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COMPARATIVE STUDY OF FIELDPEA, CHICKPEA AND THEIR CULTIVARS

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ABSTRACT

The physico-chemical properties of two varieties of Chickpea (*Cicerarietinum*) i.e. HC-1 and C-235 and field pea (*Pisumsativum)* i.e.Jayanti and Uttara were studied. HC-1 had minimum hydration capacity (0.11g/seed) whereas Jayanti had the maximum (0.17g/seed) hydration capacity. Among all the varieties, swelling index showed non-significant ($P<0.05$) difference and Uttara required minimum cooking time i.e. 60 minutes whereas HC-1 required maximum cooking time. Nutritional evaluation revealed chickpea varieties had significantly ($P<0.05$) higher amount of protein and fat than those of field pea. Total carbohydrates was found to be maximum (62.70 percent) in Uttara. As regards to mineral profile, calcium and zinc are significantly ($P<0.05$) more in chickpea varieties as compared to field pea varieties. In chickpea varieties 12.20 to 12.46, 2.33 to 2.52 and 9.68 to 10.13 g/100g whereas in field pea varieties 5.80 to 6.02, 0.48 to 0.50 and 5.32 to 5.52g/100g of total soluble sugar, reducing sugar and non-reducing sugar was present respectively. Chickpeas had higher concentration of polyphenols than field peas. HC-1 of chickpea and Jayanti of field pea was nutritionally superior varieties than C-235 of chickpea and Uttara of field pea as they had more (*in vitro)* protein and lower starch digestibility than those of field pea.

KEY WORDS

Chickpea, Field pea; proximate composition and Physico-chemical properties.

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INTRODUCTION

Legumes are dicotyledonous seeds of plant that belong to family *Leguminosae*. Legumes not only are healthy vegetarian food but also bring to the cereals variety of taste, texture and nutrients (carbohydrates and minerals) which ensure a balanced diet, meeting all nutritional requirements[1]. They are a cheap source of high quality protein in the diets of millions in developing countries, who cannot afford animal protein for balanced nutrition. In spite of a good nutritional profile, as well as reported medicinal properties, chickpea has several

nutritional and processing problems, such as the presence of antinutrients, prolonged cooking time, hard-to-cook phenomenon and poor digestibility. Its chemical composition is subject to fluctuations, depending on various factors, e.g. cultivar and maturity stage, environment (mostly weather conditions), and agrotechnics[2].

Chickpeas (*Cicerarietinum*), also known as garbanzo beans or Bengal gram, are the third most important type of legume after dry beans and peas. Chickpeas are the second most important grain legume cultivated in Asia, Mediterranean regions, Australia, Canada, the USA and Africa[3]. Among food legumes, chickpea is the most hypocholesteremic agent, and germinated chickpea is reported to be effective in controlling cholesterol level in rats[4].

Field pea (*Pisumsativum, L.*) is an important season pulse crop that originated approximately 9000 years ago. The pea is a legume with great nutritional potential due to its high protein content and it has been suggested as an alternative protein source to soybean in countries where the former legume is not a native crop, or in situations where soybean cannot be used due to allergic reactions or intolerances[5]. The functional properties of whole pea flour, high fibre, fibrestarch and high protein ingredients, derived from yellow field peas, indicate that these products could contribute desirable functional characteristics to a wide range of food products. The whole pea flour has also been attributed a good source of polyphenols[6].

Some studies report low nutritional values for legumes, the protein digestibility having considerable influence on these bad results, due to its chemical structure. Also influential are antinutritional factors, such as protease inhibitors, lectins, phytate, tannin and dietary fibre, including resistant starch. The primary action of fibres in the human organism occurs in the gastrointestinal tract, presenting different physiological effects. Indeed, the physiological effects caused by the fibres, such as alteration of the gastrointestinal transit time, satiety changes, influence on the levels of body cholesterol, after-meal serum glucose and insulin levels, flatulence and alteration in nutrient bioavailability, are due to the physico-chemical properties of the chemical components of which they are composed[7]. Thus, the aim of this study was to evaluate the nutritional content of commonly used cultivars of field pea and chickpea and to determine the concentration of antinutritional factors. Also study *in vitro* protein and starch digestibility.

