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Effects of processing on phytic acid, iron and its bioavailability of Macrotyloma uniflorum

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Horse gram is one of the inexpensive sources of protein, calcium and iron. Simple processing such as germination and roasting of horse gram were used to reduce the anti-nutritional factors. The germination was carried out by washing, soaking (8 h), germination period (48 h), and oven drying (50ºC) and ground into flour in grinder. In another processing method the horse gram was roasted for 10 minutes on low flame, cooled and powdered. Result of the present study revealed that germination and roasting have good effects on increasing in vitro iron bioavailability. While anti-nutritional factor phytates also reduced on both processing. The content of iron was also increases after germination and roasting as compared to untreated horse gram flour.

Key Words : Horse gram, Germination, Roasting, Iron, Anti-nutritional

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INTRODUCTION

The horse gram (Macrotyloma uniflorum) commonly known as *Kulthi* is a traditional unexploited tropical grain legume and well known for its hardiness, adaptability to poor soil and adverse climatic conditions. The horse gram is a cheapest source of protein. Further it is also rich in minerals such as calcium. Horse gram is an excellent source of iron and molybdenum. Horse gram is native to the old world tropics. It was probably domesticated in India where its cultivation known since prehistoric times. Now-a-day's horse gram is cultivated as a low grade pulse crop in Southern Asia mainly from India to Myanmar, it is also grown as a forage and green manure in many tropical countries especially Africa horse gram is recorded, to occur wild or neutralized in Central, East and Southern Africa. It is a popular pulse, locally known as Gaheth belongs to the family Fabaceae that still remain an under exploited legume crop. Seed of horse gram consumed after cooking, frying or as sprouts in rural parts of India by the poorer section of the population. As the name implies, it is also used as horse and cattle feed. The seed and its extracts are used to treat kidney stones, urinary diseases and piles in traditional medicine (Yadava and Vyas, 1994). Horse gram seeds also contain important anti-nutritional proteins like trypsin inhibitors and lectins (Liener and Kakade, 1980). Dehusking, germination, cooking, and roasting have been shown to produce beneficial effects on nutritional quality of the legume (Kadam and Salunkhe,1985). The germination is a simple method of food processing that result in increased nutritive value and decreases the phytates, tannin level and increases the availability of iron and calcium (Borade *et al*., 1984). Dehusking, germination, cooking, and roasting

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have been shown to produce beneficial effects on nutritional quality of the legume (Kadam and Salunkhe, 1985). The germination is a simple method of food processing that result in increased nutritive value and decreases the phytates, tannin level and increases the availability of iron and calcium (Borade *et al*., 1984). Information on effect of processing and cooking method on nutritional quality of legumes is scarce. Therefore, the aims of this work were a) to study the effect of germination and roasting on iron content of horse gram, b), to study the in vitro iron bioavailability in horse gram c), to study the changes in phytic acid content at germination and roasting.

METHODOLOGY

The horse gram used in this study was procured in March, 2015 from Bohra Ganesh Market, Udaipur, Rajasthan. The chemicals used for the analyses were of analytical grade and they were getting from the department of Foods and Nutrition, College of Home Science, MPUAT, Udaipur. The chemical analyses of the horse gram flour samples were carried out in the Food Science and Technology Laboratory, Department of Foods and Nutrition, College of Home Science, MPUAT, Udaipur. The samples were divided into three batches of 250 g each. These constituted samples for germination and roasting while one batch that was untreated constituted the control.

Processing of horse gram flour :

Raw horse gram flour :

250 g of horse gram was weighed sorted and oven dried 50°C for 8 h. The dried horse gram was milled in kitchen grinder machine, sieved wire mesh and packed in polyethylene nylon, put in covered container and stored at room temperature prior to analysis.

Germinated horse gram flour :

250 g of horse gram were weighed, sorted, steeped in water for 8 h at room temperature and then completely drained of steep water. The drained horse gram legume were then spread on a moistened cloth and allowed to germinate at room temperature (48 h). The germinated horse gram oven dried at 50°C for 7 to 8 h. The dried legumes were milled using kitchen grinder machine, sieved and packaged in polyethylene bags, put in an airtight container and stored under room temperature prior to analysis.

Roasted horse gram flour :

For roasting horse gram was weighted sorted and roasted for 10 minutes in low flame. After cooling, it was milled in kitchen grinder machine, sieved wire mesh and packed in polyethylene nylon, put in covered container and stored at room temperature prior to analysis.

Nutrient composition analysis :

Estimation of moisture was done by the method of Bhatnagar and Mathew (1991). In mineral constituent iron and its bioavailability were determined by atomic absorption spectrophotometer upon digestion with a mixture of concentrated nitric acid, sulfuric acid (5:1 v/v) (Bhatnagar and Mathew, 1991).

