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Changes in phytic acid and iron content during germination and roasting of moth bean

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The present investigation was conducted to study the effect of processing (germination) and cooking (roasting) methods on the total iron, invitro iron and phytic acid of moth beans. The processing (germination) and cooking (roasting) methods caused increase in iron bioavailability content of moth beans. Mean while, phytate contents were decreased of the studied moth beans. These resulted revealed that the processing (germination) and cooking methods (roasting) was more effective in eliminating the contents of phytic acid in moth beans which plays major role hinder the absorption of minerals.

Key Words : Moth beans, Germination, Roasting, Iron, Phytic acid

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INTRODUCTION

India is the major legume producing country in the world and legume crops continue to occupy an important place from nutrition point of view in daily diets of the people in the country. It is a matter of great concern that the supply of proteins in the daily diets is the lowest in India and no significant improvement has taken place during the last three decades. Consumption of legumes in India is restricted due to the scarcity caused by their present low yields and consequent higher cost, and due to certain drawbacks in their nutritional and food use qualities. Legumes are widely grown throughout the world and their dietary and economic importance is globally appreciated and recognized. They are important sources of proteins, carbohydrates including fibre, certain minerals such as Ca, Mg, Zinc, Iron, Potassium and Phosphorus etc. (Kataria *et al.*, 1989 and Negi *et al.*, 2001). But the biological utilization of existing nutrients of these legumes is limited by the presence of various anti nutritional substances. The mineral content of legumes is generally high, but the bioavailability is poor due to the presence of phytate, which is a main inhibitor of iron and zinc absorption. Phytate not only decreases the bioavailability of essential minerals, it also decreases the bioavailability of forming insoluble phytate-mineral and phytate-protien complexes. However, remarkable improvements in the nutritive value of legume seeds have been achieved by adopting various processing techniques, such as dehulling, soaking, heat treatment and germination.

Moth bean (*Vigna aconitifolia* L.) is the most drought-tolerant pulse crop grown in arid and sandy tracts of Rajasthan, India's driest state. It is an exceptionally hard legume thrives in South Asia in hot, dry, tropical conditions. A legume of subfamily Papilionoideae, moth bean is also known by various other names including mat, matki, math, or mout bean.

Consumption of Moth bean is limited to some states

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in India. Though extensive information is available on the nutritive value of moth bean is limited. Moth beans are normally consumed in India as cooked and seasoned (with spices) beans (whole as well as dhal) or sprouted and cooked (usually stir-fried with suitable spices) beans, prior to consumption. Grains and legumes in India are processed and consumed in a variety of forms. Traditional method of processing includes germination, fermentation, and pressure cooking and roasting. Soaking and germination is an integral part of traditional methods of processing moth bean seeds in India, thus offers the dual advantage of saving energy costs by shortening cooking time as well as removing certain anti nutritional factors like phytic acid. In household situations legumes are typically soaked in water forovernight (12-14 hrs) at room temperature.

Phytic acid, myo – inositol 1, 2, 3, 4, 5, 6– hexa – kis (dihydrogen phosphate) widely distributed in mature legume grains, stores most of the grain phosphorus. Phytic acid (myo-inositol hexaphosphate or $InsP_6$), is a major phosphorus storage form in plants, and its salts known as phytates regulate various cellular functions such as DNA repair, chromatin remodeling, endocytosis, nuclear messenger RNA export and potentially hormone signaling important for plant and seed development (Zhou and Erdman, 1995). It is often regarded as an antinutrient because of strong mineral, protein and starch binding properties thereby decreasing their bioavailability (Weaver and Kannan, 2002). Phytate play important role in plant metabolism, stress and pathogen resistance in addition to their beneficial effects in human diets by acting as anticarcinogen (Shamsuddin, 2002) or by promoting health in other ways such as in decreasing the risk of heart disease or diabetes. Pulses have high content of phytate, which is located in the protein bodies in the endosperm. Raw lentil contained 0.3 $mmol \cdot kg^{-1}$ of $InsP_3$ (Morris and Hill, 1996). The most abundant inositol phosphate in raw, dry legume is $InsP_6$, accounting for an average of 83% of the total inositol phosphates, ranging from 77% in chickpea to 88% in black bean. The $InsP_6$ concentration tends to be higher in raw dry bean, blackeye pea, and pigeonpea than in lentil, green and yellow split pea, and chickpea and ranged between 14.2 and 6 $mmol \cdot kg^{1}$ in black bean and chickpea, respectively (Shamsuddin, 2002). *In vivo* and *in vitro* studies have demonstrated that inositol hexaphosphate ($InsP_6$, phytic acid) exhibits significant anticancer (preventive as well as therapeutic) properties. The anticarcinogenic properties of phytic acid may result from numerous factors. The backbone of most inositol phosphates in cells is myo-inositol. Myo-inositol and $InsP_6$ have synergistic or additive effects in inhibiting the development of cancer. In mice, dietary myoinositol has been shown to be effective in preventing cancer of the lung, fore stomach, and liver.

