Effect of processing methods on antinutritional factors of field pea (*Pisum sativum*)

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Abstract: *Phytic acid and polyphenols were considered as anti-nutrient mainly due to their ability to bind essential dietary minerals as well as proteins and starch, and to consequently reduce their bioavailability in humans. Soaking, dehulling, roasting and germination are technologic application widely used for its ability to decrease levels of anti-nutritional factors present in legume seeds and improve the concentration and availability of their nutrients. The present investigation was undertaken to evaluate the effect of soaking, dehulling, roasting and germination treatments on phytic acid and polyphenols of four field pea varieties. Field pea varieties viz. HFP-4, HFP-529, HFP-9907B and HFP-9426 were analyzed. The variety HFP-9426 had the highest (762.67mg/100g) amount of phytic acid whereas variety HFP-529 had highest polyphenols (185.48mg/100g). All the processing methods led to a significant (P=0.05) reduction in phytic acid and polyphenols. Highest decrease in phytic acid was found due to dehulling (9.09 to 33.09%) as well as germination (7.46 to 31.82%) followed by roasting (1.85 to 16.78%) and soaking (1.47 to 14.86%). Among all the processing methods, highest (20.36 to 30.13%) reduction in polyphenol content was observed in dehulled samples. Germination, roasting and soaking reduced the polyphenols from 15.43 to 23.97 %, 6.58 to 12.08% and 8.05 to 13.02%, respectively.*

Key Words: *Field pea, soaking, dehulling, roasting, germination, phytic acid, polyphenol*

1. INTRODUCTION:

Legumes are the edible fruits or seeds of pod-bearing plants belonging to the family Leguminosae and are widely cultivated throughout the world (Kaur et al 2007). Like other pulses, fieldpea is used alongwith cereals such as rice, wheat, maize or millets so as to balance the level of essential amino acids, because of the fact that pulses are deficient in methionine and rich in lysine, whereas cereals are rich in methionine but deficient in lysine (Srivastava and Ali 2004). It is consumed both as green immature seeds as well as dry seeds. Blending cereals with pulses or vice versa has been found to improve protein quality as compared to cereals or legumes alone.

Although legume seeds contain a moderately high amount of protein, calories, certain minerals and vitamins, their use in food and feed is still limited by the presence of several antinutritional factors. Among these are, phytic acid (Urbano *et al*., 2000), condensed tannin (Reddy *et al*., 1985) and trypsin inhibitors (Gupta, 1987; Singh, 1988) which reduce the nutritional quality of the protein. Phytic acid was considered as an anti-nutrient mainly due to its ability to bind essential dietary minerals as well as proteins and starch, and to consequently reduce their bioavailability in humans (Phillippy, 2003). Phenols are designated as anti-nutrients because they decrease the digestibility of proteins, carbohydrates and minerals (Rao and Deosthale,1982). Phenolic compounds or their oxidized products form complexes with essential amino acids, enzymes and other proteins, thus lowering their protein digestibility and nutritional values (Shahidi and Naczk,1992).

Tannins have been reported to inhibit the digestive enzymes and thereby lower digestibility of most nutrients, especially protein and carbohydrates (Reddy *et al*., 1985). Trypsin inhibitors strongly inhibit trypsin activity reducing the digestion and absorption of dietary protein (Norton, 1991).

Consumption of pulses requires pre-treatments such as dehulling, rehydration and heat processing. A variety of treatments has been examined already in plant materials such as soaking (Frias *et al.,* 2000), boiling (Marquez and Alonso 1999), autoclaving (Mansour *et al.,* 1993), microwaving (Marconi *et al*., 2000), roasting, dehulling, germination and fermentation (Chitra *et al.,* 1996). Germination is a technologic application widely used for its ability to decrease levels of anti-nutritional factors present in legume seeds and improve the concentration and availability of their nutrients.

This paper reports the effect of processing (soaking, dehulling, roasting and germinaion) on the (antinutrients) phytic acid and polyphenols of the pea seeds that would facilitate utilization as well as improve food value of this legume.

2. MATERIAL AND METHODS:

Procurement of material :

Four varieties of field pea, namely HFP-4, HFP-529, HFP-9907B and HFP-9426 were procured in a single lot from the Pulse section, Department of Genetics and Plant Breeding, College of Agriculture, CCS Haryana

Agricultural University, Hisar. The seeds were cleaned and made free of dust, dirt and foreign materials prior to processing.

