ASSESSMENT OF FUNCTIONAL & NUTRITIONAL PROFILING OF BREAD BY INCORPORATION OF WHEAT, OAT AND RICE BRANS

Mehwish Zerlasht[1], Dr.Sadaf Javaria[2] and Dr Anjum Murtaza[3]

[1,2]Institute of Food Science and Nutrition, Gomal University, D.I.Khan
[3]Institute of Food Science and Nutrition, University of Sargodha
Corresponding Author E-mail: *mzerlasht@yahoo.com*

ABSTRACT:

The effect of different levels of wheat, rice and oat bran on the total phenolic content, mold count and sensory characteristics viz color, texture and overall acceptability of bread was studied. Wheat flour was replaced by the brans at 0,5,10 % level. Levels of different brans significantly affected TPC, mold growth and sensory characteristics. In general bread samples supplemented with brans levels had lower L values and higher a and b values. Moreover total phenolic content was also increased with increasing levels of brans. The fiber rich bread samples were also evaluated organolepticaly. There was a clear correlation between the brans level and organoleptic characteristics. It was observed that wheat bran increased shelf life and imparted good characteristics to bread. All the samples were accepted by the panelists. However T2 was given maximum sensory score.

Key Words: Bread, Brans, Physico chemical attributes

1.   Introduction

With continuous developments in the field of nutrition Consumers prefer to eat nutritious and healthy foods in order to supplement nutrients and to prevent non-communicable diseases as well. To address the reason, researchers are involved to formulate bread with healthy ingredients (Dewettinck *et al.,* 2008) as people like bread as a staple food with high nutritional value and easy digestive properties(Amir *et al*., 2013). Diet, health relation and concept of diet-based therapy have introduces functional foods (Suleria *et al*., 2015). Development of functional bakery products it is important to develop a product with effectiveness and consumer's acceptance in terms of appearance, taste and texture (Siro *et al.,* 2008).

Lack of dietary fiber consumption is associated with the development of many health ailments including bowel disease, Cro'hn's disease, colon cancer, constipation, diabetes, diverticulitis, gallstones, heart disease, high cholesterol, hyperlipidemia, and obesity (Butt and Sultan, 2011). According to Park and Floch (2007), it has been observed that combinations of different types of dietary fibers leads to optimal health impacts as compared to one type of fiber alone. It is believed that these favorable effects are mediated by several components and techniques. Furthermore, incorporation of suitable bran in proper proportion is essential (Aivazand Mosharraf, 2013). Addition of high amount of bran is a technological challenge, both in terms of flavor and texture of the finished product as product perception by sensory parameters is most important.

Among the various brans incorporated in bread, wheat bran is the traditional source of dietary fiber. Gomez *et al.* (2003) demonstrated that up to 20% flour replacement in breads supplemented with wheat bran have a substancial effect on increase in fecal nitrogen and fat and reductions in fecal transit time and serum triglyceride levels. However, breads fortification at this level of flour replacement also require additional components to maintain the bread structure (Curti *et al.*, 2013).

Rice bran (RB), is byproduct of milling rice, a very nutritive soft brown powder comprising about 10% by weight of the paddy rice (Gharib*et al.*, 2011). Rice bran consists of 20-29% oil, 10-15% proteins and 20-27% fibers (Abdul and Luan, 2000.).

In spite of being in access as by product during processing of rice and nutritionally valuable, RB is under-utilized in food product development. RB could be a good substitute for supplementation in wheat flour to enhance the nutritive value and reduce the cost of bread.

Oat bran is another important ingredient that can be incorporated in several food formulations specially bread. The hypocholesterolemic and anti-cancer effects of oat bran in humans have been documented. in addition It also has high fiber and protein content (Abdul *et al.*, 2015).

MATERIALS AND METHODS

Procurement of raw materials

All the raw material were procured from the local markets of Dera Ismail khan. Materials comprised of - wheat flour, yeast, sugar, salt, shortening, stabilizers, preservatives; wheat, oat and rice brans.

