EFFECT OF PROCESSING ON NIGER SEEDS: A RICH SOURCE OF IRON

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ABSTRACT

Niger seed (Guizotia Abyssinica) is an underutilized oilseed crop which is commonly known as ram til or kala til. It has been used in many food items like niger seed laddoos and in other sweet items. The present paper examines the iron, bioavailable iron and anti-nutrient (phytic acid) content of niger seeds at different processing techniques i.e. soaking, germination and roasting. Results showed that the iron content in raw (control), soaked, germinated and roasted niger seeds ranged between 38.56 - 42.43 mg/100g. The germination process increased the bio-availability of iron (36%) and reduced the phytic acid level (52.6%) of niger seeds. This information would be useful for various food industries and common people for its better utilization in food items.

Key words: IDA, In vitro iron, Iron, Niger seeds, Phytic acid.

INTRODUCTION

Iron deficiency anaemia (IDA) is the most prevalent micronutrient deficiency among human beings all over the world. Iron deficiency anaemia affected more than 3.5 billion people globally (ACC/SCN, 2000). The prevalence of anaemia could be as high as 74 per cent in children below three years of age, 85 per cent in expectant mothers and 90 per cent among adolescent girls in some population groups (MOHFW, 1998-1999).

Nutritional strategies to combat iron deficiency anaemia include food-based approaches such as food or dietary diversity, pharmaceutical approaches (iron and folic and supplementation) and bio fortification.

Food diversity involves increasing the quantity and the variety of iron-rich foods consumed (Allen et.al. 2006). This may include promoting the production and consumption of foods rich in iron, and foods that contain substance that enhance iron absorption, and the use of food processing methods such as germination, soaking, and fermentation, that reduce the content of iron absorption inhibitors. Dietary diversity has the advantage of simultaneously improving the intake of multiple micronutrients.

Improvement in supply and consumption of iron rich foods and enhancing the bioavailability to iron from foods are important strategies to improve the iron status of population (Jemima and Bhavani, 2004).

In country like India where plenty of natural resources are available and majority of population is vegetarian, which has low bioavailability, consumption of iron rich foods significantly help for reduction of iron deficiency anaemia. Most of the research work on the availability of iron has been carried out on plant foods like cereals, pulses and vegetables. Such studies, however, are limited in the area of nuts and oilseeds even though they are consumed by all the segments of population irrespective of socio economic status. Studies on the availability of iron from nuts and oilseeds may make possible the identification of specified nuts and oilseeds rich in available iron.

In nutrition, a new era is emerging that is characterized by search for dietary constituents that have benefits beyond those ascribed to the macro and micronutrients. Nuts and oilseeds are complex plant foods that are not only rich sources of unsaturated fat but also contain several non fat constituents such as plant protein, fibre, micronutrients (e.g. copper and magnesium), plant sterols and phytochemicals (Rainey and Nyquist, 1997). Frequency of nut consumption seems to be...
inversely related to all-cause mortality in several population groups (Fraser and Shavlik, 1997; Fraser et al., 1997). However, in amounts they are consumed, may not contribute much to the intake for the beneficial effect. Nuts and oilseeds have an important place in Rajasthani dietary. In India niger seed is cultivated in the states of MadhaPradesh, Orissa, Maharashtra, Bihar, Karnatak, AndhraPradesh, Uttar Pradesh, Rajasthan, Gujrat and Tamil Nadu. The annual production of niger seeds in India is about 180,000 tonnes (Getinet and Sharma, 1996).

Niger seed (Guizotia abyssinica) is a type of oilseed crop which is reported to be containing very high amount of iron (56.7 mg/100g) in plant based foods and may be of immense help in improving the iron status of vulnerable population group (Gopalan et al. 2000). Baranwal et al. (2011) found in their study that 25 g/day of niger seed laddoo supplementation to iron deficient adolescents girls (16-17 yrs) improves the nutritional status of girls.

Though, the iron content of niger seeds is very high but due to the presence of phytic acid, the bio-availability is low. This gap can be fulfilled by using the home based various processing techniques like soaking, germination and roasting. Thus keeping these things in mind the present study was undertaken with a specific objective that is to assess the effect of processing on the total iron, bioavailable iron and the anti-nutrient, phytic acid in niger seeds.