Processing of field pea varieties :

All the fieldpea varieties were subjected to various processing methods including, soaking, dehulling, roasting and germination as per methods given below:

Soaking :The cleaned field pea seeds were soaked in distilled water (1:4 w/v) for 12 hours at room temperature, and then washed and rinsed with distilled water.

Dehulling :After soaking the seeds overnight (12 hours), hulls were removed manually.

Roasting : Seeds soaked for 4 hours, sun dried and then roasted in an open pan.

Germination: Soaked seeds (12 hrs) were kept in Petridishes lined with wet filter paper for germination in an incubator at 37ºC for 24 hours. Seeds were kept moist by sprinkling distilled water frequently.

All the processed samples were dried in hot air oven at 55°C for 5h. Dried samples were ground to a fine powder and stored in air tight plastic containers for further chemical analysis.

Chemical analysis:

Phytic acid was extracted in 0.5M nitric acid and determined by using the method of Davies and Reid (1979). Polyphenols were extracted by the method of Singh and Jambunathan (1981). The amount of polyphenolic compounds was estimated as tannic acid equivalent according to Folin-Danis procedure (Swain and Hills, 1959).

Statistical analysis :

The obtained data were statistically analysed using completely randomized design (C.R.D) test to find the significant differences among varieties and treatments

3. REULTS AND DISCUSSION:

phytic acid:

The phytic acid content of unprocessed field pea varieties ranged from 616.00 to 762.70 mg/100g (Table 1). Phytic acid decreased significantly during all the processing methods. Highest decrease in phytic acid was found due to dehulling (9.09 to 33.09%) as well as germination (7.46 to 31.82%) followed by roasting (1.85 to 16.78%) and soaking (1.47 to 14.86%). The values of phytic acid obtained in present study for filed pea varieties are similar to the values reported by earlier workers (Amarkoon *et al.*, 2012 and Wang *et al.*, 2008). They found 600 to 710 and 640 to 830 mg/100g phytic acid, respectively, in field peas. Similar values of phytic acid were also reported for lentils (Thavarajah *et al.*, 2009). Phytic acid values were also comparable with those reported by Wang and Daun (2004), but lower than the values (810 mg/100g) reported by Wang *et al.* (2010) and much lower than the values (1190 to 1330 mg/100g) observed by Alonso *et al.* (1998).

Table 1: Effect of processing methods on phytic acid content of field pea varieties (mg/100g, on dry matter basis)

Processing Methods	Varieties				
	HFP-4	**HFP-529**	**HFP-9907B**	**HFP-9426**	**Mean**
Control (unprocessed)	717.3±11.62	682.7±11.62	616.0±9.24	762.7±5.33	704.66±12.75
Soaking	706.7±7.05 (-1.47)	610.7±7.05 (-10.54)	600.0 ±5.33 (-5.63)	649.3±5.81 (-14.86)	641.67±10.67
Dehulling	585.3±6.67 (-18.40)	512.2.±3.53 (-29.97)	560.0±2.67 (-9.09)	510.3.±1.33 (-33.09)	541..95±5.01
Roasting	704.0±4.62 (-1.85)	570.6±2.67 (-16.42)	600.0±2.67 (-2.59)	634.7±5.33 (-16.78)	627.10±14.34
Germination	592.0±8.0 (-17.46)	520.0±4.62 (-23.83)	570.3±11.6 (-7.46)	520.0±4.62 (-31.82)	550.57±11.74
Mean	661.06±19.98	579.24±27.72	589.26± 23.97	615.4±27.61	
CD (P=0.05) Varieties: 8.65 Methods: 9.67 Interaction (Varieties X Methods): 19.34					

Values are mean ± SE of three independent determinations

Figures in the parentheses indicate percent increase (+) or decrease (-) over the control values.

The results are in agreement with those of the earlier workers (Ramkrishna *et al.*, 2006; Shimelis and Rakshit, 2007; Kakati *et al.,* 2010). Ramkrishna *et al.* (2006) reported that phytic acid content reduced by 18 per cent during soaking for 8 h in Indian bean .The results of our study are in accordance with those recorded by Wang *et al (*2008), Saharan *et al.* (2002). They reported that soaking for 12h brought 26% reduction in level of phytic acid and sprouting further decreased its level to 30% over control values. Khattab and Arntfield (2009) also reported a decrease of 42.82 to 48.91% phytic acid contents in field pea after soaking. This could be due to the fact that phytic acid in dried legumes exists wholly as a water soluble salt (probably as potassium phytate) (Crean and Haisman,1963) or may be due to leaching out of phytate ions under the influence of concentration gradient, which governs the rate of diffusion (Kakati *et al*., 2010).

