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Development of High Fibre Biscuits Using Wheat Bran

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Abstract - High fiber biscuits were developed from the blends of refined flour and wheat bran for human consumption. The incorporation of ground wheat bran increased the contents of proximate compositional constituents of refined flour. The results of sensory evaluation showed that the incorporation of wheat bran in blends of refined flour up to 20% for developing biscuits was found most suitable. The inclusion of bran in refined flour significantly (P≤0.05) increased the protein, fat, minerals and crude fiber content and diluted the carbohydrate in biscuits without affecting the sensory scores in biscuits made form the crude fiber increased 4 folds containing the lends 20 percent wheat bran than control biscuits adversely.

Keywords: **Wheat bran biscuits, sensory evaluation, expansion ratio, hardness.**

I. INTRODUCTION

Wheat is the largest cereal grain crop of the world and the second largest in India [1]. The present annual production of wheat in India is about 93.8 million tonnes. There are approximately, 867 roller flour mills with installed capacity of 18.0 million tonnes but their capacity utilization is only 33.0 percent. Of the total production, about 12 per cent wheat go to milling industry before they are utilized. On this basis, it is estimated that roughly 2.1 million tonnes of wheat bran is produced annually. Wheat bran fetches lower prices in the market and is used as cattle feed. Besides economic concern, the flour undergoes a substantial reduction in nutritional value as nutrients rich bran and germ are separated out from the starchy endosperm. Due to high content of many essential nutrients such as minerals, vitamins, proteins and dietary fiber as well as, present day better understanding of the nutritive and physiological role of bran for humans, new areas of bran utilization have emerged including baked goods and many other cereal food products [2]. The nutritive value of bran depends on the chemical composition of bran, the digestibility and availability of its components, and also on its physical properties, such as particle size, density, water absorption capacity, hardness etc, which influence certain physiological processes taking place during food digestion. In the aleurone layer and pericarp the highest concentrations of minerals, vitamins and proteins are located, the major site being the aleurone granules. The important and positive role of the wheat bran as a source of ballast substances has been recognized both from physiological and nutritional point of view. Today, when we are at the twenty first century demand for ready to eat processed foods with better shelf life, satisfying taste, and with high nutritional quality has increased throughout the world, because of growing urbanization and increased employment of women in industrial and public sectors. Bakery products are the most important items that can satisfy all these requirements. However, the information on utilization of wheat bran to prepare biscuits is very scanty. In the present investigation, therefore, the composites of wheat bran and refined four were baked to develop highly acceptable biscuits.

II. MATERIAL AND METHODS

Fine wheat bran and refined flour were procured from the wheat flour, Victoria Foods Private Limited, B-32, Lawrence road, Industrial area, Delhi-110035. All other ingredients were purchased from local market. Wheat bran was thoroughly cleaned by removing dust, dirt and admixture of other grains. The cleaned wheat bran were ground in a domestic grinder (Philips). Fine wheat bran were sieved through an 80-100 mesh sieve. Wheat bran was included 0, 5, 10, 15, 20, 25 and 30 percent in refined flour to prepare blends. All composites were sifted through 60 mesh sieve to obtain uniform mixing.

Preparation of biscuits

Sweet biscuits were prepared using the traditional creamery method described by [3] Refined flour/ blends 64gm, Sugar Powder 18gm, Vegetable oil/ Shortening 16gm, Skim milk powder 1gm, Glucose 1gm, Ammonium bicarbonate 0.5gm, Common salt 0.4gm, Baking powder 0.3gm, Sodium bicarbonate 0.2gm, Vanilla flavour 0.02ml and Water as required for proper consistency were used as the recipe for preparing biscuits. Sugar, fat and flavor (vanilla) were creamed in a mixer. To this, a well-mixed blend of white flour/blends skim milk powder and baking powder was added along with water containing glucose, common salt, ammonium bicarbonate and sodium bicarbonate. The contents were mixed further for 2 minutes to make the dough. Using a wooden rolling pin, the dough was sheeted on a specially fabricated aluminium platform to a uniform thickness of 2.5 mm. Circular biscuits of 6 cm diameter were cut and baked for 8-9 minutes at 200 ^{0}C in a baking oven. Biscuits were prepared from refined flour (control) and blends of refined flour and wheat bran using the above proportions.

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Proximate Composition

The moisture, protein, fat and ash were determined by [4] method. The carbohydrates were calculated by subtracting the sum of moisture, protein, fat, ash and fiber from 100. The crude fiber was estimated using [5] method.

Physical Characteristics

Diameter (D): The diameter of biscuits was measured by laying six biscuits edge-to-edge and measuring to the nearest mm [5].The biscuits were rotated at 90° and their diameter was re-measured as a check determination. The average value was reported in mm.

