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Nutritional composition and sensory evaluation of *dodol* formulated with different levels of stabilised rice bran

(Komposisi pemakanan dan penilaian nilai rasa *dodol* yang diadun dengan dedak beras stabil pada kadar yang berbeza)

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Keywords: *dodol*, rice bran, nutritional, organoleptic quality

Abstract

Dodol was formulated with different levels (10, 20, 30, and 40%) of stabilised rice bran. The products were then evaluated for chemical and sensory properties. Proximate analyses showed that substitution of rice flour with different levels of rice bran significantly increased (p <0.05) protein, fat and crude fibre contents of the *dodol*. Mineral and vitamin were observed to increase significantly (p <0.05) with increased levels of rice bran in the formulation. Increasing levels of rice bran were also found to increase levels of dietary fibre in the product. The *dodol* was acceptable to the sensory panellists with mean score for all attributes greater than 5. *Dodol* with 20–40% levels of rice bran were significantly different from the control sample in terms of colour, texture, taste, aroma and overall acceptability.

Introduction

Dodol, one of the popular Malay traditional cakes, is a rice-based product with ingredient primarily from glutinous rice. It is well-liked by many particularly during festive season (Zainun and Rokiah 2007). Other than glutinous rice, the main ingredients used in the making of *dodol* are sugar and coconut milk. It is also gaining popularity among the urban consumers and with availability of modern packaging technology, suitable for branding and marketing purposes, *dodol* which is unique to Malaysian can be turned into a market winner.

Dodol is usually consumed as a snack. They are not designed to be alternatives to the daily three main meals and further, they are not eaten solely to satisfy hunger or to supply our bodies with nutrients, but mainly for social reasons (Delroy 1985). It was reported that the content of carbohydrate in *dodol* ranges from moderate to high (40–70%), while the crude fibre and vitamin contents were generally low (Khatijah et al. 1992). *Dodol* can be enriched with various types of functional additives to improve the nutritional value of the product. Rice bran, a nutritious byproducts of rice processing, can be incorporated into *dodol* to increase the nutritional value of the product and this is in line with the current trend, to increase production of foods with special benefits to health.

Rice bran is the outer brown layer, including the rice germ, that is removed during milling of brown rice to produce milled rice (Juliano and Bechtel 1985). Each rice kernel comprises 10% by weight rice bran which contains 80% of the nutrients

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found in each rice kernel. Rice bran is a rich source of proteins, fats, minerals and micronutrients, such as B-vitamins and trace elements (Bor et al. 1991). Full fat rice bran is a rich source of dietary fibre and several bioactive phytochemicals such as phytosterol, oryzanol, tocopherol and tocotrienol. It has been used significantly for its hypoallergenic properties, which is suitable for those who are gluten intolerance.

One of the problems in incorporating rice bran in food products is its high instability due to the presence of lipase, which catalyzes the splitting of the triglycerides into free fatty acids and gycerols, thus reducing its shelf life (Fernando and Hewavitharana 1990). To capture the goodness of rice bran, one needs to stabilise the bran. Methods proposed to stabilise rice bran are based on altering the moisture content, temperature or pH to destroy the activity of the lipase (Prabhakar 1987). Apart from that, bran needs to be ground, sieved and separated to reduce the roughage.

The development of value-added products from stabilised rice bran had been recommended as a way to increase the opportunity to expand the utilization of rice bran in our country. In addition, it is necessary to develop a standardized food grade rice bran to ensure that a dependable high-quality bran reaches the user and consumer. One potential food application for rice bran is its usage in composite flours for the production of bakery products. Making bakery products from rice bran flour has been extensively studied by several researchers (Sangnark and Noomhorm 2003).

The study was carried out to determine the suitability of substitution of rice flour (MR 220) with different levels (10, 20, 30 and 40%) of stabilised rice bran in *dodol*. The effects on the chemical and sensory characteristics of the *dodol* were investigated.

Materials and methods

Materials

Sugar, brown sugar, fresh coconut milk and salt were obtained from local market. Rice of local variety, MR 220, was used to prepare the rice flour. The rice flour was processed by dry milling method using air isolating type grinding machine and then mixed with determined levels of rice bran to produce rice bran flour (80-mesh sieve).

