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Rheological profile and quality assessment of cereal Brans enriched buns, pizza base and flatbread

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Abstract
Cereal bran, a functional by-product obtained from cereal industries is a rich source of proteins, vitamins, minerals, dietary fiber and bioactive compounds. In this study, physicochemical and rheological analysis of wheat bran (WB), oat bran (OB) and rice bran (RB) were evaluated and their utilization in the preparation of baked products viz., buns, pizza base and flat bread were studied. Baked products are considered as an excellent vehicle for fortification, value addition and feeding at mass scale. The effect of incorporation of cereals brans- WQ, OB and RB singly or in combination at varying levels (5, 10 and 15%) on the quality characteristics of baked products viz., buns, pizza base and flatbread including Loaf weight, Loaf volume, color, texture and overall acceptability were evaluated. On the basis of quality characteristics no significant difference was observed between the buns and pizza base prepared with 10 per cent supplementation of WB and OB whereas 5 per cent for RB and bran in combination respectively when compared with control with no cereal bran. Results reveals that cereal bran can be used as functional food ingredient being rich source of vitamins, minerals, dietary fiber and bioactive compounds in baked products at a level 5-10 per cent.

Keywords: Bran, farinograph, dietary fiber, buns, pizza base, flatbread

Introduction
In recent years, there has been a growing interest in the fiber rich food in the human diet due to their potential health benefits (Kamran *et al*., 2008) [17]. Cereal bran is one of the best source of dietary fiber in human diet, but they are being removed during processing like milling, debraning, polishing etc. Dietary fiber is defined the fraction of food that escapes digestion in small intestine and gets ferment by colon and thereby prevents arthrosclerosis, cardiovascular heart diseases (CHD), type 2 diabetes, obesity and improving laxation (Yadav *et al*., 2010) [41]. Other than dietary fiber cereal bran also contains proteins, vitamins (B-vitamins), minerals, dietary fiber and bioactive compounds viz., phenolics, inositol hexaphosphate, flavonoids, anthocyanin, carotenoids, tocols, glutathione etc. (Reisinger *et al*., 2013) [29]. Bioactives present in bran posses antioxidant, anticancerous, antimicrobial, anti-mutagenic, anti-diarrheal, and wound healing activity. Therefore, enrichment of food products with bran is the need of an hour due to change in the lifestyle and need of the consumers. Now a day's consumers are demanding healthy food and bakery products are considered as an excellent vehicle to serve the healthy and value added product to the mass due to their convenience, unique taste and ready availability. India's bakery and cereal market is worth $1 billion, the 3rd largest in Asia pacific after Japan and Australia. Bran can be added back to the food products for the preparation functional and nutraceutical food (Chen, *et al*., 2013) [7]. Bran contributes a pleasing sweet, nutty flavour when added as a flour replacement in baked products and pasta. Wheat bran (WB), oat bran (OB) and rice bran (RB) are used in this study are good source of both soluble and insoluble dietary fiber, esp. oat and rice bran are rich in β-glucan and oryzanol respectively. Several products rich in fiber are successfully developed and available in market like fiber rich snacks (Sarojini and Maya, 1998) [32], bread (Anette *et al*., 2004) [4], meatballs (Waszkowiak *et al*., 2001) [40], cakes (Lee *et al*., 2004) [22], biscuits and chapaties (Ghufran Saeed *et al*., 2009) [13].

Still some of the areas are left therefore, in present study WB, OB, RB were incorporated singly or in combination in the preparation of commonly eaten bakery products buns, pizza base and flatbread and effect of these brans on the quality characteristics were studied.

Material and Methods

Raw materials

Refined wheat flour (RWF) and oat bran (OB) (Baggry's) were purchased from the local market, Ludhiana, Punjab, India. Wheat bran (WB) was collected from Ludhiana Flour Mill, Ludhiana whereas rice bran (RB) was obtained from A.P. Solvex Pvt. Ltd., Dhuri, Punjab, India. The brans were subjected to dry heat treatment at 110°C for 25 min to inactivate enzymes. Wheat flour and heat treated brans were packed in a air tight container at room temperature (25°C) for further analysis. Other raw material such as vegetables, yeast, salt, spices were purchased from local market, Ludhiana, Punjab, India.

Preparation of blends

Data in Table 1 shows the brans used in the present study with their respective levels. The brans were mixed thoroughly with refined wheat flour by sieving them thrice.