Antinutritional feature :

Phytic acid :

Phytate is a hexaphosphate of vitamin inositol widely distributed in edible plants. It interacts with the absorption of mineral like Ca, Mg, and Fe. It was determined by the method of Bhatnagar and Mathew (1991). Phtic acid reacts with $FeCl_3$ and precipitated as ferric phytate.

Statistical analysis :

The data were analysed using SPSS version 16.0. The mean and standard error of means of the triplicate analyses of the samples were calculated.

OBSERVATIONS AND ASSESSMENT

The results related to moisture showed that control sample content 8.61 g/100 g moisture. There was a reduction in moisture on germination (8.2g/100g) and roasting process (7.6g/100g). The results are comparable with findings of Ghavidel and Prakash (2007) and Thirukkumar and Sindumathi (2014).

Changes in iron content of raw, germinated and roasted horse gram flour :

The mineral composition of raw, germinated and roasted horse gram flour is shown in Table 1. The iron content of raw horse gram showed there is increased after germination and roasting. Mineral content were also higher in sprouts as the hydrolysis of phytic acid phytic enzyme activated during germination.

In comparison, the mineral composition of germinated

horse gram flour was higher in iron than roasted and raw horse gram flour. It was observed in this study that germination processing techniques improved the iron composition of the flour sample. This observation could be attributed to bio-synthesis and activities of micro-organism during germination process (Gabriel and Akharaiyi, 2007). Nutritionally, the ratio of iron of the flour sample range between 5.3 for roasted horse gram flour and 5.8 for germinated horse gram flour. This finding indicates that the germinated horse gram flour samples would serve as good source iron which is considered as essential for hemoglobin of red blood cells, in order to transport oxygen from the lungs to the tissues. However, it is evident that the influence of germination increased the availability of iron in legumes (Luoa *et al.*, 2013).

Iron bioavailability :

Table 1 showed the values related to iron bioavailability. Table revealed that in vitro iron availability of germinated horse gram flour was increased in compare to the roasted and control horse gram flour. In germinated horse gram flour increase of iron bioavailability is due to soaking and germination treatment which causes reduces in phytate content which is a main inhibitor of Fe and Zn absorption (Sandberg, 2002).

Germination caused significant increase in protein, thiamin, in vitro iron and calcium bioavailability and in vitro starch and protein digestibility contents of the legume samples. Phytic acid and tannin were reduced by 18–21 per cent and 20–38 per cent, on germination (Ghavidel and Prakash, 2006). The *in vitro* bioavailability of iron and zinc were significantly improved as a result of soaking and germination treatments (Afify *et al.*, 2011). *In vitro* bioavailability of roasted flour was less due to phytic acid in roasting decrease not as much as in germination.

Phytate :

Phytate (inositol hexaphosphate) constitutes 1–3 per cent of cereal grains, legume seeds and nuts. In particular, wholegrain cereals and legumes have a high content of phytate but also of the minerals Zn, Fe and Mg. In legume seeds, phytate is located in the protein bodies in the endosperm. Phytate occurs as a mineral complex, which is insoluble at the physiological pH of the intestine. It is considered antinutritional, causing reduced uptake in the human intestine of essential dietary minerals such as Fe, Zn and Ca (Sandberg, 2002).

Phytic acid content was decreased in germinated horse gram flour. Germination reduced total phytic acid contents in horse gram flour sample. The decreased in phytic acid content was due to enzymatic changes during germination period in seeds (Rusydi and Azrina, 2012). In another study phytate content was significantly reduced from 23.59 to 32.40 per cent for soaking treatment and 24.92 to 35.27 per cent for germination treatments, respectively (Afify *et al.,* 2011). In a roasted horse gram sample there is slightly reduction in phytic content in compare to untreated horse gram flour because roasting probably removes a significant portion of phytic acid. Roasting removes 32-68 per cent of phytic acid in chick peas and roasting grains removes about 40 per cent of phytic acid (Nagel, 2010). It was found that on roasting or soaking and drying of horse gram phytate content reduced to 4.38mg/g on soaking and drying and after roasting it was only 1.49 mg/g (Thirukkumar and Sindumathi, 2014).

Conclusion :

The result of this study indicates that horse gram flour is good source of iron. Hence, suitably processed horse gram flour could be used in the preparation of

Table 1 : Changes in phytate in horse gram during germination and roasting

Samples	Total iron (mg/100g)	Bio availability of iron (mg/100g)	%
Control horse gram flour	5.0	1.3	26
Germinated horse gram flour	5.8	2.2	37.93
Roasted horse gram flour	5.3	1.5	28.30

Table 2 : Changes in phytic acid after germination and roasting

Sr. No.	Processing	P % of total
1.	Control	42.33
2.	Germination	31.66
3.	Roasting	41

various food products. Of the different processes employed, roasting and germination was effective in reducing anti-nutritional factors. The results obtained from this study indicate that the processes of germination or roasting are simple methods to eliminate the antinutrients content of horse gram and able to increase iron bioavailability. Horse gram, being a locally available pulse, can be thus used after simple processing to improve the mineral content.

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