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Functional properties of dietary fibre prepared from defatted rice bran

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Abstract

Acumulating evidence favours the view that increased intake of dietary fibre in an otherwise low-fibre diet can have beneficial effects in both human and experimental animals. These benefits include prevention or alleviation of maladies such as cardiovascular disease, diabetes, diverticulosis and colon cancer. Studies have repeatedly shown that rice bran gives interesting health benefits. Compositional analysis reveals that rice bran consists of almost 27% dietary fibre and has been reported to have positive effects, such as laxative and cholesterol-lowering ability. This suggests that rice bran is a good fibre source that can be added to various food products. This paper examines the use of a dietary fibre preparation, derived from defatted rice bran, as a functional ingredient added to bakery products. The results show that dietary fibre from defatted rice bran has comparable water-binding capacity to FIBREX, commercial fibre from sugar beet. Dietary fibre from rice bran exhibited higher fat binding and emulsifying capacity compared to FIBREX. However, rice bran fibre was found to be less viscous than FIBREX. Addition of 5 and 10% dietary fibre preparation reduced loaf volume significantly and increased the firmness of the breads. Sensory evaluations revealed that breads with 5 and 10% rice bran fibre were comparable to high-fibre bread available in the market. This confirms that the dietary fibre preparation from defatted rice bran has great potential in food applications, especially in development of functional foods.

1. Introduction

Since the middle of the 1970s, the role of dietary fibre in health and nutrition has stimulated a wide range of research activities and caught public attention. Accumulating evidence favours the view that increased intake of dietary fibre can have beneficial effects against chronic diseases, such as cardiovascular diseases, diverticulosis, diabetes and colon cancer (Cara, Borel, Armand, Lafont, Lesgards & Lairon, 1992; Chen & Anderson, 1986; Cummings, 1985; Dukehart, Dutta & Vaeth, 1989; Spiller, Chernoff, Hill, Gates, Nassar & Shipley, 1980; Wrick et al., 1983). In view of the therapeutic potential of dietary fibre, more fibre incorporated food products are being developed. Addition of dietary fibre to a wide range of products will contribute to the development of value-added foods or functional foods that currently are in high demand. In addition to the physiological benefits provided by high fibre foods, studies have shown that fibre components can give texture, gelling, thickening, emulsifying and stabilizing properties to certain foods (Dreher, 1987; Sharma, 1981). By understanding functional properties of dietary fibre, one can increase its use in food applications and aid in developing food products with high consumer acceptance.

The objective of the paper is to study the functional properties of dietary fibre derived from defatted rice bran and to develop an acceptable food enriched with fibre from defatted rice bran.

2. Materials and methods

2.1. Methodology

Brown rice was obtained from LPN, Kajang, Selangor, Malaysia. Rice bran was obtained by milling brown rice in a Grain Testing Mill (Sateka). Milled rice bran was then passed through a 600 μm sieve to achieve appropriate particle sizes. Defatting was immediately carried out using of Soxhlet apparatus utilizing *n*-hexane as a

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solvent. This step is crucial to prevent the development of off-flavour in the bran as a result of hydrolysis of its oil. The dry defatted rice bran was then kept in a sealed container in a desiccator until further treatments/analysis was performed.

2.2. Extraction of dietary fibre preparation

Dietary fibre was extracted using the modified AOAC enzymatic-gravimetric method of Prosky, Asp, Schweizer, De Vries, and Furda, (1988). The defatted rice bran was gelatinized with termamyl (heat stable alpha-amylase) at 100°C for 1 h and then digested with protease (60°C, 1 h), followed by incubation with amyloglucosidase (60°C, 1 h) to remove protein and starch. Four volumes of 95% ethanol (preheated to 60°C) were then added to precipitate soluble dietary fibre. Precipitation was allowed to form at room temperature for 60 min, followed by filtration. The residue was then washed with 78% ethanol, 95% ethanol and acetone. The residue was then oven-dried (105°C) overnight in an air oven and then weighed.

Values obtained by the enzymatic method were then corrected by analysing for by nitrogen by the Kjeldahl method and ashing at 525°C.

