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Effect of Household Germination on Phytic Acid and Iron in Finger Millet [*Eleusine coracana* (L.) Gaertn]

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ABSTRACT

Presence of abundant phytic acid in finger millet grain reduces the bioavailability of iron to the human body due to the higher molar ratio of phytic acid to iron, which is preferred to be less than 10:1. One of the traditional approaches being commonly used to reduce this ratio could be the germination process. Hence, the present study was undertaken to evaluate influence of germination on phytic acid and ironin finger millet germplasm. The molar ratio of phytic acid to iron was calculated both in raw and germinated form.Molar ratio of phytic acid to iron decreased from 17:1 in raw to 15:1 in the germinated seeds for 72 hrs with a progressive decrease from 24 hrs onwards. These results shows that the possibility of reduction in molar ratio of phytic acid to iron with one of the processing techniques like germination. Hence, this feasible and easy technique may be used to screen the large number of genotypes to arrive at lower molar ratio of phytic acid to iron.

Key words: *Finger millet, Phytic acid, Molar ratio.*

INTRODUCTION

Phytic acid in cereals, millets, legumes, nuts and oil seeds acts as an anti-nutritional factor that forms complexes with minerals such as calcium, magnesium, zinc and ironthus reduces their bioavailability. In present scenario, micronutrient malnutrition is prevalent inmore than three billion people in the world. Iron deficiency is the most common and widespread nutritional deficiency in the world and is the major cause of anemia across countries and women are more commonly afflicted[12]. In India, more than 50 per cent of the anemic population in the country is ascribed to iron deficiency. More than half of children are anemic in ten of the 15 States/Union Territories. Similarly, more than half of women are anemic in eleven States/Union Territories[2]. Since, finger millet is rich in calcium, iron, zinc and other micronutrients, inclusion of finger millet especiallyin the diet of low income population could become one of the means in improving the nutritional security.

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Finger millet (*Eleusine coracana* L.) is one of the promising millets with treasure of nutrients which could be suitably usedas nutrientrich food source. Although finger millet occupies the largest area under cultivation among the small millets in India[3] presence of antinutritional factors makes the decreased availability of minerals. Phytic acid is one of the predominant antinutritional factors, which interacts with food constituents such as essential minerals and make them unavailable to the body[10,19]. Hence, finding the effective means to reduce the antinutritional factors makes possible strategies to enhance the nutrient bioavailability.

Phytate in cereals, millets, legumes, nuts and oil seeds accounts for 60 to 90 per cent of total phosphorus content[13]. Although studies revealed that phytate may have beneficial roles as an antioxidant and anticarcinogen[11], owing to its ability to chelate and precipitate minerals, phytate will decrease the bioavailability of nutritionally important minerals such as zinc, iron, calcium[25] and magnesium[17]. Globally, daily intake of phytic acid varies from 0.2 to 4.6 g and vegetarian diets generally contain higher amounts of phytic acid compared to mixed diets[20,21].

One of the methods used in the determination of the bioavailability of minerals in the human body is the molar ratio of phyate to minerals in the food[6]. Ma *et al*.[14] reported that phytate to minerals molar ratios are used to predict the inhibitory effect of phytate on the bioavailability of mineral. Iron absorption has been shown to be inhibited when the phytic acid: iron ratio increases above 10:1[8]. Hence, it is necessary to understand molar ratio of phytic acid to iron. Several processing techniques like germination, cooking, roasting *etc*., could be employed to reduce phytic acid to mineral molar ratio. However, the germination process could be an easy and feasible approach to reduce the molar ratio. Therefore, an attempt has been made in the present study to assess the effect of germination process on phytic acid to iron molar ratio.

MATERIAL AND METHODS

Finger millet germplasm 3353 (Brown),4983 (White), and 6370 (Brown) were procured from All India Co-ordinated Research Project on Small Millets (AICRPSM), Gandhi Krishi Vignana Kendra, Bengaluru. Seeds were thoroughly cleaned to remove extraneous matter, deglumed and further were subjected for germination process. For germination process muslin cloth was used. Seeds were germinated for the period of 24, 48 and 72 hrsdried in oven at 45±5˚ C. Further germ portion was removed with proper care to avoid contamination, degermed seeds were ground in a coffee bean grinder to obtain fine powder and passed through a 60 mesh sieve, further subjected for phytic acid and iron estimation.

