ORIGINAL SCIENTIFIC PAPER

Influence of Mixed Rice Bran in the Rheological Characteristics of Dough and Quality of Bread

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Summary

During the last decade the production of white bread was trend in our place but actually recently the consumers show more interest on the quality respectively for nutritive value of food products. Dietary fibers usage is positive since they are reducers of calories, cholesterol in blood, cardiovascular disease and cancer in colon; therefore they are ranking on the top ten functional foods.

Because of the fact that bread is widely consumed in our place the bread is a good dietary fiber supporter, therefore in this study we include the mixture of rice bran in the bread production. Rice bran beside dietary fibers also is rich with essential amino acids especially with lysine, high content of antioxidants, vitamins from B group and minerals.

This study provides a mixture of three fractions of the whitening of the rice bran in different proportion, by adding 10% and 15% of these mixtures in wheat flour type 500 in order to produce bread with good technological and health quality.

The results have proven that all mixtures have same rheological characteristic, although mixtures with 15% rice bran have proven poor quality. All the mixtures have optimal maximal viscosity for the actual bread production.

Breads from mixtures tagged as 2 1 M and 3 2 M, have very good specific volume and good appearance which is acceptable for the consumers while as all the special (mixed) breads have lower digestibility than the bread produced using wheat flour only.

Key words: *rice bran, dietary fiber, rheological characteristics, bread, specific volume.*

Introduction

The rice bran appear as a byproduct of the brown rice from the whitening process.

Several researchers have reported the nutritional quality of rice bran, which is composed of protein, lipids, dietary fiber, vitamins, and minerals.

From proteins containing about 37% albumins, 36% globulins, 22% glutelins and 5% prolamins (Betschart et al., 1977), where amino acid profile has been generally reported to be superior to cereal grain proteins (Farrell, 1994), respectively the protein of rice bran is relatively of high nutritional value, because it is a good source of lysine and methionine and can be an effective tool to supplement the lysine and the methionine in the deficient foods such as wheat, maize and sorghum in order to overcome the malnutrition problem prevailing among people (Dale, 1997).

From fatty acids containing about 12-18% palmitic acid, 40-50% oleic acid and 30-35% linoleic acid, which makes them represent about 90% of the fatty acids (Malekian et al., 2000). The rice bran has high dietary fiber during the first step of whitening. Dietary fibers 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; Brownlee, 2011). They contain about 9-12.8% cellulose, 8.7-11.4% 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.

Producing food with high content of fibers and with considerable level of calories and also good physical and organoleptic characteristics acceptable for consumers is big challenge for producers (Gajula, 2007).

According to Seibel (1983) adding fibers in the bread production process indicate the following technological changes: wetter and shorter dough, less tolerable dough fermentation, smaller bread volume, nonelastic bread middle, change on the smell and the taste which depends on the types of bran and flour used.

The evaluation of the sensory quality of the bread gained from the rice bran addition stabilized with a lot of fat shows that the bread is different in color and taste as well as in the symmetry and the character of the crust and the middle (Shahen, 2004). However according to (Sharif et al., 2006) highest evaluation for volume, color and appearance of the crust, porosity and color of middle, flavor and taste provides to the bread with 5% rice bran and the same was recommended for commercial production. Also other researchers (Lima et al., 2002) said that rice bran adding in wheat flour increases the mastication and hardness of breads.

Other researchers have added rice bran in yeast bread 15-30% and concluded that rice bran amount can be increased successfully up to 15% without affecting the loaf weight, height or volume (Sharp et al., 1990).

In the begging the influence of the added rice bran is estimated according to the three whitening steps, separately, in quantities of 5%, 10%, 15% and 20% in recipe, on the rheological and baking properties of the dough. The rice bran of the first and the second whitening step added by 5% in a recipe

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Table1. *Composition of mixtures of wheat flour type 500 and fraction of rice bran*

Type of mixtures	Share of wheat flour type 500 in mixtures (%)	Share of rice bran in mixtures (%)		
		I steps of whitening	II steps of whitening	III steps of whitening
1 1 M	90	2.0	3.4	4.6
2 1 M	90	2.5	1.7	5.8
3 1 M	90	2.3	3.8	3.9
4 1 M	90	3.0	2.0	5.0
1 2 M	85	3.0	5.1	7.0
2 2 M	85	3.7	2.5	8.8
3 2 M	85	3.5	5.8	5.8
4 2 M	85	4.5	3.0	7.5

gave bread with satisfactory and acceptable quality but the quality of the bread obtained with 10% of rice bran of the third whitening step was better.