Dehulling reduced the phytic acid content from 9.09 to 33.09 per cent in field peas. Highest (33.09%) and lowest (9.09%) decrease in phytic acid was observed in varieties HFP-9426 and HFP-9907B, respectively. Similarly, reductions in phytic acid content of dehulled (20.7%) and soaked (26.7%) samples of field pea were reported by Mubarak (2005). On dehulling the loss may be because of removal of husk, as husk contained relatively higher concentration of phytic acid as compared to whole grain and therefore, removal of husk accounted for significantly lower phytic acid content in dehulled seeds.

The phytic acid content decreased significantly after roasting. Per cent reduction in phytic acid content ranged from 1.85 to 16.78 % in roasted field pea varieties. Khattab and Arntfield (2009) reported that roasting caused 35.25 to 40.15 % reduction in phytic acid content in field peas. Mittal *et al.* (2012) reported that roasting caused 3.46% reduction in phytic acid content in chickpeas. The reduction in phytic acid content in roasted samples of legume seeds may be due to the heat labile nature of phytic acid and the formation of insoluble complexes between phytate and other components (Udensi *et al.*, 2007).

In present study percent decrease in phytic acid content ranged from 7.46 to 31.82% in germinated field pea. Urbano *et al*. (2005) noticed similar reduction (32.6%) in phytic acid after a 2 day germination of field peas. Souza (2013) and Mittal *et al* (2012) also found a reduction in phytic acid content after germination, soaking and roasting in field beans and chickpeas, respectively. The decrease in phytic acid content after germination could be because it is used as a source of phosphorus. Besides this, phytase activity is enhanced during germination which leads to hydrolysis of phytic acid. (Kumar *et al*., 1978)

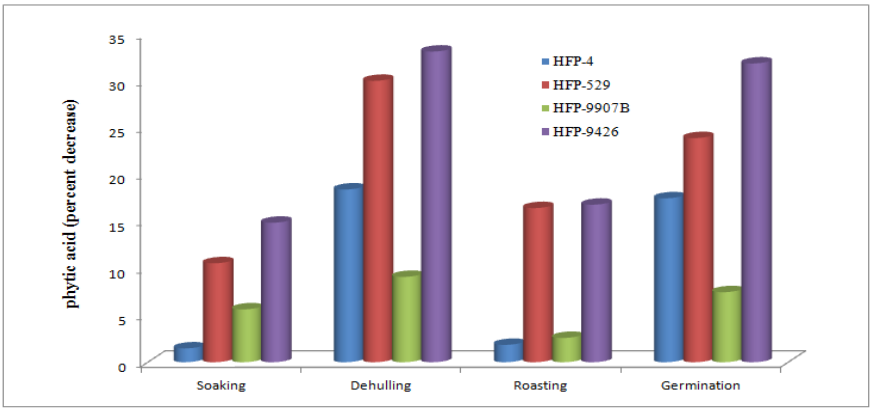

Fig. 1 : Per cent decrease in phytic acid content during different processing methods

Polyphenols : The polyphenol content of field pea varieties ranged from 139.94 to 185.48 mg/100g (Table 2). Wang *et al.* (1998) reported very low amount of polyphenols (16.2 to 32.5 mg/100g) whereas Habiba (2002) reported 206 mg/100g tannins in white flowered pea cultivars. The differences in antinutrient contents may be due to the variety, climatic conditions, locations, irrigation conditions, type of soil and year during which the plant grow (Urbano *et al.*, 2000).

Table 2: Effect of processing methods on polyphenols content of field pea varieties (mg/100g, on dry matter basis)

Processing Methods	Varieties				
	HFP-4	HFP-529	HFP-9907B	HFP-9426	Mean
Control (unprocessed)	162.15±1.11	185.48±4.44	139.94±3.84	165.49±1.11	163.26±5.04

Soaking	141.05±1.11 (-13.02)	168.82±2.22 (-8.98)	127.72±1.11 (-8.73)	152.16±1.11 (-8.05)	147.43±4.59
Dehulling	113.29±3.33 (-30.13)	147.72±2.22 (-20.36)	102.18±2.22 (-26.98)	118.84±2.22 (-28.18)	120.51±5.18
Roasting	148.83±2.94 (-8.21)	173.26±1.92 (-6.58)	125.50±4.84 (-10.31)	145.49±2.21 (-12.08)	148.27±5.29
Germination	123.28±3.33 (-23.97)	149.94±3.33 (-19.16)	121.06±2.22 (-13.49)	139.94±1.92 (-15.43)	133.55±3.79
Mean	137.72±4.79	165.04±3.99	123.28±3.49	144.38±4.16	
CD (P=0.05) Varieties: 3.42 Methods: 3.82 Interaction (Varieties X Methods): 7.64					

Values are mean ± SE of three independent determinations
Figures in the parentheses indicate percent increase (+) or decrease (-) over the control values.

