

## Original Research Article

### Comparative Assessment of Nutritional Attributes in Selected Vegetable Legume Crops

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#### ABSTRACT

#### Keywords

Vegetable soybean, nutritional composition, protein and starch analysis

The present investigation based on nutritionally rich crops aimed at comparing green and mature stages of vegetable legumes. Evaluation of selected vegetable type legumes for macro and micro nutritional quality traits viz. calcium, iron, zinc, copper, manganese, starch and protein revealed that the green stage legumes had higher amount of minerals viz., iron, zinc, copper and manganese while grain stage legumes had higher amount of protein, starch and calcium. Vegetable soybean was an exception as calcium was higher in green stage and iron content was higher in grain stage in this crop.

#### Introduction

Legumes constitute about 5% of the cultivated crops for human consumption. Most of the populations in India are vegetarians, leguminous vegetables serve as the major source of protein in the diet. In developing third world countries, especially for the poor, the major protein source in the diet are vegetable legumes. Most leguminous vegetables are rich in phosphorus, calcium, iron, and a number of essential vitamins. Crops like soybean and

groundnut are also rich in fats which are needed by the body to absorb vitamin A. (Shanmugasundaram, 1988). In international trade leguminous vegetables play an important role. Dry seeds, canned and frozen foods, and processed food products from leguminous vegetables enter the international market where they are important commodities for foreign exchange (Shanmugasundaram, 1988). Year 2016 has been declared as 'International Year of

Pulses' by the Food and Agricultural Organisation (FAO) of United Nations with the slogan Nutritious seeds for a sustainable future (IYP, 2016). Such is the role played by the legumes in satisfying the 'hidden hunger' or malnutrition of the growing population.

Legumes, being the richest source of plant based proteins (Tharanathan and Mahadevamma, 2003), plays a key role in the Indian diet as India is home to the highest vegetarian population in the world. (Anonymous, 2015). They are also important sources of minerals including calcium, iron, zinc and provitamin A (Keatinge, 2011)

### **Materials and Methods**

The present investigation was conducted at the field of Department of Agricultural Botany, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra state during *Kharif* and *Rabi* seasons of 2015-2016. The Genotypes used in present study are enlisted in (Table 1).

The observations on various characters were recorded on five competitive randomly selected plants in each genotype and in each replication as described above and were averaged to represent the treatment means of the replication. Observation based on nutritional traits like (with units in brackets) Calcium-Ca (mg/100 g), Iron-Fe (mg/100 g), Zinc-Zn (mg/100 g), Copper-Cu (mg/100 g), Manganese-Mn (mg/100 g), Carbohydrate-Starch (g/100 g) and Protein (g/100 g) content.

### **Results and Discussion**

The present study aimed at assessing the nutritional composition of selected legumes at green and mature stages. Seven nutrient

traits were analyzed in both green and mature stages. The results of nutritional composition are mentioned crop-wise to analyze the status of each crop. They are presented in the (Tables 2 to Table 7).

The results of nutritional composition are presented and discussed nutrient-wise in the following paragraphs in the sequence mentioned in the outline of research work

### **Calcium (Ca)**

In the present study, the Calcium content present in the green and mature stages of selected legume seeds was analyzed through EDTA Titration method. The calcium content is discussed crop-wise including both green and mature stages in the following paragraphs. Among the soybean genotypes, calcium content ranged between 79.2 mg/100 g to 197.2 mg/100 g. The highest calcium content was recorded in the green stage of AGS-459 (197.2 mg/100 g) and lowest amount of calcium was found in mature stage of JS-335(79.2 mg/100g). The mean values were 180.24 mg/100 g in the green stage and 84.72 mg/100 g in the mature stage. Similar results were reported by Keatinge *et al.*, (2011) and Garg *et al.*, (2014).

In the mungbean genotypes, calcium content ranged between 107.4 mg/100 g to 134.8 mg/100 g. The highest calcium amount was observed in mature stage of Utkarsha (134.8 mg/100 g) and lowest calcium content was found in green stage of Kopergaon (107.4 mg/100 g). The mean values were 114.04 mg/100 g in the green stage and 124.78 mg/100 g in the mature stage. Similar observations were reported by Anwar *et al.*, (2007).

Calcium content ranged between 65.5 mg/100 g to 98.3 mg/100 g in the cowpea

genotypes. The highest calcium amount was observed in mature stage of AKCP-6 (98.3 mg/100 g) and lowest calcium content was found in green stage of Kokan Sadabahar (65.5 mg/100 g). The mean values were 69.96 mg/100 g in the green stage and 88.98 mg/100 g in the mature stage. Similar results were reported by Carvalho *et al.*, (2012).

Among the pigeonpea genotypes, calcium content ranged between 89.4 mg/100 g to 117.3 mg/100 g. The highest calcium amount was observed in mature stage of BDN 2001-09 (117.3 mg/100 g) and lowest calcium content was found in green stage of ICP-7035 (89.4 mg/100 g). The mean values were 91.78 mg/100 g in the green stage and 112.92 mg/100 g in the mature stage. Similar reports were given by Saxena *et al.*, (2010) and Patil *et al.*, (2015).

Among the chickpea genotypes, calcium content ranged between 99.5 mg/100 g to 127.9 mg/100 g. The highest calcium amount was observed in mature stage of PKV Kabuli-2 (127.9 mg/100 g) and lowest calcium content was found in green stage of JAKI-9218 (99.5 mg/100 g). The mean values were 108.26 mg/100 g in the green stage and 115.38 mg/100 g in the mature stage. Similar results were reported by Nobile *et al.*, (2013), Garg *et al.*, (2014) and Mohammadi *et al.*, (2015).

Within the field pea genotypes, calcium content ranged between 80.4 mg/100 g to 94.2 mg/100 g. The lowest calcium amount was observed in mature stage of HFP-4 (80.4 mg/100 g) and highest calcium content was found in green stage of DDR-55 (94.2mg/100 g). The mean values were 86.14 mg/100 g in the green stage and 90.3 mg/100 g in the mature stage. Similar observations were reported by (Harmankaya *et al.*, 2010).The graphical representation of the above discussed calcium content of

selected legume crops can be seen in (Figure 1).

