Nutritional composition and sensory properties of kuih baulu incorporated stabilised rice bran
(Kandungan pemakanan dan ciri-ciri nilai rasa kuih baulu yang ditambah dengan dedak beras distabil)

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Keywords: kuih baulu, rice bran, nutrition, sensory

Abstract
Rice bran is a valuable by-product from the rice processing industry. Stabilised rice bran (SRB) was used to complement rice flour (MR 220) to add value to Malaysian traditional sponge cake known as kuih baulu. Four levels of stabilised rice bran (10, 20, 30 and 40%) were used in the formulations. Chemical analysis and sensory evaluation were carried out. The protein, fat and ash contents increased with increasing proportions of the rice bran. All SRB-incorporated kuih baulu had higher values for mineral and vitamin contents as compared to the control. Products with 20–40% levels of rice bran were significantly different from the control sample in terms of colour, texture, taste, flavour and overall acceptability. For texture, tenderness was found to increase with increasing SRB content. Panelists indicated that the addition of SRB resulted in darker kuih baulu. SRB could replace about 30% rice flour without diminishing acceptability. Sensory evaluation showed that all SRB-incorporated kuih baulu were acceptable.

Introduction
Nowadays, there is increasing interest in the production of traditional cakes due to an increased demand in both local and export markets (Abd. Rahim 2006). In Malaysia, home-made traditional cakes are increasing in popularity, and large quantities of the products are being consumed in both villages and the cities. Production of the traditional cakes is currently going towards commercialisation and the industry is being supported by various agencies under the Ministry of Agriculture and Agro-based Industry.

Kuih baulu, a popular traditional cake in Malaysia is usually served during the festive seasons especially during Hari Raya. Nowadays, it is easily obtainable in shops and stalls. It is prepared by baking using special moulds of various shapes. According to Khatijah et al. (1992), kuih baulu is high in carbohydrates and low in mineral and vitamin contents. The increasing awareness that health may be modified through diet has led to an upsurge in the availability of nutritionally functional foods that have potential health benefits beyond the basic nutrition (Hasler 1998). Accordingly, kuih...
**Nutritious kuih baulu from stabilised rice bran**

*baulu*, properly formulated with high nutritional and sensory qualities, has the potential of being a source of essential nutrients especially for children and teenagers.

Malaysia produces approximately 0.2 million metric tonnes of rice bran annually. Rice bran, produced in modern mills, is mixed with rice germ and starch from the endosperm (Rosniyana et al. 2007b). The yield of husk and brown rice from 100 kg paddy are 22.8 kg and 73 kg respectively. The recovery of bran depends upon the degree of milling of brown rice, which may vary from 5% to 10%.

Rice bran, a by-product of the rice milling industry, is needed for the development of value-added food products. Rice bran is easily incorporated into rice flour which is extensively used in different food products. It can be incorporated into breads, muffins, snacks and biscuits as a source of fibre (Saunders 1990). The problem in effective utilisation of rice bran is the storage stability attributed to the presence of lipase and unsaturated fatty acids (Rosniyana et al. 2005a). Since rice bran is hygroscopic, it may absorb moisture from the atmosphere resulting in increase of free fat acidity. Heat treatment is one of the methods used to stabilise the rice bran. Studies showed that the storage of rice bran could be extended to 4 and 6 months by autoclaving and parboiling process respectively (Rosniyana et al. 2005a).

Parboiled rice bran has been successfully used in bread at 8% levels to produce fibre rich food (Skuarray et al. 1988). Parboiled rice bran was significantly higher in nutritional contents than other stabilised brans. It is recommended to use parboiled rice bran in food applications which will result in more nutritious products (Rosniyana et al. 2007a). Although the food industries have developed nutritionally enhanced products that are available to consumers, the use of parboiled rice bran is relatively rare in processing *kuih baulu*. Therefore, this study was carried out to evaluate the effects of incorporating parboiled rice bran on the nutritional and sensory properties of *kuih baulu*.

**Materials and methods**

**Production of rice flour**

Rice of local variety, MR 220, supplied by MARDI Tanjung Karang was used to prepare the rice flour which was processed by dry milling using an air isolating type grinding machine. It was then mixed with determined levels of rice bran to produce rice bran flour which was then kept in sealed plastic bags (orientated polyethylene) at room temperature until further use.

