

Study of Phosphorus Profile in Indian Wheat Varieties

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Abstract: *In the present study, total phosphorus and inorganic phosphorus content were determined in twenty wheat varieties. Among twenty wheat varieties, LOK-1 variety was found to have higher content except in kilning processed seeds. During the study, total phosphorus range was 1.80 ± 0.36 to 4.57 ± 0.07 mg/g and inorganic phosphorus 0.22 ± 0.02 to 2.03 ± 0.03 mg/g were observed, respectively through different processed wheat varieties; germination, soaking, heating, kilning and grinding.*

Keywords: Total phosphorus, inorganic phosphorus, wheat, germination.

1. Introduction

Wheat is largely consumed in various forms like breads, biscuits, cookies, cakes, pasta, noodles and major source of dietary energy and protein for humans [1]. Developing seeds represent a major sink for plant phosphorus. Seeds typically accumulate several-fold more phosphorus than is needed to support basic cellular functions [2]. Seed germination also increases vitamin concentrations and bioavailability of trace elements and minerals [3]. Breakfast cereal is defined as food obtained by soaking, swelling, heating, toasting, grinding, rolling or flaking and shredding of puffing of any cereal and which is usually eaten in breakfast. Flaking is one of the methods of processing breakfast cereal, which involves cleaning and conditioning to suitable moisture content of the whole grain and lightly rolled between smooth rolls to fracture the outer layer [4]. Scientific studies have established that processes such as cooking, dehulling, soaking, fermentation and germination improve nutritional quality of food products by reducing or eliminating antinutrients in them [5]. Flour from germinated seeds has better nutritional properties than flour from non-germinated cereals [6]. Milled whole grains can be nutritionally superior to intact grains for human consumption because poor digestible compounds are removed during milling process and nutrient bioavailability is enhanced [7]. Phytic acid metabolism during seed development and germination may be important to phosphorus, functioning to maintain a constant non-phytic acid phosphorus or inorganic phosphorus cellular concentration [8]. About 60–90% of total phosphorus in plant feedstuffs is bound as phytate phosphorus [9]. Phosphorus is not utilised by human beings, birds or a gastric animals because they lack sufficient endogenous intestinal phytase, which releases orthophosphate from the phytate molecule in the gastrointestinal tract [10]. Phytases catalyse the phosphate monoester hydrolysis of phytate, which results in the stepwise formation of myo-inositol pentakis, tetrakis, tris, bis and monophosphates as well as the liberation of inorganic phosphate [11].

2. Materials & Methods

2.1 Wheat variety collection

Twenty locally available wheat varieties were purchased from Alopibagh market, Allahabad, India to go through the practical aspect of the project work which are namely DBW-17, WH-1021, HD-2894, PBW-502, PBW-226, RAJ-3765, HUW-234, PBW-154, K-9107, K-7903, WR-544, LOK-1, PBW-373, PBW-550, WH-711, SONALIKA, WH-1025, RAJ-3777, KUNDAN and HW-2045. For experiment purpose native of all the twenty wheat varieties seeds as well as processed seeds *i.e.* soaked (overnight), germinated (after overnight soaking kept for 7 days), kilned (after overnight soaking, kept for 7 days and 2 hrs air dry at 40°C), heated (30°C heating) and ground seeds were used for sample preparations.

2.2 Determination of total phosphorus and inorganic phosphorus

The determination of total phosphorus method described by Fiske and Subbarow [12]. 0.5g sample weighed and mixed with 3 times its weight of fusion mixture and heated the mixture in a porcelain dish until a white ash is obtained. Cooled it to room temperature then extracted with 10% TCA and made up the volume to 200 ml with TCA. Pipette out 2 ml of the extract into a test tube and made up the volume to 4.2 ml with water. Added 0.6 ml of acid molybdate reagent then mixed and 0.2 ml of ANSA reagent to each tube added and mixed again. After 10 min incubation, recorded the absorbance at 660 nm. For inorganic phosphorus, 0.5 g sample was mixed with 100 ml of 12.3% aqueous trichloroacetic acid on a mechanical shaker with 5000g for 12 hrs at 25°C and centrifuged at 2000 g for 30 min [13] and Pipette out 2 ml of the extract into a test tube and made up the volume to 4.2 ml with water then followed Fiske and Subbarow method.

