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Acceptable entity of vegetable soybean

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Abstract: Vegetable soybean (*Glycine max.),* a nutritious legume harvested at R_6 stage of development is rich in protein, vitamins, minerals and may serve as new alternative to supply the micronutrients. A total of seven vegetable soybean varieties / genotypes *viz.*, EC175329, KDS-726, 2000-05, Seminol, Karune, DSb 21 along with JS 335(control) harvested during *Kharif*-2015 were screened for physical, chemical and sensory parameters. Except seed thickness, all the physical parameters of both pod /seed varied significantly (pd"0.05). Variety Karune exhibited highest pod length (42.42 mm), pod width (11.63mm), pod thickness (9.50 mm) and weight of 100 pods (135.5 g) among all the seven soybean varieties/ genotypes. The highest seed length was evidenced in control - JS 335 (12.89) where as least was observed in variety Seminol (9.72 mm). Among the quality characteristics studied v control, JS 335 exhibited highest yellow (b* = 22.39) colour and hard texture (0.926 g^f) compared to other vegetable soybean varieties/genotypes. Sensory evaluation of boiled soybean revealed that varieties Karune and DSb 21 showed higher acceptable indices (86.85) while minimum was observed in genotype Ec175329(74.07). Proximate principles including moisture, protein, fat, crude fibre, ash and carbohydrate content of vegetable soybean varieties/genotypes ranged between 55.56 - 66.52 g , 13.41- 13.67g, 7.80 – 8.75 g, 2.15 - 2.78 g, 1.34 - 1.74g and 6.94 - 18.26 g per 100 g of the sample respectively. Variety Karune and DSb 21 were found to be nutritionally superior and organoleptically acceptable.

Key words: Carbohydrate, Phytochemicals, Quality parameters, Vegetable soybean

Introduction

Soybean with large seed size harvested at immature green seed stage (R_6) could be consumed as a vegetable, much like sweet peas (*pisum sativum* L.) .Vegetable soybean also known as edamame in Japan is also popular in Korea, China and Taiwan and its consumption are increasing very rapidly. The soybeans are consumed in stews, salads or salted snacks (Santana *et al.,* 2012).Vegetable soybeans are excellent sources of protein, minerals, vitamins and omega-3 fatty acids(www.coolbean.info/ soybean/EDAMAME_). Compared to grain type soybean, edamame has advantages as a food for human consumption, e.g. green color, soft texture, large seed size, sweet and less beany flavor. Additionally, vegetable soybean is rich in phytochemicals which are beneficial to the human being and is therefore considered a neutraceutical or a functional food crop (Mebratu , 2008) . Isoflavones present in soybean are believed to be major components responsible for the antioxidative activity and offers numerous health benefits such as lowering the cholesterol levels, prevention of cardiovascular disease (Gil-Izquierdo *et al.,* 2012) and reduction in mammary, breast and prostrate cancers (Kim *et al.,* 2014). Individuals select food for nutrition, convenience, culture, economics, taste and concern for weight. Introducing green soybean as a vegetable would add variety in the diet. Soybean producers have conjectured that the desired qualities of cooked vegetable soybeans are appearance, aroma, flavor and firm texture. The flavors most desired in beans are said to be sweetness and nuttiness and no beany taste. Texture to be firm and nut-like, not mushy or hard. Shades of green are desirable. Hence screening of vegetable soybean varieties/genotypes for chemical composition and acceptability will aid in selection of the best variety that had potential benefits for human consumption.

Material and methods

The vegetable soybean varieties/genotypes harvested at R_6 stage (65 days after sowing) were obtained from AICRP on soybean, MARS, Dharwad during *Kharif* 2015-16.

The physical parameters of vegetable soybean varieties/ genotypes including length, width and thickness of fresh pods/ seeds were measured using standard procedures. The color was measured in chromatic component of lightness (L*), red-green component (-a*) and yellow-blue component (b*) by using Spectrophotometer Konica Minolta, CM - 2600/ 2500d model. Seed texture was measured in terms of hardness (g^f) using texture analyzer machine (Exponent software). Hardness was determined by the puncture test of texture analyzer with test speed of 5 mm/sec and full-scale load of 50 Kg.

