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EFFECT OF RICE BRAN SUPPLEMENTATION ON COOKIE BAKING QUALITY

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Rice bran, a by-product obtained during polishing of un-milled rice, contains a large quantity of essential nutrients such as minerals, vitamins, fiber, amino acids and antioxidants. Supplementation of rice bran in cookies can improve their nutritional value. In the present study, cookies were prepared from wheat flour with supplementation of rice bran @ 5, 10, 15 and 20 percent. The rice bran was stabilized with acid and dry heat treatment before supplementation. Chemical analysis of the cookies revealed that there was no significant difference in chemical and physical properties of cookies supplemented with acid stabilized rice bran (ASRB) and heat stabilized rice bran (HSRB). The moisture, crude protein, fat and mineral contents were significantly increased with the increment of rice bran. Average width, thickness and spread factor of cookies also increased with the increase in percentage of rice bran. Sensory evaluation of cookies showed that scores for color of cookies decreased significantly with increase in level of rice bran and sensory scores were significantly higher in the cookies prepared with HSRB. However the decrease was non-significant at 10 percent level of substitution. Highest scores for overall acceptability of supplemented cookies was recorded at 15 percent level of substitution as compared to other treatments. Hence it is concluded from the results that supplementation of HSRB @ 10 percent is more suitable for production of rice bran supplemented cookies.

Keywords: Rice bran, baking, sensory evaluation, cookies

INTRODUCTION

Rice is ranked second among cereal crops that are being produced in Pakistan and is being processed in well established rice industry but its by-products primarily rice bran is going as waste without considering its nutritive importance (Kestin *et al.*, 1990). In Pakistan, during 2008-09, yield of rice was 6.9 million tons and thus 450 to 500 thousand tons of rice bran is generated (GOP, 2009). The potential of producing rice bran at the global level is 27.3 million tons (Prakash, 1996). Rice bran is a by-product of white rice obtained from the outer layer of the brown (husked) rice kernel during milling. It is a good source of amino acids, antioxidants, B vitamins and contains minerals such as iron, potassium, calcium, chlorine, magnesium, and manganese (Saunders, 1985; Holland *et al.*, 1991).

The anti-nutritional factors present in rice bran limit its use as a food and feed ingredient. These factors include lipases, trypsin inhibitors, haemagglutinin-lectin and phytates. Phytotoxins which get accumulated in bran during polishing of rice hinder the digestibility and availability of nutrients. Therefore, it is used in livestock or poultry feed as a low quality ingredient (Warren and Farrell, 1990). Studies show that all the other undesirable factors except "phytates" present in rice bran are protein in nature. Therefore, it may be postulated that mild acid and alkali treatment and thermal cooking can denature or modify the structure of these proteins (Jiaxun, 2001). Therefore, in order to utilize nutritional potential of rice bran efficiently, these anti-nutritional factors must be eliminated to improve its nutritional quality. Many efforts have been made in the past to remove these anti nutritional factors but these were generally focused to remove one or the other toxic factor only (Saunders, 1990). Many scientists have devised effective methods to stabilize the rice bran and utilized them as potential source of nutrients (Young, 2000; Jiaxun, 2001). The baking is a developing industry in Pakistan, which is growing in size. Foods that are good in taste are reasonably priced and those carrying a favorable nutritional image are in great demand. Among bakery products especially cookies are liked by the all age groups. The functional and nutritional properties of rice bran supplemented cookies ensure to replenish the malnutrition problem among the various segments of Pakistani population. Keeping in view the above facts, this study was designed to prepare cookies from stabilized rice bran that could increase the nutritional quality of cookies. The main objectives of this study were to evaluate the suitability of acid stabilized rice bran (ASRB) and heat stabilized rice bran (HSRB) supplemented cookies and to prepare and analyze rice bran supplemented cookies for their chemical, physical and sensory attributes.

MATERIALS AND METHODS

***Collection of raw materials*:** Freshly milled rice bran was collected from Capital Dall Mill, Islamabad and shifted to the Department of Food Technology, PMAS-Arid Agriculture University Rawalpindi. Rice bran was treated to inactivate endogenous lipase and lipoxygenase enzymes and denature trypsin inhibitors. To achieve this objective the rice bran was subjected to the following chemical and heat treatments.

