that a healthy digestive system is an essential factor in determining the overall quality of life (Brouns *et al.*, 2002).

Several studies have suggested that consumption of unripe bananas exerts a beneficial effect on human health, associated with the indigestible components. Unripe bananas are a good source of carbohydrates and nutritionally interesting bioactive compounds. However, there is an excess of production and large quantities of fruit are lost during commerce as a consequence of deficient postharvest handling. New economic strategies are therefore being considered for bananas as a food ingredient (Ovando-Martinez *et al.*, 2009). According to the literature, green bananas are very rich in starch and the flour may provide 61.3–76.5 g/100 g of starch with a fiber content of 6.3–15.5 g/100 g. Moreover, a great part of the starch found in green banana flour is the resistant starch type 2 (RS2) from 52.7 to 54.2 g/100 g (Tribess *et al.*, 2009). Resistant starch (RS) has attracted interest because of its positive effects in the human colon and implications for health. It can be found in both processed and raw food materials. According to various RS types, RS2 is

found in the native uncooked granules of some starches such as those in raw potatoes and green bananas, whose crystallinity makes them barely susceptible to hydrolysis (Englyst *et al.*, 1992).

Some research has been recently carried out to improve the nutritional properties of food products adding to its supplements from unripe banana flour. Choo and Aziz (2010) reported that green banana flour has potential as a source of fiber when substituted in yellow alkaline noodle products. The incorporation of 30% banana flour significantly increased the total dietary fiber of noodles, the resistant starch, total starch and some essential minerals, including phosphorus, magnesium, potassium, and calcium. Aparicio-Saguilán *et al.* (2007) found that a resistant starch-rich powder prepared from banana starch was a potential ingredient for bakery products containing slowly digestible carbohydrates. Ovando-Martinez *et al.* (2009) reported that pasta products containing banana flour exhibit a low rate of carbohydrate enzymatic hydrolysis and they could help broaden the range of low-glycaemic index foods available to consumers. However, there is no information on the use of unripe banana flour in dried noodle making. Therefore, the objective of this study was to use unripe banana flour as an ingredient to make dried noodle products of high nutritional quality with low carbohydrate digestibility that were rich in resistant starch. The effect of wheat flour substitution with unripe banana flour was investigated in terms of the physicochemical, textural, cooking and sensory qualities of the dried noodles.

MATERIALS AND METHODS

Banana flour preparation

Unripe banana (*Musa paradisiaca* L.) fruit was purchased from a local market in Kanchanaburi province, Thailand. Unripe banana flour was prepared using the procedure described by Ovando-Martinez *et al.* (2009). Fruits were

peeled and cut into 3 mm slices and immediately rinsed in sodium metabisulfite (0.25% w/v). The slices were dried at 50 °C, ground using a commercial grinder and stored at 25 °C in sealed plastic containers prior to further analyses. The commercial wheat flour used for this study was also obtained from the local market.

Dried noodle processing

Noodles were prepared in the laboratory following the procedures of Bui and Small (2007). The basic ingredients used for making dried noodles were: 100.0 g flour, 30.0 g water, 10.0 g egg powder, 3.0 g salt, 2.0 g propylene glycol, 1.5 g sodium carbonate, and 0.2 g polyphosphate. Control dried noodles were prepared from 100% wheat flour. Five additional dried noodle samples were prepared by substituting wheat with 10, 20, 30, 40 and 50% banana flour.

The different formulations were processed into noodles using a Kenwood mixer and a small spaghetti maker (Imperia brand, Italy) consisting of two rolls with adjustable gap settings and a cutting roll attachment. In brief, salt, egg powder, propylene glycol, sodium carbonate, and polyphosphate were dissolved in the water and this solution was added to the flour in the mixer (set at speed 1). After that, the speed of the mixer was increased. The resultant dough had a crumbly consistency similar to that of moist breadcrumbs. The dough was first formed into a dough sheet by a process of folding and passing the crumbly dough through the rollers of the noodle machine several times. Then, this combined sheet was allowed to rest in a plastic bag at room temperature for 30 min. The sheet was cut into strands 2.0 mm wide using the cutting roll attachment of the noodle machine. The noodle strands were then cut to 25 cm in length before steaming over boiling water for 2 min. Subsequently, the steamed noodles were dried in an oven at 50 °C for a total drying time of 1.5 h.