### **Iron (Fe)**

The graphical representation of iron content of selected legume crops can be seen in (Figure 2). In the present study, the iron content present in the green and mature stages of selected legume seeds were analyzed through Atomic Absorption Spectroscopy. In the soybean genotypes, iron content ranged between 9.03 mg/100 g to 13.49 mg/100 g. The highest iron content was observed in mature stage of AGS 459 (13.49 mg/100 g) and the lowest iron content was found in green stage of JS 335 (9.03 mg/100 g). The mean values were 9.51 mg/100 g in the green stage and 12.33 mg/100 g in the mature stage. Similar results were reported by Garg *et al.*, (2014).

In the mungbean genotypes, iron content ranged between 6.15 mg/100 g to 9.17 mg/100 g. The highest iron content was observed in green stage of Kopergaon (9.17 mg/100 g) and the lowest iron content was found in mature stage of Utkarsha (6.15 mg/100 g). The mean values were 8.44 mg/100 g in the green stage and 7.64 mg/100 g in the mature stage. Similar results were reported by Anwar *et al.*, (2007).

In the cowpea genotypes, iron content ranged between 6.12 mg/100 g to 9.78 mg/100 g. The highest iron content was observed in green stage of Arka Samrudhi (9.78 mg/100 g) and the lowest iron content was found in mature stage of AKCP-6(6.12mg/100 g). The mean values were 7.79 mg/100 g in the green stage and 6.62 mg/100 g in the mature stage. Similar results were reported by Garg *et al.*, (2014).

In the pigeonpea genotypes, iron content ranged between 4.36 mg/100 g to 5.52

mg/100 g. The highest iron content was observed in green stage of BDN 2001-09 (5.52 mg/100 g) and the lowest iron content was found in mature stage of ICP-7035 (4.36 mg/100 g). The mean values were 5.34 mg/100 g in the green stage and 4.55 mg/100 g in the mature stage. Similar results were reported by Saxena *et al.*, (2010).

In the chickpea genotypes, iron content ranged between 5.22 mg/100 g to 9.12 mg/100 g. The highest iron content was observed in green stage of PKV Kabuli-2 (9.12 mg/100 g) and the lowest iron content was found in mature stage of JAKI-9218 (5.22 mg/100 g). The mean values were 7.81 mg/100 g in the green stage and 5.9 mg/100 g in the mature stage. Similar results were reported by Nobile *et al.*, (2013).

In the field pea genotypes, iron content ranged between 2.11 mg/100 g to 3.93 mg/100 g. The highest iron content was observed in green stage of HFP-4 (3.93 mg/100 g) and the lowest iron content was found in mature stage of Rachana (2.11 mg/100 g). The mean values were 3.54 mg/100 g in the green stage and 3.14 mg/100 g in the mature stage. Similar results were reported by Harmankaya *et al.*, (2010).

## **Zinc**

In the present study, soybean genotypes contained zinc in the range of 3.79 mg/100 g to 4.83 mg/100 g. The highest zinc content was observed in green stage of JS-335 (4.83 mg/100 g) and the lowest zinc content was found in mature stage of AGS-457 (3.79 mg/100 g). The mean values were 4.55 mg/100 g in the green stage and 4.05 mg/100 g in the mature stage. Similar results were reported by Garg *et al.*, (2014).

Among the mungbean genotypes, zinc content ranged between 1.37 mg/100 g to

2.39 mg/100 g. The highest zinc content was observed in green stage of Kopergaon (2.39 mg/100 g) and the lowest zinc content was found in mature stage of BM 2003-2 (1.37 mg/100 g). The mean values were 1.98 mg/100 g in the green stage and 1.69 mg/100 g in the mature stage. Similar results were reported by Anwar *et al.*, (2007).

Within the cowpea genotypes, zinc content ranged between 2.51 mg/100 g to 4.93 mg/100 g. The highest zinc content was observed in green stage of Arka Samrudhi (4.93 mg/100 g) and the lowest zinc content was found in mature stage of Kokan Sadabahar (2.51 mg/100 g). The mean values were 3.86 mg/100 g in the green stage and 3.09 mg/100 g in the mature stage. Similar results were reported by Carvalho *et al.*, (2012).

Pigeonpea genotypes had zinc content between 2.85 mg/100 g to 4.58 mg/100 g. The highest zinc content was observed in green stage of AKTM 11-12 (4.58 mg/100 g) and the lowest zinc content was found in mature stage of ICP-7035 (2.85 mg/100 g). The mean values were 3.91 mg/100 g in the green stage and 3.35 mg/100 g in the mature stage. Similar results were reported by Saxena *et al.*, (2010) and Patil *et al.*, (2015).

Among the chickpea genotypes, zinc content ranged between 2.98 mg/100 g to 4.26 mg/100 g. The highest zinc content was observed in green stage of AKG-1109 (4.26 mg/100 g) and the lowest zinc content was found in mature stage of PKV Kabuli-2 (2.98 mg/100 g). The mean values were 3.69 mg/100 g in the green stage and 3.31 mg/100 g in the mature stage. Similar results were reported by Nobile *et al.*, (2013).

In the field pea genotypes, zinc content ranged between 2.04 mg/100 g to 3.61 mg/100 g. The highest zinc content was

observed in green stage of HFP-4(3.61 mg/100 g) and the lowest zinc content was found in mature stage of DDR-55 (2.04 mg/100 g). The graphical representation of iron content of selected legume crops can be seen in (Figure 3). The mean values were 3.19 mg/100 g in the green stage and 2.69 mg/100 g in the mature stage. Similar results were reported by Harmankaya *et al.*, (2010).

