Research Article

Quality Assessment and Physicochemical Characteristics of Bran Enriched Chapattis

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Cereal brans singly and in combination were blended at varying levels (5 and 10%) for development of Chapattis. Cereal bran enriched Chapattis were assessed for quality and physicochemical characteristics. On the basis of quality assessment, 10% enrichment level for Chapatti was the best. Moisture content, water activity, and free fatty acids remained stable during the study period. Quality assessment and physicochemical characteristics of bran enriched Chapattis carried out revealed that dough handling and puffing of bran enriched Chapatti prepared by 5 and 10% level of bran supplementation did not vary significantly. All types of bran enriched Chapattis except rice bran enriched Chapattis showed nonsticky behavior during dough handling. Bran enriched Chapattis exhibited full puffing character during preparation. The sensory attributes showed that both 5 and 10% bran supplemented Chapattis were acceptable.

1. Introduction

Chapattis are a form of unleavened flatbreads of Indian/Eastern origin. They form an integral part of Indian diet, especially for those who have type 2 diabetes for whom white rice is considered less desirable because of its high GI. Chapattis and other flatbreads are popular in Europe also where they form a part of daily diet among members of ethnic minority groups who follow traditional dietary patterns. Chapattis are made from whole-wheat flour and cooked on hot flat open griddles. They can also be prepared by substituting wheat flour with other cereal or legume flours at different levels. This could result in either improvement or deterioration of texture and taste of Chapattis. Incorporation of cereal brans at proportions up to 10% has resulted in good quality Chapattis. The color and appearance of Chapattis were found to be good with substitution of wheat flour with up to 10% cereal brans [1]. Generally, Chapatti is prepared from whole-wheat flour obtained by grinding wheat in a disk mill (locally known as chakki). Chapatti quality can be assessed from its softness and flexibility which may be affected by flour protein quantity and quality. The Chapatti quality is also influenced by the dough consistency, which in turn depends mainly on the quantity of water added. Chapatti of good quality can be made by adding cereal brans even up to 10% [1]. The Chapatti made from composite flour showed higher extensibility even after 24-hour storage.

Bran is the hard outer layer of cereal grains, rich in a myriad of healthy phytochemicals, namely, phenolics, flavonoids, glucans, and pigments. Unfortunately, these nutrition-rich components are often discarded during milling out of ignorance, organoleptic reasons, and rancidity problems. Knowing the phytochemical constituents and pharmacological profile of bran is expected to give insight to their potential application in promotion of health. Cereal brans, the by-products obtained in large amounts in grain milling industry, considered as inedible material for humans, is mostly used as animal feed. However, brans are concentrated source of dietary fibre and other nutrients (proteins, B-vitamins, and minerals). Brans are generally composed mainly of insoluble cellulose and hemicellulose, with only about 5 percent soluble...
fibre, and have little hypercholesterolemia effect [2]. Bran contributes a pleasing, sweet, nutty flavour when added as a flavour enhancer in a variety of food products.

2. Materials and Methods

2.1. Raw Materials Used in the Investigation. Commercial wheat flour and oat bran (Baggry’s India Ltd., New Delhi, India) were purchased from local market. Wheat bran was collected from Ludhiana Flour Mill, Ludhiana, India. Rice bran was purchased from “Ricela Health Foods Ltd.”, Dhuri, Punjab, India.

2.2. Product Preparation. Chapatti was prepared by the addition of cereal brans (wheat, oat, and rice) singly and in combination (w:r:o::2:1.5:1.5) to wheat flour at 5 and 10% bran supplementation. Chapatti. Cereal brans singly and in combination at 5 and 10% level were added to wheat flour and required quantity of water which were mixed manually to obtain dough of suitable consistency. The dough was rounded manually and kept for half an hour at room temperature. The dough was divided into four equal parts and moulded into circular Chapattis of 15.0 cm in diameter with rolling pin and board [3].

Traditional home baking procedure was followed to bake Chapattis on iron plate (Tawa). Chapattis were cooled and comparative evaluation was done using the following criteria which also included observations on dough handling properties.

2.3. Physicochemical Composition of Prepared Products. Physicochemical composition of prepared product was determined by standard methods [4].