***Stabilization of rice bran*:** Freshly milled bran was treated with commercial grade hydrochloric acid solution 30 percent (v/v) at the rate of 44 ml per kilogram to reduce pH to 4.0. The HCl was sprayed on the rice bran and mixed to get ASRB. Whereas to prepare HSRB, the rice bran was placed in an oven, maintained at a temperature of 120 °C for 10 to15 seconds. The treated and stabilized rice bran was, packed in jute bags and stored in dark cold store at 10 °C according to the previous method given by Iqbal (2005).

***Preparation of cookies*:** The cookies were prepared by supplementing rice bran in wheat flour @ 0, 5, 10, 15 and 20 percent level as given in Table 1 according to the procedure described by McWatters *et al.* (2003) with slight modifications. The basic ingredients used were 380 g of flour blend, 100 g vegetable shortening, 225 g of granulated cane sugar, 21 g of beaten whole egg, 3.75 g of salt, and 1.8 g of baking powder. The dry ingredients were weighed and mixed thoroughly in a bowl by hand for 3-5 min. The shortening was added and rubbed-in until uniform. The egg was added and dough thoroughly kneaded in a mixer for 5 min. The dough was rolled thinly on a sheeting board to a uniform thickness (8.0 mm) and cut out using a round scorn cutter to a diameter of 35.0 mm. The cut out dough pieces were baked on greased pans at 160°C for 15 min in baking oven. The prepared cookies were cooled at room temperature (30±2°C) and packed in high density polyethylene bags.

Table 1. Treatments used in the study

Treatments	Wheat Flour (%)	Rice bran (%)
T_0	100	0
T_1	95	5
T_2	90	10
T_3	85	15
T_4	80	20

***Chemical analysis*:** Wheat flour, rice bran and rice bran supplemented cookies were analyzed for moisture content, crude protein and crude fat according to their respective methods as described in the AACC (2000).

***Moisture content*:** The moisture content was determined by drying 3 g sample in an air forced draft oven maintaining temperature at 105 ± 5 °C as per procedure given in AACC (2000) method No. 44-15A.

***Crude protein*:** The nitrogen content in each flour sample was determined by Kjeldahl's method as described in AACC (2000) method No. 46-10. The protein percentage was calculated by multiplying nitrogen percent with a factor 5.7.

***Crude fat*:** The crude fat (ether extract) was determined by using Soxtec System HT2, extraction unit of Tecator, Hoganas, Sweden by following the instructions provided in the manufacturer's manual and the procedure described in AACC (2000) method No. 30-10.

***Mineral estimation*:** The minerals Fe, Ca, Mg, Mn, and Zn were determined after wet digestion by using Atomic Absorption Spectrophotometer (Model Varian Spectra AA 240) in the National Institute of Food Science & Technology, University of Agriculture, Faisalabad, according to AACC (2000) method No. 40-70.

***Physical evaluation*:** Physical characteristics like width, thickness and spread factor were determined according to the AACC (2000) Method No. 10-53.

***Width (W)*:** Six cookies were placed horizontally (edge to edge) and rotated at 90° angle for reading.

***Thickness (T)*:** Six cookies were placed one another to compute thickness.

***Spread factor (SF)*:** It was calculated according to the following formula:

$$SF = (W/T \times CF) \times 10$$

Where; CF= Correction factor (1.0 in this case)

***Sensory evaluation*:** A panel of five judges selected from the post graduate students of the Department of Food Technology PMAS Arid Agriculture University, Rawalpindi evaluated the cookies for their sensory parameters like color, flavor, taste, texture and overall acceptability according to the method described by Larmond (1977) using 9 point hedonic scale with following individual scores: liked extremely-9, liked very much-8, liked moderately-7, liked slightly-6, neither liked nor disliked-5, disliked slightly-4, disliked moderately-3, disliked very much-2 and disliked extremely-1, to find out the most suitable composition of cookies for commercialization.

***Statistical analysis*:** The data obtained was analyzed statistically to assess the changes in various parameters of the study by using analysis of variance (Steel *et al.*, 1997) and DMR test for means separation by Minitab Software

Package Version 14.0 (Minitab, Inc., State College, PA, USA).

RESULTS AND DISCUSSION

Chemical assay of rice bran**:** Rice bran obtained after stabilization was chemically analyzed (Table 2). The analysis showed that moisture, crude protein, and crude fat were found to be 18 to 18.17 %, 12.60 to 13.25% and 16.67 to 16.93 %, respectively between ASRB and HSRB. Mineral assay showed that HSRB contained Fe 63.24 ppm, Mn 16.53 ppm, Zn 24.44 ppm, Ca 294.88 ppm and Mg 270 ppm with no significant difference to ASRB. Numerous studies conducted on various aspects of rice bran showed that it contains 13.2 to 17.3 percent protein, crude fat 11 to 18 percent, crude fiber 9.5 to 13.2 percent, and 9.2 to 12.2 percent total ash on dry weight basis (Houston. and Kohler, 1970; Pomeranz and Oryl, 1982; Holland *et al.*, 1991).