Chemical analysis

The chemical proximate compositions of unripe banana flour, wheat flour and different raw dried noodle samples were determined as follows. The moisture content was determined by gravimetric heating (130 °C for 2 h) using a 2–3 g sample. Ash and protein were analyzed according to American Association of Cereal Chemists methods 08-01 and 46-13, respectively (AACC, 2000). Total dietary fiber (DF) was evaluated using Official Methods of Analysis 985.29 (AOAC, 1999). Resistant starch was measured by the method proposed by Goñi *et al.* (1996). All analyses were performed in triplicate.

Cooking qualities

The qualities of the cooked dried-noodles, cooking time and cooking loss were evaluated according to Chillo *et al.* (2008). Optimal cooking time was evaluated by observing the time of disappearance of the core of the noodle strand during cooking (every 30 s) by squeezing the noodles between two transparent glass slides. The cooking loss was determined by measuring the amount of solid substance lost to cooking water. A 10 g sample of noodles was placed into 300 mL of boiling distilled water in a 500 ml beaker. Cooking water was collected in an aluminum vessel which was placed in an air oven at 105 °C and evaporated to dryness. The residue was weighed and reported as a percentage of the starting material. For each optimal cooking time and cooking loss value, five determinations were performed to obtain the mean values.

Noodle color analysis

The color of the dried noodle sheets and the optimally cooked noodle samples were measured with a Chroma-meter (Minolta, Tokyo, Japan) equipped with a D65 illuminant using the CIE L*a*b* system. The L*, a* and b* readings were obtained directly from the instrument and provided measures of lightness, redness and

yellowness, respectively. All measurements were performed in triplicate.

Noodle texture analysis

Noodles were optimally cooked, cooled for 1 min under running distilled water, drained, stored for exactly 10 min at 25 °C as described by Kruger *et al.* (1994) and submitted to tensile testing using the TA-XT2i texture analyzer (Lu *et al.*, 2000). Instrument settings were extension mode; trigger type, auto-0.5 g; pretest speed 2.0 mm/s; post test speed 10 mm/s; test speed 3.0 mm/s; and trigger distance 80 mm. From force-distance curves, two texture parameters were obtained: tensile strength (maximum force; g) and breaking length (distance at maximum force; mm). Three replicates of cooked noodles at each level of unripe banana flour were determined.

Sensory evaluation

All dried noodle samples were prepared for sensory evaluation. The samples were boiled using tap water for the optimum cooking time. The samples were then stored for not more than 30 min in tightly covered plastic food containers before testing. Optimally cooked noodles with soup were evaluated for appearance, flavor, taste, texture and overall liking of the samples by 30 untrained panelists using nine-point hedonic scales, where 9 = extremely like and 1 = extremely dislike. Each panelist evaluated six samples (identified by unique three-digit codes) in a balanced sequential order. The optimal ratio of banana flour in the noodles was investigated using sensory qualities in comparison to the control noodles.

Consumer evaluation

Dried noodle samples prepared from the optimal ratio of mixtures of banana flour per wheat flour were analyzed by the consumers in a central location. One hundred consumers aged between 18 and 40 y with no previous experience in sensory analysis were recruited from Mahidol University,

Kanchanaburi Campus, Thailand. Each consumer evaluated samples of both raw dried noodles and optimally cooked noodles with soup using the same nine-point hedonic scales. The attributes for the raw noodle samples were color, texture and overall liking, whereas the attributes of appearance, flavor, taste, texture and overall liking were used for the cooked noodles. The consumers were briefed on how they should perform the evaluations. In addition, they were asked to give their purchase intentions and overall impression of the dried wheat noodles supplemented with unripe banana flour.

Statistical analysis

The means and standard deviations were determined for all the physicochemical, textural, cooking and sensory qualities studied. The significant difference of mean values was assessed with one-way analysis of variance (ANOVA) followed by Duncan's test using SPSS software at a significance level of ($P < 0.05$).