**Production of stabilised rice bran (SRB)**

Paddy was subjected to stabilisation process by parboiling whereby the harvested paddy was subjected to soaking (2 h) and steaming (30 min) before being dried and milled (Rosniyana et al. 2005b). The hull was then removed by using paddy dehusker, followed by removal of bran to yield parboiled white rice and bran. The stabilised rice bran was dried at 60 °C until the moisture content was 5% and then sieved through a 50-mesh sieve.

**Preparation of rice bran flour**

Five blends of SRB and rice flour (MR 220) were prepared as described in Table 1. The blends consisted of varying SRB from 0% to 40% mixed with rice flour sample (MR 220) using formulation F1 through F5 while keeping other ingredients constant. The rice bran flour, a mixture of SRB and rice flour, were prepared in different ratios, namely, 0:100, 10:90, 20:80, 30:70 and 40:60.

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Stabilised rice bran</th>
<th>Rice flour</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>F2</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>F3</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>F4</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>F5</td>
<td>40</td>
<td>60</td>
</tr>
</tbody>
</table>

Table 1. Ratio of stabilised rice bran and rice flour in rice bran flour formulation
**Preparation of kuih baulu**

The ingredients used for preparation of *kuih baulu* include rice bran flour, eggs and sugar. A modified *kuih baulu* formulation, using 44% egg and 25% sugar by weight of total ingredients, was developed to suit the rice flour (MR 220). The procedure described by Zaidah (1986) was used for preparing the *kuih baulu*. Eggs and sugar were thoroughly mixed for 10 min. Sifted rice bran flour, at 20% by weight of total ingredients, was added into the mixture. The batter was then poured into a mould and baked at 220 °C for 15 min. The preparation of *kuih baulu* from each blend of rice bran flour was carried out in two replicates.

**Chemical analysis**

Samples of *kuih baulu* were taken for analyses of moisture, protein, crude fibre, fat, ash, phosphorous, potassium, sodium, calcium, iron, thiamine, niacin and riboflavin. Moisture, protein, fat, free fatty acid and ash were determined using standard AOAC methods (AOAC 1990). Protein was determined by Kjeldahl nitrogen method using Kjeltec system 1026 (Tecator 1978). Fat was determined by Soxhlet extraction and ashing was done at 550 °C to constant weight. Determination of crude fibre was carried out by Weende method using fibertec system (Tecator 1978). Minerals, vitamins and dietary fibre were analysed by an accredited company Edtech Associates Sdn. Bhd. (Penang) according to the method by AOAC (1993). Each analysis was carried out in duplicate. Carbohydrate was calculated by subtracting the values of moisture, protein, crude fibre, fat and ash, from 100.

**Sensory evaluation**

The *kuih baulu* was evaluated by a sensory panel comprising 15 trained panellists. Characteristics of *kuih baulu* which were frequently assessed include flavour, tastes, colour and texture (Mandala and Daoucher 2005). Sensory evaluation was determined using a 7-point Hedonic rating scale ranging from 1 to 7. For flavour, the samples that were rated with 1 has no flavour and 7 with good flavour. Score 1 for colour indicates too light (unbaked), too dark or burnt product, while 7 denotes brown, shiny, uniform colour. For texture, score 1 denotes too dry or too soft and cohesive (unbaked) product, while score 7 indicates tender (soft) crumb and very good cohesiveness. The taste was rated 7 when it indicates a perfectly balanced taste and sweetness, while 1 denotes extremely bad taste, unbaked, over baked or bitter *kuih baulu*. Each sample was assessed for overall acceptability which covered these factors.

**Data analysis**

In this study, each formulation was carried out in two replicates. All determinations were statistically analysed by analysis of variance and the mean values are presented. The Duncan Multiple Range Test (DMRT) was used to detect differences between treatments (Gomez and Gomez 1984).

**Results and discussion**

**Chemical composition**

The mean values for proximate composition of *kuih baulu* are shown in Table 2. The moisture content of *kuih baulu* increased significantly (*p* <0.05) with incorporation of SRB. According to Skuarray et al. (1988), the water absorption increased with the amount of rice bran in the *kuih baulu*. This might have resulted from the addition of bran which increased the absorption rate during mixing. This was expected because of the high fibre content of rice bran (Skuarray et al. 1988). The free hydroxyl groups of the cellulose and hemicellulose bound with water molecules contributed to a greater water holding capacity (Sangnark and Noomhorm 2003). Thus, with increasing levels of SRB, there will be higher water absorption and this contributed to higher moisture content.

