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Processing And Nutritional Composition of Rice Bran

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ABSTRACT

Rice bran is a component of raw rice that is obtained when it is removed from the starchy endosperm in the rice milling process. Processing was carried out by using microwave and probiotic treatment. The study revealed that rice bran was stabilized by microwave heating (2450MHz for 3min). Stabilized rice bran was inoculated with *Lactic Acid Bacillus* culture and used as probiotic treated rice bran. Free fatty acid percentage of stabilized rice bran ranged from 4.10 to 7.50 from initial to 4th week and in probiotic treated rice bran it was 4.35 to 7.95 up to 4 weeks of storage period. Functional properties of rice bran were analyzed for stabilized and probiotic treated rice bran *i.e.* bulk density (0.22-0.38g/ml), water absorption (2-3ml/g), oil absorption (1.5-2.5ml/g), water solubility (7.3-8.0%) and swelling power (6.7-7.2%) respectively. Macronutrient composition of stabilized and probiotic treated rice bran for moisture, protein, fat, ash and carbohydrate were 4.30 and 5.40, 17.50 and 19.25, 13.10 and 17.20, 4.92 and 4.64, 52.33 and 48.55 g/100g respectively and it contained 7.85 and 4.96g crude fibre, 21.17 and 13.10g insoluble dietary fibre, 2.17 and 1.80g soluble dietary fibre and 23.34 and 14.90g total dietary fibre. Mineral content of stabilized and probiotic treated rice bran for calcium, phosphorous, iron and zinc were 52.10 and 49.90, 1185.20 and 1186.50, 28.10 and 30.05, 6.02 and 5.89 mg/100g respectively. Processing helps in destroying the lipolytic activity using microwave stabilizing technology, which increases the shelf life of rice bran and improves the nutrient content.

Keywords: Rice bran, Stabilization, Probiotic treatment, Free fatty acid.

INTRODUCTION

Rice is a major food commodity throughout the world. Rice bran is the cuticle existing between the rice and the husk of the paddy and consists of embryo and endosperm of the seeds of *Oryza sativa*, family *Graminae.* It constitutes 8 per cent of the weight of the whole grain and contains most of the nutrients. Rice bran, a "little known" food is highly nutritious and delivers a powerhouse of health supporting nutrients which is either thrown away or used for low-level animal feed (Qureshi *et al.,* 2000)[1]. It has a potential to be used as a food ingredient, since it has good amounts of nutrients. However, bran must be stabilized immediately upon production due to the presence of lipase, an enzyme that rapidly hydrolyzes oil to free fatty acid (FFA) and glycerol, which results in a drastic quality reduction of the rice bran. These shortcomings have now been overcome by destroying the lipolytic activity using an advanced stabilizing technology, the resulting material thus obtained is called "stabilized" rice bran which has a good taste, readily soluble with a longer shelf life. The primary means for rice bran stabilization includes deactivating the enzyme through heat treatment such as microwave heating. The nutritional composition of rice bran has led the discovery of varied health benefits. Also rice bran is used for the enrichment of foods, due to its high nutrient content. The objective of the present study was to process the rice bran and to analyse its nutritive value.

MATERIALS AND METHODS

Procurement of rice bran

The rice bran was procured from NEIST (North East Institute of Science and Technology) Jorhat, Assam, India.

Analysis of rice bran for heavy metals, pesticide residue and microbial load

The rice bran was subjected to heavy metals, pesticide residue and microbial study. There was no microbial load and the contents of heavy metal were less than 0.01ppm and the pesticide residues were less than 0.02 mg/ Kg hence the bran obtained was safe for further processing.

Processing of rice bran

Processing of rice bran includes two methods *i.e.* microwave stabilization and probiotic treatment of rice bran.

Microwave stabilization of rice bran

Rice bran sample was sieved to get uniform particle size, 100 grams of rice bran sample was taken and microwave stabilization was done at 2450MHz for 3 minutes (10 ml of water was added to avoid the char in bran). The stabilized rice bran was then subjected to determine the percentage of free fatty acid (Fig. 1).

Five grams of stabilized rice bran was taken for which 15 ml of hexane was added to it and heated up to 60^{0}C for 20 min, the mixture was centrifuged and supernatant collected. This solvent was oven dried to extract the oil. FFA is determined from the oil extract.

Probiotic treatment of rice bran

Sporlac containing 150 million spores of *Lactic Acid Bacillus* per gram was purchased from the medical shop and used as starter culture. 100g of stabilized rice bran sample was taken, for which 4g of *Lactic Acid Bacillus* culture was added and kept for fermentation (24 hrs at 30^{0}C). Fermented rice bran sample was subjected to dehydration technique *viz*. freeze drying. Before the sample is dehydrated it is kept under cold storage for 24 hrs. Then it is subjected to lyophilization process, where freeze drying was done for 34 hrs at -33^{0}C using Lyodel lab model Lyophilizer. Later stored in the air tight zip bag for further use (Fig. 2). FFA is determined from the oil extract.

