



Evaluation of Cooking Properties of Vegetable Soybean (*Glycine max* (L.) Merrill) Genotypes

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Nowadays, there is an increased demand for the less expensive plant-based protein sources. Due to its high protein content, legumes are considered as poor man's meat. Vegetable soybean belongs to the same species as grain soybean, are harvested at R6 growth stage (full pod) when

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the seeds are still immature and green but fully developed inside the pods (80-90% of the pod cavity). This contrast with the dry mature harvest (R8 stage) of grain soybean. In the present study, the cooking properties of 11 vegetable soybean genotypes and one check variety (DSB34-Contrl) at the R6 and R8 stages were analysed. The results of the study found significant variation ($p < 0.01$) among all the selected genotypes at both the stages. Among the R6 stage samples, AGS447 genotypes exhibited the highest swelling capacity, swelling index, cooked L/Bratio and cooked 100 seed weight. The cooking time of R6 stage samples ranged between 35.33-38.75min. The large seed genotype AGS447 observed the highest swelling capacity and index, hydration capacity and index, cooked L/B ratio, and elongation ratio. Cooking time and water uptake ratio of grain types soybean (DSB34) was significantly higher than vegetable soybean genotype at R8 stage. The solid gruel loss of AVSB2001 and AVSB2004 were high and Karune found the lowest value. Soaking and cooking are fundamental preparation steps for beans consumption, which increases the digestibility of protein, maximum retention of nutrients, reduces the antinutrients and improves the sensorial attributes.

Keywords: Genotypes; cooking property; vegetable soybean.

1. INTRODUCTION

Due to their low production costs, adaptability to a variety of climatic conditions, and abundance of macro and micronutrients, legumes are a staple food in most parts of the world. Among the legumes, soybean has grown the greatest during the last thirty years (Agyenim-Boateng et al., 2023). Soybean (*Glycine max* L. Merrill) is one of the important and oldest world crops belongs to Fabaceae family (Zewudie and Gemedie, 2024). It serves as a major oilseed crop and also provides more than a quarter of the total protein for the world's food (Tian et al., 2025). As one of the most significant crops, soybeans have the potential to significantly improve the nutritional status of people all over the world. As a functional ingredient, soybean reduces the risk of various diseases such as atherosclerosis, osteoporosis and different types of cancers. Though, India is one of the largest producers of the soybean, utilization of soybean in food use is less than 1% of the total production because of beany flavour do not suit the Indian palate (Kumar et al., 2006).

Soybeans can be consumed as a vegetable crop or processed into a variety of goods. Vegetable soybeans, also referred to as "edamame" in Japan, "maodou" in China, and "poot kong" in Korea, belongs to the same species as grain type soybean. But beans are eaten when they are still immature or unripe; in other words, the pods are picked at the R6 stage Mozzonia and Chen, 2018; Jiang et al., 2022; Ribera et al., 2022; Nair et al., 2022; Djanta et al., 2020). During crop rotation, vegetable soybean can fit into small windows due to its short growing period. Vegetable soybean can be cooked just

like sweet pea, chickpeas or lima beans, their green seeds can be added to stews and soups, boiled in salt water, or roasted like peanut seeds. Immature vegetable soybean genotypes are potential source of nutrients like vitamins (B1 and B2), minerals (iron, calcium, phosphorus), and protein content compared to green seeds of other legumes (Williams et al., 2022; Mozzonia and Chen, 2018; Ribera et al., 2022). The Antioxidant content in vegetable soybeans can strengthen the body's immune system and reduce the risk of cancer, while the presence of isoflavones that reduce cancer risk, prevent heart disease, lower blood pressure, and reduce disorders during menopause (Amilia et al., 2021).

Though many studies are available on the cooking properties of different types legumes (Chuwa et al., 2023; Wani et al., 2015; Huma et al., 2008), cooking properties data on the selected vegetable soybean genotypes harvested at two stages (R6 and R8 stage) is not widely reported. Therefore, the present study was designed to analyse the cooking properties of recently developed (<https://avrdc.org/seed/improved-lines/vegetable-soybean/>) vegetable soybean genotypes and compared the coking properties of vegetable soybean genotypes with those of the grain type soybean.