The pods of vegetable soybean were boiled for 10 min at 100 ÚC and subjected for sensory evaluation. The sensory scores for appearance, texture, color, flavor, taste and overall acceptability of boiled vegetable soybean seeds added with 0.5 per cent salt were evaluated by semi trained panelists(N=15) using 9 point hedonic scale as outlined by Amerine *et al.* (1965).

$$\text{The acceptability index} = \frac{\text{Total scores of all attributes}}{45} \times 100$$

The proximate principles *viz.,* protein, fat, crude fibre and ash contents of vegetable soybean seeds were analyzed in triplicates using standard AOAC (Anon., 2005) procedures. Carbohydrate and energy contents were computed using differential method. The statistical tool SPSS (16.0) program was used to estimate the mean, standard error of mean, CD and F value. ANOVA was employed to know the varietal differences (Fisher and Yates,1963).

Results and discussion

A total of seven varieties/genotypes of vegetable soybean *viz.,* EC175329, Seminol, DSb 21, Karune, Kds-726, 2000-05 along with JS 335 as control were selected for the study.

Physical characteristics including pod length, width , thickness and 100 pod weight of vegetable soybean varieties/ genotypes ranged between 31.39 - 42.42 mm, 8.48 -11.63 mm. 4.57-9.50mm and 61.50-135g/100 respectively (Table 1). Significant (pd"0.01) differences were found in all the physical characteristics among vegetable soybean varieties/genotypes. The values obtained in present study are closer to the values documented by Kumar *et al.* (2006) and lower than the values reported by Salmoni (2010) Variation in physical characteristics of pod may be due to genotypic variation.

The physical characteristics of vegetable soybean seeds are represented in Table 2 . There was significant (pd≤0.05) variation in seed characteristics including seed length, width and 100 seed weight among soybean seeds of different varieties/genotypes. Seed length, width, thickness and weight of 100 seeds ranged from 9.72 -12.89 mm, 6.83-8.66 mm, 5.12- 6.85 mm, 5.12- 6.85 mm, 25.5 -31.59 g per cent respectively. Variety Karune scored highest values for seed characteristics in comparison with other varieties /genotypes. These results reported in present study are lower than those documented by Kundagol (2015). The weight of hundred seeds in present study were less than those reported by Kumar *et al.* (2006). The significant variation in seed characteristics of vegetable soybean seed varieties/ genotypes may due to genetic traits of particular variety in the parent seeds.

The color components are reported in Table 3. The component L * value ranged between 43.05 - 65.44. The greenness *i.e.,* - a* value was higher in variety Seminol (-2.38) followed by Karune (-4.53). The reported color parameters in the present study agree with those mentioned by Kundagol (2015) where the L* a* and b* values of vegetable soybean genotype ranged between 48.83 to 65.98,-3.41 to -9.42 and 21.77 to 31.87 respectively. Variations in the color components of vegetable soybean may due to genetic differences, presence of phenolic compounds at the time of harvest as well as chlorophyll content of seeds.

Textural quality of vegetable varieties/genotypes is presented in Table 3. Textural qualities of fresh vegetable soybean genotypes/varieties differed significantly (pd≤0.01). Control - JS 335 had highest textural value (1.034g^{f}) followed byDsb-21 (0.0753g^{f}) and it had softest texture among all the varieties. Song *et al.* (2003) reported that the textual value (575.6g^{f}) for vegetable soybean varieties/genotypes. The results of the present study are lower than those reported by Song *et al.* (2003) which may be due to the probe and test speed used and moisture content of seeds. Sensory scores pertaining to boiled vegetable soybean varieties are described in Table 4. The scores for sensory

