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Effect of Rice Variety on Rice Based Composite Flour Bread Quality

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ABSTRACT. *This study was carried out to find the effect of incorporating widely grown popular rice varieties, namely Bg 300, Bg 352, Bg 403, Bg 94-1, Ld 356, Bw 272-6b, At 405 and At 306 in bread making at a level of 30% mixed with wheat flour. Physical dough properties (i.e. water absorption, dough development time, stability, time of breakdown and tolerance index) of composite flour were tested using the Brabender Farinograph. The bread properties tested were loaf weight, volume, specific loaf volume and crumb firmness. Sensory evaluation of bread was done using 14 trained panellists. Except the variety At 405, all the other varieties had a high amylose content (21.49±1.47 % in At 405 to 36.93±0.35 in Bg 94-1) and the protein content of rice varieties ranged from 6.84±0.02 in Bg 94-1 to 11.18±0.22 in Ld 356. Incorporation of different rice varieties at 30 % level into wheat flour had a significant ($p<0.05$) variation in physical dough properties. Water absorption value ranged from 59.67±0.58 % in Bg 94-1 to 61.33±0.58 % in Bg 352. Dough development time ranged from 3.3±0.3 min. for Bg 352 to 7.3±0.3 min. for Bw 272-6b. Rice variety Bw 272-6b incorporated blend had the highest stability with 16.3±1.3 min. Rice variety Bg 352 incorporated bread had a significantly ($p<0.05$) highest specific loaf volume (5.22±0.11 g/ml) and lowest firmness (6.52±0.30 N). Bread with high specific loaf volume and low firmness was produced with rice varieties, Bg 352, Bg 300, Bg 94-1 and At 405.The results of the sensory evaluation revealed that a single variety did not perform well in all the attributes of rice bread but the overall acceptability was high in Bg 94-1 incorporated bread. Dough development time correlated positively and significantly ($p<0.05$)with bread weight and negatively with volume and specific volume. Incorporation of rice varieties, Bg 300, Bg 352, Bg 403, Bg 94-1, Ld 356, Bw 272-6b, At 405 and At 306 at 30 % level to wheat had a significant influence on quality characteristics of bread.*

INTRODUCTION

Rice (*Oryza sativa* L.) is the staple food of Sri Lanka. Rice provides 45 % calorie and 40 % total protein requirement of an average Sri Lankan (Mendis, 2006). Sri Lanka is a rice producing country having achieved self sufficiency in rice production during 2007 & 2008. Rice is cultivated in about 900,000 ha in Sri Lanka.

The per capita consumption of rice is around 100 kg depending on the price of rice, bread and wheat flour. Per capita consumption of wheat flour is around 40 kg (Department of

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Census and Statistics, 2007). Annual importation of wheat to the country is around 900,000 tons (Central Bank, 2007). This leads to a loss of foreign exchange in large amounts from the country. Diversifying the methods of rice consumption by developing rice based products, will enable the consumers to have a wide range of products. This will also increase the demand for rice and increase the income of farmers and reduce the importation of wheat saving the loss of foreign exchange.

Rice has properties such as absence of gluten forming ability, low levels of sodium, protein and fat. It also has high amount of easily digestible carbohydrate. Since rice possess unique nutritional, hypoallergenic and bland taste, consumption by coeliac patients has been increasing (Sivaramakrishnan *et al*., 2004).

Rice protein lacks the functionality of wheat protein in producing convenient food products such as noodles, bread and other baked products. Wheat protein has the protein gluten, which forms the structure responsible for the viscoelastic properties of wheat. Gluten is the essential structure building protein, important in providing appearance and crumb structure of bakery products. The gluten matrix is a major determinant of the important rheological characteristics of dough such as elasticity, extensibility, resistance to stretch, mixing tolerance and gas holding ability (Lazaridou *et al.*, 2007).

Many attempts have been made to prepare gluten free bread using rice flour (Nishitha *et al*., 1976; Nishitha and Bean, 1979; Noomhorm *et al*., 1994; Mi *et al*., 1997; Gujral *et al*., 2003; Dhingra and Jood, 2004). A yeast leavened bread formula was developed by Nishitha *et al*., (1976) using Hydroxypropyl methyl cellulose (HPMC) as a substitute for gluten during proofing. Subsequently, Nishitha and Bean (1979) studied the physicochemical properties of rice that affect bread quality and they concluded that low amylose content, low gelatinization temperature, low amylograph viscosity of paste cooled to 50 °C, and soft eating quality of milled rice were the determinants of good bread making.

