International Food Research Journal 18(4): 1309-1312 (2011)

# Textural properties of laksa noodle as affected by rice flour particle size

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**Abstract:** This study examined the physicochemical properties of rice flours with five different particle sizes (≤63, 80, 100, 125, and 140 µm) prepared by dry milling and their effects on textural properties of laksa noodles. Rice flour with the smallest particle size had the highest water absorption index, peak viscosity, hot paste viscosity, breakdown, final or cold paste viscosity and gel hardness, but the lowest gelatinization temperature. Reduction of rice flour particle size improved textural properties of laksa noodle. Laksa noodle produced from rice flour with the smallest particle size had the best textural properties.

**Keywords: Rice flour, particle size, physicochemical, textural, laksa noodle**

## Introduction

Laksa noodle, produced from rice flour, is one of the most popular and widely consumed noodles in Southeast Asia. Different from rice vermicelli, laksa noodle has a larger diameter and looks like white spaghetti. There are two types of laksa noodles available in the market, fresh and dried. Similar to rice vermicelli, laksa noodles are made from long-grain rice with medium to high amylose content (>22 g/100 g) (Juliano and Sakurai, 1985; Tungtrakul *et al*., 1988; Fu, 2007) that plays a critical role in creating a gel network and setting the noodle structure (Mestres *et al*., 1988).

Cooking and textural qualities are two main attributes of rice noodle and vermicelli quality (Tungtrakul *et al*., 1988; Bhattacharya *et al*., 1999; Yoenyongbuddhagal and Noomhorm, 2002; Vangsawasdi *et al*., 2002; Hormdok and Noomhorm, 2007). However, textural quality of cooked noodles is the most important characteristic that determines consumer acceptance. Previous studies reported that certain physicochemical properties of rice flour, including flour swelling power, pasting properties, and gel hardness were highly correlated to the textural quality of rice noodle and vermicelli (Bhattacharya *et al*., 1999; Yoenyongbuddhagal and Noomhorm, 2002; Hormdok and Noomhorm, 2007).

Textural quality of noodle was found to be affected by flour particle size. Flour with fine particle size gave cooked wheat noodles with the best textural parameters (Hatcher *et al*., 2002). Similarly, sorghum flour with smaller particle size produced stronger and firmer noodle (Suhendro *et al*., 2000). Yoenyongbuddhagal and Noomhorm (2002) reported that reduction of particle size in wet-milled rice flour produced acceptable vermicelli in terms of cooking and textural quality. The effect of flour particle size on the textural properties of laksa noodle, however, has not been studied. In this study, the physicochemical properties of dry-milled rice flours with five different particle sizes and their effects on textural properties of laksa noodle were determined.

## Materials and Methods

### *Sample preparation*

Malaysian rice with medium amylose content was procured from a local supermarket. In the preparation of the flour, rice grains were dry-milled (Good and Well, Malaysia) using a rice miller with a 200 µm sieve. Rice flour sample was placed in a sieving machine (Fritsch Analysette 3, Germany) with 200 mm diameter sieves of particle sizes 63, 80, 100, 125, and 140 µm. The processing of laksa noodle was adopted from home industries with some modification. Rice flour with each particle size was mixed with boiled water. The amount of boiled water added was 60% of the total weight of dough formed. The mixture was kneaded until the dough was well homogenized. The kneaded dough was extruded through the holes (3 mm in diameter) of a cylindrical shaped mould. The extruded noodle was then boiled in water until it floated (10 min) and then transferred into cooled water, strained, and dried at 40°C until the final moisture was about 10-12%.

### *Chemical analyses of rice flour*

Ash and moisture contents were determined using the AOAC methods 923.03 and 925.10, respectively (AOAC, 2005). Total fat was determined with FOSS Soxtec Automated System 2050 (FOSS, Sweden)

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which complied with AOAC method 920.85 (AOAC, 2005). Total protein was determined using Kjeldahl method based on AOAC method 920.87 (AOAC, 2005). The amylose content was determined using FIAstarTM method (FOSS, Sweden).

*Physical properties of rice flour*

Water Absorption Index (WAI) was determined using Anderson *et al*. (1969) method. Pasting properties were determined using a Rapid Viscosity Analyzer (RVA) (Newport Scientific, Australia) based on AACC method 61-02 (AACC, 2000). The cold paste from the RVA test run was used to determine its gel hardness with a Texture Analyzer (TA.XT.plus, Stable Micro System, UK) following the method of Yoenyongbuddhagal & Noomhorm (2002).