Preparation of bread

Yeast, salt and sugar were added to luke warm water and let it stand for 5 minutes to make yeast active. Afterwards wheat flour and water were put into dough mixer fitted with rotating blades to form a homogenous mixture to make dough by proper kneading remaing ingredients were added after it as well. The kneaded dough was allowed to ferment for 30 minutes covered with a neat muslin cloth and allowed to rise it. The dough was punched to exclude air bubbles entrapped in dough structure then placed in greased moulds. The dough was placed in warm place for proofing for 50 additional minutes. Afterwards it was baked in a preheated oven at 225°c for 20-25 minutes. The baked bread was then allowed to cool and sliced for further study.

Physico chemical & functional properties of flour

Bread was cooled for an hour in an ambient temperature and then put on instrumental measurements and sensory tests. Slices of 12.5mm width was made from one part of bread, mechanically by a bread slicer. Tests moisture, ash fibre, protein, iron , zinc of raw flour contained raw material by the methods of AACC (2000).

Quality Evaluation of Bread

Total Phenolic Content:

Total phenolic content were evaluated by using central slice of bread. Folin & Ciocalteu's phenol reagent (Folin-C reagent) was used for determination of total phenolic content. Water is extracted from dried extracts with sonication followed by reaction with the Folic-C reagent. The resultant colorimetric reaction was measured at 765nm and compared with a standard curve produced with gallic acid standard solutions. The validation results were compared with *Standard Method Performance Requirement* (SMPR[®]) 2015.009, developed by the Stakeholder Panel on Dietary Supplements (AOAC SMPR 2015.009).

Shelf life evaluation

Visual assessment of the mold growth on crust and crumb of breads was done and counting was made using modified method of Fox (1993).

Sensory evaluation

Descriptive profiling test was performed for the sensory evaluation of bread. Five traits selected were brightness, hardness, stickiness, astringency and sweetness from list of standardized lexicons of terminologies for evaluation of bread. (Meilgaard*et al*., 1999) Reference products for each characteristic was decided with one accord as the sensory intensity index by the panel. A nine-point hedonic scale was employed for sensory evaluation as described by Lawless and Haymann (1998).

 Statistical analysis

Statistical analysis of the data for given parameters was done using the Analysis of Variance (ANOVA) technique and the Least Significance Difference (LSD) to compare the means according to Steel and Torrie (1980) using the Statistix 8.1 version

RESULTS AND DISCUSSION

Proximate Analysis of raw material

Each sample of raw material was analyzed for proximate composition viz. fiber (%), ash (%), protein (%), fat (%) and moisture (%) content. The proximate composition was given in Table 1.

Table 1: Proximate composition of raw material

Raw material	Moisture	Ash	Fiber	Fat	Protein	zinc	Iron
Wheat bran	12.25 ±0.28	0.63±0.19	1.11±0.47	0.63±0.28	10.58±0.88	5.28±2.58	18.92±4.39
Oat bran	12.35±0.37	0.62±0.19	1.11±0.46	0.62±0.27	10.59±0.86	5.29±2.6	18.78±4.33
Rice bran	12.24±0.28	0.63±0.18	1.12±0.47	0.66±0.29	10.49±0.85	5.28±2.58	9.72±2.46

Total Phenolic content:

In the current study, different bread samples were evaluated for their total phenolic content. It was concluded from statistical analysis, that treatments and storage had significant effect on total phenolic content of bread samples prepared with different percentages of wheat bran, oat bran and rice bran. Total phenolic content in control bread were found to be 123.62 mg GAE/100g. Incorporation of wheat bran from 10% to 40% increased the TPC from 131.43 mg GAE/100g to 208.28 mg GAE/100g. It decreased to a level of 190.37 mg GAE/100g at 40% wheat bran addition till 96 hour storage time. Likewise addition of oat and rice bran from 10 to 40% increased the TPC content from 136.31 mg GAE/100g to 212.39 mg GAE/100g and from 141.73 mg GAE/100g to 1977.50 mg GAE/100g, respectively. Addition of bran to wheat bread substantially improved total phenolic content of the samples. During storage interval of 96 hours, substantial reduction in total phenolic content was observed (Table 2).