Mi *et al*., (1997) studied the interrelation of rice bread quality with the physicochemical properties of milled rice and they found that high amylose rice was the most suitable for rice bread processing, contradicting the earlier study of Nishitha and Bean (1979). Using three Thai rice varieties, Noomhorm *et al*., (1994) studied the effect of rice variety on composite bread quality and concluded that rice variety with low amylose content yielded better bread quality than bread made from high amylose rice. The studies of Perumpuli and Wijerathne (2006) indicated that, rice flour can be incorporated up to 20 % in bread making. According to earlier studies (unpublished data) in preparation of bread, a level of 30% incorporation of rice flour to wheat flour gave the best quality attributes in terms of specific loaf volume and crumb structure and maintained this level throughout the study.

There are long grain, medium grain and short grain varieties of rice available in the market. Different rice varieties exhibit compositional variation with respect to protein, lipid, starch (amylose, amylopectin), minerals and vitamins. These compositional differences contribute to the diversity of chemical and physical properties of rice such as viscosity, starch gelatinization and water absorption (Noomhorm *et al*., 1994; Juliano, 1985). Therefore, the objective of this study was to find the effect of widely grown popular rice varieties, namely Bg 300, Bg 352, Bg 403, Bg 94-1, Ld 356, Bw 272-6b, At 405 and At 306 in bread making at a level of mixing 30% with wheat flour.

MATERIALS AND METHODS

Materials

Paddy samples were collected from the Rice Research and Development Centre, Bathalagoda, Sri Lanka and its respective regional stations: Bg 300, Bg 403, Bg 94-1 and Bg 352 from Bathalagoda (Bg); At 306 and At 405 from Ambalantota (At); Bw 272-6b from Bombuwala (Bw); and Ld 356 from Labuduwa (Ld). Wheat flour used was from Prima Ceylon Ltd., (Mill Brand). Sugar, salt, instant dry yeast (Mauripan) and fat (Hyco) were purchased from the local market.

Sample preparation

The paddy was dehulled in a commercial dehuller (Type LM 24-2C, Rubber roller, Shuang Feng, China) and the brown rice was polished at a polishing rate of 10-12 % in a polisher (Model N-70, Shuang Feng, China) at a commercial grinding mill in Colombo. Rice was ground to flour using the universal milling machine (Model PE 402, Universal mill, Bauermeister, Germany) fitted with a 0.5-mm sieve attachment, at the Industrial Technology Institute (ITI).

Physicochemical analysis

Crude protein (Kjeldhal nitrogen using DK 6 Heating digester and Kjeltec Semi-automatic distillation unit, UDK 132, VELP Scientifica, Italy) of rice varieties was determined according to the AACC method (1995). Amylose content (AC) of rice was determined according to the method of Juliano (1985).

Analysis of physical dough properties

The effect of incorporating flour of different rice varieties on dough mixing properties was investigated using a Brabender Farinograph (BD 810100, Brabender, Duisburg, Germany). The study was conducted by following the AACC method. A 300 g flour blend, which contains 30 % rice flour, was used. The interpretations made from the graph were, water absorption, dough development time, stability, time of breakdown and tolerance index.

Preparation of bread

Bread was prepared using the following method. The level of 30 % rice flour incorporation to wheat flour was maintained throughout the study. Flour blend of 1kg was dry mixed with sugar (1 %, flour basis), salt (1 % flour basis), and yeast (1.5 %, flour basis) in a Hobart mixer (Model CE 100, Hobart, London, UK). Water was added to the blend according to water absorption measured by Brabender Farinograph, while mixing at speed 1. Once the dough was formed, the fat (2 %, flour basis) was mixed. Then the dough was mixed at speed 2 for 2 minutes and allowed to ferment for 45 minutes. A constant weight of dough (250 g) was scaled in the pan and allowed to proof for 60 minutes at room temperature (28 °C) and relative humidity of 75 %. This was followed by baking at 200 °C for 35 minutes in an electric oven (Model T90, Indesit, Milano, Italy). Bread was removed from the pan and cooled on a rack for one hour.