2.4. Texture and Colour Analysis

2.4.1. Colour Analysis. Colour analysis of cereal bran enriched Chapatti was done by using Hunter Lab colorimeter. The instrument was calibrated with the user supplied black plate calibration standard that was used for zero setting. Minolta supplied white calibration plates were used for white calibration setting. The sample was uniformly packed in clean petri plates with lid. The instruments were placed on the plate and three exposures at different places were conducted. Readings were displayed as $a^*$, $b^*$, and $L^*$ color parameters according to the CIELAB system of color measurement. The $a$ value ranges from $-100$ (redness) to $+100$ (greenness) and the $b$ value ranges from $-100$ (blueness) to $+100$ (yellowness), while the $L$ value, indicating the measure of lightness, ranges from 0 (black) to 100 (white). The following guidelines indicate colour status (Figure 1).
2.4.2. Texture Profile Analysis. Cutting force of Chapatti was evaluated by using texture analyser (Stable Micro Systems, Model TA-HDi, UK). Strips measuring 4 cm × 2 cm were cut from each Chapatti. One strip at a time was placed on the centre of the sample holder and the blade was allowed to cut the Chapatti strip. The force (N) required to cut Chapatti strip into two pieces was recorded. The speed was maintained at 1.70 mm/s.

2.5. Sensory Evaluation. Bran enriched products such as extruded snacks, breakfast cereal-Porridge, and Chapatti were evaluated for sensory attributes (appearance, colour, texture, flavor, and overall acceptability) through a panel of semi-trained judges using 9-point hedonic scale [5].

2.6. Water Activity. Water activity of bran enriched products was estimated using water activity meter having HygroLab 3 bench-top indicator (Rotrogenic Company).

2.7. Free Fatty Acids. Standard AOAC procedure [6] was followed for free fatty acids determination in cereal bran enriched products. Product sample (5 g) was taken in flask and 50 mL benzene was added and kept for 30 min for extraction of free fatty acids. After extraction, 5 mL extract, 5 mL benzene, 10 mL alcohol, and phenolphthalein as indicator were taken in flask and titrated against 0.02 N KOH till light pink colour disappeared:

\[
\% \text{FFA} \ (\% \text{oleic acid}) = \frac{282 \times 0.02 \times \text{wt of sample taken}}{1000 \times \text{mL of alkali used} \times \text{dilution factor}}
\]

moisture content by method of AACC 2000 [4],
total plate count by method of Maturin and Peeler [7].

2.8. Statistical Analysis. Data collected from the aforesaid experiments was subjected to statistical analysis for standard error and Duncan’s multiple range test using Minitab software. Values are mean of triplicates.

3. Results and Discussion

3.1. Bran Enriched Chapatti

3.1.1. Quality Assessment. The quality evaluation of Chapattis prepared by different bran enriched levels is mentioned in Table 1. The pooled scores obtained by the various bran enriched levels of Chapattis for appearance, color, texture, and flavor were 7.92, 7.18, 7.68, and 8.10 for wheat bran, rice bran, oat bran, and bran in combination enriched Chapattis, respectively. All bran enriched Chapattis were in highly acceptable range. The overall acceptability at 5 and 10 percent level of supplementation was 7.65 and 7.80, respectively. However, it was 7.89 for control Chapattis. Butt et al. [1] reported that Chapattis, prepared by the addition of 10% bran, showed better performance and were quite comparable with whole-wheat flour regarding the proximate components and sensory attributes.

Dough handling characteristics of bran enriched Chapattis do not show much variation with respect to type of bran used. Except for rice bran incorporated dough for Chapatti (slightly sticky), all others showed nonsticky behavior during dough development. The puffing character also did not vary much. All types of bran enriched Chapattis showed full puffing except 10% rice bran enriched Chapatti in which partial puffing during Chapatti preparation was visualised.

3.2. Colour and Texture Analysis. The data presented in Table 2 depicted color and texture analysis of bran enriched Chapatti. Statistically significant (P ≤ 0.05) difference was observed in L* value of bran enriched Chapatti. L* value of various cereal bran enriched Chapatti was 64.37, 59.12, 60.04, and 61.92 for wheat, rice, oat, and bran in combination, respectively. L* value showed decreasing trend with increase in level of supplementation of cereal brans in Chapatti. The L* value of 66.83, 61.59, and 61.14 was observed at 0, 5, and 10% level of supplementation, which means slightly lower brightness at higher levels of supplementation. Reverse trend to that of L* value was observed in a* values of Chapattis. Chapattis having maximum L* values recorded minimum a* value and vice versa. a* value of wheat, rice, oat, and bran in combination was 4.18, 5.24, 4.71, and 4.28, respectively. With increase in level of supplementation, a* value (redness) increased from 3.14 at 0% level of supplementation to 5.11 at 10% level. The hue angle of bran enriched Chapatti varied from 72.36 to 75.56. Altan et al. [8] stated that, among the color parameters, the L* and a* values showed marked changes due to addition of tomato pomace. An increase in tomato pomace level decreased the L value of the sample and increased the a* value of samples. Also, increasing bran level supplementation resulted in a decrease in the b* value of Chapattis. A negative correlation was found between a* value and b* value of the enriched Chapatti.