Functional properties of rice bran

Bulk density

The bulk density was determined according to the method described by Narayana and Rao (1982)[2] and calculated as weight per unit volume of sample.

Water and Oil absorption capacity

The water and oil absorption capacities were determined by the method of Sosulski *et al*. (1986)[3]. The sample (1.0 g) was mixed with 10 ml distilled water or refined soybean oil, kept at ambient temperature for 30 min and centrifuged for 10 min at 2000 rpm. Water or oil absorption capacity was expressed as percent water or oil bound per gram of the sample.

Swelling power

Two hundred and fifty mg of finely ground sample was thoroughly mixed with 15 ml of distilled water and heated to 65^{0}C. The content was then cooled to room temperature and centrifuged at 5000 rpm for 10 min. The soluble solid content was calculated as percentage of sample soluble in water. The sample has been heated at 65^{0}C for 30 min, the residue was weighed and the increase in weight was calculated as the swelling power of the sample at that particular temperature (Iyer and Singh,1997)[4].

Chemical analysis of rice bran

Stabilized and probiotic treated rice bran were analyzed for moisture, protein, fat, crude fibre, total dietary fibre, ash, calcium, phosphorous, iron and zinc.

Estimation of moisture

The moisture content was determined by drying 3 g sample in an air forced draft oven maintaining temperature at 105 ± 5Ú C as per procedure given in AOAC (1980)[5] method.

Estimation of protein

The protein content of the dried samples was estimated as per cent total nitrogen by the Micro-kjeldahl procedure. Protein per cent was calculated by multiplying the per cent nitrogen by the factor 6.25 (AOAC 1980)[6].

Estimation of fat

Fat was estimated as crude ether extract using moisture free sample. The solvent was removed by evaporation and the residue of fat was weighed (AOAC 1980)[7].

Estimation of crude fibre:

Crude fibre of the sample was estimated by using moisture and fat free samples and expressed as g/100g of the sample (AOAC 1980)[8].

Estimation of insoluble dietary fibre

Defatted foods were gelatinized and proteins and starch were removed by enzymatic digestion. The residue was quantified gravimetrically which is insoluble dietary fibre (AOAC 1995)[9].

Estimation of soluble dietary fibre

The soluble fibre is estimated in the filtrate obtained after enzymatic digestion of protein and carbohydrates of defatted food. The soluble fibre is precipitated and estimated gravimetrically (AOAC 1995)[10].

Estimation of total dietary fibre

The total dietary fibre is the sum of the insoluble and soluble dietary fibre.

Total Dietary Fibre = IDF+SDF values

Estimation of total ash

The ash content of sample was obtained by dry ashing the samples completely by heating it over a flame. This was expressed as g/100g of the sample (AOAC, 1980)[11].

Preparation of mineral solution

The mineral solution of all samples were prepared by dissolving the ash obtained after ashing the samples in a muffle furnace in dilute hydrochloric acid (1:1 v/v) (AOAC, 1980)[12]. The minerals Ca, P, Fe and Zn (Page *et al*., 1992)[13] were determined after wet digestion by using Atomic Absorption Spectrophotometer.

Estimation of antioxidant activity (DPPH)

The DPPH radical scavenging capacity of each extract was determined according to the method of Miliauskas *et al.* (2004)[14]. The mixture containing the DPPH turns from deep violet to a yellow solution higher the antioxidant activity faster is the discolouration rate. The absorption is measured using a spectrophotometer at 515nm which gives the per cent inhibition of the sample.

Phytic acid estimation

The estimation of phytic acid was based on the principle that the phytate is extracted with trichloroacetic acid and precipitated as ferric salt (Sadasivam and Manickam, 1992)[15]. The iron content of the precipitate was determined colorimetrically and the phytate phosphorous content calculated from this value assuming a constant 4 Fe: 6 molecular ratios in the precipitate.