Bread properties

Bread weight and volume

The cooled loaves were immediately weighed. Loaf volume was measured by standard rapeseed displacement method (SLS 141, 1992). Specific loaf volume was calculated by dividing loaf volume by loaf weight.

Bread Firmness

Bread firmness was determined using the firmness tester (Model QB-129, LABSCO, Hanover, Germany) with a slight modification to the method of Gujral and Rosell (2004). The bread loaf was cut into slices from the middle of the loaf. The size of slice tested was 50 mm×50 mm×20 mm. The slice was kept at the bottom of the plate and compressed between parallel plates. The cross speed was 2 mm/second. Bread firmness (N) was taken as the force required for compressing the bread sample by 75 %.

Sensory analysis of bread

Sensory analysis of bread was conducted by using 14 trained panelists of the ITI. The characteristics assessed were crust colour, appearance, crumb texture, taste and overall acceptability. A nine point hedonic scale from 'like extremely' (9) to 'dislike extremely'(1) for each characteristic was used as explained by Dhingra and Jood (2004) and Lazaridou *et al*., (2007).

Statistical analysis

Analysis of Variance (ANOVA) was performed and mean separation was done at α=0.05 significance level using Fishers Least Square difference (LSD). The sensory data were analyzed using Freidman non-parametric 2 way ANOVA. Pearson correlation coefficients among parameters were also calculated. The SAS (v. 6.12) was used in the statistical data analysis.

RESULTS AND DISCUSSION

Physicochemical properties of rice

The amylose content (AC) of rice varieties (polished rice) are given in the Table 1. According to classification of amylose content by Juliano (2003), all the varieties belong to high AC rice (>25 %) except At 405 which belongs to Intermediate AC rice (20-25 %). Variety Bg 94-1 had the highest AC (36.93±0.35 %). Significant differences were observed among the AC of the rice varieties. Protein content ranged from 6.84±0.20 in Bg 94-1 to 11.18±0.22 in Ld 356. Protein content was comparatively lower in Bg varieties.

Table 1. Amylose and protein content of rice

Variety	Amylose (%, db)	Protein (%, db)
Bg 352	34.26±0.50^{b}	8.39±0.43^{c}
Bg 300	32.77±1.21^{b,c}	7.84±0.07^{d}
Bg 403	33.17±0.72^{b,c}	7.34±0.14^{e}
Bg 94-1	36.93±0.35^{a}	6.84±0.20^{f}
Ld 356	32.81±0.49^{b,c}	11.18±0.22^{a}
Bw 272-6b	32.51±1.09^{c}	9.76±0.03^{b}
At 405	21.49±1.47^{e}	8.55±0.44^{c}
At 306	28.02±0.69^{d}	10.02±0.08^{b}

Data represented as Mean±SD. Same superscripts in each column indicate that there is no significant difference in mean values at α= 0.05 signifcance level.

Dough rheological properties

The Farinograph measures and records resistance of a dough to mixing. It is used to determine the stability and other characteristics of dough during mixing. The interpretation made from Farinograph for composite flour with 30 % rice flour level to wheat flour, is given in Table 2.

Water absorption capacity

Water absorption of dough is the water to flour ratio that corresponds to the 500 Brabender units (BU) line in the Farinograph. This is generally lower than the baking or operational absorption (Stauffer, 1998). The water absorption value was 58 % for dough made out of only wheat flour, but the water absorption values were high for wheat flour and rice flour blend at 30 % levels (Table 2). Significant difference ($p<0.05$) was observed for water absorption for composite flour mixture with different varieties of rice. Rice variety Bg 352 incorporated dough had the highest value for water absorption. Water absorption value ranged from 59.67±0.58% in Bg 94-1 to 61.33±0.58% in Bg 352. This may be due to increased level of damaged starch content, which is the most important fraction in the flour, the improving water absorption. The relative water uptakes for the flour components are 0.44 g/g for granular starch, 2.0 g/g for damaged starch, 1.3 g/g for protein and 7 g/g for pentosans (Stauffer, 1998).

Dough development time (DDT)

Dough development time is the time taken from the start of mixing to the point of maximum viscosity just before the curve starts to weaken. During this stage of mixing the flour water mixture is converted from a thick viscous mass to a smooth viscoelastic mass. The dough development is related to changes occurring in gluten protein (Appolonia and Kunerth, 1994). DDT for wheat flour is 2.3 minutes. All the rice flour blends had higher values than wheat for DDT which ranged from 3.3±0.3 min. for Bg 352 to 7.3±0.3 min. for Bw 272-6b. Flour blend with Bg 352 had the lowest value for DDT.

