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Utilization of Defatted Rice Bran for the Development of High Fiber Bread

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Abstract: In the present study, physico-chemical characteristics, antioxidant potential of microwave stabilized rice bran and its utilization in the preparation of bread were evaluated. The effect of supplementation of rice bran at 5-25% on the proximate composition, texture, crumb color and sensory attributes were evaluated and dietary fiber content and antioxidant activity were determined. The proximate composition of the composite bread increased significantly (p<0.05) with increased level of supplementation. The incorporation of rice bran gives significant (p<0.05) effects towards the bread volume and texture attributes, where the bread becomes denser and harder in texture with increased supplementation of bran. The increasing bran levels darkened the product as shown by decrease in lightness (L^*) and whiteness; whereas, other color attributes, dietary fiber content and antioxidant activity increased significantly (p<0.05) with increased bran percentage. Thus, supplementation of rice bran up to 15% level would improve the nutritional quality of bread without adversely affecting the sensory parameters.

Keywords: Rice bran, Bread, Dietary fiber, Antioxidant, Sensory

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1. Introduction

Rice bran is one of the most abundant by-products produced in a rice milling industry, is obtained from outer layer of the brown (husked) rice and constitute approximately 10% of the total weight of rough rice. Rice bran is a good source of protein, mineral, fatty acids and dietary fiber (McCaskill and Zhang, 1999). The bioactive phytochemicals present in rice bran are γ-oryzanol, tocopherols, tocotrienols, phytosterols, squalene and phospholipids. They have antioxidant activity and health beneficial effects on blood pressure, lipid profiles, glucose metabolism, and coronary management (Gopala Krishna, 2002; Cicero and Derosa, 2005; Shirakawa *et al.* 2006). The instability of rice bran is attributed to the activity of endogenous enzyme such as lipases present in outer layers of the rice kernel, which can hydrolyze triglycerides into glycerol and free fatty acids. The free fatty acids formed are harmful compounds that render the rice bran rancid and inedible on account of reduced pH, rancid flavor and soapy taste yield (Lai *et al.* 2005; Yilmaz *et al.* 2014).

Stabilization of rice bran by various means *viz*. extrusion (Sharma, 2004), microwave treatment (Ramezanzadeh *et al.* 1999), ohmic heating (Lakkakula, 2004), dry heat treatment (Sharma, 2004), gamma-irradiation (Shin and Godber, 1996), parboiling and autoclaving (Rosniyana *et al.* 2007) as well as toasting (Da Silva *et al.* 2006), are carried out by inactivation of enzyme lipase, for possible applications in food industries. Stabilized rice bran can be used for the formulation of various products owing to its high fiber and low saturated fat content (Sharif *et al.* 2005), thereby enhancing the nutritive value of formulated products which are beneficial for human health and value addition.

Being one of the cheaper cereal by-product, rice bran offers great potential to be used in various food matrices such as bakery (Irakli *et al.* 2015; Tuncel *et al.* 2014; Yadav *et al.* 2012; Sairam *et al.* 2011), beverages (Faccin *et al.* 2009) and meat products (Tuncel *et al.* 2014; Choi *et al.* 2011; Shih and Daigle, 2003) for functional and nutritional purposes. Little information is available regarding the processing effect on the antioxidant activity of rice bran supplemented bread. Thus, the present study was designed to evaluate the effects of stabilized rice bran supplementation on quality attributes, antioxidant activity and sensory parameters of substituted wheat breads.

2. Materials and Methods

Paddy (cv *Sambha mansoori*) was procured from Department of Agronomy SHIATS, Allahabad. The paddy was milled to obtain rice bran that was stabilized by microwave heating (Patil *et al.* 2016).

2.1. Bread Making Process

Bread was prepared from commercial refined wheat flour (100 g), microwave stabilized rice bran (0 (control bread), 5.0, 10, 15, 20 and 25% based on flour weight), sugar (20 g) instant yeast (*Saccharomyces cerevisiae*) (10 g), milk powder (5g), sunflower oil (1.5 g), salt (NaCl) (1.5 g) and water (up to optimum absorption). All ingredients were thoroughly mixed in a mixer to form dough for 10-15 min depending on the bread type. Dough's were manually rounded and allowed to rest at room temperature for 15 min. After the resting time, the dough's were put into pans, punched to give the shape, and proofed for 1 h at 35-40°C. They were baked at 180°C in an electric oven (Birla Electricals Ltd, New Delhi, India) for 20-25 min.