### **Copper**

The graphical representation of copper content of selected legume crops can be seen in (Figure 4). The results of soybean genotypes showed that copper content ranged between 1.33 mg/100 g to 1.79 mg/100 g. The highest copper content was observed in green stage of Swarna vasundhara (1.79 mg/100 g) and the lowest copper content was found in mature stage of AGS-459 (1.33 mg/100 g). The mean values were 1.69 mg/100 g in the green stage and 1.42 mg/100 g in the mature stage. Similar observations were reported by Garg *et al.*, (2014).

Mungbean genotypes had copper content ranged in the range of 0.95 mg/100 g to 1.52 mg/100 g. The highest copper content was observed in green stage of PKV Greengold (1.52 mg/100 g) and the lowest copper content was found in mature stage of Kopergaon (0.95 mg/100 g). The mean values were 1.35 mg/100 g in the green stage and 1.25 mg/100 g in the mature stage. Similar results were reported by Anwar *et al.*, (2010).

Within the cowpea genotypes, copper content ranged between 1.15 mg/100 g to 1.93 mg/100 g. The highest copper content was observed in green stage of AKCP-6 (1.93 mg/100 g) and the lowest copper content was found in mature stage of Kokan Sadabahar (1.15 mg/100 g). The mean

values were 1.69 mg/100 g in the green stage and 1.45 mg/100 g in the mature stage. Similar observations were reported by Carvalho *et al.*, (2012).

Amongst pigeonpea genotypes, copper content ranged between 1.01 mg/100 g to 1.64 mg/100 g. The highest copper content was observed in green stage of AKTM 11-11 (1.64 mg/100 g) and the lowest copper content was found in mature stage of ICP-7035(1.01 mg/100 g). The mean values were 1.38 mg/100 g in the green stage and 1.18 mg/100 g in the mature stage. Similar results were reported by Patil *et al.*, (2015).

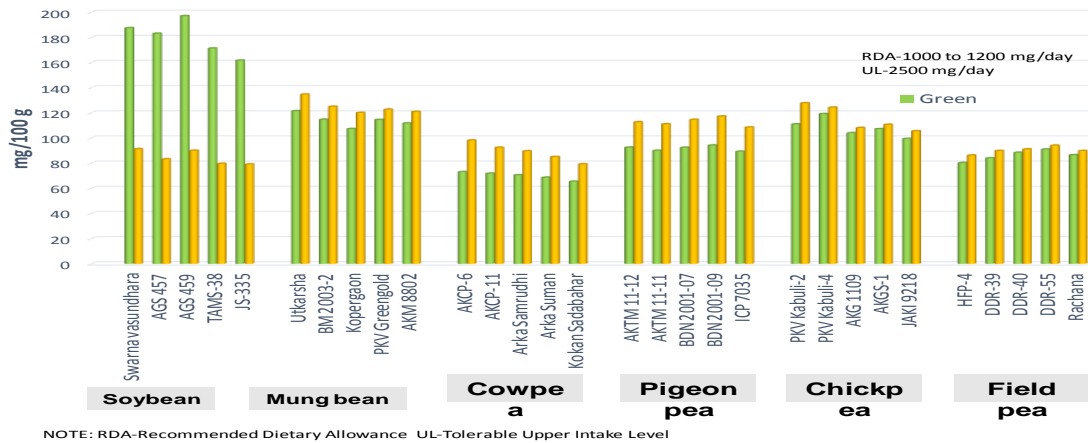
In the chickpea genotypes, copper content ranged between 0.92 mg/100 g to 1.37 mg/100 g. The highest copper content was observed in green stage of JAKI-9218 (1.37 mg/100 g) and the lowest copper content was found in mature stage of AKG-1109 (0.92mg/100 g). The mean values were 1.18 mg/100 g in the green stage and 1.05 mg/100 g in the mature stage. Similar results were reported by Mohammadi *et al.*, (2015).

Among the field pea genotypes, copper content ranged between 0.79 mg/100 g to 1.16 mg/100 g. The highest copper content was observed in green stage of DDR-55(1.16 mg/100 g) and the lowest copper content was found in mature stage of HFP-4 (0.79 mg/100 g). The mean values were 0.99 mg/100 g in the green stage and 0.9 mg/100 g in the mature stage. Similar results were reported by Harmankaya *et al.*, (2010).

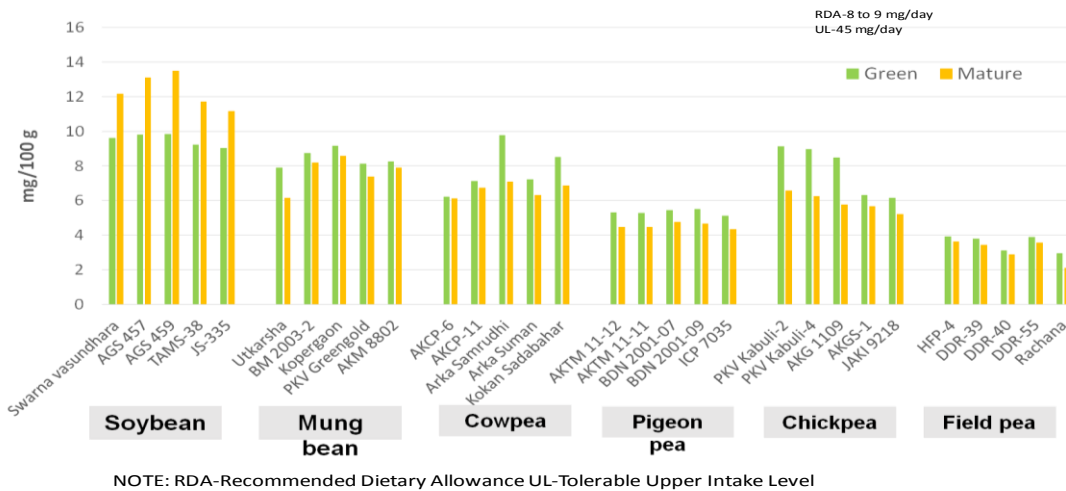
### **Manganese**

The graphical representation of manganese content of selected legume crops can be seen in (Figure 5). In the present study, Soybean genotypes showed manganese content ranging between between 2.14 mg/100 g to 3.12 mg/100 g.

