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EFFECT OF TRADITIONAL PROCESSING METHODS ON PROTEIN DIGESTIBILITY AND STARCH DIGESTIBILITY OF FIELD PEA (Pisum sativum)

Rinku Sharma[1]* and Darshan Punia[1]

*Corresponding Author: Rinku Sharma, ✉ rinku44sharma@gmail.com

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Grain legumes are important sources of proteins, minerals and vitamins for millions of people in the world, particularly in the developing countries. Low digestibility of legume protein and starch is one of the main drawbacks limiting the nutritional quality of food legumes. Processing treatments have been reported to be beneficial for enhancing the nutritive value of various food legumes, as they reduce the content of anti nutritional factors and improve the digestibility of carbohydrate and protein. The present study was undertaken to determine the variability in starch and protein digestibility of field pea varieties and to investigate the effect of processing on in vitro protein and starch digestibility. protein digestibility of field pea varieties varied from 63.29 to 76.50%, variety HFP-9426 having lowest protein digestibility. A significant difference was found among varieties HFP-4, HFP-529 and HFP-9426 for protein digestibility. Among all the processing methods highest improvement in protein digestibility over the unprocessed varieties was found due to germination (16.14 to 40.38%). Starch digestibility of field pea varieties varied from 22.00 to 29.33 mg maltose released/g being highest in variety HFP-4. Highest increase in in vitro starch digestibility was observed after dehulling (71.24 to 113.87%) followed by germination (22.53 to 72.20%), roasting (4.54 to 36.12%) and soaking (14.99 to 25.00%).

Keywords: Field pea, Soaking, Dehulling, Roasting, Germination, Protein digestibility, Starch digestibility

INTRODUCTION

Legumes are widely grown throughout the world and their dietary and economic importance is globally appreciated and recognized. Legumes grains are being cultivated in India since time immemorial. They have high total protein content (20-26%) and can be considered as a natural supplement to cereals.

Field peas are rich in proteins (18 to 30%) (Kaur *et al*., 2007) and contain high levels of lysine which can be used to balance the deficiencies of this essential amino acid in cereal-based diets (Chel *et al.,* 2007). Field peas are rich in several mineral elements, vitamins and other nutrients and are characterized by a relatively high antioxidant activity (Han and Baik, 2008).

Low digestibility of legume protein is one of the main drawbacks limiting the nutritional quality of food legumes. Even after cooking, the digestibility of legume seed protein is quite low. Several properties of legumes aûect starch and protein digestibility, including high content of viscous soluble dietary fiber constituents, the presence of various antinutrients, including polyphenols and phytic acid, and relatively high amylose/amylopectin ratios (Deshpande and Cheryan, 1984; and Thomson and Yoon, 1984). Phytic acid forms complexes with proteins, proteases and amylases of the intestinal tract, thereby inhibiting proteolysis (Bressani 1993; and Ramakrishna *et al.,* 2006). Phenols are designated as anti-nutrients because they decrease the digestibility of proteins, carbohydrates and minerals (Rao and Deosthale, 1982). They also lower the activity of digestive enzymes

[1] Department of Foods and Nutrition, CCS Haryana Agricultural University, Hisar, Haryana, India.

such as amylases, trypsin and chymotrypsin thereby, causing damage to mucosa of digestive tract (Salunkhe *et al.*, 1990; and Liener, 1994). 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). These antinutritional factors present in the raw pulse are partly removed during domestic and industrial processing resulting in improving its nutritional quality (Singh and Jambhunathan, 1981). Due to poor digestibility compared to that of other cereals, legume starches promote slow and moderate postprandial glucose and insulin responses, and have low GI values (Jenkins *et al.*, 1980).

Processing techniques like soaking, germination, fermentation and cooking reduce the phytate and polyphenol content of pulses and increases the digestibility of proteins as well as availability of minerals (Beal and Mehta, 2006). Processing treatments have been reported to be beneficial for enhancing the nutritive value of various food legumes, as they reduce the content of anti nutritional factors and improve the digestibility of carbohydrate and protein (Kataria, 1992). Soaking could be one of the process to improve soluble anti nutritional factors, which can be eliminated with the discarded soaking solution. Cooking generally inactivates heat sensitive factors such as trypsin and chymotrypsin inhibitors and volatile compounds. 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. Cooking also reduces the levels of anti-nutrients such as trypsin-inhibitors and flatulence-causing oligosaccharides, resulting in improved nutritional quality (Wang *et al.*, 2008).