Chemical analysis of cookies**:** Rice bran supplemented cookies were chemically analyzed for their proximate composition as depicted in Table 3. Cookies prepared with HSRB were not significantly different to ASRB for proximate composition and mineral content. The chemical analysis of cookies supplemented with different levels of rice bran manifested that significantly highest moisture content were found in T_4 (6.52 percent) followed by T_3 (6.25 percent) and significantly lowest were found in T_0 (5.13 percent) non supplemented cookies (Table 3). As 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 an increase in moisture content of cookies. Protein content was also affected significantly due to addition of various levels of rice bran. The highest protein content (13.63 percent) was found in T_4 followed by 12.6, 11.70, 11.13, and 10.20 percent for T_3, T_2, T_1, and T_0, respectively. The mean values for crude fat were 14.20, 15.11, 16.02, 16.22, and 18.02 percent for T_0, T_1, T_2, T_3, and T_4, respectively. The increase in protein and content may be ascribed to the higher protein and fat content of rice bran. With the increase in level of rice bran, protein and fat content of cookies increased accordingly.

Mineral contents of cookies substituted with rice bran are shown in the Table 4. Significantly highest Fe content (41.55ppm) was found in T_4 followed by 38.95, 36.30, 32.92 and 29.75 ppm in T_3, T_2, T_1, and T_0, respectively. Mean values showed that highest Zn content was found to be 12.28 ppm for T_4 followed by 11.16, 10.32, 9.35 and 7.89 for T_3, T_2, T_1, and T_0, respectively. The lowest Zn content was observed in non-supplemented cookies. Zinc content increased significantly with increase in the level of rice bran. It is obvious from chemical assay of rice bran (Table 2) that it is a very good source of Zn (24.44 ppm). Highest Manganese content (8.08 ppm) was found for T_4 followed by 7.05, 6.18, 5.18 and 4.36 ppm for T_3, T_2, T_1 and T_0 respectively. Highest calcium content (71.51 ppm) was found for T_4 followed by 65.22, 54.45, 39.18 and 25.84 ppm for T_3, T_2, T_1, and T_0, respectively. More pronounced increase for Ca content in case of T_4 (71.51 ppm) may be attributed to the higher Ca content of the rice bran, as the minerals are concentrated in the bran portion of grains. Results expressed that highest Mg content (99.04 ppm) was found for T_4 followed by 83.84, 70.7, 59.93 and 46.78 ppm for T_3, T_2, T_1, and T_0, respectively. The lowest Mg content was observed in case of T_0. Mg content was increased by increasing level of rice bran. These results are in accordance with the findings of Sharif *et al.*, (2009) who reported a proportionate increase in the mineral content of cookies made with addition of different proportions of rice bran. Defatted rice bran adds significant amino acids, minerals and vitamins to baked goods (Lynn, 1969).

Sensory evaluation of cookies**:** Cookies prepared with HSRB got significantly higher scores as compared to ASRB cookies. When the effect of substitution of different levels of rice bran studied the cookies prepared with wheat flour got the highest scores for color, taste, flavor, texture and overall acceptability followed by T_1, T_2, T_3 and T_4 respectively (Table 5). Sensory evaluation of cookies emphasized that scores for color of cookies decreased significantly with increase in level of rice bran. However the decrease was non-significant at 10 percent level of substitution. Highest scores for overall acceptability of supplemented cookies was recorded at 15 percent level of substitution as compared to other treatments. These results are in agreement with the findings of Sharma and Chauhan (2002) who have reported that dry heat stabilized rice bran performed better than the extruded bran with respect to overall acceptability score of cookie. Sudha *et al.* (2007) reported that progressive increase in supplementation level of rice bran produced progressively darker cookies. Carroll (1990) found that a high level (20 percent) of rice bran in muffins affects overall appearance, volume, taste and texture. These results are also in conformity with the findings of Sharma and Chauhan (2002) who reported that flavour response decreased with increase in the level of bran in the cookies and 20 percent replacement of flour with wheat bran imparted a bran flavor to cookie. Hence it is concluded from the results that supplementation of HSRB @ 10 percent is more suitable for production of rice bran supplemented cookies.