MATERIALS AND METHODS

Procurement of Legumes

Two varieties of legumes namely HC-1 and C-235 of chickpea, Jayanti and Uttara of field pea having high consumer acceptability were procured in a single lot from the Forage Section of Department of Plant Breeding, College of Agriculture, Chaudhary Charan Singh Haryan Agriculture University, Hisar.

Physico-chemical properties of raw cultivars

Seed weight

Seed weight was recorded as the weight of 1000 healthy seeds.

Density

Legume seeds (100g) were weighed accurately and transferred to measuring cylinder. Then 100ml distilled water was added to it. Seed volume was recorded as total volume-100ml. Density was recorded as g/ml.

Hydration Capacity

Seeds weighing 100g each were counted and transferred to measuring cylinders and 100 ml water was added. The cylinders were covered with aluminium foils and left overnight at room temperatures. Next day seeds were darined, superfluous water was removed with filter paper and swollen seeds were reweighed. Hydration capacity per seed was determined using following formula:

$$Hydrationcapacityperseed\left(\frac{g}{seed}\right) = \frac{wt.ofsoakedseeds - wt.ofseedsbeforesoaking}{numberofseeds}$$

Hydration Index

Hydration index was calculated as below:

$$\text{Hydration index} = \frac{Hydrationcapacityperseed}{Weightofoneseed\ (g)}$$

Swelling Capacity

Seeds weighing 100g, were counted, their volume noted and soaked overnight. The volume of the soaked seeds was noted in graduated cylinder.

Sweeling capacity per seed was determined using following formula:

$$\text{Swelling capacity (ml/seed)} = \frac{volumeaftersoaking - volumebeforesoaking}{volumeofoneseed}$$

Swelling Index

Swelling index was calculated as below:

$$\text{Swelling index} = \frac{Swellingcapacityperseed}{Volumeofoneseed}$$

Cooking Time

Seeds (100g) were taken in beakers fitted with condensers to avoid evaporation during boiling. Water was added in a ratio of 1:4 (w/v). Samples were stirred at two minute intervals. After 45 minutes one seed was withdrawn without interrupting the boiling. Degree of cooking was tested by pressing seeds between forefinger and thumb. If seeds were felt uncooked, one seed was again tested after five minutes. This procedure continued until five seeds tested were found cooked. At this time total cooking time was recorded.

Nutritional evaluation of unprocessed chickpea and field pea cultivars

Preparation of Samples

The seeds were cleaned of dust and other foreign materials were handpicked. Raw seeds were ground in an electric grinder.

The ground samples were analyzed for proximate composition, carbohydrate contents, antinutritional factors, *in vitro* protein and starch digestibility and total minerals as per method below:

Moisture

Moisture was determined by standard method of analysis[8]. Moisture was calculated in accordance with the formula:

$$\text{Moisture (\%)} = \frac{Lossinweight\ (g)}{Weightofsample(g)} \times 100$$

Crude Protein

The total nitrogen was estimated by the standard method[8]. A factor of 6.25 was applied to convert the amount of nitrogen to crude protein.

Crude Fat

Crude fat was estimated using the Soxhlet extraction apparatus[8.]

Total Ash

Ash in the sample was estimated by employing the standard method of analysis[8].

Crude Fibre

Percentage of crude fibre was calculated in accordance with the standard method of analysis[9].

Total Carbohydrates

Amount of carbohydrate was calculated from the sum of moisture, protein, fat, ash and crude fibre and lastly subtracting it from 100.

Total Minerals

Minerals were determined by the Atomic Absorption Spectrophotometer 2380, PERKIN- ELMER (USA) according to the method of Lindsey and Norwell[10].

Total Soluble Sugars

Total soluble sugars were determined by the ferricyanide, method of Hulme and Narain[11].

Reducing sugars and Non-reducing sugars

The reducing sugars were estimated from the sugar extract by the same method as used for total sugars. The amount of non-reducing sugar was calculated as the difference between total soluble sugars and reducing sugars.