Cutting force (N) reflects the texture of the Chapatti and it stimulates the biting action of the human teeth on Chapatti [9]. Cutting force (N) of various bran enriched Chapatti varied as 6.56 N, 5.92 N, 5.30 N, and 5.99 N for wheat, rice, oat, and bran in combination. Cutting force increased due to presence of more fibres at higher enrichment levels. At 0, 5, and 10 percent level of supplementation, the corresponding cutting force (N) was 5.25, 5.91, and 5.97 N, respectively. Manu and Prasada Rao [10] reported that cutting force of Chapatti prepared from different wheat varieties ranged from 4.22 to 6.96 N. Hemalatha et al. [11] also reported that the cutting force (N) for Chapatti made from different wheat varieties ranged between 4.22 and 6.67. The variation in cutting force might be because of variation in protein and fibre content of brans which determine the resistance offered by the samples.
**Table 1: Quality evaluation of bran enriched Chapatti.**

(a) Type of bran & supplementation (%) | Dough handling | Puffing | Appearance | Color | Texture | Flavor | Overall acceptability
---|---|---|---|---|---|---|---
Control | NS | FP | 8.2 | 7.6 | 8.06 | 7.7 | 7.89
Wheat bran | 5 | NS | FP | 8.1 | 7.9 | 7.76 | 7.6 | 7.84
10 | NS | FP | 8.2 | 8.1 | 7.7 | 8.0 | 8.00
Mean | | | 8.15 | 8.0 | 7.73 | 7.8 | 7.92
Rice bran | 5 | SS | FP | 8.0 | 8.0 | 8.0 | 8.0 | 8.00
10 | SS | PP | 6.5 | 6.5 | 6.5 | 6.0 | 6.37
Mean | | | 7.25 | 7.25 | 7.25 | 7.0 | 7.18
Oat bran | 5 | NS | FP | 7.25 | 7.25 | 7.0 | 8.1 | 8.10
10 | NS | FP | 8.0 | 8.0 | 8.25 | 8.25 | 8.12
Mean | | | 7.62 | 7.62 | 7.62 | 7.87 | 7.68
In combination | 5 | NS | FP | 8.3 | 8.2 | 7.8 | 8.1 | 8.10
10 | NS | FP | 8.3 | 8.16 | 7.8 | 7.2 | 8.11
Mean | | | 8.30 | 8.18 | 7.80 | 7.65 | 8.10

NS: non-sticky; S: slightly sticky; FP: full puffing; P: partially puffing.

(b) Mean ± SE | Appearance | Color | Texture | Flavor | Overall acceptability
---|---|---|---|---|---
Bran | | | | | |
Wheat | 8.15 ± 0.04 | 8.0 ± 0.06 | 7.73 ± 0.03 | 7.80 ± 0.10 | 7.92 ± 0.04 |
Rice | 7.25 ± 0.34 | 7.25 ± 0.34 | 7.25 ± 0.34 | 7.00 ± 0.045 | 7.18 ± 0.36 |
Oat | 7.62 ± 0.17 | 7.62 ± 0.17 | 7.62 ± 0.28 | 7.87 ± 0.17 | 7.68 ± 0.19 |
In combination | 8.30 ± 0.01 | 8.18 ± 0.02 | 7.80 ± 0.05 | 7.65 ± 0.20 | 8.10 ± 0.03 |
Level mean | 5% | 7.91 ± 0.12 | 7.83 ± 0.11 | 7.64 ± 0.08 | 7.80 ± 0.08 | 7.65 ± 0.22 |
10% | 7.75 ± 0.22 | 7.69 ± 0.21 | 7.56 ± 0.026 | 7.36 ± 0.26 | 7.80 ± 0.10 |