Production of stabilised rice bran

Paddy was subjected to stabilisation process by parboiling. The process described by Rosniyana et al. (2005) was carried out, whereby the paddy was subjected to soaking and steaming before being dried and milled. The hull was then removed, followed by removal of bran to yield parboiled white rice and bran. The stabilised rice bran (SRB) were dried at 60 °C to bring the moisture content to less than 5%, sieved through an 80-mesh sieve and then used for the preparation of rice bran flour by incorporating different levels of SRB.

Experimental design

The experimental design (*Table 1*) consisted of varying SRB from 0% to 50% in rice flour sample (MR 220) from formulation F1 to F6 while keeping other ingredients constant. The rice bran flour was prepared by mixing the SRB and rice flour in different ratios i.e. 0:100, 10:90, 20:80, 30:70, 40:60 and 50:50.

Table 1. Ratio of stabilised rice bran and rice flour in *dodol* formulation

Formulation	Stabilised rice bran	Rice flour
F1	0	100
F2	10	90
F3	20	80
F4	30	70
F5	40	60
F6	50	50

Dodol formulation and preparation

Dodol was prepared using rice bran flour containing different levels of rice bran (*Table 1*). A modified *dodol* recipe, as described by Zainun and Rokiah (2007) was used for *dodol* preparation. The basic ingredients used were rice bran flour (9%), sugar (17%), brown sugar (5%), coconut milk (25%), water (43%) and salt (1%). Flour, salt, water and coconut milk were thoroughly mixed in the cooking vessel for 10 min. The mixture, at heating temperature of 90 °C, was constantly stirred until the product became thick and glossy. At a determined viscosity, sugar and brown sugar were added and the mixture was cooked until it turned into a cooked mass and did not stick to the cooking vessel. The *dodol* was removed from the heat and then poured into a mould. After cooling, the *dodol* (150 g) was packed in oriented polypropylene/polypropylene and used for evaluation of various chemical and sensory properties. The preparation of *dodol* from each blend of rice bran flours was carried out in two replicates.

Chemical analysis

Samples of *dodol* were taken and analysed for moisture, protein, crude fibre, fat, ash, magnesium, 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 testing laboratory, Edtech Associates Sdn. Bhd. (Pulau Pinang) 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 analysis

The *dodol* characteristics frequently assessed are flavour, tastes, colour and texture (Meilgaard et al. 1991). Sensory evaluation scores were determined using a 9-point Hedonic scale ranging from 1 to 9. Score 1 indicates not acceptable while 9 denotes very strong flavour. For colour, 1 denotes too light and 9, dark brown, shiny, uniform colour. The texture is rated 9 for soft, very good cohesiveness while 1 for too soft. Scale of 1 and 9 indicate extremely off taste and a perfectly balanced taste of *dodol* respectively. The 20 untrained taste panellists assessed the samples for overall acceptability, which covered these sensory attributes.

Data analysis

For this study, each *dodol* product was analysed in two replicates. All determinations were statistically analysed by analysis of variance and mean values are presented. The Duncan Multiple Range Test was used to detect differences between treatments (Gomez and Gomez 1984).

Results and discussion

Chemical composition

Table 2 shows the proximate composition of *dodol* with different levels of stabilised rice bran (SRB). It is observed that the addition of SRB into *dodol* increased the moisture, ash, fat, protein and crude fibre but decreased the carbohydrate content of the *dodol*. The increased in moisture content could have resulted from water retention of fibrous material present in rice bran flour. Studies had reported that the major carbohydrates in bran are cellulose and hemicellulose (Juliano and Betchel 1985). 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 level of SRB,

Table 2. Proximate composition of *dodol* formulated with different levels of stabilised rice bran

