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Wheat and wheat-barley composite bread - the functional foods for healthy living

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ABSTRACT

Bread is an important staple food and the most widely consumed bakery product all over the world. By substituting white wheat flour with a number of whole grain cereal flours of different origin may contribute to enhanced nutrient composition and content in the end product, thus making them as functional foods. Hence in the present study an attempt was made to incorporate wheat flour and barley flour to produce functional bread. In the present study, refined white flour used in bread making was completely replaced by whole wheat flour and this acts as control bread (CB). Further the whole wheat flour was substituted by barley flour at the ratio of 10%, 20%, 30% and 40% and these breads were named as Wheat-Barley composite breads (WB1, WB2, WB3 and WB4). The prepared breads were analysed for physical and sensory properties. From the analysis report, the selected wheat-barley composite bread and control bread was tested for its nutritive content in comparison to refined flour bread. Results showed significant changes in the physical properties of the composite bread in comparison to the control bread. Sensory evaluation of bread displayed that bread made with 10% barley flour had no significant difference in all the attributes in comparison to control but 20% barley substitution showed significant change in appearance compared to control. With respect to nutritive content, both control and the

selected wheat-barley composite bread noted to be highly nutritious with enriched fiber when compared to the refined white flour bread.

Keywords: beta-glucan, wheat-barley composite bread, sensory properties etc.

1. INTRODUCTION

Functional foods are those foods that are advantageous to health and also helpful in decreasing the hazards of chronic diseases. The awareness about the functional foods has increased in the current years as everyone looks for better way to improve general health and wellness. In India, despite of low level of public awareness compared to western markets, functional foods and ingredients are finding huge growth as consumers switch on to the promise of healthier foods, beverages and supplements.

On the contrary, due to urbanization the increased demand for ready to eat products at reasonable costs also increased, particularly the bakery products. But in recent times functional foods are rapidly increasing in popularity in sectors such as dairy products or confectionery, in bakery it is still relatively underdeveloped. Bread is one such important staple food and the most widely consumed bakery product all over the world. In bread making, the use of white flour (refined) has been increased with an aim of improving the aesthetic value of white bread, which in-turn led to drastic reduction in the nutritional density and fiber content when compared to bread made from whole grain cereals.

In recent years, cereals and its ingredients such as beta-glucan, arabinoxylan, resistant starch, oligosaccharides etc are accepted as functional foods and nutraceuticals. Cereals, in particular oat and barley, offer another ideal way for the production of functional foods. By supplementing or substituting white wheat flour with a number of whole grain cereal flours of different origin may contribute to enhanced nutrient composition and content in the end product, thus making them as functional foods.

In developing functional bakery products (including bread), it is important to achieve the functional food quality not by simply delivering the active principle but also by satisfying consumer's requirements in terms of appearance, taste and texture.

Hence in the present study functional bread was developed using whole wheat flour and barley flour since wheat flour is the most commonly used cereal source and barley is one the beta-glucan rich source that is less exploited and underutilized in our community. Also bread is an ideal nutrient enrichment vehicle due to its use as a food staple with high acceptance in various forms throughout the world.

2. METHODS AND MATERIALS

Selection of Raw Materials

For the process of bread making, whole wheat flour were chosen, since it is highly nutritious when compared to white wheat flour. The barley flour selected for producing bread was prepared from the whole hulled barley and other ingredients chosen are yeast, sugar, fat, salt and water.

Procurement of Raw Materials

Whole wheat flour packed in air-tight plastic bags, yeast (dried powder), sugar, fat and salt that are commercially available were purchased whereas the whole barley was procured in the form of seed and de-husked. The de-hulled barley was finely ground to flour and stored in air tight plastic bags un-till use. All the materials chosen for bread-making were purchased from the local market in Puducherry region

Selection and Formulation of Composite Flour Blends

Recent study on barley substitution in bread-making proved 20% of maximum substitution yields good quality bread in respect to control bread (Aziz El Yamlahi et al., 2013). Whereas the researcher felt interested in increasing the proportion of barley flour to wheat flour since barley has much attention as functional ingredient. Hence five ratios were adopted for the present study and the selected ratios are: Wheat flour: Barley flour - 100:0, 90:10, 80:20, 70:30 and 60:40.