2.3 Statistical analysis

The data were analyzed by randomized block design (RBD) using SPSS software. The F-test at 5% level of significance, mean values and standard error of the mean (SEM), critical difference (CD) and coefficient of variation (CV%) were reported.

3. Results & Discussion

The data pertaining to biochemical parameters *i.e.* inorganic and total phosphorus contents in twenty wheat varieties through different processing germination, soaking, heating, kilning and grinding are presented under present study.

3.1 Total phosphorus content

It is clear in table 1 and figure 1 that maximum total phosphorus content was recorded in LOK-1 (3.27 ± 0.03) native seeds followed by germination (4.57 ± 0.07), soaking (3.10 ± 0.06), heating (2.77 ± 0.15), kilning (RAJ-3777, 3.39 ± 0.20) and grinding (2.33 ± 0.19 mg/g) while least was reported in PBW-373 (2.63 ± 0.32) native seeds followed by germination (WH-711, 2.60 ± 0.80), soaking (WH-1021, 1.95 ± 0.42), heating (WR-544, 1.80 ± 0.36), kilning (LOK-1, 3.73 ± 0.03) and grinding (WH-1021, 1.93 ± 0.03 mg/g), respectively. Turksoy *et al.* reported 3.85 in Bezostaya, 4.03 in Gun-91, 4.31 in Dagdas-94, 4.05 in Gerek-79, 3.71 in Kirgiz-95 and 3.34 mg/g total phosphorus in Ikizce Turkish wheat flour [14]. Total phosphorus concentration typically ranges from 3.0 to 4.0 mg/g in seed produced by crops [15]. The total phosphorus content was observed in wheat 3.33 mg/g and rice 4.34 mg/g but after one day soaking 3.2 mg/g and ten days of germination 3.6 mg/g observed in Nigerian wheat [16]. Nour *et al.* reported a range of 4.41 to 4.58 mg/g for three days old sorghum cultivars [17]; Larsson *et al.* reported a range of 1.3 to 4.0 mg/g for white wheat and whole wheat [18] while Barrier-Guillot *et al.* reported a range of 2.25 to 4.24 mg/g for 56 different wheat cultivars [19]. This narrow range of phosphorus content shows that not only the phosphorus status of soil or fertilizer determines phosphorus contents of grains but also root uptake of phosphorus [20]. The increase in total phosphorus resulted from changes in dry matter due to sprouting process. It has been found that about 60–90% of total phosphorus is bound as phytate phosphorus in cereals and legumes [9].

3.2 Inorganic phosphorus content

It is clear in table 2 and figure 2 that maximum inorganic phosphorus content was recorded in LOK-1 (0.67 ± 0.03) native seeds followed by germination (2.03 ± 0.03) and heating (0.64 ± 0.03) but in soaking (PBW-226, 1.58 ± 0.14) kilning (WH-711, 1.66 ± 0.06) and grinding (RAJ-3765, 0.70 ± 0.20 mg/g) was higher found while least was reported in WH-1021 (0.29 ± 0.09) native seeds followed by germination (PBW-154, 1.47 ± 0.24), soaking (DBW-17, 1.13 ± 0.03), heating (WH-711, 0.24 ± 0.14), kilning (LOK-1, 1.30 ± 0.17) and grinding (WH-1025, 0.22 ± 0.02 mg/g), respectively. Turksoy *et al.* reported 0.61 in Bezostaya, 0.62 in Gun-91, 0.63 in Dagdas-94, 0.73 in Gerek-79, 0.72 in Kirgiz-95 and

0.70 mg/g inorganic phosphorus in Ikizce Turkish wheat flour [16] while according to Poiana *et al.*, 0.7 in native, 1.23 in soaked and 1.95 mg/g in germinated wheat seeds were observed. In other cereals, maize 0.74, rye 0.91 and barley 1.02 mg/g in native; maize 0.93, rye 1.48 and barley 1.18 mg/g in soaked seeds; maize 1.31, rye 2.09 and barley 1.74 mg/g inorganic phosphorus in germinated seeds were observed [21]. This is a possibility since increase in phytase activity during germination can result in increased inorganic phosphorus availability. During germination, phytase sequesters orthophosphate groups from the inositol ring of phytic acid to produce free inorganic phosphorus, along with a chain of intermediate myo-inositol phosphates [22] and releasing bound phosphorus in feed ingredients of vegetable origin, phytase makes more phosphorus available for bone growth and protects the environment against phosphorus pollution [23].