Table 2. Effect of treatment and storage on total phenolic content (mg GAE/100g) of bread samples

Treatments	Duration (Hours)					Mean
	0	24	48	72	96	
T0	123.62	121.32	120.87	120.01	118.64	120.89ij
T1	145.51	144.56	143.38	141.87	139.59	126.99i
T2	153.86	151.72	149.38	148.67	146.72	150.68ef
T3	178.39	176.39	173.29	172.94	170.83	174.21d
T4	191.8	187.34	186.76	184.56	183.68	196.61b
T5	133.23	132.07	131.73	129.27	127.23	131.32h
T6	139.86	138.21	137.04	135.78	133.26	158.92e
T7	148.54	146.32	145.29	143.38	141.92	186.84c
T8	158.65	156.30	155.81	154.07	152.49	209.80a
T9	146.92	145.01	143.19	142.82	140.27	138.52g
T10	169.38	167.08	165.79	163.48	162.39	146.83f
T11	198.43	196.39	195.09	192.93	190.37	167.91de
T12	213.54	211.94	210.07	208.82	205.78	191.46bc
Mean	167.06A	163.00B	161.26C	159.65D	157.10E	

LSD for treatments = 2.0357

LSD for time = 1.2625

LSD for treatment × time = 4.5521

Means carrying same letters are not statistically significant from each other

T0 control, T1 Wheat 90% +Wheat bran 10%, T2 Wheat 80% + Wheat bran 20%, T3 Wheat 70% + Wheat bran 30%, T4 Wheat 60% + Wheat bran 40%, T5 Wheat 90% +Oat bran 10%, T6 Wheat 80% + Oat bran 20%, T7 Wheat 70% + Oat bran 30%, T8 Wheat 60% + Oat bran 40%, T9 Wheat 90% + Rice bran 10%, T10 Wheat 80% + Rice bran 20%, T11 Wheat 70% + Rice bran 30% , T12 Wheat 60% + Rice bran 40%

3: Effect of Treatment on Total phenolic content (TPC), Firmness on day 1 and day 3 of storage, and color values.

L Value:

The statistical analysis revealed significant effect for the treatment on L value of bread crumb. L value in control was 64.3 that were reduced to 63.9 by incorporation of 0.25% garlic powder and to 63.2 by 1% bran. Addition of cumin powder and fenugreek powder from 10 to 40% reduced the L value from 62.7 to 61.2 and from 63.3 to 61.20, respectively (table 3).

a* Value:

Effect of treatment on a* value was found to significant as measured statistically. Control bread showed a* value of 1.8 that increased to 1.9 by adding 0.25% garlic powder and to 2.9 by 1% garlic powder. Supplementation with cumin powder from 0.25 to 1%, an increase from 2.2 to 3.2 was observed. Likewise, a* value increased from 2.5 to 3.4 by the substitution of 0.25% and 1% fenugreek powder, respectively (table 3).

b* Value:

Substitution of wheat flour with garlic, cumin and fenugreek powder had a significant effect on b* value of bread samples. B value in control was found to be 19.8 that was increased to 21.9 in T4. Samples prepared with 1% cumin and fenugreek powder also experienced rise in b* value as shown in table 3.

Table 3.

Treatment	L	a*	b*
T0	65.2bc	1.9fg	20.6d
T1	66.4b	2.2f	20.9cd
T2	64.7c	3.4e	21.3c
T3	59.2d	4.8d	22.9bc
T4	55.4ef	5.9b	24.6ab
T5	68.4ab	2.4f	21.2c
T6	65.4bc	3.1e	21.5c
T7	58.6d	5.2c	23.3b
T8	52.3f	6.9a	24.9ab
T9	69.1a	2.1f	21.0cd
T10	64.9b	3.2e	21.6c
T11	56.2e	5.8b	23.4b
T12	53.0f	6.7a	25.4a
LSD (0.05)	0.5035	0.0368	0.1842

Means carrying same letters are not statistically significant from each other

T0 control, T1 Wheat 90% +Wheat bran 10%, T2 Wheat 80% + Wheat bran 20%, T3 Wheat 70% + Wheat bran 30%, T4 Wheat 60% + Wheat bran 40%, T5 Wheat 90% +Oat bran 10%, T6 Wheat 80% + Oat bran 20%, T7 Wheat 70% + Oat bran 30%, T8 Wheat 60% + Oat bran 40%, T9 Wheat 90% + Rice bran 10%, T10 Wheat 80% + Rice bran 20%, T11 Wheat 70% + Rice bran 30% , T12 Wheat 60% + Rice bran 40%

Shelf Life Evaluation of Bread:

The prepared bread samples were further scrutinized for mould count, firmness and antioxidant activity to elucidate the influence of different treatments on them during a storage period of 96 hours.

