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Rice husk as a source of dietary fiber

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ABSTRACT

The rice grain has a hard husk protecting the kernel inside. Husk contains 25% celloluse,30% lignin, 15% pentosan and 21% ash. After the husk is removed, the remaining product is called brown rice, including bran, germ and endosperm.The commercial rice-milling process leads to products with low-value fractions,such as husk and bran. Because rice husks are inedible, they are used in various non-food applications as low-value waste materials.This study was designed to characterize one of valuable nutritional advantages of rice husk that is dietary fiber extracted from it. We extracted dietary fiber from rice husk in two chemical and enzymatic methods; and then, compared some their functional properties and chemical constituents. It was found that dietary fiber from rice husk in enzymatic method is the best dietary fiber for food applications.

Keywords: Rice husk, dietary fiber, chemical extraction, enzymatic extraction.

INTRODUCTION

The rice grain has a hard husk protecting the kernel inside. Because rice husks are inedible, they are used in various non-food applications as low-valuable waste materials. However, it was demonstrated that rice husk can be considered as a valuable source of bioactive components with high antioxidant properties. Rice husk, as a valuable source of phenolic acids, is an effective source of natural antioxidants; and so, it protects the rice seed from oxidative stress [8].

Potential of by-product from agricultural bioproduct may serve as important sources of raw material that could be used as functional food ingredients and nutraceuticals [24].

In recent years , dietary fiber has received increasing attention from researchers and industry due to the likely beneficial effects on the reduction of cardiovascular [20] and diverticulitis diseases , blood cholesterol [7,12,14], diabetes [6,14,17], and colon cancer [1,13,22,23]. In addition to nutritional effects , dietary fiber 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 currently are in high demand [11,13,16,18,19,21,24,25]; also, it can give these functional properties to the foods.

There are many definitions for dietary fiber. The American Association of Cereal Chemists (2001) adopted this definition for dietary fiber: 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 [22] are currently used in the world [10].

The present work was dedicated to study the extraction of dietary fiber from rice husk in chemical and enzymatic methods, and the characteristics of extracted dietary fibers; then, compare the characteristics of two dietary fiber samples with each other and , on basis of this, choose the best dietary fiber for food applications.

MATERIALS AND METHODS

2-1 Material

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

2-2 Extraction procedures of dietary fiber

Dietary fiber was extracted from rice husk in chemical and gravimetric-enzymatic methods.

2-2-1 Chemical extraction of dietary fiber

The fiber extraction was conducted as outlined by standard AACC(2000) method . Defatted rice husk was digested by 1.25% H_2SO_4. Filtration of sample was continued by washing with water and 1.25% NaOH. then samples were washed with 1.25% H_2SO_4 and ethanol. The residue was then oven-dried (105°C) in an air oven and then weighed (a). 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 fiber content.

2-2-2 Gravimetric – enzymatic extraction of dietary fiber

Defatted rice husk was treated enzymatically using the method of Azizah & Yu (2000) and standard AOAC (2000) method . The defatted rice husk 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 fiber. 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 .

2-3 Chemical analysis

Dietary fiber 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, at 550°C for 5 h. Dietary fiber content of the defatted samples was determined by decomposing starch with acids , proteins and base, and then filtering [15]. All results were expressed on a dry weight basis.

2-4 Functional properties

Fat binding capacity (FBC) and water binding capacity (WBC) of dietary fiber samples were estimated according to Azizah & Yu (2000) and Hu, Huang, Cao & Ma (2009) , respectively. WBC of the extracted fiber samples was determined under external centrifugal force according to the standard AACC (2000) method.

For FBC, four grams of sample added to 20 ml of corn oil in 50 ml centrifuge tubes. The contents were 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 decanted and absorbed oil was then determined. The FBC was expressed as absorbed oil per gram sample.

2-5 Statistical analysis

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

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

RESULTS AND DISCUSSION

3-1 Chemical characteristics of dietary fiber samples

The mean values for analysis of two fiber samples are shown in Table 1. The moisture content of dietary fiber extracted using chemical procedure was 3.80%, and that of other dietary fiber sample was estimated to be 2.50% . Ash, protein, and starch contents of dietary fiber extracted using chemical procedure were 1.00% , 0.88% , and < 0.1% , respectively. These characteristics in relation to fiber extracted using enzymatic procedure calculated 17.65% , 2.30% , and <0.1% , respectively. The total dietary fiber (TDF)content of rice bran in chemical procedure was 44.66% , whereas that of other procedure was estimated to be 66.70% .

Table 1. Chemical composition of dietary fiber samples extracted from rice husk [*]

Extraction procedure of dietary fiber	Moisture (%)	Ash (%)	Protein (%)	Starch (%)	Total dietary fiber (g/100g)
Chemical	3.80 [b]	1.00[a]	0.88[a]	<0.1[a]	44.66[a]
Enzymatic	2.50[a]	17.65[b]	2.30[b]	<0.1[a]	66.70[b]

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

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, that was nearly in the same range as that previously reported for total dietary fiber extracted from rice bran in enzymatic method [9] ; protein value in dietary fiber 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 fiber. With enzymatic method, rice husk is treated with amylase, amyloglucosidase , and protease to remove starch , protein and other impurities , and finally , it was 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, lower influence of enzymes on some constituents of dietary fiber (in compared with chemical extraction), further mineral content.

3-2 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) .Number of hydroxyl group which exist in the fiber structure is mainly caused water absorption and allow water interaction through hydrogen bonding [25] . The influence of WBC on functional properties of food is especially examined in bakery industry. Water plays important role on changes (including gelatinization, denaturation, yeast and enzyme inactivation , flavor and color formation) which are observed during baking [1] ; and addition of dietary fiber to bread, as a functional ingredient, led to decrease volume of bread and increase bread firmness [1,13].

Table 2. Functional properties of dietary fiber samples extracted from rice husk [*]

Extraction procedure of dietary fiber	FBC (ml/g)	WBC (ml/g)
Chemical	3.28[a]	6.03[a]
Enzymatic	3.42[a]	7.00[b]

[*]Determined in triplicate dry samples (mean values).
Mean values having the same superscript within columns are not significantly different (p<0.05).

The influence of extraction procedure of dietary fiber on its FBC resulted in FBC of fiber extracted in enzymatic procedure (3.42 ml/g) is significantly higher than that of fiber extracted in chemical procedure (3.28ml/g); however, it was no significant.

In result , further purity of dietary fiber extracted from enzymatic procedure , more favorable functional properties .

CONCLUSION

The study confirms that rice husk has more than 30% dietary fiber. In addition, it is also an excellent source of protein and mineral, so it could used in food industry especially developing functional foods. Results show that enzymatic extraction gives more fiber from rice husk than chemical method(33.97% vs. 67.53%) and the extracted fiber 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 fiber extracted from rice husk in two chemical and enzymatic techniques, it was demonstrated that although chemical extraction of dietary fiber from rice husk is easier than enzymatic extraction, dietary fiber extracted in enzymatic method was chosen as preference fiber .

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