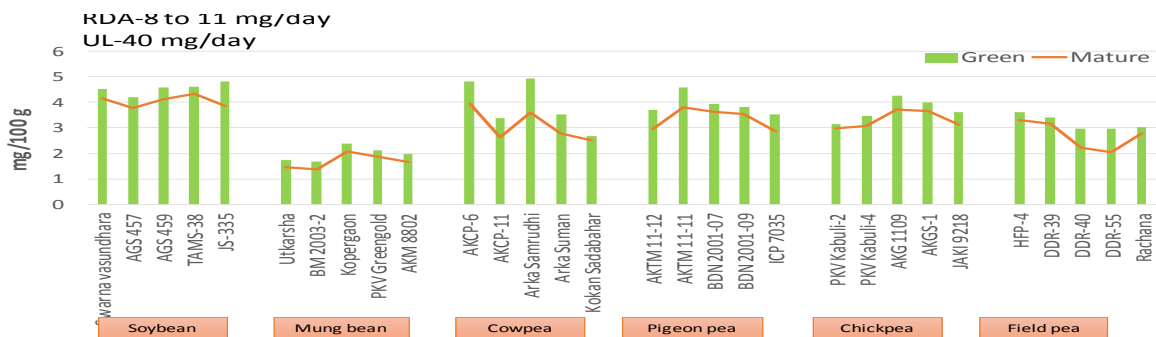
**Fig.1** Calcium content in green and mature stage of vegetable legumes



**Fig.2** Iron content in green and mature stage of vegetable legumes



**Fig.3** Zinc content of green and mature stage in vegetable legumes

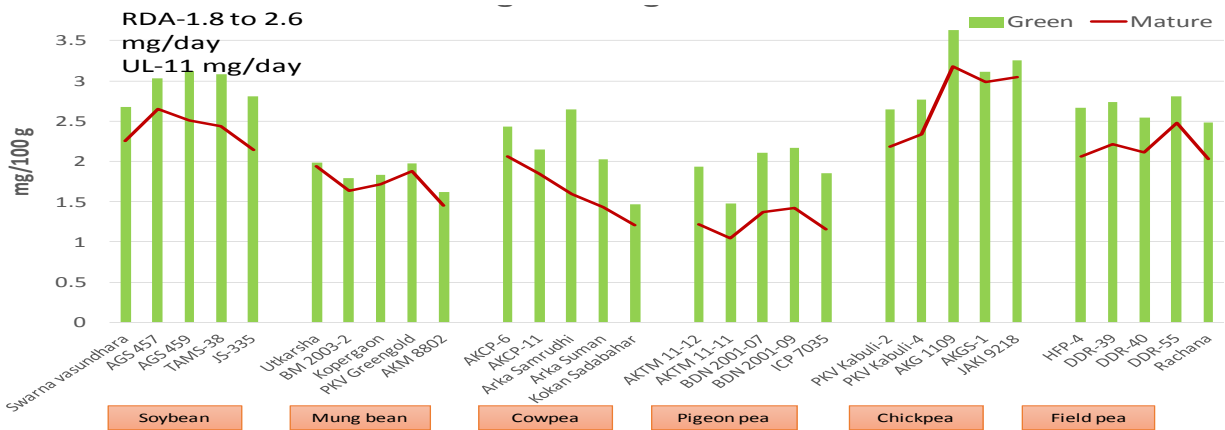


**Fig.4** Copper content in green and mature stages of vegetable legumes



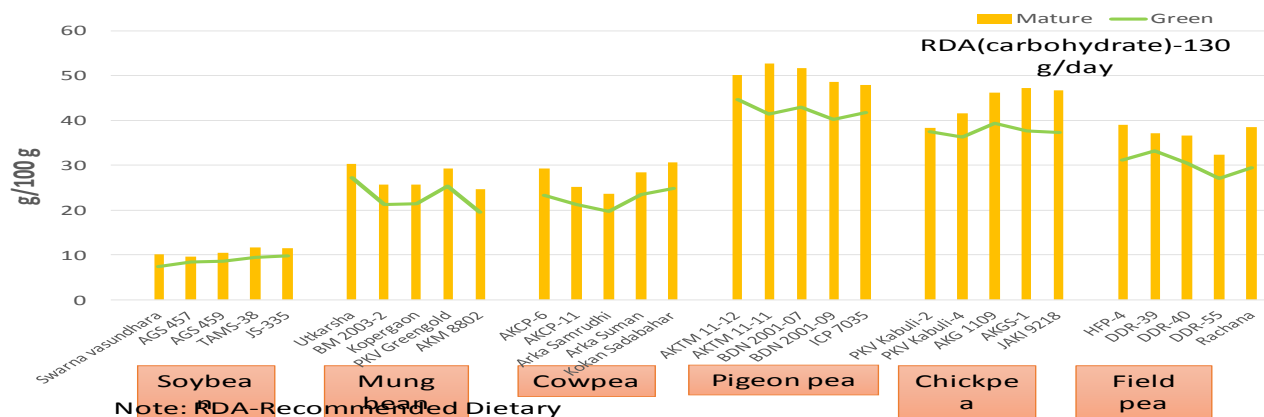
NOTE: RDA-Recommended Dietary Allowance UL-Tolerable Upper Intake Level