Thus the aim of present study was to determine the effect of traditional processing methods on protein digestibility and starch digestibility of field pea.

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. Next morning, the unimbibed water was discarded. The soaked seeds were rinsed twice using distilled water.

Dehulling: Field pea seeds were soaked in distilled water (1:4 w/v) for 12 h at room temperature. Next morning, the soaked seeds (12 h) were dehulled manually.

Roasting: Field pea seeds were soaked for 4 h and washed with distilled water. The washed seeds were spread on filter paper for removal of extra water. The seeds were spread in the tray lined with filter paper for drying upto 6 h. Heated the sand in *karahi* and put the dried seeds in heated sand. The seeds were roasted for 3-6 min till brown color appeared.

Germination: Soaked seeds (12 hrs) were kept in Petridishes lined with wet filter paper for germination in an incubator at 37 ºC 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 5 h. Dried samples were ground to a fine powder and stored in air tight plastic containers for further chemical analysis.

Chemical Analysis: *In vitro* starch digestibility was assessed by employing pancreatic amylase and then measuring maltose (mg maltose released per gram defatted sample) liberated by using dinitrosalicylic acid reagent. (Singh *et al.*, 1982). Digested protein of samples was determined by using Microkjeldahl method (AOAC, 2000). *In vitro* protein digestibility was analyzed by using pepsin and pancreatin (Mertz *et al.*,1983). Protein digestibility was calculated by following formula given as under:

$$Protein\ digestibility\ (\%) = \frac{Digested\ \ protein}{Total\ \ protein} \times 100$$

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.

REULTS AND DISCUSSION

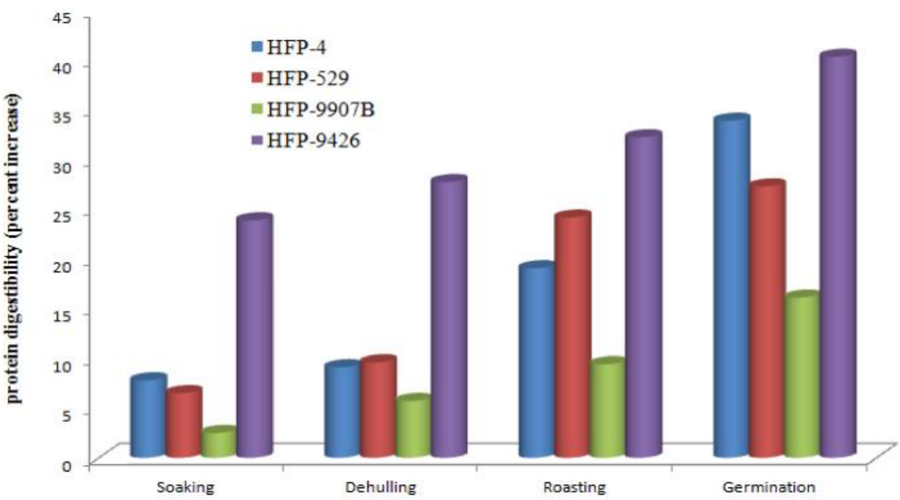
Protein Digestibility: The data presented in Table 1 and Figure 1 indicated that the protein digestibility in field pea varieties ranged from 63.29 to 76.50%. Protein digestibility

Table 1: Effect of Processing Methods on *in vitro* Protein Digestibility of Field Pea Varieties (%, on Dry Matter Basis)

Processing Methods	Varieties				
	HFP-4	HFP-529	HFP-9907B	HFP-9426	Mean
Control (unprocessed)	69.73±0.27	74.26±0.67	76.50±0.50	63.29±1.38	70.94±1.56
Soaking	75.18±0.42 (+7.80)	79.11±0.25 (+6.53)	78.42±0.32 (+2.51)	67.28 ±0.57 (+23.90)	74.99±1.43
Dehulling	76.09±0.27 (+9.12)	81.39±0.56 (+9.60)	80.87±0.22 (+5.71)	70.22±0.42 (+27.77)	77.14±1.36
Roasting	83.04±0.24 (+19.08)	92.22±0.93 (+24.18)	83.72±0.37 (+9.43)	72.88 ±0.20 (+32.27)	82.97±2.10
Germination	93.40±0.46 (+33.94)	94.56±0.48 (+27.33)	88.85±0.81 (+16.14)	80.28±0.53 (+40.38)	89.27±1.17
Mean	79.49±8.44	84.31±2.10	81.67±1.17	70.79±1.55	
CD (P=0.05), Varieties 0.72, Methods: 0.81, Interaction (Varieties X Methods): 1.26					