2.2. Proximate Composition

The moisture, crude protein, crude fat, ash and crude fiber content of the microwave stabilized rice bran and bread samples were analyzed using the methods (AOAC, 2015). The carbohydrate content was calculated by different methods.

2.3. Physical Analysis

Loaf volume was determined by the method (Giarni *et al.* 2004). Loaf weight was taken by electronic weighing balance and specific loaf volume was calculated as (loaf volume/loaf weight).

2.4. Color

Crumb color of the breads was measured using X-rite (Grandville, MI, USA). The color attributes i.e. Hunter lightness (L^*), redness (a^*), and yellowness (b^*) were recorded 6 times for each loaf (n=3). Additional color attributes, such as chroma, redness, whiteness value and ΔE (total color change) were calculated L^*, a^* and b^* values according to (Chen *et al.* 1997).

$$\Delta E = [(\Delta L)^* + (\Delta a^*)2\ (\Delta b^*)^2]^{1/2}$$

$$\text{Chroma} = (a^2 + b^2)^{½}$$

$$\text{Whiteness Value} = 100\text{-}[(100\text{-}L^*)^2 + a^{*2} + b^{*2}]^{1/2}$$

$$\text{Redness Value} = a^* / b^*$$

2.5. Dietary Fiber Analysis

Soluble, insoluble and total dietary fiber analysis were carried out according to the enzymatic-gravimetric AACC, 2000 method (Method No: 32-07) using total dietary fiber assay kit (Sigma Aldrich).

2.6. Texture

Texture parameters (hardness, adhesiveness, springiness, cohesiveness, gumminess and chewiness) of bread samples were measured by using a texture analyzer TA-XT2i (TAHDI, Stable Microsystem, UK) as adopted by the standard method by AACC, method 74-09 (AACC, 2000). The probe was calibrated according to the instruction before conducting the test. A cube sample (2cm x 2cm x 2cm) was cut from the middle of the sample (bread) and was placed centrally beneath the probe [(p/36 cylinder probe (36mm)] in order to meet with a consistent flat surface. The compression test was selected in texture analysis using a 5 kg load cell and the sample was compressed to 45% of its original height. The strain required for 45%compression was recorded using the following conditions: pretest speed: 1.0 mm/s, test speed: 1.7 mm/s, post test speed: 10 m/s, compression distance: 25% and trigger type: auto 5 g. The values reported were the average of three readings. Data was analyzed using Texture expert Version 1.05 (Stable Micro system Ltd) software.

2.7. Antioxidant Activity of Bread

The total phenolic content of the bread samples was determined by the Folin–Ciocalteu method (Matthaus, 2002). Free radical scavenging activity of various extracts was measured from the bleaching of purple colored methanol solution of DPPH (2,2-diphenyl-1-picrylhydrazyl) by the method of (Brand-Williams *et al.* 1995). FRAP (Ferric reducing antioxidant power) was determined according to (Sutharut and Sudarat, 2012). Metal chelating activity of the extract was determined by the method of (Dinis *et al.* 1994).

2.8. Sensory Evaluation of Bread

Sensory evaluation was conducted for the freshly baked composite bread by semi-trained panelists consisting of research scholars and staff aged between 22 to 45 years old from Centre of Food Technology, University of Allahabad. Sensory evaluation was conducted by using a 9-point hedonic scale as described by (Rangana, 2005). The samples were sliced into equal size before serving. Three pieces from each lot of bread was presented to each of 30 panelists to rate sample's attributes in ascending order of their choice by giving them a numerical number between 1-9 for all characteristics of bread.

3. Statistical Analysis

All the experiments were conducted in triplicate, and the results were expressed as means ± standard deviation. The experimental data were analyzed statistically by using SPSS Version 16.0 software program (SPSS Inc., Chicago, IL, USA). Analysis of variance and Duncan's multiple range tests were used to determine and compare the statistical differences of each data in this study. p-Value of less than 0.05 was considered to be statistically significant.