Starch

Starch from the sugar-free pellet was estimated by the method of Clegg[12].

Antinutritional Factors

The methods used were based on Haug and Lantzsch[13] for phytic acid, Singh and Jambunathan[14] for total polyphenols and modified method of Roy and Rao[15] to assess Trypsin inhibitor activity.

***In vitro* Digestibilities**

In vitro protein digestibility was carried out by the modified method of Mertz *et al*.[16] and in vitro starch digestibility was assessed as per the method of Singh et al[17].

Statistical analysis

The data were subjected to statistical analysis for "t "analysis of variance and correlation coefficients as per standard methods (Snedecor and Cochran[18]). ANOVA was used for testing the difference among more than two sample means.

RESULTS

Proximate composition

The physico-chemical properties chickpea and field pea varieties are presented in Table No.1. it is clear from table that 1000 seed weight of chickpea varieties ranged between 114.80 to 133.80 g. C-235

had significantly (P<0.05) difference in 1000 seed weight in Jayanti (186.50g) and Uttara (165.80g) varieties of field pea was also observed, Sood*et a.l*[19] reported that 100 seed weight of desi varieties of chickpea ranged between 14.20 to 26.83g with a mean of 18.14g.

Non-significant difference was observed in density between chickpea varieties whereas field pea varieties differed significantly (P<0.05) from each other. A range of 1.70 to 2.42 g/ml in chickpea varieties was reported by Sood*et al*[19]. Hydration index of C-235 variety of chickpea was highest (1.05) followed by HC-1 variety of chickpea (0.86), Jayanti variety of field pea (0.84) and Uttara variety of field pea (0.79).

Chickpea varieties required significantly (P<0.05) higher cooking time (65.50 to 70.30 min) than field pea varieties (60.00 to 62.50 min) while lower values (46.50 to 62.50 min) were reported by Sood*et al.*[19] in chickpea varieties.

NUTRITIONAL PARAMETERS

Proximate Composition

Proximate composition of chickpea and field pea varieties has been presented in Table No.2.

Moisture

Chickpea varieties had significantly lower moisture content ranging from 7.15 to 7.17 (g/100g, DM basis) whereas field pea varieties had higher moisture content (7.89 to 8.83 g/100g, DM basis). Similar results have also been reported by Mcintosh and Topping[20] in chickpea and field pea.

Crude Protein

Crude protein content was found highest in HC-1 of chickpea and lowest in Uttara of field pea. A non-significant (P<0.05) difference in crude protein content of HC-1 and C-235 of chickpea and Jayanti and Uttara of filed pea was there, whereas chickpea varieties had significantly (P<0.05) more protein than the field pea varieties. More amount of protein was reported in chickpea by Sood*et al*[19] and in field pea by Mcintosh and Topping[20].

Crude Fat

A wide range of crude fat content was observed in chickpea and field pea legumes, the lower being in field pea and higher in chickpea (Table No.2). However, a non-significant (P<0.05) difference in fat contents between chickpea (HC-1 and C-235) and field pea (Jayanti and Uttara) varieties was observed. Mcintosh and Topping[20]reported 4.7g/100g of fat content in chickpea and 2g/100g and 1.1 g/100g (Gopalan*et al.*[21]) fat content was found in field pea.

Total Ash

All the four varieties of legumes differed significantly (P<0.05) from each other. The result of ash obtained in the present study is similar to the earlier results obtained y Savage and Deo[22], Singh[23], Sood*et al*[19].

Crude Fibre

The crude fibre content in chickpea and field pea varities namely HC-1, C-235, Jayanti and Uttara was recorded as 5.06, 5.20, 4.75 and 5.35 respectively. Significant (P<0.05) difference was observed in chickpea and field pea cultivars. The crude fibre content of chickpea and field pea observed in the present study was comparable to the range reported earlier by Ulloa*et al.*[24], Gopalan*et al.*[21] and Sood*et al*[19].

Total Carbohydrates

Carbohydrate content was found to be maximum in Uttara (62.70 g/100g) followed by Jayanti (62.37 g/100g), HC-1 (57.83 g/100g) and C-235 (57.8 g/100g), respectively. A significant (P<0.05) difference was found in carbohydrate content of chickpea and field pea varieties.