Table 1: Bran addition level

Brans	Levels (%)
Wheat Bran	5
	10
	15
Oat Bran	5
	10
	15
Rice Bran	5
	10
	15
Combination	5 (WB:OB:RB- 2:1.5:1.5)
	10 (WB:OB:RB- 4:3:3)
	15 (WB:OB:RB- 6:4.5:4.5)

Proximate Composition

Proximate composition of blended flour samples were determined using standard AACC methods (2000) [1]. Moisture content was determined by hot air oven method, crude protein by Macro-Kjeldahl, ash by dry ashing method, fat by Soxtec (Foss), fiber using Fibertec (Foss), carbohydrate using difference method and dietary fiber by extracting with neutral detergent solution as prescribed by Robertson and Van Soest (1981)[30]. The amount of carbohydrate present was calculated by difference method.

Rheological Properties

Pasting Profile

The pasting profile of the blended flour samples were analysed using Rapid Visco Analyzer (RVA) model starch Master (Newport Scientific, Warrie Wood, Australia) as per Reddy *et al*., 2016 [28]. The slurry was prepared using 3.0 g of sample with 25 ml distilled water in a canister and mixed properly using paddle. Then, it was allowed to heat 50 °C with continuous stirring for 15s and held for 1 min. The temperature were further elevated to 95°C (heating rate 6 °C/min) for 7.5 min and held for 4.8 min and finally the system is cooled down to 50 °C (Cooling rate 6 °C/min).

Farinographic Properties

Constant flour method (50g, 14% mb) of (AACC 2000) was followed. The curve was centered on 500 BU line using pre determined farinograph water absorption. The dough was initially mixed for 5 mins. The curve was interpreted for farinographic water absorption, dough development time, mixing tolerance index, dough stability and time to break down.

Product preparation

i) ***Bun*****:** The buns were prepared with the bran enrich flour and the recipe for bun preparation along with the ingredient is: 100 g RWF and bran blends, 2.5 g yeast, 50 ml water, 1-5 g salt, 0.5 g lemon essecence, 15 g sugar, 4 g skim milk powder and 12 g shortening were mixed together to form a dough. The dough was allowed to ferment for 1 hour and knock back punching was done and dough was allowed to relax for 30 min. Then, dough was divided into balls to form the buns shape and placed in pre-greased pan, proofing was done for 30 min and then buns was baked at 210 ^{0}C, 25 min. After that buns were cooled at room temperature and packed in LDPE for further analysis. Buns prepared with RWF were served as control.

ii) ***Pizza base*****:** The pizza base were prepared with the bran enriched flour and the recipe for pizza base preparation along with the ingredient is: 100 g RWF and bran blends, 2.5 g yeast, 60 ml water, 2 g salt, 4 g sugar and 4 g shortening were mixed to form dough. The dough was allowed to ferment for 30 min and knock back punching was done to equilibrate the gas released by enzyme action and dough was allowed to relax for 15 min. The dough was divided and shaped; proofing was done for 10 min and baking was done at 240 ^{0}C for 3 min. After that pizza base were cooled at room temperature and packed in LDPE for further analysis. Pizza base prepared with RWF were served as control.

iii) ***Flatbread*****:** The Flatbread were prepared with the bran enriched flour and the recipe for flat bread preparation along with the ingredient is: 100 g RWF and bran blends, 1g yeast, optimum water and 1g salt was mixed to form a dough. The dough was allowed to ferment for 45 min. After that dough was sheeted and shaped and allowed for proofing for 15 min and then it was baked at 300 ^{0}C for 4 min. After that flatbread were cooled at room temperature and packed in LDPE for further analysis. Flatbread prepared with RWF was served as control.

Quality characteristics of baked products

Loaf Weight

The loaf weight of baked products was measured by using standard weighing balance with 200 mg accuracy.

Loaf Volume

It was measured by rapeseed displacement method.

Color

Color analysis of buns, pizza base and flat bread was done using Hunter Color Lab Calorimeter (D-25, Hunter Associated Laboratory, USA) and the results were expressed in terms of L*, a* and b*. The –L* represent lightness of the sample, +L* represent darkness of the sample whereas -a* represent greenness to +a* represents redness and –b* represent blueness to +b* represents yellowness of the sample. The readings were recorded in triplicate and the mean was calculated.

Texture

Texture analysis of buns, pizza base and flat bread was done using Texture Analyser (TA-Hdi, stable Micro System, England). The analyser pre-tested speed was set at 5 mm/s, test speed at 1 mm/s and post-test speed at 10 mm/s, at a distance of 10 mm with 12.5 pps data acquisition rate with 50 kg load cell. For analysis P75 probe was used to study the hardness (maximum force), gumminess, chewiness, springiness and cohesiveness. The readings were recorded in triplicate and mean was calculated.