4. Conclusion

It is concluded that total phosphorus and inorganic phosphorus profile were higher in LOK-1 wheat variety in all processed stage except in kilning for total phosphorus; soaking, kilning and grinding for inorganic phosphorus.

5. Acknowledgement

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Table 1: Comparison of total phosphorus (mg/g) in twenty Indian wheat varieties

Variety name	Native	Germination	Soaking	Heating	Kilning	Grinding
DBW-17	3.13±0.09	4.47±0.03	3.00±0.06	2.42±0.22	3.67±0.04	2.27±0.18
WH-1021	2.88±0.07	3.80±0.44	1.95±0.42	2.25±0.13	3.60±0.06	1.93±0.03
HD-2894	3.20±0.10	4.50±0.00	3.03±0.03	2.40±0.21	3.72±0.02	2.25±0.16
PBW-502	2.90±0.06	3.17±0.73	2.56±0.32	2.17±0.09	3.54±0.03	2.00±0.06
PBW-226	3.03±0.09	3.17±0.44	2.69±0.35	2.13±0.09	3.54±0.03	2.07±0.03
RAJ-3765	3.07±0.12	3.67±0.44	2.91±0.15	2.07±0.12	3.49±0.06	2.03±0.03
HUW-234	3.20±0.10	4.10±0.26	3.00±0.06	2.67±0.17	3.69±0.01	2.20±0.06
PBW-154	3.03±0.09	4.17±0.24	2.97±0.09	2.24±0.13	3.58±0.02	2.17±0.12
K-9107	2.90±0.05	4.23±0.22	2.55±0.32	1.87±0.30	3.57±0.03	2.20±0.15
K-7903	3.00±0.06	4.30±0.20	2.93±0.12	1.83±0.33	3.55±0.05	2.27±0.12
WR-544	2.80±0.15	3.97±0.26	2.53±0.32	1.80±0.36	3.55±0.03	2.17±0.04
LOK-1	3.27±0.03	4.57±0.07	3.10±0.06	2.77±0.15	3.73±0.03	2.33±0.19
PBW-373	2.63±0.32	4.00±0.12	2.44±0.24	2.24±0.12	3.59±0.06	1.96±0.04
PBW-550	3.00±0.06	3.87±0.19	2.50±0.25	2.27±0.15	3.53±0.03	1.97±0.03
WH-711	2.91±0.05	2.60±0.80	2.39±0.20	1.90±0.21	3.52±0.04	1.97±0.03
SONALIKA	3.03±0.09	3.50±0.29	2.48±0.24	2.20±0.10	3.53±0.03	1.97±0.03
WH-1025	2.89±0.07	4.11±0.06	1.97±0.49	2.14±0.09	3.55±0.03	1.94±0.06

RAJ-3777	2.93±0.03	3.93±0.04	2.87±0.09	2.21±0.11	3.39±0.20	2.03±0.04
KUNDAN	2.82±0.13	3.85±0.10	2.83±0.09	2.18±0.09	3.51±0.05	1.93±0.13
HW-2045	2.91±0.05	3.77±0.11	2.86±0.09	2.32±0.19	3.53±0.03	1.96±0.10
CD	0.3	0.9	0.65	0.5	0.17	0.28
CV%	6.07	14.02	14.69	13.82	2.86	8.02

All value are given in table expressed as Mean±SEM of triplicate data (n=3) observed in experiment at 5% level of significance.