The selected ratios were prepared to blends by mixing 10%, 20%, 30% and 40% of the barley flour to the wheat flour in a blender for a period of 1 hour to produce uniform mixture. The flour blends in addition to 100% wheat flour were stored at ambient temperature (29°C ± 2°C) in a sealed polyethylene bags until required.

Formulation of Composite Flour and Other Ingredients for Bread Production

Five different bread samples were produced and they were coded as 100:0, 90:10, 80:20, 70:30 and 60:40. Sample 100:0 served as the control which contained only 100% wheat. Other samples consisted of wheat/barley flours and other ingredients for bread production. The composition of bread samples were given in the below table

Composition of functional bread ingredients

	SAMPLES				
Ingredients	**100:0 (Control)**	**90:10**	**80:20**	**70:30**	**60:40**
Wheat flour (gm)	100	90	80	70	60
Barley flour (gm)	0	10	20	30	40
Yeast (gm)	2	2	2	2	2
Salt (gm)	1.5	1.5	1.5	1.5	1.5
Sugar (gm)	10	10	10	10	10
Fat (gm)	3	3	3	3	3
Water (ml)	80	80	80	80	80

Bread Production by Straight Dough Method

The straight dough method was used to produce the bread (Chauhan et al., 1992). This method involves the addition of all ingredients like flour, salt, fat, water, sugar and yeast at mixing stage and kneading same to obtain the dough. The different dough samples were placed in baking pans smeared with vegetable oil and was covered for the dough to ferment for one hour this may result in gas production and gluten development. The dough was then baked in the oven at 230˚C for 30minutes. The baked loves were carefully removed from the pans and allowed to cool and packaged in polyethylene bags for further analysis.

Analysis on Wheat and Wheat/Barley Composite Bread

Determination of Physical Properties of the Bread Loaves

Loaf Height: A bread loaf was placed on a plain surface against a graduated scale without any disturbance. The height was determined by placing a flat scale on top of the loaf without pressing it. The flat scale points out the reading in the graduated scale which was taken as the height of the loaf in centimeters. Thus the height of all the composite breads produced were determined and expressed in centimeters.

Loaf Weight: The prepared bread loaf after cooled for an hour was placed in an electronic balance and the reading shown was noted as the weight of the loaf. Thus the weight of the each composite bread loaves was determined using a simple weighing machine and expressed in grams.

Loaf Volume: Loaf volume was determined using the rapeseed displacement method as reformed by Giami et al., 2004. A box of fixed dimensions (13×26.8×10cm) of internal volume 3484 $cm^3$was put in a tray, half filled with pearled barley, shaken vigorously for few times, then packed till slightly overfilled so that overspill fell into the tray. The box was again shaken thrice, and a straight scale was utilised to press across the top of the box to attain a level surface. The seeds were decanted from the box and weighed. The procedure was repeated three times and the mean value for seed weight was noted (C gm). A weighed loaf was placed in the box and weighed seeds (3000gm) were used to fill the box and levelled off as before. The overspill was weighed and from the weight obtained the weight of seeds around the loaf and volume of seed displaced by the loaf were calculated using the following equations by AACC method 10-05. 01 (2000).

Seed displaced by loaf (L) = C gm + overspill weight – 3000gm.

Volume of loaf (V) = L × 3484 / C.

Specific Volume: The specific loaf volume was determined by dividing the loaf volume by its corresponding loaf weight as per the procedure given by Araki et al., 2009.

Sensory Evaluation of the Bread Loaves

The five samples of bread were coded and presented to the ten member panel of judges for the sensory analysis. The panellist scored the appearance, crust colour, crumb texture, taste and overall acceptability of the bread using five point hedonic scale, where 5 indicates very good and 1 indicates very poor.

Nutritive Evaluation of the Selected Breads

From the sensory analysis, the composite bread with maximum substitution of barley flour that has high quality and overall acceptance was selected for nutritive evaluation along with the 100% whole wheat bread (CB) and refined wheat flour bread. The components such as carbohydrate, protein, fat were determined according to the procedure of American Association of Cereal Chemist (AACC, 2000) and dietary fiber was estimated according to the method of IS 11062 (1984).

