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Assessment of Nutritional Quality of Developed Faba Bean (*Vicia faba* L.) Lines

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ABSTRACT

Five promising lines of faba bean, which includes two line i.e. 2011215 and 2011410 for grain purpose with yield potential of >5.0t/ha and three promising lines viz., VFBP201302, VFBP201304 and VFBP201306 were identified for vegetable purposes with green pod yield potential of 21.51 to 23.54 t/ha, suitable for Eastern Parts of India.These developed lines were evaluated along with national check varieties viz., Vikrant and Pusa Sumeet for its nutritional and antinutritional quality.Developed lines containmore dietary fiber, total soluble sugar, total starch, phosphorus, iron manganese and zinc. Less phytate was found in the developed lines as compare to checks varieties. Maximum (1.56%) fat was reported in VFBP 201304 (IC No IC No. 0595988), Maximum dietary fiber (13.49%) was obtained in the 2011410 line (IC No.0595986), however, minimum dietary fiber was found in check variety Vikrant (11.94). Similarly, minimum (0.10%) phytate was noticedin the line 2011215(IC No. 0595985).

Keywords : Faba bean,nutritional quality,phytochemicals

INTRODUCTION

Faba bean is an annual legume botanically known as *Vicia faba* L is one of the oldest crops grown by man and is used as a source of protein in human diet, as fodder and forage crop for animals, and for available nitrogen in the biosphere(Singh and Bhatt, 2012b). Wide cultivation and spread of faba bean (*Vicia faba* L.) in temperate and subtropical region has ranked it the fourth most important legume crop in the world next to dry beans, dry peas and chickpea (Singh and Bhatt , 2013).Faba bean is widely used in the Mediterranean region as source of protein in both human and animal nutrition (Larralde, 1982). It is popularly called as "Bakla" in Hindi heartland. They were introduced to India by Arab traders. The name is derived from Arabic name "Baquila". In slang they are also called "Kala Mattar" In some Ayurvedic terms; it is also called "Anturi". Its critical role in crop rotation, reducing energy cost, improving soil physical conditions and decreasing the amount of diseases and weed populations has long been recognized (Singh*et al.*,2010).In spite of its potential, the total area of faba bean cultivation has steadily decreased in many countries over the last century (Singh*et al.*, 2013b and Singh and Bhatt, 2012a).Faba bean, like other beans, are a good source of calories, protein, carbohydrates, and fibre they are also rich in phosphorus, iron, potassium, and vitamin B complex (Clarke, 1970; Eden, 1968). However, Phytochemicals present in the diet, include phenolic acids, flavonoids, alkaloids, carotenoids, minerals and vitamins. These non-nutrient metabolites, when compared to pharmaceuticals, have a low potency, but being a part of the regular diet in considerable amounts, they render evident long-term health profiting effects (Singh*et al.*, 2013a). The bioactivity of these compounds has been seen to be correlated to their antioxidant properties.Studies depict that antioxidant components have the potential to lower the risk of several diseases (Kahkonen*et al.*, 1999). The occurrence of some antinutritional factors such as phytohemagglutinins, protease inhibitors, polyphenols, saponins, phytates, etc., has hampered a wider nutritional utilization of this legume (Singh*et al.*, 2013a). However, the ratio of calcium to phosphorus is low, so the calcium may not be well utilized unless other foods rich in calcium and somewhat lower in phosphorus (such as dairy products and green leafy vegetables) are consumed in addition to the beans. Young faba bean can be eaten raw and fresh. The young pods are green, thick, fleshy and leathery in texture, which can also be eaten. Raw broad beans contain a chemical that induces *hemolyticanemia* in people with hereditary G6PD deficiency. This condition is called favism(Liener, 1980; Gupta, 1987and Singh*et al.*, 2012b).

