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Effect of Soaking on Calcium, Phosphorus, Magnesium and Sodium Contents of Chickpea (*Cicer aritinum* L.)

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Abstract: The aim of this study was to evaluate the effect of soaking on peas minerals. Raw peas were soaked for 8, 12 and 24 h in tap water. After drying and acid digestion, 70 samples in 4 groups of raw, 8, 12 and 24 h soaked and also soaking waters of all soaking hours, minerals were measured and compared. The result of present study showed that after 12 and 24 soaking hours, calcium content of peas and after 8, 12 and 24 h soaking time, magnesium and phosphorus content of samples were decreased and also in soaking water samples, comparing the tap water used for soaking, after 24 h of soaking calcium content was increased and after 8 and 12 h, phosphorus content was decreased. Also, magnesium content of soaking water samples was increased and Na content was decreased. It appears that the soaking as an effective method of reducing flatulent materials and anti-nutrients, causing the reduction of minerals by leaching into the water does not have a significant effect on bioavailability of minerals.

Key words: Pea, soaking, calcium, phosphorus, magnesium, Iran

INTRODUCTION

Due to expensive animal protein sources, plant protein sources' use is increasing. Legumes are the most important source of dietary protein in many developing countries and are in the second rank after the consumption of grains.

Legume seeds have an average of twice as much protein as cereals and the nutritive value of the proteins are usually high and therefore constitute the main food crops in areas that increase the nutritional value (Youssef *et al*., 1987). Chickpea (*Cicer aritinum* L.) a diploid plant, from legume family (Leguminose), subfamily of Papilionideae and the tribe is Cicereae Alef. The genus *Cicer* contains 43 species including 9 annual species, 33 perennial species and one uncertain species (www.agron.agri-jahad.ir). Compared with grain protein, pea protein contains more lysine amino acid and less methionine and cysteine.

Now-a-days, most attention has focused on herbal foods; on the other hand, there is a reality in the name of anti-nutrients in herbal foods. Methods such as soaking scorching, etc., are strategies to increase the protein digestibility, increase mineral bioavailability and thus increase the nutritional value of herbal foods (Nergiz and Gokgoz, 2007; Iyayi *et al*., 2008). Phytate is one of the anti-nutrients that is commonly found in high-fiber foods such as legumes and grains (Oatway *et al*., 2001).

Minerals, categorized as micronutrients are required by our body in small amounts. Deficiency in minerals, however can have a major effect on health such as anemia and osteoporosis that commonly occur in both developed and developing countries.

Phytate binds with minerals and inhibits mineral absorption. Due to the structure of phytate which has high density of negatively charged phosphate groups which make very stable complexes with mineral ions causing non-availability for intestinal absorption (Lopez *et al*., 2002)

The findings of some studies have shown that soaking significantly decreases the amount of phytate and other anti-nutrients (Karkle and Beleia, 2010; Huma *et al*., 2008). Other studies also have shown that some minerals leached into the water during soaking, leading to a significant reduction in the available quantities (Wang *et al*., 2008). Another study also indicates that been leaching of minerals into the water and also absorption of some of this minerals, happen simultaneously (Bayram *et al*., 2004). This study focused only on Calcium (Ca), Phosphorus (P), Magnesium (Mg) and Sodium (Na).

Since the loss of minerals by soaking was inconsistent with its main objective to increase bioavailability of minerals, researchers decided to study the effect of soaking time on the mineral content of peas.

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MATERIALS AND METHODS

First 10 different samples were collected after cleaning the peas, the amount of 25 g of each sample was soaked in 150 mL of water for 8, 12 and 24 h. Then, the phloem and the water from soaking the peas were packed separately. After grinding the samples, 5 g from all of the dry, 8, 12 and 24 h soaked samples were separated and moisture was measured according to the methods listed in the book of Food Quality Control and Chemical Tests authored by Parvaneh (1992). Then for acid digestion, to 2 g of each sample, 10 mL hydrochloric acid and 4 mL citric acid were added and diluted to a volume of 100 cc with distilled water; after 48 h, boiled at boiling temperature for at least 1 h.

For measurement of calcium and phosphorus, final samples were prepared according to the instructions listed in the kits related to measuring of serum calcium and phosphorus concentration. Phosphorus concentrations in samples were measured in wavelength of 630 nm and calcium concentration in wavelength of 560 nm at room temperature by a spectrophotometer. Magnesium (Mg) and sodium (Na) were measured by the atomic absorption spectroscopy method with the flame atomic absorption device (model: CTA 2000). To compare dry and soaked samples' minerals, results should be expressed in mg mineral per dry matter.

Thus, using calculated moisture percent, dry matter percent of samples and the amount of minerals in the amount of dry matter was calculated as: Dry matter (%) = (100-Moisture (%))/100. Milligram of minerals per g of dry matter = Mineral concentration (mg dL^{-1}) × 50 × Dry matter (%)/10.

