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# Effect of Different Fermentation Time and Baking on Phytic Acid Content of Whole-wheat Flour Bread

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**Abstract:** An experiment was conducted to study the different fermentation time and baking on phytic acid content of whole-wheat flour. Result revealed that the Ghaznavi and Fakhr-e-Sarhad contain 7.32 and 9.32% moisture, 1.50 and 1.30% ash, 9.20 and 10.68% crude protein, 1.60 and 2.00% crude fat, 2.00 and 1.60% crude fiber and 78.38 and 75.10% NFE, respectively. Phosphorus and iron content of whole-wheat flour of two cultivars were also determined, which contain 4.00, 4.32 mg $100g^{-1}$ iron and 245, 330.5 mg $100\ g^{-1}$ phosphorus respectively. Ghaznavi and Fakhr-e-Sarhad cultivars of wheat were analyzed for phytic acid composition in whole-wheat flour and bread. They contain 869.2 and 869.4 mg $100\ g^{-1}$ phytic acid in whole-wheat flour. The phytic acid content of Ghaznavi for control bread (unleavened) is 752.3 mg $100\ g^{-1}$ and for bread leavened for 15, 30 and 45 minutes it was 662.1, 512.1 and 280.3 mg $100\ g^{-1}$. Similarly for Fakhr-e-Sarhad, phytic acid content is 751.7 mg $100\ g^{-1}$ for control (unleavened) bread, 661.1 and 510.8 and 280.4 mg $100\ g^{-1}$ for fermented breads (leavened) for 15, 30 and 45 min., respectively. The data indicate the higher phytic acid value for unleavened breads and lower phytic acid value at 45 min. fermented breads (leavened) of both the cultivars. Statistical analysis of the data revealed that the treatments have significant effect on the reduction of phytic acid content as compare to the varietal and interaction means, and fermentation time and baking. Data showed that treatment cultivars and their interaction significantly improved the sensory qualities such as color, taste, texture and overall acceptability. The results of this work suggest that fermentation of whole-wheat flour for 45 min. can reduce significantly the amount of phytic acid. Bread preparation from such treated flours dough will have, high nutritional impact.

**Key words:** Whole-wheat flour, phytic acid, fermentation time, baking

## Introduction

Wheat (*Triticum aestivum* L.) is a man's common food and constitutes a major source of most of the diet in the developing countries including Pakistan. It is consumed primarily as a source of carbohydrate and protein but is also a potential source of minerals including trace elements. Wheat is consumed as staple diet in Pakistan and most of it is used in chapatti making and remaining is used in other products. Wheat contributes more than 60% of the total protein and calories requirements in the daily diet (Anonymous, 1986). The wheat cultivation in Pakistan has made a remarkable progress in elevating wheat per unit area as well as production (Agri. Stat. Pak., 1999-2000). The major contribution in the development is due to the introduction of new semi dwarf high yielding disease resistant and fertilizer responsive varieties. The presence of gluten protein (glaidin and glutenin) content makes the wheat unique from other cereals. When glaidin and glutenin content is hydrated they form viscoelastic dough. Consumption of fiber-rich foodstuffs usually results in elimination of alternative dietary components, which may have higher fat and or refined starch contents. Phytic acid is a hexaphosphoric acid ester of inositol present mainly in cereal grains, nuts and legumes. However, it should not be considered a phosphate source for humans. When phytic acid combines with calcium or magnesium, it forms an insoluble salt referred to as a phytin. More than 50% of the phosphorus in mature seeds is in the form of phytin. Furthermore, in the intestine phytic acid may combine with calcium, iron, zinc and magnesium, reducing their absorption (Ensminger *et al*., 1986). Among cereals wheat is a good source of protein, minerals and vitamins. Beside of nutritious it also contains some antinutrients i.e. phytate which is the principal source of phosphorus. Phytic acid (Inositol Hexaphosphoric Acid) is a constituent of cereal grains (1-5%) and is known to decrease the bioavailability of zinc and other trace elements to humans and monogastric animals (Oberleas *et al*., 1961). Phytic Acid forms complexes with divalent and trivalent metallic ions, such as $Zn^{+2}$, $Fe^{+3}$,$Ca^{+2}$ and $Cu^{+2}$, which are not absorbed in the gastrointestinal tract and decrease the bioavailability of

several essential elements leading to deficiency diseases (Smith and Circle, 1978). Interaction of phytate with protein, vitamins and minerals are important factors, which limit the nutritive value of these cereals.