Sensory Evaluation

To assess the quality and overall acceptability of the buns, pizza base and flat bread, sensory evaluation was done by semi-trained panelist from the Department of Food Science and Technology, Punjab Agricultural University, Ludhiana for appearance, color, flavour and texture with the help of 9-point hedonic scale (Larmond 1970)[21].

Statistical Analysis

Analytical determination was carried out in triplicates for flour, bran, buns, pizza base and flat bread and mean were calculated. The data was subjected for statistical analysis with the help of factorial completely randomized design. The least significant difference (LSD) ($p \leq 0.05$) was used to analyze the significant difference between the mean values of the samples using IBM SPSS software, version 16.0. (SPSS, New York).

Results and Discussion

Proximate Composition

Crude protein, ash, fat carbohydrates and dietary fibers of RWF, WB, OB and RB are depicted in Table 2. It is clear from the table that the composition of RWF and bran differ differ significantly ($p < 0.05$) with each other. The cereal brans were found to contain more amount of crude protein than the RWF. The mean values of crude protein of cereal brans ranged from 9.40 to 15.08 per cent, the highest value being observed in OB (15.08%) followed by RB (11.83%) and WB (9.40%). The crude protein content of RWF was found to be lowest i.e., 8.60%. Hahn *et al.,* (1990) [15] also reported the same results. They found that OB contains 15.03 per cent crude protein. Singh *et al* (1995) [36] recorded 12.5 per cent protein in unstablized RB. The ash content of cereal brans ranged between 1.45-6.72 per cent. RB showed highest value for ash content (6.72%), followed by WB (4.06%) and OB (1.45%). RWF on the other hand, found to contain low level of ash content (0.60%) than cereal brans due to refining process. The higher ash content of RB was may be due to the presence of higher percentage of phosphorus and resistant starch content in their starches (Reddy *et al.*, 2014; Singh *et al*., 2003) [27, 37]. Cereal brans, particularly, OB and RB were found to contain high amount of fat 19.31 and 10.59 per cent respectively. The fat content of wheat flour was found to be 2.2 per cent whereas wheat bran contained 4.07 per cent fat, about 47 per cent more than the wheat flour. The high fat content of cereal bran may lead to quality deterioration of brans and hence their stabilization is prerequisite. According to Slavin and Lampe (1992) [38], fat content of rice bran varied from 16-22 per cent. Whole grain cereals are considered as good sources of dietary fiber and other nutrient like vitamins, minerals, bioactives (Gani *et al*., 2012) [12]. Refining decreases the dietary fiber and nutrients in the refined flour and concentrates it in the bran portion. In our study, highest amount of dietary fibers was found in RB (38.9%) followed by WB (33.4%). Wheat flour contained 9.8 per cent dietary fibers. Oat bran had a least value for dietary fiber (14.0%) amongst all the cereal brans. Delahaye *et al* (2002) [9] reported that dietary fiber content in rice bran was ranging from 38 to 47 per cent. Flour had higher percent of carbohydrate (73.80%) as compared to cereal bran i.e., WB (60.52%), OB (55.62%) and RB (36.63%). The extent of carbohydrate in any food product has inverse relation with fiber present (James and Mark, 2010)[16]. This statement is very well justified by our results obtained. Cereal brans being concentrated source of fiber yield less carbohydrate.

Table 2: Proximate composition* of the raw materials

Sample	Crude protein (%)	Ash (%)	Fat (%)	Carbohydrate (%)	Dietary Fiber (%)
RWF	8.60	0.60	2.20	73.80	9.80
WB	9.40	4.06	4.07	60.52	33.40
OB	15.08	1.45	10.59	55.62	14.00
RB	11.83	6.72	19.31	36.63	38.90
LSD (p < 0.05)	0.12	0.13	0.16	0.31	0.21

*Expressed at 14% moisture basis

Rheological Properties

Pasting profile of the flour blend

Pasting properties are mainly depends on the source, size of starch granule, structure of amylose and amylopectin, ratio of amylose to amylopectin and interaction between the food components (Reddy *et al*., 2014) [27]. In order to study the pasting profile sample were subjected to thermal process in presence of water, which results in swelling of starch granules and viscosity increased gradually. Pasting profile of cereal bran blends are depicted in Table 3. Significant variation was found between the RWF and flour blend. It is clear from the table that all the parameters like pasting temperature, Peak, Hold, Final, Breakdown and Setback viscosity of RWF were found to be significantly higher than the flour blends due to the presence of bran which slightly interferes with the pasting properties of the flour and it has inverse relation with the concentration of bran. The high pasting temperature signifies more amylose or starch content that is resistant to swelling and rupturing. Peak viscosity indicates the water holding capacity of the flour which found to be slightly higher for RWF. Final Viscosity indicates the retrogradation behaviour after cooling which is higher for RWF then flour blends. Breakdown viscosity indicates the degradation of starch granules due to continuous shearing at high temperature (Ahmad *et al*., 2016) [2]. In our study, breakdown viscosity is higher for RWF which is due to the high content of starch in the RWF than flour blends. Set back viscosity depicts the reorientation of the starch molecules and it was found to be higher for RWF which is due to the more of amylose in the RWF than flour blend. Amylose molecules reorient more readily than amylopectin results in more retrogradation (Shafi *et al*., 2016) [34].