Table 1. Physical characteristics of vegetable soybean varieties/genotypes

Varieties/genotypes	Length (mm)	Width (mm)	Thickness(mm)	Weight of 100 pods(g)
EC175329	38.5±0.41^{c}	11.62±0.23^{a}	6.75±0.20^{e}	61.50±0.60^{g}
Kds-726	40.64±0.15^{b}	9.73±0.16^{c}	6.83±0.11^{e}	132.5±0.17^{b}
2000-05	31.39±0.21^{f}	9.59±0.15^{c}	6.88±0.11^{e}	101.51±0.32^{e}
Seminol	34.48±0.23^{e}	9.20±0.15^{c}	4.57±0.10^{f}	79.49±0.46^{h}
Karune	42.42±0.12^{a}	11.63±0.20^{a}	9.50±0.49^{a}	135.32±0.28^{a}
DSb 21	40.34±0.12^{b}	10.3±0.49^{c}	8.80±0.12^{b}	128.3±0.37^{c}
JS 335	37.75±0.32^{d}	8.48±0.17^{d}	7.61±0.28^{c}	94.59±0.24^{f}
Mean	37.9±3.64^{d}	10.08±1.15^{b}	7.27±1.52^{d}	104.70±0.10^{d}
F value	720.90	66.858	271.61	267.60
S.Em±	0.25	0.26	0.21	0.28
C.D. @ 0.01	0.43**	0.44**	0.29**	0.52**

Note: Values are mean of three replications **Significant @ 0.01 level, NS- non significant
S.Em± Standard error of mean, C.D. - Critical difference,
Different superscripts within a column indicate significant difference at 0.05 level by DMRT

Table 2. Physical characteristics of seeds of vegetable soybean varieties/genotypes

Varieties/genotypes	Length (mm)	Width (mm)	Thickness(mm)	Weight(g/100seed)
EC175329	10.92±0.54^{c}	6.20±0.82^{e}	5.82±0.51^{a}	30.1±0.56^{d}
Kds-726	12.24±0.5^{b}	7.81±0.81^{c}	6.2±0.62^{a}	32.3±0.78^{a}
2000-05	9.85±0.83^{d}	6.23±0.54^{e}	5.12±0.03^{a}	31.4±0.98^{c}
Seminol	9.72±0.76^{e}	6.97±0.51^{d}	5.46±0.05^{a}	25.8±1.42^{e}
Karune	12.69±0.23^{a}	8.66±0.76^{a}	6.85±0.25^{a}	31.59±1.6^{b}
DSb 21	10.22±1.23^{d}	7.92±0.52^{b}	5.14±0.23^{a}	24.88±0.44^{f}
JS 335	12.82±0.51^{b}	7.85±0.73^{c}	6.32±0.67^{a}	30.36±0.5^{d}
Mean	11.2±0.58	7.37±0.54	5.84±0.98	29.49±0.75
S.Em±	0.03	0.12	0.31	0.05
C.D. @ 0.05	0.12*	0.43*	NS	0.18*

Note:Values are mean of three replications, *Significant @ 0.05 level, NS- non significant
S.Em-Standard error of mean, C.D. - Critical difference.
Different superscripts within a column indicate significant difference at 0.05 level by DMRT

Table 3. Color and texture profile of vegetable soybean varieties/genotypes

Varieties/genotypes	Color components			Texture (g_f)
	L*	a *	b *	
EC175329	58.23±0.17^{e}	-5.75±0.13^{c}	19.29±0.25^{d}	0.0600±0.008^{e}
Kds-726	63.18±0.15^{b}	-6.45±0.12^{d}	21.68±0.14^{b}	0.0798±0.001^{d}
2000-05	43.05±0.17^{f}	-5.44±0.10^{c}	20.32±0.20^{c}	0.0892±0.001^{b}
Seminol	62.26±0.31^{c}	-2.38±0.29^{a}	19.25±0.37^{d}	0.0678±0.001^{e}
Karune	60.21±0.31^{e}	-4.36±0.35^{b}	20.37±0.38^{c}	0.0800±0.003^{c}
DSb 21	61.39±0.04^{d}	-5.50±0.10^{c}	21.45±0.12^{b}	0.0752±0.006^{d}
JS 335	65.44±0.19^{a}	-8.53±0.47^{e}	22.39±0.30^{a}	0.1032±0.001^{a}
Mean	59.11±7.05	-5.48±1.79	20.68±1.16	0.0796±0.013
F value	363.60	150.87	57.49	137.246
S.Em±	0.241	0.268	0.270	0.09
C.D. @ 0.05	0.375*	0.463*	0.480*	0.05**

Note:Values are mean of three replications, ** Significant @ 0.01 level * Significant @ 0.05 level, NS- non significant, S.Em± - Standard error of mean, C.D, - Critical difference. L - Lightness, ranging from 0 to 100 indicaated black to white a, (+a redness d" and –agreenness) b, (+b, yellowness and greenness), Different superscripts within a column indicate significant difference at 0.05 level by DMRT, # seeds

