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PROCESSING STRATEGIES TO REDUCE ANTINUTRIENT CONTENTS OF CHICKPEA FOR ENHANCING MINERAL BIOAVAILABITY

Mani G. Singh*, Ila Joshi and Nikita Wadhawan*****

ABSTRACT

Micronutrient deficiencies are major health concern in rural India where cereal and pulses form the chief source of nutrition. Legumes like chickpea are rich in various minerals but their bioavailability is hindered by presence of various antinutrients. Simple, yet effective household processing strategies like fermentation and germination improve micronutrient bioavailability by reducing / removing these absorption modifiers. Chickpea is a staple in the state of Rajasthan and is a very good source of minerals like iron, calcium, phosphorus and zinc. Hence, a study was conducted to evaluate the effect of germination and fermentation on polyphenols and phytic acid content of desi chickpea, which would help enhancing the bioavailability of these minerals in the daily diet of rural population of the state. The study revealed that germination brought a significant reduction in both polyphenol and phytic acid content (58% and 47%, respectively). Fermentation significantly reduced both the anti nutrients to about 45%. Germination was found to be more effective than fermentation in reducing phytic acid but for polyphenol both the processes brought almost similar effect. Hence it was concluded that if whole *desi* chickpea is consumed using these processing strategies, the nutritional status of the rural population of Rajasthan can be definitely improved with regard to mineral deficiencies.

INTRODUCTION

Deficiency of micronutrients such as vitamin A, iron, iodine and zinc is a major health issue concerning rural population of India which chiefly depends on cereals and pulses for their nutrition. There is a growing recognition that legumes are good sources of minerals and vitamins and not just proteins. They are considerably rich vitamins and minerals as compared to cereals. Riboflavin may be five times more and thiamine may be ten times more than that of most cereals (Singh & Singh, 1992). They are also relatively rich in minerals especially calcium, iron zinc and phosphorus (Iqbal et al., 2006).But presence of certain anti nutritional factors reduce the bioavailability of minerals in legumes (Akande et al., 2010). Strategies for enhancing mineral bioavailability range from plant breeding, use of fertilizers and genetic engineering to changes in food preparation at the household level. Most processing methods are known to remove anti nutritional factors such as soaking (Khandelwal et al., 2009) boiling (Babar et. al.,1998), roasting (Chitra et al., 1996) germination (Gitanjali et. al., 2004) dehulling (Singh,1988) and fermentation (Yadav and Khetarpaul, 1994) and their removal has a significant impact on the bioavailability of these nutrients (Henry and Massey, 2001;Hemlatha, et al., 2007; Nestares et al., 1997; Rajalakshmi and Vanja, 1967). Among the various legume grains, Chickpea is one of the major pulse crop in the state of Rajasthan, occupying 12.31 lakh ha and sharing 16.70% of the total chickpea producing area in the country. Rajasthan is one of the leading chickpea producing states with a production of 5.73 lakh tones and average productivity 465.48 kg/ha. (Agropedia, 2011). Nutritionally, chickpea seeds are richer source of iron as compared to other legumes. It is also rich in other minerals like phosphorus calcium, potassium, magnesium, copper and zinc (Jambunathan and Singh, 1981). Information on the influence of germination and fermentation on anti nutrient content in chickpea is limited. Germination and fermentation of chickpea are common domestic

* Faculty, Department of Dairy and Food Technology, CDFST, MPUAT, Udaipur.
** Professor & Head, Department of Home Science, International College for Girls, The IIS University, Jaipur
*** Assistant Professor, DREE, CTAE, MPUAT, Udaipur

processing methods widely used in rural India. Both these processes enhance the bioavailability of minerals (Hemlatha, et al., 2007), are economic, convenient and don't require any technical skills or equipments. The present investigation was therefore carried out to examine the effect of the germination and fermentation on antinutrient content of *desi* chickpea thereby helping in increasing the bioavailability of these minerals and improving in nutritional status of the rural population of the state.