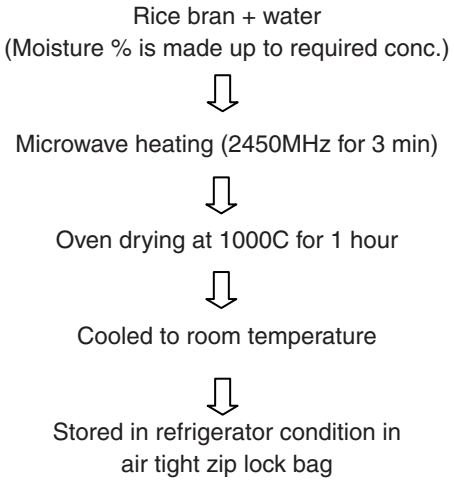

Fig. 1: Microwave stabilization of rice bran

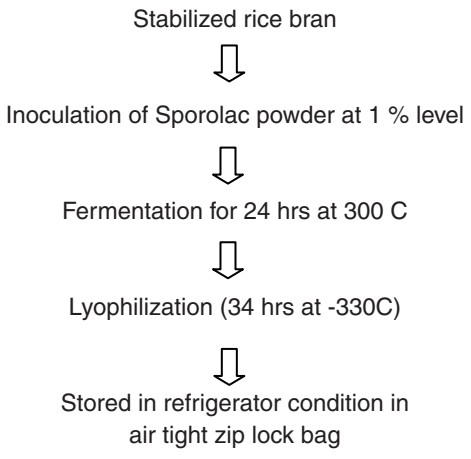

Fig. 2: Probiotic treatment of rice bran

Trypsin Inhibitors estimation

Trypsin inhibitors activity (TIA) in both stabilized and probiotic treated samples were measured by inhibiting the activity of trypsin as per the method followed by Kakade *et al*. (1969)[16].

Statistical analysis (Fisher and Yates, 1963)[17]

One way analysis of variance (F-test) was applied on the sensory mean scores of 21 panel members in order to find the significant difference between the different characteristics of products, under the study. Complete Randomized Design (CRD) analysis of variance was applied and the data obtained for each nutrient and functional property was subjected to statistical analysis to determine the level of significance. The statistical analysis was done by using Minitab software (Minitab v1511). Significant difference was defined as p d" 0.05.

RESULTS AND DISCUSSION

Free fatty acid percentage of rice bran on storage

The free fatty acid percentage of control, stabilized and probiotic treated rice bran is given in Table 1. Stabilization of rice bran was carried out by using microwave method. The free fatty acid percentage of microwave stabilized rice bran from initial, 1st, 2nd, 3rd and 4th week was 4.10, 4.98, 5.20, 6.80 and 7.50 respectively. Probiotic treatment of rice bran was carried out by using *Lactic Acid Bacillus* (LAB) culture. The free fatty acid percentage of probiotic treated rice bran from initial to fourth week was 4.35, 5.0, 5.50, 7.05 and 7.95 per cent respectively. There existed a non significant difference between the control, stabilized and probiotic treated rice bran during the initial period

Table 1: Percentage of free fatty acid (FFA) in rice bran on storage

Type of rice bran	Storage time (weeks)				
	Initial	1	2	3	4
			FFA%		
Control	4.36	8.48	12.98	16.50	24.70
Microwave stabilized rice bran (SRB)	4.10	4.98	5.20	6.80	7.50
Probiotic rice bran (PRB)	4.35	5.00	5.50	7.05	7.95
F-value	NS	*	*	*	*
SEm±	0.06	0.58	0.08	0.08	0.08
CD	0.18	1.78	0.25	0.25	0.25

Standard value for free fatty acid: <10%
SRB: Stabilized Rice Bran; PRB: Probiotic treated Rice Bran
NS - Non Significant; * Significant at 5%

Table 2: Functional properties of processed rice bran samples

Type of bran	Bulk density (g/ml)	Water absorption (ml/g)	Oil absorption (ml/g)	Water Solubility (%)	Swelling power (%)
Stabilized rice bran (SRB)	0.22	2.0	1.5	7.3	6.7
Probiotic treated rice bran (PRB)	0.38	3.0	2.5	8.0	7.2
F-value	*	NS	NS	NS	NS
SEm±	0.01	1.0	1.0	0.10	0.10
CD	0.03	3.08	3.08	0.31	0.31

SRB: Stabilized Rice Bran PRB: Probiotic treated Rice Bran
NS - Non Significant * Significant at 5

of storage and significant difference was found between the three types of rice bran during the time intervals. Lakkakula *et al.* (2004)[18] observed that the FFA percentage of microwave heated bran sample stored in polyethylene bags at 4^{0}C for six weeks increased from 2.8 per cent to 3.89 per cent, where as in case of un-stabilized rice bran percentage of FFA increased from 3.96 per cent to 18.03 per cent. Enochain *et al.* (1981)[19] reported that the FFA percentage below 10 per cent is acceptable for human consumption.

Functional properties of processed rice bran samples

The functional properties analysed for the rice bran were bulk density, water absorption, oil absorption, water solubility and swelling power capacity (Table 2).