**Fig.5** Manganese content in green and mature stage of vegetable legumes



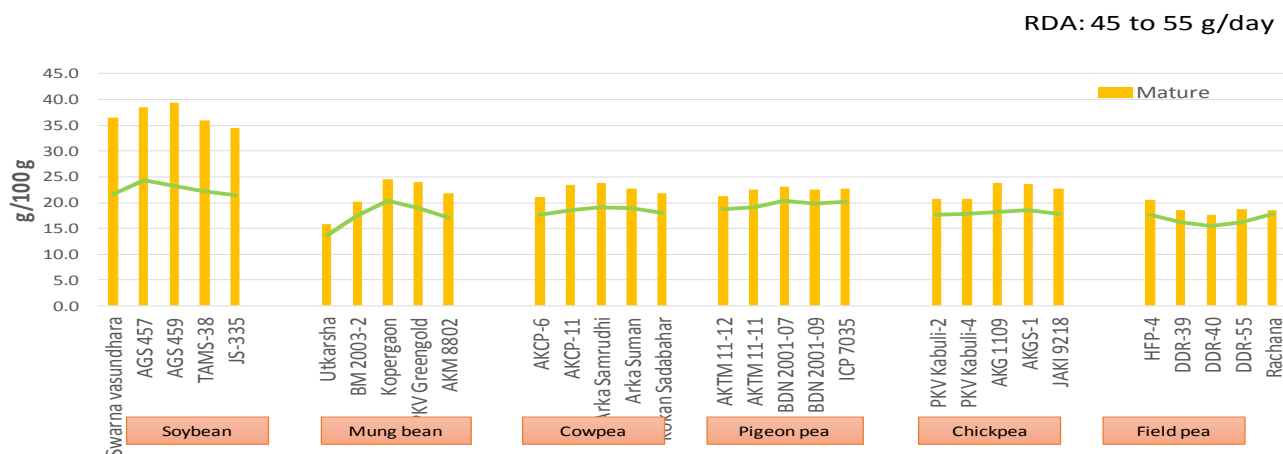
NOTE: RDA-Recommended Dietary Allowance UL-Tolerable Upper Intake Level

**Fig.6** Starch content of green and mature stage of legumes



Note: RDA-Recommended Dietary Allowance

**Fig.7** Protein content of green and mature stage of vegetable legumes



Note: RDA-Recommended Dietary Allowance

**Table.1** List of the genotypes of selected vegetable type legume crops and their sources

SN	Crop	Genotype	Source
I.	1 Soybean	Swarna Vasundhara	AVRDC, Hyderabad
		AGS 457	AVRDC, Hyderabad
		AGS 459	AVRDC, Hyderabad
		TAMS-38	RRC, Amravati
		JS-335	Dr. PDKV, Akola
I.	2 Green gram	Utkarsha	MAHABEEJ, Akola
		BM 2003-2	VNMKV, Parbhani
		Kopergaon	Dr. PDKV, Akola
		PKV Green Gold	Dr. PDKV, Akola
		AKM 8802	Dr. PDKV, Akola
I.	3 Cowpea	AKCP-6	Dr. PDKV, Akola
		AKCP-11	Dr. PDKV, Akola
		Arka Samrudhi	IIHR, Bengaluru
		Arka Suman	IIHR, Bengaluru
		Kokan Sadabahar	Dr. BSKKV, Dapoli
I.	4 Pigeonpea	AKTM 11-12	Dr. PDKV, Akola
		AKTM 11-11	Dr. PDKV, Akola
		BDN 2001-07	MAU, Parbhani
		BDN 2001-09	MAU, Parbhani
		ICP 7035	ICRISAT, Hyderabad
I.	5 Chickpea	PKV Kabuli-2	Dr. PDKV, Akola
		PKV Kabuli-4	Dr. PDKV, Akola
		AKG 1109	Dr. PDKV, Akola
		AKGS-1	Dr. PDKV, Akola
		JAKI 9218	Dr. PDKV, Akola
I.	6 Field pea	HFP-4	IARI, New Delhi
		DDR-39	IARI, New Delhi
		DDR-40	IARI, New Delhi
		DDR-55	IARI, New Delhi
		Rachana	CSAU, Kanpur
7	Rajma	GR-1	Gujarat
		R-13-4	IIPR, Kanpur
		R-13-5	IIPR, Kanpur
		R-13-17	IIPR, Kanpur
		VL-63	VPKAS, Almora



**Table.2** Nutritional Composition of Soybean Genotypes

S N	Genotype	Calcium (mg/100 g)		Iron (mg/100 g)		Zinc (mg/100 g)		Copper (mg/100 g)		Manganese (mg/100 g)		Carbohydrate(S tarch) (g/100 g)		Protein (g/100 g)	
		Green	Matur e	Gree n	Matur e	Green	Matu re	Gre en	Matu re	Gree n	Mat ure	Green	Mature	Gree n	Matur e
1	Swarna vasundhara	187.6	91.3	9.61	12.17	4.521	4.17	1.79	1.56	2.68	2.25	7.5	10.2	21.7	36.42
2	AGS 457	183.2	83.3	9.82	13.11	4.214	3.79	1.78	1.41	3.03	2.65	8.5	9.7	24.3	38.54
3	AGS 459	197.2	90.1	9.83	13.49	4.592	4.13	1.75	1.33	3.12	2.51	8.7	10.5	23.2	39.43
4	TAMS-38	171.4	79.7	9.24	11.72	4.623	4.33	1.59	1.37	3.08	2.44	9.5	11.7	22.1	35.91
5	JS-335	161.8	79.2	9.03	11.16	4.829	3.86	1.58	1.47	2.81	2.14	9.8	11.5	21.5 4	34.56
	Mean	180.24	84.72	9.506	12.33	4.5558	4.056	1.69 8	1.428	2.94 4	2.39 8	8.8	10.72	22.5 68	36.972
	Range	79.2-197.2		9.03-13.49		3.79-4.829		1.33-1.79		2.14-3.12		7.5-11.7		21.54-39.43	