Phytic acid phosphorous (PA-P) was estimated by the Wade reagent method. Phytic acid was obtained by multiplying the phytic acid phosphorous with the conversion factor 3.55[7]. Standard curve for phytic acid estimation was developed by using sodium salt of phyticacid with the concentration 1.12 to 11.2 µg/L of phytic acid phosphorous and was considered based on the phosphorous (18.38 mg/100 g) content of standard sodium salt of phytic acid. Iron was estimated by inductively coupled plasma-optical emission spectrometry (ICP-OES). Ground powder of 1.0 g of each sample was weighed in clean acid washed in 100 ml conical flasks and then 10 ml of nitric acid was added and kept overnight for cold digestion. Next day, 10 ml of nitric acid and perchloric acid mixture was added (10:4) and kept on hot plate at 120ºC for digestion. The digested solution was diluted to 50 ml with double distilled water and filtered through membrane filters (0.1 - 5.0 µm pore). These extracts were used for the measurement of iron. Results were expressed in dry weight (mg/100g). The molar ratio between phytic acid and iron were calculated by dividing the mole of phytic acid with mole of iron content using the following formula.

$$\text{PA: Fe} = \frac{\text{PA}/\text{MW(PA)}}{\text{Fe}/\text{ MW(Fe)}}$$

Where, PA = Phytic acid analysed; $MW_{(PA)}$ = Phytic acid molecular weight (660.04 Da);
Fe = Analysed iron content; $MW_{(Fe)}$ = Iron molecular weight (Fe =55.845 Da).

Statistical analysis

From the data mean values and standard deviation were analysed. Least significantdifference between the mean values were calculated at P<0.05 %.

Table 1: Effect of germination on phytic acid content in finger millet germplasm

Germplasm	Phytic acid content (mg/100 g)	Per cent reduction
Raw		
GE 3353	686.38 ± 19.16[a]	-
GE 4983	677.73 ± 10.75[a]	-
GE 6370	648.27 ± 21.58[b]	-
Mean	670.79	-
24 hrs germination		
GE 3353	660.00 ± 17.25[ab]	3.84
GE 4983	598.24 ± 15.81[c]	13.42
GE 6370	538.48 ± 11.95[d]	16.90
Mean	598.90	-
48 hrs germination		
GE 3353	594.26 ± 18.26[c]	11.73
GE 4983	500.63 ± 12.44[e]	26.13
GE 6370	498.63 ± 17.25e	29.95
Mean	531.17	
72 hrs germination		
GE 3353	570.35 ± 15.04[c]	16.94
GE 4983	474.73 ± 13.80[e]	23.08
GE 6370	447.51 ± 14.88[f]	30.97
Mean	497.53	-
LSD	26.92	-

Note: Values are mean of three replicates ±SD, number in the same column followed by the same letter are not significantly different at p<0.05.

Table 2: Effect of germination on iron content in finger millet germplasm

Germination period (hrs)	Germplasm	Iron content (mg/100 g)
Raw	**GE 3353**	3.62±0.10[a]
	GE 4983	3.03±0.09[d]
	GE 6370	3.39±0.10b[c]
	Mean	3.36
24	**GE 3353**	3.49±0.07[ab]
	GE 4983	3.03±0.13[d]
	GE 6370	3.24±0.07[c]
	Mean	3.25
48 hrs	**GE 3353**	3.28±0.04[c]
	GE 4983	2.86±0.09[e]
	GE 6370	3.10±0.08[d]
	Mean	3.08
72 hrs	**GE 3353**	3.05±0.06[d]
	GE 4983	2.61±0.06[f]
	GE 6370	2.76±0.10[e]
	Mean	2.81
LSD		0.14

Note: Values are mean of three replicates ±SD, LSD: Least significant difference

Table 3: Molar ratio of phytic acid to iron at different germination period in finger millet germplasm

Germination period (hrs)	Germplasm	PA/Fe
Raw	GE 3353	16.04
	GE 4983	18.70
	GE 6370	16.19
	Mean	17.
24	GE 3353	15.99
	GE 4983	16.72
	GE 6370	14.05
	Mean	15.58
48	GE 3353	15.33
	GE 4983	14.83
	GE 6370	13.61
	Mean	14.59
72	GE 3353	15.84
	GE 4983	15.39
	GE 6370	13.72
	Mean	15.01