The products had protein contents between 7.9–8.8% (*Table 2*). There was significant increment of protein in *kuih baulu* with increasing levels of SRB. The free hydroxyl groups of the cellulose and hemicellulose bound with water molecules contributed to a greater water holding capacity (Sangnark and Noomhorm 2003). Thus, with increasing levels of SRB, there will be higher water absorption and this contributed to higher moisture content.
Nutritious *kuih baulu* from stabilised rice bran

The protein contents in the 20, 30 and 40% SRB added *kuih baulu* differed significantly with the 10% SRB level. The decrease in protein content may indicate that the chemical composition of the rice bran was affected by the milling process and this was supported by an earlier study which showed that rice bran produced at 8% milling degree had the lowest protein (Rosniyana et al. 2007b). Rice bran is a rich source of protein (14–16%) with higher lysine and lower glutamic acid content than rice and wheat. It has a better balance of essential amino acid score of 80% and 90% in terms of lysine and threonine respectively (Anderson and Guraya 2001). It was reported to have a Protein Energy Ratio (PER) value of nearly 2.0. Landers and Hamaker (1994) also reported that rice bran had better balance of essential amino acids and may be utilised to improve the nutritional value of rice flour. Report by Hamada (2000) also indicated that addition of rice bran improved lysine content of developed products.

The fat content of the products varied from 2.3% to 3.9%. It was significantly higher in SRB-incorporated *kuih baulu* but there was no significant difference between the control and 10% level of SRB *kuih baulu* (*Table 2*). Rice bran is high in fat content ranging from 16–22% (Goffman and Bergman 2002). As rice bran is rich in fat content, a significant increase in percentage of fat was observed as the level of SRB in the product was increased.

Ash was present in the range of 0.7–1.7%. The ash content in SRB-incorporated *kuih baulu* was significantly higher (*p* < 0.05) than the control. According to Juliano and Bechtel (1985), the high content in ash was contributed by the mineral contents. Thus, the ash content in SRB-incorporated *kuih baulu* depends on the quality of flour (Kim 1996) which corresponds to the higher mineral content especially potassium.

Control *kuih baulu* had significantly higher (*p* < 0.05) carbohydrates than SRB-incorporated *kuih baulu* (*Table 2*). The carbohydrate in rice bran is a mixture of complex carbohydrates and starch (Narasinga Rao 1988) and the major ones include cellulose, hemicellulose and pentosans (Juliano and Bechtel 1985). Pentosans have been shown to improve the dough in cakes and muffins and the complex carbohydrate in the rice bran flour is believed to enhance the gas-holding properties, improve machinability or retard staling in bakery products (Hammond 1994).

**Mineral compositions**

The mineral compositions in SRB containing *kuih baulu* were higher than the *kuih baulu* without SRB (*Table 3*). Rice bran is a good source of minerals and much superior than other cereals. However, it has been reported by several studies that rice bran is low in sodium (reference and yr). Thus, the high values of sodium in the developed product may arise from the ingredients used in *kuih baulu*. Results also showed that the 40%

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**Table 2. Proximate compositions of *kuih baulu* incorporated with different levels of stabilized rice bran**

<table>
<thead>
<tr>
<th>Properties (%)</th>
<th>Levels of stabilized rice bran (%)</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td></td>
<td>21.60 ± 0.75d</td>
<td>29.40 ± 0.50c</td>
<td>33.40 ± 0.50b</td>
<td>34.90 ± 0.50a</td>
<td>34.70 ± 0.75a</td>
</tr>
<tr>
<td>Ash</td>
<td></td>
<td>0.70 ± 0.01e</td>
<td>1.00 ± 0.05d</td>
<td>1.20 ± 0.02c</td>
<td>1.40 ± 0.02b</td>
<td>1.70 ± 0.01a</td>
</tr>
<tr>
<td>Protein</td>
<td></td>
<td>7.90 ± 0.02c</td>
<td>8.80 ± 0.01a</td>
<td>8.30 ± 0.01b</td>
<td>8.40 ± 0.02b</td>
<td>8.30 ± 0.02b</td>
</tr>
<tr>
<td>Fat</td>
<td></td>
<td>2.30 ± 0.01d</td>
<td>2.30 ± 0.05d</td>
<td>2.80 ± 0.01c</td>
<td>3.30 ± 0.02b</td>
<td>3.90 ± 0.01a</td>
</tr>
<tr>
<td>Crude fibre</td>
<td></td>
<td>0.20 ± 0.01c</td>
<td>0.80 ± 0.05d</td>
<td>1.30 ± 0.01c</td>
<td>1.60 ± 0.02b</td>
<td>2.40 ± 0.01a</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td></td>
<td>67.30 ± 0.25a</td>
<td>57.70 ± 0.55b</td>
<td>53.00 ± 0.50c</td>
<td>50.70 ± 0.50d</td>
<td>49.00 ± 0.75d</td>
</tr>
</tbody>
</table>