Table 3: Effect of cereal bran supplementation on the pasting properties of the Flour blend

Cereal bran and Supplementation levels (%)	Paste Temp. (°C)	Peak Viscosity (cp)	Hold Viscosity (cp)	Final Viscosity (cp)	Breakdown Viscosity (cp)	Set back viscosity (cp)
Wheat Bran						
0	92.8	2217	1447	2858	770	1411
5	95.7	1653	1083	2424	600	1341
10	94.7	1562	1030	2049	532	1019
15	92.2	1538	1010	1948	528	938
Mean	93.8	1742.5	816.8	2312.3	607.5	1177.2
Oat Bran						
0	92.8	2217	1447	2858	770	1411
5	93.6	1736	1320	2448	463	1128
10	91.1	1783	1281	2285	455	1004
15	91.1	1683	1256	2188	427	932
Mean	92.1	1854.8	1326	2444.7	528.7	1118.7
Rice Bran						
0	92.8	2217	1447	2858	770	1411
5	94.5	1640	1054	2439	586	1385
10	94.6	1411	927	2302	484	1375
15	94.8	1136	796	2106	340	1310
Mean	94.2	1601.1	1056	2426.2	545	1370.2
Combination**						
0	92.8	2217	1447	2858	770	1411
5	95.5	1326	934	1779	415	906
10	91.5	1281	869	1775	392	848
15	91.5	1198	839	1669	359	845
Mean	92.8	1505.5	1022.2	2020.2	484	100.2
LSD (p<0.05)	1.0	9.1	11.2	13.2	11.6	23.3

**5% - -2% wheat bran; 1.5% Rice bran; 1.5% Oat bran
10%-- 4%wheat bran; 3% Rice bran; 3 % Oat bran
15%--6% wheatbran; 4.5% Ricebran; 4.5% Oat bran

Farinographic properties

Water absorption of wheat flour and flour blends increased with increase in level of brans. Maximum water absorption was observed in WB blends, followed by OB, RB and brans in combination (Table 4). Highest water absorption was found at 15 per cent level of bran incorporation, which can be attributed with the increased fiber. Pomeranz *et al* (1997) [25] and Chen *et al* (1988) [6] also reported that there was significant increase in farinographic water absorption by addition of fibre source. Dough development time (DDT) was observed to be more as the concentration of bran increases and it was found highest for 15 per cent of bran incorporation. Mean data for DDT showed less variation among the blends and ranges between 3 to 5 min. DDT has direct relationship with the water absorption indicating that bran particles required more time to hydrate and for the development of gluten and hence dough development time. Blending of brans resulted in increase in dough stability time as percentage of bran increased in relation to control having stability of 1.50 minutes. Mean stability time for all brans lies between 2 to 3 mins. Increase in dough stability time is due to the reason that fibre provides strength to develop gluten and make it resistant to mechanical damage (Chen *et al* 1988) [6]. Mixing tolerance index decreased with increase in bran per cent. Minimum mixing tolerance index was observed at 15 per cent level of incorporation. This change may be attributed to the dilution in the gluten content of flour by addition of fibre. Higher mixing tolerance index was observed for rice bran. According to Kulp (1972) [19] dough stability is dependant not only on the quality of gluten but is also affected by gluten starch interaction.

Table 4: Effect of cereal bran supplementation on the farinographic properties of Flour blends

Cereal brans and supplementation level (%)	Water absorption (%)	Dough Development Time (min.)	Dough stability time (min.)	Mixing tolerance index (BU)
Wheat Bran				
0	50.6	1.6	1.5	60
5	55.8	3.3	2.0	43
10	59.6	4.0	3.5	30
15	60.2	4.3	4.0	27
Mean	56.5	3.3	2.7	40
Oat Bran				
0	50.6	1.6	1.5	60
5	54.8	2.3	2.0	32
10	56.0	5.8	2.3	25
15	57.8	7.5	3.0	13
Mean	54.8	4.3	2.2	32.5
Rice Bran				
0	50.6	1.6	1.5	60