RESULTS AND DISCUSSION

Chemical compositions of raw noodles, banana and wheat flours

The chemical compositions of raw dried noodles with added banana flour, the control raw dried noodles and their respective flour compositions (banana and wheat flour) are presented in Table 1. It can be observed that the moisture content of dried noodles decreased when the level of banana flour in the noodles increased. As described by Ovando-Martinez *et al.* (2009), this pattern is related to the decrease in the protein content with the increase in the amount of banana flour in the noodles where the network produced by the gluten is reduced; consequently, the separation of water during the drying is higher. Low-moisture content is important in the shelf-life of food products. The fat content did not change with the addition of banana flour, but the

ash content increased when the banana flour amount in the noodles increased. The ash content depends on the quality of the flour and thus corresponds to the higher mineral content, especially potassium (Kim, 1996). Banana contains high amounts of potassium (400 mg/100 g pulp) and magnesium (34 mg/100 g edible portion contents) (McCance and Widdowson, 2002).

Important increases in the dietary fiber (DF) and resistant starch (RS) levels were obtained in the noodles with the addition of banana flour. The control sample showed the lowest value of DF (3.70%) and RS (0.40%), while the noodles containing 50% banana flour possessed the highest values of DF (5.94%) and RS (4.71%), which were

related to the high DF and RS contents of banana flour (7.8% and 56.17%, respectively). Faisant *et al.* (1995) reported that unripe bananas are the natural product with the highest RS content. RS values of 57.2% and 47.3% were determined in unripe banana flour using two different methods.

Cooking qualities

The cooking time and cooking loss of dried noodles supplemented with banana flour are shown in Table 2. The degree of cooking can be observed either by eye or image analysis (Sozer *et al.*, 2007). In the present study, it was determined by the disappearance of the core of the noodle strand during cooking. The optimum cooking times of all noodle samples ranged from 13.0 to

Table 1 Chemical composition of raw materials and raw dried noodles supplemented with banana flour (%).

Sample	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Dietary fiber (%)	Resistant starch (%)
0% BF noodle	11.10±0.00 ^b	4.98± 0.01 ^e	16.46±0.03 ^a	0.04±0.01 ^d	3.70±0.01 ^e	0.40±0.05 ^f
10% BF noodle	10.07±0.04 ^d	4.98± 0.02 ^d	15.75±0.02 ^b	0.04±0.03 ^d	4.44±0.06 ^d	2.13±0.13 ^e
20% BF noodle	10.31±0.03 ^c	5.20±0.00 ^c	14.87±0.02 ^c	0.22±0.09 ^c	4.51±0.05 ^d	2.76±0.02 ^d
30% BF noodle	9.42±0.01 ^f	5.31± 0.02 ^b	13.68±0.02 ^d	0.12±0.03 ^{cd}	4.77±0.03 ^c	2.77±0.15 ^d
40% BF noodle	9.98±0.00 ^e	5.44± 0.00 ^a	13.40±0.03 ^e	0.16±0.01 ^c	4.98±0.05 ^c	3.62±0.05 ^c
50% BF noodle	8.67±0.02 ^g	5.35±0.01 ^a	12.35±0.02 ^f	0.14±0.01 ^{cd}	5.94±0.13 ^b	4.71±0.00 ^b
BF	7.58±0.01 ^h	3.31±0.04 ^f	3.18±0.02 ^h	0.38±0.08 ^b	7.80±0.06 ^a	56.17±1.50 ^a
WF	11.86±0.05 ^a	0.59±0.00 ^g	11.64±0.02 ^g	1.14±0.01 ^a	3.00±0.07 ^f	0.45±0.01 ^f

Values are shown as mean ± SD; n = 3.

Different superscript letters in a column indicate significant differences ($P \leq 0.05$).

BF = banana flour; WF = wheat flour.

Table 2 Cooking time and cooking loss of noodles supplemented with banana flour (%).

