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RESEARCH PAPER

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The influence of stabilized rice bran on rheological properties of wheat flour dough

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SUMMARY :

The impact of adding 5 per cent to 20 per cent stabilized rice bran to wheat flour on the rheological behaviour of the dough was investigated using Farinograph, Extensograph and Amylograph. The parameters determined were water absorption or percentage of water required to yield dough consistency of 500 BU (Brabender Units), dough development time (DDT, time to reach maximum consistency in minutes), stability time (dough consistency remains at 500 BU), mixing tolerance index (MTI, consistency difference between height at peak and that 5 min later, BU). Results from the farinograph analysis showed that addition of rice bran to wheat flour had a marginal effect on the water absorption of flour, water absorption increased with increased addition of rice bran. The dough development time and dough stability increased with increased addition rice bran flour. The development time in dough containing 5, 10, 15 and 20 per cent rice bran increased to 5.7, 7, 6.5 and 6.2 min, respectively in comparison with the control wheat flour dough 6 min. As the proving time of wheat flour dough increased, the energy required for the extension gets decreased. Also, energy required for the extension gets decreased with increased addition of rice bran flour. As the proving time of wheat flour dough increased, the resistance to extension (BU) gets decreased. Also, resistance to extension (BU) gets decreased with increased addition of rice bran flour. As the proving time of wheat flour dough increased, the extensibility (mm) gets decreased. Also, extensibility gets decreased with increased addition of rice bran flour. The amylogram parameters give information about the viscosity generated by the gelatinization of starch. In the case of the control wheat flour used in this study, the maximum gelatinization value was very high (1622 AU). The addition of rice bran reduced it slightly, although not significantly from functional point of view.

KEY WORDS : Rheology, Stabilized rice bran, Farinograph, Extensograph, Amylograph

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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). Hot air heating or Autoclave treatment given to rice bran for its stabilization (Bagchi *et al*., 2014) and (Rosniyana *et al*., 2009), respectively. 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 and Renuka and Arumughan, 2007). 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 rheological properties of wheat flour dough which is being used for developing bakery products.

Farinograph is an instrument that can be used to understand physical properties of dough. The rheological properties of dough affect both the machinability of the dough and the quality of the end product. Farinograph is one of the most extensively used methods to measure the rheological characteristics of dough (Bloksma and Bushuk, 1988). In addition, water absorption calculation from the farinograph provides the researcher with close approximation of the optimal water addition to the flour to make the optimal dough.

The stability time and mixing tolerance index values generally give some indication of the tolerance of the dough to breakdown during mixing (AACC, 2000). Collectively, the measured farinograph properties indicate if a specific flour is classified as weak or strong. Strong gluten flour is preferred for bread making over a weak gluten flour since the gluten has structural and gas retaining properties, which ultimately is important in bread (Wang and Khan, 2009). However, flour blends may be needed to create finished products with the proper sensory and quality characteristics. Farinograph test can be completed in less than 30 minutes while full baking tests can take several hours. Therefore, the use of farinograph would allow researchers to screen more formulations that contain non-traditional ingredients in a shorter amount of time compared to a complete baking test if a correlation can be established between rheological properties and final bread quality.

EXPERIMENTAL METHODS

The research work was carried out at Department of Food Engineering, College of Food Technology, Vasantarao Naik Marathwada Krishi Vidhyapeeth in collaberation with Mahatma Phule Krishi Vidhyapeeth, Maharashtra in the year 2016. The rice bran was procured from the Shri laxmi Narsinhma Rice Mill, Secunderabad. Wheat flour and other ingredients were collected from Parbhani local market. Other required materials and machineries were 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 color 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).

Rheological characteristics of wheat flour dough prepared using stabilized rice bran:

Rheological characteristics of flour samples were determined with brabender farinograph, extensograph and amylograph according to the method number 54-21 as described in (AACC, 2000). Dough characteristics such as water absorption, dough development time, dough stability and tolerance index were interpreted from farinogram.

Farinograph :

– A flour sample of 50 or 300 g on a 14 per cent moisture basis were weighted and placed into the corresponding farinograph mixing bowl.

– Water from a burette was added to the flour and mixed to form a dough.

– As the dough was mixed, the farinograph recorded a curve on graph paper

– The amount of water added (absorption) which affected the position of the curve on the graph paper. Less water increased dough consistency and moved the curve upward.

– The curve was centered on the 500 brabender unit (BU) line ±20 BU by adding the appropriate amount of water and it was ran until the curve leaves the 500 BU line.