5	55.4	3.0	2.5	35
10	55.6	3.3	3.0	35
15	55.8	4.3	3.5	37
Mean	54.3	3.0	2.6	41.7
Combination**				
0	50.6	1.6	1.50	60
5	54.8	3.3	2.0	48
10	55.0	3.3	2.0	25
15	55.6	4.1	2.5	25
Mean	54.0	3.08	2.0	39.5
LSD ($p < 0.05$)	0.19	0.16	0.16	1.1

**5% - -2% wheat bran; 1.5% Rice bran; 1.5 Oat bran
10%-- 4%wheat bran; 3% Rice bran; 3 % Oat bran
15%--6% wheat bran; 4.5% Rice bran; 4.5% Oat bran

Buns

The effect of bran supplementation on the quality characteristics of buns is depicted in Table 5. Highest loaf weights were obtained in oat bran supplemented buns followed by brans in combination, wheat bran and then rice bran supplemented bun. Higher loaf weight was observed at 15 per cent level of bran supplementation as compared to control having 93 g of loaf weight. It signifies that as the level of bran increased the loaf weight also increased. Significant decreased in loaf volume was observed with increase in amount of blended bran (combination of wheat, rice and oat) beyond 5 per cent level, this may be due to the interruption of bran in the gluten formation. Dietary fiber or bran negatively affects the quality of bread, it decreases the loaf volume of the bakery products (Khater and Bahnasawy, 2014; Rubel *et al*., 2015) [18, 31]. Anil (2007) [5] observed reduction in the loaf volume of bread after supplementation of hazelnut dietary fiber. Rubel *et al*., 2015 [31] also reported reduction in the loaf volume of bread after supplementation with bran, due to the dilution of gluten.

The color is an important sensory parameter which influences the acceptability of buns. Supplementation of RWF with brans (WB, OB, RB and Combination) in the formulation of buns affects the surface color of the buns is depicted in Table 4. Bun supplemented with OB have highest L* value (darkness) and b* value (yellowness) but lower a* value (redness), this may be due to the baking effect whereas for WB, L* value is slightly lower and a* value and b* were found to higher this may be due to the augmentation of redness and yellowness of the buns during baking. RB buns have lower L* value, slightly lower a* and lowest b* value which was at par with combination bran buns. It was observed that with increase in the level of supplementation there was an increase in the a* value whereas decrease in L* and b* value. This data is in agreement Gajula *et al* (2008) [11], who observed increase in redness and decrease in yellowness as the bran level increased from 0 to 15 per cent. Grossi (2011) [14] Also observed that high dietary fiber content underwent a color change and make the product more browner due to the oxidation reaction and caramelization during baking process. The bran content influences the amount of melanoids form during baking process. Overall results indicated that increased bran level in wheat flour led to products that were substantially darker and redder in appearance.

In buns texture play an important role, it depicts the product acceptability to the consumers. Bran has been known to alter the textural properties viz., springiness and firmness of the finished product (Kurek and Wyrwisz 2015) [20]. In our study, hardness and springiness were measured as they inversely related with each other. Bun prepared with bran in combination were found to have highest hardness value (20.77 N) whereas lowest was observed for WB (19.39 N) than control (17.63 N) hardness value. Increase in the protein content of the combination flour could also be the factor to increase hardness of bun. Protein interact with other components and results in hardness (Cheng and Bhat, 2016)[8]. It was observed that as the level of bran increases the hardness of the buns increases whereas springiness decreases and vice-versa. Bran impairs the formation of gluten due to high water binding capacity which makes water unavailable for the gluten to for 3-dimensional structure (Ranasalva and Visvanathan, 2014)[26]. Overall acceptability showed OB and WB supplemented buns were highly acceptable at 5-10 per cent level of incorporation whereas RB and bran in combination were acceptable at 5 per cent level (Figure 1).

Table 5: Effect of cereal bran supplementation on the quality characteristics of buns

Cereal bran and supplementation level (%)	Loaf weight (g)	Loaf volume (cc)	Color			Hardness (N)	Springiness	Overall acceptability
			L*	a*	b*			
Wheat Bran								
0	93	390	75.31	1.30	15.95	17.63	0.84	8.6
5	97.09	365	68.59	1.93	15.80	19.40	0.83	8.3
10	97.58	280	68.44	2.72	15.72	20.10	0.83	8.2
15	106.95	260	63.71	3.71	14.99	20.46	0.81	7.9
Mean	98.6	323.7	69.01	2.41	15.61	19.39	0.83	8.25
Oat Bran								
0	93	390	75.31	1.30	15.95	17.63	0.84	8.6
5	101.54	340	72.00	1.32	15.44	19.65	0.84	8.3
10	102.46	325	70.93	1.41	15.36	20.25	0.83	8.2
15	106.37	290	66.99	2.02	15.25	20.76	0.82	8.1
Mean	100.8	336.2	71.31	1.51	15.50	19.57	0.83	8.3
Rice Bran								
0	93	390	75.31	1.30	15.95	17.63	0.84	8.6
5	93	310	67.04	1.37	15.02	20.01	0.82	8.0