Thickness (T): Thickness or height of the biscuits was measured by stacking six biscuits one above the other and the average value was expressed in mm [5].

Spread ratio (D/T): The spread ratio was calculated by dividing the average value of diameter (D) by the average value of thickness (T) of biscuits [5].

Per cent spread factor: The per cent spread factor was calculated by the following formula:

$$\% \text{ Spread Facotr} = \frac{\text{Spread ratio of biscuits prepared from blend}}{\text{Spread ratio of biscuits prepared from control}} \times 100$$

Density of biscuits: Density of biscuit was calculated by dividing weight by volume. Weight of 6 biscuits at a time was measured from which, weight of single biscuit were calculated. Volume of the biscuit was determined by rapeseed displacement method [6].

Hardness: Hardness of biscuits was measured by Stable Micro-System Texture Analyzer (TAXT 2i). The hardness was measured in terms of maximum force used to break the biscuit. The biscuits were placed under 2 mm diameter cylindrical probe and the texture analyzer settings were fixed (return to start option, pre test speed 2.0 mm/sec, test speed 0.5 mm/sec, post test speed 10 mm/sec, distance 4.0 mm/sec, load cell 50 and 200 points per second for graph). The maximum force was expressed in gram or Newton's.

Sensory evaluation of biscuits

Different biscuits prepared were subjected to sensory evaluation by using untrained laboratory panel. The biscuits were evaluated between 11:00 am and 12:00 noon or from 02:00 pm to 03:00 pm. The panelists were presented the samples and requested to record their ratings for appearance, colour, texture, flavour and overall acceptability on a 9 point Hedonic Scale using numerical values ranging from 1 to 9, where 1 represented disliked extremely and 9 represented liked extremely. The data obtained were analysed statistically on a completely randomized design using analysis of variance technique [7] to find if the differences were significant or not at 5 percent level of significance.

III. RESULTS & DISCUSSION

Blends of refined flour and wheat bran

Proximate composition

The result presented in Table 1 showed that refined flour and wheat bran contained 11.6 per cent and 17.47 per cent protein, respectively. The value for protein content in refined flour was within the range (8.0 to 15.6 per cent) reported by [8], [9] and [10] obtained from different varieties of wheat. The values for wheat bran were in the range of 12.1 to 21.7% reported by [11] and [12]. The protein content of raw blends varied proportionately and the variation was significant ($p<0.05$). This indicated that the blends of refined flour with wheat bran will have higher amount of protein content with improved nutritional value as the bran proteins are known to contain higher amount of albumins and globulins. The values for fat content in refined flour and wheat bran obtained in the present investigation were 0.94 per cent and 5.90 per cent respectively. The value for white flour was slightly lower than the range of 1.4 to 2.3 per cent reported [8] and [13]. However, the values for fat content in wheat bran was higher than 4.0 per cent reported by [12], [14], [15] and [16]. The fat content of raw blends varied proportionately with the amount of refined flour and wheat bran in raw blends. The variation in fat due to blending was significant ($P< 0.05$) in the blends. In the present study, a value of 0.75 per cent for ash content was obtained in refined flour and 5.10 per cent in wheat bran. The ash content of former was within the range of 0.43 to 1.8 per cent reported by [8] and [13] however, the values for later were towards the lower side than the range (5-8 per cent) reported by [17] but were within the range (3–9 per cent) estimated by [16]. The ash content of blends varied in proportion with the amount of refined flour and wheat bran. There was found an increase which was significant ($P<0.05$) with 10 per cent and more increase in wheat bran inclusion with refined flour.

Table – 1: Proximate composition of refined flour, wheat bran and their blends

Proportion of wheat bran %	Protein	Fay	Ash	Crude fiber	Carbohydrate
100	17.47	5.90	5.00	11.81	59.82
0	11.6	0.98	0.78	0.58	86.07
5	11.92	1.25	1.01	1.16	84.8
10	12.24	1.51	1.25	1.73	83.51
15	12.56	1.78	1.51	2.31	82.23
20	12.98	2.04	1.71	2.89	80.97
25	13.2	2.31	1.95	3.47	79.68
30	13.52	2.57	2.18	4.04	78.41

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Mean	12.57	1.78	1.48	2.31	82.24
C.D at 5%	0.11	0.16	0.04	0.12	0.70

Values are the average of three determinations

The values for crude fiber content in refined flour and wheat bran were 0.58 and 11.81 per cent, respectively. The crude fiber content increased significantly (P≤ 0.05) by blending of wheat bran with refined flour. The results presented in Table 1 of wheat bran in refined flour enriched the blends with protein, fat, minerals and crude fibre contents.