## Materials and Methods

All the work reported in this experiment was carried out in the department of food sciences and technology of NWFP Agricultural University, Peshawar. Samples of two cultivars of wheat Fakhr-e-Sarhad and Ghaznavi were collected from Agricultural University, Peshawar. The samples were thoroughly cleaned manually and then washed and sun dried. Wheat grain of each variety was tempered to 14% moisture level and allowed to stand for 24 h at room temperature. The amount of water required for tempering of wheat grain was computed according to the expression given in AACC (1983). The wheat grain was milled by using udy-cyclone, and was packed separately into polythene bags. The bags were then stored in a cool place for further processing and analytical work. The chemical analysis included moisture, ash, crude protein, crude fat, crude fiber and nitrogen free extract were performed in accordance with AOAC (1990). Iron of whole-wheat flour was determined by Atomic Absorption Spectrophotometer and whereas Phosphorus was determined Spectrophotometerically. Phytic acid was determined by means of Haug and Lantzsch (1983) procedure. Breads prepared from both cultivars according to the standard method of AACC (1983). Organoleptic Evaluations of Breads cultivars of wheat were evaluated for color, taste, texture and over all acceptability, according to the method of Matz (1960).

## Results and Discussion

Wheat cultivars viz. Ghaznavi and Fakhr-e-Sarhad were analyzed for chemical composition and the data was represented in Table 1.

Analysis of the data (Table 1) revealed that both cultivars Ghaznavi and Fakhr-e-Sarhad contain 7.32 and 9.32% moisture, 1.50 and 1.30% ash, 9.20 and 10.68% crude protein, 1.60 and 2.00% crude fat, 2.00 and 1.60% crude fiber and 78.38 and 75.10% Nitrogen Free Extract (NFE), respectively. It was found that Ghaznavi has higher content of ash, crude fiber and carbohydrate than Fakhr-e-Sarhad, while crude protein, crude fat and moisture contents of Ghaznavi were lowered as compared with Fakhr-e-Sarhad. Hussain (2001) reported that wheat-whole grain flour on average contain 12.00% moisture, 10.90% protein, 1.60% fat, 1.30% fiber, 1.40% ash and 72.60% NFE. According to Janick and Kowalczyk (1967) reported the composition of rye and wheat that contain about 12% protein, 2% lipids (fat), 71-72% NFE, 2% crude fiber and 2% minerals. These results agree with those reported by Hussain (2001) and contrary to those reported by Janick and Kowalczyk (1967). This could be due to the difference in chemical composition of wheat, mainly due to genetic make up of a variety and climatic condition in which the wheat is grown (Pomeranz and Shellenberger, 1971).

Mean value of the data (Table 2) regarding phosphorus, iron and phytic acid content of whole-wheat flour of two cultivars reveled that the Ghaznavi and Fakhr-e-Sarhad contained 4.00, 4.32 mg 100 $g^{-1}$ iron and 245.0, 330.5 mg 100 $g^{-1}$ phosphorus respectively. These finding are closely in agreement with those reported by Hussain (2001). Mean value of the data (Table 2) reveled that phytic acid content of Ghaznavi and Fakhr-e-Sarhad cultivars were 869.4 and 869.2 mg 100 $g^{-1}$ respectively. These results agree with those reported by Graf and Eaton (1990). Reddy *et al.* (1989) reported that phytic acid is present in the range of 1-5% of many cereals, legumes, and oil seeds.

Mean value of the data (Table 3) revealed that the phytic acid content of Ghaznavi for controlled bread (unleavened) is 752.3 mg 100 $g^{-1}$ and for bread leavened for 15, 30 and 45 min. they are 662.1, 512.1 and 280.3 mg 100 $g^{-1}$ respectively. Likewise, phytic acid content of Fakhr-e-Sarhad, is 751.7 mg 100 $g^{-1}$ for controlled (unleavened) bread, and fermented breads (leavened) for 15, 30 and 45 min. they are 661.1, 510.8 and 280.4 mg 100 $g^{-1}$, respectively. Mean values of the data (Table 3) indicate that the higher phytic acid value for unleavened breads and lower phytic acid value at 45 min. fermented breads (leavened) of both the cultivars. The results indicate significant difference at $\alpha$ 0.05 for both the cultivars, The treatments has significant effect on the reduction of phytic acid content as compare to the varietal and interaction means. The fermentation time and baking have significant effect on the reduction of phytic acid. These results agree with those reported by Poonam and Salil (1993) who claim reduction in phytic acid content in the processed weaning food, after mixing with locally available cereals (wheat and barley) and pulses. The results are also in agreement with those represented by Mameesh and Tomar (1993), whereas Almana (2000) observed that fermentation of soybean fortified wheat flour resulted in complete removal of phytic acid. Likewise Kelbessa *et al.* (1999) reported the complete removal of phytic acid upon fermentation by fortifying soy flour with wheat flour.