10	96	300	66.41	2.12	14.98	20.89	0.81	7.5
15	103	280	64.64	2.30	14.65	21.02	0.80	7.2
Mean	96.25	320	68.35	1.77	15.15	19.88	0.82	7.83
Combination*								
0	93	390	75.31	1.30	15.95	17.63	0.84	8.6
5	95.35	285	66.38	2.35	15.58	21.41	0.83	7.9
10	99.17	270	64.72	2.42	15.55	21.95	0.82	7.9
15	110.25	250	63.25	2.48	14.77	22.10	0.80	7.2
Mean	99.4	298.7	67.42	2.14	15.46	20.77	0.82	7.9
LSD (p<0.05)	0.05	1.02	0.95	0.96	0.20	0.35	NS	NS

**5% - -2% wheat bran; 1.5% rice bran; 1.5 oat bran
10%-- 4%wheat bran; 3% rice bran; 3 % oat bran
15%--6% wheat bran; 4.5% rice bran; 4.5% oat bran

WB (10%) **OB (10%)** **RB (5%)** **Bran in combination (5%)**

Fig 1: Bran enriched Buns

Pizza Base

Pizza base was prepared by supplementing WB, OB, RB and combination of bran in RWF and the effect on the quality characteristics were studied (Table 6). Significant difference was noticed in pizza base making quality at different levels of bran incorporation. WB incorporated pizza base has highest loaf weight followed by OB, RB and combination. Bran play significant role with regard to loaf volume of the baked products. Loaf volume of pizza bases follows different pattern highest loaf volume was of RB followed by WB and combination was at par and OB. Shogren *et al* (1981) [35] reported decrease in loaf volume and specific volume with increase in level of bran and conclude that decreased in volume is due to dilution of gluten by addition of fibre. Sosulski and Wu (1988) [39] reported that as the level of bran increases loaf volume of the pizza base decreases due to the interruption of fiber in gluten formation.

Color of the pizza base was significantly affected by the bran supplementation. L* values decreased significantly with the incorporation of cereal bran as well as with its increasing levels. Pizza base supplemented with WB have maximum value for L*, a* and b* followed by OB. The value of L*, a* and b* for RB and brans in combination was at par. It was observed that with increase in the level of supplementation there was an increase in the a* value whereas decrease in L* and b* value. This data is in agreement Gajula *et al* (2008)[11], who observed increase in redness and decrease in yellowness as the bran level increased from 0 to 15 per cent.

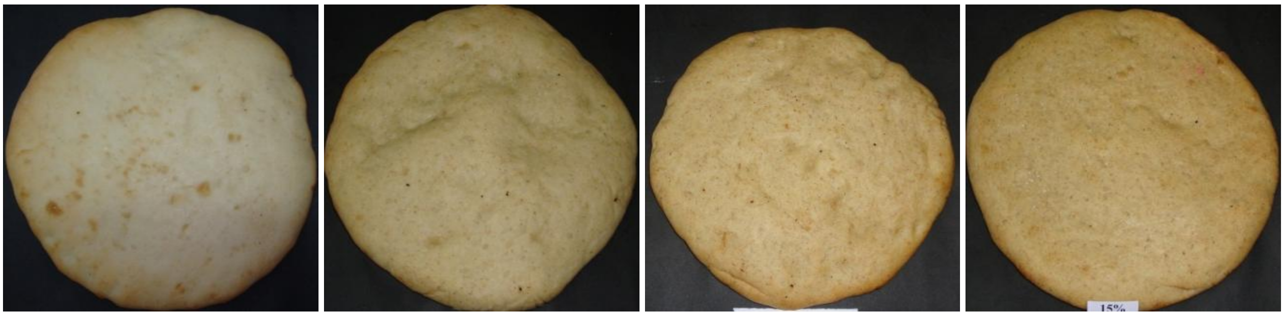
Texture is one of the most important factor in depicting the acceptability of any food. For pizza hardness was measured and significant difference were observed in the hardness of pizza bases, pizza base with bran in combination was found to have maximum value of hardness i.e., 21.34 N followed by RB, OB and WB. This may be due to the higher concentration of bran in combination blended flour which hinders the gluten protein to develop. In our study a trend was noticed for all samples that as the level of bran increased from 0 to 15 per cent the hardness also increases which is not desired in pizza base, it should be firm. This hardness may be due to the unavailability of water for gluten formation because of the presence of bran which is having good water absorption capacity (Chen *et al*., 2013; Ranasalva and Visvanathan, 2014) [7, 26]. Overall acceptability showed WB and OB supplemented pizza base were highly acceptable at 5-10 per cent level of incorporation whereas RB and bran in combination were acceptable at 5 per cent level (Figure 2).