Table – 2: Effect of incorporation of wheat bran with refined flour in formulation on Physical characteristics of biscuits

PHYSICAL CHARACTERISTICS									
proportion of Wheat Bran	Water added ml	Weight of biscuit gm	Volume of biscuits cc	Density g/cc	Diameter mm	Thickness mm	Spread ratio d/t	% Spread factor	Hardness n
0	15.0	8.02	15.73	0.51	58.95	7.14	8.26	100	21.49
5	15.3	8.12	15.69	0.51	58.84	7.07	8.32	100.73	22.12
10	15.7	8.21	15.55	0.53	58.73	6.96	8.44	102.18	22.75
15	16.1	8.32	15.40	0.54	58.69	6.66	8.81	106.66	23.10
20	16.5	8.42	15.18	0.56	58.29	6.55	8.90	107.75	23.60
25	16.9	8.51	14.84	0.57	58.48	6.48	9.02	109.20	24.02
30	17.4	8.62	13.52	0.64	58.15	6.40	9.09	110.05	24.50
Mean	16.13	8.32	15.13	0.55	58.59	6.75	8.69	105.22	23.08
C.D at 5%	0.61	0.20	0.87	0.51	NS	0.49	0.51	1.13	2.27

* NS: Non Significant

Results presented in Table 1 showed that the blending of wheat bran with refined flour enriched blends with protein, fat, ash and crude fiber significantly (P≤0.05), however diluted with carbohydrate significantly (P≤0.05) in the blends used for biscuits making. The amount of carbohydrate (by difference) in refined flour and wheat bran were 86.07 per cent and 59.82 per cent, respectively. The value for wheat bran obtained in present investigation is similar to the range of 20-60 per cent reported by [18], [16], [19] and [20]. The carbohydrate content of raw blends varied proportionately and differences due to blending were significant (P<0.05).

Quality characteristics of biscuits

Effect of substitution of wheat bran on biscuits

The high fiber biscuits were made from the blends containing wheat bran up to 30 per cent with refined flour. The biscuits thus obtained were analyzed for physical, proximate and sensory characteristics.

Physical characteristics

High fiber biscuits were prepared by substituting refined flour with wheat bran to the proportion of 0, 5, 10, 15, 20, 25 and 30 per cent. The biscuits thus obtained were evaluated for weight, volume, density, diameter, thickness, spread ratio, per cent spread factor and hardness. The data obtained are given in Table 2. The results shows that the water requirement for dough formation increased from 15 to 17.4 ml per 100 g as the bran content in the formulation increased from 0 to 30 per cent. The increase in the water requirement was probably due to the presence of high amount of non-starchy polysaccharides which are present in the wheat bran. Similar observations were made by [21] and [20]. Whereas [22] also observed higher water absorption by the dough with increase in the level of fiber incorporation. By increasing the amount of wheat bran in the formulation for biscuits making, the weight, density, spread ratio, per cent spread factor and hardness increased significantly (p≤0.05). Whereas volume, diameter and thickness of biscuits decreased significantly (p≤0.05) with an increase in the proportion of wheat bran in the biscuits formulation. Similar results were reported by [20], [23] reported a decrease in the height of biscuits made from wheat flour substituted with hulls. [21] also reported that the density of biscuits increased gradually with increased level of bran incorporation. Thickness of biscuits on the other hand decreased gradually with increase in the amount of bran. They observed no significant change in the spread ratio of biscuits due to the incorporation of bran. These changes in the physical parameter were reflected in the spread ratio of biscuits which increased with the increase of bran. These finding are more or less similar to the finding of the present investigation. The hardness of biscuits in the present investigation increased from 21.49 to 24.50 Newton's by increasing bran incorporation from 0 to 30 per cent. [21] also reported that addition of bran resulted in harder texture of the biscuits. They further reported that beyond 30 per cent level of bran addition, the biscuit became slightly harder and darker in colour.

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Table – 3: Mean Sensory score for sensory attributes of biscuit made from the blends of refined flour and wheat bran

Sensory Attributes (Mean Sensory Score)	Proportion of Wheat Bran (Percent)							
	0	5	10	15	20	25	30	CD at 5%
Colour and appearance	8.0	7.9	7.8	7.7	7.6	7.4	5.9	0.43
Body and Texture	8.0	7.9	7.8	7.6	7.3	7.1	6.1	0.39
Taste and Flavour	8.2	8.1	8.0	7.9	7.7	7.5	5.8	0.42
Overall acceptability	8.1	8.0	7.9	7.7	7.5	7.3	5.9	0.41