Extensograph :

Preparation :

– A 300 g flour sample on a 14 per cent moisture basis was combined with a salt solution and mixed in the farinograph to form dough.

– After the dough was rested for 5 min, it is mixed to maximum consistency (peak time).

Analysis :

– A 150 g sample of prepared dough was placed on the extensograph rounder and shaped into a ball.

– The ball of dough was removed from the rounder and shaped into a cylinder.

– The dough cylinder was placed into the extensograph dough cradle, secured with pins, and rested for 30 min in a controlled environment.

– A hook was drawn through the dough, stretching it downwards until it breaks.

– The extensograph recorded a curve on graph paper as the test was run.

– The same dough was shaped and stretched at 60 and 90 min and similarly the extensograph recorded a curve on graph paper as the test was run.

Amylograph :

– A sample of 80 g of flour was combined with 450 ml of distilled water and mixed to make slurry.

– The slurry was stirred while being heated in the amylograph, beginning at 30^{o}C and increasing at a constant rate of 1.5^{o} C per minute until the slurry reaches 95^{o} C.

– The amylograph recorded the resistance to stirring as a viscosity curve on graph paper.

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 % level is mentioned wherever required (Panse and Sukhatame, 1967).

EXPERIMENTAL FINDINGS AND ANALYSIS

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Rheological characteristics of wheat flour dough supplemented with stabilized rice bran :

Rheological characteristics of flour samples were determined with brabender farinograph and extensograph according to the method number 54-21 as described in (AACC, 2000).

The effect of different levels of stabilized rice bran on farinograph characteristics of dough was shown in Table 1. The parameters determined were water absorption or percentage of water required to yield dough consistency of 500 BU (Brabender Units), dough development time (DDT, time to reach maximum consistency in minutes), stability (time dough consistency remains at 500 BU), mixing tolerance index (MTI, consistency difference between height at peak and that 5 min later, BU). Results from the farinograph analysis showed that addition of rice bran to wheat flour had a marginal effect on the water absorption of flour, water absorption increased with increased addition of rice bran. The dough development time and dough stability increased with increased addition rice bran flour. The development time in dough containing 5, 10, 15 and 20 per cent rice bran increased to 5.7, 7, 6.5 and 6.2 min, respectively in comparison with the control dough 6 min. Rosell *et al.* (2001) pointed that there were many hydroxyl groups in fiber structures (such as rice bran) which caused water absorption to increase with producing hydrogen bonds (Randall *et al.*, 1985). The results of the mentioned research were similar to those of Milani *et al.* (2006) and Sudha *et al.* (2007) that examined the efficiency of pretreated rice bran addition to flour and concluded that this addition caused water absorption increase in farinogram. Similar studies using farinograph analysis on the effect of gluten, or the lack thereof, on dough consistency and strength have been reported in the literature by Taghinia *et al.* (2015); Ghufran *et al.* (2009) and Roya and Seyed (2011).

The effect of different levels of stabilized rice bran on energy (cm^2) required for extension was shown in Table 2. As the proving time of wheat flour dough increased, the energy required for the extension gets decreased. Also, energy required for the extension gets decreased with increased addition of rice bran flour. The energy (cm^2) required for extension was found maximum 98 (cm^2) in T_0 sample and minimum 34 (cm^2) in T_4 sample at 30 min. The energy (cm^2) required for extension at 60 min was found maximum 95 (cm^2) in T_0 sample and minimum 31 (cm^2) in T_4 sample. The energy (cm^2) required for extension at 90 min was found maximum 71 (cm^2) in T_0 sample and minimum 26 (cm^2) in T_4 sample. The extensograph assessments of the sample in Table 2 showed that, energy (cm^2) required for extension in a 30, 60 and 90 minute fermentation in 5, 10, 15 and 20 per cent, as compared with the control. The results obtained are in agreement with those reported by Roya and Seyed (2011).