Mould Count

The mould count on bread crumb and crust was analyzed during storage period of 96 hours. It was revealed from statistical analysis that treatments had non-significant effect on mould count on bread crumb whilst storage period showed momentous rise in mould count. The mould count ranged from 1.41 to 2.15 (log CFU/g) by adding 10 to 40% wheat bran. It increased to 3.47 and 3.87 with the addition of 10% and 40% wheat bran respectively. Likewise addition of oat and rice bran gave mould count around 2.15, 2.83 (log CFU/g) and 2.59, 1.75 (log CFU/g) from 10 to 40% bran addition, respectively. It increased momentously during storage period of 96 hours (table 3)

Likewise mould growth on bread crust increased with increase in storage interval as explained in table 4

Table 3. **Effect of treatment and storage on mould count (log CFU/g) of bread crumb samples**

Treatment	Duration (Hours)					Mean
	0	24	48	72	96	
T0	1.41ab	1.61Za	2.02vwxy	2.58qrst	3.21hijk	2.17g
T1	1.52a	1.83xyz	2.57qrst	2.98jklmno	3.47efgh	2.47f
T2	1.14b	1.91wxyz	2.54rts	3.31efghij	3.43efgg	2.47f
T3	2.18uvw	2.55rst	2.59qrst	2.87klmnop	3.19hijkl	2.68e
T4	2.15vwx	2.74opqrs	3.24ghijk	3.39 efghi	3.87cd	3.08c
T5	2.15vwx	2.27tuv	2.63pqrs	2.81NOPQRS	3.44efgh	2.66e
T6	2.89klmnopqrs	2.98jklmno	3.18hijkl	3.48EFGH	3.55defg	3.22bc
T7	2.61qrs	2.97jklmno	3.43efgh	3.95bc	4.34a	3.46a
T8	2.83mnopqrs	2.82nopqrs	3.34efghi	3.57def	3.87cd	3.29b
T9	2.59qrst	2.71opqrs	3.09ijklmn	3.84cd	4.21ab	3.29b
T10	2.58qrst	2.87klmnopq	2.90klmnopq	3.71cde	3.95bc	3.20bc
T11	1.98vwxy	2.16vwx	2.84mnopqrs	3.34fghi	3.98bc	2.86d
T12	1.75yz	2.52stu	2.67opqrs	3.45efgh	3.96bc	2.87d
Mean	2.14e	2.46d	2.85c	3.33b	3.73a	

LSD value for treatment = 0.0371
LSD value for time = 0.0230
LSD value for interaction = 0.0830
Means carrying same letters are not statistically significant from each other

T0 control, T1 Wheat 90% +Wheat bran 10%, T2 Wheat 80% + Wheat bran 20%, T3 Wheat 70% + Wheat bran 30%, T4 Wheat 60% + Wheat bran 40%, T5 Wheat 90% +Oat bran 10%, T6 Wheat 80% + Oat bran 20%, T7 Wheat 70% + Oat bran 30%, T8 Wheat 60% + Oat bran 40%, T9 Wheat 90% + Rice bran 10%, T10 Wheat 80% + Rice bran 20%, T11 Wheat 70% + Rice bran 30% , T12 Wheat 60% + Rice bran 40%

4.: Effect of treatment and storage on mould count (log CFU/g) of bread crust samples