Table 6: Effect of cereal bran supplementation on the quality characteristics of pizza base

Cereal bran and supplementation level (%)	Loaf weight (g)	Loaf volume (cc)	Color			Hardness (N)	Overall acceptability
			L*	a*	b*		
Wheat Bran							
0	160.7	400	73.82	2.42	20.96	20.63	8.4
5	162.02	398	71.85	2.58	19.09	20.70	8.0
10	178	379	70.52	4.66	19.00	20.90	7.7
15	188.8	358	70.40	4.70	18.96	21.0	7.3
Mean	172.38	383.75	71.64	3.6	19.5	20.80	7.85
Oat Bran							
0	160.7	400	73.82	2.42	20.96	20.63	8.4
5	165.8	391	69.54	2.50	19.08	20.66	8.0
10	167.09	378	67.25	2.85	18.93	20.87	7.7
15	188.04	356	66.45	2.89	18.89	21.50	7.4
Mean	165.7	350	69.26	2.76	19.4	20.91	7.8

Rice Bran							
0	160.7	400	73.82	2.42	20.96	20.63	8.4
5	151.57	386	66.35	2.49	19.05	20.70	7.4
10	160.40	378	58.76	2.86	18.89	21.20	7.0
15	171.0	369	55.76	2.96	18.75	21.70	6.4
Mean	160.9	470.8	63.67	2.68	19.4	21.05	7.3
Combination*							
0	160.7	400	73.82	2.42	20.96	20.63	8.4
5	164.2	384	65.49	2.50	18.01	21.12	7.4
10	158.02	381	58.95	2.93	17.89	21.62	6.8
15	160.25	370	56.56	2.99	17.66	22.0	6.2
Mean	160.7	383.75	63.70	2.71	18.63	21.34	7.2
LSD (p<0.05)	0.34	2.02	0.85	0.51	0.26	0.36	NS

**5% - -2% wheat bran; 1.5% rice bran; 1.5 oat bran
10%-- 4%wheat bran; 3% rice bran; 3 % oat bran
15%--6% wheat bran; 4.5% rice bran; 4.5% oat bran



WB (10%) **OB (10%)** **RB (5%)** **Bran in combination (5%)**

Fig 2: Bran enriched Pizza base

Flatbread

The data presented in Table 7 is depicted the loaf weight, loaf volume, color, texture and overall acceptability of the bran enriched flat bread. Flatbread was prepared by supplementing WB, OB, RB and bran in combination at 0-15 per cent level. Flatbreads differ significantly with regards to loaf weight and loaf volume at different level of bran addition. WB supplemented flatbread has higher value for loaf weight followed by OB, RB, and bran in combination whereas loaf volume also follows the same trend. As the level of bran increase the loaf weight increases and loaf volume decreases. The increase in fiber content leads to degradation of the 3-D structure of gluten which results in lowering the loaf volume of the flatbread (Schleibinger *et al*., 2013)[33].

L* value shows a statistical difference for all the flatbread. L* value showed decrease in trend with increase in the level of bran in flat bread. Bran in combination flatbread showed highest L* value followed by WB, OB and RB. a* value tells the redness of the sample and it is highest for RB followed by WB, OB and bran in combination and it was observed that increase in the level of bran lightness increases and it is reverse for a* value. Dar *et al*., 2013 [10] results are in comparison with our results. Altan *et al*., 2008[3] reported that L* and a* value showed marked change in the color after the incorporation of tomato pomace, they also notice an increase in the level of pomace resulted in decreased value of L* and increased value of a*. Also increase in bran level results in a decrease in b* value of flatbread. An inverse correlation was found between the a* and b* value of the bran enriched flatbread.