The effect of different levels of stabilized rice bran on resistance to extension (BU) was shown in Table 3. As the proving time of wheat flour dough increased, the resistance to extension (BU) gets decreased. Also, resistance to extension (BU) gets decreased with increased addition of rice bran flour. The resistance to extension (BU) was found maximum 312 BU in T_0 sample and minimum 239 BU in T_4 sample at 30 min. The resistance

Table 1 : Effect of different levels of stabilized rice bran on farinograph characteristics of dough

Treatments	Water absorption (corrected for 500 FU) (%)	Water absorption (corrected for 14% moisture) (%)	Dough development time (min)	Dough stability (min)	Tolerance index (MTI) (BU)	Time to breakdown (min)	Farinograph quality number	Consistency (FU)
T_0	59.1	59.1	6.0	7.6	37	9.6	96	479
T_1	59.6	59.6	5.7	7.5	49	8.8	88	522
T_2	60	60	7.0	8.6	41	10.6	106	481
T_3	60.1	60.1	6.5	9.4	31	11.5	115	482
T_4	60.6	60.6	6.2	8.0	39	10.2	102	479
S.E. ±	0.0281	0.0281	0.0274	0.0346	0.149	0.032	0.282	0.383
C.D. (P=0.05)	0.0847	0.0847	0.0826	0.1043	0.448	0.096	0.851	1.152

Treatment Details are Refined Wheat Flour : Stabilized Rice Bran Proportion

T_0 - 100:00 T_1 - 95:05 T_2 - 90:10 T_3 - 85:15 T_4 - 80:20

Table 2 : Effect of different levels of stabilized rice bran on energy (cm^2) required for extension

Treatments	Proving time (min)		
	30	60	90
(Control) T_0	98	95	71
T_1	62	61	56
T_2	54	50	43
T_3	52	47	42
T_4	34	31	26
S.E. ±	0.383	0.240	0.188
C.D. (P=0.05)	1.152	0.723	0.567

to extension (BU) at 60 min was found maximum 251 BU in T_0 sample and minimum 217 BU in T_4 sample. The resistance to extension (BU) at 90 min was found maximum 240 BU in T_0 sample and minimum 182 BU in T_4 sample. The extensograph assessments of the sample in Table 3 showed that, resistance to extension (BU) in a 30, 60 and 90 minute fermentation in 5, 10, 15 and 20 per cent, as compared with the control. The results obtained are in agreement with those reported by Roya and Seyed (2011).

The effect of different levels of stabilized rice bran on extensibility (mm) was shown in Table 4. As the proving time of wheat flour dough increased, the extensibility (mm) gets decreased. Also, extensibility gets decreased with increased addition of rice bran flour. The extensibility (mm) was found maximum 173 mm in T_0 sample and minimum 106 mm in T_4 sample at 30 min. The extensibility (mm) at 60 min was found maximum 202 mm in T_0 sample and minimum 104 mm in T_4 sample. The extensibility (mm) at 90 min was found maximum 165 mm in T_0 sample and minimum 101 mm in T_4 sample. The extensograph assessments of the sample in Table 4 showed that, extensibility (mm) in a 30, 60 and 90 minute fermentation in 5, 10, 15 and 20 per cent, as compared with the control. The results obtained are in agreement with those reported by Roya and Seyed (2011).

The effect of different levels of stabilized rice bran on maximum (BU) (mm) was shown in Table 5. As the proving time of wheat flour dough increased, the maximum (BU) gets decreased. Also, extensibility gets decreased with increased addition of rice bran flour. The extensograph assessments of the sample in Table 5

Table 3 : Effect of different levels of stabilized rice bran on resistance to extension(Bu)

Treatments	Proving time (min)		
	30	60	90
(Control) T_0	312	251	240
T_1	265	246	230
T_2	273	237	218
T_3	320	252	236
T_4	239	217	182
S.E. ±	0.346	0.319	0.298
C.D. (P=0.05)	1.042	0.962	0.897

Table 4 : Effect of different levels of stabilized rice bran on extensibility (mm)

Treatments	Proving time (min)		
	30	60	90
(Control) T_0	173	202	165
T_1	151	156	143
T_2	134	143	126
T_3	117	129	125
T_4	106	104	101
S.E. ±	0.461	0.411	0.305
C.D. (P=0.05)	1.390	1.237	0.919

Table 5 : Effect of different levels of stabilized rice bran on maximum (BU)

Treatments	Proving time (min)		
	30	60	90
(Control) T_0	444	340	316
T_1	312	297	275
T_2	297	254	231
T_3	324	264	240
T_4	241	219	185
S.E. ±	0.549	0.442	0.377
C.D. (P=0.05)	1.654	1.331	1.135

showed that, maximum (BU) in a 30, 60 and 90 minute fermentation in 5, 10, 15 and 20 per cent, as compared with the control. The results obtained are in agreement with those reported by Roya and Seyed (2011).