Treatment	Duration (Hours)					Mean
	0	24	48	72	96	
T0	1.52v	1.83uv	2.57pqrs	2.98jkl	3.47fgh	2.47f
T1	2.15t	2.27st	2.63nopqr	2.81lmnopqr	3.44fgh	2.66e
T2	2.59nopqr	2.71mnopqr	3.09ijkl	3.84cde	4.21ab	3.29b
T3	2.18t	2.55qrs	2.59nopqr	2.87klmnop	3.19hij	2.68e
T4	2.27st	2.63nopqr	2.81lmnop	3.44fgh	3.87cd	3.00c
T5	2.15t	2.27st	2.63nopqr	2.81lmnopqr	3.44fgh	2.66de
T6	2.61nopqr	2.97jklm	3.43fgh	3.95bc	4.34a	3.46a
T7	2.89jklmno	2.98jklm	3.18hij	3.48fgh	3.55defg	3.22b
T8	2.83lmnopqr	2.82lmnopqr	3.34ghi	3.57defg	3.87cd	3.29b
T9	2.61nopqr	2.98jklm	3.42fgh	3.94bc	4.35a	3.46a
T10	2.58pqrs	2.87klmnop	2.90jklmn	3.71cdef	3.95bc	3.20b
T11	1.98tu	2.16t	2.84lmnopq	3.34ghi	3.98bc	2.86d
T12	1.75uv	2.52rs	2.67mnopqr	3.45fgh	3.95bc	2.87d
Mean	2.32Ee	2.58d	2.93c	3.39b	3.82a	

LSD value for treatment = 0.0339

LSD value for time = 0.0210

LSD value for interaction = 0.0759

Means carrying same letters are not statistically significant from each other

T0 control, T1 Wheat 90% +Wheat bran 10%, T2 Wheat 80% + Wheat bran 20%, T3 Wheat 70% + Wheat bran 30%, T4 Wheat 60% + Wheat bran 40%, T5 Wheat 90% +Oat bran 10%, T6 Wheat 80% + Oat bran 20%, T7 Wheat 70% + Oat bran 30%, T8 Wheat 60% + Oat bran 40%, T9 Wheat 90% + Rice bran 10%, T10 Wheat 80% + Rice bran 20%, T11 Wheat 70% + Rice bran 30% , T12 Wheat 60% + Rice bran 40%

2.   **SENSORY EVALUATION:**

The main objective of this study was sensory evaluation of the best bread made through different composition of bran s. The investigation attribute and results are given below:

6.1. Texture

The results indicated that there was significant difference in the texture score of bread. The maximum texture score (7.65±0.11) was recorded in T2 followed by 7.46±0.19 in T0. The minimum score (4.06±0.11) was recorded for T12. Likewise, texture score declined as the treated bread samples were stored for a storage period of 96 hours (table 5).

5. Effect of treatments and storage on texture score of bread samples

Treatments	Duration (Hours)					Mean
	0	24	48	72	96	
T0	7.46±0.19ab	6.92±0.21abcd	6.48±0.18bcdefg	6.02±0.31cdefghij	5.54±0.18fghijkl	6.48±1.01a
T1	7.41±0.18ab	7.05±0.26abc	6.54±0.21abcdef	6.02±0.34cdefij	5.29±0.11hijklmn	6.46±1.16a
T2	7.65±0.11a	7.08±0.24abc	6.73±0.27abcde	5.18±0.37ijklmnop	5.01±0.31ijklmnopqr	6.33±1.45a
T3	6.39±0.12bcdefgh	5.19±0.19ijklmnop	4.89±0.29jklmnopqrs	4.65±0.24lmnopqrstu	3.27±0.33vwxyz	4.88±1.65c
T4	4.19±0.31nopqrstuvw	4.11±0.34pqrstuvwx	4.01±0.25qrstuvwx	3.67±0.23tuvwxyz	3.21±0.36vwxyz	3.84±0.87f
T5	6.41±0.23BCDEFGH	6.09±0.32CDEFGHI	5.52±0.28FGHIJKLM	5.19±0.21IJKLMNOP	4.49±0.38LMNOPQRSTU	5.54±1.02b
T6	5.63±0.24EFGHIJKL	5.15±0.31IJKLMNOPQ	4.68±0.31JKLMNOPQRST	3.13±0.19VWXYZ	2.71±0.31YZ	4.26±1.45e
T7	4.56±0.43LMNOPQRSTU	4.18±0.18NOPQRSTUVW	3.69±0.19TUVWXY	3.29±0.14VWXYZ	3.09±0.23WXYZ	3.76±1.31fg
T8	4.15±0.38OPQRSTUVW	4.03±0.11PQRSTUVWX	3.78±0.17STUVWXY	3.51±0.11UVWXYZ	3.22±0.26VWXYZ	3.74±0.65fg
T9	5.83±0.37defghijkl	5.39±0.14FGhijklm	4.51±0.34LMNOPQRSTU	4.29±0.42MNOPQRSTUV	4.08±0.28pqrstuvx	4.82±1.01cd
T10	5.33±0.32ghijklmn	4.89±0.13jklmnopqrs	4.51±0.11lmnopqrstu	4.09±0.28pqrstuvwx	3.61±0.13tuvwxyz	4.49±0.87d
T11	5.01±0.19jklmnopqr	4.98±0.12ijklmnopqr	4.62±0.14lmnopqrstu	3.91±0.29rstuvwx	3.61±0.11tuvwxyz	4.43±0.58de
T12	4.06±0.11pqrstuvwx	3.98±0.11rstuvwx	3.19±0.17vwxyz	2.98±0.26xyz	2.51±0.19z	3.34±0.74g
Mean	5.70±1.03a	5.31±1.98b	4.86±1.76c	4.30±1.56d	3.82±1.78e	