MATERIALS AND METHODS

Present study was undertaken to find out the effect of processing and cooking on the total iron, bioavailable iron and anti-nutrient, phytic acid content in the niger seeds. It was selected as they are commonly consumed in the most part of India. Selected sample was subjected to processing like soaking, germination and cooking by roasting.

Collection of sample: Niger seeds were purchased from the local market in a single lot

Storage of niger seeds: 100 grams of the sample for each processing and cooking technique cleaned to make them free from dust and dirt and stored in clean and closed poly bags to avoid contamination through insects and rodents.

Processing and cooking methods: Soaking, germination and cooking by roasting methods were used during the present study.

Soaking: 100 grams of niger seeds were soaked in distilled water for 12 hours at room temperature and the excess water was discarded.

Germination: The soaked niger seeds were tied separately in clean muslin cloth and allowed to germinate at room temperature for 36-48 hours till the sprouts appeared.

Roasting: Niger seeds were roasted in a frying pan on medium low heat for 5 minutes, until they were fragrant and the pan began to smoke. Then removed from flame and cooled.

Chemical analysis of samples: The chemical analysis of raw, processed and cooked sample for total iron, available iron and phytic acid were done by following methods:

Iron: The estimation of iron was done using the principle of colorimetry. In this method, orthophenanthroline is used which readily reacts with ferrous ion giving the color. The method of Chapman and Pratt (1961) was used for the analysis.

Prepared test solution using the wet ash method. 5 ml of this solution was taken in 25 ml volumetric flask. To this, 2 ml sodium citrate, 1 ml hydroquinone and 1 ml orthrophenanthroline were added. Made up volume to 25 ml with distilled water and allowed to stand for an hour at room temperature. Optical density(OD) was read in a spectrophotometer at 508 nm. To determine the OD of the standard iron solutions 0.1, 0.2, 0.4, 0.6, 0.8 and 1 ml of standard solution was taken instead of the test solution and rest of the steps were followed. The iron concentration of the sample was determined using the standard graph.

Bioavailability of iron: Bioavailability is viewed as the portion of iron present in food stuff which is absorbed or utilized by the body. It is the actual amount iron available to the body after digestion and absorption of food item. The method given by Lock and Bender (1980) was used.

Procedure: One gram ground sample was weighed in a conical flask and added 50 ml 0.03 N HCl. The mixture was incubated at 37°C in a shaker cum water bath for three hours to simulate conditions that occur in a stomach. The mixture was filtered through whatman filter paper No. 42 and the filtrate was dried in an oven. Filterate was removed and
digested in diacid mixture (Nitric acid: Perchloric acid:: 5:1) over a digestion rack at low temperature, till clear precipitate was obtained. Volume was made up to 100 ml and process for iron determination was followed. Per cent extractability, an index of iron bioavailability was calculated.

**Calculation:** Extractability (%) = \( \frac{\text{HCl extractable iron (ml)}}{\text{total iron}} \times 100 \)

**Phytic acid:** Phytic acid content of the samples was estimated using the method given by Peach and Tracy (1955). Ten grams of finely ground samples was taken in a conical flask and added 50 ml HCl. The mixture was shaken in a shaker for three hours and filtered. The clean filterate thus obtained was reduced to 25 ml over water bath. The filtrate was neutralized adding required amount of sodium hydroxide. 10 ml of 0.01 per cent ferric chloride was then added and the 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.

**Calculation:** Phytin phosphorus (g/100g) = \( \frac{\text{weight of dried paper}}{\text{weight of sample}} \times 100. \)

**Statistical analysis:** Results obtained were analysed by ANOVA one way classification.

**RESULTS AND DISCUSSION**

Table 1 revealed that the control, soaked, germinated and roasted niger seeds were having 42.43, 38.56, 39.30 and 42.43 mg/100g iron content respectively. It was found in the present study that iron content decreased after germination and soaking (Table 1). It is well documented by other authors (Enujiugha et al., 2003). This reduction could be due to leaching of solid matter in soaking water. It can be observed that iron content of niger seeds increased after roasting when the mean value was compared to control. Processing techniques including simple homestead technologies aim at improving the bioavailability of nutrients. In the present study iron bioavailability of the samples was analysed and comparisons were made between the untreated and treated niger seeds. It can be observed that there was not any large change found in the control and roasted niger seeds (Table 1). The processing techniques, soaking and germination could increase the bioavailability of iron 5.24% and 37.17% respectively, in niger seeds. The reason behind that the reduction of phytates content in the sample (Fig.1).

