International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(5): 2260-2266

Received: 25-07-2019
Accepted: 27-08-2019

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Evaluation of improved varieties of field pea (*Pisum sativum*) for nutritional and functional quality

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Abstract
The study was undertaken for evaluation of improved varieties of field pea (*Pisum sativum*) for nutritional and functional quality. The results of proximate composition of improved varieties of field pea revealed that the moisture content of field pea varieties varied from 12.31 to 13.44% total ash from 2.86 to 3.22% crude protein from 16.14 to 20.32% crude fat from 0.90 to 2.17% crude fibre from 1.56 to 3.39% carbohydrates from 58.46 to 64.08% and physiological energy from 329 to 339 kcal/100g. Moisture content was highest in Pant pea-13 total ash content and energy value were highest in Pant Pea-42 crude protein and crude fibre were highest in Pant Pea-25 crude fat was highest in Pant Pea-14 and carbohydrate content was highest in Pant Pea-74. Results of Functional properties revealed that Water absorption capacity least gelation concentration and bulk density of field pea varieties ranged from 1.04 to 1.20 ml/g 7-8% and 0.71 to 0.77 g/ml respectively. The highest water absorption capacity was seen in Pant Pea-13 Pant Pea-14 and Pant Pea-74 least gelation concentration was highest in Pant Pea-25 and Pant Pea-42 and highest bulk density was seen in Pant Pea-14. Particle size index revealed that maximum retention of varieties of field pea was found in 60 mesh sieve while minimum retention was found in 85 mesh sieve.

Keywords: Field pea functional quality proximate composition mesh sieve

Introduction
Legumes are the edible portions of pod-bearing plants of family Leguminosae and is widely cultivated globally (Singh *et al.* 2004) [42]. Seeds from the whole legume plant are of major concern to humans as they are rich source of proteins ranging from 20-50% (Singh *et al.* 2004) [42].

Among 20 most commonly utilized leguminous species for human nutrition pea or *Pisum sativum L.* is consumed in high amounts in Asian countries along with common bean (*Phaseolus vulgaris L.*) in Latin American and African countries chickpea (*Cicer arietinum L.*) in India and lentil (*Lens culinaris Med.*) in the Middle East nations (Morrow 1991) [31].

In addition to protein grain legumes are also found to be a rich source of vitamins especially of the B-complex groups and minerals such as calcium and iron. The cultivation of Field peas (*Pisum sativum L.*) is limited in India but witness production and yield in northern Europe USA Canada Russia and China (Singh 1999) [43]. Canada is the leading producer and exporter of the field pea (Agboola *et al.* 2010; Wang *et al.* 2003) [2, 50]. Yellow field peas are appropriate to meet the demands of the health conscious consumers as they are rich in starch and nutrients such as fibre micronutrients and high quality protein (Wang *et al.* 2003) [50]. This has resulted in the establishment of field pea as one of the most valued crop for the generations to come in the global market (Tian *et al.* 1999) [45].

Among grain legumes pea (*Pisum sativum*) ranks fourth in world production (Food and Agriculture Organization FAO 1997) [19] and its production is increasing at a tremendous rate with ample amount available as animal feed. According to FAO (2004) [20] data about 12.2 million ton of pea production was achieved in 6.3 million hectares of land worldwide with an average yield of 1.93 tons/hectares (Duzdemir *et al.* 2009) [17]. In India a total production of 4006.17 thousand tons of pea is witnessed on an area of 420.90 thousand hectares (Anonymous 2012) [4].

The health impact of yellow field pea is of more importance as it is rich in protein starch fiber and vitamins like B-complex and minerals like calcium which makes it suitable for its use as a supplement in human nutrition and diet. The presence of fiber makes it suitable to function as

an effective functional food having healthy effect on gut mobility. The seed coats of leguminous plants have also been shown to contain a significant amount of polyphenols (Barampama and Simard 1993) [7] which are proven to possess therapeutic effect in human diet (Beninger and Hosfield 2003; Salah *et al.* 1995) [9, 40]. As pea hulls are a good source of both dietary fibre and polyphenols its flour can be used as a health promoting ingredient.

Pea (*Pisum sativum L.*) has gained the popularity among food legumes because of its wide utility as a vegetable pulse and animal feed. It is the second most producible crop after chick pea among cool season legumes in the world. India is the third largest country in context of pea cultivation after Canada and Russia (Khan and Dixit 2001) [27]. Peas are commonly consumed as a green vegetable chat (spicy dish) chhola (whole grain) dal (pulses) and flour. It helps in significant contribution in the Indian economy (Choudhury *et al.* 2007) [13].

