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Nutritional and sensory quality of wheat bread supplemented with stabilized rice bran

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This project was designed to evaluate the suitability of stabilized rice bran for the supplementation of bread. Freshly milled rice bran was treated with autoclave heating for its stabilization. The effect of stabilized rice bran supplementation on nutritional and sensory properties of wheat bread was determined. Blends of wheat flour and rice bran (95:5, 90:10, 85:15 and 80:20) were used to bake bread with 100 per cent wheat flour as control. Thereafter, proximate, mineral composition and sensory properties of the bread loaves were determined, using standard methods of analysis. The moisture content, crude protein, crude fat, crude fibre and ash of the composite bread loaves increased significantly ($p < 0.05$) from 31.12 per cent to 33.98 per cent, 11.87 per cent to 13.38 per cent, 1.52 per cent to 3.95 per cent, 0.82 per cent to 2.65 per cent and 1.52 per cent to 2.09 per cent, respectively; while carbohydrate content decreased with increased level of supplementation from 53.13 per cent to 43.92 per cent. Mineral content of the bread increased significantly ($p < 0.05$) with increased level of supplementation from 6.44 mg/100g to 15.61 mg/100g (Iron), 80.64 mg/100g to 221.22 mg/100g (Potassium), 84.47 mg/100g to 153.41 mg/100g (Calcium), 13.67 mg/100g to 161.86 mg/100g (Magnesium) and 2.24 mg/100gm to 4.13 mg/100g (Zinc). However, there was a significant decrease ($p < 0.05$) in sodium with increased level of supplementation from 304.31 mg/100g to 227.24 mg/100g. The control sample of bread was acceptable similar to 15 per cent rice bran supplemented bread. The bread supplemented with stabilized rice bran at 20 per cent got the lowest sensory score than other composite and control bread. But, all the composite bread samples had significantly ($p< 0.05$) higher values for nutritional parameters. It can be concluded from the results that upto 15 per cent stabilized rice bran can be successfully incorporated in the bread to improve the sensory and nutritional attributes.

Key Words : Composite bread, Rice bran, Nutritional quality, Supplementation, Sensory quality

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INTRODUCTION

Consumer demand for healthy diets and convenient foods creates a huge commercial market for functional foods. Functional foods are defined as innovative, physiologically-active foods, which can provide additional health benefits beyond basic nutrition. Food fortification is one of the major techniques used to create functional food products (Abdel-Salam, 2010). This process is defined as the addition of one or more components, whether or not they are normally contained in the food, for the purpose of correcting and/or improving a potential biological activity of the designed food product.

Bread is one of the most popular staple foods in the world. In view of its nutritive value, low price, and its simplicity of usage, it has become the basis of all civilizations diets. Bread consumption provides energy (mainly from starch) and delivers dietary fibre and a wide

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range of vitamins and minerals (Dewettinck *et al*., 2008). Moreover, optional ingredients can be added to improve processing or to produce specialty and novelty bread with enhanced nutritional and nutraceutical quality (Dewettinck *et al.*, 2008; Gawlik-Dziki *et al.*, 2009; Gawlik-Dziki *et al.*, 2013 and Sivam *et al.*, 2010).

Rice is a staple food for more than half of humanity. The major rice growing countries are China, India, Indonesia, Bangladesh, Thailand, Burma, Vietnam, Japan and the Philippines. Rice bran is a by-product obtained from outer rice layers and is a good source of protein, mineral, and fatty acids, and dietary fibre content (Mccaskill and Zhang, 1999). Also rice bran is used for the enrichment of some foods, due to its high dietary fibre content.

Rice processing or milling produces several streams of material, including husks, milled rice, and bran. Rice bran, a byproduct of rice milling industry is an indispensable, less expensive abundantly available as soft and fluffy off-white powdery material, during the milling period. It constitutes 8 per cent of the weight of the whole grain that contains most of the nutrients (65 %). During milling process rice containing nutrients is completely removed with bran (Saunders, 1990). Immediately following the milling process, rapid deterioration of the crude fat in the bran by lipase and to a lesser extent, oxidase occurs and makes the bran unfit for human consumption. Several different thermal methods are used for rice bran stabilization (to inhibit lipase activity). Most of the processes involve dry or moist heat treatment. To achieve proper stabilization, every discrete bran particle must have a proper moisture content, depending upon the time and temperature of the treatment. Hot air heating or Autoclave treatment given to rice bran for its stabilization (Bagchi *et al*., 2014) and (Rosniyana *et al*., 2009). Rice bran is an under utilised by-product of rice milling, despite being a nutrient-dense product and a rich source of protein, fat, carbohydrate, and a number of micronutrients such as vitamins, minerals, antioxidants, and phytosterols (Schramm *et al.*, 2007; Iqbal *et al.*, 2005; Renuka and Arumughan, 2007).