Table 4. Sensory evaluation of boiled vegetable soybean varieties/genotypes

Varieties/ genotypes	Appearance	Color	Texture	Aroma	Taste	Overall acceptability	Acceptability index	Rank
EC175329	6.1±0.7^{c}	6.2±1.0^{b}	7.1±0.8^{a}	6.9±0^{b}	7.1±0.9^{a}	7.6±0.84^{a}	74.07	VI
Kds-726	7.0±0.9^{b}	6.9±0.8^{a}	7.1±1.1^{a}	7.2±1.1^{a}	7.9±0.9^{a}	7.3±0.81^{a}	77.96	VII
2000-05	7.3±0.9^{a}	7.5±1.1^{a}	7.5±0.9^{a}	7.4±0.8^{a}	7.3±1.3^{a}	7.8±0.82^{a}	82.03	V
Seminol	7.6±0.6^{a}	8.0±0.6^{a}	7.8±0.8^{a}	7.2±1.1^{a}	7.1±0.8^{a}	6.6±0.96^{b}	83.14	IV
Karune	7.7±0.6^{a}	8.0±0.9^{a}	7.8±0.8^{a}	7.8±1.0^{a}	7.8±0.7^{a}	7.8±0.91^{a}	86.85	I
DSb 21	7.3±0.4^{a}	7.4±0.5^{a}	7.9±0.7^{a}	7.1±0.5^{a}	7.7±0.8^{a}	7.8±0.78^{a}	83.70	II
JS 335	7.7±0.6^{a}	7.7±0.6^{a}	7.3±0.9^{a}	7..4±0.8^{a}	7.5±0.5^{a}	7.3±0.48^{a}	83.14	III
Mean	7.2±0.7^{a}	7.28±0.9^{a}	7.48±0.9^{a}	7.3±0.9^{a}	7.3±0.9^{a}	7.3±0.88^{a}		
F value	5.31	4.56	1.19	1.03	1.17	2.87		
S.Em±	0.18	0.26	0.20	0.20	0.20	0.19		
C.D. @ 0.05	0.60**	1.41**	NS	0.81*	NS	0.72*		

Note: Values are mean of three replications, **Significant @ 0.01 level *Significant @ 0.05 level , NS- non significant S.Em. - Standard error of mean, C.D. - Critical difference
Different superscripts within a column indicate significant difference at 0.05 level by DMRT

Table 5. Proximate composition (g%) of vegetable soy bean varieties

Varieties/genotypes	Moisture	Protein	Fat	Crude fibre	Ash	CHO(%)	Energy
Karune	66.52±0.07^{a}	13.67±0.46^{a}	8.55±0.19^{a}	2.78±0.09^{a}	1.54±0.03^{b}	6.94	159.39
DSb 21	66.41±0.99^{a}	13.42±0.16^{a}	7.80±0.19^{b}	2.15±0.02^{b}	1.74±0.01^{a}	8.48	157.8
JS 335	55.56±0.38^{b}	13.41±0.14^{a}	8.78±0.13^{a}	2.65±0.17^{a}	1.34±0.09^{c}	18.26	205.72
Total mean	62.83±5.48	13.50±0.28	8.37±0.46	2.52±0.30	1.54±0.18	11.22	174.30
F value	315.43	0.771	0.031	0.014	0.003		
S.Em±	0.40	0.28	0.21	0.17	0.12**		
C.D. @ 0.01	1.22**	NS	0.35**	0.23**	0.11		

Note: Values are mean of three replications, **Significant @ 0.01 level Significant @ 0.05 level, NS- non significant
S.Em - Standard error of mean, C.D. - Critical difference,
Different superscripts within a column indicate significant difference at 0.05 level by DMRT
Acceptable varieties

attributes *viz.,* appearance, color, texture, aroma, taste and over all acceptability varied significantly (pd"0.05) among all the varieties which ranged between 6.1-7.7, 6.2-8.0, 7.1-7.8, 6.9-7.8, 7.1- 7.9 and 6.6- 7.8 respectively. Among all the sensory attributes studied , variety Karune had highest sensory scores. Variety Karune was highly acceptable followed by variety DSb 21. The results are in agreement with the research findings of Swamy (2009) where in, sensory scores of 12 varieties of cooked vegetable soybean for appearance, color, aroma and flavor ranged between 2-4 i., from highly acceptable to acceptable norms under 4 p0int hedonic scale.The variation in sensory profile of vegetable soybean varieties/genotypes which may be due to the presence of amino acid and sugar content and genetic trait of specific variety (Santana *et al.,* 2012).