According to Davidsson *et al.* (2001) [15] as pea (*Pisum sativum L.)* is a potential legume with high content of protein it is a great option as a substitute of soybean where the cultivation of the latter is less or in the circumstances were allergy or intolerance is seen due to soy protein. However the potential benefits might be limited by the presence of antinutritional factors including trypsin inhibitor activity (TIA) (Urbano *et al.* 2003; Vidal-Valverde *et al.* 2003) [47, 49] phytic acid and α-galactoside oligosaccharides (Urbano *et al.* 2003; Vidal-Valverde *et al.* 2002) [47, 48].

According to Ferreira *et al.* (1995) [18]; Jachmanian *et al.* (1995) [24]; Podesta and Plaxton (1994) [38]; Ziegler (1995) [51] new processing techniques have been developed to increase the bioavailability of nutrients along with the objective of enhanced nutrient content. Germination is one such technique that involves a complex metabolic reactions where carbohydrates proteins and lipids are converted into simpler forms for better absorption of energy and amino acids for plant's growth.

With the aim of increased productivity and better nutrient content and availability research is being carried out to evolve new varieties of pea. There is very limited information about the nutritive value of these newly evolved improved varieties of peas.

Therefore the present study was undertaken with the objective of evaluation of improved varieties of field pea (*Pisum sativum*) for nutritional and functional quality.

Materials and Methods

The present study has been carried out in the Department of Foods and Nutrition College of Home Science G.B. Pant University of Agriculture and Technology Pantnagar Uttarakhand. Five improved varieties of Field pea (*Pisum sativum*) were obtained from CRC (Crop Research Centre) Pantnagar. The improved varieties studied were: Pant P-13 Pant P-14 Pant P-25 Pant P-42 and Pant P-74.

The samples of all the five field pea varieties were cleaned free from dust dirt and the extraneous material and were stored in clean air tight glass jars. The whole grains samples were ground in a mixer grinder and then passed through a sieve. The flour was stored in air tight containers for further analysis.

Proximate composition and Functional properties of five varieties of field pea were estimated. All the samples were analyzed in triplicates.

Proximate composition: This involves the determination of the per cent of moisture crude protein total ash crude fat and crude fiber in the food. Proximate composition was determined by AOAC (1995) [5] standard method.

Moisture: Moisture content was determined as per AOAC (1995) [5] procedure. Two gram of sample was taken in a clean dried (at 130±3 °C for 20 min) and weighed aluminum dish. The sample was dried in oven at 130±3 °C for 1 hour till a constant weight was obtained and cooled in desiccator. After cooling the loss in weight was taken as moisture content and expressed in terms of percentage.

$$\text{Percent Moisture} = \frac{W2-W3}{W2-W1} \times 100$$

Where
W_1 = Weight of empty aluminum dish
W_2 = Weight of aluminum dish + sample before drying
W_3 = Weight of aluminum dish + sample after drying

Total ash: The ash content was determined using AOAC (1995) [5] method. Five gram sample was weighed in a pre-dried porcelain dish and ignited on hot plate till the sample was charred. It was then cooled in desiccator and then transferred to a muffle furnace at 550^0 C until light grey ash results and subsequently cooled in a desiccator then weighed soon after reaching room temperature. The weight of the residue was then noted and the per cent ash was calculated as follows:

$$\text{Per cent ash} = \frac{W2-W1}{W} X100$$

Where
W1 = Weight of porcelain dish (before incineration)
W2 = Weight of porcelain dish + Weight of sample (after incineration)
W = Weight of sample

Crude fat: It was estimated using SOCS plus (Pellican equipments) method given by AOAC (1995) [5]. Two gram powdered sample was weighed and placed inside the thimbles. The beakers were washed and dried in hot air oven at 100 °C. The beakers were then cooled in the desiccator for about 5 minutes and then weighed to obtain the weight of empty beaker i.e. W_1. About 80 ml of petroleum ether (B.P 60-80 °C) was poured inside each beaker and then these beakers were attached to the SOCS plus assembly kept at 80 °C. Fat was extracted by using petroleum ether for 45-60 minutes placing the thimbles inside the beakers. After 1 hour the recovery temperature for petroleum ether was just doubled from 80 to 120 °C. Rinsing was done about two times in order to collect the remaining fat that may be present in the sample. All the beakers were then taken out of the system and placed in hot plate for about 15 to 20 minutes at 100 °C. Then they were cooled in desiccator for about 5 minutes and weighed. This was the final weight W_2. The difference in the initial and final weight of the beaker was reported as fat content. The amount of extracted fat was expressed on per cent basis. Per cent crude fat was calculated as follows.

