

Changes in Phytate Content of Newly Released wheat Varieties during Different Processing Methods

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Abstract: *Wheat (Triticumaestivum) is the most important staple food crop and occupies a unique position for more than one third of the world population. Globally, wheat is the leading source of vegetable protein in human food, having a higher protein content than other major cereals, maize (corn) or rice. In terms of total production tonnages used for food, it is currently second to rice as the main human food crop and contributes more calories and proteins to the world diet than any other cereal crops. Wheat is nutritious and provides more nourishment for humans than any other food source. The wheat flour contains various anti-nutrients like phytates, oxalates, polyphenols etc.,. Phytic acid (also known as phytate) is a substance (anti nutrient) found in many types of plant foods, such as grains (wheat, maize, bajra etc.), legumes (including peanuts and soybeans), nuts, and seeds. It is found that phytic acid is found predominantly (about 80% of it) in the bran, or outermost shell, of whole grains. The various processing methods like soaking, roasting, sprouting and malting reduces the phytic content in wheat. Two newly released varieties of wheat (WH-1080 and WH-1025) and one conventional variety of wheat C-306 were procured from the Department of Genetics and Plant Breeding, College of Agriculture, CCS HAU, Hisar in a single lot. All the wheat varieties were cleaned, washed well under running tap water to get rid of all the dust, soil particles and foreign matter, dried & ground to flour using aatachakki and processed in three different ways roasting, sprouting and malting and were used for nutritional evaluation of raw and processed wheat varieties and inference. Phytic acid content in unprocessed wheat varieties ranged from 234.15 mg/100g to 253.9 mg/100g and in processed wheat varieties from 167.18 mg/100g to 241.63 mg/100g. Processing treatments resulted in significant decrease in the phytic acid levels. Lowest phytic acid content was found in sprouted WH-1080 variety (167.18 mg/100g). Sprouting significantly ($P \leq 0.05$) reduced the anti nutrient as compared to malting and roasting. There was reduction of 19.21% - 28.6% of phytic acid levels during sprouting. Thus sprouting method was found to be most beneficial in reducing anti nutrient (phytic) of all the wheat varieties.*

Keywords: anti-nutrients, phytic acid, malting, sprouting

1. Introduction

Wheat (*Triticumaestivum*) is the most important staple food nourishment crop and occupies a unique position for more than one third of the world population. It is nutritious and provides more for humans than any other food source. It is one of the least expensive cereals available in fabricated form rich in nutrition. It also contains a diversity of minerals like calcium, iron, zinc, phosphorous, magnesium, potassium etc., (Sikandra 2005, Hussain 2010) vitamins like thiamine (Yadav *et al.*, 2011) and fatty acids like stearic acid, myristic acid, palmitic acid etc.,. On an average, wheat contains energy 320 – 350 kcal, carbohydrate 74-78%, protein 10-13%, lipids 1-3% and considerable proportions of vitamins i.e., thiamine 0.3-0.5 mg and riboflavin 0.2-0.45 mg and minerals zinc 2.0- 3.43 mg, iron 2.8- 3.5mg and magnesium 110-130 mg/100g. The wheat flour contains various anti-nutrients like phytates, oxalates, polyphenols etc., (Qazi 2003, Mallick 2013) the most important out of these are phytic acid. Phytic acid (also known as phytate) is a substance (anti nutrient) found in many types of plant foods, such as grains (wheat, maize, bajra etc.), legumes (including peanuts and soybeans), nuts, and seeds. It's the storage form of phosphorus, an important mineral constituent which is used in the production of energy as well as the formation of structural elements like cell membranes. It is found that phytic acid is found predominantly (about 80% of it) in the bran, or outermost shell, of whole grains.

These anti-nutrients are reduced by some cooking treatments like boiling, sprouting, fermentation, roasting, malting etc., (Hemlath *et al.*, 2007, Priyanka *et al.*, 2011) These anti-nutrients are reduced to a considerable level and thus the products which are consumed have low levels of these anti-nutrients as the flour have been processed to make the products organoleptically.

2. Review of Literature

Hooda (2002) evaluated the anti-nutritional factors in wheat and found that phytic acid concentration. Qaziet *al.* (2003) studied two wheat varieties and found phytic acid content as 869.2 and 869.4 mg/100 g which reduced upto 280.3 mg/100g after formation of unleavened bread. Sikandra (2005) also evaluated phytic acid content in wheat flour sample and the result showed that it was 212.67mg/100g to 297.33mg/100g. Manu (2006) also studied the phytic acid content in whole wheat flour compared to composite flour with supplementation and found that it was 214.33 mg/100g of whole wheat flour. Singh (2006) also studied the phytic acid levels and the result was 232.53mg/100g & of wheat flour. Nikita *et al.*, (2008) analyzed the proximate composition of five wheat varieties grown under organic and inorganic farming conditions and found that the C-306 variety had the lowest amount of phytic acid (240 mg/100 g) while WH- 912 had the highest (269 mg/100 g) grown under inorganic conditions. Rakhi and

Punia, (2013) found the phytic acid content of wheat varieties from 206.71 to 240.10 mg/100g.