2.3. Functional properties of dietary fibre preparation

Water binding capacity (WBC) of the extracted fibre was determined using a method based on that of AACC (1983) which determined WBC of dietary fibre under external centrifugal force. Fat binding capacity (FBC) was measured using a method adapted from Lin, Humberty, and Sosulki, (1974). A four gram of sample was added to 20 ml of corn oil in a 50 ml centrifuge tube. The content was then stirred for 30 s every 5 min and, after 30 min, the tubes were centrifuged at $1600\times g$ for 25 min. The free oil was then decanted and absorbed oil was then determined by difference. The fat binding capacity was expressed as absorbed oil per gram sample. Emulsifying capacity of dietary fibre was measured according to the method of Yasumatsu et al. (1972). Twenty millilitres of 7% aqueous dispersion of the fibre was mixed with 20 ml of corn oil and blended in a Waring blender for 5 min at high speed. An aliquot was then centrifuged at $3000\times g$ for 5 min. The percentage of total mixture that remained emulsified after centrifugation was expressed as stability index. The stability index of a good emulsion would be greater than 94%, while that of a poor emulsion would only be 50% (Wang & Kinsella, 1976; Yasumatsu et al., 1972).

Viscosity of the dietary fibre was determined using the method of Frost, Hegedus and Licksman (1984). Four different concentrations of sample slurry, namely 1, 3, 5 and 7%, were prepared by slowly adding an appropriate amount of dietary fibre preparation to distilled water and mixing at high speed in a Waring blender for 1 min. The solution was allowed to sit at room temperature for 24 h to come to equilibrium and entrapped air to escape before viscosity measurements were made. The viscosity was measured using a calibrated "Brookfield Digital viscometer" Model DV- II +, spindle SC 4-18/13R at 50 rpm. The measurement was done at room temperature,

2.4. Baking performance

Baking tests were carried out by adding 5 and 10% of dietary fibre preparation to bread formulations. A simple formulation was used to reduce additional effects of other ingredients consisting of wheat flour, water, sugar, butter, dry activated yeast, sodium chloride and bread improver.

2.5. Measurement of loaf volume

Loaf volume was determined using the volume displacement method. Green beans were used as medium displacement. The volume of the container used was determined by filling the container with green beans, the bread was then placed inside the container, followed by the green beans. The green beans that were not required to fill the container were used to express volume of the loaf (ml).

2.6. Measurement of bread firmness (texture)

Firmness or texture of 1 day old bread was determined using a Model 5565 Instron Universal testing instrument. The texture was measured by adjusting the portion of the compression plunger until it barely touched the surface of the bread at the centre of the slice. The plunger was then lowered at a constant speed until it compressed the bread to a predetermined degree (percentage of compression). The resulting peak force was measured in kilograms.

2.7. Sensory evaluation

Sensory evaluations of the breads were conducted by 30 panellists, consisting of Faculty of Science and Biotechnology staff and students, using a nine-point hedonic scale for six attributes (colour, taste, odour, softness, chewiness and overall accepability) where 9 is like extremely and 1 dislike extremely. Five coded samples were served and water was provided for rinsing between samples.

2.8. Statistical analysis

Data obtained were analyzed using the Statistical Analysis System, SAS Institute 1987 (SAS Institute INC., Cary, NY). Significance of differences between control and treated samples was evaluated using Duncan's multiple range test at 5% level.

3. Results and discussion

Table 1 shows composition of rice bran used in the study. As illustrated, rice bran is an excellent source of protein (14.6%), mineral (7%), mostly unsaturated fat (17%) and dietary fibre (27%). Chemical composition of the dietary fibre prepared from defatted rice bran was 65% total dietary fibre (9% soluble dietary fibre), 17% protein and 18% ash.

3.1. Functional properties of dietary fibre from defatted rice bran

Table 2 shows the water-binding capacity (WBC), fat binding (FBC) and emulsifying capacity (EC) of dietary fibre preparation from defatted rice bran (Bfibre) and FIBREX (commercial fibre preparation). There was no significant difference ($p < 0.05$) between WBC of Bfibre and FIBREX, namely 4.89 and 4.56 ml/g, respectively. This is supported by Dreher (1987) who reported that FIBREX can bind water five times its weight. However, Chen, Pina and Labuza (1984) reported that rice bran and wheat bran had WBC of only 1 and 2.6 ml/g, respectively. The result suggested that dietary fibre from rice bran is able to bind/entrap more water than wheat bran. Water-binding capacity has been widely studied in food functionality, due to its importance in foods. Water plays an important role in the major changes that occur during baking, which include starch gelatinization, protein denaturation, yeast-and enzyme-inactivation, flavour and colour formation (Pomeranz, 1985).