Noodles	Cooking time (min)	Cooking loss [†] (%)
0% BF	13.0	9.35±0.12 ^c
10% BF	13.5	8.71±0.06 ^d
20% BF	14.0	9.31±0.09 ^c
30% BF	14.5	11.15±0.00 ^b
40% BF	13.5	11.09±0.02 ^b
50% BF	13.0	11.49±0.08 ^a

Cooking loss values are shown as mean ± SD; n = 5.

[†]Different superscript letters in a column indicate significant differences ($P \leq 0.05$).

BF = banana flour.

14.5 min. The cooking loss is the amount of dry matter in the cooking water of optimally cooked noodles. An increase in the cooking loss with noodles containing banana flour (Table 2) may have been due to weakening of the protein network by the presence of banana flour. This may allow more solids to be leached out from the noodles into the cooking water (Rayas-Duarte *et al.*, 1996). These results are in the agreement with Ovando-Martinez *et al.* (2009) who reported that partial or complete substitution of durum wheat semolina with fiber material can result in negative changes to pasta quality, including increased cooking loss.

Color characteristics

Color is a key quality trait (Mares and Campbell, 2001) because of the visual impact at the point of sale. It provides some indication of the quality of the starting materials and, in some cases, the age of the product. Asian customers prefer bright yellow, alkaline noodles that retain a stable color for 24–48 h after preparation and consider red or dull grey noodles as undesirable (Asenstorfer *et al.*, 2006). Factors controlling color stability, which include alkaline formulation, flour refinement and enzymatic browning associated with polyphenol oxidase, have been extensively investigated (Hatcher *et al.*, 2008).

Color characteristics of raw sheet and optimally cooked noodles supplemented with

banana flour are shown in Table 3. The results indicated that as the amount of banana flour increased, the appearance of the raw sheet and the cooked noodles supplemented with banana flour grew darker. The darkness of the both raw sheet and the cooked noodles supplemented with banana flour is a product of the Maillard reaction between reducing sugars and proteins (Mohamed *et al.*, 2010). The redness (a^*) and yellowness (b^*) values were also significantly different between all samples. The redness values significantly increased relative to the banana content, while the yellowness values significantly decreased. These results were similar to the report on yeast leavened banana-bread by Mohamed *et al.* (2010). They found that samples with more banana powder will be darker due to excess sugar.

Noodle texture analysis

Instrumental texture tests on cooked noodles have been well reviewed by Ross (2006). Despite profound differences in the “test” environments, repeated studies have shown the ability of instrumental texture tests of a variety of types to correlate closely with related sensory texture attributes. Tensile tests used to measure elasticity and related attributes are amenable to interpretations of the raw time/force data that can be used to determine fundamental rheological parameters (Ross, 2006). Tensile parameters,

Table 3 Color characteristics of raw sheet noodles and optimally cooked noodles supplemented with banana flour (%).

Noodles	Raw sheet noodles			Optimally cooked noodles		
	L^*	a^*	b^*	L^*	a^*	b^*
0% BF	83.52±0.70 ^a	-1.44±0.14 ^d	18.73±0.22 ^c	74.49±0.48 ^a	-2.10±0.17 ^c	19.86±0.85 ^a
10% BF	76.65±1.68 ^b	0.24±0.11 ^c	17.67±0.46 ^c	61.81±1.32 ^b	2.25±0.61 ^d	17.53±0.61 ^b
20% BF	70.39±1.23 ^{de}	2.23±0.19 ^a	20.73±0.45 ^a	53.02±0.56 ^c	3.86±0.23 ^b	14.02±0.38 ^c
30% BF	72.07±0.60 ^c	2.25±0.26 ^a	19.38±0.76 ^b	48.01±0.37 ^d	3.19±0.31 ^c	11.60±0.39 ^d
40% BF	71.01±0.52 ^{cd}	1.31±0.10 ^b	18.10±0.08 ^{de}	47.38±1.09 ^d	3.88±0.25 ^b	13.79±0.19 ^c
50% BF	69.02±1.18 ^e	2.28±0.18 ^a	18.40±0.22 ^{cd}	45.67±1.17 ^e	4.68±0.41 ^a	13.62±0.45 ^c

Values are shown as mean ± SD; n = 3.

Different superscript letters in a column indicate significant differences ($P \leq 0.05$).

