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Short Communication

Impact of Decortication on Phytate Content in Pearl Millet Grains

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Abstract

To find out the distribution of phytate in pearl millet grain, grains samples of 7 hybrids and 4 composites were decorticated and phytate content of whole grain along with decorticated grain and bran fraction was estimated simultaneously. Bran yield of analyzed hybrids/composites varied from 9.2 to 13.8 %. In decorticated grains (endosperm fraction) phytate content varied from 5.0 mg/g (HC 20) to 6.54 mg/g (HHB 67 improved) with an average value of 5.92 mg/g while in bran fraction it varied from 3.96 mg/g to 4.90 mg/g with an average value of 4.42 mg/g. On an average 5.34 % increment in phytate content was observed on decortications which varied from 3.5 to 9.2 %. A positive correlation was observed between bran content and increase in phytate content in decorticated grains. It is concluded that phytate deposition occurs throughout the endosperm and bran fractions but deposition in endosperm fraction is significantly denser than that in bran fraction. Therefore, decortications might not be the effective process in reduction of phytate content in pearl millet to improve the micronutrient bioavailability.

Keywords: Bran; Decortications; Pearl millet; Phytate

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Introduction

Food security has always been key priority due to increasing demand for food with ever increasing population. Pearl millet (*Pennisetum glaucum* (L.) R. Br.) is an important coarse grain cereal and forage crop of the arid and semi-arid tropics of the Indian subcontinent and several African regions? It is also a central component of the food and fodder security of the rural poor residing in these areas. The pearl millet grain is small but has a proportionally larger germ than all other cereal grains, except maize [1]. The pearl millet grain comprises about 8% pericarp, 17% germ and 75% endosperm [2]. A thin waxy cutin layer covers the surface of the pericarp and this layer helps to decrease the effect of weathering. Beneath the pericarp are a thin layer of seed coat, and then a single aleurone layer (one-cell thick). Bran is hard outer layer of cereals which consists of combined aleurone, pericarp and part of germ that is rich in dietary fibre, essential fatty acids, protein (17%), oil (32%), ash (10.4%) and starch, vitamins and dietary minerals. Pearl millet is rich in micro-nutrient like Fe and Zn and also posse's appreciable level of antioxidant compounds. It contains >1000 µg vit.C equi/g total antioxidant activity [3]. Among all the anti-nutritional components, phytic acid is of the prime concern for human nutrition and health management. The chemical description for phytic acid is myoinositol (1,2,3,4,5,6) hexakisphosphoric acid and it also called as IP6. The unique structure of phytic acid offers it the ability to strongly chelate with divalent cations such as calcium, magnesium, zinc, copper, iron and potassium to form insoluble salts. Therefore, it adversely affects the absorption and digestion of these minerals by human and animals [4]. Hence, phytic acid is considered to be an anti-nutrient that renders these minerals unavailable for absorption and interferes with utilization of proteins as well [5]. Berwal et al., reported appreciable amount of phytate in released pearl millet hybrids [6]. Lestinne et al., showed that iron *in vitro* availability of bran fraction was not only limited by phytate but also by the other anti-nutritional factors, and both iron binding phenolic compounds and fibers could be responsible for the inhibition of iron *in vitro* bio-availability [7]. The reducing cations bio-availability, monogastric animals (human beings, dogs, pigs, birds or agastric animals) are unable to remove the phosphates from the myo-inositol ring because they lack the intestinal digestive enzyme phytase, and therefore, are incapable of utilizing the phosphorus present in food grains [8,9]. Keeping this view in mind, the present study was conducted to investigate whether decortications can help in reduction of phytate content in pearl millet hybrids/composites vastly adopted by the farmers of Haryana, India.

Material and Methods

Plant material

Grain samples of pearl millet (*Pennisetum glaucum* (L.) R. Br.) of kharif 2012 season were procured from Bajra Section, Department of Genetics and Plant Breeding, CCS HAU, Hisar. The grain samples freed of extraneous matter were stored at room temperature at pearl millet quality laboratory, CCS HAU, Hisar for further use.

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Decortication of grains

Decortication of the grains was performed on rice polishing machine (Satake, Japan). The weighed grain sample (10 gm) was fed into the chamber in which air from an impeller conveyed the kernels against a cylindrical abrasive surface. The mill was run for 2 minutes. Bran particles left the grinding compartment and were carried by an air stream to a cyclone connected to a glass receiver. The debraned grain sample was collected in a clean glass receiver. Bran fraction was collected by removing the screen and the bran fraction which stuck to the screen covering the discs of polishing chamber was removed manually with a fine brush.

Phytate estimation

Phytate was determined by employing the method of Haug and Lantgsch [10]. Finely ground sample (500 mg) was extracted with 25 ml of 0.2 N HCl for 3 hours with continuous shaking on orbital shaker. After proper shaking it was filtered through whatman No. 1 filter paper. The filtrate was used for Phytate estimation. An aliquot (0.5) of above sample extract along with 0.1, 0.2, 0.3, 0.4 and 0.5 ml of standard sodium phytate solution (200µg/ml) was taken in test tubes and made up the volume to 1.4 ml with distilled water. To all the tubes 1 ml 0.02% ferric ammonium sulphate solution (prepared in 0.2N HCl) was added and then placed in a boiling water bath for 30 minute. One ml of supernatant from all the tubes was transferred to fresh test tubes and to which 1.5 ml of 1% bipyridine solution was added. Mixed the content throughly and the absorbance was measured on UV-Vis spectrophotometer (Thermo Scientific, EVOLUTION 201) at 519 nm against distilled water blank. Phytate content was calculated by using standard curve prepared with sodium Phytate and expressed as mg/g DW.