Whole-wheat flour breads prepared from two cultivars (controlled and fermented breads) are evaluated organoleptically. Mean value of the score for various parameters such as color, flavor, texture and overall acceptability are represented in Table 4, 5, 6 and 7.

Table 1:Proximate composition of whole-wheat flour (percent)

| Cultivars | Moisture | Ash | C. Protein | C. Fat | C. Fiber | NFE |
|---|---|---|---|---|---|---|
| Ghaznavi | 7.32 | 1.50 | 9.20 | 1.60 | 2.00 | 78.38 |
| Fakhr-e-sarhad | 9.32 | 1.30 | 10.68 | 2.00 | 1.60 | 75.10 |

Table 2:Iron, Phosphorus and Phytic Acid Compositions of Whole-Wheat Flour (mg 100 g-1)

| Cultivars | Iron | Phosphorus | Phytic acid |
|---|---|---|---|
| Ghaznavi | 4.00 | 245 | 869.4 |
| Fakhr-e-sarhad | 4.32 | 330.5 | 869.2 |

Table 3: Effect of fermentation and baking temperature on phytic acid content of whole-wheat flour bread (mg 100 $g^{-1}$)

| | | Leavened | | | |
|---|---|---|---|---|---|
| Cultivars | Unleavened | 15 min | 30 min | 45 min | Mean |
| Ghaznavi | 752.3 | 662.1 | 512.1 | 280.3 | 551.7a |
| Fakhr-e-sarhad | 751.7 | 661.1 | 510.8 | 280.4 | 550.9a |
| Mean | 752.0a | 661.6b | 511.45c | 280.35d | |

Table 4: Organoleptic evaluation of whole-wheat flour bread for color (9-Point Hedonic Score)

| | | Leavened | | | |
|---|---|---|---|---|---|
| Cultivars | Unleavened | 15 min | 30 min | 45 min | Mean |
| Ghaznavi | 6.57 | 7.28 | 7.71 | 7.85 | 7.35a |
| Fakhr-e-sarhad | 6.85 | 6.57 | 8.14 | 6.85 | 7.10b |
| Mean | 6.71d | 6.92c | 7.92a | 7.35b | |

Table 5: Organoleptic evaluation of whole-wheat flour bread for taste (9-Point Hedonic Score)

| | | Leavened | | | |
|---|---|---|---|---|---|
| Cultivars | Unleavened | 15 min | 30 min | 45 min | Mean |
| Ghaznavi | 5.55 | 7.42 | 6.85 | 7.71 | 6.88a |
| Fakhr-e-sarhad | 5.85 | 6.42 | 6.85 | 7.14 | 6.56a |
| Mean | 5.70c | 6.92b | 6.85b | 7.43a | |

Table 6: Organoleptic evaluation of whole-wheat flour bread for Texture (9-Point Hedonic Score)

| | | Leavened | | | |
|---|---|---|---|---|---|
| Cultivars | Unleavened | 15 min | 30 min | 45 min | Mean |
| Ghaznavi | 5.14 | 7.85 | 7.00 | 7.42 | 7.02a |
| Fakhr-e-sarhad | 5.85 | 5.85 | 7.00 | 6.85 | 6.68b |
| Mean | 5.49d | 6.85c | 7.00b | 7.13a | |

Table 7: Organoleptic evaluation of whole-wheat flour bread for Overall Acceptability (9-Point Hedonic Score)

| | | Leavened | | | |
|---|---|---|---|---|---|
| Variety | Unleavened | 15min | 30min | 45min | Mean |
| Ghaznavi | 5.75 | 7.52 | 7.18 | 7.66 | 7.03a |
| Fakhr-e-sarhad | 6.18 | 6.28 | 7.33 | 6.94 | 6.68b |
| Mean | 5.97c | 6.89b | 7.26a | 7.30a | |

