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# The effect of infrared stabilized rice bran substitution on physicochemical and sensory properties of pan breads: Part I

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ABSTRACT

Infrared stabilized rice bran (SRB) substitution to white wheat, wheat bran and whole grain wheat breads at the levels of 2.5, 5.0 and 10.0% was evaluated in terms of proximate composition, crumb color, dietary fiber, texture and sensory attributes. An increasing tendency was observed in crude fat and ash content of the breads. Redness ($+a^*$), yellowness ($+b^*$) chroma and redness ($a^*/b^*$) values were increased gradually with the addition of SRB. Crumb color was found to be darker when 10% of SRB was added to the breads. SRB inclusion did not affect the content of soluble dietary fiber while it significantly increased the insoluble and total dietary fiber contents of the breads ($p < 0.05$). In general, whole grain wheat bread differed from the other bread types in terms of textural behavior. Based on the overall acceptability scores, white wheat and wheat bran breads were sensory accepted up to 10% of flour replacement with rice bran, while substitution levels higher than 2.5% negatively affected the sensory scores of whole grain wheat bread.



## 1. Introduction

Rice bran is a by-product that is obtained during the polishing step of brown rice. The bran constitutes approximately 8–10% of the total grain (paddy). It comprises pericarp, aleurone layer, embryo and some endosperm. Rice bran is rich in protein, lipid, fiber, vitamins and minerals (Kahlon, 2009). Rice bran protein has a high protein efficiency ratio of 2.0–2.2, comparable to casein. Fatty acid composition of rice bran oil consists of 41% monounsaturated, 36% polyunsaturated, and 19% saturated fatty acids (Kahlon, 2009). It is also a good source of antioxidants such as polyphenols, tocopherols, tocotrienols and gamma-oryzanol which help in preventing the oxidative damage of body tissues and DNA. Many studies reported that rice bran has cholesterol lowering properties, cardiovascular health benefits and anti-tumor activity (Kahlon et al., 1992; Qureschi et al., 2000). Despite its excellent nutrition, it is mainly utilized for animal feed or simply discharged due to the rancidity problem caused mainly by lipases. Inactivation of the deteriorative enzymes in freshly milled rice bran, which is a process called "stabilization", enables incorporation of this healthy ingredient back into our diet. The employed stabilization approaches are extrusion (Sharma et al., 2004), microwave treatment (Ramezanzadeh et al., 1999), ohmic heating (Lakkakula et al., 2004), dry heat treatment (Sharma et al., 2004), gamma-irradiation (Shin and Godber, 1996), parboiling, toasting (da Silva et al., 2006), etc. Each method has advantages and disadvantages to consider. In our previous study, we used infrared radiation as a rice bran stabilization method and found that the shelf life of rice bran can be extended up to 6 months with infrared stabilization (Yılmaz et al., 2013).

Stabilized rice bran or its components have been used in various food matrices such as bread (Hu et al., 2009), cookies (Bhanger et al., 2008), pizza (de Delahaye et al., 2005), beverages (Faccin et al., 2009), tuna oil (Chotimarkorn et al., 2008), milk powder (Nanuna et al., 2000), and ground beef (Shih and Daigle, 2003) for functional and nutritional purposes. Rice bran is also used in meat emulsions and batter mixes industrially.

The aim of this study was to evaluate the potential utility of infrared stabilized rice bran as a nutritious bread making ingredient by supplementing it to white wheat, wheat bran and whole grain wheat breads at the levels of 2.5, 5.0 and 10.0%.

## 2. Materials and methods

### 2.1. Material

Freshly milled rice bran was procured from a local milling factory in Çanakkale, Turkey. Raw rice bran was immediately stabilized with the laboratory-type infrared stabilization system.

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### 2.2. Infrared stabilization of rice bran

The experimental set-up developed for infrared stabilization of rice bran consisted of two IR emitters (Heraeus-Noblelight, short wave, 405 mm, Hanau, Germany) with the maximum power of 1200 W and a conveyor system with teflon belt (20 cm width, 110 cm length). The stabilization chamber has a loading unit, which enables the bran to spread out uniformly and in the form of a thin layer on the belt. Infrared radiation intensity or output power of the emitters could be varied by regulating the voltage through a variac (RTM Electronics, 220 V, AC Dimmer, 4000 W, Istanbul, Turkey). Both the speed of the conveyor namely sample flow rate and the process time could be arranged by controlling rotational speed of the electric motor (Yılmaz, MR475-63/4b, Istanbul, Turkey) with a speed control device (adjustable frequency AC drive) (Power Flex 4M, Allen-Bradley-Rockwell Automation, Milwaukee, USA). Rice bran stabilization was employed at 700 W IR power for 3 min.