$$\text{Per cent crude fat} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100$$

Crude protein: Crude protein content was determined by the Kjeldahl method of AOAC (1995). Two gram powdered sample was digested with 10 g of digestion mixture of potassium sulphate and copper sulphate in the ratio of 96: 4 and 25 ml of concentrated sulphuric acid. The sample was then digested till a carbon free clean light green colour liquid was obtained. The volume of the digested material was made up to 100 ml with distilled water. A 20 ml aliquot of digested sample was distilled with 40 per cent sodium hydroxide solution for 15-20 minutes. The ammonia liberated was collected in a conical flask containing 25 ml of 4 per cent boric acid solution to which a few drops of mixed indicator was added (bromocresol green and methyl red in the ratio 2:1) and the distillate was titrated against 0.1N H_2SO_4 until the end point (light pink colour) was reached. Blank determination was done by taking sucrose in place of sample.
Nitrogen content in the sample was calculated using the following formula:

$$\text{Percent nitrogen} = \frac{(\text{Sample titre volume} - \text{blank titre volume}) \times 0.0014 \times \text{total volume of sample}}{\text{Weight of the sample Aliquot distilled}} \text{X}100$$

Percentage of Protein = Per cent Nitrogen x Conversion factor (6.25)

Crude fibre: Crude fibre determination was done as per the method described in AOAC (1995) [5]. Two gram defatted sample was weighed and transferred in a spout less 600ml beaker containing 200 ml of 1.25 per cent H_2SO_4 and boiled for 30 min. After 30 minutes the beaker was removed and the solution was filtered through Whatman No. 54 filter paper and the residue washed with 100ml hot distilled water using Buchner funnel. The residue was then boiled in 1.25 per cent sodium hydroxide solution for exactly 30 minutes. After 30 min of boiling the contents were filtered through Whatman No. 54 filter paper and washed with hot distilled water using Buchner funnel under gentle suction. The filter paper with the residue was dried in oven at 105^0 C for 3 to 4 hours or till constant weight. It was cooled in a desiccator and then weighed. The loss in weight represented the crude fibre content. It was calculated using the following formula:

$$\text{Per cent crude fibre} = \frac{\text{W2} - \text{W1}}{\text{Weight of sample}} X100$$

Where
W1 = Weight of filter paper (g)
W2 = Weight of residue + filter paper (g)

Carbohydrates (by difference): The carbohydrate content present in the sample was expressed as per cent and determined by "difference" i.e. by subtracting the sum of the values (per100g) moisture crude protein crude fat and total ash from 100.

Per cent Carbohydrate = 100 – [moisture (%) + ash (%) + crude fat (%) + crude protein (%)]

Physiological energy value: The physiological fuel value (Kcal/100g) of sample was calculated by method given by Mudambi *et al*. (1989) [32]. The energy value was calculated by summing up the products of multiplication of per cent protein fat and carbohydrates present in the sample by 4 9 and 4 respectively i.e.

Physiological fuel value (Kcal/100g) = $4\times\ protein\%+\ 9\ \times\ fat\%\ +\ 4\ \times\ carboh\ ydrates\%$

Functional properties of different varieties of field pea seed flour: Flours of five varieties of field pea seed were evaluated for functional properties viz. water absorption capacity gelation capacity bulk density and particle size distribution. The samples were analyzed in triplicates.

Water absorption capacity (WAC): The WAC of different varieties of field pea flour was determined according to the method of Smith and Circle (1972) [44]. Exactly 5gm of flour was mixed well with 30ml of distilled water at room temperature in centrifuge tube using a glass rod. After 5 minutes the content was centrifuged at 2000 rpm for 5 minutes. The supernatant was measured using graduated cylinder and WAC was calculated as:
Volume of water absorbed = 30 – supernatant

$$\text{Water absorption capacity (\%)} = \frac{\text{Volume of water absorbed}}{\text{Weight of sample}} \times 100$$

Least gelation concentration (LGC): The gelation properties of flour were determined by the method described by Adeleke and Odedeji (2010) [1]. A series of tubes containing flour sample of 0.05g 0.10g 0.15g 0.20g 0.25g 0.30g 0.35g 0.40g 0.45g 0.50g 0.80g 0.85g 0.90g 0.95g and 1.0g were taken. Then 5ml of distilled water was added to each test tube. After that the suspensions were boiled in water bath for 2 hrs. Then the suspensions were cooled under running tap water and kept into ice bath for 1 hr. Then test tube were inverted and least gelation concentration was determined.