In this study aiming to obtain bread which would be reacher with bran nutrients, the rice bran of the three steps of whitening are mixed and added by 10% and 15% of the wheat flour.

Materials and methods

***Raw Materials*:** The wheat flour type 500 is taken from the market. The rice bran is from the three steps of whitening and obtained of local milling factory - Zito Ko-Kocani. The rice bran have been treated thermally in a temperature of 120 ^{0}C for ten minutes also then they are cooled and sieved in sieve with dimensions of 800 μm and then they are placed in a freezer at a temperature of -18 ^{0}C until the day of the usage and all this in order to be stabilized, respectively to inactive the lipases.

Chemical ingredient analysis: The wheat flour type 500 and the rice bran of three steps of whitening have been chemical analyzed (moisture, ash, proteins, lipids, starch and acidity) according to the Regulation of methods of physical and chemical analysis for quality control of grain, milling and bakery products, pasta and quickly frozen dough (Official Journal SFRJ no. 74/1988). Soluble, insoluble and total dietary fiber content was determined according to the AACC methods. 44-15A, 46-13, 54-20. In order to analyze the rheological and bread properties of the fraction of rice bran of the three steps whitening process they have been mixed with flour type 500, Table 1.

Rheological properties: The rheological quality of the dough is determined with a Max Egger promylograph TS, which actually records the dough attitude when mixed with water and works in the same way the Brabender farinograph is working. The extensigraph and promylograph TS6 also measures the dough extensibility and resistance to the process of extension while as its viscosity is determined with Promylograph T2 VQ. The results from the Max Egger instruments were evaluated according to ISO 5530-1 (farinograph) and 5530-2 (extensigraph).

Bread making procedure and Bread quality: For the actual bread production wheat flour type 500, rice bran, yeast (*Saccharomyces cerevisiae*) 4.0%, salts 1.8%, and water, absorption according to the farinograph were used. The ingredients were mixed for 6 min in a mixer two-speed spirals, type "Mondial - Forni" (Italy). The dough was manually divided into pieces of 200 g and it was set in the fermenting rooms for 75 minute in the temperature of 30^0 C and relative humidity of 70%. The dough was baked in an electric steam oven floor type "Mondial - Forni" (Italy) at the temperature of 226 ^{0}C/20 minute. The qualitative qualities and the sensor properties of the bread were evaluated after 8 h of staying in a cool room temperature according the AACC methods (Kaluđerski et al., 1998). The average and the standard deviations were calculated using Microsoft Office Excel 2007 (Microsoft Corporation, Redmond, WA).

Results and Discussion

The data about the chemical composition of the type 500 flour and the actual fractions of the rice bran are given in Table 2. The chemical properties of the flour used are optimal for the bread production process, while as from the data covered about the rice bran fractions the mixtures have been obtained in various reports of their participation in the fractions.

Table 2. *Chemical composition of flour type 500 and fractions of rice bran, Data are presented as means of three determinations ± SD*

Chemical characteristics		Wheat flour type 500	Fractions of rice bran		
			I	II	III
Moisture (%)		13.10 (±0.125)	9.98 (±0.11)	12.73 (±0.103)	12.96 (±0.0656)
Ash (%)		0.51 (±0.0089)	9.18 (±0.04)	8.11 (±0.0141)	8.45 (±0.071)
Proteins (%)		11.47 (±0.0439)	10.50 (±0.19)	9.11 (±0.192)	8.05 (±0.055)
Lipids (%)		0.86 (±0.011)	20.01 (±0.235)	17.00 (±0.04)	16.24 (±0.168)
Starch (%)		67.31 (±0.974)	17.89 (±0.154)	19.34 (±0.151)	19.22 (±0.111)
The degree of acidity		0.84 (±0.005)	10.88 (±0.0729)	7.56 (±0.032)	6.72 (±0.045)
Dietary fiber	*Soluble dietary fiber*	-	2.03 (±0.034)	1.87 (±0.00356)	1.89 (±0.0430)
	Insoluble dietary fiber	-	22.42 (±0.116)	21.13 (±0.0046)	20.87 (±0.0779)

The fraction I contains the largest amount of ash compared with the other two fractions, also fraction I contains larger amount of protein, lipid and acidity level then the fraction II and fraction III. The starch amount increases during the three fractions. Also fraction I has larger amount of dietary fibers than the two other fractions, respectively insoluble dietary fibers have 22.42(±0.116) % for rice bran in fraction I, 21.13 (±0.0046) % fraction II and 20.87 (±0.0779) % fraction III.