Bulk density

The bulk density of stabilized rice bran was found to be 0.22 g/ml and that of probiotic treated rice bran was 0.38 g/ml. The results are on par with the reported values of Chandi and Sogi (2006)[20]. The differences between stabilized and probiotic treated rice bran were found significant.

Table 3: Nutrient composition of rice bran per 100g

Nutrients	Stabilized rice bran (SRB)	Probiotic rice bran (PRB)
Moisture (%)	4.30	5.40
Protein (g)	17.50	19.25
Fat (g)	13.10	17.20
Crude fibre (g)	7.85	4.96
Insoluble dietary fibre (g)	21.17	13.10
Soluble dietary fibre (g)	2.17	1.80
Total dietary fibre (g)	23.34	14.90
Carbohydrate (g)	52.33	48.55
Energy (KCal)	398	426
Ash (g)	4.92	4.64
Calcium (mg)	52.10	49.90
Phosphorus (mg)	1185.20	1186.50
Iron (mg)	28.10	30.05
Zinc (mg)	6.02	5.89
Antioxidant activity (Vit-C Eq. µg/g)	65	70
Anti-nutrients		
Phytic acid (mg/g)	23.50	22.15
Trypsin Inhibitor (mg/g)	10.80	10.20

Water and oil absorption capacity

Water absorption capacity ranged from 2-3 ml/g, where as oil absorption ranged from 1.5-2.5 ml/g. There existed a non significant difference among the stabilized and probiotic treated rice bran for water and fat absorption capacity. Dietary fibre present in the bran is known to bind water. The hydrophyllic nature of crude fibre might have contributed to the increased water absorption in the probiotic treated rice bran samples. Probiotic treated rice bran have higher water absorption capacity than stabilized rice bran.

Water solubility (%)

Highest water solubility per cent was found in stabilized rice bran 7.3, followed by probiotic treated rice bran *i.e.* 8.0. There was non significant difference between the samples.

Swelling power (%)

Swelling power capacity of probiotic treated rice bran was 7.2 followed by stabilized rice bran *i.e.* 6.7. The difference in swelling power was found to be non significant. The results were within range as reported by Sharma *et al.* (2004)[21] *i.e.* 9.34 per cent.

Nutrient composition of rice bran

Nutrient composition of stabilized and probiotic treated rice bran samples were shown in Table 3. The macronutrient composition of stabilized and probiotic treated rice bran were in the order of moisture (4.30 and 5.40 %), protein (17.50 and 19.25 g), fat (13.10 and 17.20 g), crude fibre (7.85 and 4.96 g), insoluble dietary fibre (21.17 and 13.10), soluble dietary fibre (2.17 and 1.80), total dietary fibre (23.34 and 14.90), carbohydrate (52.33 and 48.55 g), energy (398 and 426 Kcal) and ash(4.92 and 4.64) respectively. The micronutrient composition of stabilized and probiotic treated rice bran samples were calcium (52.10 and 49.90 mg), phosphorous (1185.2 and 1186.5 mg), iron (28.10 and 30.05 mg) and zinc (6.02 and 5.89 mg) respectively. Rao (1998)[22] reported similar results for macronutrient composition where as Rabbani and

Ali (2009)[23] revealed similar results for micronutrient composition.

The content of carbohydrate, fibre, ash and calcium were decreased in the probiotic treated rice bran compared to the stabilized rice bran because these compounds are the principal energy source of fermenting microorganisms, so that the level of these compounds decreased during the microbial fermentation. Certain amino acids may be synthesized during the fermentation process. The protein, fat, phosphorous and iron contents were increased in the probiotic treated rice bran as the availability of these nutrients increases by the probiotic treatment process (Robert Nout, 2010)[24].

The antioxidant activity for stabilized rice bran was 65 Vit-C Eq. µg/g and probiotic treated rice bran was 70 Vit-C Eq. µg/g respectively. Antinutritional factors for stabilized and probiotic treated rice bran were, Phytic acid (23.5 and 22.15mg/g), Trypsin Inhibitor (10.8 and 10.2mg/g) respectively. The results found were within the safe limits and are in correlation with the study conducted by Kaur *et al*. (2011)[25].

Rice bran is a by-product obtained during rice milling process. After separating the bran from the grain during milling, the material turns rancid liberating toxic free fatty acids. These shortcomings have been overcome by destroying the lipolytic activity using an advanced stabilizing technology, the resulting material thus obtained is called “stabilized” rice bran which has a good taste, readily soluble with a longer shelf life. Processed rice bran is good source of protein, fat, crude fibre, total dietary fibre, carbohydrate, ash, calcium, phosphorous, iron and zinc. The protein, fat, phosphorous and iron contents increased in the probiotic treated rice bran as the availability of these nutrients will increase by the probiotic treatment process.

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