Rakhi and Punia (2013) found that Phytic acid content of unprocessed wheat varieties ranged from 206.71 to 240.10 mg/100g which after germination reduced to 129.40 to 160.36 mg/100g.

3. Materials and Methods

The present study was carried out in the Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar. Two newly released varieties of wheat (WH-1080 and WH-1025) and one conventional variety of wheat C-306 were procured from the Department of Genetics and Plant Breeding, College of Agriculture, CCS HAU, Hisar in a single lot.

This chapter contains relevant information related to the research design and methodologies used for the present investigation. The research procedures have been clearly described under the following headings and subheadings:

3.1 Procurement of material

3.2 Processing of varieties

3.2.1 Roasting

3.2.2 Sprouting

3.2.3 Malting

3.3 Phytic Acid estimation of raw & processed wheat varieties

3.1 Procurement of Material

Newly Released Wheat varieties (WH 1025, WH 1080) and one conventional variety C-306 were procured from the Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar in a single lot. All the wheat varieties were cleaned, washed well under running tap water to get rid of all the dust, soil particles and foreign matter, dried & ground to flour using *aatachakki* available in the departmental laboratory and was used for nutritional evaluation of raw and processed wheat varieties and inference.

3.2 Processing of Varieties

3.2.1 Roasting

The procured wheat grains were washed to remove dust and other foreign particles and was dried under sun to remove excess water and then dried in hot air oven at 50°C for 24 hrs.

3.2.2 Sprouting

Grains were washed to remove soil and dust and then soaked for 12 hrs and after that they were kept in petri dishes which were lined with wet filter paper for germination/sprouting in an incubator at 30°C for 48 hrs. Grains were kept moist by sprinkling distilled water frequently. After 48 hours sprouts can be seen emerging out.

3.2.3 Malting

Malting was done by the method of Chaturvedi and Sarojini (1996). There were four major stages involved. These were:

3.2.3.1 Steeping

This involved soaking of seeds in excess water for rehydration and to facilitate germination. All the three wheat varieties were soaked in germinating dish by using double the amount of 0.1 % formaldehyde solution (to avoid microbial degradation). The mouth of the dish was covered with a muslin cloth using rubber band and the grains were allowed to soak for 6 hrs at 25°C – 30°C in an incubator. The unimbibed water was drained off without removing the cloth.

3.2.3.2 Aeration

For enhancement of enzyme activity aeration was done by removing cloth for a period of 3 hrs in a well ventilated room. During aeration, grains were rotated occasionally by glass rod. After aeration, grains were re steeped with fresh formaldehyde solution for a period of 16 hrs and the mouth of the dish was again covered. At the end of steeping period, water was drained off, cloth was removed and the sample was air rested for a period of 2 hours.

3.2.3.3 Germination

The soaked seeds were sprayed with 25 ml of 0.1 % formaldehyde solution to prevent the mold growth and allowed to germinate in an incubator at 25°C -30°C. The grains were roasted twice daily. A constant humidity was maintained inside the incubator by means of keeping a pan of water. Grain samples were removed from the incubator after 48 and 72 hours.

3.2.3.4 Kilning

The germinated grains were dried in hot air oven at 50°C for 24 hrs. Kilned grains were de vegetated by abrasive action. After kilning, grains with characteristic malt aroma were obtained.

3.3 Phytic acid estimation

Phytic acid content was determined by using the method of Davies and Reid (1979).

3.3.1 Reagents Required

- 1) **0.5 M HNO₃**: 15.96 ml of 69.5% HNO₃ was diluted to 500 ml with water.
- 2) **Ferric ammonium sulphate**: 2.5 mg ferric ammonium sulphate was dissolved in water, added a few drops of HCl and made volume to 500 ml with water.
- 3) **Ammonium thiocyanate**: Ten gram of ammonium thiocyanate was dissolved in water and made to 100 ml.
- 4) **Iso-amyl alcohol**
- 5) **Sodium phytate**: 30.54 mg sodium phytate was dissolved (5.5% H₂O, 97% purity and containing 12 Na/mole) in 100 ml 0.5 M HNO₃ which gave a solution containing 20 mg phytic acid in 100 ml or 200 mg phytic acid/ml.