Proximate composition of biscuits

The proximate composition of biscuits prepared from the blends of refined flour with wheat bran is presented in Table 3. The moisture, protein, fat, ash and crude fiber showed an increasing trend with an increase in the level of wheat bran in blends. A slight increase in moisture content was observed which might be due to more retention of water because of more amounts of polysaccharides present in bran. The biscuits made from the blend containing 20 per cent bran showed the increase in protein, fat, ash and crude fiber content. The increase in protein, fat, ash and crude fiber was found 11.9, 3.84, 120 and 396 percent in biscuits made form the blends containing 20 percent wheat bran. However decrease of 4.6 percent was observed in carbohydrate content. These changes in composition of biscuits might be due to the high amount of these nutrients in bran. It showed that incorporation of wheat bran with refined flour increased 5 fold in crude fiber. Hence fiber rich biscuits can be made from the blends containing 20 per cent bran. The biscuits made from the blend containing 20 per cent bran increased protein, ash, crude fiber significantly ($P \leq 0.05$) with respect to control. The results of the present investigation showed 12 and 18 percent enhancement in the protein and ash, respectively in composition to biscuits made from refined flour and wheat bran blends. Further a 5 fold enhancement was noted in crude fiber content because of the blending of wheat bran upto 20 per cent proportion.

Sensory characteristics

The biscuits made from the blends obtained by blending wheat bran with refined flour were subjected to sensory evaluation. The sensory attributes namely colour and appearance, body and texture, taste and flavour, and over all acceptability were evaluated on 9-point Hedonic scale and sensory score obtained were represented in Table 4. The mean sensory scores for colour and flavour of biscuits made from the blends of wheat bran with refined flour are presented in Table 4.

Table 4: Proximate composition of biscuits made from blends of refined flour and wheat bran

Proportion of Wheat bran	Moisture %	Protein %	Fat %	Ash %	Crude fiber %	Carbohydrate %
0	3.30	6.46	15.90	0.45	0.32	73.57
5	3.35	6.46	16.05	0.58	0.64	72.74
10	3.40	6.82	16.20	0.72	0.95	71.91
15	3.44	6.99	16.35	0.87	1.27	71.08
20	3.49	7.23	16.51	0.99	1.59	70.19
25	3.50	7.35	16.65	1.13	1.91	69.46
30	3.52	7.53	16.80	1.26	2.23	68.66
Mean	3.43	6.98	16.35	0.86	1.27	71.09
CD at 5%	NS	0.09	0.08	0.06	0.30	0.50

NS: Non Significant

The inclusion of wheat bran upto 20 percent did not vary the colour and appearance significantly with respect to control sample. Thereafter the variation was significant ($P \leq 0.05$). However biscuits made from the sample containing 25 per cent wheat bran were ranked in acceptable range on 9 point Hedonic scale by the panellists. The mean sensory scores for body and texture of biscuits made from the blends of refined flour and wheat bran are presented in Table 4. The results showed that the mean scores decreased significantly ($P \leq 0.05$) after the inclusion of wheat bran at 20 percent and more proportion of wheat bran in refined flour as ranked by the panellists. The biscuits made from refined flour scored maximum but the biscuits made from the blends containing wheat bran up to 15 percent did not vary significantly. However the biscuits made from the blends containing 20, 25 and 30 percent bran were reported in acceptable range on 9 point Hedonic scale of sensory evaluation by the panellists. The results of sensory score for taste and flavor presented in Table 4 revealed that the mean sensory score was highest for the biscuits made from refined flour, however the variation in mean sensory score in the biscuits made from the blends upto 15 percent inclusion of wheat bran was non-significant. The biscuits made from the blends upto 25 percent level of wheat bran scored in acceptable range by the panellists on

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9 point hedonics scale. The biscuit made from the blend with 30 percent bran was scored unacceptable as the biscuits were slightly gritty and had branny mouth feel. The mean sensory scores for over all acceptability of biscuits made from the blends of refined flour and wheat bran are presented in Table 4. The biscuits made from refined flour had highest mean sensory score followed by the biscuits made from the blends containing 5, 10, 15 per cent wheat bran. The biscuits made from the blends containing 20, 25 and 30 per cent bran portion were rated significantly ($P \leq 0.05$) lower than the control sample, however the biscuits made from the blends with 20 and 25 percent incorporation of bran were rated acceptable by the panellist on 9 point Hedonic scale. On the basis of the results of mean sensory score it was concluded that wheat bran may be included successfully up to 20 per cent which increased the crude fiber (5fold), protein (11.9%), minerals (120%) content and lowered the carbohydrate without affecting the sensory scores adversely. Hence on inclusion of wheat bran 20% with refined flour developed fiber rich biscuits.

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