Statistical analysis

The data were analyzed with the online statistical analysis software O.P. STATE available at http://hau.ernet.in/about/opstat.php [11].

Results and Discussion

To investigate the effect decortications on phytate content in pearl millet grains, grain samples of 11 hybrids/composites were decorticated and phytate content of whole grain along with decorticated grain and bran fraction was estimated simultaneously. Average bran fraction (10.94%) of the 7 hybrids and 4 composites were observed (Table 1). Bran fraction varied significantly among hybrids and composites with variation from 9.2 (HC 20) to 13.9 % (HMP 802). It was observed that phytate was deposited throughout the endosperm and bran fractions but deposition in endosperm fraction is slightly denser than that in bran fraction. Significant variation was observed in Phytate content of whole grains along with decorticated grains and bran fraction. In whole grains, it varied from 4.78 mg/g (HC 20) to 6.12 mg/g (HHB 67 Improved) with an average value of 5.62 mg/g, these values are very much corresponded with the values reported by [6] in released pearl millet hybrids and composits, while in decorticated grains (endosperm fraction) phytate varied from 5.0mg/g (HC 20) to 6.54 mg/g (HHB 67 improved) with an average value of 5.92 mg/g and in bran fraction it varied from 3.96 mg/g to 4.90 mg/g with an average value of 4.42 mg/g (Table 1).

The average phytate content of decorticated grain of eleven pearl millet hybrids/composites was 5.70 mg/g, while in bran fraction it was 4.42 mg/g. It is clear from these data that phytate is distributed in pearl millet grains throughout the endosperm and bran fraction but the magnitude of deposition is slightly denser in endosperm than that of bran fraction. These results corresponded with earlier published reports [12,13]. They reported that bran fraction of pearl millet had slightly lower phytate content (4.09 mg/g) than that of endosperm fraction (6.32 mg/g) because phytate in pearl millet is mainly located in germ layer [14]. Interestingly the % bran fraction was positively correlated with the % increase in phytate content in pearl millet grains on decortications ($r = 0.641$, $p \geq 0.001$) (Table 2). This correlation also support that bran fraction has lower phytate deposition than that of endosperm fraction. But Suma and [15] reported a slight reduction in anti-nutritional factors in semi refined (milled) pearl millet flour. In general, IP6 accumulates in the protein storage bodies as mixed salts called phytate that chelate a number of divalent cations. During the

S. No.	Hybrids/Genotypes	Bran (% of grain wt.)	Phytate content (mg/g)			% increase in Phytate content after Decortication
			Whole Grains	Decorticated Grains	Bran Fraction	
1	HHB 67 Imp	11.1	6.12	6.54	4.57	6.9
2	HHB 94	10.1	5.43	5.74	3.96	5.7
3	HHB 146	12.6	5.65	5.87	4.72	3.9
4	HHB 197	10	5.7	5.95	4.26	4.4
5	HHB 223	11.5	5.82	6.05	4.11	4
6	HHB 226	10	5.69	5.89	4.6	3.5
7	HHB 234	10.1	5.54	5.79	4.29	4.5
8	HC 10	12	5.93	6.37	4.9	7.4
9	HC 20	9.2	4.78	5	4.23	4.6
10	HMP 802	13.9	5.11	5.58	4.48	9.2
11	WHC 901-445	9.8	6.09	6.32	4.46	3.8
	Mean	10.94	5.62	5.92	4.42	5.34
	C.D. ($p < 0.05$)	0.298	0.15			

Table 1: Phytate content of whole grains, decorticate grain and bran fraction of pearl millet hybrids/composites.

process of germination, endogenous grain phytase is activated, which degrades phytate content and release stored phosphorus, myo-inositol and bound mineral cations [16] that are further utilized by the developing seedlings, but due to lack the intestinal digestive enzyme phytase, monogastric animals (beings, dogs, pigs, birds or agastric animals) including human being are unable to remove the phosphates from the myo-inositol ring [8].

	Phytate content		% increase in phytate	Bran content
	Whole Grain	Bran		
Phytate (Whole Grain)	1			
Phytate (Bran)	0.440^{NS}	1		
% increase in phytate	0.080^{NS}	0.252^{NS}	1	
Bran Content	0.160^{NS}	0.453^{NS}	0.641*	1

Table 2: Pearson Correlation Matrix among phytate content and Bran fraction.

*significant @ 1% level of significance

Conclusion

From the above study it is concluded that phytate is distributed in pearl millet grain throughout the endosperm and bran fraction but the deposition is denser in endosperm than that of bran fraction. Therefore, decortication is not at all a good practice for reduction of phytate content in pearl millet grains.

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