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Genetic variability and genotype × environment interaction for biochemical and nutritional traits in Brinjal (*Solanum melongena* L.)

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Abstract

Brinjal (*Solanum melongena* L.) is one of the most important vegetable crops cultivated widely in tropical and subtropical regions. In addition to its economic importance, brinjal is valued for its nutritional and antioxidant properties. The present investigation was conducted to assess the variability in ascorbic acid and total phenol content among different brinjal genotypes. The experiment was carried out during Rabi 2024–25 at the College of Horticulture, Sri Konda Laxman Telangana Horticultural University, Rajendranagar, Hyderabad. Significant differences were observed among the genotypes for both biochemical traits, indicating the presence of substantial genetic variability. The ascorbic acid content ranged from 1.79 to 5.79 mg/100 g, whereas the total phenol content varied from 55.14 to 134.44 mg/100 g. Among the evaluated genotypes, IC-090942 recorded the highest ascorbic acid content (5.79 mg/100 g), while IC-354140 exhibited the highest total phenol content (134.44 mg/100 g). The wide range of variation observed for these quality traits suggests considerable scope for the improvement of nutritional and antioxidant attributes through selection and breeding. The superior genotypes identified in the present study may serve as valuable genetic resources for future brinjal improvement programmes aimed at enhancing nutritional quality and antioxidant potential.

Keywords: Brinjal, ascorbic acid, total phenols, antioxidants, genetic variability and nutritional quality

Introduction

Brinjal (*Solanum melongena* L.), commonly known as eggplant or aubergine, belongs to the family Solanaceae and is widely cultivated in India and other Asian countries. It is an important vegetable crop valued for its adaptability, productivity, and culinary uses. West Bengal is the leading brinjal-producing state. India accounts for nearly 680,000 hectares under brinjal cultivation, producing around 12,810,000 metric tonnes (NHB Database 2024).

The production of brinjal in Telangana was 54.940 tons, down from 69.213 tons in 2024 and area was reported to be 2.195 hectares (NHB Database 2024). There are three main botanical varieties under the species *melongena* (Choudhary, 1976). Round or Egg-shaped cultivars are grouped under var. *esculentum*, the long or slender types are included under var. *serpentinum* and the dwarf brinjal plants are grouped under var. *depressum*. Brinjal fruits are rich sources of minerals like calcium, magnesium, potassium, iron, zinc and copper. Eggplant is rich in glycoalkaloids, compounds known for their anti-cancer activity. One such compound, Solasodine, has been reported to inhibit human lung cancer cells under laboratory conditions (Shen *et al.*, 2017) ^[15].

Genetic variability for biochemical traits offers opportunities for the selection and development of nutritionally superior cultivars. Genetic advancement in brinjal largely depends on the systematic evaluation and characterisation of germplasm for traits of economic significance. Assessing genetic divergence is essential for pinpointing superior genotypes, safeguarding genetic resources and formulating effective breeding strategies. Investigations into genetic variability reveal the inheritance of traits and the breadth of diversity, which can be exploited to develop high-yielding, disease-resistant and climate-resilient cultivars (Allard *et al.*, 1999) ^[1].

These bioactive substances also help reduce inflammation and support cholesterol management. Alongside them, phenolic acids and anthocyanins provide a range of health benefits (Plazas *et al.*, 2013; Braga *et al.*, 2016) ^[12, 3].

The flesh of purple eggplant contains abundant nasunin, which helps mitigate lipid peroxidation and ROS buildup linked to excess iron in cells (Casati *et al.*, 2016) ^[4]. Elevated ascorbic acid levels in brinjal enhance fruit nutritive quality, supporting better preservation of flavour and colour (Kumar *et al.*, 2013) ^[9]. Glycoalkaloids present in eggplant have anti-cancer actions. Naturally occurring aglycone compound (solasodine) decreases human lung cancer cells *in vitro* (Shen *et al.*, 2017) ^[15]. They also have anti-inflammatory functions and are beneficial in lowering blood cholesterol. Both phenolic acids and anthocyanins have multiple properties beneficial for human health (Plazas *et al.*, 2013; Braga *et al.*, 2016) ^[12, 3].

Therefore, the present investigation was carried out to determine the stable genotypes both in terms of qualitative and quantitative traits. Plant breeders have been striving to develop genotypes with superior yield, quality and other desirable characteristics over a wide range of different environmental conditions. Genotype x Environment (G x E) interaction is one of the main complications in the selection of broad adaptation in most breeding programmes. The phenotype of an organism is determined by the combined effect of the environment and the genotype, which interact with one another. Numerous studies have shown that a proper understanding of the environmental and genetic factors causing the interaction, as well as an assessment of their importance in the relevant G x E system, could have a large impact on plant breeding (Kang *et al.*, 1993) ^[8] and (Bisford and Cooper, 1998) ^[2].

