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Some chemical and functional characteristics of dietary fiber from five fiber sources

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ABSTRACT

Dietary fiber is defined as 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. It can be extracted from different sources such as potato, wheat, beet, apple, bran, husk etc. In addition to nutritional effects, dietary fiber has functional properties; and for this, it plays key role in development of value-foods containing dietary fiber are known as value-added foods or functional foods. The main objective of this research was to introduce the most preference fiber for food application by determination of some chemical and functional characteristics of dietary fiber from apple, wheat bran, sugar beet, rice bran and husk. This research confirms that fiber extracted from rice bran, in enzymatic method, can have great potential in food application, especially in development of functional foods.

Keywords: Rice husk, rice bran, wheat bran, apple, sugar beet, dietary fiber.

INTRODUCTION

Dietary fiber is the food fraction that is not enzymatically degraded within the human alimentary digestive tract. Fiber is found in varying quantities in all plant foods including legumes, cereals, some fruits (particularly apples and bananas) and berries, certain vegetables (such as broccoli, carrots and root vegetables, potatoes, sweet potatoes, and onions), and seed husk and bran.

The commercial rice-milling process leads to products with low-value fractions, such as husk and bran. The rice grain has a hard husk protecting the kernal inside. After the husk is removed, the remaining product is called brown rice including bran, germ and endosperm. Rice bran is produced as a by-product during the milling process in the production of white rice from brown rice[1].

One recent trend is to increase the fiber content in food products to overcome health problems such as hypertension, diabetes, and colon cancer among others. Consumption of high fiber products consisting of indigestible cellulose, hemicelluloses, lignin and gums have several health benefits [2]. So, in recent years , dietary fiber has received increasing attention from researchers and industry due to the likely beneficial effects on the reduction of cardiovascular [3] and diverticulitis diseases , blood cholesterol[4,5,6], diabetes[6,7,8] and colon cancer[9,10,11,12]. 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 [2,9,13,14,15,16,17,18]; also, it can give these functional properties to the foods.

There are many definitions for dietary fiber. The American Association of Cereal Chemists [19] 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 [20] that chemical (AOAC Official Method 962.09) and gravimetric-enzymatic (AOAC Official method 985.29) methods [10] are currently used in the world [21] .

The aim of this experimental work was to compare water binding capacity (WBC), fat binding capacity (FBC), protein, ash and moisture of dietary fibers extracted from rice bran and husk, in enzymatic method, and commercial dietary fibers, including apple, wheat bran, sugar beet, with each other; and then, to determine the most preference fiber for application in food industry.

MATERIALS AND METHODS

2-1 Fiber sources
Sources of fiber for this research were as follows: rice bran, rice husk, apple, wheat bran, sugar beet.

2-2 Fiber preparation
Dietary fibers extracted, in enzymatic method, from Commercially available rice bran and husk of Alikazemi variety (Fuman, Gilan, Iran; because previous works indicated that fibers extracted from rice bran [22] and husk [23] in enzymatic method in comparison to chemical method had been selected as preference fibers) were used. Commercially available apple, wheat bran and sugar beet fibers were received as fine particles from JRS, Germany, and used as are.

2-3 Chemical analysis
Moisture, ash and protein contents of dietary fiber samples were determined according to the standard AACC methods[24].

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 . 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 [25] and Hu *et al*. [9] , respectively. WBC of the extracted fiber samples was determined under external centrifugal force according to the standard AACC method [24].

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 chemical composition of all dietary fiber samples is presented in Table 1.Apple fiber

Table 1. Chemical characteristics of dietary fiber samples[*]

Parameters	Apple	Wheat bran	Sugar beet	Rice bran	Rice husk
Protein(%)	5.60 [f]	5.30[d]	1.25[a]	2.53[b]	2.30[c]
Ash(%)	2.05[b]	3.80[c]	1.00[a]	19.17[e]	17.65[d]
Moisture(%)	3.01[abc]	5.21[d]	4.60[c]	1.27[a]	2.50[ab]

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

Contained significantly higher (p<o.o5) protein than other fibers. Protein content of wheat bran, sugar beet, rice bran and rice husk fibers was 5.30%, 1.25%, 2.53%, and 2.30%, respectively. Ash content of rice bran and husk fibers was as high as 19.17% and 17.65%,respectively and that of other fibers ranged between 1% and 3.80%. Moisture content was significantly different (p<o.o5) among the samples. Values varied from 1.27% in rice bran fiber to 5.21% in wheat bran fiber.

3-2 Functional properties of dietary fiber samples

Fat binding capacity (FBC) and water binding capacity (WBC) values are indicated in Table 2. WBC values varied significantly (p<0.05), and ranged from 3.00ml/g for apple

Table 2. Functional properties of dietary fiber samples[*]

Parameters	Apple	Wheat bran	Sugar bran	Rice bran	Rice husk
WBC(ml/g)	3.00[a]	4.00[b]	3.70[b]	8.00[d]	7.00[c]
FBC(ml/g)	1.00[a]	0.86[a]	2.20[b]	3.50[c]	3.41[c]

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

fiber to 8.00ml/g for rice bran fiber. This property for rice bran (8ml/g) and husk (7ml/g) fibers was significantly the highest; These values were higher than those reported for rice bran hemicellulose B (RBHB, 5.20ml/g) and insoluble dietary fiber from defatted rice bran (RBDF, 5.11ml/g) by Hu *et al*.(who confirmed that the RBHB and RBDF preparation from defatted rice bran has great potential in food application, especially in development of functional foods, including functional bakery products)[9] and the value reported for RBDF (4.89ml/g) by Abdul-Hamid & Luan (who resulted that addition of dietary fiber to wheat flour reduced loaf volume and increased firmness of the breads)[12].

Number of hydroxyl groups which exist in the fiber structure is mainly caused water absorption and allow water interaction through hydrogen bonding [2]. 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 [12]; and addition of dietary fiber to bread, as a functional ingredient, led to decrease volume of bread and increase bread firmness [9,12]. So, one can be expected rice husk fiber, the same as rice bran fiber, has the potential of developing fiber-rich biscuits [2] and breads [9,12] in order to increase the dietary fiber intake.

FBC content of rice bran and husk fibers was significantly the highest (p<0.05), followed by sugar beet, apple and wheat bran fibers.

CONCLUSION

From the overall results, it could be concluded that rice bran fiber had high water binding capacity. It exhibited nearly high fat binding capacity. So, by understanding functional properties of dietary fiber, this work confirms that fiber extracted from rice bran in enzymatic method can have great potential in food application, especially in development of functional foods. In addition, fiber extracted from rice husk in enzymatic method also was enriched of protein and minerals and, after rice bran, had unique functional properties; so, it could be also used in food industry.

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