3.3.2 Extraction

Five hundred mg sample was extracted with 20 ml 0.5M HNO₃ for 3 h and continuous shaking on a shaker at room temperature. After proper shaking, it was filtered through

Whatman filter paper No. 1. Filtrate was used for the estimation of phytic acid.

3.3.3 Estimation Procedure

One ml HNO₃ extract was taken in a stoppered test tube and made a final volume of 1.4 ml with water. One ml ferric ammonium sulphate solution was added. The content was mixed in the tubes thoroughly and placed in a boiling water bath for 20 minutes. Tubes were cooled down to room temperature under running tap water. Five ml iso-amyl alcohol was added, mixed the contents vigorously and added 0.1 ml ammonium thiocyanate solution. The tubes were shaken well and centrifuged at 3000 rpm for 10 minutes. Color intensity in the alcohol was read at 465 nm against iso-amyl alcohol blank exactly after 15 minutes of addition of ammonium thiocyanate.

For plotting standard curve, 0.4-1.0 ml standard phytate solution containing 80-200 mg phytic acid was taken and made to 1.4 ml with water. 0.341 O.D. corresponded to 160 mg phytic acid.

4. Results

The present study was conducted to assess the nutrient composition of newly released wheat varieties viz. WH-1080 & WH-1025 and one conventional variety C 306. Various processing methods like roasting, sprouting & malting were used to check the levels of phytic acid. The results so obtained during the course of investigation were subjected to suitable statistical analysis, tabulated and have been presented systematically in the tables below.

Table 1: Phytic Acid content of wheat varieties (mg/100g, on dry weight basis)

Varieties	Phytic Acid
WH-1080	234.5 ± 1.14
WH 1025	238.06 ± 2.10
C 306	253.9 ± 1.18
C.D(P _≤ 0.05)	3.9

Values are mean ± SE of three independent determinations

Table 2: Effect of processing on phytic acid content of wheat varieties (mg/100g, on dry weight basis)

Variety	WH-1080	WH 1025	C 306	Variety Mean
Treatment				
Unprocessed (Control)	234.15 ± 1.14	238.06 ± 2.10	253.9 ± 1.18	222.9 ± 0.25
Roasted	223.72 ± 2.4	226.61 ± 3.4	241.63 ± 1.1	230.41 ± 2.07
Sprouted	167.18 ± 1.1	183.48 ± 1.1	205.11 ± 0.5	215.86 ± 0.98
Malting	222.98 ± 1.1	219.73 ± 0.6	229.44 ± 1.1	211.55 ± 1.12
Treatment Mean	212.75 ± 1.27	216.97 ± 2.16	228.52 ± 1.05	
CD(P _≤ 0.05)	Variety : 2.87 Treatment : 2.79 Interaction : 4.97 (Variety x Treatment)			

Values are mean ± SE of three independent determinations

Phytic acid content in unprocessed wheat varieties ranged from 234.15 mg/100g to 253.9 mg/100g and in processed wheat varieties from 167.18 mg/100g to 241.63 mg/100g. Processing treatments resulted in significant decrease in the phytic acid levels. Decrease in phytic acid levels were highest during sprouting treatment (19.21% - 28.6%) as compared to the roasting (4.45% to 4.83%) and malting treatment (4.77% to 9.63%). Lowest phytic acid content was found in sprouted WH-1080 variety (167.18 mg/100g).

5. Discussion

The present investigation was conducted to evaluate two newly released wheat varieties namely WH-1080, WH-1025 and one conventional wheat variety C-306 for their physico-chemical properties and nutritional composition. The wheat varieties were procured from the Department of Genetics and Plant Breeding, College of Agriculture, CCS HAU, Hisar in a single lot. Wheat grains were manually cleaned to remove broken seeds, dust and other foreign matter and washed under running water then dried & ground to flour using *Aatachakki*. The varieties were processed using roasting, sprouting and malting methods. The phytic acid content of wheat varieties ranged from 234.5 to 253.9 mg/100g. Wheat variety C-306 had highest (253.9 mg/100g) amount of phytic acid whereas variety WH-1080 had lowest amount (234.5 mg/100g). Evidence has shown that, there are many factors such as genetics, environmental fluctuations, type of soils, year and fertilizer application that

can affect the antinutrient composition of cereal grains (Muahamad *et al.* 2010).