Phytic acid has anti nutritional properties owing to its ability to chelate several minerals and thereby reduce their bioavaibility. The effect of germination conditions on the chemical composition, biochemical constituents and anti nutritional factors of moth bean was studied (Salve and Mehrajfateman, 2011). Moth bean are the unexploited legumes of the tropics and subtropics grown mostly under dry-land agriculture. Dehusking, germination, cooking and roasting have been shown to produce beneficial effects on nutritional quality of moth beans. It requires prolonged cooking to obtain product of acceptable nature.

Moth bean is mostly consumed as dhal or sprouts. However, it is consumed as a whole seed, sprouts, or whole meal by a large population in rural areas of southern India. The greatest reduction of phytates and phytic acid was achieved by soaking and cooking without the soaking water (Elmaki *et al*., 2007; Nergiz and Gokgoz, 2007 and Toledo and Canniatti- Brazaca, 2008).

METHODOLOGY

Procurement of raw material :

Seed sample were collected from local markets of Udaipur. Seeds were cleaned and freed from broken seeds, dust and other foreign materials.

Processing methods :

There are two methods used given below :

Germination :

Germination is a specific form of plant growth process during which the rootlet breaks through the seed coat and sprout emerges. The beginning of the germination process is conditioned by adequate moisture and temperature level as well as by access to fresh air. The first two factors play a dominant role because they initiate biochemical reactions conditioning all the phenomena (Grezesuk and Kulka, 1981).

Roasting :

Roasting was done by using heating medium in an open iron pan for 5-10 minutes then it cooled at ambient temperature and grind finely and oven dried for analysis.

Nutrient analysis :

Moisture:

Moisture is the major component of food. The moisture content of any food is determined not only to analyze the chemical composition of food material on moisture free basis but also to access shelf-life of the products. Moisture content of samples was analyzed by the method described by NIN (2003). Ten gram sample was weighed in a dried and weighed petri dish. The weight of the sample along with the petri dish was taken at regular intervals until a constant weight was obtained. The moisture percentage was calculated by using following formula:

Moisture (g/100g) = Initial weight (g) - Final weight (g) / Weight of sample *

Anti nutritional factor :

Phytic acid:

Phytic acid content of the sample was analyzed by using the method compiled by Mathew and Bhatnagar (1991). 10 g of moisture free finely ground sample was taken in a conical flask and added 100ml HCl. The mixture was shaken in a shaker for 3 hours and filtered. The clear filtrate thus obtained was reduced 25ml over water. The filter was neutralized adding required amount of sodium hydroxide. Ten ml of 0.01 per cent ferric chloride was then added and mixture heated over water bath for 15 minutes, cooled to room temperature and filtered again using a pre weighed filter paper. The residue was washed with ethanol and then ether. The filter paper was dried and weighed.

Phytic acid (g/100g) = Weight of dried precipitate / Weigh of sample *100

Mineral analysis:

Iron:

Mineral contents in the samples of both raw and germinated moth beans as well as in cooking water were determined by the standard methods of AOAC (2000). The dried samples were wet acid digested using a nitric acid and perchloric acid mixture (HNO_3: $HClO_4$, 5:1 w/v). Total iron and in vitro iron were determined by atomic absorption spectrophotometer (Alam *et al.*, 2007).

OBSERVATIONS AND ASSESSMENT

The results in Table 1 showed that moisture in control samples ranged from 8.5 to 11.7 g/100 g. There was a reduction in moisture on roasting in moth beans. According to Salve and Mehraj fatema (2011) an increase in moisture content was observed in moth beans. The increment may be due to gradual absorption of moisture by grains during soaking.

