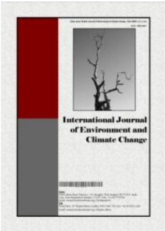

International Journal of Environment and Climate Change

12(11): 1419-1425, 2022; Article no.IJECC.90114
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Nutrient Composition and Total Antioxidant Activity in Eggplant (*Solanum melongena*) Germplasm

Minakshi Dutta [a#], Debanjal Borah [a#], Samindra Baishya [a†] and Sunayana Rathi [a*]

[a] *Department of Biochemistry and Agricultural Chemistry, Assam Agricultural University, Jorhat-785013, India.*

Authors' contributions

This work was carried out in collaboration among all authors. Author MD designed the study methodology, data compilation and writing initial draft of the manuscript. Author DB performed the statistical Analysis of the study. Author SB managed the editing of the paper. Author SR did the concept, methodology and final editing. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2022/v12i1131121

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/90114

Original Research Article

Received 02 June 2022
Accepted 08 August 2022
Published 11 August 2022

ABSTRACT

Brinjal, also referred to as eggplant, is one of the most consumed vegetables worldwide. In this investigation, the nutritional makeup and antioxidant capacities of ripe fruits from six different eggplant germplasms were assessed using accepted methodologies. Germplasms differed significantly in terms of variables such as moisture (88.140–91.327%), total soluble sugar (4.559–6.827%), ash (6.576–9.5%), reducing sugar (0.575–3.383%), crude fat (0.940-1.813%), crude protein (0.783–2.736%), and crude fibre (1.410–3.420%). Ascorbic acid, chlorogenic acid, total phenol, anthocyanins, flavonoids, and DPPH radical scavenging activity all exhibited antioxidant properties, with respective concentrations of 12.486-31.78 mg/100g, 150.820-342.650 mg/100g, 604.920-1007.006 mg GAE/100g, 5.156-14.5174 mg/100g, 10.729-22.192 mg/100g, and 88.860-205.070 µg/ml IC_{50}. The nutritional value of JC-1 and the antioxidant characteristics of SM-6-7 were shown to be superior to other germplasms. The superior germplasms can be recommended for consumption as well as for use in breeding.

[#] *Research Scholar;*
[†] *Prof. & Head, of Biochemistry and Agricultural Chemistry, AAU;*
**Corresponding author: E-mail: sunayana.rathi@aau.ac.in;*

Keywords: Anthocyanin; brinjal; fibre; flavonoids; soluble sugar.

1. INTRODUCTION

In all of India, eggplant, also known as brinjal, or *Solanum melongena* L., is a widely produced and consumed vegetable. In practically all Indian cuisines, it has a notable presence. In addition to its culinary qualities, eggplants provide a number of health advantages. One vegetable with a lot of antioxidant activity is eggplant. In India, eggplant is frequently referred to as baingan and goes by a variety of names in various Indian languages, including badne kai in Kannada, begun in Bengali, vankaya in Telugu, bengena in Assamese, and vangi in Marathi. These names were derived from the Sanskrit word "Vatingam" which describes the vegetable's capacity to absorb gas. It is thought that eggplant originated in the Indo-Burman region and then expanded to temperate and tropical regions of the world. Due to its diversity, China is viewed as the secondary centre of origin for eggplant, whereas India is thought to be its primary source [1]. In India, Nepal, Bangladesh, Pakistan, China, the Middle East, the Philippines, the Far East, Egypt, Italy, France, and the United States, eggplant is widely grown [2]. India and China are the top two producers of eggplant.

As a result of its excellent nutritional value and low caloric value, eggplant is an often-consumed food. In addition to having a variety of bioactive substances like phenolics, carotenoids, and alkaloids, eggplant is a rich source of minerals like potassium, magnesium, calcium, sodium, and iron [3]. It also contains saccharides like glucose and fructose. Hydroxycinnamic acids (HCA) and its derivatives are the class of phenolic acid that is most frequently found [4]. Ascorbic acid and phenol, which give eggplant its antioxidant properties, are abundant in eggplant. The phenolic content, skin colour, and fruit size of eggplant all have a positive correlation with its antioxidant capacity. Purple eggplant peel has a stronger antioxidant potential because it contains the potent anthocyanin nasunin, also known as delphinidin-3-p-coumaroylrutinoside-5-glucoside, which inhibits lipid peroxidation and has the ability to chelate iron and reduce ROS production [5]. Assam cultivates a variety of native eggplant genotypes in addition to improved cultivars, although information on their biochemical properties appears to be scarce. The germplasms selected in this study has not been explored earlier for their nutritional and antioxidant activity. In light of the aforementioned facts, a study was done to determine the nutritional makeup and antioxidant activity of Assam eggplant germplasm.