Total Minerals

Total calcium, iron and zinc content of unprocessed varieties of chickpea and field pea are presented in Figure No.1.

Total Calcium

Total calcium content ranged from 146.00 to 146.50 mg/ 100g in chickpea varieties and 112.25 to 119.00 mg/100g in field pea varieties. A non-significant (P<0.05) difference was observed in the calcium content of HC-1 and C-235 varieties of chickpea whereas significant difference occurred in calcium content of field pea varieties. A significant (P<0.05) higher amount of calcium was present in chickpea as compared to field pea varieties.

Total Iron

The content of iron in HC-1, C-235, Jayanti and Uttara was found to be 5.20, 5.30, 5.00 and 4.90

mg/100g, respectively. Non-significant (P<0.05) variation was observed with regard to iron content among chickpea and field pea varieties.

Total Zinc

Total zinc content ranged between 2.55 to 3.51 mg/100g. Chickpea varieties had significantly (P<0.05) higher content of zinc as compared o field pea varieties. Similar values for calcium and zinc but higher values for iron in chickpea have been reported by Kumar and Kapoor[25]. Matthews[26] reported low calcium and high iron and zinc content in peas.

Carbohydrate Profile

Total soluble sugars, reducing sugars, non reducing sugars and starch content of chickpea and field pea cultivars have been listed in Table No.3.

Total soluble sugars

Total soluble sugar content of chickpea and field pea varieties varied from 9.20 to 9.46 g/100g and 5.80 to 6.02 g/100g, respectively. When compared to filed peas, the chickpea varieties had significantly (P<0.05) higher levels of total soluble sugars.

Reducing sugars

There was non-significant (P<0.05) difference in reducing sugar content of chickpea varieties i.e. HC-1 and C-235 and field pea varieties i.e. Jayanti and Uttara. Field pea varieties had significantly (P<0.05) less content of reducing sugars than the chickpea varieties. C-235 had the maximum (1.52g/100g) reducing sugar followed by HC-1 (1.3352g/100g), Jayanti (0.5052g/100g) and Uttara (0.4852g/100g).

Non-reducing sugars

Similar to the reducing sugar content, a wide range (5.32 to 8.1352g/100g) in non-reducing sugar content was observed in four different varieties of legumes.

Starch

There was a significant varietal difference in starch content of chickpea and field pea. Field pea varieties had significantly (P<0.05) higher level of starch as compared to chickpea varieties. The findings of the present study are consistent with those reported earlier in chickpea (Saini and Knight[27]) and field pea (Bishnoi and Khetarpaul[28]) whereas approximately same amount of starch and low amount of total soluble sugars, reducing sugars and non-reducing sugars were noticed by Jood*et al*.[29] in chickpea.

ANTINUTRITIONAL FACTORS

Phytic acid

It is known to be a major storage form of phosphorus in legumes and is considered an antinutritional factor in legumes. The phytic acid content ranged from 700-800 mg/100g in chickpea and 675 to 750 mg/100g in field pea varieties (Figure No.2). The field pea varieties had significantly (P<0.05) lower level of phytic acid than that of chickpea varieties. Among the chickpea and field pea varieties, c-235 andUttara had higher content of phytic acid i.e. 800 and 750 mg/100g, respectively. Different workers have reported a wide variation for phytic acid content among different varieties of chickpea and field pea (Savage and Deo[22], Duhan*et al*.[30]).

Polyphenols

The polyphenolic compounds have been expressed as tannic acid equivalent. Chickpea varieties had significantly higher amount of polyphenols than those of field pea varieties (Figure No.2). The values of polyphenol obtained in the present study are in consistent with the observation made by Savage and Deo[22], Bishnoi and Khetarpaul[31] but appear to be lower than the values reported by Singh and Jambunathan[14].