*Textural properties of laksa noodle*

Texture profile analysis (TPA) of cooked laksa noodle was determined with a Texture Analyzer following the method of Bhattacharya *et al*. (1999) method.

*Sensory evaluation*

Sensory evaluation of cooked laksa noodle prepared using flours with five different particle sizes (≤63, 80, 100, 125, and 140 µm) was carried out with fifty panelists comprising of students and staff on Faculty of Food Science and Technology, Universiti Putra Malaysia. Testing was conducted in the sensory laboratory. Panelists were required to evaluate the aroma, appearance, taste, texture, and overall acceptability of the cooked laksa noodles using the 9-point hedonic scale with 1=dislike extremely, 2=dislike very much, 3=dislike moderately, 4=dislike slightly, 5=neither like nor dislike, 6=like slightly, 7=like moderately, 8=like very much, and 9=like extremely.

*Statistical analysis*

Laksa noodle production and all analyses were performed in triplicates. Data were subjected to analysis of variance (ANOVA) followed by Fisher's least significant difference test (LSD) to compare treatment means; differences were considered at significant level of 95% (P<0.05) (SPSS v.17 software).

## Results and Discussion

*Chemical analyses of rice flour*

Proximate compositions of the rice flours with different particle sizes are presented in Table 1. The moisture content was 8.50-8.58% for all samples. Total ash and protein contents were 0.40-0.48% and 7.37-7.45%, respectively. The fat content of all samples was 0.45-0.69%. Amylose content was 23.14-23.30% for all samples.

**Table 1.** Chemical compositions of rice flours with different particle sizes

| Particle size (µm) | Moisture (%) | Ash (%) | Protein (%) | Fat (%) | Amylose (%) |
|---|---|---|---|---|---|
| ≤63 | 8.58±0.01 | 0.48±0.09 | 7.37±0.06 | 0.67±0.00 | 23.14±0.08 |
| 80 | 8.52±0.01 | 0.47±0.03 | 7.37±0.06 | 0.69±0.11 | 23.30±0.19 |
| 100 | 8.50±0.07 | 0.42±0.01 | 7.43±0.01 | 0.45±0.01 | 23.29±0.05 |
| 125 | 8.58±0.03 | 0.41±0.01 | 7.44±0.01 | 0.57±0.10 | 23.28±0.16 |
| 140 | 8.57±0.01 | 0.40±0.00 | 7.45±0.00 | 0.65±0.15 | 23.19±0.12 |

Values are means ± standard deviations of triplicate determinations.

*Physical properties of rice flour*

The WAI and gel hardness of rice flours with different particle sizes are shown in Figure 1 and 2, respectively. The WAI was 66.17-83.70% for all samples. Figure 1 shows that flour particle size was inversely proportional to the WAI. Smaller particles have higher surface area for water absorption to occur. The gel hardness of all samples ranged from 30.00-59.67 g. The gel hardness was also inversely proportional to the particle size of the flour (Figure 2). The smaller the rice flour particle size, the more amylose was released into the starch gel which could result in rapid retrogradation. The retrograded starch gel would increase the gel hardness. Gel hardness of flour was considered to be a dominant factor for texture of cooked noodle (Bhattacharya *et al*., 1999; Yoenyongbuddhagal and Noomhorm, 2002; Hormdok and Noomhorm, 2007).

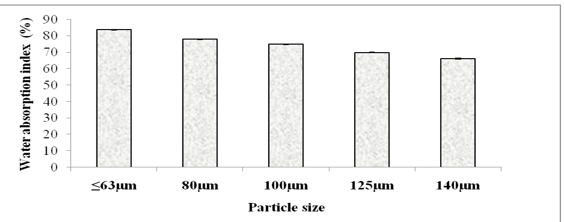


**Figure 1**. Water absorption index (WAI) of rice flours with different particle sizes. WAI values are means ± standard deviations of triplicate determinations.