From fatty acids containing about 12-18 per cent palmitic acid, 40-50 per cent oleic acid and 30-35 per cent linoleic acid, which makes them represent about 90 per cent of the fatty acids (Malekian *et al*., 2000). The rice bran has high dietary fibre during the first step of whitening. Dietary fibres have shown to have important health implications in the prevention of chronic diseases such as cancer, cardiovascular diseases and diabetes mellitus (Rodriguez *et al*., 2006 and Brownlee, 2011). They contain about 9-12.8 per cent cellulose, 8.7-11.4 per cent hemicelluloses, and a significant amounts of starch (5-15%) that is much less than in the endosperm and that depends on the level of the whitening of the rice and the β- glucans (Saunders, 1990). Rice bran contain large amount of minerals too.

Thus, rice bran could be a good candidate for supplementation in wheat flour to enhance the nutritive value and reduce the cost of cereal based food products. Therefore, it is desirable to evaluate the effect of substitution of rice bran on the nutritional quality and consumers acceptability of bakery products.

Yeast is needed in dough leavening to generate adequate carbon dioxide as well as to obtain a fine aerated structure of bread. Destruction of yeast cells caused a reduction in gas production and hence, affected quality of the final bakery products (Kenny *et al.*, 1999 and Newberry *et al*., 2002). Baking is important because several fundamental complex physical processes are coupled during baking, such as, evaporation of water, volume expansion, gelatinization of starch, denaturation of protein and crust formation etc. As soon as the dough is properly baked into bread, a product with superior quality and sensory features occurs. Fresh bread usually presents an appealing brownish and crunchy crust, a pleasant aroma, fine slicing characteristics, a soft and elastic crumb texture and a moist mouth feel (Giannou *et al.*, 2003). Due to its nutritional value, low cost (Douaud, 2007) and potential use in human nutrition, many studies have been conducted to evaluate use of rice bran in food. It has been used abroad in breakfast cereals and in granola tablets, snacks and as a supplement for bakery products in functional diets since, it is similar to high fibre bread (Abdul-Hamid and Luan, 2000) and in soft drinks and as supplementary component in the food industry (Kahlon, 2009).

METHODOLOGY

The research work was carried out at Department of Food Engineering, College of Food Technology, Vasantarao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra in the year 2016. The rice bran was procured from the Shri Laxmi Narsinhma Rice Mill, Secunderabad. Wheat flour and bread ingredients will be collected from Parbhani local market. Chemicals required for preparation and analysis of bread will be obtained from Department of Food Engineering, College of Food Technology, V.N.M.K.V., Parbhani. Other required materials and machineries will be obtained from College of Food Technology, Parbhani.

Collection and processing of rice bran:

The rice bran, one of the valuable by products of rice milling, is normally finely granulated, light tan in colour and has a bland flavour. The sample namely full fatted raw rice bran was procured from the Shri laxmi Narsinhma Rice Mill, Secunderabad.

Stabilization of rice bran:

The stabilization method reduces or inhibits the activity of lipase enzyme. This process increases the shelf-life of the rice bran. The autoclave method of stabilization was tried to get a well stabilized full fatted raw rice bran (Rosniyana *et al*., 2009).

Formulation and preparation of bread:

Stabilized rice bran was used in preparation bread in different quantities for value addition. Coarseness of rice bran was removed using sieving method. Formulation of functional wheat bread supplemented with stabilized rice bran is given in Table A and the recipe for preparation of bread is outlined and mentioned below in Table B.

Table A : Formulation of wheat bread supplemented with stabilized rice bran

Treatments	Refined wheat flour (%)	Stabilized rice bran (%)
(Control) T_0	100	0
T_1	95	5
T_2	90	10
T_3	85	15
T_4	80	20

Table B : Bread recipe used in bread production

Sr. No.	Ingredients	Weight (g)
1.	Flour	100.0
2.	Water	60 .0
3.	Sugar	25.0
4.	Shortening	5.0
5.	Salt	1.5
6.	Yeast	5.0
7.	SMP	1.0
8.	GMS	0.2
9.	Calcium propionate	0.15

Preparation of wheat bread using stabilized rice bran:

Sieving and mixing of ingredients along with refined wheat flour and rice bran
↓
Fermentation (at 21-26^{0}C)
↓
Knock back
↓
Dividing
↓
Intermediate proofing
↓
Molding and panning
↓
Pan proofing
↓
Baking (200^{0}C for 20 min.)
↓
Cooling (2 hrs)
↓
Slicing
↓
Wrapping

Fig. A : Flow sheet for preparation of wheat bread (Rodge *et al.*, 2012)

Method:

Straight dough method with slight modification was used for the formulation of bread.