Chemical properties	Levels of rice bran (%)					
	0	10	20	30	40	50
Moisture content	23.39 ± 0.25d	23.56 ± 0.15d	24.10 ± 0.7c	25.41 ± 0.75b	25.80 ± 0.50b	26.90 ± 0.50a
Ash	0.62 ± 0.75f	0.84 ± 0.75e	0.97 ± 0.15d	1.04 ± 0.25c	1.24 ± 0.50b	1.43 ± 0.75a
Protein	1.52 ± 0.25d	2.75 ± 0.50c	3.05 ± 0.75b	3.09 ± 0.25b	3.60 ± 0.50a	3.65 ± 0.75a
Fat	0.79 ± 0.75d	0.90 ± 0.50d	1.33 ± 0.25c	1.46 ± 0.75b	1.52 ± 0.45a	1.63 ± 0.15a
Crude fibre	1.47 ± 0.25b	1.16 ± 0.75b	2.34 ± 0.25a	2.64 ± 0.75a	2.68 ± 0.45a	2.22 ± 0.25a
Carbohydrate*	72.21 ± 0.75	70.79 ± 0.45b	68.21 ± 0.45c	66.36 ± 0.45d	65.16 ± 0.45e	64.17 ± 0.45e

*Calculated by difference
Mean values in the same row with different letters are significantly different at $p < 0.05$

there will be higher water absorption and this contributed to higher moisture content.

The study showed the products, with the basic ingredient remained constant, had protein contents varied from 1.52 to 3.65% There was significant difference ($p > 0.05$) between the control *dodol* and SRB incorporated *dodol*. No significant difference was observed in protein content of *dodol* with 20% and 30% levels of SRB but there was a significant increased in protein content for SRB incorporated *dodol* at 40% and 50% as compared to *dodol* at 20% and 30% levels of SRB. According to Anderson and Guraya (2001), the range of protein content present in rice bran is 14–16%. Similar observation was reported by Prakash and Ramanathan (1995) and they stated that protein concentrate prepared from rice bran gave good nutritional quality in weaning food. Saunders (1990) reported that rice bran protein has relatively high nutritional value and higher lysine content but a lower glutamic acid content than wheat. With a better balance of essential amino acids which was reported by Landers and Hamaker (1994), results suggested that the rice bran may be utilised to improve the nutritional value of *dodol*. Reports by Hamada (2000) also indicated that addition of rice bran improved the lysine content of developed products.

The fat content of *dodol* ranged from 0.79–1.6%. The value is significantly higher in SRB incorporated *dodol* than the control *dodol* and this observation was also reported by Narasinga Rao (1988) in other food products. Studies by Goffman and Bergman (2002) had indicated that rice bran is high in fat content ranging from 16–22%. As rice bran is rich in fat content, a significant increase in percentage of fat was observed due to increase in the levels of SRB in the *dodol*.

Ash was present in the range of 0.62–1.43% in the *dodol*. The high content in ash contributed to its mineral content (Juliano dan Bechtel 1985). The ash content showed significant difference between *dodol*. Higher values of ash content in SRB incorporated *dodol* were due to the contributory effect of SRB. The carbohydrates ranged from 64.17–72.21%. SRB incorporated *dodol* had significantly lower carbohydrates content than control *dodol*.

Mineral composition

The minerals found in the *dodol* were present in varied amounts as given in *Table 3*. The major mineral in the product was magnesium (72–408 mg/100 g). Phosphorus was present within a range of 58–188 mg/100 g sample, while potassium was 42–150 mg/100 g sample. The level of iron in *dodol* with SRB was above 5.5 mg/100 g and is of considerable nutritional significance (Tee et al. 1997). All SRB incorporated *dodol* had significant higher content of sodium and calcium minerals as compared to control sample indicating that the developed products offer a nutritional

Table 3. Mineral composition of *dodol* formulated with different levels of stabilized rice bran

Mineral (mg/100 g)	Levels of rice bran (%)					
	0	10	20	30	40	50
Ca	23 ± 1.25d	31 ± 1.50c	32 ± 1.17c	35 ± 1.50b	37 ± 2.25b	43 ± 1.25a
K	42 ± 1.75f	65 ± 1.50e	86 ± 1.50d	110 ± 1.65c	130 ± 1.50b	150 ± 2.50a
Na	10 ± 0.25d	13 ± 0.75c	14 ± 0.25c	14 ± 0.25c	19 ± 0.75b	27 ± 0.50a
Mg	72 ± 1.25f	85 ± 1.75e	160 ± 2.50d	244 ± 2.25c	309 ± 1.25b	408 ± 1.75a
Fe	4.3 ± 0.25f	5.5 ± 0.50e	6.8 ± 0.25d	8.1 ± 0.50c	9.4 ± 0.75b	12 ± 1.25a
P	58 ± 2.50f	80 ± 1.25e	106 ± 1.75d	124 ± 1.50c	163 ± 1.25b	188 ± 1.75a