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MATERIALS AND METHODS

Faba bean Samples

Five (05) newly developed faba bean lines have been taken as sample to analysis biochemically to know the presence of some important parameters.Single plant selection (SPS) is the one of the best way to identify and purify the desirable traits. All lines were screened and purified adopting the same technique. These lines are found suitable for Eastern Parts of India as compare to National check *i.e.*"Vikrant" and"Pusa Sumeet". The major characteristic features of these lines are given in table 1. (Singh*et al.*, 2012bandSingh*et al.*, 2012c)All the developed faba bean line has been deposited to National Gene Bank, National Bureau of Plant Genetic Resources (NBPGR) New Delhi and an IC Numbers has been allocated for these developed lines as mentioned in table 1. Further one set of above mentioned seeds samples of faba bean were supplied to National Bureau of Plant Genetic Resources (NBPGR) New Delhi for its biochemical analysis. Accordingly faba bean seeds samples were analysed following protocol as mentioned bellow

Table1 : Important characteristic of developed faba bean lines

Traits	Promising lines					National Check	
	2011215	2011410	VFBP 201302	VFBP 201304	VFBP 201306	Vikrant	# Pusa Sumit
	IC No. 0595985	IC No. 0595986	IC No. 0595987	IC No. 0595988	IC No. 0595989		
Plant height (cm)	80	90	84.5	74.5	77.9	95.6	72.3
Days to maturity	112	122	94.5	87.5	95.5		98.5
Yield potential (t/h)	4.6	5.75	3.69	3.57	3.61	2.36	29.7
HI	0.61	0.63	0.56	0.58	0.54	0.49	
1000 grain wt. (g)	235.6	228.9	438.54	391.05	413.65	-	-
Green pod yield (t/ha)	-	-	23.54	21.51	22.64		18.92
First pod picking (DAS)	-	-	63.5	65.5	66.5	69.5	
1st podding height (cm)	5	7.5	7.2	7.7	8.9		
Recommended for	Irrigated as well as rainfed condition	Irrigated condition	Irrigated condition	Irrigated condition	Irrigated condition	Irrigated condition	Irrigated condition

National Check *Vikrant (grain type) & # Pusa Sumeet (vegetable type)
Source: Singh & Bhatt, 2013 and Singh *et al.*, 2012.

Sample Preparation

The faba bean seeds were first grounded into powdered flour and stored in a closed container at room temperature for research purposes. 50 g of the *faba* bean flour was then mixed with 200 ml of methanol. The mixture was incubated for 24h and then filtered. The solvent was evaporated under vacuum and resulting extracts were stored at 4°C.

Biochemical analysis

Moisture content

The samples were dried at 65°C in a hot-air oven for 72 h until constant dry weight (DW) was achieved. Moisture content was determined as 100 x [(FW-DW) / FW)] and expressed in per cent Piper (1950).

Ash determination

For the determination of ash content, 5g of dried ground sample taken in silica crucible and initially charred at 250° C for 1 h and then temperature was raised gradually to 550° C and maintained for 4 hr. Ash content was expressed as g per 100 fresh weights.

Estimation of crude fat

10 g of dried and homogenized sample was extracted with petroleum ether 40-60°C AR grade as solvent as per AOAC official method 920.39. Samples were extracted for 24 hours and dried overnight before and after extraction.

Estimation of total protein

Total protein was estimated as per AOAC official method 976.05 with some modifications in digestion of samples. One hundred mg of dried and homogenized sample was digested with sulphuric acid – selenium– anhydrous sodium sulphate – hydrogen peroxide digestion mixture in glass digestion tubes at 350°C for 45 min as per the

method of Piper (1950), Nitrogen percentage in digest was estimated by Kjeltech (FOSS tecator) nitrogen autoanalyser.

Estimation of total dietary fibre

Total dietary fiber was estimated by enzymatic-gravimetric method as per AOAC Official Method 985.29. Total dietary fiber assay kit (K-TDFR) and total dietary fiber control kit (K-TDFC) was obtained from Megazyme, Ireland were used in analysis.

Total carbohydrates

Total carbohydrates were calculated using formulae : Available carbohydrates (% fresh weight) = 100 - moisture (%) - protein content (% fresh weight) - crude fat (% fresh weight) - ash (% fresh weight) and reported as total carbohydrates in %.

Extraction of soluble sugars and phenols

100 mg sample was extracted with 5.0 ml of 80% ethanol in ultrasonic bath at 70^0C for 60 min. Contents were centrifuged at 5000 g for 20 min and supernatants were collected. Residue was re-extracted in 5 ml of 80% ethanol thrice, supernatants were pooled and volume was made up to 25 ml. This supernatant was stored in -20^0C in the dark until analysis. Residue left from centrifugation after extraction used for starch estimation.