4. Results and Discussion

4.1. Proximate Composition

The nutritional composition of bread prepared with different levels of rice bran (5-25%) is presented in Table 1. The results showed that moisture, protein, fat, crude fiber and ash content increased significantly ($p<0.05$) from 11.46% to 15.8%, 7.75% to 12.6%, 2.0% to 5.6%, 1.13% to 9.93% and 0.66% to 2.33%, respectively with increased level of supplementation of rice bran. The carbohydrate content decreased with increased levels of supplementation from 74.1% to 64.3%. Rice bran contains more cellulose and other non-starch polysaccharides that hold moisture several times higher to its weight, so with the increase of rice bran level there was increase in moisture content of bread. Rice bran is an excellent source of lipids, protein, dietary fibers and could be an effective way in incorporating lysine and methionine deficient foods such as wheat, maize and sorghum to overcome the prevailing malnutrition problem.

4.2. Physical Evaluation

The physical properties of bread loaves are presented in Table 4. The loaf volume and specific loaf volume decreased significantly ($p<0.05$) with increased supplementation of rice bran from 625 to 528 ml and 4.2 to 3.1 ml/g, respectively. This may be due to higher levels of gluten present in control flour compared to composite blends that results in weak dough structure, which could not be properly stretched by carbon dioxide gas during fermentation and proofing (Chen *et al.* 1997). Similar results were obtained for specific loaf volume which was highest in control bread flour (4.2 ml/g) and lower value was observed for 25% rice bran level. Appreciable amounts of water could have strongly bound to the added fibers during bread making, so less water was available for the development of starch-gluten network, causing an underdeveloped gluten network and reduced loaf volume (Brennan and Cleary, 2007).

The weight of composite bread loaf was significantly increased ($p<0.05$) on supplementation with rice bran at various levels. The increase in loaf weight might be due to high water absorption by the rice bran and the reduced air entrapment, resulting in heavy dough.

4.3. Color Measurement

The color (L^*, a^*, b^*) characteristics of crumb of bread samples with different percentage of rice bran is presented in Table3. Crumb of bread samples containing rice bran had significantly ($p<0.05$) lower L^*values compared to control samples. By increasing the percentage of rice bran in bread formulation, darkness gradually increased with significant ($p<0.05$) difference among all composite breads. The present results are in agreement with Tuncel *et al.* (2014) who found darker crumb color with the addition of rice bran. Abdul-Hamid and Luan (2000) also reported darker crumb color with the addition of 10% dietary fiber prepared from defatted rice bran. Reduced lightness of bread may be result of water being bound by fibers (Feili, 2013). Supplementation of rice bran at various levels significantly ($p<0.05$) increased redness (+a^*), yellowness (+b^*), chroma and redness (a^*/b^*) values in composite breads whereas whiteness of bread decreased significantly as the supplementation level increased. Total color change (ΔE) increased with the increased percentage of rice bran. The increased values for ΔE were directly related to the increased bran content. The highest ΔE was observed at 25% bran level.

4.4. Dietary Fiber

Bread supplemented with rice bran at different levels showed variation in soluble, insoluble and total dietary fiber (Table 4). Soluble, insoluble and total dietary fiber content (TDF) increased significantly ($p<0.05$) from 0.5 to 2.8%, 1.4 to 5.4% and 1.9% to 8.2% with rice bran supplementation. The total dietary fiber content increased about 10.8 % with the supplementation of 25% rice bran. Significant negative correlation was found between dietary fiber content and specific volume of breads (r=-0.951, p=0.05). Fiber addition to dough reduces loaf volume by changing crumb structure and impairing carbon dioxide retention (Pomeranz *et al.* 1977). Furthermore, Curti *et al.* (2013) indicated that the competition of bran for water with starch and gluten might hinder a sufficient hydration of gluten, resulting in the reduction of the loaf volume.

