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Full Length Research Paper

Comparison of some functional properties and chemical constituents of dietary fibers of Iranian rice bran extracted by chemical and enzymatic methods

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Rice is the second most consumed cereal grain in the world. It consists of almost 20% rice bran which is a by-product during the milling process in the production of white rice from brown rice. Bran is often used for non-food applications including animal feed stock, fuel, fertilizer or for preventing clumping; as this by-product is enriched with nutrients and dietary fibre, it is also used in food industries. Since the middle of the 1970s when the role of dietary fibre was known in health, it has caught public attention. This study reveals some compositional and functional analysis of dietary fibre extracted from rice bran using chemical and enzymatic methods. The results show that dietary fibre extracted from rice bran using enzymatic method is the best dietary fibre for food applications.

Key words: Rice bran, dietary fiber, chemical extraction, enzymatic extraction.

INTRODUCTION

Rice is a staple food for more than half of world population. Rice bran is a by-product obtained from outer rice layers and is a good source of protein, mineral, fatty acids and dietary fiber content. Rice bran is used for the enrichment of some foods, due to its high dietary fiber content (Hu et al., 2009; Abdul-Hamid and Luan, 2000).

In recent years, dietary fiber has received increasing attention from researchers and industry due to the likely beneficial effects on the reduction of cardiovascular (Prosky, 2001) and diverticulitis diseases, blood cholesterol (Borderias et al., 2005; Dubois et al., 2003; Jenkins et al., 2002), diabetes (Panlasigui, 2006; Jenkins et al., 2002) and colon cancer (Hu et al., 2009; Rodriguez et al., 2006; Scheppach et al., 2004; Abdul-Hamid and Luan, 2000). In addition to nutritional effects, dietary fibre has functional properties such as water binding capacity (WBC) and fat binding capacity (FBC). So, addition of dietary fiber to a wide range of products will contribute to the development of value-added foods or functional foods that are currently in high demand (Day et al., 2009; Peressini, 2009; Sudha, 2007; Pacheco De Delahaye, 2005; Quereshi, 2002); also, it can give these functional properties to the foods.

There are many definitions of dietary fiber. The American Association of Cereal Chemists (2001) adopted this definition for dietary fibre: The edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. Several extraction procedures for dietary fiber have already been adopted as official analytical methods within the AOAC (Official Methods of Analysis, 2000) that chemical (AOAC Official Method 962.09) and gravimetric-enzymatic (AOAC Official method 985.29) methods (Rodriguez et al, 2006) are currently used in the world (Cui, 2002).

The objective of this study was to determine some chemical constituents and functional properties of two dietary fiber samples extracted from rice bran using chemical and enzymatic methods, and compare the characteristics of two dietary fibre samples, and on this basis, choose the best dietary fibre for food applications.

MATERIALS AND METHODS

Commercially available rice bran of Alikazemi variety was prepared from rice factory (Fuman, Gilan,Iran). Defatting was immediately carried out using of Soxhlet apparatus utilizing n-hexane as a solvent. The dry defatted rice bran was then kept in a sealed container in desiccators until further treatment was performed.

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Table 1. Chemical composition of dietary fibre samples extracted from rice bran*.

Extraction procedure of dietary fibre	Moisture (%)	Ash (%)	Protein (%)	Starch (%)	Total dietary fiber (g/100 g)
Chemical	3.70^{b}	2.03^{a}	3.63^{a}	$<0.1^{a}$	33.97^{a}
Enzymatic	1.23^{a}	19.17^{b}	2.53^{b}	$<0.1^{a}$	67.53^{b}

*Determined in triplicated dry sample (mean values). Mean values having the same superscript within column are not significantly different ($p<0.05$).

Extraction procedures of dietary fiber

Dietary fiber was extracted from defatted rice bran using chemical and gravimetric-enzymatic methods.

Chemical extraction of dietary fiber

The fibre extraction was conducted as outlined by standard AACC (2000) method. Defatted rice bran was digested by 1.25% H_2SO_4. Filtration of sample was continued by washing with water and 1.25% NaOH. Samples were washed with 1.25 H_2SO_4 and ethanol. The residue was then oven-dried (105°C) in an air oven and weighed (a). Then, the residue was incinerated in a muffle furnace, maintained at 550°C for 5 h and weighed (b). The difference between (a) and (b) showed the fibre content.

Gravimetric-enzymatic extraction of dietary fiber

Defatted rice bran was treated enzymatically using the method of Azizah (2001) and standard AOAC (2000) method. 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 ethanol and acetone. The residue was oven-dried (105°C) overnight in an air oven and then weighed. Values obtained by the enzymatic method were then corrected by analyzing for nitrogen using the Kjeldahl method and ashing at 550°C.