**Table.3** Nutritional Composition of Mungbean Genotypes

		Calcium (mg/100 g)		Iron (mg/100 g)		Zinc (mg/100 g)		Copper (mg/100 g)		Manganese (mg/100 g)		Carbohydrate (Starch) (g/100 g)		Protein (g/100 g)	
Genotype		Green	Mature	Green	Mature	Green	Mature	Green	Mature	Green	Mature	Green	Mature	Green	Mature
1	Utkarsha	121.6	134.8	7.89	6.15	1.75	1.45	1.38	1.25	1.98	1.94	27.2	30.35	13.7	15.8
2	BM 2003-2	114.8	125.08	8.75	8.2	1.67	1.37	1.47	1.4	1.79	1.63	21.3	25.74	17.5	20.22
3	Kopergaon	107.4	120.2	9.17	8.58	2.39	2.08	1.08	0.95	1.83	1.71	21.45	25.75	20.3	24.55
4	PKV Greengold	114.6	122.8	8.12	7.37	2.11	1.88	1.52	1.45	1.97	1.88	25.34	29.31	18.9	23.9
5	AKM 8802	111.8	121.06	8.27	7.9	1.98	1.67	1.28	1.2	1.62	1.45	19.56	24.63	17.1	21.85
	Mean	114.04	124.788	8.44	7.64	1.98	1.69	1.346	1.25	1.838	1.722	22.97	27.156	17.5	21.264
	Range	107.4-134.8		6.15-9.17		1.37-2.39		0.95-1.52		1.45-1.98		19.56-30.35		13.7-24.55	

**Table.4** Nutritional Composition of Cowpea genotypes

Genotype		Calcium (mg/100 g)		Iron (mg/100 g)		Zinc (mg/100 g)		Copper (mg/100 g)		Manganese (mg/100 g)		Carbohydrate Starch) (g/100 g)		Protein (g/100 g)	
		Green	Mature	Green	Mature	Green	Mature	Green	Mature	Green	Mature	Green	Mature	Green	Mature
1	AKCP-6	73.1	98.3	6.231	6.12	4.81	3.95	1.93	1.74	2.43	2.06	23.26	29.26	17.6	21.1
2	AKCP-11	71.9	92.5	7.13	6.75	3.371	2.64	1.66	1.49	2.15	1.85	21.34	25.23	18.5	23.5
3	Arka Samrudhi	70.6	89.7	9.78	7.08	4.929	3.59	1.85	1.59	2.65	1.59	19.73	23.74	19.1	23.8
4	Arka Suman	68.7	85.1	7.21	6.33	3.536	2.78	1.73	1.29	2.03	1.43	23.47	28.45	18.9	22.7
5	Kokan Sadabahar	65.5	79.3	8.52	6.86	2.671	2.51	1.32	1.15	1.47	1.21	24.83	30.74	18.1	21.9
	Mean	69.96	88.98	7.7742	6.628	3.8634	3.094	1.698	1.452	2.146	1.628	22.526	27.484	18.44	22.6
	Range	65.5-98.3		6.12-9.78		2.51-4.93		1.15-1.93		1.21-2.65		19.73-30.74		17.6-23.8	

**Table.5** Nutritional Composition of Pigeonpea genotypes

Genotype		Calcium (mg/100 g)		Iron (mg/100 g)		Zinc (mg/100 g)		Copper (mg/100 g)		Manganese (mg/100 g)		Carbohydrate (Starch) (g/100 g)		Protein (g/100 g)	
		Green	Mature	Green	Mature	Green	Mature	Green	Mature	Green	Mature	Green	Mature	Green	Mature
1	AKTM 11-12	92.6	112.8	5.33	4.47	3.695	2.962	1.27	1.15	1.93	1.22	44.63	50.21	18.7	21.3
2	AKTM 11-11	90.1	111.2	5.28	4.48	4.584	3.814	1.64	1.54	1.48	1.04	41.44	52.78	19.1	22.5
3	BDN 2001-07	92.5	114.7	5.46	4.77	3.942	3.624	1.31	1.02	2.11	1.37	42.95	51.74	20.4	23.1
4	BDN 2001-09	94.3	117.3	5.52	4.68	3.817	3.537	1.43	1.21	2.17	1.42	40.21	48.68	19.9	22.5
5	ICP 7035	89.4	108.6	5.13	4.36	3.517	2.854	1.27	1.01	1.85	1.16	41.85	47.86	20.1	22.7
	Mean	91.78	112.92	5.344	4.552	3.911	3.3582	1.384	1.186	1.908	1.242	42.216	50.254	19.64	22.42
	Range	89.4-117.3		4.36-5.52		2.854-4.584		1.01-1.64		1.04-2.17		40.21-52.78		18.7-23.1	

**Table.6** Nutritional Composition of Chickpea genotypes

		Calcium (mg/100 g)		Iron (mg/100 g)		Zinc (mg/100 g)		Copper (mg/100 g)		Manganese (mg/100 g)		Carbohydrate (Starch) (g/100 g)		Protein (g/100 g)	
Genotype		Green	Mature	Green	Mature	Green	Mature	Green	Mature	Green	Mature	Green	Mature	Green	Mature
1	PKV Kabuli-2	111.1	127.9	9.12	6.59	3.143	2.986	1.27	1.13	2.65	2.18	37.57	38.32	17.56	20.67
2	PKV Kabuli-4	119.3	124.4	8.96	6.24	3.462	3.087	1.02	0.95	2.77	2.34	36.24	41.56	17.89	20.73
3	AKG 1109	104.1	108.2	8.48	5.78	4.264	3.728	1.08	0.92	3.63	3.18	39.36	46.21	18.23	23.85
4	AKGS-1	107.3	110.8	6.32	5.67	3.987	3.658	1.16	1.04	3.11	2.99	37.67	47.23	18.51	23.62
5	JAKI 9218	99.5	105.6	6.17	5.22	3.621	3.119	1.37	1.21	3.26	3.05	37.36	46.79	17.76	22.75
Mean		108.26	115.38	7.81	5.9	3.6954	3.3156	1.18	1.05	3.084	2.748	37.64	44.022	17.99	22.324
Range		99.5-127.9		5.22-9.12		2.986-4.264		0.92-1.37		2.18-3.63		36.24-47.23		17.56-23.85	