Physical evaluation of cookies**:** The mean values for width of cookies (Table 6) showed a decreasing trend with the proportionate increase of rice bran supplementation. Cookies prepared with HSRB got no significant difference when compared to ASRB supplemented cookies for physical attributes. The results elucidated that T_0 (cookies without rice bran) exhibited maximum width 52.27 mm, followed by

T_3 (52.19mm) and T_2 (50.84 mm) while minimum width (49.21mm) was observed in T_4 (cookies with 20 percent rice bran). The results pertaining to means for thickness of cookies (Table 6) revealed increasing trend with proportionate increase of rice bran in commercial straight grade flour. The results explicated that T_4 (cookies with 20

Table 2. Chemical assay of rice bran

Proximate Composition	HSRB (%)	ASRB (%)
Moisture	18.00a	18.17a
Crude protein	13.25a	12.60a
Crude fat	16.67a	16.93a
Mineral contents (ppm)		
Iron (Fe)	63.24a	60.19a
Manganese (Mn)	16.53a	15.83a
Zinc (Zn)	24.44a	22.06a
Calcium (Ca)	244.88a	235.21a
Magnesium (Mg)	270.12a	253.89a

All the values are means of three replications; Means carrying similar alphabets in a row or a column do not differ significantly ($p<0.05$); HSRB = Heat Stabilized Rice Bran; ASRB = Acid Stabilized Rice Bran

Table 3. Proximate composition of rice bran supplemented cookies

	Treatments	Control	5percent	10 percent	15 percent	20 percent	Means
Moisture (%)	**HSRB**	5.15	5.60	6.06	6.3	6.63	5.94 a
	ASRB	5.11	5.36	5.86	6.20	6.40	5.79 a
	Mean	5.13 b	5.48 ab	5.96 ab	6.25 ab	6.52 a	
Protein (%)	**HSRB**	10.20	11.08	11.78	12.56	13.75	11.87 a
	ASRB	10.20	11.18	11.63	12.64	13.51	11.83 a
	Mean	10.20 c	11.13 bc	11.70 bc	12.6 ab	13.63 a	
Fat (%)	**HSRB**	14.20	15.07	15.93	16.17	18.10	15.89 a
	ASRB	14.20	15.15	16.12	16.27	17.93	15.93 a
	Mean	14.20 b	15.11 ab	16.02 ab	16.22 ab	18.02 a	

All the values are means of three replications; Means carrying similar alphabets in a row or a column do not differ significantly ($p<0.05$); HSRB = Heat Stabilized Rice Bran; ASRB = Acid Stabilized Rice Bran

Table 4. Effect of rice bran substitution on mineral content of cookies

	Treatment	Control	5percent	10 percent	15 percent	20 percent	Means
Iron (mg/Kg)	**HSRB**	29.75	33.16	37.23	40.82	43.02	36.80 a
	ASRB	29.75	32.69	35.36	37.08	40.08	35.00 a
	Mean	29.75 d	32.92 cd	36.30 bc	38.95 ab	41.55 a	
Manganese (mg/Kg)	**HSRB**	4.36	5.19	6.22	7.09	8.06	6.18 a
	ASRB	4.36	5.16	6.14	7.00	8.10	6.15 a
	Mean	4.36 d	5.18 cd	6.18 bc	7.05 ab	8.08 a	
Zinc (mg/Kg)	**HSRB**	7.89	9.24	9.91	11.39	12.26	10.14 a
	ASRB	7.89	9.46	10.73	10.92	12.30	10.26 a
	Mean	7.89 d	9.35 c	10.32 b	11.16 b	12.28 a	
Calcium (mg/Kg)	**HSRB**	25.84	39.92	55.61	65.57	70.96	51.58 a
	ASRB	25.84	38.43	53.29	64.87	72.05	50.90 a
	Mean	25.84 e	39.18 d	54.45 c	65.22 b	71.51 a	
Magnesium (mg/Kg)	**HSRB**	46.780	60.64	70.29	84.43	100.11	72.45 a
	ASRB	46.780	59.22	71.11	83.26	97.96	71.67 a
	Mean	46.780 e	59.93 d	70.7 c	83.84 b	99.04 a	

All the values are means of three replications; Means carrying similar alphabets in a row or a column do not differ significantly ($p<0.05$); HSRB = Heat Stabilized Rice Bran; ASRB = Acid Stabilized Rice Bran