Sprouting treatment decreased phytic acid content. There existed significant difference in all the varieties. Sprouting significantly reduced the phytic acid content as compared to malting and roasting. Rakhi and Punia (2013) had results that there was reduction of phytic acid content after germination and heat treatment. The loss of phytic acid during sprouting may have been due to hydrolytic activity of the enzyme phytase, which is reported to be present in various plant foods. Sandberg (1991) and Agte and Joshi (1997) observed that food processing such as soaking and sprouting of whole cereals and legumes activate the endogenous plant phytases as well as bacterial phytases. These reduce the hexaform of phytic acid into lower forms having lower acids and B-complex vitamins. The results of present study showed that sprouting could significantly decrease phytic acid in wheat grain, which is in agreement with the reports about similar treatment on other cereals such as steeping and sprouting of oats or corn (Larsson and Sandberg, 1995; Fageer *et al.* 2004), sprouting and malting of pearl millet (Archana *et al.* 1998), soaking and sprouting of mungbean (Grewal *et al.* 2006; Khattab *et al.* 2009). The observed reduction in phytic acid content during heat treatments may be partly due to heat labile nature of phytic acid and formation of insoluble complexes between phytate and other components (Udensiet *et al.* 2007). This decrease could also be related to that fact that these compounds are heat labile and degrade upon heat treatment (Rakic *et al.* 2007).

6. Summary & Conclusions

The phytic acid content of wheat varieties ranged from 234.5 to 253.9 mg/100g. Wheat variety C-306 had highest (253.9 mg/100g) amount of phytic acid whereas variety WH-1080 had lowest amount (234.5 mg/100g). There existed significant difference in all the varieties. Sprouting significantly ($P \leq 0.05$) reduced the antinutrient as compared to malting and roasting. There was reduction of 19.21% - 28.6% of phytic acid levels during sprouting. Thus sprouting method was found to be most beneficial in reducing antinutrient (phytic) of all the wheat varieties.