Nutritionists now recognize that only a proportion of the nutrients ingested are biologically available (Gibson, 1994). This is due to a number of reasons related to the physical nature and chemical composition of foods and to the individual’s digestive capacity. One of the most important factors seems to be the presence of dietary components that interfere with digestion and inhibit absorption of some nutrients.

The anti-nutrient present in food grains pose as obstructing agents for the absorption and availability of nutrients. It is therefore of paramount importance that processing of grains be done to reduce the amount of these antinutrient.

Simple processing methods can be used to reduce the level of phytates and thus improve mineral bioavailability. Soaking the grain or legume, cooking the soaked seeds and germination of the raw seeds are known to reduce phytate content. Germination are frequently used to reduce the effects of phytates on mineral absorption (Henry and Massey, 2001).

Data illustrating the effect of various treatments on phytic acid has also been studied and the results have been given in Table 1 revealed that

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Samples</th>
<th>Iron content (mg/100g) Mean</th>
<th>SD</th>
<th>Bioavailable iron (%) Mean</th>
<th>SD</th>
<th>Phytic acid (mg/100g) Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control</td>
<td>42.43</td>
<td>0.11</td>
<td>5.73</td>
<td>0.05</td>
<td>242.54</td>
<td>1.16</td>
</tr>
<tr>
<td>2.</td>
<td>Soaked niger seeds</td>
<td>38.56</td>
<td>0.57</td>
<td>6.03</td>
<td>0.05</td>
<td>191.27</td>
<td>0.75</td>
</tr>
<tr>
<td>3.</td>
<td>Germinated niger seeds</td>
<td>39.30</td>
<td>0.17</td>
<td>7.86</td>
<td>0.05</td>
<td>115.04</td>
<td>4.62</td>
</tr>
<tr>
<td>4.</td>
<td>Roasted niger seeds</td>
<td>42.43</td>
<td>0.05</td>
<td>5.79</td>
<td>0.05</td>
<td>238.60</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td>CD5%</td>
<td>0.58</td>
<td>0.10</td>
<td></td>
<td></td>
<td>4.57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CD1%</td>
<td>0.89</td>
<td>0.16</td>
<td></td>
<td></td>
<td>7.03</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Critical value</td>
<td>0.76</td>
<td>0.93</td>
<td></td>
<td></td>
<td>1.23</td>
<td></td>
</tr>
</tbody>
</table>
the control sample was having high amount of phytic acid 242.54 mg/100g while after soaking and germination, it was reduced to the amount 191.27 to 115.04 mg/100g respectively. The effect of roasting was not seen as much as on the phytate content of the sample (Fig. 2).

The reduction can be due to the leaching of phytic acid in water during the soaking treatment given prior to germination. The results were found to be in agreement with the findings of Kataria (1989), Henry and Massey (2001) and Vidal-Valverde (2002). These researches reported germination to be a biochemical tool to reduce the anti-nutrients in various seed grains.

CONCLUSION

It was concluded in the present study that niger seeds had a large amount of iron (42.43 mg/100g) among other plant foods. The effect of processing was observed that the iron content decreased after soaking and germination in niger seeds. Iron content was not affected by roasting process in the sample. The percent extractability in vitro bioavailable iron was low due to the higher amount of presence of phytic acid. Soaking and germination processing increased the in vitro bioavailability of iron by 5.23% and 37% respectively in the sample. The difference between the mean value of % extractable iron in control and roasted

![FIG. 1: Effect of processing on percent increase of bioavailable iron in niger seeds](image)

![FIG. 2: Effect of processing on percent reduction of phytate content in niger seeds](image)
niger seeds was slightly. Germination improved in vitro iron bioavailability of niger seeds in this study. Phytic acid reduced by 52.6% in germinated samples over control. This information would be useful for various food industries and common people for its better utilization in food items.

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