Statistical analysis: In order to determine the leakage of minerals into the water during soaking, all the values were also measured in the tap water used for soaking. Data were analyzed by one-way ANOVA. A p-value of <0.05 was considered statistically significant.

RESULTS

The results obtained from measuring and calculating moisture percent is listed in Table 1. Minerals of every 10 samples at different soaking hours and dry samples are shown in Table 2.

According to statistical analysis, results of the comparing different soaking hours (8, 12 and 24 h) with raw peas were shown in the study.

Comparing 8 h soaked sample with raw samples there was not a significant difference in calcium content but the difference was significant in comparing 12 and 24 h soaked samples with raw ones ($p<0.0001$, $p = 0.008$, respectively). There was a significant difference between P and Mg contents of 8, 12 and 24 h soaked samples ($p<0.001$) while there was not a significant difference between soaked and raw peas.

Table 1: Average moisture percent of samples

Samples type	Moisture (%)
Raw pea	5.57±0.475
8 h soaked pea	55.82±1.311
12 h soaked pea	57.88±1.072
24 h soaked pea	56.39±1.668

Table 2: Ca, P, Mg and Na contents in different soaking hours and dry samples (mg/100 g dry matter)

Samples type	Ca	P	Mg	Na
Raw	270.99±39.54	457.17±40.25	10.80±0.08	7.71±3.85
8 h soaked	251.94±63.50	213.83±19.44	5.02±0.11	7.49±1.16
12 h soaked	217.45±36.40*	237.50±25.66	4.81±0.13	6.15±1.70
24 h soaked	92.60±54.51*	183.35±18.63	4.93±0.18	7.63±2.67

*In comparison with raw samples ($p<0.01$)

Table 3: Mineral contents in water samples after soaking peas and in tap water (mg/100 g dray matter)

Samples type	Ca	P	Mg	Na
Tap water	142	71.5	2.05	8.02
8 h soaked	123.45±48.41	35.9±24.88	2.139±0.10**	6.5463±0.15**
12 h soaked	148.1±32.63	46.85±26.22[a]	2.163±0.09**	6.502±0.12**
24 h soaked	175.2±43.75*	61.35±50.22[a]	2.196±0.09**	6.257±0.20**

*In comparison with tap water ($p = 0.04$); [a]In comparison with tap water ($p<0.05$); **In comparison with tap water ($p<0.01$)

In water samples from soaking peas, like other samples, minerals were measured and compared with the same values in tap water used for soaking. The results are shown in Table 3. According to statistical analysis, in water samples after soaking, results of the comparing different soaking hours (8, 12 and 24 h) with tap water were discussed.

There was a significant difference between Ca content of soaking water after 24 h of soaking and tap water ($p = 0.04$) and also P content of soaking waters after 8 and 12 h had a significant difference comparing tap water ($p<0.001$, $p = 0.01$, respectively) while there was not such a significant difference in 24 h soaking. There was a significant difference between Na and Mg content of soaking water in all soaking hours and tap water.

DISCUSSION

In the present experiment, some minerals decreased during soaking time. In studying the effect of soaking legumes, Huma *et al.* (2008) also observed that soaking legumes such as peas, beans, etc., can lead to loss of minerals. Probably in the samples that were soaked more by growing the sprouts, more stored nutrients from the cotyledon is taken out and also minerals leach into the water used for soaking (Karkle and Beleia, 2010). In a

similar study on field peas (*Pisum sativum*), it was observed that soaking for 24 h had a significant effect on the increase in calcium and copper and will decrease iron and zinc contents of samples (Wang *et al*., 2008). According to the results of present experiment, there was a reduction in Ca contents of samples after 12 and 24 h of soaking and after 8, 12 and 24 h of soaking, the amount of Mg and P was reduced. The difference between the results of Ca content of samples between the two studies may be due to the fact that water used for soaking was tap water and the amount of minerals in each region is different and also raw pea samples in Wang's study had 75-91 mg/100 g calcium while this value was higher in raw pea samples used in the experiment (211.15-342.38 mg/100 g).

On the other hand, a similar study on soy bean showed that 12 h soaking had no effect on the calcium content (Karkle and Beleia, 2010).

In soaking water samples, after 24 h soaking Ca content increased and after 8 and 12 h soaking P and Na content decreased. A similar study on changes in properties of soaking water during production of soy-bulgur showed that all the properties of soaking water such as soluble solids content, conductivity and color were affected and minerals, total soluble compounds and yellowness were increased during soaking (Bayram *et al*., 2004). The results of this study and the present one showed that leaching and reabsorption of some nutritional compounds occurs simultaneously so this causes some irregularities in the course of the decrease or increase of the mineral contents in related charts.

CONCLUSION

It is noteworthy that soaking as an effective method of reducing the anti-nutrients and flatulent materials causing the reduction of minerals by leaching into the water, does not have a significant effect on bioavailability of minerals.

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