**Table.7** Nutritional Composition of Field pea genotypes

		Calcium (mg/100 g)		Iron (mg/100 g)		Zinc (mg/100 g)		Copper (mg/100 g)		Manganese (mg/100 g)		Carbohydrate (Starch) (g/100 g)		Protein (g/100 g)	
Genotype		Green	Mature	Green	Mature	Green	Mature	Green	Mature	Green	Mature	Green	Mature	Green	Mature
1	HFP-4	80.4	86.3	3.93	3.655	3.612	3.307	0.87	0.79	2.67	2.06	31.27	39.02	17.65	20.56
2	DDR-39	84.1	89.9	3.814	3.459	3.416	3.15	1.12	1.05	2.74	2.21	33.26	37.19	16.25	18.63
3	DDR-40	88.5	91.2	3.123	2.912	2.962	2.212	0.92	0.85	2.54	2.11	30.44	36.59	15.54	17.63
4	DDR-55	91.1	94.2	3.905	3.562	2.962	2.044	1.16	0.99	2.81	2.48	27.06	32.32	16.23	18.65
5	Rachana	86.6	89.9	2.95	2.11	3.023	2.785	0.92	0.82	2.48	2.03	29.56	38.48	17.81	18.56
Mean		86.14	90.3	3.5444	3.1396	3.195	2.6996	0.998	0.9	2.648	2.178	30.32	36.72	16.696	18.806
Range		80.4-94.2		2.11-3.93		2.044-3.612		0.79-1.16		2.03-2.81		27.05-39.01		15.54-20.56	

**Table.8** Overall nutritional composition of the vegetable type legume crops

S. No.	Crop	Calcium (mg/100 g)		Iron (mg/100 g)		Zinc (mg/100 g)		Copper (mg/100 g)		Manganese (mg/100 g)		Carbohydrate (Starch) (g/100 g)		Protein (g/100 g)	
		<i>Green</i>	<i>Mature</i>	<i>Green</i>	<i>Mature</i>	<i>Green</i>	<i>Mature</i>	<i>Green</i>	<i>Mature</i>	<i>Green</i>	<i>Mature</i>	<i>Green</i>	<i>Mature</i>	<i>Green</i>	<i>Mature</i>
1	Soybean	180.24	84.72	9.506	12.33	4.5558	4.056	1.698	1.428	2.944	2.398	8.8	10.72	22.568	36.972
2	Mungbean	114.04	124.788	8.44	7.64	1.98	1.69	1.346	1.25	1.838	1.722	22.97	27.156	17.5	21.264
3	Cowpea	69.96	88.98	7.7742	6.628	3.8634	3.094	1.698	1.452	2.146	1.628	22.526	27.484	18.44	22.6
4	Pigeonpea	91.78	112.92	5.344	4.552	3.911	3.3582	1.384	1.186	1.908	1.242	42.216	50.254	19.64	22.42
5	Chickpea	108.26	115.38	7.81	5.9	3.6954	3.3156	1.18	1.05	3.084	2.748	37.63972	44.022	17.99	22.324
6	Field pea	86.14	90.3	3.5444	3.1396	3.195	2.6996	0.998	0.9	2.648	2.178	30.31515	36.72098	16.696	18.806

The highest manganese content was observed in green stage of AGS-459 (3.12 mg/100 g) and the lowest manganese content was found in mature stage of JS-335 (2.14 mg/100 g). The mean values were 2.94 mg/100 g in the green stage and 2.4 mg/100 g in the mature stage. Similar observations were reported by Garg *et al.*, (2014).

Amongst Mungbean genotypes, manganese content ranged between 1.45 mg/100 g to 1.98 mg/100 g. The highest manganese content was observed in green stage of Utkarsha (1.98 mg/100 g) and the lowest manganese content was found in mature stage of AKM 8802(1.45 mg/100 g). The mean values were 1.84 mg/100 g in the green stage and 1.72 mg/100 g in the mature stage. Similar observations were reported by Li *et al.*, (2010). In the Cowpea genotypes, manganese content ranged between 1.21 mg/100 g to 2.65 mg/100 g. The highest manganese content was observed in green stage of AKCP-11 (2.65 mg/100 g) and the lowest manganese content was found in mature stage of Kokan Sadabahar (1.21 mg/100 g). The mean values were 2.14 mg/100 g in the green stage and 1.62 mg/100 g in the mature stage. Similar observations were reported by Carvalho *et al.*, (2012).

In the Pigeonpea genotypes, manganese content ranged between 1.04 mg/100 g to 2.72 mg/100 g. The highest manganese content was observed in green stage of BDN 2001-09 (2.72 mg/100 g) and the lowest manganese content was found in mature stage of AKTM 11-11(1.04mg/100 g). The mean values were 1.91 mg/100 g in the green stage and 1.24 mg/100 g in the mature stage. Similar observations were reported by Patil *et al.*, (2015).

In the Chickpea genotypes, manganese content ranged between 2.18 mg/100 g to

3.63 mg/100 g. The highest manganese content was observed in green stage of AKG 1109 (3.63 mg/100 g) and the lowest manganese content was found in mature stage of PKV Kabuli-2 (2.18 mg/100 g). The mean values were 3.08 mg/100 g in the green stage and 2.74 mg/100 g in the mature stage. Similar observations were reported by Mohammadi *et al.*, (2015).

In the Field pea genotypes, manganese content ranged between 2.03 mg/100 g to 2.51 mg/100 g. The highest manganese content was observed in green stage of DDR-55 (2.81 mg/100 g) and the lowest manganese content was found in mature stage of Rachana (2.03 mg/100 g). The mean values were 2.65 mg/100 g in the green stage and 2.17 mg/100 g in the mature stage. Similar observations were reported by Harmankaya *et al.*, (2010).

### **Starch**

Carbohydrates are the primary energy sources for the human body. Starch and sugars are the major forms of energy sources for the body. The recommended dietary allowance of carbohydrate is 46 g to 56 g per day. The tolerable upper intake level is 25 % of the energy intake (National academies). The graphical representation of starch content of selected legume crops can be seen in (Figure 6).

In the Soybean genotypes, Starch content ranged between 7.5 mg/100 g to 11.7 mg/100 g. The highest starch content was observed in mature stage of TAMS-38 (11.7 mg/100 g) and the lowest starch content was found in green stage of Swarna vasundhara (7.5 mg/100 g). The mean values were 8.8 mg/100 g in the green stage and 10.72 mg/100 g in the mature stage. Similar observations were reported by Keatinge *et al.*, (2011) and Garg *et al.*, (2014).