– Sieve refined wheat flour, millet flour and gluten and make a uniform blend.

– Dissolve yeast in a little amount of water.

– Dissolve sugar and salt in another small quantity of water.

– Put the flour into the dough mixer and add water in which salt and sugar have been dissolved, also add yeast mixture and fat in the flour.

– Mix all the ingredients for 3-4 minutes and knead to soft smooth dough.

– Keep the dough at approximately 30°C for 90 minutes.

– Punch the dough and again allow it to ferment at 30°C for 60 minutes.

– Sheet, roll and mould the dough. Place the dough in greased bread tin and cover with a wet cloth. Allow the dough to rise in bread tin.

– Spray water on the bread surface before putting it in oven.

– Bake the bread at 200°C for 20 minutes.

– After 20 minutes, take out the bread from oven and allow it to cool.

– Slicing of bread and packaging of bread in LDPE bags.

Proximate analysis of wheat flour, rice bran and bread samples :

The proximate composition of wheat flour, stabilized rice bran and bread was analyzed. Moisture was determined by drying the sample in hot air oven at 105°C for 4 h (AOAC, 2005). Protein was analyzed by the Kjeldahl method (AOAC, 2005). Crude fat was determined by the Soxhlet extraction technique followed by (AOAC, 2005). The carbohydrate content was estimated by the difference method. It was calculated by subtracting the sum of percentage of moisture, fat, protein and ash contents from 100 per cent as described by (Ihekoronye and Ngoddy, 1985). The bulk of roughage in food is referred to as the fibre and is called crude fibre. Milled sample was dried, defatted with ethanol acetone mixture and then the crude fibre was determined using the standard method as described in (AOAC, 2005). Ash content was analyzed by burning the sample in a muffle furnace at 525°C for 5 h (AOAC, 2005).

Mineral composition:

The minerals Ca, Mg, K, Na, Fe and Zn were determined by using atomic absorption spectrophotometer (AAS) as described by Onwuka (2005).

Sensory evaluation of wheat bread:

Freshly prepared bread samples were subjected to sensory evaluation by a semi trained panel using a 9-point hedonic rating scale. The panelists were selected from the staff of College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Meilgaard *et al*., 2007).

Statistical analysis:

Triplicate data of the all experimental treatments were statistically analyzed by Completely Randomized Design (CRD) using analysis of variance (ANOVA) in SAS statistical software. The analysis of variance revealed at the significance of S.E. and C.D. at 5 per cent level is mentioned wherever required (Panse and Sukhatme, 1967).

OBSERVATIONS AND ASSESSMENT

Table 1 summarizes the proximate composition of wheat flour and the stabilized rice bran. It was observed that obtained wheat flour found to contain 13.47 per cent of moisture. The lower moisture content of wheat flour justifies the suitability for long term storage without deterioration. The carbohydrate content of wheat flour was found to be 71.43 per cent with the protein content of 12.71 per cent. Higher protein content is important for strong elastic dough which having high water absorptive capacity, excellent gas holding properties and will yield bread with good volume, grain and texture. The observed values for crude fat and ash content were 0.94 per cent and 0.71 per cent, respectively. The stabilized rice bran contains 6.74 per cent moisture, 17.14 per cent fat, 13.11 per cent protein, 9.9 per cent ash, 7.0 per cent crude fibre and 46.08 per cent of carbohydrate. The results were in agreement with previously reported results by (Quilez *et al.*, 2013; Pacheco De Delahaye *et al.*, 2009; Rodge *et al*., 2012 and Singh *et al*., 2013).

Table 1 : Proximate composition of refined wheat flour and stabilized rice bran

Constituents	Amount (%)	
	Refined wheat flour	Stabilized rice bran
Moisture	13.47	6.74
Fat	0.94	17.14
Protein	12.71	13.11
Ash	0.71	9.9
Crude fibre	0.64	7.0
Carbohydrate	71.43	46.08

*Each value is average of three determinations

Results of the proximate composition of the bread samples are presented in Table 2. The moisture, crude protein, crude fat, crude fibre and ash contents increased significantly ($p<0.05$) from 31.12 per cent to 33.98 per cent, 11.87 per cent to 13.38, per cent, 1.52 per cent to 3.95 per cent, 0.82 per cent to 2.65 per cent and 1.52 per cent to 2.09 per cent, respectively; with increased level of supplementation. This is in agreement with Farrell (1994), who earlier reported that rice bran is a good source of proteins, lipids, dietary fibre and minerals and could be an effective tool in supplementing lysine and methionine deficient foods such as wheat, maize and sorghum to overcome the prevailing malnutrition problem. The carbohydrate contents decreased with increased level of supplementation from 53.13 per cent to 43.92 per cent. This is expected since there is very little carbohydrate