RESEARCH METHODOLOGY

For the present study, samples of six promising cultivars of *desi* chickpea (*Cicer arietinium*) viz.

RSG823, RSG931, RSG959, RSG963, RSG973, RSG974, were procured from Chickpea Research Centre, Agriculture Research Station, Durgapura, Jaipur. They were cleaned manually to remove dirt, grit, broken grains and foreign matter and were coded as C1, C2, C3, C4, C5 and C6, respectively. The influence of two home scale processing techniques i.e. germination and fermentation on two most important anti nutrients (polyphenol and phytic acid) was studied. For this, first these anti nutrients were analysed in raw form and then they were again analyzed after subjecting them to germination and fermentation. The chickpea cultivars were soaked in distilled water at the room temperature for a period of 12 hours. They were then further processed by the two techniques.

Germination

The excess water was drained off and soaked samples of chickpea cultivars were incubated for 48 hours in a BOD incubator (22ºC) (Sood and Malhotra, 2001). After this duration, the germinated seeds were then dried in a hot air oven, at 60ºC ±5ºC till constant weight was obtained and thereafter, were ground to obtain powder. The various powders obtained from various cultivars were stored in air tight containers for further use in investigation.

Fermentation

The chickpea cultivars were ground in an electric grinder to form a smooth paste by adding distilled water. The paste was then collected in a clean glass container and was diluted with distilled water to form a batter like consistency. It was then covered with lid and incubated at room temperature for 24 hours to ferment naturally (Zamora and Fields, 1979). The fermented batter was then transferred in a clean stainless steel plate on which it was spread in as thin layer as possible and was kept for drying in a hot air oven at 60ºC±5ºC till constant weight was obtained. The dried powders were stored in air tight containers for further use in investigation.

The polyphenol content of the selected chickpea cultivars was estimated by standard method (Khandelwal *et al.*, 2009) and phytic acid content was estimated using method given by Wheeler and Ferril (1971).

Statistical techniques:

The mean values and the standard deviations were calculated from the data obtained with triplicate trials. Analyses of variance using ANOVA were conducted. Differences between the sample means were analyzed by Duncan's Multiple Range tests at á = 0.05 by SPSS software.

RESULTS AND DISCUSSION

The influence of germination and fermentation on desi chickpea is presented in Table 1.

Table 1: Mean anti nutrient content of *desi* chickpea cultivars in raw and processed form

Anti nutrients	Raw	Germinated	Fermented
Polyphenol (g/100g)	0.62 ±1.98	0.26 ±0.09	0.34 ±0.10
Phytic acid (g/100g)	0.93 ±0.29	0.49 ±0.14	0.51 ±0.16

Mean ± Standard Deviation

Is was observed that the process of germination significantly reduced polyphenol and phytic acid content in chickpea (58% and 47%, respectively). A decrease of 73 % phytic acid in case of kabuli and of 32 % in case of *desi,* was observed by Khalil *et al.*, 2007. Similar results have been reported by El - Adawy, 2002, in chickpea and by Chitra *et al.*, 1996 in various pulses. Effect of germination on tannins and total phenolic compounds, has earlier been discussed by by Deostale, 1981 in chickpea and Gitanjali *et al.*, 2004, in green gram, who also found similar results. Losses of total polyphenols and tannins ranging from 43 to 59 % after germination for 24 hours in bengal gram have been reported by Khandelwal *et al.*, 2009.

The process of fermentation too, was shown to significantly reduce both polyphenols and phytic acid content in chickpea to around 45%. Higher values of reduction of about 84%, 92% and 86%, of polyphenol content in soybean, cowpea and ground bean, respectively have been reported by Egounlety and Aworh, 2003 by fermentation. Chitra *et al.*, 1996, showed that 24 hours of fermentation resulted in 54%, 42%, 40% and 26%, decrease in the phytate content of pigeon pea, soybean, chickpea and mung bean, respectively. Similar results for phytic acid reduction by fermentation have also been shown by Yadav and Khetarpaul,1994 in black gram *dal*. Rajalakshmi and Vanja, 1961 too showed a significant decrease in phytates in *idli* and *khaman* that are popular products prepared by fermentation A reduction of 90% and 88% for phytic acid and tannins after fermentation for about 50 hours in chickpea has been reported by Moreno *et al.*, 2004.