BF= banana flour.

tensile strength and breaking length of cooked noodles made from wheat flour and supplemented with banana flour are compared in Figure 1. The tensile strength of cooked noodles was significantly different, while the breaking length of noodles was not significantly different with the variation of banana flour content. The tensile strength decreased when the banana flour content increased. Notably, the addition of banana flour, a non-gluten flour, in the fabrication of dried noodles diluted the gluten strength of the wheat flour and interrupted as well as weakened the overall structure of the noodles. These results are in line with Kovacs *et al.* (2004) who reported that about 80% of the total protein of wheat flour is gluten. Gluten proteins are composed of gliadins and glutenins, which are responsible for gluten or dough extensibility (viscosity) and strength (elasticity), respectively. Therefore, removal of wheat flour would impair the gluten matrix, hence leading to the weakening of noodle texture.

Sensory evaluation

Asian consumers normally purchase noodle products daily from either convenience stores or local manufacturers, basing their purchasing decisions upon their initial assessment of noodle quality by its visual appearance, that is,

color, brightness and the absence of undesirable specks (Hatcher *et al.*, 2009). In the present study, the sensory evaluation of optimally cooked noodles supplemented with banana flour was carried out with the objective to select the best-suited banana flour (by percentage) for the preparation of the noodles. The means sensory liking scores for appearance, flavor, taste, texture and overall liking of optimally cooked noodles supplemented with banana flour are shown in Figure 2. Most panelists scored the optimally cooked noodles supplemented with 10%, 20% and 30% banana flour to be equally acceptable as the control noodles. No statistically significant difference could be found for any of the sensory attributes. It is noted that the sensory liking scores for the flavor and taste attributes of noodles were not significantly different with variation in the banana flour content. In order to make dried noodle products of high nutritional quality with low carbohydrate digestibility and rich in resistant starch, the noodles supplemented with 30% banana flour were selected and subsequently used for the consumer test.

One hundred consumers (22 males and 78 females) participated in the consumer test. Consumers were asked to complete a short questionnaire following the preference test. This

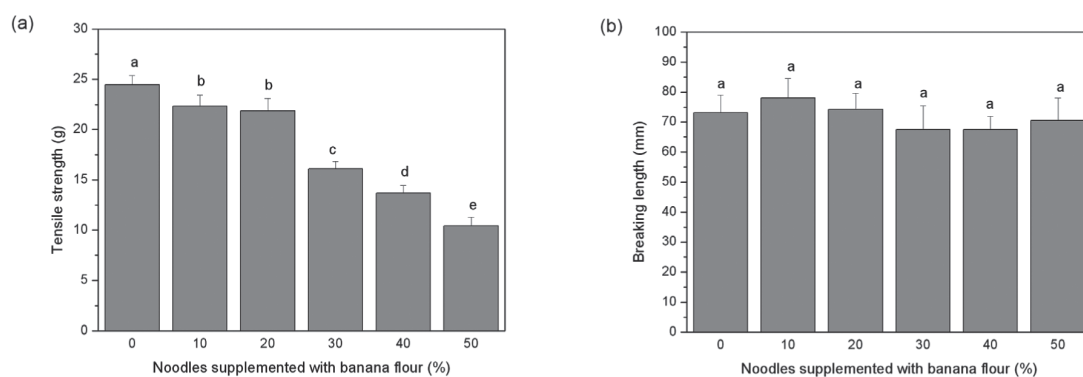


Figure 1 Effect of banana flour (%) on: (a) tensile strength; and (b) breaking length of optimally cooked noodles supplemented with banana flour. The same letter above columns indicates there is no significant difference ($P > 0.05$). The vertical bars on each column indicate the standard deviation.

questionnaire asked for demographic information and examined the respondents' consumption habits with regard to yellow alkaline noodles. Analysis of the results indicated that 88% of the consumers accepted the product and 61% of the consumers

were willing to purchase it. The overall liking scores of uncooked and cooked dried noodles were at the moderate level (Figure 3). According to this consumer test, the category of invention and health product was the main reason for the consumption