Mean values in the same row with different letters are significantly different at $p < 0.05$

Table 4. Vitamin composition and selected phytochemicals of *dodol* formulated with different levels of stabilized rice bran

Nutrients (mg/100 g)	Levels of rice bran (%)					
	0	10	20	30	40	50
Thiamine	0.12 ± 0.01e	0.18 ± 0.02d	0.21 ± 0.02c	0.22 ± 0.03c	0.29 ± 0.02b	0.33 ± 0.03a
Riboflavin	0.09 ± 0.02c	0.14 ± 0.01b	0.14 ± 0.02b	0.14 ± 0.01b	0.15 ± 0.01b	0.18 ± 0.01a
Pyridoxine	0.27 ± 0.05e	0.31 ± 0.01d	0.34 ± 0.02d	0.77 ± 0.02c	1.1 ± 0.05b	1.4 ± 0.02a
Niacin	0.77 ± 0.01e	0.93 ± 0.02d	1.5 ± 0.15c	1.7 ± 0.02c	2.0 ± 0.01b	2.5 ± 0.02a
Tocopherol	0.14 ± 0.01e	0.17 ± 0.02e	0.23 ± 0.01b	0.24 ± 0.02b	0.25 ± 0.02b	0.4 ± 0.03a
Dietary fibre (g)	0.2 ± 0.01f	1.2 ± 0.01e	2.1 ± 0.03d	3.2 ± 0.01c	6.2 ± 0.02	6.8 ± 0.02ab
Soluble fibre (g)	0.10 ± 0.01e	0.3 ± 0.01d	0.5 ± 0.01c	0.7 ± 0.05b	0.9 ± 0.02a	0.9 ± 0.01a
Starch (g)	40.6 ± 1.50c	42.2 ± 1.25b	43.3 ± 1.50a	43.5 ± 1.40a	43.8 ± 1.50a	44.1 ± 1.25a

Mean values in the same row with different letters are significantly different at $p < 0.05$

added value. The result indicated that increased addition of rice bran resulted in increase in mineral contents. Carroll (1990) observed that incorporating bran would significantly increase the mineral content of the finished products. Another study by Hammond (1994) reported that rice bran is a concentrate source of meal, whereby the minerals can be concentrated to produce nutrient mixture.

Vitamin composition and dietary fibre

The *dodol* products had varied amounts of vitamin content as shown in *Table 4*. An appreciable amount of niacin was present in the samples analysed (0.77–2.5 mg/100 g sample). The product also had reasonable pyridoxine (0.27–1.4 mg/100 g sample) contents. The thiamine content varied (0.12–0.33 mg/100 g) and *dodol* at 50% rice bran had 0.33 mg/100 g thiamine. Riboflavin was present in the range of 0.09–0.18 mg/100 g sample. Results showed that the vitamin contents increased significantly 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.

According to Codex (2001), products with >6% dietary fibre is considered high in dietary fibre. It was found that *dodol* formulation with 40% and 50% SRB have high dietary fibre. *Dodol* containing 50% SRB had the highest total dietary fibre at 6.8%. Studies suggested that rice bran can be incorporated in food products as a source of dietary fibre and for nutritional quality improvement. Rice bran was reported containing 25.3 g of dietary fibre per 100 g which can meet the recommended dietary fibre intake.