Mean values in the same row with different letters are significantly different using DMRT with *p* < 0.05.
SRB-incorporated *kuih baulu* had the lowest sodium content (*Table 3*). This indicated that incorporation of SRB at this level may reduce the total sodium content in the products.

In addition to that, the sodium contents in the bran varied according to the degree of milling which indicated that the distribution of sodium constituents in the bran layers differed (Rosniyana et al. 2007b). Phosphorus was present within a range of 40–145 mg/100 g sample, while potassium was found to be between 53 and 96 mg/100 g sample. The iron content varied from 2.2–6.3 mg/100 g sample. Levels of iron above 5.5 mg/100 g were of considerable nutritional significance (Tee et al. 1997).

All SRB-incorporated *kuih baulu* had significantly higher minerals compared to the control except sodium indicating that the developed products had a nutritional added value. The results indicated that increasing levels of rice bran resulted in increasing levels of mineral contents. Carroll (1990) also observed that incorporation of bran significantly increased the mineral content of the finished products. Other studies by Hammond (1994) also reported that rice bran is a concentrate source of meal, where the minerals can be concentrated to produce a nutrient mixture.

**Vitamin composition and dietary fibre**

The amount of vitamins present in the *kuih baulu* varied and niacin was the major vitamin B-complex in the product (*Table 4*). Rice bran is rich in vitamin B-complex particularly thiamine and niacin. With the exception of niacin, other components of vitamin B-complex was not present in the control. However, results showed that the vitamin B-complex significantly increased in all levels of the SRB-incorporated products.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Levels of stabilized rice bran (%) (mg/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Calcium</td>
<td>12.0 ± 0.5c</td>
</tr>
<tr>
<td>Potassium</td>
<td>53.0 ± 0.5c</td>
</tr>
<tr>
<td>Sodium</td>
<td>93.0 ± 0.7a</td>
</tr>
<tr>
<td>Magnesium</td>
<td>13.0 ± 0.5c</td>
</tr>
<tr>
<td>Iron</td>
<td>2.20 ± 0.01e</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>40.0 ± 0.5c</td>
</tr>
</tbody>
</table>

Mean values in the same row with different letters are significantly different using DMRT with *p* <0.05

<table>
<thead>
<tr>
<th>Properties</th>
<th>Levels of stabilized rice bran (%) (mg/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Thiamine</td>
<td>0.00d</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0.00d</td>
</tr>
<tr>
<td>Niacin</td>
<td>0.20 ± 0.01d</td>
</tr>
<tr>
<td>Pyridoxine</td>
<td>0.00d</td>
</tr>
<tr>
<td>Tocopherol</td>
<td>0.07 ± 0.01d</td>
</tr>
<tr>
<td>Dietary fibre/g</td>
<td>2.90 ± 0.01e</td>
</tr>
<tr>
<td>Soluble fibre/g</td>
<td>0.50 ± 0.01e</td>
</tr>
<tr>
<td>Starch/g</td>
<td>20.50 ± 0.50d</td>
</tr>
</tbody>
</table>

Mean values in the same row with different letters are significantly different using DMRT with *p* <0.05
Nutritious kuih baulu from stabilised rice bran

The most pronounced increment was observed in niacin and pyridoxine contents in the 40% SRB added kuih baulu. Similar increment was observed for thiamine and riboflavin in SRB-incorporated kuih baulu as compared with the control. This indicated that the vitamin contents increased significantly ($p < 0.05$) with increasing levels of rice bran. Similar observation was reported by Juliano (1985) which stated that the major proportion of vitamins in rice was located in the bran and this content was significantly reduced during milling of rice.

Vitamin B-complex is essential for growth, development and a variety of other bodily functions. It plays a major role in the activities of enzymes, proteins that regulate chemical reactions in the body, which are important in turning food into energy and other needed substances.