Estimation of total soluble sugars

Total soluble sugar in 80% ethanolic extract of the sample was estimated using anthrone reagent and glucose as standard (Roe, 1955). One hundred µl of extract was evaporated to dryness in test tubes on water bath. Residue was dissolved in 1.0 ml of water and 4.0 ml of anthrone reagent was added. Absorbance was read at 660 nm and corrected against sample blank. Total soluble sugars include sucrose, hexose, pentose and their phosphate derivatives as well as soluble oligosaccharides.

Estimation of starch

Residue from sugar and phenol extraction was used for starch estimation as per AOAC Method 996.11 by enzymatic hydrolysis using Megazyme Total Starch Assay kit K-TSTA. It employs heat stable a-amylase and amyloglucosidase and estimatereleased glucose by glucose oxidase – peroxidase system.

Estimation of total Flavonoids

Total Flavonoids content was determined using Aluminium chloride colorimetric method (Jia*et al.,* 1999). The optical density for the standard (Catechin), and sample extract was measured at 765 nm against DMSO blank, the total flavonoid content was expressed in µg of Catechin equivalents per mg of weight of extracts.

Estimation of phenols

Total Phenolics content of the dried *faba* seeds was estimated by Folin-Ciocalteu reagent method as described by Slinkard and Singleton (1977). The absorbance of the standard (gallic acid) and the extract of *Vicia faba* seedswas measured spectrophotometrically at 765 nm against DMSO blank. The results were expressed as gallic acid equivalents (GAE, µg/mg of weight of extract).

RESULTS AND DISCUSSION

All developed faba bean (five) lines along with check Vikranta has been evaluated biochemically to assess the nutritionalas well as anti-nutritionalquality.

Moisture content

Moisture content was determined and expressed in per cent. Perusal of data presented in table 2, revealed that maximum moisture content (14.00%) was recorded in case of faba bean line 2011410 bearing IC No. 0595986, corresponding lowest value (9.34%) was noticed in case of National check *i.e.* Vikrant. It was worth to mention here that all the newly developed line has retained more moisture as compared to both the National check *i.e.*Vikrant and Pusa Sumeet. Variation in this trait may be due to its genetic makeup and geographical adoption to Eastern part of India as both of National check was developed at New Delhi and Haryana *i.e.* North Western part of India, a bit drier part as compare to Easter Part of India (Gupta, 1987 and Singh and Bhatt, 2012a).

Ash content

Data presented in table 2, revealed that maximum ash content (3.97%) was recorded in case of faba bean variety Vikran a National check corresponding lowest value (2.37%) was noticed in case line 2011410 bearing IC No. 0595986. Vegetable type line contains more ash as compare to grain type faba bean seeds. Most of developed line contains lower ash as compare to National Check (Table 2). This might be due to more moisture retaining capacity in developed lines as compared to the National check *i.e.* Vikrant and Pusa Sumeet. Variation in this trait may be due to its genetic makeup and geographical adoption to Eastern part of India as both of National check was developed at New Delhi and Haryana *i.e.* North Western part of India , a bit drier part as compare to Easter Part of India. There is some indication

of inverse type relationship between moisture contains and ash content(Liener, 1980).

Fat content

Faba bean contains least fat and is good for the health point of view. Seed were also analysed for fat estimation purposes. Results summarized in table 2 clearly indicate that no seed samples contains fat > 1.7%. Maximum (1.56%) fat was reported in the seed samples of VFBP 201304 (IC No IC No. 0595988), corresponding lowest (1.23%) was noticed in line 2011215(IC No. 0595985). Faba bean seed in general contains less fat as compare to some of leguminous seeds (Singh and Bhatt, 2012a).

Protein content

Faba bean contains high quality protein. The crude protein content of the seeds varies widely depending on many factors, for example variety, fertilizer application, and location of growth. The seed coat may contain less protein and more carbohydrate in comparison to cotyledons and whole seeds. Perusal of data presented in table 2 revealed that among developed lines maximum seep protein (31.31%) seep protein was obtained by the vegetable type line VFBP 201304(IC No. 0595988), similarly minimum seep protein (30.09%) was obtained by the grain type line 2011215(IC No. 0595985). Among the tested check Vikrant produced maximum seep protein (30.51).