Table 5. Effect of rice bran substitution on the sensory properties of cookies

	Treatment	Control	5percent	10percent	15percent	20percent	Means
Color	**HSRB**	7.000	6.200	6.000	5.533	5.033	5.953 a
	ASRB	7.000	6.167	6.000	5.200	4.267	5.727 b
	Mean	7.000 a	6.184 b	6.000 b	5.367 c	4.650 d	
Texture	**HSRB**	6.000	5.500	5.767	6.533	4.933	5.747 a
	ASRB	6.000	6.200	5.533	4.533	4.267	5.307 a
	Mean	6.000 a	5.850 a	5.650 a	5.533 ab	4.599 b	
Taste	**HSRB**	5.976	5.200	5.967	5.100	4.210	5.291 a
	ASRB		5.833	5.500	4.100	3.867	5.053 b
	Mean	5.967 ab	5.517 a	5.734 ab	4.600 b	4.039 b	
Flavour	**HSRB**	6.567	6.000	5.800	5.867	4.267	5.499 a
	ASRB	6.567	5.500	5.767	4.283	4.100	5.043 b
	Mean	6.567 a	5.750 b	5.784 b	5.075 c	4.184 d	
Overall	**HSRB**	6.967	6.200	6.200	6.000	4.500	5.933 a
acceptability	**ASRB**	6.967	6.133	6.033	4.000	4.300	5.293 b
	Mean	6.967 a	6.167 b	6.117 b	5.000 c	4.400 d	

All the values are means of three replications; Means carrying similar alphabets in a row or a column do not differ significantly ($p<0.05$); HSRB = Heat Stabilized Rice Bran; ASRB = Acid Stabilized Rice Bran

Table 6. Effect of rice bran substitution on physical properties of cookies

	Treatments	Control	5percent	10 percent	15 percent	20 percent	Means
Thickness	**HSRB**	9.30	9.91	9.69	10.24	10.45	50.78 a
(cm)	**ASRB**	9.30	9.91	10.07	10.20	10.60	50.91a
	Mean	9.30 b	9.91 ab	9.88 ab	10.22 a	10.53 a	
Width	**HSRB**	52.27	51.88	50.51	49.81	49.46	50.79 a
(cm)	**ASRB**	52.27	52.49	51.17	49.46	48.95	50.91 a
	Mean	52.27 a	52.19 a	50.84 b	49.72 c	49.21 c	
Spread	**HSRB**	55.25	54.15	52.49	50.91	50.53	52.64 a
factor	**ASRB**	55.25	54.03	52.87	50.20	48.66	52.24 a
	Mean	55.25 a	54.09 b	52.68 c	50.56 d	49.60 e	

All the values are means of three replications; Means carrying similar alphabets in a row or a column do not differ significantly ($p<0.05$); HSRB = Heat Stabilized Rice Bran; ASRB = Acid Stabilized Rice Bran

percent rice bran) exhibited maximum thickness (10.53 mm) followed by T_3 (10.22 mm) and T_2 (9.88 mm) while minimum thickness (9.30 mm) was measured in T_0 (cookies with 0 percent rice bran). There was a decreasing trend in the spread ratio of cookies with the proportionate increase of supplementation. The spread factor of cookies, prepared from different treatments ranged from 49.60-55.25. The maximum value (55.25) for spread ratio was observed in T_0 (cookies with 0 percent rice bran) whereas minimum (49.60) in cookies prepared from 20 percent rice bran supplementation. Rice bran replacement up to 10-20 percent was found to be appropriate in cookies. These results are in accordance with the findings of Sharif *et al.* (2009) who reported that spread factor of rice bran supplemented cookies decreased with the increasing level of rice bran. Sharma and Chauhan (2002) also reported that physical properties of cookies like width, thickness and spread factor were affected significantly with the increase in the level of bran and also by method of stabilization. Sekhon *et al.* (1997) also reported that cookie spread progressively decreased with an increase in the level of both laboratory and commercially defatted brans.

CONCLUSION

Keeping in view the results given above it can be easily concluded that small to moderate inclusion levels of rice bran, especially in the range of 10 to 15 percent, results in acceptable baked products. The cookies prepared with rice bran improved its nutritional value therefore it is suggested that stabilized rice bran must be used in baking industry to provide value added products to consumer. Hence it is inferred from the results that supplementation of HSRB @ 10 to 15 percent is more suitable for production of rice bran supplemented cookies.

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