LSD for treatments = 0.1268

LSD for time = 0.0787

LSD for treatment × time = 0.2836

Means carrying same letters are not statistically significant from each other

T0 control, T1 Wheat 90% +Wheat bran 10%, T2 Wheat 80% + Wheat bran 20%, T3 Wheat 70% + Wheat bran 30%, T4 Wheat 60% + Wheat bran 40%, T5 Wheat 90% +Oat bran 10%, T6 Wheat 80% + Oat bran 20%, T7 Wheat 70% + Oat bran 30%, T8 Wheat 60% + Oat bran 40%, T9 Wheat 90% + Rice bran 10%, T10 Wheat 80% + Rice bran 20%, T11 Wheat 70% + Rice bran 30%, T12 Wheat 60% + Rice bran

6.2 Overall Acceptability

The data revealed that treatments had significant effect on overall acceptability of dough. Maximum over all acceptability score (8.23±0.13) was recorded in T0 followed by T2 (7.66±0.21). Minimum score of overall acceptability was noted in T12 (3.63±0.16) which was statistically at per (100 % wheat flour). Likewise, overall acceptability score declined as the treated bread samples were stored for a storage period of 96 hours (table 6).

6.   Effect of treatments and storage on overall acceptability score of bread samples

Treatments	Duration (Hours)					Mean
	0	**24**	**48**	**72**	**96**	
T0	8.23±0.13	7.05±0.43	6.54±0.17	6.02±0.17	5.29±0.13	6.63±1.56a
T1	7.36±0.24	7.09±0.23	6.89±0.21	5.65±0.15	5.27±0.17	6.45±1.08a
T2	7.66±0.21	7.11±021	6.73±0.24	6.25±0.19	6.01±0.18	6.75±1.01a
T3	6.41±0.16	6.03±0.18	5.62±0.26	5.12±0.22	4.63±0.11	5.56±1.31b
T4	5.13±0.26	5.01±0.15	4.78±0.19	4.61±0.23	4.43±0.15	4.79±0.98c
T5	6.46±0.19	6.09±0.25	5.52±0.17	5.19±0.26	4.49±0.19	5.55±0.97b
T6	5.63±0.17	5.16±0.28	4.83±0.16	4.28±0.18	3.78±0.32	4.74±0.87c
T7	5.43±0.21	5.18±0.21	4.64±0.21	4.28±0.11	3.98±0.43	4.70±0.76c
T8	4.63±0.26	4.39±0.28	3.78±0.22	3.51±0.18	3.21±0.33	3.90±0.65d
T9	6.76±0.28	5.29±0.24	5.01±0.18	4.72±0.32	4.26±0.31	5.21±1.31bc
T10	5.33±0.27	5.13±0.17	4.69±0.16	4.32±0.21	3.93±0.28	4.68±0.63c
T11	4.23±0.11	3.89±0.19	3.51±0.17	3.09±0.22	2.61±0.24	3.47±0.78de
T12	3.63±0.16	3.39±0.15	2.78±0.16	2.51±0.21	2.22±0.26	2.91±0.67e
Mean	5.91±1.87a	5.45±1.65b	5.02±1.63c	4.58±1.52d	4.16±1.14e	