Materials and Methods

The present investigation was carried out at the experimental was conducted during the *Rabi* season of 2024-25 at the College of Horticulture, Rajendra Nagar, Hyderabad. The experiment was carried out in the PG block of the main campus. The soil type of the experimental field is alluvial, and the irrigation water used has a neutral PH. The region experiences a temperate climate with moderate summers. The experiment was laid out in a Randomised Block Design of Twenty diverse brinjal genotypes were evaluated for genetic evaluation and divergence studies during the *Rabi* season at the Experimental Field, College of Horticulture, Rajendranagar, Hyderabad. Qualitative parameter i.e. ascorbic acid content, were estimated through the titration method as given by Rangana (1976) and total phenol content was estimated with Folin- Ciocalteu reagent using catechol as a standard, as suggested by Thimmaiah (1999) ^[16]. Genotype x environment interaction and stability analysis of different genotypes across the six environments were worked out as per the statistical technique proposed by Eberhart and Russel (1966) ^[6].

Estimation of Ascorbic Acid

The ascorbic acid content of fresh fruits was estimated and

expressed as mg per 100 g fresh weight. Standard analytical procedures were followed for biochemical estimation.

Estimation of Total Phenol Content (Thimmaiah, 1999) ^[16]

Total phenol content was estimated using standard colourimetric procedures and expressed as mg per 100 g.

Results and Discussion

Ascorbic Acid Content (mg/100 g)

The present investigation revealed significant variation in ascorbic acid content among the evaluated brinjal genotypes, indicating substantial genetic diversity with respect to nutritional traits. The ascorbic acid content ranged from 1.79 to 5.79 mg/100 g. The genotype IC-090942 recorded the highest ascorbic acid content (5.79 mg/100 g), followed by IC-090031 (3.65 mg/100 g) and IC-111010 (3.58 mg/100 g). The higher ascorbic acid content observed in these genotypes indicates their superior nutritional quality and antioxidant potential. Since vitamin C plays an important role in improving human health by scavenging free radicals and enhancing immunity, these genotypes can be considered promising candidates for nutritional improvement programmes. Lower values of ascorbic acid were observed in genotype IC-090099, which recorded the minimum value of 1.79 mg/100 g. The variation observed among the genotypes may be attributed to differences in genetic constitution, enzyme activity, and biosynthetic pathways involved in ascorbic acid synthesis. The existence of wide variability for ascorbic acid content among brinjal genotypes has also been reported by several earlier workers, confirming the possibility of improving nutritional quality through selection and breeding. Sharma *et al.* (2018) also reported significant differences in ascorbic acid content among brinjal genotypes due to genetic variability and environmental influence. The existence of wide variability for ascorbic acid content in the present study confirms the possibility of improving nutritional quality in brinjal through selection and breeding approaches.

Total Phenol Content (mg/100 g)

Significant variation was also observed among the evaluated genotypes for total phenol content. The phenol content ranged from 55.14 to 134.44 mg/100 g. Among the genotypes, IC-354140 exhibited the highest phenol content (134.44 mg/100 g), followed by IC-347962 (132.75 mg/100 g) and IC-345738 (131.59 mg/100 g). Phenolic compounds are important antioxidants that contribute to plant defense mechanisms and protect plants against various biotic and abiotic stresses. Higher phenol content may also contribute to enhanced resistance against pests and diseases. The lowest phenol content was recorded in genotype Shyamala (55.14 mg/100 g). Similar findings were also reported by M. A. Hanson and Yang (2006) ^[7]. The observed differences among the genotypes may be due to variations in genetic makeup, metabolic efficiency, and environmental interactions influencing phenolic biosynthesis. The presence of genotypes with high phenolic content suggests their potential utility in breeding programmes aimed at improving antioxidant properties and stress tolerance in brinjal.

Mean performance of different genotypes for ascorbic acid and total phenol content

S. No.	Name of the Genotype	Ascorbic acid (mg/100 gm)	Total phenols (mg/100 gm)
1	IC-111010	3.58	68.41
2	IC-111013	2.60	64.46
3	IC-345738	2.19	131.59
4	IC-104076	1.99	86.40
5	IC-345748	3.47	98.46
6	IC-111018	2.86	68.98
7	IC-090099	1.79	98.90
8	IC-354511	3.10	89.30
9	IC-347962	2.57	132.75
10	IC-104089	3.30	114.21
11	IC-354525	2.08	91.04
12	IC-354539	2.45	107.42
13	IC-090942	5.79	113.11
14	IC-354140	2.24	134.44
15	IC-090031	3.65	96.18
16	Pusa Hara Baigan	2.15	100.42
17	Gulabi	2.46	121.67
18	Pusa Purple Long	2.72	69.08
19	Shyamala	2.30	55.14
20	Bhagyamathi	3.00	109.96
	S.Em	0.06	7.46
	CD	0.17	20.85
	CV	439	5.56

Conclusion

The present investigation demonstrated considerable variability among brinjal genotypes for ascorbic acid and total phenol content. Genotype IC-090942 was identified as superior for ascorbic acid content, whereas IC-354140 showed maximum total phenol content. The identified genotypes possessing higher nutritional and antioxidant properties may be effectively utilized in future breeding programmes aimed at developing quality-rich brinjal varieties. The study also highlights the importance of biochemical characterization in selecting nutritionally superior germplasm for crop improvement and functional food development.

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