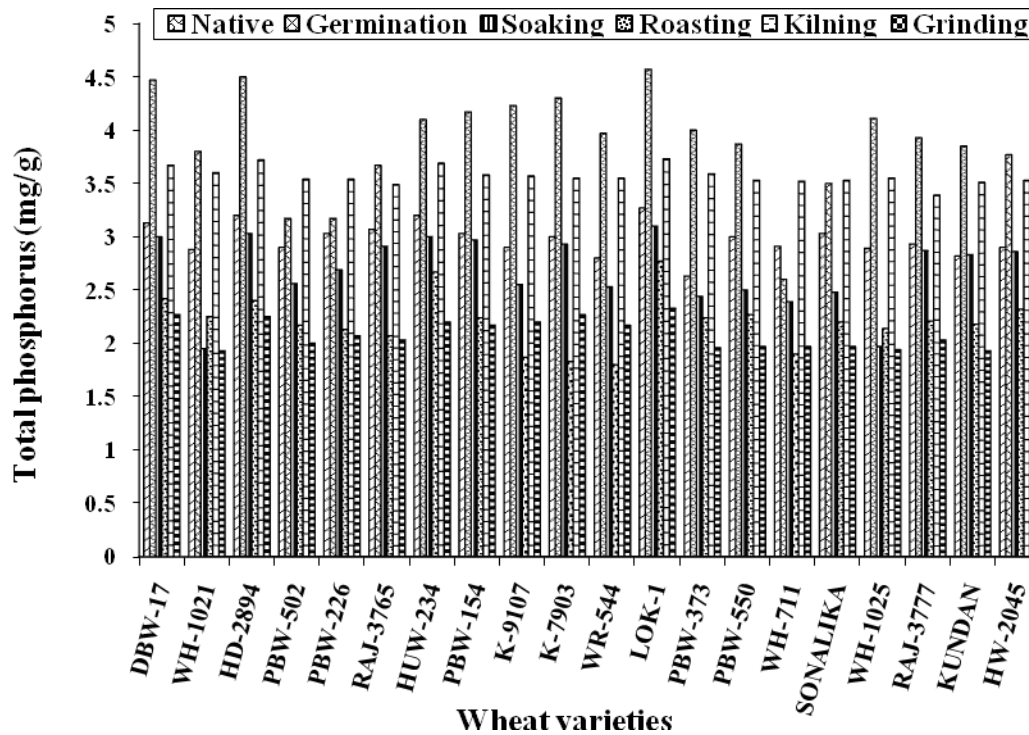


Figure 1: Total phosphorus profile of twenty Indian wheat varieties

Table 2: Comparison of inorganic phosphorus (mg/g) in twenty Indian wheat varieties

Variety name	Native	Germination	Soaking	Heating	Kilning	Grinding
DBW-17	0.67±0.03	1.97±0.09	1.13±0.03	0.57±0.09	1.57±0.03	0.67±0.03
WH-1021	0.29±0.09	1.53±0.27	1.23±0.03	0.33±0.08	1.57±0.03	0.29±0.09
HD-2894	0.63±0.07	2.00±0.06	1.31±0.10	0.50±0.12	1.41±0.10	0.63±0.07
PBW-502	0.50±0.00	1.83±0.09	1.30±0.06	0.43±0.07	1.43±0.07	0.50±0.00
PBW-226	0.53±0.03	1.85±0.07	1.58±0.14	0.46±0.09	1.55±0.03	0.53±0.03
RAJ-3765	0.70±0.20	1.86±0.07	1.22±0.04	0.53±0.19	1.56±0.03	0.70±0.20
HUW-234	0.57±0.03	2.02±0.04	1.31±0.10	0.57±0.03	1.59±0.01	0.57±0.03
PBW-154	0.53±0.07	1.47±0.24	1.56±0.17	0.53±0.07	1.43±0.09	0.53±0.07
K-9107	0.57±0.03	1.90±0.06	1.47±0.09	0.57±0.03	1.46±0.09	0.57±0.03
K-7903	0.54±0.06	1.82±0.10	1.24±0.03	0.54±0.06	1.40±0.10	0.54±0.06
WR-544	0.59±0.01	1.91±0.06	1.25±0.03	0.59±0.01	1.45±0.09	0.59±0.01
LOK-1	0.67±0.03	2.03±0.03	1.55±0.16	0.64±0.03	1.30±0.17	0.67±0.03
PBW-373	0.60±0.00	1.85±0.08	1.29±0.11	0.60±0.00	1.45±0.10	0.60±0.00
PBW-550	0.59±0.01	1.85±0.08	1.24±0.03	0.59±0.01	1.61±0.01	0.59±0.01
WH-711	0.30±0.10	1.89±0.06	1.53±0.23	0.24±0.14	1.66±0.06	0.30±0.10
SONALIKA	0.57±0.03	2.02±0.04	1.56±0.11	0.57±0.03	1.62±0.02	0.57±0.03
WH-1025	0.22±0.02	1.91±0.06	1.57±0.18	0.16±0.07	1.58±0.02	0.22±0.02
RAJ-3777	0.57±0.03	1.87±0.07	1.50±0.00	0.57±0.03	1.63±0.03	0.57±0.03
KUNDAN	0.55±0.05	1.90±0.06	1.49±0.11	0.55±0.05	1.64±0.04	0.55±0.05
HW-2045	0.54±0.06	1.84±0.09	1.57±0.15	0.54±0.06	1.44±0.09	0.54±0.06
CD	0.18	0.3	0.31	0.21	0.2	0.18
CV%	20.33	9.59	13.55	25.21	7.97	20.33