Table 3. *Rheological characteristics of dough with wheat flour type 500 and mixture of rice bran*

Mixtures	Farinograms			Extensograms	Amilograms	
	Water absorption (%)	Dough development time (min)	Degree of softening (FU)	Energy (cm^2)	Max. viscosity (AU)	Stability of gelatinization (min)
Flour type 500						
Mean	57.35	2.13	82.5	74.0	455	3.65
Standard Deviation	0.05	0.176776695	5.535534	0.424264	7.071068	0.070710678
With 10% mixture of rice bran						
1 1 M	56.9	1.25	100	52.2	485	4.0
2 1 M	56.7	1.50	105	59.1	525	4.2
3 1 M	56.9	1.50	90	61.6	520	3.4
4 1 M	57.1	1.50	85	52.1	520	3.6
Mean	56.90	1.44	95.00	56.25	512.5	3.80
Standard Deviation	0.163299	0.125	9.128709	4.843208	18.48423	0.365148372
With 15% mixture of rice bran						
1 2 M	56.9	1.50	95	53.9	600	4.6
2 2 M	57.0	1.25	100	57.0	580	4.0
3 2 M	57.2	1.25	90	50.6	580	3.8
4 2 M	57.0	1.25	100	53.6	580	5.4
Mean	57.03	1.31	96.25	53.775	585	4.45
Standard Deviation	0.125831	0.125	4.787136	2.615817	10	0.718795288

In Table 3 the rheological characteristics of dough prepared with wheat flour type 500 and mixture of rice bran in different reports, in amount of 10 and 15% are given.

The dough water absorption is lower in all the mixtures than the water absorption of dough prepared using wheat flour type 500 (57.35% and standard deviation 0.05) and it is up to 56.7% for mixture tagged as 2 1 M, up to 57.2% for mixture tagged as 3 2 M, which actually overlaps with the information provided by (Delahaye et al., 2009) who used mixtures with full fatty stabilized rice bran.

The dough development time for all mixtures prepared with wheat flour type 500 and mixture of rice bran is shorter than the dough development time just with wheat flour type 500 (2.13 minute and standard deviation 0,176776695), mixtures with 10% mixture of rice bran has dough development time 1.44 minute and standard deviation 0.125, while as mixtures with 15% mixture of rice bran has dough development time 1.31 minute and standard deviation 0.125, which is in accordance with (Ghufran et al., 2009) who used 0-20% non stabilized rice bran.

The degree of softening of the dough with flour type 500 is 82.5 FU and standard deviation 3.535534, mixtures with 10% mixture of rice bran it increased to 95.0 FU but with standard deviation 9.128709, this growth continues with the addition of 15% mixture of rice bran 96.25 FU with standard deviation 4.787136, while mixture tagged as 4 1 M have the degree of softening approximate with dough of wheat flour, which is consistent with the information that came (Delahaye et al., 2009) who used mixtures with full fatty stabilized rice bran with 5% to 10% in recipe.

The energy required for dough extension from the very moment of extension until the moment of break, is equivalent to the surface under extensograph and it can be used as an indicator for the actual quality of the flour, respectively, that flour can be „strong" or „soft" (Sinani, 2009). All mixtures have lower energy than that of the wheat flour type 500 (74.0 cm^2 and standard deviation 0.424264), in mixtures with 10% mixture of rice bran the energy significantly decreased at 56.25 cm^2 and standard deviation 4.843208, that decreasement of energy continued and mixtures with 15% mixture of rice bran rice appeared with 53,775 cm^2 and standard deviation 2.615817. These results coincide with the results obtained throw following the rheological of dough prepared with flours that are produced by different degrees of milling, or dough from flours with a higher degree of milling (93%) and have less energy than dough prepared from flours with 70% milling (Aziz et al., 2006).

The maximum viscosity of suspensions of all the mixtures from wheat flour type 500 and mixture of rice bran, is higher than the maximal viscosity of only wheat flour type 500 which is 455 AU and standard deviation 7.071068, mixtures with 10% mixture of rice bran viscosity increased to 512.5 AU and standard deviation 18.48423, and mixtures with 15% mixture of rice bran viscosity increased at 585 AU and standard deviation 10.0. From the results shown we can see that all mixtures have optimal viscosity for bread production which is 450-650 AU. These results are in correlation with results obtained by (Gajula, 2007) who added wheat bran in wheat dough and showed that the maximal viscosity increased by adding wheat.