Both the anti nutrients i.e. polyphenol and phytic acid were found to be significantly reduced by both the processing techniques, when compared with their raw counterparts. Upon comparing the two processesing methods, it was observed that in case of polyphenol content, germination brought a significantly higher reduction as compared to fermentation but in case of phytic acid, both germination and fermentation brought almost similar reduction (Figure 1). Soaking, a process that preceeds germination and fermentation, brings a loss of nearly 50% of the polyphenolic compounds due to leaching (Saxena, 2003).

During germination, reduction in polyphenols during may be attributed to increased activity of enzyme polyphenol oxidase in germinated seeds resulting in the break down of polyphenolics compounds (Babar, *et al.*, 1988). Reduction in phytic acid content during germination, results due to increased endogenous phytase activity in grains as a result of *de novo* synthesis and/or activation.The decreasing effect of fermentation on polyphenols may be due to the activity of polyphenol oxidase present in the food grain or microflora (Subrota, *et al.*, 2013). Similarily, phytase reduction due to fermentation, also would be a result of presence of phytase in grain itself or production of enzyme by the fermenting microorganism (Fellers, 1960). The enzyme phytase solubilizes phytates and would release soluble protein and minerals (Nestares, et al., 2009) thus enhancing their bioavailability.

Effect of different processing methods on the antinutrient content of chickpea

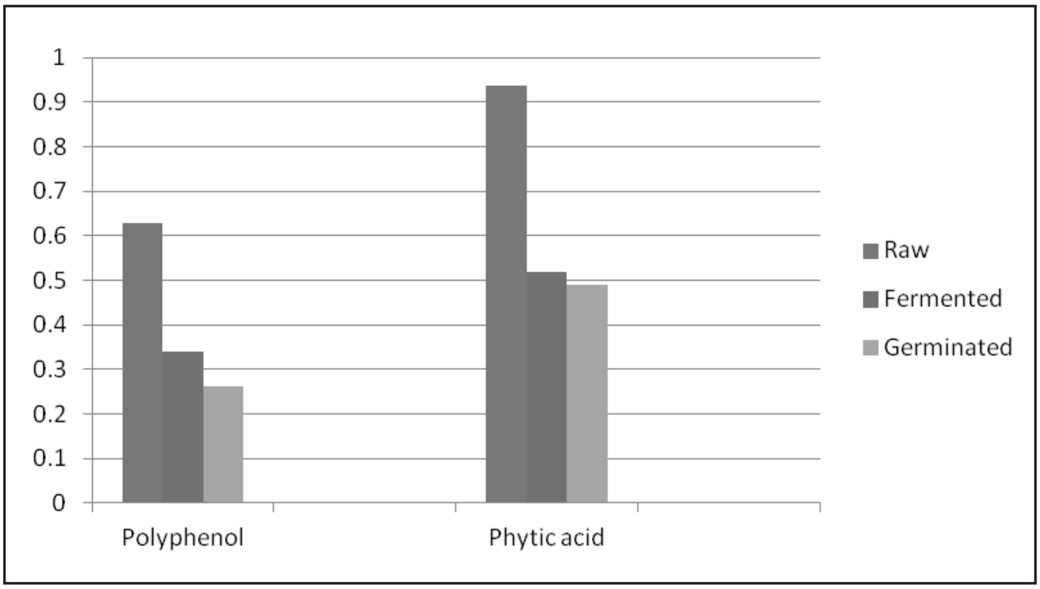

Figure 1

CONCLUSION

Levels of polyphenols and phytic acid are considerably reduced by both germination and fermentation. These techniques can can therefore be adopted as important strategy to improve the mineral bioavailability by the rural population of Rajasthan where *desi* chickpea is a staple to improve their micronutrient status.

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