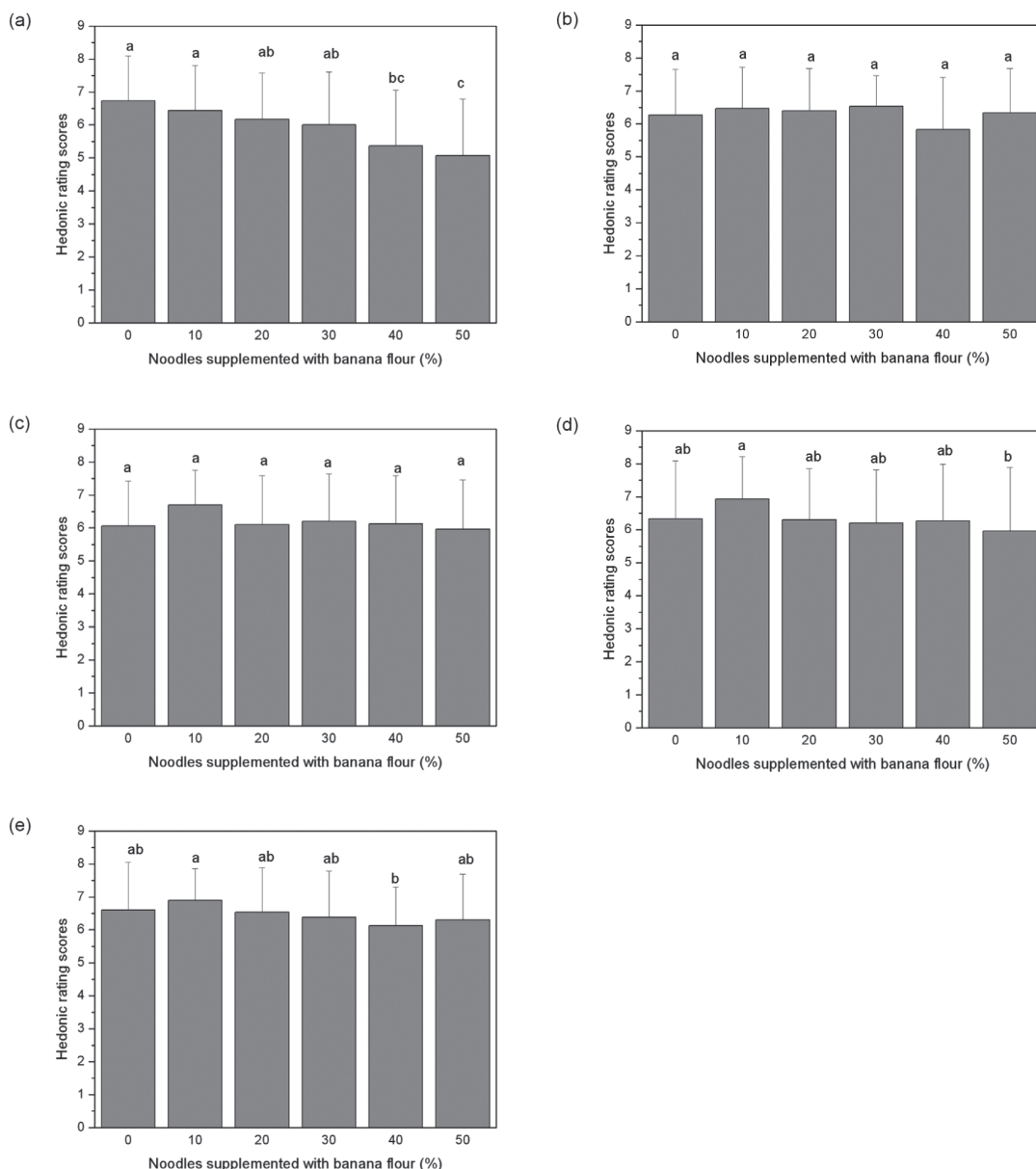


Figure 2 Effect of banana flour (%) on sensory liking scores for: (a) appearance; (b) flavor; (c) taste; (d) texture; and (e) overall liking of optimally cooked noodles supplemented with banana flour. The same letter above columns indicates there is no significant difference ($P > 0.05$). The vertical bars on each column indicate the standard deviation.