3. RESULTS AND DISCUSSION

Physical Properties of the Wheat and Wheat/Barley Composite Bread:

Physical property determines the external property of the bread such as height, weight, volume and specific volume. In the present study, the developed composite breads were evaluated for its physical property and the values obtained are reported below;

Physical Properties of the Wheat and Wheat/Barley Composite Bread

Samples Wheat: Barley	Height (cm)	Weight (g)	Volume (cm^3)	Specific Volume (cm^3/g)
100:00	8.82 ± 0.192^{a}	182.2 ± 1.095^{a}	701.85 ± 8.467^{a}	3.85 ± 0.053^{a}
90:10	8.07 ± 0.058^{b}	179.7 ± 1.155^{ab}	687.33 ± 10.15^{a}	3.82 ± 0.069^{a}
80:20	7.12 ± 0.259^{c}	179.4 ± 1.949^{b}	633.64 ± 16.58^{b}	3.53 ± 0.129^{b}
70:30	6.3 ± 0.071^{d}	178.6 ± 1.140^{b}	529.23 ± 10.90^{c}	3.05 ± 0.074^{c}
60:40	5.68 ± 0.164^{e}	173.4 ± 1.140^{c}	487.34 ± 13.04^{d}	2.73 ± 0.075^{d}

The values are expressed as the mean of three replicate sampels ± standard deviation. Values with similar superscripts in a column do not differ significantly ($P < 0.05$)

The loaf height and weight of the bread decreased with increase in the substitution of barley flour. The height and weight of the composite bread ranged from 8.07cm to 5.68cm and 179.67gm to 173.4gm. There was a significant difference in all the samples with respect to loaf height. Loaf weight reduction during cooking is an undesirable quality attribute as consumers are often attracted to bread with high weight and volume believing that it has more substance for the same price (Malomo S A., 2011).

The volume of the bread made from composite flours was less than the standard flour (100% wheat flour). The obtained result of reduced bread volume in substitution of barley flour with wheat flour was in accordance with the study conducted by Gill S et al, 2002. The composite ratio 90:10 wheat/barley bread had no significant difference with control bread hence it showed a similar bread quality like the 100% wheat bread. Whereas the incorporation of higher levels of barley flour had a negative effect on the volume of bread. This is in accordance with the report of Akobundu et al, (1988) that said the reduction in the wheat structure forming proteins and a lower ability of the dough to enclose air during proofing might have a volume depressing effect on bread. This could be also evidenced in the reduction in specific volume of the bread. Specific volume of the composite wheat/barley flour bread decreased significantly with increasing proportion of barley flour ranging from 3.82 cm^3/g to 2.73 cm^3/g for 10% substitution level to 40% substitution. Conferring to China Grain Products Research and Development Institute, CGPRDI (1983), the specific volume of standard bread should be 6 cm^3/g and should not be less than 3.5 cm^3/g (Lin et al., 2009). It seems that two composite ratios 90:10 and 80:20 in the present study fulfilled the basic criteria, with similar quality characteristic like wheat bread.

Sensory Evaluation of the Wheat and Wheat/Barley Composite Bread

The quality of a product assessed by means of sensory organs is termed as sensory or subjective evaluation. The process by which bread quality is determined still depends greatly on subjective assessment. The sensory evaluation results of developed composite wheat/barley breads were tabulated below;

Sensory Evaluation of the Wheat and Wheat/Barley Composite Bread

Samples Wheat: Barley	Appearance	Crust colour	Crumb Texture	taste/flavor	overall acceptability

100:00:00	8.3±0.823[a]	7.5±1.509[a]	8.0±1.054[a]	7.6±1.578[a]	7.8±1.398[a]
90:10:00	7.8±0.919[a]	7.5±1.650[a]	8±1.354[a]	7.9±1.370[a]	7.5±0.972[a]
80:20:00	6.1±0.738[c]	6.1±1.101[ab]	7.5±0.943[a]	6.6±1.265[a]	6.4±0.966[ab]
70:30:00	3.5±1.581[b]	4.9±2.025[bc]	4.8±2.616[b]	5.8±0.919[bc]	5.1±2.079[b]
60:40:00	2.9±1.912[b]	2.9±1.912[c]	4.6±2.271[b]	5±2.108[c]	5±1.633[b]

The values are expressed as the mean of three replicate samples ± standard deviation. Values with similar superscripts in a column do not differ significantly ($P < 0.05$)

Appearance: Appearance is the foremost characteristic that determines the quality of the product. In the developed composite breads, all the ratios had significant difference with respect to 100% wheat flour bread except 90:10 ratio which produced similar appearance after baking.