Table 1 : Changes in moisture content of moth beans during germination and roasting

Sr. No.	Processing method	Moisture (g/100g)
1.	Control	8.6± 0.1
2.	Germination	11.7± 0.3
3.	Roasted	8.5±0.2

Effect of germination and roasting on Phytic acid :

The results presented in Table 2 clearly show that germination was very effective in lowering phytate phosphorus contents of the moth beans. The decrease in phytic acid amounted to 50 per cent and 69 per cent in germination and roasting, respectively. Roasting was not as effective as germination process methods but the losses in phytic acid were seen.

Table 2 : Change in phytate of moth beans during germination and roasting

Sr. No.	Processing method	Total Phytate (%)
1.	Control	90.66
2.	Germination	50
3.	Roasted	69

Antu Grewal and Sudesh Jood reported 19 per cent reduction in phytic acid in mung bean soaked for 12 hrs. Phytic acid is water soluble and the reduction of the same in seeds during soaking could be attributed to leaching out in soaking water under concentration gradient and appearance of phytase during soaking.

Decrease in phytic acid content during germination could be due to increase in phytase activity as reported by several authors in faba bean (Eskin and Wiebe, 1983), broad bean, chickpea and lentil (Egli *et al.*, 2002) and several other legumes (Kyriakidis *et al.*, 1998). Domestic processing and cooking methods are known to reduce the anti nutrients and thus improve the nutritive value of legume grains (Khokhar and Chauhan, 1986 and Sharma and Sehgal, 1992). Germination caused the most significant reduction in phytates. The longer period of germination, led to greater reduction in phytic acid content; germination of seeds for 48 h caused a reduction of 66 to 69 per cent. This reduction was possibly due to activation of phytase during germination (Sharma and Sehgal, 1992).

Effect of germination and roasting on iron :

Table 3 clearly showed the effect of germination and roasting on total iron content and bioavailability of iron**.** It was observed that germination influenced invitro availability of iron more positively then controlled and roasted sample. Increase mineral availability during germination may be due to increase phytase enzyme activity, which resulted in decrease content of phytase in sprouts.

Table 3 : The effect of germination and roasting on total iron content and bioavailability of iron

Sr. No.	Processing method	Total iron (mg/100g)	*In vitro* iron	*In vitro* as % of total
1.	Control	4.1	2.1	51.21
2.	Germination	4.4	2.8	64.28
3.	Roasted	3.6	1.91	53.33

On germination, the per cent bioavailable iron increased significantly ($P<0.05$) by 64.6%, 67.8%, 75.8% and 81.3% in chickpea, green gram, cowpea and lentil, respectively, over the control samples (Krishna, 2012). Similar findings were reported by Juyang and Zakari (2008), the germination would increase the mineral content due to an increase in phytase enzyme activity. The enzyme will hydrolyze the bond between the protein enzyme minerals become free, therefore increasing the availability of minerals. This study in line with the molar ratio of phytate to iron of control, soaked and germinated chickpea were in the range of 0.98 to 1.28, but germination significantly ($p<0.05$) reduced the phytate to iron ratio and followed by soaking (Beruk, 2014).

Conclusion :

Moth beans have a great deal of iron. One cup of cooked moth beans contribute nearly one-third of the recommended intake of iron for a woman ages twenty to fifty. Moth beans, as other beans, do contain a potent iron inhibitor called phytic acid that reduces absorption of the iron in the beans but simple process technique, including soaking moth beans overnight in warm water before cooking reduce the phytic acid content. Mostly developing contries which is prevalent in anemia due to vegan diet consumption, they can use different domestic processing and cooking methods for improving iron availability as result showed of study that Germination improved invitro iron availability and decrease phytic acid which inhibit the absorption of iron. Germination combined with dehulling process improve quality of legumes by enhancing the bioavailability and digestibility of nutrients and reducing the antinutrients. Soaking and germination increased carbohydrate and energy, but it decreased anti-nutrients content (phytate and condensed tannin) and improved bioavailability of minerals (Ca and Fe) and protein digestibility. Generally, soaking and germination of legumes can be used for improvement of nutrient bioavailability and nutrient density so that it is appropriate technique for production of infant and young children foods.

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