2. MATERIALS AND METHODS

The present study was conducted at the Post Graduate and Research Center, PJTAU, Hyderabad, Telangana, Inda. Vegetable soybean genotypes (n=11) namely AVSB2001, AVSB2002, AVSB2004, AVSB2006, AVSB2007, AVSB2009, AVSB2012, AVSB2013, Swarna

Vasundhara, Karune and AGS447, along with grain soybean (DSB34) were selected for the study. All the samples were harvested at R6 stage (Growth stage when the seeds are still immature and green but are fully developed inside the pods) and R8 stage (full maturity of the seed) for further evaluation. The cooking properties such as swelling capacity, swelling index, cooking time, L/B ratio and Cooked 100 beans weight of vegetable soybean genotypes at R6 stage were determined after boiling the fresh sample. While cooking properties of R8 stage vegetable soybean genotypes were analysed by the standard methods of Wani et al. (2015).

3. RESULTS AND DISCUSSION

Cooking quality of vegetable soybean genotypes at R6 stage: Cooking includes starch gelatinization, protein denaturation, polysaccharide solubilization and collapse, and softening of the structural materials in the cotyledon (Hamid et al., 2016). From the consumers point of view, the cooking quality is also judged to some extent by increase in volume after cooking, duration of cooking, amount of water absorbed and the time required to attain desired softness (Sethi et al., 2011). Cooking time is a very important quality criterion in terms of consumers. Excess cooking decreases the nutritive value of protein, and essential amino acid content (Karayel and Bozoglu, 2015). The cooking time of vegetable soybean genotypes at R6 stage ranged between 35.33-38.75min. The genotype AVSB2013 reported the lowest cooking time and DSB34 found the highest cooking time. Cooking time of vegetable soybean genotypes was significantly lower than the grain type soybean. The swelling capacity of cooked vegetable soybean genotypes at R6 stage were ranged between 0.023 (Karune)-0.048 (AGS447). The swelling index of AGS447 is significantly higher than the other genotypes. The cooked length-width ratio of AGS447 (1.35) genotypes and Karune (1.23) was significantly higher than other genotypes. The amount of increase in weight of 100 beans ranged between 63.99-81.30gm/100beans. Among the genotypes, 100 beans cooked weight was found highest in AGS447 and lowest in DSB34.

Cooking quality of vegetable soybean genotypes at R8 stage: The cooking quality properties like seed volume, swelling capacity and cooking time are important traits for consumers, particularly when whole grains are

consumed after soaking and cooking. Cooking is the fundamental preparation step of beans for consumption, which increases the digestibility of protein, maximum retention of nutrients, reduces the antinutrients and improves the sensorial attributes. The cooking properties of vegetable soybean genotypes at R8 stage were analysed and the results were presented in Table-2. Hydration capacity determines the extent to which seeds absorb water on soaking. Chemical composition of seed coat and cotyledons influences the hydration capacity of the seeds (Bewley et al., 2006). The hydration capacity of AGS447 (0.40g/ seed) was significantly higher than other genotypes. The hydration index was varied significantly ($p < 0.01$) among the genotypes. Differences in seed size, seed coat thickness and water absorption characteristics of seeds influences the differences in both hydration capacity and hydration index of vegetable soybean genotypes (Kimothi et al., 2020). Swelling capacity and swelling index also displayed significant differences among the genotypes. The swelling capacity of genotypes ranged between 0.17 (DSB34)-0.49 (AGS447). The swelling index of AGS447 was significantly higher than other genotypes. Various factors such as seed size, seed density and weigh of the grain had great influence on the swelling capacity and swelling index of the seeds (Kimothi et al., 2020). It was reported that the legumes having the higher hydration and swelling coefficients require less cooking time (Nciri et al., 2014; Thapa and Shrestha, 2017).