Bulk density: Bulking density was followed according to the method of Asoegwu *et al.* (2006) [6]. Samples were placed in a 25 ml graduated cylinder and packed by gently tapping the cylinder on the bench top 10 times from a height of 5 cm and the volume of the sample was recorded. The procedure was repeated three times for each sample and the bulk density was computed as g/ml of the sample.

$$\text{Bulk density} = \frac{\text{Weight of sample (g)}}{\text{Volume of sample (ml)}}$$

Colour evaluation: Colour of five improved varieties of field pea seed flour was determined using Munsell Soil Colour Chart (1954) [33]. The figures of hues and values were matched with the chart and equivalent colour was recorded.

Particle size index (PSI): The particle size distribution of flour sample was determined according to the method of Bedolla and Rooney (1984) [8] by sieving 100 g flour in a series of 16 36 60 85 and 100 mesh standard sieves. The sieves were shaken for 15 minutes in a Rotary type sieve shaker. Weight of the sample over 16 36 60 85 and 100 mesh sieve was recorded. Percentage of the sample particles on each sieve was calculated.

Results and Discussion
Results on proximate composition of improved varieties of field pea seed flour have been presented in Table 1.

Moisture: The moisture content of the five improved varieties of field pea seed flour ranged from 12.31 to 13.44 per cent (mean 12.85 per cent). Pant Pea-13 was found to contain the maximum whereas Pant Pea-14 showed minimum moisture content. Statistical analysis of data showed that Pant Pea-13 Pant Pea-25 and Pant pea-74 differed significantly

from Pant Pea-14 and Pant Pea-42 whereas there was non-significant difference between Pant Pea-14 and Pant Pea-42.
The moisture content in the present study was lower than the value given by Gopalan *et al.* (2011) [21] which is 16 per cent in dry peas. However the values obtained in the present study were higher than the values reported by Duke (1981) [16] which is 10.9 per cent. According to Boye *et al.* (2010) [10] yellow peas contained 14.19% moisture. Kohajdova *et al.* (2013) [28] reported 7.92% moisture in pea flour.

Total ash: The total ash content of the five improved varieties of field pea seed flour ranged from 2.86 to 3.22 per cent (mean 3.07 per cent). The total ash content was found to be maximum in Pant Pea-42 whereas minimum was found in Pant Pea-25. Statistical analysis of data showed that all varieties differed significantly except Pant Pea-42 and Pant Pea-74.
According to Gopalan *et al.* (2011) [21] ash content of dry peas was 2.2 per cent which is lesser than the value obtained in the present study and value given by Duke (1981) [16] was 2.8g/100g. Costa *et al*. (2006) [14] and Perez-Maldonado *et al*. (1999) [37] reported ash content in the range of 3.05-4.06 per cent. According to Boye *et al.* (2010) [10] yellow peas contained 2.42 per cent ash.

Crude protein: The Crude protein content of the five improved varieties of field pea seed flour ranged from 16.14 to 20.32 per cent (mean 18.94 per cent). Pant Pea-25 contained maximum whereas Pant Pea-74 contained minimum Crude protein. It was found that Pant Pea-13 Pant Pea-14 and Pant Pea-42 differed significantly from Pant Pea-25 and Pant Pea-74.
Gopalan *et al*. (2011) [21] mentioned 19.7 per cent of crude protein in dry peas. Tzitzikas *et al*. (2006) [46] found that the concentration of protein in fifty-nine pea lines ranged from 13.7 to 30.7 per cent of seed DM with an overall average of 22.3 per cent. The values of crude protein obtained in the present study were in the range obtained by Tzitzikas *et al*. (2006) [46]. Hood-Niefer *et al*. (2012) [23] reported an effect of environment on the concentration of protein in peas but observed a narrow range in protein concentration (24.2–27.5 per cent on a moisture-free basis) in ten genotypes grown in four locations in Saskatchewan Canada over two growing seasons. According to Nikolopoulou *et al.* (2007) [34] protein content of the peas varied from 24.3 to 32.6 per cent.