All value are given in table expressed as Mean±SEM of triplicate data (n=3) observed in experiment at 5% level of significance.

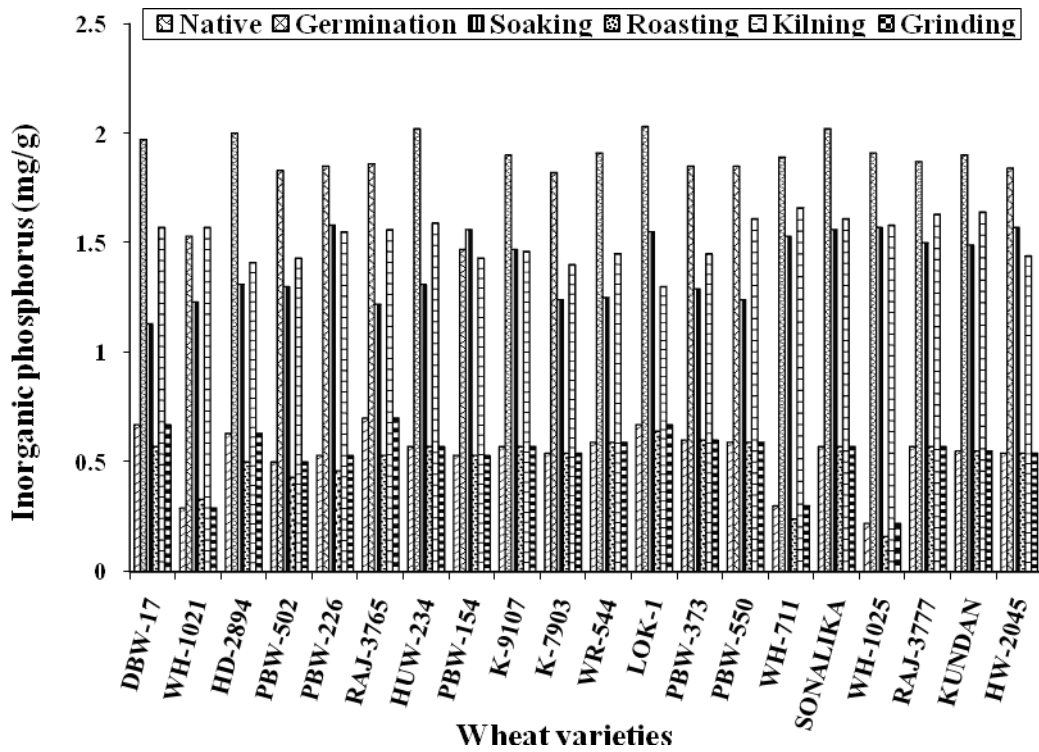


Figure 2: Inorganic phosphorus profile of twenty Indian wheat varieties