Water absorption of legumes is a measure of gross water uptake by seeds during soaking (Urga et al. 2006). Water uptake or water absorption capacity of seeds depends on the cell wall structure, composition of seed and compactness of the cells (Sethi et al., 2011). A significant difference was observed in the water uptake ratio of vegetable soybean genotypes. Among the genotypes highest water uptake ratio was observed in Karune (2.47) and lowest in DSB34 (2.22).

For both consumers and food processors, cooking time is an important quality attribute because longer cooking time is inconvenient, require pre-soaking and is more costly, as it requires more electricity or fuel (Wood, 2017). The amount of time required for beans to reach the cooked texture considered acceptable to consumers is called as cooking time. It is a more ideal parameter, as it is very close to the texture preferred by the

Table 1. Cooking quality of vegetable soybean genotypes at R6 stage

Genotype	Sweeling capacity	Swelling index	Cooking time	L/B ratio	Cooked weight/100beans
AVSB2001	0.035±0.00b	0.057±0.00c	35.83±0.76ab	1.13±0.00ab	64.76±0.87b
AVSB2002	0.038±0.00bc	0.069±0.01cd	36.42±1.23abc	1.07±0.02a	64.42±0.37b
AVSB2004	0.037±0.00bc	0.064±0.00cd	36.50±0.50abc	1.09±0.02a	69.37±0.83b
AVSB2006	0.038±0.00bc	0.067±0.00cd	37.70±0.61cde	1.10±0.03a	66.41±0.19b
AVSB2007	0.039±0.01c	0.073±0.00d	38.17±0.57de	1.15±0.05ab	69.00±0.45b
AVSB2009	0.039±0.00c	0.070±0.01cd	36.92±0.87abcd	1.12±0.01a	63.99±0.06b
AVSB2012	0.037±0.00bc	0.063±0.08cd	35.48±0.50a	1.11±0.02a	64.00±0.05b
AVSB2013	0.047±0.00d	0.106±0.01e	35.33±0.57a	1.14±0.05ab	64.65±0.25b
Swarna Vasundhara	0.025±0.00a	0.030±0.02c	37.44±0.38bcde	1.13±0.01ab	69.17±0.74b
Karune	0.023±0.00a	0.025±0.01ab	38.38±0.23de	1.23±0.01b	70.64±0.17b
AGS447	0.048±0.00e	0.107 ±0.01f	38.55±0.17de	1.35±0.09c	81.30±0.36c
DSB34	0.024±0.00a	0.015±0.00a	38.75±0.66e	1.11±0.02a	57.73±0.68a
F value	187.32	158.46	10.47	11.34	8.56
p value	0.00**	0.00**	0.00**	0.00**	0.00**

Note: The values are presented as the mean±SD of (n=3) replications. NS-non-significant, *Significant at 5%, **Significant at 1%. Values with a different superscript in the same column are significantly different ($p \leq 0.05$)

Table 2. Cooking quality of vegetable soybean genotypes at R8 stage

Genotype	Swelling capacity (ml/seed)	Swelling index	Hydration capacity (g/seed)	Hydration index	Water uptake ratio	Cooking time (min)	Solid loss (%)	L/B ratio	Elongation ratio
AVSB2001	0.23±0.01b	1.35±0.12bcd	0.25±0.00ab	0.91±0.07a	2.24±0.04ab	82.00±2.00abc	15.83±0.16g	1.42±0.03 ab	1.39±0.07a
AVSB2002	0.25±0.02bc	1.43±0.27bcd	0.26±0.01ab	1.28±0.14ab	2.24±0.04ab	87.33±2.51cde	12.83±0.57cde	1.38±0.04ab	1.59±0.08b
AVSB2004	0.26±0.03bc	1.32±0.14abc	0.25±0.02ab	1.18±0.09ab	2.29±0.08abc	87.00±3.60bcde	14.16±0.64f	1.48±0.03abc	1.58±0.05b
AVSB2006	0.35±0.00ef	1.62±0.07cd	0.28±0.04abc	1.07±0.18ab	2.34±0.04d	87.67±0.10cde	11.88±0.42c	1.44±0.05ab	1.62±0.03bc
AVSB2007	0.29±0.00cd	1.19±0.01ab	0.28±0.05abc	1.19±0.13ab	2.30±0.03bcd	89.00±1.00cde	12.13±0.31cd	1.36±0.03a	1.68±0.01bcd
AVSB2009	0.26±0.02bc	1.45±0.21bcd	0.27±0.02abc	1.19±0.09ab	2.26±0.01abc	84.33±0.30bcd	12.23±0.52cd	1.49±0.08bc	1.63±0.09bc
AVSB2012	0.32±0.00de	1.56±0.03cd	0.26±0.01ab	1.12±0.08ab	2.35±0.02d	80.00±0.43ab	13.04±0.00de	1.59±0.04cd	1.79±0.09d
AVSB2013	0.27±0.03bc	1.04±0.17a	0.26±0.03ab	0.94±0.06a	2.36±0.06d	76.33±1.52a	13.72±0.88ef	1.50±0.03bc	1.55±0.03b
Swarna Vasundhara	0.38±0.01f	1.63±0.23d	0.35±0.08bcd	1.01±0.23ab	2.31±0.03bcd	92.00±0.20e	9.10±0.38ab	1.69±0.02d	1.63±0.02bc