Field pea varieties were subjected to different processing treatments and the reduction in total phenolic content of field pea varieties by various processing methods are depicted in Table 2. In the present investigation, among all the processing methods, highest (20.36 to 30.13%) reduction in polyphenol content was observed in dehulled samples.

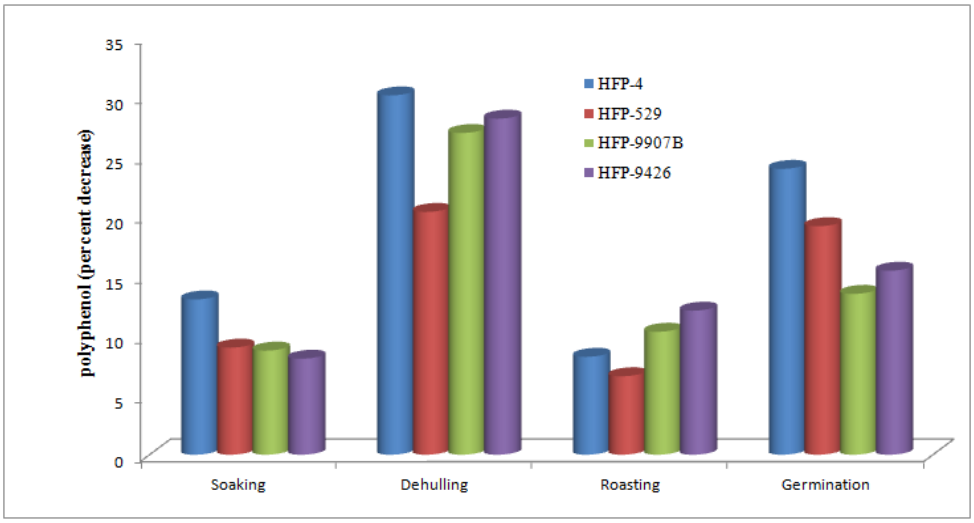

Fig. 2 : Per cent decrease in polyphenol content during different processing methods

Germination, roasting and soaking reduced the polyphenols from 15.43 to 23.97, 6.58 to 12.08% and 8.05 to 13.02%, respectively. These results are consistent with the findings of other workers who found reduction in polyphenols to the extent of 31 and 49% after soaking and sprouting, respectively, in rice bean (Saharan *et al.* 2002). Igbedioh *et al* (1998) reported that all processing methods reduced the levels of total phenols in *Cajanus cajan* to varying extent, i.e. soaked seeds, and dehulling of soaked seeds showed lower level of phenolic content (35% and 49%, respectively). Results of Reihanah *et al*. (2007) are closely similar to our findings who reported 20-36% reduction in polyphenols of dehulled sample of green gram. As polyphenols are present in periphery of the seed, there is possibility of their passing out into the soaking medium through seed coat (Drumm *et al*, 1990). Loss of polyphenols during soaking may be attributed to this effect, as seed coat contains maximum of polyphenols and dehulling results in losses of polyphenols. Grewal and Jood (2006) reported that reductions in polyphenols in germinated samples were 41 to 42%. Before germination, soaking is also done and some loss of polyphenols during soaking is also expected because of its leaching into soaking water. Germination has been reported to decrease the polyphenol content in various legumes (Preet and Punia, 2000; Duhan *et al.,* 2001 and Saharan *et al.,* 2002). According to Chopra and Sankhala (2004), polyphenol contents reduced significantly in germinated samples of moth bean and horse gram which might be due to presence of polyphenol oxidase and enzymatic hydrolysis besides leaching of some polyphenols into water.

4. CONCLUSION:

Phytic acid and polyphenols are present in significant amounts in field peas as in other food legumes. All the processing methods led to a significant (P=0.05) reduction in phytic acid and polyphenols. Dehulling processing method was more effective to decrease the phytic acid and polyphenol content followed by germination, soaking and roasting.

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