Dietary Fiber

Faba bean is avery good source of dietary fiber and its lowers the blood cholesterol levels (Singh and Bhatt 2012a). Contrary to the popular notion, beans have more fiber than most fruits and vegetables. It is a good source of both soluble and insoluble dietary fiber. Results presented in table 2 confirm that grain type faba bean line contains more dietary fiber as compare to Vikrant and Pusa Sumeet. Maximum dietary fiber (13.49%) was obtained in the 2011410 line (IC No.0595986). Corresponding minimum dietary fiber was found in check variety Vikrant (11.94).

Phytate

Phytate or phytic acid has been held responsible for the commonly observed interference by plant sources of protein on the availability of dietary minerals. The nutritional importance of physic acid lies in its ability to chelate several mineral elements, especially calcium, magnesium, zinc, copper, and iron, and if thereby reduces the availability of these elements in the intestinal tract. Perusal of data presented in table 2 revealed that this anti-nutritional trait is reported minimum (0.10%) in the developed line 2011215(IC No. 0595985). However in the National check varieties, it was recorded maximum (0.64% and 0.51) in the Vikrant and Pusa Sumeet respectively.

Total carbohydrate, Total soluble sugar and Total soluble sugar

Phytochemical analysis was also done with respect to total carbohydrate (%), total soluble sugar (%), total soluble sugar (%) and total starch (%). Maximum total carbohydrate (53.58%) was recorded in Vikrant, corresponding lowest value (41.55%) was noticed in line 2011215 (IC No. 0595985). Similarly in case of total soluble sugar (%) Maximum and minimum (10.90% and 9.53) was recorded in line 2011215 (IC No. 0595985) and National check Vikrant. Likewise in case of total starch (%), All the developed lines contains more than 40% with highest value of 44.16% in developed line 2011410 (IC No. 0595986). It is worth to mention that all the National check

Table 2 : Nutritional quality of developed faba bean lines

Parameters	Promising lines					National Check	
	2011215	2011410 201302	VFBP 201304	VFBP 201306	VFBP	Vikrant Sumit	# Pusa
	IC No. 0595985	IC No. 0595986	IC No. 0595987	IC No. 0595988	IC No. 0595989		
Moisture (%)	13.52	14.00	11.43	11.67	12.47	9.34	10.38
Ash (%)	2.45	2.37	3.21	3.37	3.13	3.97	3.14
Fat (%)	1.23	1.54	1.41	1.56	1.32	1.58	1.49
Protein (%)	30.09	31.12	30.79	31.31	30.44	30.51	29.15
Dietary Fiber (%)	12.57	13.49	12.25	12.71	12.41	11.94	12.10
Phytate (%)	0.10	0.07	0.37	0.36	0.24	0.64	0.51
Total carbohydrate (%)	41.55	49.72	47.56	51.65	44.56	53.58	50.57
Total soluble sugar (%)	10.90	10.34	10.21	9.93	10.56	9.53	9.87
Total starch (%)	43.96	44.16	40.10	40.20	42.03	36.25	38.18

recorded less than 40% total starch. Vikrant contains only 36.25% total starch.

Mineral composition

To know the nutritive value of the developed faba bean lines seed samples were also analysed for its mineral constituents.

Phosphorus (P)

Data presented in table 3 revealed that maximum (0.154%) phosphorus was recorded in case of developed line 2011410 (IC No. 0595986) corresponding minimum (0.038%) was noticed in case of faba bean line 2011215 (IC No. 0595985).Vegetable type line VFBP201306 (IC No. 0595988) recorded (0.1%). Further, other tested line/varieties were in the range of 0.040 to 0.046% with respect to phosphorus content.

production of energy and enhancing the activity of antioxidant enzymes. Data presented in table 3 revealed that maximum (12.32) manganese content was recorded in case of developed line 2011215 (IC No. 0595985) however corresponding minimum (11.40) was noticed in case of developed line 2011410 (IC No. 0595986). Vegetable type line VFBP201306 (IC No. 0595989) recorded (12.10).