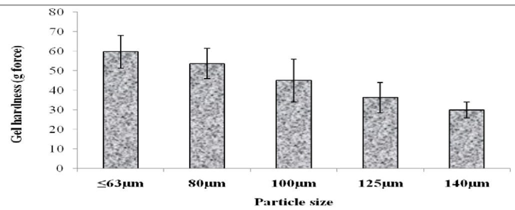


**Figure 2.** Gel hardness of rice flours with different particle sizes. Gel hardness values are means ± standard deviations of triplicate determinations.

*Pasting properties of rice flours*

The pasting properties of rice flours with different particle sizes are presented in Figure 3 and Table 2, respectively. Pasting temperatures (PT) of rice flour samples were 80.81-82.37ºC. PT was reduced as particle size decreased (P<0.05). This might be due to the smaller particle size of rice flour that could rapidly absorb water and its starch granules quickly

**Table 2.** Pasting properties of rice flours with different particle sizes

| Particle ssize (µm) | PV (RVU) | HPV (RVU) | BD (RVU) | FV (RVU) | SB (RVU) | PT (˚C) |
|---|---|---|---|---|---|---|
| ≤63 | 237.36a±1.28 | 160.56a±2.65 | 76.81a±3.62 | 332.53a±5.76 | 95.17a±6.57 | 80.81a±0.15 |
| 80 | 232.17b±1.26 | 159.17a±8.03 | 73.00b±9.27 | 327.97ab±4.71 | 95.81a±5.97 | 80.97a±0.51 |
| 100 | 229.08bc±1.59 | 156.53ab±2.87 | 72.56a±4.44 | 326.14ab±1.98 | 97.06a±3.54 | 81.40b±0.00 |
| 125 | 226.58c±2.76 | 154.78ab±4.09 | 71.81a±2.68 | 321.86bc±4.44 | 95.28a±2.51 | 81.52b±0.06 |
| 140 | 221.21d±1.04 | 150.67b±0.50 | 70.54a±1.54 | 317.38c±4.88 | 96.17a±5.92 | 82.37c±0.30 |

PV = peak viscosity, HPV = hot paste viscosity, BD = breakdown (PV- HPV), FV = final viscosity, SB = setback (FV- PV). Measured in RVU (Rapid Visco Analyser Unit). PT = pasting temperature (measured in ˚C).
Values are means ± standard deviations of triplicate determinations.
Means for each characteristic followed by the same letter within the same column are not significantly different at P<0.05 by LSD test.

**Table 3.** Textural properties of laksa noodle prepared using flours with different particle sizes

| Particle size (µm) | Hardness (g) | Adhesiveness (gs) | Springiness | Cohesiveness | Chewiness (gmm) |
|---|---|---|---|---|---|
| ≤63 | 2369.00a±8.06 | 87.93a±12.94 | 0.78a±0.16 | 0.49a±0.04 | 911.67a±27.82 |
| 80 | 2186.00ab±18.71 | 56.67b±17.79 | 0.67ab±0.06 | 0.52ac±0.03 | 774.67ab±15.64 |
| 100 | 2168.67ab±4.74 | 60.00b±22.54 | 0.70ab±0.01 | 0.51a±0.02 | 775.67ab±51.05 |
| 125 | 2063.67bc±9.30 | 51.00b±7.00 | 0.72ab±0.04 | 0.48ab±0.02 | 704.67ab±28.11 |
| 140 | 1848.67c±4.80 | 49.00b±9.00 | 0.68ab±0.44 | 0.42b±0.05 | 535.67b±10.58 |

Values are means ± standard deviations of triplicate determinations.
Means for each characteristic followed by the same letter within the same column are not significantly different at P<0.05 by LSD test.

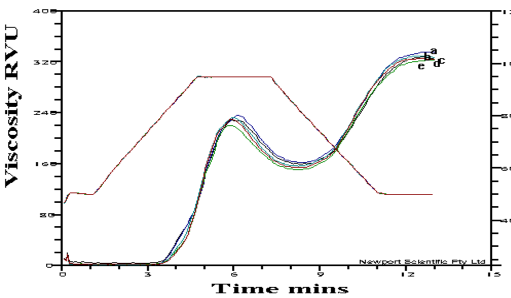


**Figure 3.** Pasting properties of rice flours with different particle sizes. Samples are indicated as: a (≤63 µm); b (80 µm); c (100 µm); d (125 µm); and e (140 µm).

swelling resulting in easily gelatinizing of starch at lower temperature.