Dietary fiber from rice bran mainly contains cellulose, lignin, and hemicellulose, of which the major portion is insoluble (Chinma *et al.* 2015; Elleuch *et al.* 2011). Insoluble dietary fibre promotes human health by supporting the growth of the intestinal microflora, increase the faecal bulk and decrease the intestinal transit time (Foschia *et al.* 2013). Recently the importance of consuming dietary fiber has increased owing to its relation with the reduction of blood cholesterol level, lower inulin demand and improved laxative properties (Chawla and Patil, 2010). The recommended daily intake of total dietary fiber is between 30 to 38g/day for male and 21 to 26 g/day for female (Chawla and Patil, 2010). In view of that a slice of bread weighs approximately 25g, it can be said that 3-4 slices of bread supplemented with 15% of rice bran provides the daily intake.

4.5. Texture of Breads

The results of texture profile analysis are presented in Table 5. The inclusion of rice bran at various levels affected the textural properties of bread. Hardness of bread samples were significantly ($p<0.05$) increased by increasing the bran percentage from 5 to 25%. Similar results were reported by (Tuncel *et al.* 2014) for rice bran supplemented bread. Many researchers observed that the texture of the dough becomes harder on increasing the wheat bran level. Some workers attributed this effect to the thickening of the walls surrounding the air bubbles in the crumb and due to the interaction between gluten and fibrous matrix (Curti *et al.* 2013; Gomez *et al.* 2011; Gomez *et al.* 2003).

Adhesiveness was not significantly affected on rice bran supplementation for the formulation of composite bread. Springiness of bread samples up to 5% rice bran was not significantly different ($p>0.05$). Above 5% level springiness was found to be increased from 1.20 to 1.36. Cohesiveness was significantly ($p>0.05$) affected by the inclusion of rice bran. It decreased from 0.93 to 0.47 as the addition of rice bran increased from 5 to 25%. This reduction indicates that bread formulated with rice bran has low ability to resist before the bread structure deformed under teeth. Higher values for gumminess and chewiness were obtained with the inclusion of rice bran. Wang *et al.* (2002) showed a similar trend for breads with addition of fiber since they caused an increase in gumminess and chewiness of bread.

4.6. Antioxidant Activity of Bread

Epidemiological studies showed that consumption of phenolic rich foods is associated with low risk of several chronic diseases such as aging, cancer, cardiovascular disease and Alzheimer disease. The total phenolic content was expressed as mg gallic acid per gram of dry weight. As summarized in Table 6 Total phenolic content (TPC) of rice bran substituted bread varied significantly between the substitution levels. Supplementation of rice bran in bread resulted in an increase in the total phenolic content. The bread containing 25% rice bran resulted in highest TPC as compared to other samples and control bread, which showed an increase (16.54 to 54.7mg GAE/100g) as the level of rice bran was increased from 10 to 25%. This increase in TPC during the baking process is because of increased content of free and bound phenolic acid in rice bran.[14] The Maillard reaction products formed during the production of bread could also act as the antioxidants and scavenge free radical, which consequently contribute to better antioxidant activity of the biscuit (El-Massary *et al.* 2003; Jing and Kitts, 2000). The percentage of DPPH radical scavenging activity increased significantly ($p<0.05$) as the level of rice bran increased from 5 to 25%. As compared to the control bread, total antioxidant activity increased from 31.7% to 67.2%in rice bran substituted bread. High antioxidant activity of rice bran substituted bread compared to the control might be due to the high phenolic compounds *viz* ferulic acid, *p*-coumaric acid and sinapic acid of the rice bran. FRAP assay measures the reducing potential of an antioxidant reducing with a ferric tripyridyltriazine (Fe^{3+} -TPTZ) complex and producing a coloured ferrous tripyridyltriazine (Fe^{2+} -TPTZ). Generally, the reducing properties are associated with the presence of compounds which exert their action by breaking the free radical chain by donating hydrogen atom. FRAP values of the extracts of control and rice bran substituted bread is summarized in Table 7. FRAP values of rice bran substituted bread were significantly varied from 1.01 to 2.17 mmol Fe(π)eqv/g.