**Table 2: Color and texture analysis of bran enriched Chapatti.**

(a) Type of bran & supplementation level (%) | \( L^* \) | \( a^* \) | \( b^* \) | Hue angle (°) | Cutting force (N)
---|---|---|---|---|---
Control | 66.83 | 3.14 | 15.20 | 74.76 | 5.25
Wheat bran | | | | | |
5 | 66.15 | 3.76 | 15.36 | 74.86 | 6.52
10 | 64.59 | 4.62 | 15.58 | 73.86 | 6.60
Mean | 64.37 | 4.18 | 15.47 | 74.36 | 6.56
Rice bran | | | | | |
5 | 61.32 | 4.08 | 17.15 | 76.31 | 5.88
10 | 56.92 | 6.41 | 16.52 | 73.48 | 5.96
Mean | 59.12 | 5.24 | 16.83 | 74.90 | 5.92
Oat bran | | | | | |
5 | 57.64 | 4.62 | 16.33 | 69.26 | 5.28
10 | 62.60 | 4.78 | 16.92 | 75.47 | 5.32
Mean | 60.04 | 4.71 | 16.62 | 72.36 | 5.30
In combination | | | | | |
5 | 62.41 | 4.04 | 16.93 | 76.10 | 5.96
10 | 61.44 | 4.63 | 15.74 | 75.01 | 6.02
Mean | 61.92 | 4.28 | 16.33 | 75.56 | 5.99

(b) Mean ± SE | \( L^* \) | \( a^* \) | \( b^* \) | Hue angle (°) | Cutting force (N)
---|---|---|---|---|---
Bran | | | | | |
Wheat | 64.37 ± 0.35 | 4.18 ± 0.20 | 15.47 ± 0.05 | 74.36 ± 0.23 | 6.56 ± 0.02
Rice | 59.12 ± 0.98 | 5.24 ± 0.52 | 16.83 ± 0.14 | 74.90 ± 0.63 | 5.92 ± 0.02
Oat | 60.04 ± 1.14 | 4.71 ± 0.03 | 16.62 ± 0.13 | 72.36 ± 1.39 | 5.30 ± 0.01
In combination | 61.92 ± 0.22 | 4.28 ± 0.11 | 16.33 ± 0.27 | 75.56 ± 0.25 | 5.99 ± 0.02
Level mean | 5% | 61.59 ± 0.83 | 4.13 ± 0.31 | 16.44 ± 0.21 | 74.14 ± 0.86 | 5.91 ± 0.13
10% | 61.14 ± 0.77 | 5.11 ± 0.08 | 16.19 ± 0.17 | 74.46 ± 0.24 | 5.97 ± 0.14
### Table 3: Physicochemical characteristics of enriched Chapatti.

| Type of bran & supplementation level (%) | Moisture (%) | Water activity ($a_w$) | Free fatty acids (%) | TPC ($\times 10^3$ cfu) |
|-----------------------------------------|--------------|------------------------|----------------------|-------------------------|
| Control                                 | 30.31        | 0.456                  | 0.040                | 18                      |
| Wheat bran                              |              |                        |                      |                         |
| 5                                       | 32.33        | 0.442                  | 0.052                | 12                      |
| 10                                      | 30.47        | 0.483                  | 0.063                | 14                      |
| Mean                                    | **31.40**    | **0.462**              | **0.057**            | **13**                  |
| Rice bran                               |              |                        |                      |                         |
| 5                                       | 32.50        | 0.428                  | 0.074                | 15                      |
| 10                                      | 33.58        | 0.430                  | 0.097                | 19                      |
| Mean                                    | **33.04**    | **0.429**              | **0.085**            | **17**                  |
| Oat bran                                |              |                        |                      |                         |
| 5                                       | 32.15        | 0.391                  | 0.076                | 8                       |
| 10                                      | 33.23        | 0.422                  | 0.084                | 10                      |
| Mean                                    | **32.69**    | **0.406**              | **0.085**            | **9**                   |
| In combination                          |              |                        |                      |                         |
| 5                                       | 32.65        | 0.455                  | 0.074                | 6                       |
| 10                                      | 32.38        | 0.456                  | 0.074                | 7                       |
| Mean                                    | **32.52**    | **0.455**              | **0.074**            | **6.5**                 |