Trypsin inhibitor activity

Trypsin inhibitors are the characteristics constituents of legume grains and are known to affect the digestibility and protein quality of legumes. Trypsin inhibitor activity of chickpea and field pea varieties varied significantly (P<0.05) between themselves and ranged from 540 to 550 TIU/g and 950 to 990 TIU/g, respectively. The highest trypsin inhibitor activity was in HC-1 of chickpea (550 TIU/g) and Uttara of field pea (990 TIU/g). Similar results have been reported by various workers in chickpea (Singh and Jambunathan[14], Singh23) and in field pea (Bishnoi and Khetarpaul [31]).

***In vitro* digestibilities**

In vitro protein and starch digestibility of chickpea and field pea varieties are presented in Figure No.3.

Protein digestibility

In vitro protein digestibility of chickpea varieties was significantly (P<0.05) higher than the field pea varieties (Figure No.3). The phytic acid, polyphenols and trypsin inhibitor activity had a significant

(P<0.05) negative correlation with *in vitro* protein digestibility (Table No. 4). The *in vitro* protein digestibility in chickpea genotype varied from 65.3 to 79.4 percent and negative correlation was observed between phytic acid and in vitro protein digestibility (Chitra*et al.*[32]).

Starch digestibility

Starch digestibility (*in vitro*) expressed as mg maltose releasing/g was 32.65, 35.10, 37.10 and 34.23 in C-235, HC-1, Jayanti and Uttara varieties of chickpea and field pea, respectively. Jayanti variety of filed pea had significantly (P<0.05) higher (37.10 mg maltose released/g) starch digestibility followed by HC-1, Uttara and C-235. The phytic acid, polyphenols and trypsin inhibitor activity had a significant (P<0.05) negative correlation with *in vitro* starch digestibility.

El-Faki found *in vitro* starch digestibility in chickpea to be 80.63 percent. The data of starch digestibility are consistent with those reported in peas Bishnoi and Khetarpaul[28].

Table No.1: Physico-chemical properties of chickpea and field pea legumes

S.No	Varieties	1000 seed weight(g)	Density (g/ml)	Hydration capacity (g/seed)	Hydration index	Swelling capacity (ml/seed)	Swelling index	Cooking time (min)
	Chickpea	-	-	-	-	-	-	-
1	HC-1	114.80^{a}±0.66	1.30^{a}±0.05	0.11^{a}±0.00	0.86^{a}±0.02	0.14^{a}±0.01	0.49^{a}±0.01	70.30^{a}±0.40
2	C-235	133.80^{b}±0.89	1.25^{a}±0.02	0.13^{ab}±0.01	1.05^{b}±0.01	0.17^{a}±0.01	0.50^{a}±0.00	65.50^{b}±0.29
	Field pea	-	-	-	-	-	-	-
3	Jayanti	185.50^{d}±0.74	1.18^{b}±0.02	0.17^{c}±0.01	0.84^{ac}±0.01	0.24^{b}±0.01	0.50^{a}±0.01	62.50^{c}±0.87
4	Uttara	165.80^{c}±0.93	1.25^{a}±0.03	0.15^{bc}±0.01	0.79^{c}±0.01	0.22^{b}±0.2	0.50^{a}±0.2	60.00^{d}±0.29
5	CD (P<0.05)	2.29	0.07	0.03	0.05	0.05	0.02	1.69

Values are means ± SE of three independent determinations. Values with different superscripts are significantly different (ANOVA: P<0.05) from other group, column wise.

Table No.2: Proximate composition of chickpea and field pea varieties (g/100g, on dry matter basis)

S.No	Varieties	Moisture	Crude protein	Crude fat	Total ash	Crude fibre	Total carbohydrates
	Chickpea						
1	HC-1	7.17^{a}±0.10	22.75^{a}±0.43	4.00^{a}±0.29	3.19^{a}±0.00	5.06^{a}±0.03	57.83^{a}±0.60
2	C-235	7.15^{a}±0.20	22.21^{a}±0.45	4.60^{a}±0.35	3.02^{b}±0.00	5.20^{a}±0.06	57.81^{a}±1.02
	Field pea						
3	Jayanti	7.89^{b}±0.23	19.70^{b}±0.33	1.40^{b}±0.12	3.89^{c}±0.01	4.75^{b}±0.01	62.37^{b}±0.65
4	Uttara	8.83^{c}±0.10	19.00^{b}±0.23	1.5^{b}±0.29	2.62^{d}±0.01	5.35^{b}±0.03	62.70^{b}±0.63
5	CD (P<0.05)	0.54	1.22	0.89	0.03	0.23	2.44

Values are means ± SE of three independent determinations. Values with different superscripts are significantly different (ANOVA: P<0.05) from other group, column wise.