### 2.3. Bread making procedure

White wheat bread (W) was prepared from commercial refined wheat flour (without any additive) (400 g), infrared stabilized rice bran (0 (control bread), 2.5, 5.0, and 10.0% based on flour weight), instant yeast (*Saccharomyces cerevisiae*) (5 g), sunflower oil (5 g), sodium salt (NaCl) (6 g), sugar (4 g) and tap water (up to optimum absorption). For wheat bran bread (B), 40 g (10%) of wheat bran was added to all recipes. Whole grain wheat bread (G) consisted of 200 g commercial refined wheat flour and 200 g commercial whole wheat flour which contains α-amylase, hemicellulase and lipase enzymes. The other ingredients were the same as W bread for both B and G breads. The water holding capacities of refined wheat flour and whole grain wheat flour were assessed as 60 and 70%, respectively according to the label instructions and additional water was added to the formulation at the level of 50% of the substitution dose of wheat and rice bran. The ingredients were mixed with a stand mixer (Kitchen aid, Michigan, USA) for 10–15 min depending on the bread type. Doughs were manually rounded and allowed to rest at room temperature for 15 min. After the resting time, the doughs were put into pans, punched to give the shape, and proofed for 1 h at 30–35 °C. They were baked at 200 °C in an electric oven (Inoksan FPE 110, Bursa, Turkey) for 20–25 min. All bread making and baking conditions were kept constant for each bread type. Triplicate independent batch for each bread formulation was prepared.

### 2.4. Proximate analysis, specific volume and baking loss

Moisture content of the breads was measured according to the two-stage method of AACC (Method no: 44-15) using a drying oven (Ecocell 22, Munich, Germany) (AACC, 2000). Crude fat content was determined by the Soxhlet extraction method (Method No: 945.38 F) (AOAC, 2000). Crude ash content was determined according to the AACC method (Method No: 08-01) using an electric muffle furnace (Protherm PLF 110/15, İstanbul, Turkey) and crude protein content was determined according to the macro Kjeldal method (Method No: 46-12) (AACC, 2000) using a model of K-435 digestion unit and a model of K-350 distillation unit (Buchi, Flawil, Switzerland). N was converted to protein by using a factor of 5.7. Infrared stabilized rice bran was also analyzed for its proximate composition according to the noted procedures (AACC, 2000; AOAC, 2000). Crude fat, ash and protein results were expressed based on dry weight (d.w.). Loaf volume was measured in triplicate using the volume replacement method. Results were expressed as specific volume (mL/g) which was calculated by dividing the loaf volume by the weight of the bread. Baking loss was calculated by subtracting the weight of bread after baking from the weight of dough and dividing this term by the weight of dough and given as a percentage.

### 2.5. Color

Crumb color of the breads was measured using a Minolta CR-400 model colorimeter (Minolta Co., Osaka, Japan). Lightness ($L^*$), redness ($+a^*$) or greenness ($-a^*$), yellowness ($+b^*$) or blueness ($-b^*$) were measured 6 times for each loaf ($n = 3$). Additional color attributes, such as chroma (saturation, color intensity), redness, whiteness value, and ΔE (total color change) were calculated from $L^*$, $a^*$, and $b^*$ values according to Chen et al. (1997) as shown below. ΔE represents the total color difference between the control bread and test breads which were substituted with stabilized rice bran at different levels.

$$\text{Chroma} = \left(a^{*2} + b^{*2}\right)^{1/2}$$

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

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

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

### 2.6. Dietary fiber analysis

Soluble, insoluble and total dietary fiber analyses were carried out according to the official enzymatic-gravimetric AACC method (Method No: 32-07) (AACC, 2000) using a commercially available enzyme kit (Megazyme). Due to the high fat content of rice bran, dried bread samples were defatted with a Soxhlet extractor using hexane and petroleum ether as the extracting solvent. Briefly, 1 g of dried and defatted bread sample was subjected to sequential enzymatic digestion by heat stable α-amylase, protease, and amyloglucosidase. Insoluble dietary fiber was filtered through Gooch crucibles, the residue was washed and weighed after drying at 103 °C overnight. The filtrate and water washings were combined and precipitated with hot ethanol for determination of soluble dietary fiber. The precipitate was then filtered, washed, dried and weighed. Results were corrected for protein and ash. Dietary fiber analyses were performed in triplicate and the results were expressed in percentage as defatted bread weight.

### 2.7. Texture analysis

Texture profile analysis (TPA) was performed using a texturometer (Brookfield, CT3-4500, Massachusetts, USA) equipped with a cylinder probe (TA4/1000, $D = 38.1$ mm). Mechanically cut bread slices (25 mm thickness, totally) were 40% compressed twice to give a two bite texture profile curve. Duplicate measurements were made for each loaf ($n = 3$), stacking two slices of bread for each measurement, excluding the first three slices from either end. Texture analyses were performed 3 h after baking. Trigger load and test speed were 10 g and 1 mm/s, respectively. The evaluated parameters were; hardness, adhesiveness, resilience, cohesiveness, springiness, gumminess and chewiness as calculated by the texturometer software.

### 2.8. Sensory analysis

Consumer acceptance testing was conducted on breads with participation of university staff and students ($n = \sim 60$). Each bread type (control and others substituted with 3 different levels of stabilized rice bran) was evaluated individually in the different