Stability

Stability is the time difference between the point where the top of the curve first intersects the 500 BU line and the point where the top of curve leaves the 500 BU line. This gives a measure of tolerance of flour to mixing and the cohesiveness and elasticity of the dough (Appolonia and Kunerth, 1994). The stability time for wheat flour was around 7.5 minutes. The entire rice flour incorporated blend had the higher values for stability. Stability time was significantly different among the varieties. Stability was lowest for At 405, which is close to the wheat flour reading. Bw 272-6b incorporated blend had the highest stability with 16.3±1.3 min.

Table 2. Physical properties of dough with different varieties of rice

Variety	Water absorption (%)	Dough development time (min)	Stability (min)	Time of breakdown (min)	Tolerance index (BU)
Bg 352	61.33 ± 0.58^{a}	3.3 ± 0.3^{e}	11.7 ± 0.3^{d}	14.8 ± 0.3^{e}	18.3 ± 2.9^{a}
Bg 300	$60.33\pm0.58^{b,c}$	$3.7\pm0.3^{d,e}$	$12.5\pm0.5^{c,d}$	16.3 ± 0.6^{d}	10.7 ± 1.2^{b}
Bg 403	$60.67\pm0.58^{a,b}$	5.0 ± 0.5^{b}	13.0 ± 1.0^{c}	17.5 ± 1.0^{c}	5.7 ± 1.2^{c}
Bg 94-1	59.67 ± 0.58^{c}	$4.2\pm0.3^{c,d}$	$12.3\pm0.3^{c,d}$	$16.5\pm0.5^{c,d}$	9.7 ± 0.6^{b}
Ld 356	60.16 ± 0.29^{b}	4.8 ± 0.3^{b}	14.8 ± 0.8^{b}	20.7 ± 1.2^{b}	5.3 ± 0.6^{c}
Bw 272-6b	$60.67\pm0.58^{a,b}$	7.3 ± 0.3^{a}	16.3 ± 1.3^{a}	22.8 ± 0.8^{a}	$8.3\pm2.9^{b,c}$
At 405	$60.67\pm0.58^{a,b}$	3.5 ± 0.5^{e}	8.5 ± 0.5^{e}	10.8 ± 0.3^{f}	21.7 ± 2.9^{a}
At 306	$59.83\pm0.28^{b,c}$	$4.7\pm0.3^{b,c}$	$11.8\pm0.3^{c,d}$	16.3 ± 0.3^{d}	$6.7\pm2.9^{b,c}$

Data represented as Mean±SD. Same superscripts in each column indicate that there is no significant difference in mean values at α= 0.05 signifcance level.

Time of breakdown

Time of breakdown is the time from the start of mixing to the time at which the consistency has decreased by 30 BU from the peak point. If mixing continues after peak development is reached, the dough becomes softer and less resistant to mixing action. This leads to loss of its ability to retain gases during proofing. The mechanism of breakdown is related to the destruction of laminar fibril structure (Stauffer, 1998). Time of breakdown ranged from 10.8±0.3 min. for At 405 to 22.8±0.8 min. for Bw 272-6b.

Tolerance index

Tolerance index is the difference in BU from the top of curve at peak to the top of curve measured at 5 minutes after peak is reached. Tolerance index ranged from 5.3±0.6 min. for Ld 356 to 21.7 ±2.6 min. for At 405.

Quality characteristics of bread

Loaf weight

Loaf weight was highest in the blend incorporated with rice variety Bw 272-6b. No significant differences (at α= 0.05) for loaf weight was observed among Bg 403, Bg 94-1, Bg 352, Ld 356 and Bw 272-6b (Table 3). Increase in loaf weight indicates that the extra amount of water was retained in the bread after baking. The increase in loaf weight might be due to less retention of gas in the blended dough, hence providing denser bread texture (Dhingra and Jood, 2004).