Table 2 : Chemical composition of wheat bread supplemented with stabilized rice bran

Treatments	Proximate composition (%)					
	Moisture	Fat	Protein	Ash	Crude Fibre	Carbohydrate
T_0	31.12	1.52	11.87	1.52	0.82	53.13
T_1	31.81	2.04	12.08	1.67	1.98	50.41
T_2	32.74	2.51	12.39	1.76	2.23	48.35
T_3	33.29	3.47	12.91	1.85	2.59	45.86
T_4	33.98	3.95	13.38	2.09	2.65	43.92
S.E. ±	0.159	0.139	0.141	0.025	0.014	0.050
C.D. (P=0.05)	0.180	0.418	0.426	0.075	0.043	0.151

Table 3 : Mineral content of wheat bread supplemented with stabilized rice bran

Treatments	(mg/100g)					
	Calcium	Iron	Sodium	Potassium	Magnesium	Zinc
T_0	84.47	6.44	304.31	80.64	13.67	2.24
T_1	98.88	8.21	281.13	110.41	48.71	2.76
T_2	113.65	11.34	267.34	129.76	89.41	3.16
T_3	130.38	13.52	246.62	188.58	132.25	3.51
T_4	153.41	15.61	227.24	221.22	161.86	4.13
S.E. ±	0.058	0.031	0.039	0.012	0.022	0.013
C.D. (P=0.05)	0.177	0.096	0.119	0.038	0.066	0.039

Table 4 : Sensory evaluation of wheat bread supplemented with stabilized rice bran

Treatments	Colour	Flavour	Taste	Texture	Overall acceptability
T_0	8.3	8.1	8.2	8.5	8.3
T_1	8.1	7.9	8.0	8.4	8.1
T_2	8.0	8.3	8.2	8.3	8.2
T_3	7.9	8.6	8.5	8.2	8.3
T_4	7.5	8.1	8.0	7.7	7.8
S.E. ±	0.042	0.034	0.037	0.030	0.049
C.D. (P=0.05)	0.128	0.104	0.113	0.092	0.148

left in rice bran after milling. The results were in agreement with previously reported results for this kind product (Mumtaz *et al*., 2005 and Michael *et al*., 2013).

Protein in the diet helps primarily to build and maintain body cells, while fat supplies essential fatty acids. Crude fibre plays an important role in the prevention of many diseases of the digestive tract. It has been reported that intake of more fibre results in increasing faecal bulk and lowering of plasma cholesterol (Kehlon *et al*., 1994).

Results of the mineral composition of the bread samples are presented in Table 3. There was significantly ($p<0.05$) increase in the mineral content with increased level of supplementation from 6.44 mg/100g to 15.61 mg/100g Iron, 80.64 mg/100g to 221.22 mg/100g Potassium, 84.47 mg/100g to 153.41 mg/100g Calcium, 2.24 mg/100 to 4.13 mg/100g Zinc and 13.67 mg/100g to 161.86 mg/100g Magnesium, while Sodium decreased significantly ($p<0.05$) with increased level of supplementation from 304.31 mg/100g to 227.24 mg/100g. This could be due to substitution effect caused by the high levels of minerals in rice bran as reported by (Saunders, 1990).

Minerals are vital to the functioning of many body processes. They are critical players in the functioning of the nervous system, other cellular processes, water balance and structural (e.g. skeletal) systems. The results were in agreement with previously reported results of (Michael *et al*., 2013).

The sensory scores of the bread loaves are shown in Table 4. There was a significant ($p < 0.05$) difference between the control and the composite bread in terms of colour, flavour, taste, texture and overall acceptability. Overall acceptability was determined on the basis of quality scores obtained from the evaluation of colour, flavour, taste and texture. It is evident from the result that control sample of bread was acceptable similar to 15 per cent rice bran supplemented bread by the judges. The breads supplemented with stabilized rice bran at 15 per cent increased the sensory scores. The bread supplemented with stabilized rice bran at 20 per cent got the lowest sensory score than other composite and control bread.

Conclusion :

Acceptable and nutritious bread was produced from composite flours of wheat and autoclaved (stabilized) rice bran. The control sample of bread was organoleptically acceptable similar with 15 per cent rice bran supplemented bread. But, the composite bread samples were more nutritious than control sample. Rice bran supplementation significantly improved the protein content, fat content and minerals of the bread. The breads supplemented with stabilized rice bran at 15 per cent increased the sensory scores. It can be concluded from the results that upto 15 per cent stabilized rice bran can be successfully incorporated in the bread to improve the sensory and nutritional attributes. As, Bread is a staple food for many countries. Therefore, it is concluded that stabilized rice bran can be used to replace wheat flour in product development to achieve the objectives of reducing the cost of cereal based stable foods and developing health enhancing bread for the consumers.

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