Studies on the Correlation Between the Quality Traits of Vegetable Soybean

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Abstract: Studies show that sucrose is responsible for its sweetness. The texture of vegetable soybean is rather complex in nature, the hardness□expressed as the force required to break the vegetable soybean seed□is adopted to evaluate the texture. Analysis of amino acid patterns of five varieties proved that there are significant correlations between content of glutamic acid, aspartic acid and sensory scores of taste. A significantly positive correlation between seed hardness and protein was observed.

Key words: Vegetable soybean; Quality feature; Correlation

Vegetable soybean, *Glycine max* (L.) Merrill, also known as "Edamame" in Japanese or "Mau Tou" in Chinese, is soybean harvested and used green, between the R_6 and R_7 growth stages. The ones consumed as vegetable soybeans have big pods, with bright green color and large seeded with desirable taste. The quality of vegetable soybean is generally influenced by appearance, edibility quality, nutritional quality and sanitation quality where by appearance and sanitation qualities are considered to be the most descriptive to the commodity [3,4].

Vegetable soybean appearance traits include green pod size, pod color, number of seeds per pod and seeds size. Edibility quality of vegetable soybean can be subdivided into four major categories including sweetness, taste, flavor and texture [5~8]. Two methods can be used to evaluate food quality, sensory testes and impersonal analysis of food components. Human's sense organ is very effective, and can make a general impression of food. But it is too easily to be affected by personal conditions. Many studies indicate that edibility quality is mainly determined by several food components, so it is possible to evaluate it by analysis the content of these components. The purposes of this study are to find the relationship between sensory score and vegetable soybean components.

1. Materials and Methods

In 2000, 28 vegetable soybean varieties were planted on the experiment farm of Huajia campus, Zhejiang University. On 25th March, during planting, compound fertilizer containing N, P_2O_5 and K_2O in the ratio of 15,15,15 was applied at the rate of 375kg ha^{-1} at plowing. After geminating, two seedlings were held per hole. The holes were spaced 20cm apart; the width of rows was 80cm. Plots of other single varieties consist of 5×10 holes. All varieties were grown in 3 replicates. Ten plants of each variety were harvested at green pod stage (R_6-R_7). Appearance traits such as pod length, pod width, number of seeds per pod, 100-fresh pod weight and 100-dry seed weight were examined. The seed samples were dried and ground in a grinding mill, and passed

through a 0.1mm pore size screen. The oil was extracted with ether. The defatted meal samples were used to determine the content of free amino acids. A sample of 0.3g dry flour was used to determine the Kjeldahl N content according to Huang Xielin and Cheng lunzhen (1990). The total protein content (%)=the Kjeldahl N content×6.25□Sucrose, glucose and starch content were also determined according to the means of Huang Xielin and Cheng lunzhen(1990)[9]. After vegetable soybean pods were boiled for 7 to 9 minutes in water and GY-1 fruit hardness apparatus was used to measure the seed hardness. Vit-C was extracted from vegetable soybean fresh seeds and titrated with 2,6-double chlorin indole hydroxybenzeneas described by Li Luliang(1998)[10]. Free amino acids (mg/100g) were extracted from defatted dry flour using ethanol: H_2O solution (4:1) and analyzed using an AccQ-TAG HPLC system (Qaters Nihon Millipore Co. Ltd., Tokyo, Japan). Sensory test: 500g green vegetable soybean pods of each variety were numbered and boiled for 7 to 9 minutes in water. 10 experienced panelists were involved in scoring the sweetness, texture and taste of each vegetable soybean varieties. The maximum score was 5 and the minimum was 1.

2. Results and Discussions

2.1 Correlation among vegetable soybean appearance qualities

The correlation between vegetable soybean appearance traits was listed in table1. Except for the correlation between pod length and pod width, there were significant correlation between every 2 traits of 100-pod weight, 100-fresh seed weight, 100-dry seed weight, pod length, pod width□r>0.4*□. A significant and negative correlation was observed among the number of seeds per pod and pod width, 100-fresh seed weight, which indicated the soybean varieties of wide pod and large seed usually had less number of seeds per pod.

Table 1 Correlation among vegetable appearance traits

Traits	No.of seeds per pod	Pod length (cm)	Pod width (cm)	100-pod weight (g)	100-fresh seeds weight (g)	100-seed weight (g)
No.of seeds per pod	1					
Pod length	0.093	1				
Pod width	-0.411*	0.233	1			
100-pod weight	-0.179	0.638 **	0.756 **	1		
100-fresh seeds weight	-0.485 **	0.410 *	0.714 **	0.818 **	1	
100-dry seed weight	0.019	0.572 **	0.465 *	0.585 **	0.603**	1

*, ** indicate significant at 0.05 and 0.01probability level, respectively.