Table No.3: Total soluble sugars, reducing sugars, non-reducing sugars and starch content of chickpea and field pea varieties (g/100g, on dry matter basis)

S.No	Varieties	Total soluble sugars	Reducing sugars	Non-reducing sugars	Starch
	Chickpea				
1	HC-1	$9.46^{a}\pm0.39$	$1.33^{a}\pm0.21$	$8.13^{a}\pm0.19$	$46.51^{a}\pm0.12$
2	C-235	$9.20^{a}\pm0.70$	$1.52^{a}\pm0.30$	$7.68^{a}\pm0.40$	$48.16^{b}\pm0.09$
	Field pea				
3	Jayanti	$6.02^{b}\pm0.11$	$0.50^{b}\pm0.10$	$5.52^{b}\pm0.04$	$61.30^{c}\pm0.17$
4	Uttara	$6.02^{b}\pm0.13$	$0.48^{b}\pm0.14$	$5.32^{b}\pm0.01$	$62.90^{d}\pm0.05$
5	CD (P<0.05)	1.33	0.66	0.71	0.38

Values are means ± SE of three independent determinations. Values with different superscripts are significantly different (ANOVA: P<0.05) from other group, column wise.

Table No.4: Correlation coefficient of *in vitro* protein and starch digestibility with phytic acid, polyphenols and trypsin inhibitor activity of cheickpea and field pea

S.No	Varieties	*In vitro* protein digestibility	*In vitro* starch digestibility
	Phytic acid		
1	Chickpea	-0.9899*	-0.9958*
2	Field pea	-0.9736*	-0.9914*
	Polyphenols		
3	Chickpea	-0.9960*	-0.9989*
4	Field pea	-0.9807*	-0.9219*
	Trypsin inhibitor activity		
5	Chickpea	-0.9958*	-0.9997*
6	Field pea	-0.9176*	-0.9643*

*Significant at 1% level of significance

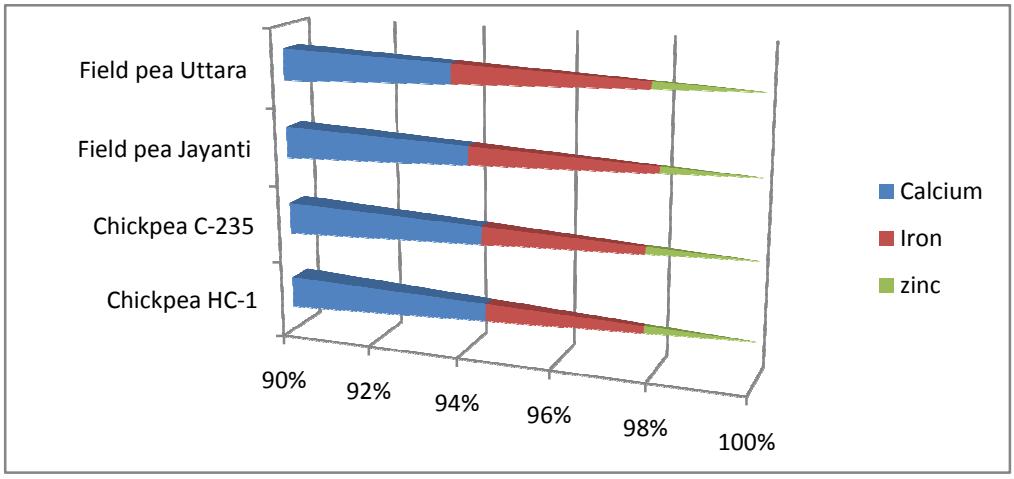

Figure No.1: Different minerals of chickpea and filed pea cultivars (mg/100g on dry matter basis)