Chemical analysis

Dietary fibre samples were analyzed, moisture, ash, protein and starch contents were determined according to the standard AACC (2000) methods. Nitrogen content was determined using the Kjeldahl method and multiplied by a factor 6.25 to determine the crude protein content. Moisture content was determined by drying the samples at 105°C to a constant weight. Ash was determined by the incineration of samples placed in a muffle furnace, maintained at 550°C for 5 h. Dietary fibre content of the defatted samples was determined by decomposing starch with acids, proteins and base, and then filtering (Nielsen, 1998). Starch was obtained by difference. All results were expressed on a dry weight basis.

Functional properties

Fat binding capacity (FBC) and WBC of dietary fibre samples were estimated according to Azizah (2001) and Hu (2009), respectively. Water binding capacity of the extracted fibre was determined using a method based on that of AACC which determined WBC of dietary fibre under external centrifugal force.

For fat binding capacity, four grams 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 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.

Statistical analysis

All analyses for samples were carried out in triplicate, expressed as the mean values, and the analysis data was statistically analyzed using completely randomized design. The parameters affected in response include gravimetric–enzymatic and chemical extractions. Response variables were chemical constituents and functional properties of rice bran extracted in chemical and enzymatic procedures.

The treatments were tested using Duncan's multiple range test. Variance analysis was calculated and duplicate means were gotten using by T test.

RESULTS AND DISCUSSION

Chemical characteristics of dietary fiber samples

The mean values for analysis of two fibre samples are shown in Table 1. The moisture content of dietary fibre extracted in chemical procedure was 3.7%, and that of other dietary fibre sample was estimated to be 1.23%. Ash, protein and starch contents of dietary fibre extracted using chemical procedure were 2.03, 3.63 and <0.1%, respectively. These characteristics in relation to fibre extracted using enzymatic procedure had 19.17, 2.53 and <0.1%, respectively. The total dietary fibre content (TDF) of rice bran in chemical procedure was 33.97%, whereas that of other procedure was estimated to be 67.53%.

With respect to Table 1, it is obvious that starch content is negligible; also, total dietary fiber extracted using chemical procedure was significantly higher ($p<0.05$) than the other method, which was nearly in the same range as that previously reported for total dietary fibre extracted from rice bran in enzymatic method (Claye et al., 1996); protein value in dietary fibre extracted with chemical method was significantly higher than that of the other sample, whereas ash content was lower. These differences could be related to extraction procedures of the dietary fibre. With enzymatic method, rice bran is treated

Table 2. Functional properties of dietary fibre samples extracted from rice bran*.

Extraction procedure of dietary fibre	FBC (ml/g)	WBC (ml/g)
Chemical	3[a]	4[a]
Enzymatic	3.50[b]	8[b]

*Determined in triplicate dry samples (mean values). Mean values having the same superscript within columns are not significantly different ($p<0.05$). FBC, Fat binding capacity; WBC, water binding capacity.

with amylase, amyloglucosidase and protease to remove starch, protein and other impurities, and finally, it led to obtaining higher dietary fiber content; however, chemical extraction is an easier and faster method than another method. Also, in enzymatic method, as protease enzyme was used, protein was degraded; hence, protein content was decreased. In dietary fiber extracted from enzymatic method, there was lower influence of enzymes on some constituents of dietary fiber (in comparison with chemical extraction), with more mineral content.

Functional properties of dietary fiber samples

The mean values for analysis of fiber samples extracted are shown in Table 2. There is significant difference in WBC between two dietary fiber samples ($p<0.05$); so that WBC in enzymatic procedure (8 ml/g) was estimated to be about twice that of chemical procedure (4 ml/g). Number of hydroxyl group which exist in the fibre structure is mainly caused by water absorption and allow water interaction through hydrogen bonding (Sudha et al., 2007). The influence of WBC on functional properties of food is especially examined in bakery industry. Water plays important role in changes (including gelatinization, denaturation, yeast and enzyme inactivation, flavor and color formation) which are observed during baking (Abdul-Hamid and Luan, 2000), and addition of dietary fibre to bread, as a functional ingredient, lead to decreesed volume of bread and increased bread firmness (abdul-Hamid and Luan, 2000; Hu et al., 2009).

The influence of extraction procedure of dietary fiber on its FBC resulted in FBC of fiber extracted using enzymatic procedure (3.50 ml/g) which is significantly higher than that of fiber extracted using chemical procedure (3 ml/g). As a result, there should be further purification of dietary fiber extracted using enzymatic procedure with more favorable functional properties.

Conclusion

This study confirms that rice bran has more than 30% dietary fibre. In addition, it is also an excellent source of protein and mineral, so it could be used in food industry, especially in developing functional foods. Results show that enzymatic extraction gives more fibre from rice bran than the chemical method (33.97 vs. 67.53%) and the extracted fibre had higher water-binding capacity and exhibited high fat binding capacity. In this research, with comparison of some chemical components and functional properties between dietary fibre extracted from rice bran in two chemical and enzymatic techniques, it was demonstrated that although chemical extraction of dietary fibre from rice bran is easier than enzymatic extraction, dietary fibre extracted with enzymatic method was chosen as the preferred fibre.

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