Table 1
Proximate analysis of rice bran

Components	Percentage (%)[a]
Fat	16.62 ± 0.05
Protein	14.6 ± 0.21
Moisture	11.19 ± 0.03
Ash	7.41 ± 0.01
Total dietary fibre	27.04 ± 0.30
Insoluble dietary fibre	24.99 ± 0.43
Soluble dietary fibre	2.25 ± 0.13
Digestible carbohydrates	23.16[b]

[a] All analyses are done in duplicate.
[b] Value was obtained via gravimetric procedure.

Table 2 also shows that Bfibre exhibited significantly higher ($p < 0.05$) fat-binding capacity than FIBREX, (4.54 and 1.29 ml/g, respectively). Dietary fibre from rice bran also exhibited significantly greater emulsifying capacity than FIBREX. Emulsifying capacity of Bfibre was 14.4% while that of FIBREX was 3.5%. Nevertheless, these two fibre sources are not good emulsifiers due to the stability indices of less than 50%. Luh (1980) reported that emulsion activity of rice bran was 50% while Prakash and Ramanathan, (1995) showed that emulsifying capacity, of protein concentrates from rice bran, ranged from 52 to 57%. Therefore, the lower EC value obtained in this study may be due to the lower protein level in Bfibre. Even though Bfibre exhibited low EC, it can still be used to aid in stabilizing emulsions of the food system, as well as being a good source of dietary fibre.

Viscosity of dietary fibre preparation from defatted rice bran and FIBREX at different concentrations can be seen in Fig. 1. FIBREX imparted higher viscosity than Bfibre. However, both samples exhibited low viscosity compared to gum solutions (Szczesniak & Farkas, 1962). This is as expected since Bfibre contains only 9% soluble fibre and water-soluble fibre was the main component to increase the viscosity of the solution.

3.2. Effect of dietary fibre on properties of bread

Table 3 summarizes loaf volume and firmness (Instron) of dietary fibre-supplemented breads. Loaf volume depressions have been reported with addition of various fibre sources (Pomeranz, Shogen, Finney & Bechtel, 1977). Pomeronz et al. (1997) suggested that added fibre reduces loaf volume by diluting gluten content and changing crumb structures, which in turns impair carbon dioxide retention. All dietary fibre-supplemented breads, except 5% FIBREX, had significantly firmer texture than control bread (no added fibre).

3.3. Sensory evaluations of breads supplemented with dietary fibre

Table 4 shows sensory scores for colour, taste, odour, texture and overall acceptability of dietary fibre

Table 2
Functional properties of dietary fibre from defatted rice bran and FIBREX[a]

Samples	Water holding capacity[b] (ml/g)	Fat-binding capacity[b] (ml/g)	Emulsifying capacity[b] (%)
Dietary fibre from rice bran	4.89a ± 0.19	4.54a ± 0.07	14.43a ± 0.16
FIBREX	4.56a ± 0.20	1.29b ± 0.07	3.46b ± 0.13

[a] Values are means of triplicate readings.
[b] Means within a column bearing the same letter are not significantly different at 5% level as determined by the Duncan multiple range test.

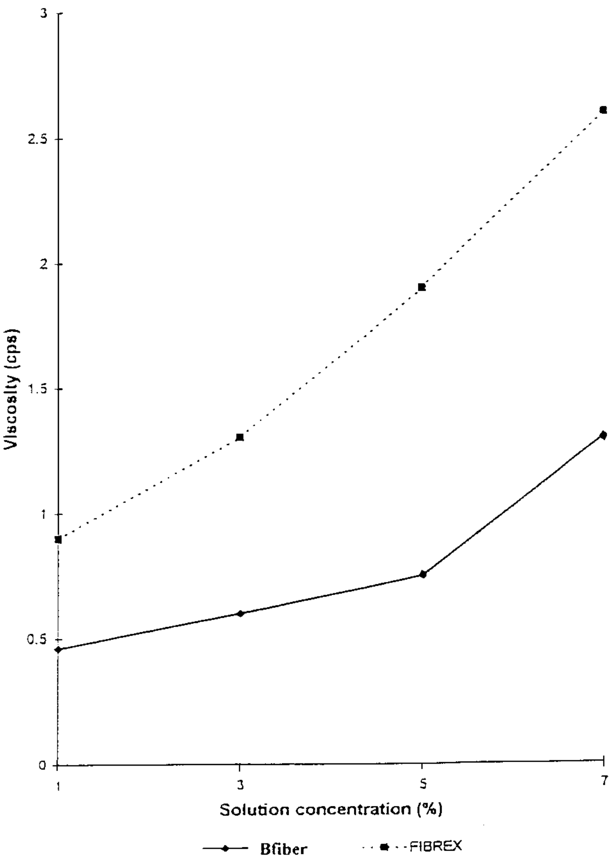

Fig. 1. Viscosity of dietary fiber from defatted rice bran (Bfiber) and FIBREX.