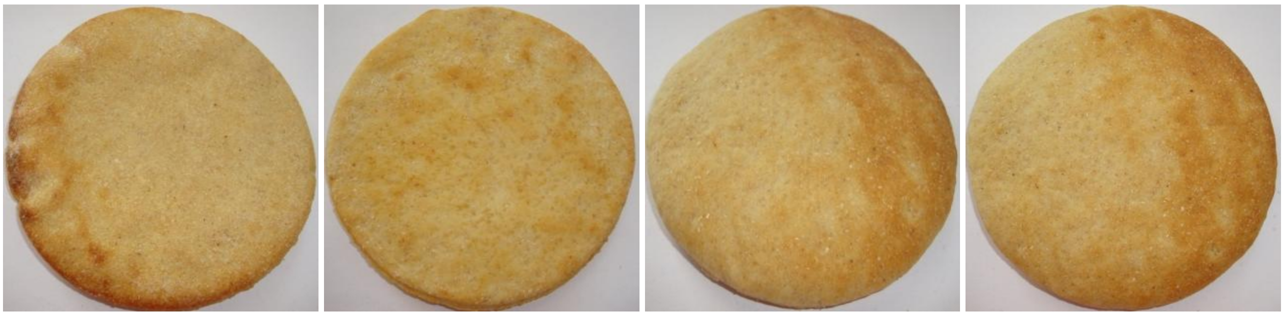
Significant variations were observed for the hardness of flatbread prepared by incorporation of fibres. Maximum hardness was observed in case of flatbread having bran in combination (21.44N) followed by RB. Hardness for control sample was 17.63 N and as the level of bran increases hardness of the flatbread also increases. Lima *et al* (2002)[23] reported that very slight hardening of the loaves occurred with 20 per cent full fat rice bran when compared to control. Overall acceptability showed WB and OB supplemented flatbread were highly acceptable at 5-10 per cent level of incorporation whereas RB and bran in combination were acceptable at 5 per cent level (Figure 3). The results are in agreement with Nareman (2016) [24].

Table 7: Effect of cereal bran supplementation on the quality characteristics of flat bread

Cereal bran and supplementation level (%)	Loaf weight (g)	Loaf volume (cc)	Color			Hardness (N)	Overall acceptability
			L*	a*	b*		
Wheat Bran							
0	60	204	59.68	3.52	17.6	17.63	8.4
5	62.02	195	54.24	5.25	16.23	18.89	8.0
10	78	174	52.80	5.42	15.53	20.16	7.7
15	88.8	105	51.19	5.74	14.88	20.96	7.3
Mean	72.02	167.5	54.47	4.90	16.06	19.41	7.85
Oat Bran							
0	60.7	204	59.68	3.52	17.6	17.63	8.4
5	65.8	173	55.23	4.02	13.88	20.36	8.0

10	67.09	150	45.99	4.86	13.51	21.29	7.7
15	88.04	143	47.61	5.61	14.55	22.36	7.4
Mean	70.40	167.5	52.12	4.5	14.88	20.41	7.8
Rice Bran							
0	60.7	204	59.68	3.52	17.60	17.63	8.4
5	51.57	125	49.15	5.24	14.74	21.46	7.4
10	60.40	116	45.39	5.30	12.93	21.96	7.0
15	71.0	102	40.60	5.85	11.39	22.06	5.4
Mean	60.9	145	48.70	4.97	14.16	20.77	7.05
Combination*							
0	60.7	204	59.68	3.52	17.6	17.63	8.4
5	64.2	135	60.47	3.48	15.57	21.91	7.4
10	58.02	110	57.22	3.26	15.48	22.90	6.8
15	60.25	95	55.83	3.91	16.47	23.32	5.2
Mean	60.79	136	58.30	3.54	16.28	21.44	6.95
LSD (p<0.05)	0.21	1.25	0.38	0.03	0.05	0.03	NS

**5% - -2% wheat bran; 1.5% rice bran; 1.5 oat bran
10%-- 4%wheat bran; 3% rice bran; 3 % oat bran
15%--6% wheat bran; 4.5% rice bran; 4.5% oat bran



WB (10%) OB (10%) RB (5%) Bran in combination (5%)

Fig 3: Bran enriched Flat bread

Conclusion

Bran is known as the functional food ingredient and rich source of vitamins, minerals, dietary fiber and bioactive compounds. Bran is removed during processing like debranning, polishing etc. Due to the presence of compounds with health benefits, they can be added back to the convenience food products to increase its nutritional value or for the preparation of value added food products. In our study, effect of bran incorporation on the rheological properties of buns, pizza base and flat bread were studied. WB, OB, RB and bran in combination were added at different level (0-15%) to make buns, pizza base and flat bread. Proximate composition and rheological properties of the bran enriched flour was studied and it was found that bran enriched flour have good nutritional composition, but it affects the pasting profile by interfering in gelatinization and due to the higher water absorption capacity of the bran dough development time (DDT) increased. Bran enriched buns, pizza base and flat bread were found to be acceptable at 5-10 per cent level of incorporation. From the data obtained from this work, WB and OB were highly acceptable at 5-10 percent level whereas RB and bran in combination were acceptable at 5 per cent level of incorporation with various health benefits.

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