#### (b)

| Mean ± SE | Moisture | Water activity | Free fatty acids | TPC ($\times 10^3$ cfu) |
|-----------|----------|----------------|------------------|-------------------------|
| Bran                   |          |                |                  |                         |
| Wheat       | 31.40$^d$ ± 0.42 | 0.462$^d$ ± 0.009 | 0.057$^a$ ± 0.002 | 13$^c$                 |
| Rice        | 33.04$^d$ ± 0.24 | 0.429$^b$ ± 0.001 | 0.085$^d$ ± 0.005 | 17$^d$                 |
| Oat         | 32.69$^c$ ± 0.24 | 0.406$^c$ ± 0.006 | 0.077$^c$ ± 0.003 | 9$^b$                  |
| In combination | 32.52$^b$ ± 0.06 | 0.455$^c$ ± 0.001 | 0.074$^b$ ± 0.001 | 6.5$^b$                |
| Level mean  |          |                |                  |                         |
| 5%          | 32.68$^d$ ± 0.10 | 0.429$^a$ ± 0.007 | 0.067$^a$ ± 0.003 | 10.25$^a$              |
| 10%         | 32.14$^d$ ± 0.33 | 0.448$^b$ ± 0.007 | 0.079$^b$ ± 0.004 | 12.50$^b$              |

### 3.3. Physicochemical Characteristics

Physicochemical characteristics of bran enriched Chapatti are elucidated in Table 3. Moisture content of bran enriched Chapatti ranged between 31.40 and 33.04%. A slight change in moisture content of Chapatti was observed with addition of bran. Increase in fibre content might have increased the water holding capacity of Chapatti and hence increased moisture content (%) with addition of bran. Yadav et al. [12] reported that moisture content (%) of bran enriched Chapatti was 31.0 percent while control had moisture content of 30.2 percent.

Water activity of bran enriched Chapatti ranged from 0.406 to 0.462. Maximum water activity was observed in rice bran enriched Chapatti (0.462) which was statistically at par with water activity of bran in combination enriched Chapatti (0.455). Water activity of oat and wheat bran enriched Chapatti was 0.429 and 0.406, respectively. It was observed from data that water activity of samples was positively correlated with moisture content and followed the same pattern. Increase in bran supplementation resulted in increase in water activity of bran enriched Chapatti. Manthey et al. [13] reported that water activity of bran/fibre enriched pasta increased with bran supplementation over control. The increase in water activity is correlated with increase in moisture content at higher levels of bran supplementation.

The data pertaining to free fatty acids (%) is presented in Table 3. The free fatty acids (%) of bran enriched Chapatti ranged from 0.057 to 0.085. The highest free fatty acids were recorded in rice bran enriched Chapatti (0.085%), being the lowest in wheat bran enriched Chapatti (0.057%). It is also evident from the table that, with increase in level of bran supplementation, free fatty acids increased significantly. The free fatty acids (%) at 5 and 10 percent level of supplementation were 0.067 and 0.079 percent, respectively. Khan et al. [14] reported similar results regarding free fatty acids while studying development and evaluation of long shelf life ambient stable Chapatti.

Total plate count of bran enriched Chapatti is tabulated in Table 3. A significant variation ($P \leq 0.05$) was observed in total plate count of bran extruded Chapatti. Total plate count of enriched Chapatti varied from 6.5 to $17 \times 10^3$ cfu/g. It is also evident from the table that with increase in bran supplementation level, a slight increase in total plate content was observed. The mean value of total plate content for
5 and 10% level of supplementation was $10.25 \times 10^3$ and $12.5 \times 10^3$ cfu/g, respectively. The total plate count of *Chapattis* was under safe limits. Frazier and Westhoff [15] reported that total plate content increased from $2.3 \times 10^2$ to $3.4 \times 10^2$ cfu/g for flour.

### 4. Conclusions

Quality characteristics for *Chapatti* revealed that dough handling and puffing of bran enriched *Chapattis* prepared by 5 and 10% level of bran supplementation did not vary significantly. All types of bran enriched *chapattis* except rice bran enriched *chapattis* showed nonsticky behavior during dough handling. Bran enriched *chapattis* exhibited full puffing character during preparation. The sensory attributes showed that both 5 and 10% bran supplemented *Chapattis* were acceptable. Physicochemical characteristics of bran enriched *Chapatti* differed significantly ($P \leq 0.05$). Rice bran enriched *Chapatti* recorded maximum moisture (%), water activity, and free fatty acids (%). With increase in level of supplementation, moisture, water activity, and free fatty acids increased. The future emphasis can be given on development of functional flatbreads which has got increased demand due to increase in health conscious consumer base.

### Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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