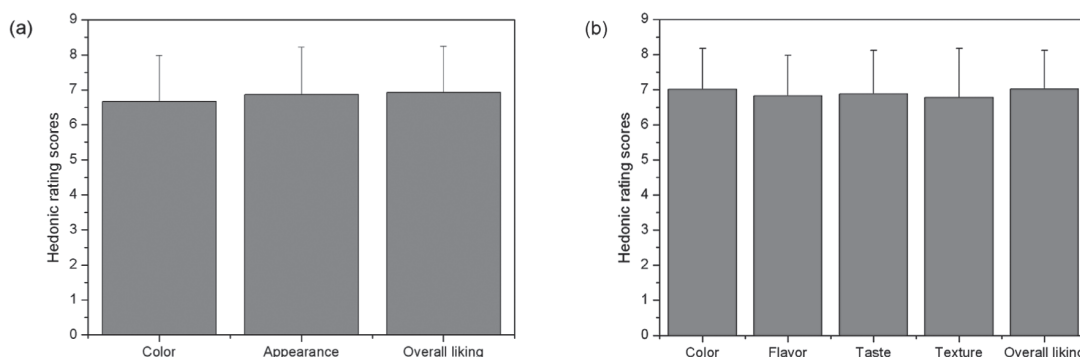


Figure 3 Average sensory liking scores of: (a) raw dried noodles and (b) cooked dried noodles prepared from the optimal ratio of mixtures of banana flour per wheat flour. The vertical bars on each column indicate the standard deviation.

of dried noodles supplemented with banana flour.

CONCLUSION

Banana flour could be added to dried noodles up to the level of 30% without any significant change in organoleptic characteristics. Dried noodles made from 30% banana flour were considered as most acceptable organoleptically and nutritionally as they contained appreciable amounts of protein (13.7%), fat (0.12%) and dietary fiber (4.8%, including 2.8% resistant starch). The development of such functional foods not only improves the nutritional status of the general population but also helps those suffering from degenerative diseases associated with today's changing life styles and environment.

ACKNOWLEDGEMENTS

This research study was funded by the Industrial and Research Projects for Undergraduate Students (IRPUS), Thailand Research Fund (TRF) under project I352A10013. The authors are grateful to the Cassava and Starch Technology Research Unit, National Center for Genetic Engineering and Biotechnology, Thailand, for allowing the use of their texture analyzer and hammer mill. The authors thank Ms. Ornnattha

Supatham, Mahidol University, Kanchanaburi Campus, Thailand, for helpful suggestions on the manuscript.

LITERATURE CITED

- AACC. 2000. **American Association of Cereal Chemists**. Approved methods of the AACC. (10th ed.) The Association. Saint Paul, MN.
- AOAC. 1999. **Official Methods of Analysis**. Association of Official Analytical Chemists. (16th ed.). Washington, DC.
- Aparicio-Saguilán, A., S.G. Sáyago-Ayerdi, A.Vargas-Torres, J. Tovar, T.E. Ascencio-Otero and L.A. Bello-Pérez. 2007. Slowly digestible cookies prepared from resistant starch-rich lintnerized banana starch. **J. Food Compos. Anal.** 20(3–4): 175–181.
- Asenstorfer, R.E., Y. Wang and D.J. Mares. 2006. Chemical structure of flavonoid compounds in wheat (*Triticum aestivum* L.) flour that contribute to the yellow color of Asian alkaline noodles. **J. Cereal Sci.** 43(1): 108–119.
- Brouns, F., B. Kettlitz and E. Arrigoni. 2002. Resistant starch and the butyrate revolution. **Trends Food Sci Tech.** 13: 251–261.
- Bui, L.T.T. and D.M. Small. 2007. The influence of formulation and processing on stability of thiamin in three styles of Asian noodles. **Food**