The stabilization of gelatinization is the width of amilograph curve 100 AU below the maximum and is expressed in minutes, for the majority of the mixtures it is higher, except mixtures with 10% mixture of rice bran, tagged as 3 1 M and 4 1 M which have almost the same value as the suspension of wheat flour (3.6 minutes).

In Table 4 are given the quality characteristics of free baked breads of all mixtures. According to data obtained we can conclude that all breads obtained from mixtures of rice bran have

lower efficiency than efficiency of bread with wheat flour (140.76%) which is from 134.81 to 137.81%, which means that is smaller by 2.1 - 4.2%. All breads obtained from mixtures of rice bran also have smaller volume compared with the volume of bread with wheat flour type 500 (529.8cm^3), which is 410.4 for bread tagged 4 2 M to 517.8cm^3 for bread mixture tagged 3 2 M.

Table 4. *Qualities characteristics of breads with wheat flour type 500 and mixture of rice bran*

Quality characteristics	Mixtures of wheat flour type 500 and mixture of rice bran				
	10% mixture of rice bran				
	0	1 1 M	2 1 M	3 1 M	4 1 M
Weight of bread [g]	172.5	168.5	168.1	168.6	168.1
Volume of bread [cm^3]	529.8	431.4	517.3	420.4	426.4
Height cutting bias [mm]	6.10	5.61	6.57	5.54	5.26
Width cutting bias [mm]	15.75	15.89	15.30	15.79	15.80
Specific volume [cm^3/g]	3.07	2.56	3.08	2.49	2.54
Efficiency of bread (%)	140.76	137.24	136.58	137.33	136.91
	15% mixture of rice bran				
	0	1 2 M	2 2 M	3 2 M	4 2 M
Weight of bread [g]	172.5	166.0	169.3	165.4	167.3
Volume of bread [cm^3]	529.8	470.6	428.6	517.8	410.4
Height cutting bias [mm]	6.10	5.83	5.16	6.20	5.33
Width cutting bias [mm]	15.75	16.42	16.13	15.70	16.03
Specific volume [cm^3/g]	3.07	2.83	2.53	3.13	2.45
Efficiency of bread (%)	140.76	135.04	137.04	134.81	136.18

If we see the value of specific volume of the bread we will prove that breads prepared by mixtures with 15% mixture of rice bran tagged as 3 2 M has specific volume of 3.13 cm^3/g, while the bread prepared by mixtures with 10% mixture of rice bran tagged as 2 1 M has a specific volume 3.08 cm^3/g, which shows slightly higher value than the specific volume of bread prepared with wheat flour only (3.07 cm^3/g), versus the lower values determined for bread from other mixtures, which is according with the knowledge provided by (Zhang et al., 1997) who used wheat bran and they obtained lower specific volume of bread.

From figure 1 we can see that the bread prepared with 10% mixture of rice bran tagged as 2 1 M looks very good, which includes good volume and shiny and glace crust which makes bread attractive for customers, while as the other breads prepared with 10% mixture of rice bran have not that good exterior appearance which automatically makes them not very attractive for customers. All breads prepared with 15% mixture of rice bran have bad external appearance, except bread tagged as 3 2 M, which has crust which is a little different from bread with wheat flour, but it is acceptable to consumers.