Crust Colour: The crust denotes the outside layer of the bread. It should be smooth and golden brown. The score for crust colour decreased as barley flour substitution level increased. However no significant difference was observed for the 100% wheat flour bread and bread sample that had 10% and 20% barley flour. Bread with 40% barley flour had the lowest score for crust colour indicating that crust colour was not attractive at higher barley substitution levels. The present observation was similar to the study done on Taro and whole wheat flour composite bread (Sanful., 2011).

Crumb Texture: Texture is the quality of the bread that can be seen by touch, the extreme to which it is rough or smooth, hard or soft. The baking conditions, state of the bread components and the amounts of absorbed water during dough mixing all contribute to the final texture of breads (Gomez et al., 2003). Addition of barley flour into the wheat bread formulation resulted in dense and coarse structure of bread. There was no significant difference in crumb texture between 100% wheat flour bread and the bread made of 10% and 20% barley flour. Whereas the increased substitution of barley flour to wheat flour made the bread to be more firm in texture. This could be attributed by the gluten dilution, which gets suppressed to form gluten network during bread making due to the soluble fiber beta glucan's utilization of water in dough development.

Taste: The taste of the bread is an important characteristic in determining the overall acceptability of the product. The taste diminished as the barley flour substitution level increased but the breads made of 100% wheat flour and 10%, 20% barley flour did not differ significantly in taste.

Overall Acceptability: The score for overall acceptability decreased as barley flour substitution level increased. The overall acceptance expresses how the consumers or panelists accept the product generally. The control received the highest score for overall acceptance followed by the 10% and 20% barley flour substituted breads. The bread with the highest barley flour substitution (40%) was unacceptable because it achieves lowest score for overall acceptability. The impaired organoleptic characteristics of the bread are generally improved by adding different combination of improvers such malt flour, wheat gluten and ascorbic acid in-order to increase the baking and sensory qualities of the product (Rodriguez et al., 2006)

On the whole, all the sensory characteristics of 90:10 ratio had no significant difference with respect to 100% wheat bread. Whereas 80:20 composite bread had significant difference in appearance in compared to control bread, but had no significant difference in other sensory qualities like crust colour, crumb colour, taste and overall acceptability. Hence it also satisfied the consumer perception on overall bread quality attributes.

Nutritive Evaluation of Refined Wheat, Whole Wheat and Wheat/Barley Composite Breads

The nutritional composition of different breads were evaluated and the content of carbohydrate, protein, fat and dietary fiber obtained were given in the below table;

Nutritional Composition of Selected Breads

Proximate composition (%)	Refined Wheat flour Bread	Control (100% wheat bread)	Sample (80:20 wheat barley composite bread)
Carbohydrate	49	42.51	44.12
Protein	9±0.360	12.74±1.532	11.80±1.984
Fat	3.2±0.360	2.87±0.756	2.84±0.691
Total dietary fiber	2.7±0.436	18.83±2.959	17.31±2.355

From the results it was noted that bread made from refined wheat flour (Maida) had less nutritional value when compared to other breads. In particular, the content of total dietary fiber was very less (2.7%) whereas the wheat and wheat/barley composite bread had 18.83 and 17.31%. This increased dietary fiber is due to the inclusion of whole grain cereal which contains the three nutrient rich parts – bran, germ and endosperm. Many significant researches proved that dietary fiber in relation to disease prevention particularly cardiovascular disease (CVD), inflammation and osteoporosis.

4. CONCLUSION

Quality is not an aim in itself, but is desired because it helps to satisfy purchase motives or values. Health is a quality dimension that has become very important to many consumers, and a number of studies indicate that, today, health is as important as taste, and that consumers form preferences based on this dimension motivated by expectations of both a longer life and one of higher quality. Thus in this study it was concluded that inclusion of whole grain cereals in-spite of refined flour is much healthier concept to produce functional foods. Further exploitation of underutilized barley flour in product development along with wheat flour also produced equal quality in terms of both sensory and health attributes.

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