Note: PA: Phytic acid and Fe: Iron

RESULTS AND DISCUSSION

The phytic acid content in raw and germinated finger millet germplasm and per cent reduction of phytic is presented in Table 1. The mean phytic acid content in raw germplasm was 670.79 mg/100 g. Present findings of phytic acid content is in tune with the report of Gunashree *et al*.[9] wherein they reported a value 685 mg/100 g in finger millet grain available in the market.The germination process was found to reduce the phytic acid content from 670.79 mg per 100 g in raw grain to 598.90, 531.17 and 497.53mg per 100 g at different germination period of 24, 48 and 72 hrs respectively. High per cent reduction of phytic acid was observed during 48 and 72 hrs of germination period compared to 24 hrs. Comparatively, similar and highest per cent reduction of phytic acid was observed in GE 4983 and GE 6370, lowest was found in GE 3353 during 72 hrs of germination. Present findings are on par with the results reported by Makokha *et al*.[16] where phytate content upon germination of finger millet was reduced by 23.09after 48 hrs and; 45.30 per cent after 96 h of germination. Similar, reports on phytic reduction during germination was also reported by Pramod. Decreased content of phytic acid during germination is due to the activity of phytase enzyme[5,23]. It was reported that during germination, phytic acid get degraded by phytase enzyme in order to support seedling growth, to remobilize the phosphorus and other minerals stored as phytate salts[18].

The iron content in raw and germinated germplasmis shown in Table 2. It could be noticed that mean iron content in raw finger millet was 3.36 mg/100 g. These values are close with the data reported by Upadhyaya *et al.*[24] in PR 202, RAU-8 and VL-149 finger millet varieties. The germination process was found to reduce the iron content from 3.36 mg per 100 g in raw grain to 3.25, 3.08 and 2.81 mg per 100 g at different germination period of 24, 48 and 72 hrs respectively.Present findings revealed the significant reduction in the iron content after germination.Similar findings of significant reduction in ironcontent during germination were also reported in a study carried out by Afify *et al.*[1] in sorghum grains.

Phy/Fe molar ratiois associated with iron absorption capacity, higher the molar ratio lower will be the absorption. It could be noticed that the phyt/Fe molar ratios ranged from 16.04to18.70 in raw finger millet germplasm as presented in Table 3.Madhavan and Vasuprada[15] reported that low bioavailability of iron is due to the low mineral levels and the presence of high phytic acid content.Phytic acid and other antinutritional

factors reduce thebioavailability of iron from 5 to15 per cent are the challenges from nutrition point of view[4]. In present findings, the molar ratio decreased progressively with increase in the time of germination. For instance, it reduced from a mean molar ratio of 17:1 (raw grain) to 15:1(germination for 72 hrs). This reduction in molar ratio was mainly due to the reduction in phytic acid content(25.8 %) compared to a lesser reduction in iron content (16.4 %). These results indicates that the germination process will reduce the phytic acid content and not the iron content resulting in lowering of molar ratio which are preferred for high iron absorption. Hence, germination process can be used as one of the means toreduce the phytate to iron molar ratio in finger millet. Suma and Usna[22]also reported that changes in mineral and antinutrient content during sprouting lead to significant variations in the antinutrient/mineral molar ratios which had a positive impact on the bioaccessible mineral content.

CONCLUSION

Germination process is one of the effective meansto reduce the molar ratio of phytic acid to iron. This would form a powerful toolto improve the bioavailability of iron and to combat the iron deficiency anaemia especially in developing countries like India where iron deficiency anaemia is a major national nutritional problem.

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REFERENCES

1. Afify, A., Belgati, H. S., Salam, S. M. and Omran, A. A., Bioavailability of iron, zinc, phytate and phytase activity during soaking and germination of white sorghum varieties. *Plos one*, **6(10):** 25512 (2011).
2. NFHS., Ministry of Health and Family Welfare, Govt. of India, National Family Health Survey (NFHS) State Fact Sheet. Mumbai: Int. Institute for Population Sci., **168:** (2015).
3. Chandra, D., Chandra, S. Pallaviand Sharma and A. K., Review of Finger millet (*Eleusine coracana* (L.) Gaertn): A power house of health benefiting nutrients. *Food Sci and Human Wellness* **5:** 149–155 (2016).
4. Das, A., Raychaudhuri, U. and Chakraborty, R., Cereal based functional food of Indian subcontinent: a review. *J Food Sci Tech.* **49(6):** 665–672 (2011).
5. Duhan, A., Khetarpaul, N. and Bishnoi, S., Effect of soaking, germination and cooking on phytic acid and hydrochloric acid extractability of a pigeonpea cultivar. *J Fd Sci Technol.,* **38:** 374–378 (2001).
6. Ellis, R. and Morris, E.R.,Relation between phytic acid and trace metals in wheat bran and soyabean. *Cereal Chem.,* **58(5):** 367-370 (1981).
7. Gao, Y., Shang, C., Saghai M., M. A., Biyashev, R. M., Grabau, E. A., Kwanyuen, P., Burton, J. W. and Buss, G. R., A modified colorimetric method for phytic acid analysis in soybean. *Crop Sci.* **47:** 1797–1803 (2007).
8. Gharib, A. G., Mohseni, S. G. and Mohajer, M., Gharib, M., Bioavailability of essential trace elements in the presence of phytate, fiber and calcium. *J. of Radio analytical and Nuclear Chem.*, **270 (1):** 209-215 (2006).
9. Gunashree, B. S., Selva Kumar, R., Roobini, R. and Venkateswaran, G., Nutrients and antinutrients of ragi and wheat as influenced bytraditional processes. *Int. J. Curr. Microbiol. App. Sci*., **3(7):** 720-736 (2014).
10. Idris, W. H., Samia, M.A., Hagir, B.E., Babiker, E.E. and Abdullahi, H.E., Effect of malt pretreatment on phytate and tannin level of two sorghum (*Sorghum bicolor*); cultivars. *Intl J of Food Sci and Technol.,* **41:** 1229-1233 (2006).
11. Jeanb M, and Thompsonm L, U., Role of phytic acid in cancer and other diseases. In: Reddy Nr, Sathe S. K.,(eds). *Food Phytates*: 25–248 (2002).