Analysis of the data (Table 4) revealed the score for color with different treatments in case of Fakhr-e-Sarhad Bread fermented for 30 min. ranks first in color, followed by Ghaznavi Bread fermented for 45, 30 and 15 min. respectively. Similar score values was also obtained for Fakhr-e-Sarhad leavened (fermented for 45 min.) and unleavened breads. The lowest values were observed for Ghaznavi unleavened breads and for Fakhr-e-Sarhad fermented at 15 min. For color the treatments and varietal effect is significant at $\alpha$ 0.05.

Mean values of the score of Ghaznavi Breads (whole-wheat flour) with 45 and 15 min. fermentation ranks 1st and 2nd respectively followed by Fakhr-e-Sarhad Breads with 45 min. fermentation. While breads prepared from both varieties with 30 min. fermentation ranks next, then followed by the bread made from Fakhr-e-Sarhad with 15 min. leavening and controlled, respectively. Ghaznavi unleavened bread got the lowest score for taste (Table 5). Statistical analysis showed significant result at $\alpha$ 0.05 for cultivars as well as treatments.

Ghaznavi Breads stands on the top in case of texture fermented with 15 and 45 min. on the basis of mean value score (Table 6), respectively. While 30 minutes fermentation got the second highest score in case of Breads of both cultivars. Control Fakhr-e-Sarhad Breads and Breads leavened for 45 and 15 min. of the two

cultivars have got the same score. While control Ghaznavi Breads (whole wheat flour) ranks the lowest.

Both the cultivars were evaluated for their overall acceptability and found suitable for baking of bread (Table 7). Among the leavened breads of the both varieties the fermentation time have a significant effect on the overall acceptability. Bread of Ghaznavi fermented with 45 min. got maximum score whereas Ghaznavi Bread fermented with 15 min. was 2nd in overall acceptability, followed by Fakhr-e-Sarhad fermented with 30 min. Mean value of the score (Table 7) revealed that the Ghaznavi and Fakhr-e-Sarhad Bread rank fourth and fifth at 30 and 45 min. fermentation respectively. Leavened bread made from Fakhr-e-Sarhad at 15 min. fermentation scored the lowest, which is at par with its control. Statistical analysis of the data revealed that there was significant effect on overall acceptance of whole wheat breads. Means having same letters were non significantly different, while values having different letters were significantly different at $\alpha$ 0.05.

Statistical analysis of the data (Tables 4, 5, 6 and 7) indicated that there is significant effect of baking on the organoleptic evaluation of bread prepared from whole-wheat flour of both cultivars. The mean values of all the organoleptic evaluation of both the cultivars are significantly different from each other at $\alpha$ 0.05. Analysis of the data revealed that treatment, cultivars and their interaction significantly improved the sensory qualities such as color, taste, texture and overall acceptability. Anuradha *et al.* (1999) reported that the general appearance with or without soybean flour such as crust color, texture, taste and flavor, the breads with or without soybean flour were well accepted. Aremu *et al.* (1995) also reported the organoleptic properties of bread of wheat flour of full fat or with defatted fermented cocoa bean powder, the organoleptic acceptability dropped with increasing percentage of cocoa supplementation. Work of Cardenas *et al.* (1993) and Abdel *et al.* (1993) reported high acceptability for wheat bread, but Jan *et al.* (2000) reported that chapattis (unleavened breads) had highest acceptability for sensory evaluation, which is in contradiction with our results. This might be due to evaluation of only unleavened bread, which he has not compared with leavened bread. Kenny *et al.* (2000) worked on incorporation of dairy ingredients (dried whole and skim milk) into wheat bread that improved the sensory characteristics of the product. Hoseney *et al.* (1968) has related protein solubility and electrophoresis studies to bread baking properties. It was shown conclusively that the water-soluble fraction of flour is not responsible for quality differences. However the water-soluble fraction is required to produce a normal loaf of bread. The water-soluble fractions were found to have a dual role i.e. by contributing to gassing power, and modifying the physical properties of the gluten. The dialyzable fraction of the water-soluble contributed to gas production and the protein is involved in the modification of the gluten. Flour containing high percent protein can be used for bread making, while low percent protein flour can be used for other bakery products.

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