2.2 Correlation between vegetable soybean edibility quality

2.2.1 Sweetness

Free amino acids had effect on vegetable soybean sweetness. Results showed that the total free amino content of vegetable soybeans occupied 0.90-1.85% of defatted dry weight. The correlations between contents of chemical components and sweet scores of vegetable soybean are shown in table 2. Although there were

positive relations between sweet scores and aspartic acid, serine, glutamic acid, glycin, histidine, threonine, alanine proline, valine, major components related to sweetness were sucrose and glucose. There was a significant positive correlation between vegetable soybean sweet score and sucrose content (r=0.977**), which indicated only sucrose concentration can be used to evaluate vegetable soybean edibility quality.

Table 2 Correlation between sweet components and sweetness scores in vegetable soybean

Component	Sweetness score	Sucrose (mg/g)	Glucose (mg/g)	ASP	SER	GLU	GLY	HIS	ARG	THR
Sweet score	1	0.977**	0.852	0.389	0.017	0.294	0.197	0.076	-0.546	0.174
Component	ALA	PRO	CYS2	TYR	VAL	MET	LYS	ILE	LEU	PHE
Sweet score	0.291	0.326	0.834	-0.129	0.155	-0.428	-0.584	-0.252	0.539	-0.409

2.2.2 Texture

The texture of vegetable soybean is rather complex in nature, the hardness, expressed as the force required to break the vegetable soybean seed□is adopted to evaluate the texture.. The significant correlations between texture scores and hardness indicated both hardness of vegetable soybean seeds which boiled 7(A) or 9 minutes (B) in water can be used to indicate vegetable soybean texture quality (table 3).

Table 3 Correlation between texture score and different means of vegetable soybean qualities

Hardness	A (kg/mm^3)	B (kg/mm^3)	Texture score
A (kg/mm^3)	1		
B (kg/mm^3)	0.990**	1	
Texture score	-0.940*	-0.939*	1

*, ** indicate significant at 0.05 and 0.01probability level, respectively.

2.2.3 Taste

Vegetable soybean has favorable seed taste. In addition to sucrose, certain amino acids are thought to be the other major contributors to the taste of vegetable soybean. With exception of aspartic acid and glutamic acid (r=0.964**, r=0.939* respectively), no significant correlation was showed in our experiments between taste scores and free amino acids (table 4). Therefore analyses of glutamic acid and aspartic acid concentrations were important in the evaluation of the taste of vegetable soybean

Table 4 Correlation between free amino acids (FAA) and taste sensory score in vegetable soybean

	FAA	**ASP**	**SER**	**GLU**	**GLY**	**HIS**	**ARG**	**THR**	**ALA**
Taste score	1	0.964**	0.828	0.939*	0.594	0.353	-0.34	0.161	0.842
	PRO	**CYS**	**TYR**	**VAL**	**MET**	**LYS**	**ILE**	**LEU**	**PHE**
Taste score	0.706	0.219	-0.02	0.381	-0.42	-0.14	-0.13	0.517	-0.07

2.2.4 Correlation analysis of vegetable soybean components

The correlation coefficients of vegetable soybean components are listed in table 5. The correlation

between starch and Vit-C was positive and significant (r=0.476*) and the correlation between protein and starch was significant and negative(r= 0.712**). Xu Zhaozheng et al.(1995) reported negative and significant (r=-0.516**) correlation between protein and Vit-C[11]. The nonsignificant correlation of -0.311 in our experiment suggested less difficulty for the breeder in developing both high protein and vitC varieties. There was a significant and positive correlation between protein content and seed hardness, the higher the protein content of vegetable soybean, the harder the seeds.

Table 5 Correlation between vegetable soybean qualities

Traits	Sucrose (mg/g)	Hardness (N/mm^3)	Protein (%)	Vit-C (mg/100g)	Dry material(%)	Starch (%)
Sucrose	1					
Hardness	-0.220	1				
Protein	-0.257	0.382*	1			
Vitc	0.165	-0.311	-0.311	1		
Dry material	0.128	0.169	0.345	0.119	1	
Starch	0.052	-0.325	-0.712 **	0.476 *	-0.076	1

3. Discussion

Previously, studies on vegetable soybean in China focused on appearance quality and very little was done on the edibility quality. Because the concentrations of free amino acids are very low in grain-type soybean, no consideration has been given to free amino acids in soybean before. However, free amino acids have important influence on edibility quality of vegetable soybean. Due to the gradually decrease free amino acid content during vegetable soybean maturing and differences in the accumulation of free amino acid in seeds, concentration of free amino acids were higher in the vegetable-type than in the grain-type cultivars in the immature stages when the soybean is harvested and consumed (Yasuhiro Yanagisw, et al., 1992)[12].

Tsou and Hong(1990) reported that free glutamic acid had the highest concentration over other amino acids, itself consist 0.43% of the fresh weight of vegetable soybean [13], while Masuda (1989) suggested that the major free amino acids in vegetable soybean in the immature seeds were asparagine, alanine, and glutamic acid. It was reported that alanine was highly correlated with vegetable soybean sweetness, and asparagine and glutamic acid are highly correlated with seed taste. This study proved the latter, but found there was no significant correlation between alanine and sweetness, sucrose was the main contributor to the edibility quality of vegetable soybean.

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