Crude fat: The Crude fat content of the five improved varieties of field pea seed flour ranged from 0.90 to 2.17 per cent (mean 1.53 per cent). It was found that Pant Pea-14 contained maximum and Pant Pea-74 contained minimum crude fat. It was observed that Pant Pea-13 and Pant Pea-74 differed significantly from Pant Pea-14 Pant Pea-25 and Pant Pea-42 whereas there is non-significant difference between Pant Pea-14 and Pant Pea-25.
Gopalan *et al*. (2011) [21] mentioned 1.1 per cent crude fat in dry peas. According to Costa *et al*. (2006) [14]; Perez-Maldonado *et al*. (1999) [37] crude fat content ranged from 0.76-3.95 per cent which is comparable to values obtained in present study. According to Boye *et al.* (2010) [10] yellow peas contained 2.01 per cent fat. Kohajdova *et al.* (2013) [28] reported 1.13 per cent fat in pea flour.

Crude fibre: The Crude fibre content of the five improved varieties of field pea seed flour ranged from 1.56 to 3.39 per cent (mean 2.56 per cent). Pant Pea-25 had maximum and Pant Pea-42 had minimum amount of crude fibre. Statistically Pant Pea-13 Pant Pea-14 and Pant Pea-74 differed significantly from Pant Pea-25 and Pant Pea-42 in crude fibre content.
Mishra *et al.* (2010) [30] reported a range of 1.23 to 1.84 per cent fibre in test varieties of field pea which is lower than the present study. Duke (1981) [16] reported 4.2 g fiber in pea flour which is higher than the values obtained in the present study. Gopalan *et al*. (2011) [21] reported 4.5 per cent crude fibre in dry peas. Hickling (2003) [22] reported 5.5 per cent crude fibre in field peas.

Carbohydrate by difference: The Carbohydrate content of the five improved varieties of field pea seed flour ranged from 58.46 to 64.08 per cent (mean 61.05 per cent). The Carbohydrate content of Pant Pea-74 was maximum while that of Pant Pea-25 was minimum. Statistical analysis of data showed that Pant Pea-13 Pant Pea-14 and Pant Pea-42 differed significantly from Pant Pea-25 and Pant Pea-74.
Gopalan *et al*. (2011) [21] mentioned 56.5 percent carbohydrate content in dry peas which is lower than the values obtained in the present study. According to Duke (1981) [16] flour contains 62.3g total carbohydrates. According to Boye *et al.* (2010) [10] yellow peas had 60.29 per cent carbohydrates. Kohajdova *et al.* (2013) [28] reported 66.38 per cent carbohydrates in pea flour which is higher than the values obtained in the present study.

Physiological energy: The energy content of the five improved varieties of field pea seed flour ranged from 329 to 339 Kcal/100g (mean 334 Kcal/100g). Pant Pea-42 contained maximum while Pant Pea-74 contained minimum amount of energy. Statistical analysis of data showed that Pant Pea-13 Pant Pea-25 and Pant Pea-74 differed significantly from Pant Pea-14 and Pant Pea-42 whereas there is non-significant difference between Pant Pea-14 and Pant Pea-42.
Gopalan *et al.* (2011) [21] mentioned 315 kcal energy in dry peas which is lower than the values obtained in the present study. According to Duke (1981) [16] flour contained 343 calories. Renu and Bhattacharya (1989) [39] reported energy value in the range of 369 to 379 kcal. Pandya (1980) [36] reported energy value in the range of 330 to 339 kcal which is nearest to the value obtained in the present study.