Peak viscosity (PV), hot paste viscosity (HPV), breakdown (BD), final or cold paste viscosity (FV), and setback (SB) of rice flour samples varied from 221.21-237.36 RVU, 150.67-160.56 RVU, 70.54-76.81 RVU, 317.38-332.53 RVU, and 95.17-97.06 RVU, respectively. PV, HPV, BD, and FV of largest particle size rice flour were significantly lower than those from the smaller particle size (P<0.05). These results indicated that rice flour with the smaller particle size reached the onset gelatinization temperature faster and exhibited higher thickening behavior than that of the larger particle sized flour. The term SB which indicates the retrogradation tendency was relatively high in all the five flours studied. This could be due to the higher amylose released in starch gel which resulted in rapid retrogradation, and as expected, the texture was harder after cooling.

*Textural properties of laksa noodle*

The results from TPA (Table 3) showed that textural properties of laksa noodle were affected by rice flour particle size. Hardness, adhesiveness, springiness, and chewiness of laksa noodles prepared from small particle sized flour were significantly higher than those prepared from large particle sized flour (P<0.05). This indicated that the laksa noodles had firmer texture, less stickiness, higher springiness, and chewiness, representing better quality of laksa noodle. The result was also in agreement with the findings of Yoenyongbuddhagal and Noomhorm (2002), Hatcher *et al*. (2002) and Suhendro *et al*. (2000) in which reduction of flour particle size improved textural properties of noodles.

It was caused by the fact that the starch granules in laksa noodle prepared from finer flours were more completely gelatinized than those prepared from coarser flours, since more heat and water penetrated into the cores of the starch granules in the flours with smaller particle sizes. This condition was supported by the lower PT. The higher paste viscosities (PV, HPV, BD, and FV) for finer rice flour (Table 2) indicated a higher proportion of gelatinized starches for rice flours with smaller particle sizes. The amount of gelatinized starch was important for rice noodle structure which functioned as binding agent during extrusion (Fu, 2007). In addition, the increased gelatinized starch improved textural quality of laksa noodle. Therefore, the rice flour samples with smaller particle size produced better laksa noodle.

*Sensory evaluation*

Results of sensory evaluation in terms of aroma, appearance, taste, texture, and overall acceptability are presented in Table 4. The evaluation of sensory attributes of laksa noodle showed differences among samples. Hedonic scales of appearance, taste, texture, and overall acceptability of laksa noodles prepared from small particle sized flour were significantly

**Table 4.** Mean of hedonic scales for panelist's acceptance of laksa noodle prepared using flours with different particle sizes

| Particl size (µm) | Aroma | Appearence | Taste | Texture | Overall acceptability |
|---|---|---|---|---|---|
| ≤63 | 5.74a±1.93 | 7.32a±1.13 | 6.12a±1.45 | 6.92a±1.26 | 7.02a±1.12 |
| 80 | 5.64a±1.69 | 6.44b±1.18 | 5.80ab±1.46 | 6.24b±1.39 | 6.36b±1.17 |
| 100 | 5.58a±1.75 | 5.76c±1.32 | 5.36b±1.60 | 5.22c±1.48 | 5.56c±1.36 |
| 125 | 5.74a±1.52 | 5.14d±1.40 | 5.24b±1.48 | 4.44d±1.46 | 4.80d±1.46 |
| 140 | 6.00a±1.57 | 4.30e±1.58 | 5.14b±1.74 | 3.66e±1.73 | 3.98e±1.61 |

Values are means ± standard deviations; n = 50.
The 9-point hedonic scale with 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much, and 9 = like extremely.
Means for each characteristic followed by the same letter within the same column are not significantly different at P<0.05 by LSD test.

higher than those prepared from large particle sized flour (P<0.05). Laksa noodles prepared from the smallest particle sized flour received scores higher than 6 (like slightly) for appearance, taste, texture, and overall acceptability attributes, implying that the laksa noodle was the most-liked by panelists.

## Conclusion

The results of this study indicated that particle size influenced WAI, pasting properties, and gel hardness of rice flours. The textural properties of laksa noodle made from smaller particle sized flour were significantly higher than those made from large particle sized flour. Flour with particle size ≤63µm produced laksa noodle with the best textural properties and sensory attributes.

## Acknowledgements

The authors thank Padiberas Nasional Berhad (BERNAS) and Universiti Putra Malaysia for financial support of this research.

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