Table 3
Effect of dietary fiber on properties of bread[a]

Type of dietary fibre	Level of fibre added (%)	Loaf volume (ml)[b]	Firmness (peak load, kg)[b]
Control	0	1727.5 + 17.7a	0.11 + 0.02d
Bfiber	5	1332.0 + 39.6b	0.21 + 0.02c
Bfiber	10	1075 + 45.9c	0.54 + 0.03a
FIBREX	5	1392.0 + 22.6b	0.13 + 0.01d
FIBREX	10	1100.0 + 14.14c	0.35 + 0.03b

[a] Values are means of triplicate samples.
[b] Means within a column bearing the same letter are not significantly different at 5% level, as determined by the Duncan multiple range test.

Table 4
Sensory scores of dietary fibre supplemented breads[a]

Type of breads	Colour	Taste	Odor	Softness	Chewiness	Overall acceptability
Control	7.47a	6.83a	6.80a	7.00a	6.73a	7.20a
5% Bfiber	6.43b	5.93b	5.97b	6.53ab	6.40ab	6.30b
5% FIBREX	6.47b	5.70b	6.03b	6.43b	6.27ab	6.33b
10% Bfiber	5.23c	4.73c	5.03c	6.23b	6.00b	5.33c
10% FIBREX	4.90c	4.97c	5.13c	6.03b	5.90b	4.83c

[a] Means within a column having the same letter are not significantly different at 5% level, as determined by the Duncan multiple range test.

supplemented breads. Crumb colour was found to be darker and less acceptable when 10% fibre (both Bfibre or FIBREX) was added to the breads. Darkness of the crumb was directly related to increased fibre content. Taste and odour ratings were significantly different for dietary fibre-supplemented breads and control. Bread with 10% added Bfibre was commented to have a nutty rice flavour, which is typical of the brans. This nutty flavour appeals to most of the panellists. The scores for softness and chewiness of the breads were all at acceptable values. Panellists also commented that the breads were comparable to high-fibre breads currently available in the market. Overall acceptability of the breads treated with 5 and 10% dietary fibre were significantly different from the control. The 10% FIBREX added bread received the lowest score. Nevertheless all the breads were acceptable.

3.4. Determination of dietary fibre in end products.

Table 5 summarizes dietary fibre content of the breads. Results indicated that contents of dietary fibre in the end products were less than amounts added. Some dietary fibre may be hydrolyzed by enzyme from the yeast used or lost due to the high baking temperature (200°C). According to Varo, Laine, and Koiivistoinen (1983), some of the water soluble fibre may be lost during cooking. Nevertheless, an appreciable amount of dietary fibre remains in both Bfibre-or FIBREX-incorporated breads and this may contribute to health benefits, for example increasing fecal bulk and lowering of plasma cholesterol.

Table 5
Composition of dietary fibre in the end products[a]

Type of breads	% Dietary fibre
Control	1.61 ± 0.02
5% Bfiber	4.67 ± 0.15
5% FIBREX	4.32 ± 0.07
10% Bfiber	8.24 ± 0.17
10% FIBREX	8.17 ± 0.06

[a] Values are means of triplicate samples.

4. Conclusion

The study confirms that rice bran has more than 20% dietary fibre. In addition, it is also an excellent source of protein, minerals, unsaturated fat and vitamins. Dietary fibre extracted from defatted rice bran (Bfibre) was comparable to FIBREX (commercial fibre source) in water-binding capacity which was found to be 4.89 ml/g. Bfibre was found to exhibit higher fat-binding (4.54 ml/g) and emulsifying capacity (14.4%) but imparted lower viscosity compared to FIBREX. Addition of dietary fibre was found to reduce loaf volume and increased firmness of the breads, as indicated by the Instron measurements. Sensory evaluation revealed that the breads incorporated with Bfibre (both at 5 and 10%) were acceptable to the panellists. In addition, analysis showed that appreciable amounts of dietary fibre remained in both Bfibre-and FIBREX-incorporated fibre and this may contribute to health benefits, such as increased fecal bulk and lowering of blood cholesterol. Therefore, data reported in this study confirmed that dietary fibre from defatted rice bran has great potential in food applications, especially in development of functional foods.

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