Table 1: Proximate composition of improved varieties of field pea seed flour

Proximate composition	Pant Pea-13	Pant Pea-14	Pant Pea-25	Pant Pea-42	Pant Pea-74	S.Em.±	CD at 5%
Moisture (%)	13.44±0.35^{a}	12.31±0.09^{b}	12.96±0.15^{a}	12.37±0.39^{b}	13.16±0.30^{a}	0.163	0.513
Ash (%)	2.96±0.05^{a}	3.11±0.05^{b}	2.86±0.04^{c}	3.22±0.03^{d}	3.20±0.04^{d}	0.025	0.080
Crude fibre (%)	2.55±0.31^{a}	2.75±0.28^{a}	3.39±0.20^{b}	1.56±0.32^{c}	2.53±0.39^{a}	0.140	0.556
Crude fat (%)	1.07±0.31^{a}	2.17±0.25^{b}	2.0±0.2^{b}	1.53±0.31^{c}	0.90±0.06^{a}	0.177	0.441
Crude protein (%)	19.44±0.17^{a}	19.15±0.17^{a}	20.32±0.33^{b}	19.64±0.33^{a}	16.14±0.33^{c}	0.162	0.510
Carbohydrates (%)	60.54±0.29^{a}	60.51±0.49^{a}	58.46±0.50^{b}	61.67±1.24^{a}	64.08±0.39^{c}	0.389	1.224
Energy (Kcal/100g)	330±2.73^{a}	338±1.55^{b}	333±2.00^{a}	339±2.37^{b}	329±0.52^{a}	1.147	3.613

All results are mean± standard deviation for three individual determinations. Means within the same row with different alphabets are significantly different (p<0.05)
S. Em -Standard error of mean CD- Critical difference

The results on functional properties of improved varieties of field pea seed flour have been presented in Table 2.

Water absorption capacity: The water absorption capacity of the five improved varieties of field pea seed flour ranged from 1.04 to 1.20ml/g (mean 1.14ml/g). The highest water absorption capacity was seen in Pant Pea-13 Pant Pea-14 and Pant Pea-74 while Pant Pea-25 and Pant Pea-42 obtained the lowest water absorption capacity. Statistical analysis of data showed that Pant Pea-13 Pant Pea-14 and Pant Pea-74 differed significantly from Pant Pea-25 and Pant Pea-42 while there was non- significant difference between Pant Pea-25 and Pant Pea-42.
In a study by Kaur *et al.* (2007) [26] Water absorption capacity (WAC) of FPF (Field pea flours) and PPF (Pigeon pea flours) ranged from 1.24 to 1.25 and 1.37 to 1.39 g/g respectively which is comparable to the present study. Different protein structures and the presence of different hydrophilic carbohydrates might be responsible for variations in the WAC of the flours.

Least gelation concentration: The least gelation concentration of the five improved varieties of field pea seed flour ranged from 7 to 8 per cent (mean 7.40 per cent). The highest least gelation concentration was seen in Pant Pea-25 and Pant Pea-42 while Pant Pea-13 Pant Pea-14 and Pant Pea-74 showed the lowest least gelation concentration. Statistical analysis of data showed that Pant Pea-13 Pant Pea-14 and Pant Pea-74 differed significantly from Pant Pea-25 and Pant Pea-42 while there was non-significant difference between Pant Pea-25 and Pant Pea-42.
Least gelation concentration (LGC) may be defined as the lowest concentration required for formation of a self-supporting gel. Samples with lower LGC have greater gelling capacity (Boye *et al.* 2010a) [10]. In a study by Kaur *et al.* (2007) [26] least gelation concentration (LGC) for various legume flours ranged from 12 to 14 per cent. The lower the LGC the better is the gelating ability of the protein ingredient (Akintayo *et al*. 1999) [3]. Pigeon pea flours formed a firm gel at a significantly higher concentration (14%) than did Field pea flours (12%) which is higher than the results obtained in the present study. In a study by Kohajdova *et al.* (2013) [28] LGC of pea flour was 12%. Similar LGC values (8-14%) were reported by Siddiq *et al.* (2010) [41]; Boye *et al.* (2010b) [10]; Kaur and Singh (2005) [25] for bean chickpea flours and legume protein concentrates which is comparable to the results obtained in the present study. On the other hand Ma *et al.* (2011) [29] and Butt and Batool (2010) [11] found higher LGC for various legume flours and protein isolates (14-20%).Variations in gelling properties have been associated with relative ratio of different constituents such as proteins lipids and carbohydrates in different legume flours (Chau and Cheung 1998) [12].

Bulk density: The bulk density of the five improved varieties of field pea seed flour ranged from 0.71 to 0.77 g/ml (mean 0.73 g/ml). The highest bulk density was seen in Pant Pea-14 while lowest was seen in Pant Pea-25 and Pant Pea-42. Statistical analysis of data showed that Pant Pea-13 Pant Pea-14 and Pant Pea-74 differed significantly from Pant Pea-25 and Pant Pea-42 while there was non-significant difference between Pant Pea-25 and Pant Pea-42.
In a study by Kaur *et al*. (2007) [26] among the flours field pea flour showed a higher bulk density (0.541–0.562 g/ml) than did Pigeon pea flour (0.471–0.467 g/ml). Bulk densities of 0.536–0.571 g/ml in chickpea flours (Kaur and Singh 2005) [25] 0.530 and 0.480 g/ml in winged bean flour and soy isolate respectively have been reported (Okezie and Bello 1988) [35]. The results obtained in the present study are higher than that reported earlier.