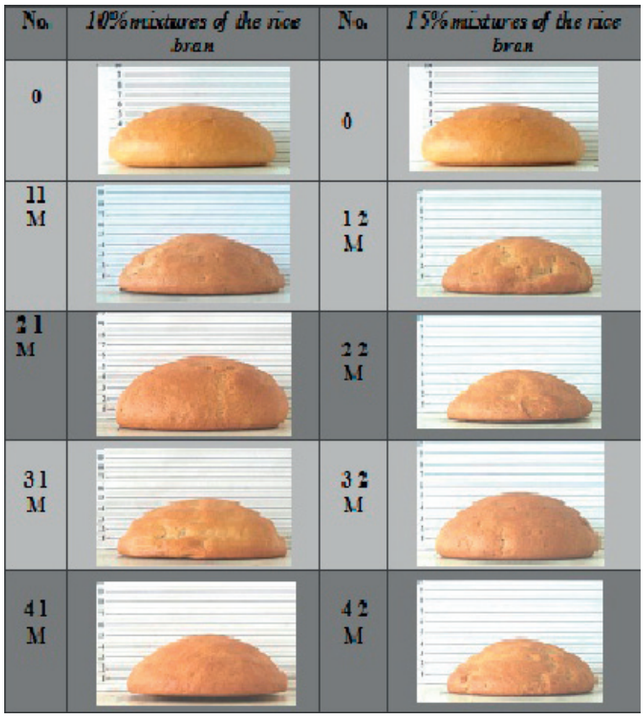

Figure 1. *Appearance of breads obtained by mixing the flour type 500 and mixture of rice bran*

In figure 2 we can see the creation or the release of reductive sugars during bread digestion in vitro with native α-amylase from saliva, expressed as mg maltose equivalents released from 1 g dry weight of bread.

From the results we can conclude that the digestibility of all special breads enriched with mixture of rice bran develops slower than bread prepared just from wheat flour. In the beginning of the process of digestion so in the first 30 minute we can notice evidently lower digestibility of all the special breads which makes it a very important fact for diabetic consumers.

Conclusion

Dough with 10% and 15% mixture of rice bran from all three whitening steps, has very similar rheological characteristics, although mixtures with 15% rice bran have generally poorer quality;

Bread prepared by mixture of rice bran does not require α amylase addition because they have optimal viscosity for bread production;

Bread made from mixtures of wheat flour with 10% mixture of rice bran tagged as 2 1 M and bread made by mixing wheat flour with15% mixture of rice bran tagged as 3 2 M, have better specific volume than bread made only with wheat flour and the external appearance is similar to that of bread only with wheat flour. Because of that only these two mixtures are acceptable for consumers;

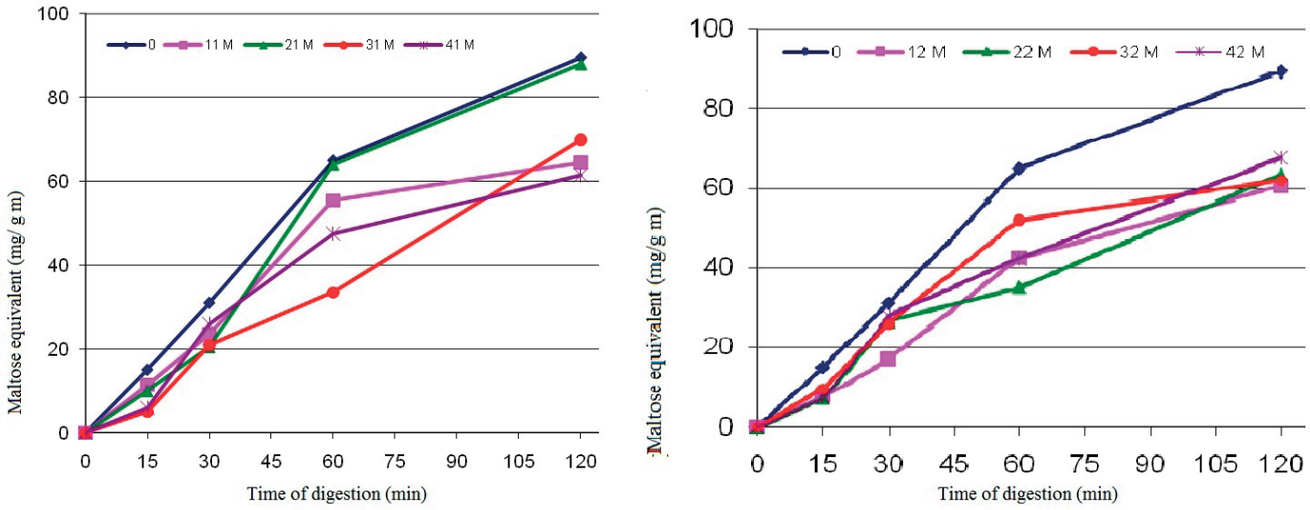

Figure 2. *Digestibility of bread prepared with wheat flour type 500 and breads prepared with mixtures of wheat flour and mixture of rice bran (a-with 10% mixture of rice bran; b-with 15% mixture of rice bran)*

Bread produced by rice bran mixtures have lower digestibility than bread made only with wheat flour. This means that they have favorable nutritional value for the consumers diagnosed with diabetics.

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