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

Figure 1: Percent Increase in *in vitro* Protein Digestibilityduring Different Processing Methods



increased in soaked field pea varieties and per cent increase ranged from 2.51 to 23.90%. Shimelis and Rakshit (2007) found an appreciable improvement in protein digestibility of kidney bean after soaking. The increase in protein digestibility after soaking may be attributed to lowered levels of antinutrients as observed in present investigation and reported by Ghavidel and Prakash (2007). Moreover, it could be due to leaching out of antinutrients in the soaking medium (Kataria *et al.*, 1989).

Dehulling further improved the protein digestibility and percent increase in protein digestibility after dehulling ranged from 5.71 to 27.27%. These results are in line with those of Ghavidal and Prakash (2007) who stated that raw green gram had 61.0% protein digestibility, after dehulling and germination, it improved up to 77.6 and 72.7%, respectively. Improvement in protein digestibility is possibly due to reduction in levels of antinutritional factors like polyphenols and phytic acid. Leaching out of antinutrients in soaking water and removal of seed coat during dehulling may be the reason for improved digestibility of proteins (Saharan *et al.,* 2002).

Percent increase in *in vitro* protein digestibility in germinated field pea varieties ranged from 16.14 to 40.38%. Similarly, Mubarak (2005) also found that protein digestibility in mung bean was highest after germination (89.1%). Other workers also reported improvement in protein digestibility of geminated and cooked legumes (Khatoon and Prakash, 2004). Similarly Garg (2001) reported increase in protein digestibility (60.73 to 79.26%) after germination in chickpea. Germination of rice bean for 24 h increased the protein digestibility by 31% over the control values (Salesh *et al.* 2006). The hydrolysis of seed proteins, protease inhibitors, phytic acid and polyphenols during germination may account for considerably increased protein digestibility in legumes (Chitra *et al.,* 1997). Significant increase in protein digestibility of germinated seeds may be attributed to the action of hydrolytic enzymes during germination. Germination causes mobilization of the protein with the help of protease, leading to the formation of polypeptides, oligopeptides and free amino acids, and also a decline in antinutritional factors like trypsin inhibitors, tannins, phytates and hence, leading to improve the digestibility of protein (Kaur, 1986; and Sharma,1992).

Roasting of field peas resulted in considerable increase (9.43 to 32.27%) in *in vitro* protein digestibility. Chitra *et al.* (1996) reported that protein digestibility of chickpea, pigeon pea, mung bean and urd bean increased significantly after roasting. The increase in protein digestibility of legume seeds after roasting is possibly due to destruction of protease inhibitors and opening of protein structure (Liener, 1978), and also by denaturing globulin proteins that are highly resistant to proteases in native state (Walker and Kochar, 1982). It has been reported that *in vitro* protein digestibility was significantly correlated with phytic acid content in cowpeas (Preet and Punia, 2000).

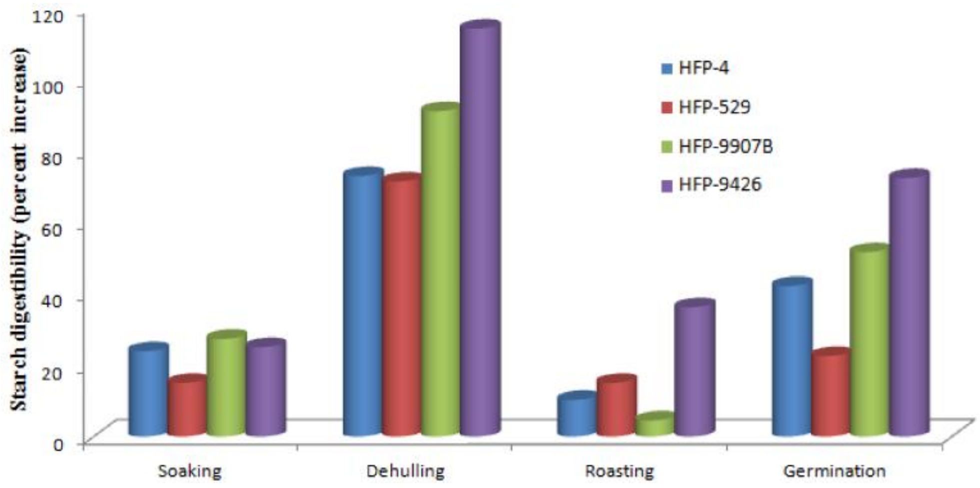
Starch Digestibility: Starch digestibility of unprocessed field pea varieties varied from 22.00 to 29.33 mg maltose released/g (Table 2 and Figure 2). In soaked field pea varieties starch digestibility ranged from 28.00 to 36.33 mg maltose released/g. *In vitro* starch digestibility improved significantly in all the varieties after soaking. Highest improvement was seen in variety HFP-9907B (27.27%). Highest increase in *in vitro* starch digestibility was observed after dehulling (71.24 to 113.87%) followed by germination (22.53 to 72.20%), roasting (4.54 to 36.12%) and soaking (14.99 to 25.00%) in field peas. In similar studies, Negi *et al.* (2001) reported that soaking increased starch digestibility by 19.25% in moth bean. Preet and Punia (2000) and Sinha *et al.* (2002) observed