- Chem.**102:1394–1399.
- Chillo, S., J. Laverse, P.M. Falcone, A. Protopapa and M.A. Del Nobile. 2008. Influence of the addition of buckwheat flour and durum wheat bran on spaghetti quality. **J. Cereal Sci.** 47(2): 144–152.
- Choo, C.L. and N.A.A. Aziz. 2010. Effects of banana flour and β -glucan on the nutritional and sensory evaluation of noodles. **Food Chem.** 119(1): 34–40.
- Englyst, H., S.M. Kingman and J.H. Cummings. 1992. Classification and measurement of nutritionally important starch fractions. **Eur. J. Clin. Nutr.** 46: 33–50.
- Faisant, N., D.J. Gallant, B. Bouchet and M. Champ. 1995. Banana starch breakdown in the human small intestine studied by electron microscopy. **Eur. J. Clin. Nutr.** 49: 98–104.
- Goñi, I., L. García-Díaz, E. Mañas and F. Saura-Calixto. 1996. Analysis of resistant starch. A method for food products. **Food Chem.** 56: 445–449.
- Hatcher, D.W., J.E. Dexter and B.X. Fu. 2008. Investigation of amber durum wheat for production of yellow alkaline noodles. **J. Cereal Sci.** 48: 848–856.
- Hatcher, D.W., J.E. Dexter, M.J. Anderson, G.G. Bellido and B.X. Fu. 2009. Effect of blending durum wheat flour with hard white wheat flour on the quality of yellow alkaline noodles. **Food Chem.** 113: 980–988.
- Kim, S.K. 1996. Instant Noodle, pp. 195–225. In J.E. Kruger, R.B. Matsuo and J.W. Dick, (eds.). **Pasta and Noodle Technology**. American Association of Cereal Chemists, Inc. Saint Paul, MN, USA.
- Kovacs, M.I.P., B.X. Fu, S.M. Woods and K. Khan. 2004. Thermal stability of wheat gluten protein: its effect on dough properties and noodle texture. **J. Cereal Sci.** 39(1): 9–19.
- Kruger, J.E., M.H. Anderson and J.E. Dexter. 1994. Effect of flour refinement on raw Cantonese noodle color texture. **Cereal Chem.** 71: 177–182.
- Lu, Q., S. Guo and S. Zhang. 2009. Effects of flour free lipids on textural and cooking qualities of Chinese noodles. **Food Res. Int.** 42(2): 226–230.
- Mares, D.J. and A.W. Campbell. 2001. Mapping components of flour and noodle color in Australian wheat. **Aust. J. Agri. Res.** 52: 1297–1309.
- Martin, J.M., B. Beecher and M.J. Giroux. 2008. White salted noodle characteristics from transgenic isolines of wheat over expressing puroindolines. **J. Cereal Sci.** 48: 800–807.
- McCance, R.A. and E.M. Widdowson. 2002. **The Composition of Foods**. 6th summary ed.. The Royal Society of Chemistry and the Food Standards Agency. London.
- Mohamed, A., J. Xu and M. Singh. 2010. Yeast leavened banana-bread: Formulation, processing, colour and texture analysis. **Food Chem.** 118(3): 620–626.
- Ovando-Martinez, M., S. Sáyago-Ayerdi, E. Agama-Acevedo, I. Goñi and L.A. Bello-Pérez. 2009. Unripe banana flour as an ingredient to increase the undigestible carbohydrates of pasta. **Food Chem.** 113(1): 121–126.
- Rayas-Duarte, P., C.M. Mock and L.D. Satterlee. 1996. Quality of spaghetti containing buckwheat, amaranth, and lupin flours. **Cereal Chem.** 73: 381–387.
- Ross, A.S. 2006. Instrumental measurement of physical properties of cooked Asian wheat flour noodles. **Cereal Chem.** 83: 42–51.
- Sozer, N., A.C. Dalgıç and A. Kaya. 2007. Thermal, textural and cooking properties of spaghetti enriched with resistant starch. **J. Food Eng.** 81: 476–484.
- Tribess, T.B., J.P. Hernández-Urbe, M.G.C. Méndez-Montevalvo, E.W. Menezes, L.A. Bello-Perez and C.C. Tadini. 2009. Thermal properties and resistant starch content of green banana flour (*Musa cavendishii*) produced at different drying conditions. **Food Sci. Technol-LEB** 42(5): 1022–1025.