Tocopherol was found in varied amount (0.14–0.4 mg/100 g). The amounts of tocopherol detected were significantly

Table 5. Sensory evaluation of *dodol* formulated with different levels of stabilized rice bran

Attributes	Levels of rice bran (%)					
	0	10	20	30	40	50
Colour	6.8c	7.0b	7.1ab	7.1ab	7.3a	6.9c
Flavour	6.9bc	7.1ab	7.2a	7.2a	7.0b	6.8c
Taste	6.7c	7.0b	7.2a	7.2a	7.2a	6.8c
Texture	6.4c	6.3c	7.0a	7.0a	7.0a	6.8b
Overall acceptability	6.7b	6.8b	7.2a	7.2a	7.2a	6.8b

Mean values in the same row with different letters are significantly different at $p < 0.05$

different among samples and significantly increased with increasing levels of SRB.

Sensory analysis

The means values for scores for different sensory quality parameters are given in *Table 5*. The control product, at 0% rice bran, obtained lower score for colour which increased progressively as rice bran level in formulation increases. Darker colour of *dodol* was preferred by the panellists. Bran which has a light tan colour, was a possible contributor to darken the colour of SRB incorporated *dodol* (Bor et al. 1991).

The overall mean score for flavour indicates that *dodol* with 20, 30 and 40% rice bran were acceptable as compared to control and *dodol* at 50% level of SRB. The acceptable taste of the products followed the same trend. Panellists described *dodol* containing more than 40% rice bran as having after taste and off flavour. Results suggested that food grade rice bran possesses relatively bland flavour with a nutty toasted overtone and this might have affected the flavour of SRB incorporated *dodol* (Bor et al. 1991).

Interestingly, panellists preferred the texture of *dodol* containing 20–50% rice bran than control. The texture of control *dodol* was rated too soft and sticky. There was a significant increase in the texture of SRB incorporated *dodol* as compared with the texture of control *dodol*. This indicated that the addition of rice bran improved the texture. Rice bran contains high hemicellullose and cellulose and hence contributes to the firmer texture of dodol. Glutinous rice flour on the other hand has 60% starch and high in amylopectin content and hence produces the sticky and soft texture of the control sample (Webb 1985).

The average score for the overall acceptability of *dodol* indicated that panellists preferred 20–40% SRB incorporated *dodol*. The results showed that the overall acceptability for *dodol* improved with increased level of rice bran. The differences between overall acceptability of *dodol* using 20, 30 and 40% levels of SRB were not significant. These trends are not common for other bran-based products as literature reports suggested that at 30% level of incorporation of rice bran is not acceptable for different products like papads (Prakash 1995) and biscuit (Shashikanth 1991). In case of SRB incorporated *dodol*, the fibre content had improved the texture of these products and the panellists commented that the stickiness of these products were reduced.

Conclusion

The study showed that higher percentage of SRB (30–50%) in *dodol* resulted in higher nutritional value in the product. It was observed that the dietary fibre was more than 6 g/100 g for *dodol* produced with addition of 40% and 50% levels of SRB and these *dodol* can be catogerised as high fibre products.

The sensory data demonstrated that the addition of 20–50% rice bran did not produce any adverse effects on the acceptability of *dodol*. On contrary, the addition of rice bran at these levels produced *dodol* with improved organoleptic properties and overall acceptability. Thus, SBR could be substituted up to 50% in the *dodol* formulation without decreasing acceptability. SRB incorporated *dodol*, thereby, to some extent can help to alleviate the general concern about high consumption of nutritious traditional cakes. SRB could potentially be applied to other similar products with the aim of increasing their overall nutritional values.

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Abstrak

Dodol diproses dengan adunan mengandungi kadar dedak beras stabil yang berbeza (10, 20, 30, and 40%). Ciri-ciri kimia dan nilai rasa produk ini telah dinilai. Analisis prosikmat menunjukkan penggantian tepung beras dengan dedak beras meningkatkan kandungan protein, lemak dan gentian yang ketara (p <0.05). Garam galian dan vitamin didapati meningkat secara ketara dengan peningkatan kadar dedak beras dalam formulasi. Penambahan kadar dedak beras juga meningkatkan kandungan gentian larut pada dodol. Dodol yang dihasilkan diterima oleh ahli nilai rasa dengan skor lebih daripada 5 untuk semua ciri nilai rasa. Dodol yang mengandungi 20–40% kadar dedak berbeza dengan ketara dengan sampel kawalan dari aspek warna, rasa, aroma, tekstur dan penerimaan keseluruhan.

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