Loaf volume

A significant ($p<0.05$) reduction of loaf volume was observed with the substitution of different rice varieties into loaf blends (Table 3). Loaf volume was highest ($P<0.05$) for Bg 352 compared to other varieties. Blend incorporated with Bw 272-6b had the lowest value for loaf volume. In wheat, the gluten network is formed due to disulfide bonds between thiol groups of high molecular weight glutelins. The substitution of rice flour in wheat creates a different bond between rice proteins due to the presence of low molecular weight thiols, especially reduced glutathione, which activates proteolytic enzymes, thereby causing a detrimental effect on loaf volume (Dhingra and Jood, 2004). Increasing levels of fat have been reported to improve the volume of wheat flour bread (Gujral and Singh, 1999).

Table 3. Quality characteristics of bread

Variety	Loaf weight (g)	Loaf volume (ml)	Specific loaf volume (g/ml)	Crumb firmness (F)
Bg 352	211.40 ± 2.07^{a}	1104.08 ± 24.97^{a}	5.22 ± 0.11^{a}	6.52 ± 0.30^{d}
Bg 300	205.53 ± 0.96^{b}	1011.53 ± 13.97^{b}	4.92 ± 0.09^{b}	7.97 ± 0.66^{b}
Bg 403	212.23 ± 0.95^{a}	$900.39\pm4.61^{d,e}$	4.24 ± 0.04^{e}	7.45 ± 0.63^{c}
Bg 94-1	210.80 ± 0.35^{a}	1009.38 ± 7.26^{b}	4.79 ± 0.04^{c}	7.47 ± 0.22^{c}
Ld 356	211.40 ± 1.20^{a}	923.42 ± 17.33^{d}	4.37 ± 0.06^{d}	8.87 ± 0.67^{a}
Bw 272-6b	212.33 ± 1.33^{a}	890.04 ± 7.95^{e}	4.19 ± 0.06^{e}	8.25 ± 0.37^{b}
At 405	206.13 ± 0.47^{b}	$988.68\pm6.64^{b,c}$	4.79 ± 0.02^{c}	6.67 ± 0.54^{d}
At 306	207.33 ± 0.57^{b}	979.43 ± 19.76^{c}	4.72 ± 0.10^{c}	7.43 ± 0.43^{c}

Data represented as Mean±SD. Same superscripts in each column indicate that there is no significant difference in mean values at $\alpha= 0.05$ signifcance level.

Specific loaf volume (SLV)

SLV gives the volume of bread loaf per gram weight. According to SLSI standard (SLS 141, 1992) the SLV (volume/mass ratio) of white bread should be above 2.5. SLV for bread loaves incorporated with rice varieties were above 2.5 (Table 3). SLV was significantly ($p<0.05$) higher for bread incorporated with the rice variety Bg 352. Loaves incorporated with Bw 272-6b gave the lowest value for SLV. There was no significant difference in SLV observed for loaves incorporated with rice varieties At 405, Bg 94-1 and At 306.

Crumb firmness

Firmness measures the crumb hardness of loaf bread. Crumb firmness values significantly ($p<0.05$) differed among different rice varieties (Table 3). The firmness was high for Ld 356 (8.87±0.67 N) and low in Bg 352 (6.52±0.30 N). Lowest crumb firmness in rice variety Bg 352 incorporated bread might be due to high SLV. Gujral *et al.*, (2003) reported that the crumb firmness showed a negative correlation with SLV.

Sensory characteristics of bread

The blending of wheat flour with different rice varieties altered the sensory characteristics of bread. The mean data on crust colour, appearance, crumb texture, taste and overall acceptability are presented in Table 4.

Crust colour

Significant differences ($p<0.05$) for crust colour were observed among the loaves incorporated with different rice varieties. The crust colour varied from creamy white to dull brown. Most panellists preferred the crust colour of bread blended with Ld 356, which was a red (red pericarp) rice variety. The panel members' judgement on the crust colour ranged from "like slightly" to "like very much". The crust colour is attributed to the Maillard reaction between reducing sugars and proteins. The reaction commences at temperatures above 150 °C. These reactions also produce the bread flavour and aroma of baking (Wiggins, 1998).

Appearance

Hosney (1994) suggested that the appearance of bread was an important sensory characteristic on which the acceptability of bread depends. External appearance of bread indicates the bread characteristics such as surface finish, size and shape. Bread made with a blend of rice variety Bg 94-1 and wheat flour had the highest value for appearance. The appearance of bread incorporated with Bw 272-6b was least preferred by the panellists and the judgment was neither 'like' nor 'dislike'. This might be due to the low volume of bread compared to the others. The appearance of bread was influenced by the variety of rice incorporated in wheat flour for bread preparation.