LSD for treatments = 0.1895
LSD for time = 0.1175
LSD for treatment × time = 0.4237
Means carrying same letters are not statistically significant from each other

T0 control, T1 Wheat 90% +Wheat bran 10%, T2 Wheat 80% + Wheat bran 20%, T3 Wheat 70% + Wheat bran 30%, T4 Wheat 60% + Wheat bran 40%, T5 Wheat 90% +Oat bran 10%, T6 Wheat 80% + Oat bran 20%, T7 Wheat 70% + Oat bran 30%, T8 Wheat 60% + Oat bran 40%, T9 Wheat 90% + Rice bran 10%, T10 Wheat 80% + Rice bran 20%, T11 Wheat 70% + Rice bran 30% , T12 Wheat 60% + Rice bran 40%

References

AACC. 2013. Whole grains. Available at http://www.aaccnet.org/initiatives/definitions/

Pages/WholeGrain.aspx.(May, 2013).

AACC.2000.Approved methods. In: American Association of Cereal Chemists Official Methods, 9th ed. method 10-90. The Association, St. Paul, MN, USA.

Aivaz, M. and L. Mosharraf. 2013. Influence of different treatments and particle size of wheat bran on its mineral and physicochemical characteristics. Int. J. Agri. Sci. 3: 608–619.

Abdul, H., A. and L. Y. Luan. 2000. Functional properties of dietary fiber prepared from defatted rice bran. Food Chem. 68:15-19.

Abdul,W.,I. Khalil, A. Javid, M. Tariq, A. Muhammad, P. Mohammad and H. Said. 2015. Effect of oat bran on the quality of enriched high fiber biscuits. World. J. Dairy and Food Sci.10:68-73.

Butt, M. S. and M. T. Sultan. 2011.*Nigella sativa*: Reduces the risk of various maladies. Cri. Rev. Food Sci.Nutri. 50: 654-665.

Curti, E., E. Carini, G. Bonacini, G. Tribuzio and E. Vittadini. 2013. Effect of the addition of bran fractions on bread properties. J. Cereal Sci.57:325–332.

Dewettinck, K., F. Bockstaele, B. Kuhne, D. Walle, T. M. Courtens and X. Gellynck. 2008. Nutritional value of bread: Influence of processing, food interaction and consumer perception. J. Cereal Sci.48:243-257.

Fox, R.T.C. 1993.Principles of Diagnostic Techniques in Plant Pathology.International mycological Institute Walling Ford, Oxon,U.K.

Gomez, M., F. Ronda, C. A. Blano, P. A. Caballero and A. Apesteguia. 2003. Effect of dietary fiber on dough rheology and bread quality.Euro. Food Res. Technol. 216:51-56

Gharib, B. S., A. AtayeandE. S. Mohammadi. 2011. The Effect of Adding Rice Bran on qualitative and Physiochemical features of Oil Cookies. MA. Thesis, Islamic Azad University, Quchan.

Meilgaard, M., G. V. CivilleandB. T. Carr. 1999. Sensory evaluation techniques. CRC Press LLC.New York. NY, USA.

Park, J. and M. H. Floch. 2007. Prebiotics, Probiotics and Dietary Fiber in Gastrointestinal Disease. Gastroenterol.Clinics of North Amm. 36: 47-63.

Suleria, H.A. R., N. Khalid, S. Sultan, A. Raza, A. Muhammad and M. Abbas. 2015. Functional and nutraceutical bread prepared by using aqueous garlic extract. Int. J. Food Safety.17:10-20.

Siro, I., E. Kapolna, B. Kapolna and A. Lugasi. 2008. Functional food.Product development, marketingand consumer acceptance-A review.Appetite.51: 456-467.

Steel, R.G.C and J. M. Torrie. 1980. Principles and Procedures of Statistics A Biometrical Approach.McGraw Hill Book Co. Inc.New York, USA