4.7. Sensory Analysis

The mean scores of hedonic sensory evaluations for color, flavor, texture, appearance and overall acceptability of bread is summarized in Table 7. Sensory analysis of bread showed that increasing rice bran percentage increases the nutritional value but at the same time it alters the quality and sensory properties of bread. Organoleptic evaluation of bread showed that all sensory results were in the range of 6-8 indicating that these breads were moderately accepted. The most acceptable colour of the composite bread was observed at 10% and 15% supplementation of rice bran whereas undesirable darker colour was obtained at 25% of rice bran inclusion. Based on the obtained results it was found that the taste of the bread was affected by the level of rice bran. Bread with 15% rice bran had the best taste of all breads and bread with 25% of rice bran got the least organoleptic score. Bran levels above 15% imposed a negative effect on the taste of panelists. The panelists found undesirable mouth feel and taste when the level of rice bran increased.

Sensory analysis of bread showed that an increasing rice bran supplementation could affect the bread flavor. In terms of flavor, the control and bread containing 15% bran were recorded as good while the highest score was obtained for 15% rice bran supplemented bread. The sensory panel reported an unacceptable taste above 15% incorporation of rice bran. No significant difference was observed in flavor at 20 and 25% levels of rice bran Bread. Flavor is generally formed during the last stage of baking as a result of Maillard and caramelization reaction. Free amino groups of lysine, peptides, or proteins could react with carbonyl groups of reducing sugars, initiating

Table 1: Nutritional analysis of rice bran supplemented bread.

Wheat flour: Rice bran	*Moisture (%)*	*Protein (%)*	*Crude Fat (%)*	*Crude Fiber (%)*	*Ash (%)*	*CHO (%)*
100:0	11.4 ± 0.3^{a}	7.75 ± 1.3^{a}	2.0 ± 0.4^{a}	1.13 ± 0.27^{a}	0.66 ± 0.13^{a}	78.1 ± 2^{d}
95:05	11.9 ± 1.0^{ab}	8.80 ± 1.3^{ab}	2.8 ± 0.5^{b}	2.80 ± 0.42^{b}	0.92 ± 0.12^{a}	75.6 ± 4^{cd}
90:10	12.4 ± 0.32^{ab}	9.91 ± 0.82^{bc}	3.4 ± 0.4^{c}	3.81 ± 0.21^{c}	1.16 ± 0.23^{a}	73.1 ± 2^{bcd}
85:15	13.6 ± 0.7^{abc}	11.0 ± 0.73^{cd}	3.9 ± 0.4^{d}	5.85 ± 0.22^{d}	1.66 ± 0.23^{a}	69.7 ± 3^{abc}
80:20	14.3 ± 0.9^{bc}	11.6 ± 0.78^{d}	4.6 ± 0.8^{e}	7.37 ± 1.19^{e}	2.16 ± 0.23^{a}	67.4 ± 3.1^{ab}
75:25	15.8 ± 2.1^{d}	12.6 ± 0.69^{d}	5.0 ± 0.8^{f}	9.93 ± 0.33^{f}	2.33 ± 0.23^{a}	64.3 ± 4^{a}

All data are the mean ± SD of three replicates. For each value means within a row not sharing a common letter differ significantly ($p < 0.05$)

Table 2. Physical Parameters of Rice Bran incorporated bread

S. No.	*Loaf Volume of Bread (ml)*	*Weight of Bread (g)*	*Specific Volume of Bread (ml/g)*
100:0	652 ± 45^{c}	154 ± 4^{a}	4.2 ± 0.3^{d}
95:05	625 ± 28^{bc}	158 ± 5^{a}	3.9 ± 0.2^{cd}
90:10	605 ± 57^{abc}	162 ± 4^{a}	3.7 ± 0.3^{bc}
85:15	578 ± 34^{abc}	165 ± 4^{a}	3.5 ± 0.2^{abc}
80:20	554 ± 42^{ab}	167 ± 6^{a}	3.3 ± 0.1^{ab}
75:25	528 ± 42^{a}	169 ± 5^{b}	3.1 ± 0.3^{a}

All data are the mean ± SD of three replicates. For each value means within a row not sharing a common letter differ significantly ($p < 0.05$)