2. MATERIALS AND METHODS

Six eggplant germplasm varieties' mature fruits, JC-1, MLC-1, MLC-3, Longai-R-1, Longai-R-2, and SM-6-7 were collected and examined for a variety of criteria from the Horticultural Experimental Farm of the Assam Agricultural University in Jorhat, Assam.

2.1 Nutritional Components

By oven drying the sample for 48 hours at 80°C (±2) until a consistent weight was attained, moisture was ascertained [6]. By utilising the anthrone method given by Clegg [7] and the method using dinitrosalicylic acid as a reagent described by Miller [8], respectively, the total soluble sugar and the reducing sugar were calculated. The crude protein content of the sample was calculated using the nitrogen value multiplied by the factor 6.25 using the Kjeldahl technique [9]. The amount of crude fat and crude fibre was measured using the Soxhlet extraction device and a defatted sample, respectively, according to the AOAC's [6] guidelines. The AOAC's [9] technique was used to determine the ash (total mineral) concentration.

2.2 Antioxidant Properties

By slightly modifying the Folin-Ciocalteau assay described by Slinkard and Singleton [10] and using gallic acid as the reference ingredient, the total phenolic content (TPC) of eggplant extract was measured. The results were represented in mg gallic acid equivalents per 100 g of dried sample. The Folin-Ciocalteau reagent was used to determine the chlorogenic acid using the method Swain and Hill [11] outlined. Quercetin was employed as the reference compound, and the values were reported in mg of quercetin equivalents per 100 g of dry weight sample, using the method outlined by Woisky and Salantino [12]. By utilising acidified ethanol (ethanol and HCl 1.0 N, 85:15 v/v), the Abdel-Aal and Hucl technique [13] was used to assess the anthocyanin content. The results were expressed as mg cyanidin-3-O-glucoside equivalents per 100 g of fresh sample. By employing the 1, 1-

diphenyl-2-picryl-hydrazyl (DPPH) technique developed by Vani et al. [15] and Blois [14], the antioxidant activity was evaluated. Using ascorbic acid as a reference substance, the interpolation from the linear regression curve was used to determine the percent inhibition and the concentration of the sample required to reduce the DPPH concentration by 50% (IC_{50} value). A one-way analysis of variance was performed using the SPPS 25.0 programme for Windows on the data collected in triplicates.

3. RESULTS AND DISCUSSION

Tables 1 and 2 show, respectively, the nutritional makeup and antioxidant properties of the ripe fruits of six different eggplant germplasms. While dried samples were utilized for other parameters (total soluble sugar, reducing sugar, crude fibre, crude fat, crude protein, ash, total phenol, chlorogenic acid and total flavonoids), fresh samples were used to measure ascorbic acid, anthocyanin, moisture content, and total antioxidant activity by DPPH. The germplasm Longai-R-1 (91.32 percent) and SM-6-7 (88.14 percent) had the highest and lowest moisture contents, respectively, supported by the works of Hanson et al. [16] and Kandoliya et al. [17]. Similar values by Khan et al. [18] supported that the total soluble sugar concentration was highest in MLC-1 (6.82 g/100g) and lowest in Longai-R-2 (4.55 g/100g). The reducing sugar concentration was discovered to be highest in JC-1 (3.38 mg/100g) and lowest in MLC-1 (0.57 mg/100g).