Table 5 depicts the proximate composition of vegetable soybean seed varieties/genotypes. Moisture content of vegetable soybean varieties ranged between 55.56 - 66.52 per cent which varied significantly (pd≤0.5) among the varieties.

Kundagol (2015) reported moisture content of vegetable soybean varieties ranging between 63.34 to 68.53 per cent. Moisture values reported in the present study are lower than those compared to Japanese cultivars and Indian variety which might be due to factors such as time of harvest, agro climatic conditions and type of soil in which vegetable soybean was grown (Salmoni, 2010). The variety Karune had highest protein content (13.67 g %) which did not vary significantly in the present study. Fat is responsible for rancidity of product during storage when exposed to air/light fat undergoes oxidation and release free-fatty acids. Fat content of vegetable soybean ranged between 7.80 - 8.78. The highest fat content was found in variety JS 335(8.78 g%). Salmoni (2010) reported the fat content of vegetable soybean ranging between 7.29 - 9.23 g/100 g. The fat contents varied significantly (pd≤0.01) among all the varieties which may attributed to genetic variation.

Crude fiber content of vegetable soybean ranged between 2.15 -2.78 g/100 g . Highest value was found in variety Karune (2.78g/ 100g). The results of the present study are in agreement with the results reported by Kundagol (2015) where crude fiber content of vegetable soybean varieties ranged between 2.01 to 2.45 g per 100 g..Salmoni (2010) reported that the crude fiber content of ten vegetable soybean genotypes ranged between 1.89 -2.62 g / 100 g.

Ash content ranged between 1.34 - 1.74 g /100g in seeds of vegetable soybean varieties studied. Highest content of ash was found in variety DSb 21(1.74 g %) followed by Karune (1.54 g%). Ash content of vegetable soybean varieties/ genotypes ranged between 4.77- 5.95g. The variation in ash content of vegetable soybean may be attributed to the nutritional profile of soil, fertility status and micronutrients present (Kumar *et al.,* 2006). In the present study carbohydrate content of vegetable soybean ranged between 6.94 - 18.26 g. Mebrahtu (2008) reported the carbohydrate content of 31 vegetable - type soybean genotypes ranging between 15.84 - 28.94 per cent where in highest was observed in JS 335. The results of the present study are lower those reported by Santana *et al.* (2012). Variation observed in proximate composition of acceptable vegetable soybean varieties can be attributed to genetic factors.

Physical characteristics of vegetable soybean pods varied significantly (Pd≤0.01) among varieties/genotypes. The physical characteristics of vegetable soybean seed differed significantly (pd≤0.05) among all varieties/genotypes except in thickness of the seeds. Color parameters of vegetable soybean varied significantly (pd≤0.05) among all varieties/ genotypes. Variety Seminol was found to be more greener than other vegetable soybean varieties/genotypes. Variety JS 335 (control) exhibited higher b* value 22.39 among other varieties/genotypes. Textural quality of vegetable soybean varieties/genotypes varied significantly (pd≤0.05). The variety JS 335 had more hardness (1.032 g^f) compared to other soybean varieties/genotypes. Except protein , proximate principles of vegetable soybean varieties varied significantly (pd≤0.05).Other proximate composition including moisture, protein, fat, crude fibre, ash and carbohydrate ranged between 55.56 – 66.52 g/100 g, 13.41 -13.67 g/100g, 7.8 - 8.78 g/100g, 2.15- 2.78 g/100g, 1.34 -1.74 g/100 g and 6.94 - 18.26g per cent respectively.Varieties Karune and DSb 21 & control JS 335 had highest overall acceptability score (7.8) and least was noted in variety Seminol (6.6). The variety Karune ranked first followed by DSb 21and JS 335 with acceptability indices of 86. 85, 83.70 and 83.14 per cent respectively.

Thus, the results revealed that variety Karune followed by DSb 21 had better texture , nutritional and sensory profile which can be harnessed for popularization among the community.

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