The effect of different levels of stabilized rice bran on ratio number was shown in Table 6. As the proving time of wheat flour dough increased, the ratio number gets decreased. Also, ratio number gets decreased with increased addition of rice bran flour. The extensograph assessments of the sample in Table 6 showed that, ratio number in a 30, 60 and 90 minute fermentation in 5, 10, 15 and 20 per cent, as compared with the control. The results obtained are in agreement with those reported by Roya and Seyed (2011).

The effect of different levels of stabilized rice bran on ratio number was shown in Table 7. As the proving time of wheat flour dough increased, the ratio number gets decreased. Also, ratio number gets decreased with increased addition of rice bran flour. The extensograph assessments of the sample in Table 7 showed that, ratio number in a 30, 60 and 90 minute fermentation in 5, 10, 15 and 20 per cent, as compared with the control. The results obtained are in agreement with those reported by (Roya and Seyed, 2011).

The effect of different levels of stabilized rice bran on amylograph characteristics of dough was presented in Table 8. The amylogram parameters give information about the viscosity generated by the gelatinization of starch. The most important of these parameters is the maximum gelatinization shown in Table 8. In the case of the control wheat flour used in this study, the maximum gelatinization value was very high (1622 AU). The addition

Table 6 : Effect of different levels of stabilized rice bran on ratio number

Treatments	Proving time (min)		
	30	60	90
(Control) T_0	1.8	1.2	1.5
T_1	1.8	1.6	1.6
T_2	2.0	1.7	1.7
T_3	2.7	2.0	1.9
T_4	2.3	2.1	1.8
S.E. ±	0.0145	0.0131	0.0122
C.D. (P=0.05)	0.0436	0.0395	0.0365

Table 7 : Effect of different levels of stabilized rice bran on maximum ratio number

Treatments	Proving time (min)		
	30	60	90
(Control) T_0	2.6	1.7	1.9
T_1	2.1	1.9	1.9
T_2	2.2	1.8	1.8
T_3	2.8	2.1	2.9
T_4	2.3	2.1	1.8
S.E. ±	0.0135	0.0137	0.0159
C.D. (P=0.05)	0.0407	0.0411	0.0480

Table 8 : Effect of different levels of stabilized rice bran on amylograph characteristics of dough

Treatments	Beginning of gelatinization (^{0}C)	Gelatinization temperature (^{0}C)	Gelatinization maximum (AU)
(Control) T_0	60.1	87.8	1622
T_1	60.4	88.9	1424
T_2	60.6	89.4	1367
T_3	60.9	89.0	1382
T_4	60.9	89.8	1374
S.E. ±	0.0245	0.0670	0.3528
C.D. (P=0.05)	0.0737	0.2016	1.0619

of rice bran reduced it slightly, although not significantly from functional point of view. Results showed that temperature required for the beginning of gelatinization gets increased with increased level of stabilized rice bran flour. The lowest value of beginning of gelatinization temperature was found 60.1^{0}C for T_0 sample. The highest value of beginning of gelatinization temperature was found 60.9^{0}C for T_4 sample.

The lowest value of gelatinization temperature was found 87.8^{0}C for T_0 sample. The highest value of gelatinization temperature was found 89.8^{0}C for T_4 sample Also, gelatinization temperature gets increased with increased level of stabilized rice bran flour. Gelatinization maximum gets decreased with increased level of stabilized rice bran flour. The results are similar to those reported by Quilez *et al.* (2013).

Conclusion :

The addition of rice bran to wheat flour had a marginal effect on the water absorption of flour, water absorption increased with increased addition of rice bran. The dough development time and dough stability increased with increased addition rice bran flour. As the proving time of wheat flour dough increased, the resistance to extension (BU) gets decreased. Also, resistance to extension (BU) gets decreased with increased addition of rice bran flour. As the proving time of wheat flour dough increased, the energy required for the extension gets decreased. Also, energy required for the extension gets decreased with increased addition of rice bran flour. As the proving time of wheat flour dough increased, the extensibility (mm) gets decreased. Also, extensibility gets decreased with increased addition of rice bran flour. As the proving time of wheat flour dough increased, the ratio number gets decreased. Also, ratio number gets decreased with increased addition of rice bran flour. The addition of rice bran to wheat flour reduced the maximum gelatinization slightly, although not significantly from functional point of view. The temperature required for the beginning of gelatinization gets increased with increased level of stabilized rice bran flour. The supplementation of stabilized rice bran to wheat flour did not significantly affect the rheological qualities of wheat flour dough, hence, it is suitable to replace wheat flour with rice bran flour for new product developement.

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