Table 4. Sensory characteristics of bread

Variety	Crust colour	Appearance	Crumb texture	Taste	Overall acceptability
Bg 352	$6.1^{c,d}$	6.6^{b}	7.5^{a}	$7.4^{a,b}$	$6.7^{c,d}$
Bg 300	$6.7^{b,c,d}$	$7.4^{a,b}$	$7.3^{a,b}$	6.9^{b}	$7.3^{a,b,c}$
Bg 403	$7.0^{b,c,d}$	6.6^{b}	7.4^{a}	$7.1^{a,b}$	$7.0^{b,c}$
Bg 94-1	$7.5^{a,b}$	8.1^{a}	7.6^{a}	7.7^{a}	7.7^{a}
Ld 356	8.0^{a}	$7.5^{a,b}$	$7.0^{a,b}$	$7.1^{a,b}$	$7.4^{a,b,c}$
Bw 272-6b	6.0^{d}	5.4^{c}	6.6^{b}	$7.5^{a,b}$	6.2^{d}
At 405	$6.4^{c,d}$	6.6^{b}	$7.2^{a,b}$	$7.2^{a,b}$	$7.1^{a,b,c}$
At 306	$7.1^{a,b,c}$	$7.5^{a,b}$	7.6^{a}	$7.4^{a,b}$	$7.4^{a,b}$

Means with similar superscripts within a column are not significantly different at $\alpha= 0.05$

Crumb texture

The texture of bread crumbs depends on its mechanical properties such as firmness or softness and resiliency. The crumb texture has attracted most attention in bread assessment because of the close association with human perception of freshness (Cauvain, 1998). The panellists' scores for crumb texture ranged between "like moderately" and "like very much". Bread incorporated with rice varieties Bg 94-1 and At 306 had the highest score for crumb texture. Rice variety Bw 272-6b had the lowest value ($P<0.05$) for texture, which means crumb was harder than all the other loaves.

Taste

The sensory panellists had judged the taste of the bread sample as "like moderately" to "like very much". The taste of bread with rice variety Bg 94-1 was the most preferred than all the other varieties. The variation among the taste scores of bread samples occurs due to interaction between the flavour and chewing quality of bread samples. The scores were more related to the studies of Noomhorm *et al*., (1994), where they reported that the rice variety had influenced the taste scores of bread samples.

Overall Acceptability

The data on the sensory evaluation for overall acceptability shows that the bread with variety Bg 94-1 had the higher value for overall acceptability. Bread with Bw 272-6b had the lowest overall acceptability and had the lowest volume. There was not much variation observed among other varieties.

Relationship of physicochemical properties of rice and functional properties of dough with composite flour bread quality

Correlation analysis of physicochemical properties of rice and Farinograph dough properties with the bread quality characteristics were examined. Pearson correlation coefficients are summarized in Table 5.

Table 5. Correlation coefficients of physicochemical properties of rice and dough properties with bread quality

	Loaf weight	Loaf volume	Specific loaf volume	Crumb firmness
Amylose	0.563*	0.133	-0.006	-0.435*
Protein	0.083	-0.318	-0.314	0.000
DDT	0.497*	-0.766*	-0.805*	-0.044
Stability	0.607*	-0.552*	-0.623*	-0.587*
Time of break	0.584*	-0.625*	-0.687*	-0.526*
Tolerance	-0.302	0.615*	0.627*	0.514*

*Significant at $p<0.05$

Amylose content of rice correlated positively ($p<0.05$) with bread weight and correlated negatively with crumb firmness ($p<0.05$). Dough development time (DDT) correlated positively and significantly ($p<0.05$) with bread weight and negatively with volume and specific volume. Stability and time of break down showed a positive correlation with bread weight and negative correlation with volume, specific volume and firmness. Tolerance index showed a positive correlation with bread volume, specific volume and firmness.

CONCLUSIONS

Incorporation of different rice varieties, namely Bg 300, Bg 352, Bg 403, Bg 94-1, Ld 356, Bw 272-6b, At 405 and At 306 at 30 % level into wheat flour had a variation in functional properties of dough, bread quality characteristics and sensory attributes of composite flour bread. Bread with high specific loaf volume and low crumb firmness were produced with rice varieties, Bg 352, Bg 300, Bg 94-1, and At 405.

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