References

- [1] Agte, V.V. and Joshi, S.R. 1997. Effect of traditional food processing on phytate degradation on wheat and millet. *J. Agric. Food Chem.*, **45** (5): 1659–1661
- [2] AOAC. 2000. Official Methods of Analysis. Association of official analytical chemist. Washington, D.C.
- [3] AOCC. 2000. Approved Method of Analysis. The American Association of Cereal Chemists, St. Paul, MN.
- [4] Archana, Sehgal, S. and Kawatra, A. 1998. Reduction of polyphenol and phytic acid content of pearl millet grains by malting and blanching. *Plant Foods Hum. Nutr.* **53** (2): 93-98.
- [5] Chaturvedi, A. and Sarojini, G. 1996. Malting of pearl millet (*Pennisetum typhoides*). Its effect on starch and protein digestibility. *J. Food Sci. Technol.* **33**(4): 342-344
- [6] Dave, S., Yadav, B.K. and Tarafdar, J.C. 2008. Phytate phosphorus and mineral changes during soaking, boiling and germination of legumes and pearl millet. *J. Food Sci. Tech.* **45** (4): 344-348.
- [7] Davies, N.T. and Reid, H. 1979. An evaluation of phytate, zinc, copper, iron and manganese content and availability of soya based textured vegetable protein, meat substitute or meat extrudes. *Brit. J. Nutr.* **41**: 579-589
- [8] Duhan, A., Khetarpaul, N. and Bishnoi, S. 2002. Effect of soaking, germination and cooking on phytic acid and hydrochloric acid extractability of a pigeon pea cultivar. *J. Food Sci. Technol.* **38**(4): 374-378.
- [9] Fageer, A.S.M. and El Tinay, A.H. 2004. Effect of genotype, malt pretreatment and cooking on *in vitro* protein digestibility and protein fractions of corn. *Food Chem.* **84**: 613-619.
- [10] Grewal, A and Jood, S. 2006. Effect of processing treatments on nutritional and anti nutritional contents on green gram. *J. Food Biochem.* **30**(5): 535-546
- [11] Hemlatha, M. S., Manu, B.T., Bhagwat, S. G., Leelawathi, and Rao, U. J. S. P. 2007. Protein characteristics and peroxidase activities of different Indian Wheat varieties and their relationship to chapatti making quality. *Europ. Food Res. Technol.* **225** (3-4) : 463-471.
- [12] Hooda, S. 2002. Nutritional evaluation of fenugreek supplemented wheat products. Unpublished M.Sc. Thesis, CCS HAU, Hisar, India.
- [13] Hussain, I., Uddin, M.B. and Aziz, M.G. 2011. Optimization of anti nutritional factors from germinated wheat and mungbean by response surface methodology. *International Food Research J.* **18**(3): 957-963
- [14] Hussain, M.A, Choudhary, A., Howladar, M.A.A., Kabir, K.A. and. 2010. Biochemical and functional properties of some newly released wheat varieties of Bangladesh. *J. Agric. Res.* **24**: 211-218.
- [15] Khattab, R.Y. and Arntfield, S.D., 2009. 1. Nutritional quality of legume seeds as affected by some physical treatments. 2. Antinutritional factors. *LWT Food Sci. and Tech.*, **42**(6): 1113-1118.
- [16] Larsson, M. and Sandberg, A. S. 1995. Malting of oats in pilot-plant process effects of heat treatment, storage and soaking conditions on phytate reduction. *Journal of Cereal Science* **21**: 87–95. Lindsey, W.L. and Norwell, M.A. 1969. A new DPTA-TEA Soil test for zinc and iron. *Agron. Abst.* **61**: 84-89.
- [17] Mallick, S. A. Kousar, A. Gupta, M. Sharma, V. and Sinha, B. K. 2013. Characterization of grain nutritional quality in wheat. *Ind. J. of Plant Physiology.* **18**(2): 183–186
- [18] Manu, 2006. Development and nutritional evaluation of traditional food products incorporating calcium rich underutilized grains and leaves. Ph.D. thesis, CCS Haryana Agricultural University, Hisar, India.
- [19] Muahamad, N., Faqir, M.A., Rai, M.A., Moazzam, R.K., Shahzad, H., Muhammad, S.J. 2010. An overview of anti-nutritional factors in cereal grains with special reference to wheat-A review Pak. *J. food Sci.* **20**(1-4): 54-61.
- [20] Nikita, Punia, D. and Khetarpaul, N. 2008. Physico-chemical characteristics, nutrient composition and consumer acceptability of wheat varieties grown under organic and inorganic farming conditions. *International J. Food Sci. and Nutr.* **59**(3): 224-245.
- [21] Priyanka and Sehgal 2011. Nutritional evaluation of raw and processed chickpea varieties and its utilization for product development. M.Sc Thesis, CCSHAU, Hisar.
- [22] Qazi, I.M., Wahab, S., Shad, A.A., Zeb, A. and Ayub, M. 2003. Effect of different fermentation time and baking on phytic acid content of whole wheat flour bread. *Asian J. Plant Sci.* **2B** (8): 597-601.
- [23] Ramee and Kiefer. 2006. Nutritional analysis of Cereals for food use. *Int. J. of Plant Physiology.* **88** (3) 111-116
- [24] Rakhi and Punia 2013, Nutritional evaluation and development of products from wheat. M.Sc Thesis, CCSHAU, Hisar.
- [25] Rakic, S., Petrovic, S., Kukic, J., Jadrnanin, M., Tesevic, V. and Povrenovic, D. 2007. Influence of thermal treatment on phenolic compounds and antioxidant properties of oak acorns from Serbia. *Journal of Food Chemistry* **104**: 830–834.
- [26] Reddy, N.R., Pierson, M.D., Sathe, S.K., and. Salunkhe, D.K. 1989. Occupance Distribution Content and Dietary Intake of phytate in Cereal and Legumes, p. 39-56. London: Thomson Science.
- [27] Rehman, S. and Kader, A. (2011). Comparison of nutritional and physicochemical properties of Bangladeshi Wheat varieties. *World Appl. Sc. Journal* **12** (2), 178-181.
- [28] Rehman, Z., and Shah, W.H. 2005. Thermal heat processing effects on antinutrients, protein and starch digestibility of food legumes. *Food Chem.* 327-331.

- [29] Sandberg, A.S. 1991. Degradation products of bran phytate formed during digestion in the human small intestine: effects of extrusion cooking on digestibility. *International J. Nutr.* **117**:2061-2065.
- [30] Sikandra. 2005. Development of value added products from sorghum and their nutritional and sensory evaluation. Msc. Thesis, CCSHAU, Hisar, India
- [31] Singh, M. Sharma, N. Khatkar, BS. 2006. End use quality of Indian wheats: Milling properties and composition. *J. Food Sci. Technol.* **43**(3) 322-324.
- [32] Udensi, E.A., Ekwu, F.C. and Isinguzo, J.N. 2007. Antinutrient factors of vegetable cowpea (*sesquipedalis*) seeds during thermal processing. *Pak. J. of Nutr.* **6** (2): 194-197.
- [33] Yadav, S. Kumar, P. Yadava, R.K. Gollen, B, Kumar, S. and Verma R.K. 2011. Nutritional Contents and Medicinal Properties of Wheat. *Life Sciences and Medicine Research.* **22**:1-10.

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