Table 3: Color Value of Rice Bran incorporated bread

Wheat flour : Rice Bran	*L*	*+a*	*+b*	*Chroma*	*Redness*	*Whiteness Value*	*Delta E*
100:0	71 ± 5^{c}	-1.5 ± 0.1^{a}	16.9 ± 2^{a}	17.0 ± 3^{a}	-0.09 ± 0.01^{a}	66.6 ± 1.6^{d}	_
95:05	69 ± 6^{c}	0.5 ± 0.2^{b}	18.3 ± 3.0^{ab}	18.0 ± 2^{ab}	0.03 ± 0.01^{b}	64.1 ± 4.2^{cd}	3.3 ± 0.1^{a}
90:10	65 ± 2^{bc}	2.2 ± 0.1^{c}	20.7 ± 2.1^{abc}	20.0 ± 1.2^{abc}	0.10 ± 0.01^{c}	59.5 ± 3.5^{bc}	8.0 ± 0.2^{b}
85:15	61 ± 7^{abc}	2.8 ± 0.1^{d}	21.8 ± 1.0^{bc}	21.8 ± 2.1^{abc}	0.13 ± 0.01^{d}	55.3 ± 4.2^{ab}	12.1 ± 0.2^{c}
80:20	57 ± 3^{ab}	3.4 ± 0.2^{e}	22.1 ± 2.3^{bc}	22.3 ± 3.2^{bc}	0.15 ± 0.02^{e}	51.8 ± 6.2^{ab}	15.7 ± 0.2^{d}
75:25	56 ± 6^{a}	3.7 ± 0.4^{e}	23.4 ± 3.0^{c}	23.7 ± 3.1^{c}	0.16 ± 0.01^{e}	49.7 ± 3.1^{a}	17.7 ± 0.4^{e}

All data are the mean ± SD of three replicates. For each value means within a row not sharing a common letter differ significantly ($p < 0.05$)

Table 4: Dietary fiber content of bread enriched with rice bran (Sambha Mansoori).

Wheat flour : Rice Bran	*Soluble Dietary Fiber (%)*	*Insoluble Dietary Fiber (%)*	*Total Dietary Fiber (%)*
100 : 0	0.5±0.1[a]	1.4±0.2[a]	1.9±0.3[a]
95: 05	0.9±0.1[ab]	1.6±0.2[a]	2.5±0.4[a]
90 : 10	1.2±0.2[b]	2.4±0.6[a]	3.6±0.8[a]
85 : 15	1.9±0.4[c]	3.4±0.5[b]	5.3±0.9[b]
80 : 20	2.8±0.2[d]	5.4±0.6[c]	8.2±1.8[c]
75 : 25	3.6±0.3[e]	7.0±0.8[d]	10.8±1.2[d]

All data are the mean ± SD of three replicates. For each value means within a row not sharing a common letter differ significantly ($p < 0.05$).

Table 5: Texture Profile Analysis of Rice Bran incorporated bread

Wheat flour : Rice Bran	*Hardness*	*Adhesiveness*	*Springiness*	*Cohesiveness*	*Gumminess*	*Chewiness*
100:0	405±28[a]	0.03±0.01[a]	1.06±0.1[a]	0.93±0.1[d]	376.6±25[a]	398±28[a]
95:05	905±60[b]	0.03±0.01[a]	1.09±0.1[ab]	0.76±0.1[cd]	687.8±50[b]	749±47[b]
90:10	1080±10[b]	0.03±0.01[a]	1.20±0.2[ab]	0.70±0.1[bc]	756±39[b]	918±19[c]
85:15	2178±105[c]	0.03±0.01[a]	1.30±0.1[ab]	0.61±0.1[abc]	1328±39[c]	1726±92[d]
80:20	3208±120[d]	0.03±0.01[a]	1.34±0.1[b]	0.52±0.1[ab]	1668±78[d]	2235±98[e]
75:25	4115±150[e]	0.03±0.02[a]	1.36±0.2[b]	0.47±0.1[a]	1934±80[e]	2630±110[f]

All data are the mean ± SD of three replicates. For each value means within a row not sharing a common letter differ significantly ($p < 0.05$).