Copper (Cu)

Like other minerals faba bean is one of the good sources of copper. It reduces the risk of inflammatory diseases like rheumatoid arthritis, and enhances the activity of enzymes that are needed to maintain the elasticity of blood vessels, ligaments and joints. Results revealed that there was not much difference in the copper among the tested faba bean developed lines as well as

Table 3 : Mineral composition of developed faba bean lines

Parameters	Promising lines					National Check	
	2011215	2011410	VFBP 201302	VFBP 201304	VFBP 201306	Vikrant	# Pusa Sumit
	IC No.	IC No. 0595985	IC No. 0595986	IC No. 0595987	IC No. 0595988	0595989	
Phosphorus (P) (%)	0.038	0.154	0.042	0.100	0.040	0.046	0.044
Potassium (K) (%)	0.028	0.024	0.028	0.027	0.028	0.028	0.028
Iron (Fe) (mg/kg)	2445.0	2420.0	2134.6	2225.1	1839.8	2124.1	2029.3
Manganese (Mn) (mg/kg)	12.32	11.40	11.88	11.42	12.10	11.45	11.67
Copper (Cu) (mg/kg)	15.00	15.10	15.04	15.09	15.02	15.08	15.06
Zinc (Zn)(mg/kg)	55.45	50.20	53.56	50.93	54.50	51.67	52.61

Potassium (K)

Perusal of data presented in table 3 reveal that that minimum (0.024%) potassium was recorded in case of developed line 2011410 (IC No. 0595986). Interestingly, all other tested other tested line/varieties were contains similar potassium (0.028%).

Iron (Fe)

Iron helps in respiration at the cellular level by synthesizing haemoglobin that helps to carry oxygen to cells. Results obtained for the iron contents in the seed samples were depicted in table 3. Maximum (2445.0) iron content was recorded in case of developed line 2011215 (IC No. 0595985) corresponding minimum (1839.8) was noticed in case of vegetable type faba bean line VFBP201306 (IC No. 0595989).

Manganese (Mn)

Faba bean is one of the good sources of manganese. It functions as a cofactor in various metabolic reactions involved in the efficient

national check varieties under the test. Copper contents varied from 15.00 to 15.10.

Zinc (Zn)

Faba bean is the good sources of zinc Data presented in table 3 revealed that maximum (55.45) zinc content was recorded in case of developed line 2011215 (IC No. 0595985) however corresponding minimum (50.20) was noticed in case of developed line 2011410 (IC No. 0595986). Vegetable type line VFBP201306 (IC No. 0595989) recorded (54.50).

CONCLUSION

All developed faba bean (five) lines along with two national checks*i.e.* Vikrant and Pusa Sumeethave been evaluated for its nutritionalas well as anti-nutritional quality. Maximum moisture content (14.00%) was recorded in case of faba bean line 2011410 bearing IC No. 0595986, corresponding lowest value (9.34%) was noticed in case of National check *i.e.* Vikrant. Maximum ash content (3.97%) was recorded in case of faba bean variety

Vikrant with lowest value (2.37%) in case line 2011410 bearing IC No. 0595986. However maximum (1.56%) fat was reported in the seed samples of VFBP 201304 (IC No IC No. 0595988), among developed lines maximum seep protein (31.31%) seep protein was obtained by the vegetable type line VFBP 201304 (IC No. 0595988.Maximum dietary fiber (13.49%) was obtained in the 2011410 line (IC No.0595986), minimum dietary fiber was found in check variety Vikrant (11.94). Similarly, minimum (0.10%) phytate in the developed line 2011215(IC No. 0595985) was noticed. Maximum total carbohydrate (53.58%) was recorded in Vikrant, corresponding lowest value (41.55%) was noticed in line 2011215 (IC No. 0595985). In case phosphorus content in seeds, maximum (0.154%) was recorded in case of developed line 2011410 (IC No. 0595986) corresponding minimum (0.038%) was noticed in case of faba bean line 2011215 (IC No. 0595985). Likewise, maximum (2445.0 mg/kg) iron content was recorded in case of developed line 2011215 (IC No. 0595985) corresponding minimum (1839.8 mg/kg) was noticed in case of vegetable type faba bean line VFBP201306 (IC No. 0595989). Maximum (12.32 mg/kg) manganese content was recorded in case of developed line 2011215 (IC No. 0595985). In case of zinc content maximum (55.45 mg/kg) was recorded in case of developed line 2011215 (IC No. 0595985).It was concluded that developed lines contains more dietary fiber, total soluble sugar, total starch, phosphorus, iron manganese and zinc. Similarly less phytate was also reported in the developed line as compare to national checks varieties *i.e.* Vikrant and Pusa Sumeet.

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