12. Kassebaum, N.J., Rashmi, J., Mohsen, N., Sarah, K., Wulf, N. J., Rafael, L. Mathilda, R. D., David, P. Chou and Thomas, P., A Systematic analysis of global anemia burden from 1990 to 2010, *Blood*. **123 (5):** 615–624 (2014).
13. Lott, J. N. A., Ockenden, I., Raboy, V. and Batten, G. D. Phytic acid and phosphorus in crop seeds and fruits: A global estimate. *Seed Science Res.,* **10(1):** 11-33 (2000).
14. Ma, G., Li, Y., Jin, Y., Zhai, F., Kok, F.J. and Yang, X.,Phytate intake and molar ratios of phytate to zinc, iron and calcium in the diets of people in China. *European J. of Clin Nutrition.,* **61(3):** 368-374 (2007).
15. Madhavan, K. N., and Vasuprada, I., Iron content, bioavailability and factors affecting iron status of Indians, *Indian J Med Res* **130:** 634-645 (2009).
16. Makokha, A, O, Oniango R. K, Njoroge S. M, and Kamar O. K., Effect of traditional fermentation and malting on phytic acid and mineral availability of sorghum (Sorghum bicolor) and finger millet (*Eleusine coracana*) grain varieties grown in Kenya. *Food Nutr. Bull.,* **23:** S241- 245 (2002).
17. Pallauf, J., Pietsch M. and Rimbach, G.,Dietary phytate reduces magnesium bioavailability in growing rats. *Nutr Res*., **18:** 1029–1037 (1998).
18. Raboy, V., Myo-inositol-1,2,3,4,5,6-hexakisphosphate. *Phytochemistry*, **64:** 1033–1043 (2003).
19. Rahaman, A. E., S. M., Elmaki, H.B., Idris, W.H., Hassan, A.H., Babiker, E.E., El Tinay, and A.H., Antinutritional factors content and hydrochloric acid extractability of minerals in pearl millet cultivars as affected by germination. *IntJ of Food Sci and Nutri* **58:** 6–11 (2007).
20. Reddy, N. R.and Sathe S. K.,Occurrence, distribution, content, and dietary intake of phytate. In: Food phytates. CRC Press, Boca Raton (2002).
21. Schlemmer, U., Frolich W., and Prieto R. M., Grases F.,Phytate in foods and significance for humans: food sources, intake, processing, bioavailability, protective role and analysis. *Mol Nutr Food Res.* **53(2):** S330-75 (2009).
22. Suma, F. and Urooj, A., Influence of germination on bioaccessible iron and calcium in pearl millet (*Pennisetum typhoideum*). *J. Fd. Sci. Technol*., **51(5):** 976-981 (2014).
23. Turk, M., Carlsson, N. G. and Sandberg, A. S., Reduction In The Levels Of Phytate During Whole Meal Bread Marking: Effects Of Yeast And Wheat Phytases. *J. Cereal Sci.*, **23:** 257-264 (1996).
24. Upadhyaya, D. P., Vijayabharathi, R., Sathyabama, S., Rajeev and Brindha., Enhancement of nutritional value of finger millet-based food (Indian dosa) by co-fermentation with horse gram flour, *Int. J. Food Sci. and Nutr*., ISSN 0963-7486 (2007).
25. Weaver, C. M. and Kannan,S., Phytate and mineral bioavailability. *Food Phytates*. CRC: 211–223 (2002).