Table 2: Effect of Processing Methods on *in vitro* Starch Digestibility of Field Pea Varieties (mg Maltose/g, on Dry Matter Basis)

	Processing Methods	Varieties				
		HFP-4	HFP-529	HFP-9907B	HFP-9426	Mean
Starch digestibility (mg maltose/g)	Control (unprocessed)	29.33±0.67	26.67±0.67	22.00±0.00	24.00±1.15	25.50±0.89
	Soaking	36.33±0.33 (+23.86)	30.67±0.67 (+14.99)	28.00±1.15 (+27.27)	30.67 ±1.33 (+25.00)	26.41±1.35
	Dehulling	50.67±0.67 (+72.75)	45.67±0.58 (+71.24)	42.00±1.15 (+90.90)	51.33±0.67 (+113.87)	47.41±1.19
	Roasting	32.33±0.33 (+10.23)	30.67±0.67 (+15.00)	23.00±0.58 (+4.54)	32.67 ±0.33 (+36.12)	29.67±1.20
	Germination	41.67±0.88 (+42.07)	32.68±0.59 (+22.53)	33.33± 0.33 (+51.50)	41.33±0.33 (+72.20)	37.25±1.30
	Mean	38.06±2.02	33.27±1.75	29.67±1.99	36.00±2.45	
	CD (P=0.05) Varieties: 0.92 Methods: 1.03 Interaction (Varieties X Methods): 2.05					

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

Figure 2: Percent Increase in *in vitro* Starch Digestibilityduring Different Processing Methods



that soaking improved the *in vitro* starch digestibility in cowpeas (23 to 24% and 10.3%, respectively). Bishnoi and Khetarpaul (1993) reported that starch digestibility in peas increased by 96 to 113% by soaking, 125 to 169% by dehulling, 46 to 65% by pressure cooking, 55 to 75% and 76 to 105% after germination for 24 h and 48 h, respectively. The increase in *in vitro* starch digestibility could be due to the increased activity of amylase which might have been brought about by reduction in antinutrients (Deshpande and Cheryan, 1984).

Dehulling brought about further enhancement in starch digestibility as reported by Preet and Punia (2000). Improvement in starch digestibility in dehulled samples might be due to removal of seed coat which had higher amount of antinutrients (Grewal and Jood, 2009). They reported that improvement in starch digestibility was 6 to 14% in soaked, 12 to 19% in dehulled, 32 to 46% in cooked and 23 to 34% in germinated samples of green gram cultivars.

Soaking and other treatments including traditional cooking, pressure cooking and germination of pulses are known to reduce the level of phytate, tannin and amylase inhibitors (Khokhar and Chauhan, 1986) which may, to some extent, be responsible for the increase in starch digestibility of processed and cooked legumes. Processing of legumes, involving heat treatment, may gelatinize starch, which is readily attacked by á-amylase. Starch in untreated samples is ungelatinised and less readily hydrolysed. This may explain partly the better starch digestibility of cooked seeds. Differences in starch digestibility during different heat treatments may be due to differences in the extent of starch gelatinization. Significant differences in amylolysis rates in the processed legume seeds, as compared to the raw, have been reported (El Faki *et al.*, 1984).

CONCLUSION

All the processing methods led to a significant (P = 0.05) improvement in *in vitro* protein and starch digestibility. Among all the processing methods germination was most effective in improving protein digestibility whereas dehulling method was more effective to increase the starch digestibility.

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