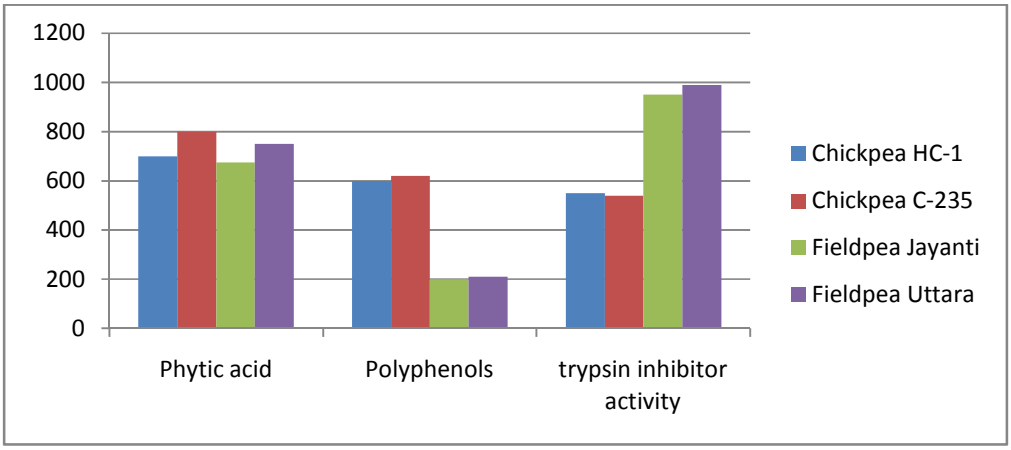

Figure No.2: Phytic acid (mg/100g), Polyphenols (mg/100g) and Trypsin inhibitor activity (TIU/g) in legume variety of chickpea and field pea

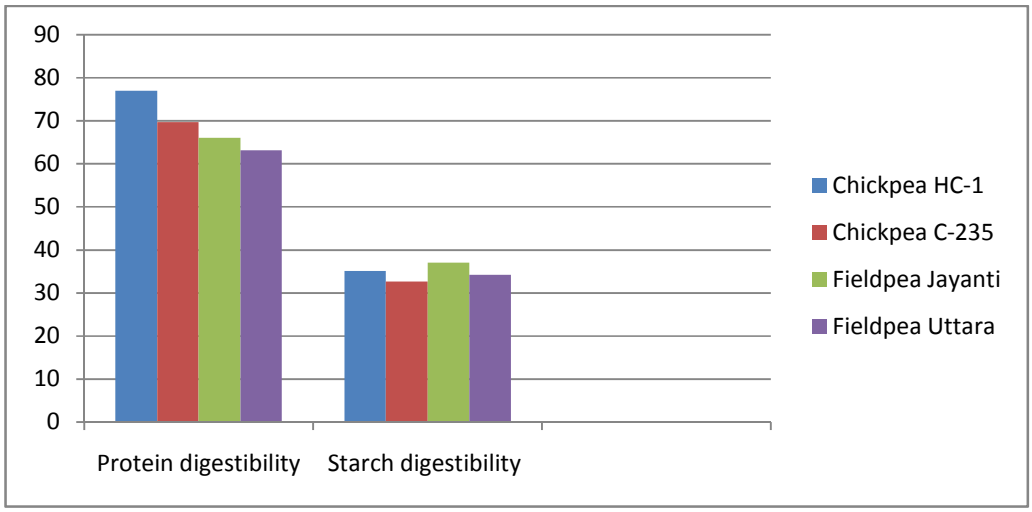

Figure No.3: *In vitro* protein (%) and starch digestibility (mg maltose releasing/g flour) of chickpea and field pea cultivars

CONCLUSION

Filed pea is a non-conventional pulse source whose potential still untapped. Nutritional properties of field pea cultivars and chickpea cultivars were compared and we can conclude that HC-1 of chickpea and Jayanti of field pea was nutritionally superior varieties than C-235 of chickpea and Uttara of field pea.

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