The present findings are supported by reports on lowering sugar by Singh et al. [19] and Bajaj et al. [20]. It was discovered that the crude protein content varied from 0.78 (SM-6-7) to 2.73 (JC-1) g/100g, which is higher than the values reported by Raigon et al. [3]. This difference in the crude protein content could be explained by variations in genotype, the nutritional status of the soil, or other biotic interactions. Similar to the results published by San José et al. [21], the crude fibre content was determined to be lowest in MLC-3 (1.41 percent) and greatest in Longai-R-2 (3.42 percent). The crude fat content was found to be lowest in Longai-R-2 (0.94%) and greatest in MLC-3 (1.81%), which is really corroborated by the studies of Joel et al. [22]. According to Khan et al.'s [18] comparable findings, the ash concentration was found to be lowest in SM-6-7 (6.57 g/100g) and highest in Longai-R-2 (9.50 g/100g).

According to the findings of Medina et al. [23], the amounts of ascorbic acid were found to be highest in JC-1 (31.780 mg/100g) and lowest in Longai-R-1 (12.486 mg/100g). Similar to the values reported by Hanson et al. [16], the total phenol content was found to be lowest in Longai-R-1 (604.92 mg GAE/100g) and greatest in SM-6-7 (1007.00 mg GAE/100g). Due to the various processing techniques used, Sembring and Chin [24] and Kadhim et al. [25] reported reduced TPC content, which may differ from the results of the current investigation. The most prevalent hydroxycinnamic acid (HCA) derivative discovered in eggplant is chlorogenic acid [26, 4]. The eggplant utilised in this investigation had between 150.82 (Longai-R-1) and 342.65 (MLC-1) mg/100g of chlorogenic acid, which is supported by the work of Gajewski et al. [27]. The anthocyanin concentration ranged from 5.15 mg Cya-3-gluE/100g (SM-6-7) to 14.51 mg Cya-3-gluE/100g (Longai-R-1). Despite having the highest antioxidant activity, cultivar SM-6-7 had the lowest anthocyanin level. This may be because less peel was included in the sample during the research because the fruit is oval-shaped. The range of 10.72 (MLC-3)-22.19 (JC-1) mg QE/100g obtained for the flavonoid content was in good accord with the values reported by Kaur et al. [28] 5.00–26.00 mgQE/100g, 3.00–10.00 mgQE/100g, 9.00–11.00 mgQE/100g, and 6.00–12.00 mgQE/100g in wild genotypes, purple genotypes, white genotypes, and green genotypes on a fresh weight basis were found to be in good accord with the current study. Eggplant germplasm had significant antioxidant activity, with an IC_{50} value between 89.13 and 205.52 µg/ml. The high phenolic content of the germplasm may be responsible for the high antioxidant activity. MLC-1 had the lowest antioxidant activity, while SM-6-7 had the highest. The results of this study were discovered to be consistent with the values published by Nisha et al. [29].

Table 1. Nutrient composition of eggplant germplasm (dry weight basis)

Genotype/Parameters	JC-1	Longai-R-1	Longai-R-2	MLC-1	MLC-3	SM-6-7	$CD_{0.05}$	S.Ed
Moisture (%)	89.72±0.71[bc]	91.32±0.61[a]	90.47±0.73[abc]	89.14±0.24[cd]	90.85±0.24[ab]	88.14±0.34[d]	0.94	0.43
Total soluble sugar (g/100g DW)	6.00±0.004[b]	5.89±0.012[c]	4.55±0.01[f]	6.82±0.01[a]	5.03±0.02[d]	4.97±0.01[e]	0.03	0.01
Reducing sugar (g/100g DW)	3.38±0.31[a]	1.93±0.05[c]	1.66±0.08[c]	0.57±0.02[d]	0.93±0.04[d]	2.74±0.14[b]	0.26	0.12
Crude protein (g/100g DW)	2.73±0.16[a]	1.76±0.24[b]	1.46±0.19[bc]	1.30±0.11[c]	1.72±0.14[bc]	0.78±0.10[d]	0.29	0.13
Crude fibre (% DW)	1.73±0.08[c]	2.43±0.23[b]	3.42±0.09[a]	2.650±0.095[b]	1.41±0.35[c]	2.67±0.09[b]	0.34	0.15
Crude fat (% DW)	1.14±0.05[d]	0.98±0.02[e]	0.94±0.04[e]	1.45±0.008[b]	1.81±0.02[a]	1.24±0.01[c]	0.05	0.02
Ash (g/100g DW)	7.33±0.22[b]	7.51±0.25[b]	9.50±0.21[a]	9.26±0.24[a]	7.58±0.23[b]	6.57±0.32[c]	0.45	0.20