Tocopherol was found in varied amounts (0.07–1.6 mg/100 g) in kuih baulu. The amount of tocopherol detected was significantly different ($p < 0.05$) among samples and significantly increased with increasing levels of SRB. Studies by Rong et al. (1999) indicated that rice bran had the richest source of tocopherol (nearly 1 g/100 g). Hence, addition of rice bran resulted in increase of tocopherol content and the results are significant.

With the exception of the control and 10% SRB-incorporated kuih baulu, all the other products are high fibre products more containing than 6% total dietary fibre based on the definition of Codex Alimentarius (Codex Alimentarius Commission 2001). Rice bran contains 25.3 g/100 g dietary fibre which can meet the recommended dietary fibre intake of an adult which is about 27 g a day (Narasinga Rao 1988). Dietary fibre in bran includes cellulose, hemicellulose and pentosans which are all insolubles fibres. In addition it also contains about 2% soluble dietary fibre. Kuih baulu incorporated with 40% rice bran had the highest total dietary fibre (11.1%) (Table 4). Studies by Thompson and Weber (1981) suggested that rice bran can be incorporated in food products as a source of dietary fibre and to improve the nutritional quality. It was also reported that dietary fibre was widely recognized as an important element in the treatment and prevention of diabetes, colorectal cancer, gastrointestinal disorders, high cholesterol, heart disease and obesity.

**Sensory evaluation**
The mean scores given by panellists for sensory characteristics are presented in Table 5. Sensory results indicated that the control kuih baulu had significantly ($p < 0.05$) higher score for most attributes than kuih baulu incorporated with SRB. Panellists perceived that the colour increased in darkness with SRB incorporation and kuih baulu with 30–40% SRB was darker. The highest score for colour was obtained in the control kuih baulu followed by 10, 20, 30 and 40%. Bran which has light tan colour, may contribute to the colour of SRB-incorporated kuih baulu (Bor et al. 1991).

The flavour of the control kuih baulu was insignificantly different ($p > 0.05$) from kuih baulu at 10% level of SRB but significantly different from kuih baulu containing 20, 30 and 40% levels of SRB. Kuih baulu incorporated with 20–30% SRB had a flavour score of 4.75, which was considered to have a moderately good flavour. The bran in the rice flour was described as having a sweet, slightly toasted,
nutty flavour (Rosniyana et al. 2005b). The compounds responsible for the characteristic flavour in rice bran are still unknown.

There were differences in scores by panellists tasting the products. Statistically, the taste of the control and kuih baulu incorporated with 10% rice bran differed significantly from the taste of kuih baulu incorporated with 20, 30 and 40% rice bran. The taste of the control kuih baulu was rated as perfectly moderate balanced taste with moderate sweetness (5), while kuih baulu incorporated with 30–40% rice bran had a slightly bitter taste. The bitter taste was presumably associated with saponin present in the rice bran (Rosniyana et al. 2005b). However, the amount of saponin in the products depends on the levels of SRB in the formulation of the product.

Sensory panel found that the control and 10% SRB-incorporated kuih baulu were slightly tender in texture while the other samples were rated as moderately tender (soft). Sensory results indicated that panellists preferred the texture of kuih baulu containing 10–40% rice bran than the control (Table 5). There was a significant increase in the texture of SRB-incorporated kuih baulu as compared to the texture of the control kuih baulu. It was indicated by Hammond (1994), that rice bran has emulsification properties which possessed similar functional characteristics as other emulsifying agents. Thus, the addition of rice bran could improve the texture of kuih baulu.

The average score for the overall acceptability of kuih baulu indicated that panellists preferred kuih baulu without the rice bran (control) as the results were significantly higher. However, the panellist rated 4.25–5.05 for overall acceptability of SRB-incorporated kuih baulu which indicated that these products were still acceptable. This trend is common for the other bran-based products as reported in the literature. At levels above 30%, the incorporation of rice bran was not acceptable in products such as papads (Prakash and Ramanatham 1995) and biscuits (Shashikanth 1991).

Conclusion
The study showed that nutritious kuih baulu can be prepared by incorporation of SRB into the formulation resulting in significant increase in proximate composition, minerals, vitamins and dietary fibre contents. High fibre kuih baulu can be made by incorporating 20–40% levels of SRB which resulted in 6.5–11.1% dietary fibre present in the products. All the kuih baulu were acceptable to sensory panellists and a significantly higher score for texture was shown in the 30% SRB-incorporated kuih baulu. This study indicated that SRB could be used in bakery products to improve their texture.

Acknowledgement
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Nutritious kuih baulu from stabilised rice bran


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Abstrak