Table 2: Functional properties of improved varieties of field pea seed flour

Flour	Water absorption capacity (ml/g)	Least gelation concentration (%)	Bulk density (g/ml)
Pant Pea-13	1.20±0.02^{a}	7.0^{a}	0.75±0.03^{a}
Pant Pea-14	1.20±0.03^{a}	7.0^{a}	0.77^{a}
Pant Pea-25	1.04±0.02^{b}	8.0^{b}	0.71^{b}
Pant Pea-42	1.04±0.02^{b}	8.0^{b}	0.71^{b}
Pant Pea-74	1.20±0.00^{a}	7.0^{a}	0.75±0.03^{a}
S.Em.±	0.012	0.058	0.013
CD at 5%	0.037	0.182	0.040

All results are mean± standard deviation for three individual determinations. Means within the same column with different alphabets are significantly different ($p<0.05$)
S.Em -Standard error of mean CD- Critical difference

Colour evaluation: As per Munsell soil colour chart colour of improved varieties of field pea seed flour have been presented in Table 3.

Table 3: Colour of improved varieties of field pea seed flour

Pant Pea-13	Pant Pea-14	Pant Pea-25	Pant Pea-42	Pant Pea-74
5Y (8/4)	10Y (8/4)	5Y (8/4)	2.5Y (8/6)	10Y (8/8)

Particle size index: Table 4 shows the specific particle distribution or percentage of the five improved varieties of field pea seed flour on each sieve size. The maximum retention of improved varieties of field pea seed flour was found in 60 mesh sieve while minimum retention was found in 85 mesh sieve.

Table 4: Particle size distribution of improved varieties of field pea seed flour

Sieve No./ Mesh size (µm)						
Flour	**44 mesh sieve (%)**	**60 mesh sieve (%)**	**72 mesh sieve (%)**	**85 mesh sieve (%)**	**100 mesh sieve (%)**	**At base (%)**
Pant Pea-13	13.92±0.19^{a}	45.86±0.65^{a}	11.20±0.55^{a}	5.64±0.10^{a}	9.31±0.15^{a}	13.97±0.11^{a}
Pant Pea-14	11.01±0.22^{b}	45.56±0.12^{a}	12.43±1.31^{a}	6.41±1.11^{a}	11.29±0.76^{b}	14.42±0.69^{a}
Pant Pea-25	16.65±0.52^{c}	49.93±1.29^{b}	10.93±0.61^{a}	3.90±0.66^{b}	5.58±0.65^{c}	12.53±0.50^{b}
Pant Pea-42	12.00±0.14^{d}	47.23±0.59^{c}	12.09±0.40^{a}	5.36±0.85^{a}	9.03±0.23^{a}	14.20±0.35^{a}
Pant Pea-74	12.16±0.30^{d}	49.98±0.15^{b}	12.82±0.7^{a}	5.60±0.25^{a}	6.51±0.11^{d}	12.90±0.42^{b}
S.Em.±	0.175	0.406	0.449	0.405	0.269	0.263
CD at 5%	0.552	1.278	1.415	1.275	0.846	0.827

All results are mean± standard deviation for three individual determinations. Means within the same column with different alphabets are significantly different (p<0.05) S.Em -Standard error of mean CD- Critical difference

Conclusion

From the present study it was concluded that variation in proximate composition and functional properties would imply that the variety stage of maturity weather conditions might have affected the physiochemical parameters of this crop. From the above results it was found that moisture content was highest in Pant Pea-13 total ash content and energy value were highest in Pant Pea-42 crude protein and crude fibre were highest in Pant Pea-25 crude fat was highest in Pant Pea-14 and carbohydrate content was highest in Pant Pea-74. The highest water absorption capacity was seen in Pant Pea-13 Pant Pea-14 and Pant Pea-74 least gelation concentration was highest in Pant Pea-25 and Pant Pea-42 and highest bulk density was seen in Pant Pea-14. Particle size index revealed that maximum retention of varieties of field pea was found in 60 mesh sieve while minimum retention was found in 85 mesh sieve.

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