In the mungbean genotypes, Starch content ranged between 19.56 mg/100 g to 30.35 mg/100 g. The highest starch content was observed in mature stage of Utkarsha (30.35 mg/100 g) and the lowest starch content was found in green stage of AKM 8802 (19.56 mg/100 g). The mean values were 22.97 mg/100 g in the green stage and 27.14 mg/100 g in the mature stage. Similar observations were reported by Li *et al.*, (2010).

In the cowpea genotypes, Starch content ranged between 19.73 mg/100 g to 30.74 mg/100 g. The highest starch content was observed in mature stage of Kokan sadabahar (30.74 mg/100 g) and the lowest starch content was found in green stage of Arka Samrudhi (19.73 mg/100 g). The mean values were 22.53 mg/100 g in the green stage and 27.48 mg/100 g in the mature stage. Similar results were reported by Garg *et al.*, (2014).

In the pigeonpea genotypes, Starch content ranged between 40.21 mg/100 g to 52.78 mg/100 g. The highest starch content was observed in mature stage of AKTM 11-11 (52.78 mg/100 g) and the lowest starch content was found in green stage of BDN 2001-09 (40.21 mg/100 g). The mean values were 42.21 mg/100 g in the green stage and 50.25 mg/100 g in the mature stage. Similar results were reported by Saxena *et al.*, (2010).

Starch content ranged between 36.24 mg/100 g to 47.23 mg/100 g. The highest starch content was observed in mature stage of AKGS-1 (47.23 mg/100 g) and the lowest starch content was found in green stage of PKV Kabuli-4 (36.24 mg/100 g). The mean values were 37.63 mg/100 g in the green stage and 44.02 mg/100 g in the mature stage. Similar results were reported by Mohammadi *et al.*, (2015).

In the field, pea genotypes, Starch content ranged between 27.05 mg/100 g to 39.01 mg/100 g. The highest starch content was observed in mature stage of HFP-4 (39.01 mg/100 g) and the lowest starch content was found in green stage of DDR-55 (27.05 mg/100 g). The mean values were 30.31 mg/100 g in the green stage and 36.72 mg/100 g in the mature stage. Similar results were reported by Harmankaya *et al.*, (2010).

### **Protein**

The graphical representation of protein content of selected legume crops can be seen in (Figure 7). In the soybean genotypes, Protein content ranged between 21.54 mg/100 g to 39.43 mg/100 g. The highest protein content was observed in mature stage of AGS 459 (39.43 mg/100 g) and the lowest protein content was found in green stage of JS-335 (21.54 mg/100 g). The mean values were 22.56 mg/100 g in the green stage and 36.97 mg/100 g in the mature stage. Similar observations were reported by Garg *et al.*, (2014).

In the mungbean genotypes, Protein content ranged between 13.72 mg/100 g to 24.55 mg/100 g. The highest protein content was observed in mature stage of Kopergaon (24.55 mg/100 g) and the lowest protein content was found in green stage of Utkarsha (13.7 mg/100 g).

The mean values were 17.5 mg/100 g in the green stage and 21.26 mg/100 g in the mature stage. Similar results were reported by Li *et al.*, (2010). In the cowpea genotypes, Protein content ranged between 17.62 mg/100 g to 23.8 mg/100 g. The highest protein content was observed in mature stage of Arka Samrudhi (23.8 mg/100 g) and the lowest protein content was found in green stage of AKCP-6(17.6 mg/100 g). The mean values were 18.44

mg/100 g in the green stage and 22.6 mg/100 g in the mature stage. Similar results were reported by Carvalho *et al.*, (2012).

In the pigeonpea genotypes, Protein content ranged between 18.7 mg/100 g to 23.1 mg/100 g. The highest protein content was observed in mature stage of BDN 2001-07(23.1 mg/100 g) and the lowest protein content was found in green stage of AKTM 11-12(18.7 mg/100 g). The mean values were 19.64 mg/100 g in the green stage and 22.42 mg/100 g in the mature stage. Similar results were reported by Patil *et al.*, (2015).

In the chickpea genotypes, Protein content ranged between 17.56 mg/100 g to 23.85 mg/100 g. The highest protein content was observed in mature stage of AKKG-1109(23.85 mg/100 g) and the lowest protein content was found in green stage of PKV Kabuli-2(17.56 mg/100 g). The mean values were 17.99 mg/100 g in the green stage and 22.32 mg/100 g in the mature stage. Similar results were reported by Mohammadi *et al.*, (2015).

In the field pea genotypes, Protein content ranged between 15.54 mg/100 g to 20.56 mg/100 g. The highest protein content was observed in mature stage of HFP-4 (20.56 mg/100 g) and the lowest protein content was found in green stage of DDR-40 (15.54 mg/100 g). The mean values were 16.69 mg/100 g in the green stage and 18.81 mg/100 g in the mature stage. Similar results were reported by Harmankaya *et al.*, (2010).

The overall nutritional composition is mentioned in the (Table 8) suggested that grain stage legumes had higher amount of protein, starch and calcium (except vegetable soybean). The increase in protein and starch may be due to the fact that the simple amino acids and simple sugars are converted to complex substances i.e. protein

and starch respectively during maturation (Geervani and Umadevi, 1989). Calcium content may rise due to the accumulation of calcium in the seed coat during seed maturation (Cabanne and Doneche, 2003). The green stage legumes had higher amounts of minerals *viz.*, iron, zinc, copper and manganese. This may be due to the fact that seeds contain enzymes in the living state and they prevent nutrient losses in the green seeds. (Lynn, 2002). The present investigation revealed that grain stage has high protein, starch and calcium content. The conversion of simple amino acids into complex substances resulted increasing in protein and starch content.

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### **Conflict of interest disclosure**

There is no conflict of interest to disclose.

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