Table 6: Antioxidant properties of rice bran incorporated bread

Wheat flour : Rice Bran	*DPPH (%)*	*Metal Chelating Activity (%)*	*FRAP (mm Fe(II)eqv/g)*	*TPC (mg gallic acid /100g)*	*Reducing Power (mg AAE/g)*
100:0	31.7±6.8[a]	64.8±3.1[a]	0.96±0.1[a]	16.0±1.2[a]	2.62±1.1[a]
95:05	34.0±3.1[a]	67.4±6.1[a]	1.01±0.1[a]	24.0±3.2[a]	3.70±0.5[b]
90:10	41.2±1.3[ab]	67.4±8.4[a]	1.13±0.2[a]	34.6±1.9[b]	5.93±0.2[c]
85:15	45.0±3.6[c]	72.8±4.5[ab]	1.31±0.1[ab]	46.0±7.6[c]	6.17±0.5[c]
80:20	62.9±7.4[d]	78.5±1.9[bc]	1.78±0.4[bc]	51.5±8.4[c]	9.48±0.8[d]
75:25	67.3±5.6[d]	84.6±5.6[c]	2.17±0.6 [c]	54.7±7.0[c]	16.1±2.2[e]

All data are the mean ± SD of three replicates. For each value means within a row not sharing a common letter differ significantly ($p < 0.05$)

Table 7: Sensory analysis (9-Point Hedonic score) of rice bran incorporated bread.

Wheat Flour : Rice Bran	*Colour*	*Flavour*	*Taste*	*Texture*	*Overall quality*
100:0	8.02 ± 0.2^{b}	8.2 ± 0.8^{a}	7.9 ± 0.4^{c}	7.4 ± 0.2^{a}	7.8 ± 0.4^{d}
95:05	7.8 ± 0.8^{ab}	8.0 ± 0.6^{ab}	7.5 ± 0.6^{bc}	7.3 ± 0.3^{ab}	7.4 ± 0.2^{cd}
90:10	7.26 ± 0.5^{ab}	7.8 ± 0.3^{bc}	7.3 ± 0.5^{abc}	7.0 ± 0.4^{bc}	7.3 ± 0.3^{cd}
85:15	7.46 ± 0.9^{ab}	7.6 ± 0.4^{bc}	7.2 ± 0.3^{ab}	6.9 ± 0.2^{bcd}	7.0 ± 0.5^{bc}
80:20	6.90 ± 0.8^{ab}	7.3 ± 0.5^{cd}	7.0 ± 0.2^{ab}	6.6 ± 0.2^{cd}	6.5 ± 0.3^{ab}
75:25	6.72 ± 0.4^{a}	6.7 ± 0.3^{d}	6.8 ± 0.3^{a}	6.2 ± 0.3^{d}	6.2 ± 0.2^{a}

All data are the mean ± SD of three replicates. For each value means within a row not sharing a common letter differ significantly ($p < 0.05$).

Maillard reactions under the baking conditions [45-46]. Similar findings have been reported by (Wang *et al.* 2002; Majzoobi *et al.* 2013) on the supplementation of baked goods with rice bran. The effect of rice bran supplementation on texture showed no significant changes up to 15% level. However, supplementation of rice bran above 15% caused significant influence on texture attributes. Texture scores decreased on enhancing the incorporation of rice bran. Highest score of texture was observed for control bread. The sensory scores for texture decreased from 7.29 to 6.52 as the level of rice bran increased from 10-25%.

5. Conclusions

Rice bran has many beneficial compounds such as antioxidants, bioactive compounds, dietary fiber and vitamins which play an important role in human well-being. Incorporation of rice bran enhances the nutritive value of bread especially dietary fiber and protein content. The specific volume of bread decreased as the percentage of rice bran increased in formulation while the texture of bread became harder. Hardness, gumminess and chewiness of breads increased proportional to the rice bran inclusion ($p < 0.05$). This is due to the fiber content of rice bran as compared to that of wheat flour. Rice bran substitution led to a significant and gradual increase in insoluble, and thereby total dietary fiber content of composite breads. The presence of rice bran in bread also effects crumb color in which it became darker compared to the bread that was not incorporated with rice bran (control).The antioxidant activity of supplemented bread was found to be much higher than control sample. Thus, it can be concluded that based on consumer perception rice bran can be used in preparation of high fiber value added bread without any adverse effect on its overall acceptability up to 15%.

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