Genotype	Swelling capacity (ml/seed)	Swelling index	Hydration capacity (g/seed)	Hydration index	Water uptake ratio	Cooking time (min)	Solid loss (%)	gruel L/B ratio	Elongation ratio
Karun	0.37±0.01f	1.61±0.03cd	0.39±0.04cd	1.38±0.26ab	2.47±0.05e	85.67±0.20bcde	8.52±0.37a	1.60±0.11cd	1.68±0.14bcd
AGS447	0.49±0.03g	2.98±0.22e	0.40±0.16d	1.43±0.52b	2.32±0.02cd	91.33±0.15de	9.66±0.14b	1.68±0.15d	1.77±0.16cd
DSB34	0.17±0.02a	1.21±0.08ab	0.20±0.07a	1.14±0.47ab	2.22±0.00a	104.00±0.36f	9.50±0.26ab	1.44±0.03ab	1.64±0.04bcd
F value	44.36	29.12	2.68	1.26	8.54	9.81	41.77	8.26	4.69
p value	0.00**	0.00**	0.02*	0.30	0.00**	0.00**	0.00**	0.00**	0.00**

Note: The values are presented as the mean±SD of (n=3) replications. NS-non-significant, *Significant at 5%, **Significant at 1%. Values with a different superscript in the same column are significantly different ($p \leq 0.05$)

consumer (Moscoso et al., 1984). The cooking time of pre-soaked vegetable soybean genotypes at R8 stage were ranged between 76.33-104min. Various factors like genetics, environment, postharvest storage, pre-processing and cooking conditions influences the cooking time of the beans (Wainaina et al., 2021). Solid gruel loss (%) of genotypes varied significantly at 1% level of significance. The percentage of solid gruel loss was found highest in AVSB2004 (14.16%) and lowest was seen in Karune (8.52%). Cooked length breadth ratio showed significant differences among the genotypes and were in the range of 1.36 (AVSB2007)-1.69 (Swarna Vasundhara). Elongation of vegetable soybean genotypes were varied significantly at 1% level of significance. Various factors such as cultivar, seed characteristics, composition of seeds, growing location and environment influences the cooking quality of the genotypes calculated (Wani et al., 2015).

4. CONCLUSION

From the present study, it can be concluded that vegetable soybean genotypes varied with respect to cooking characteristics both at R6 and R8 stages. The cooking time and cooked L/B ratio of R6 stage samples ranged between 35.33-38.75min and 1.07 to 1.35, respectively. AGS447 genotypes observed the highest cooked 100 beans weight at R6 stage. The cooking quality properties of R8 stage samples such as Swelling capacity, swelling index, hydration capacity, hydration index, cooked L/B ratio, and elongation ratio of AGS447 were significantly higher than other selected genotypes. Cooking time of grain type soybean significantly higher than vegetable soybean genotypes. These findings could provide valuable insights for breeders and consumers alike, emphasizing the benefits of selecting appropriate genotypes for desired cooking characteristics.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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