[a-f] Means in the same row with different letters are significantly different ($P < 0.05$)
Means±standard deviation of three replications

Table 2. Antioxidant properties of eggplant germplasm

Genotype/Parameters	JC-1	Longai-R-1	Longai-R-2	MLC-1	MLC-3	SM-6-7	$CD_{0.05}$	S.Ed
Ascorbic acid (mg/100g FW)	31.78±0.72[a] (309.14)*	12.48±0.28[f] (143.85)*	16.93±0.11[d] (177.68)*	15.29±0.50[e] (140.82)*	25.43±0.43[b] (277.99)*	21.58±0.28[c] (181.98)*	0.78	0.35
Total Phenol (mg GAE/100gm DW)	903.12±1.06[b]	604.92±1.25[e]	702.70±0.28[c]	631.08±0.55[d]	903.80±0.45[b]	1007.00±1.20[a]	1.02	0.46
Chlorogenic acid (mg/100g DW)	300.28±0.47[b]	150.82±0.57[f]	164.85 ±0.95[e]	342.65±1.93[a]	274.63±0.61[c]	224.07±1.11[d]	1.92	0.87
Anthocyanin content (Cya-3-gluE mg/100g FW)	10.92±0.34[b] (106.26)*	14.51±1.16[a] (167.25)*	10.59±0.84[c] (110.58)*	8.60±0.89[e] (79.22)*	9.34±0.33[d] (102.07)*	5.15±0.30[f] (43.47)*	1.31	0.59
Flavonoid content (mg QE/100g DW)	22.19±0.38[a]	12.28±0.27[d]	13.05±0.46[d]	19.72±0.25[b]	10.72±0.50[e]	14.78±0.03[c]	0.63	0.29
IC_{50} (µg/ml FW)	92.79± 0.19[e] (0.09 mg)*	111.68±0.73[c] (0.13 mg)*	105.03±0.61[d] (0. 11mg)*	205.52±0.54[a] (0.18 mg)*	195.30±1.26[b] (0.21 mg)*	89.13± 0.23[f] (0.07 mg)*	1.25	0.56

[a-f] Means in the same row with different letters are significantly different (P <0.05)
*Means±standard deviation of three replications, *Values inside brackets are on dry weight basis*

4. CONCLUSION

From the current study, it can be concluded that there is intervarietal diversity in the eggplant germplasm, which can be used in the future for various breeding programmes to generate an improved variety or be advised for consumption. The eggplant germplasm JC-1 was discovered to have high nutritional qualities with the highest amounts of reducing sugar, crude protein, flavonoid content, and ascorbic acid and the germplasm SM-6-7 was discovered to be superior in terms of antioxidant properties having highest antioxidant activity and highest content of total phenol among the other germplasms studied. These basic nutritional and antioxidant activity information on the eggplant germplasms from Assam can be used in varietal improvement programmes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Zeaven AC, Zhukovsky PM. Dictionary of cultivated plants and their centre of diversity. Wageningen, Netherlands. 1975;21.
2. Khan MM, Khan MY, Ullah RMK, Yasir M, Khalid A, Khan MA. Morphological and biochemical characters of eggplant (*Solanum melongena*) conferring resistance against whitefly (*Bemisia tabaci*). Journal of Entomology and Zoology Studies. 2018;6:915.
3. Raigon MD, Prohens J, Muñoz-Falcón JE, Nuez F. Comparison of eggplant landraces and commercial varieties for fruit content of phenolics, minerals, dry matter and protein. Journal of Food Composition and Analysis. 2008;21:370-376.
4. Stommel JR, Whitaker BD, Haynes KG, Prohens J. Genotype × environment interactions in eggplant for fruit phenolic acid content. Euphytica. 2015;205:823.
5. Noda Y, Kneyuki T, Igarashi K, Mori A, Packer L. Antioxidant activity of nasunin, an anthocyanin in eggplant peels. Toxicology. 2000;148:119.
6. AOAC. Official Method of Analysis of Association of Official Analytical Chemists. 11th Edition, Washington, D.C., 1970.
7. Clegg KM. The application of anthrone reagent to the estimation of starch in cereals. Journal of the Science of Food and Agriculture. 1956;7:40.
8. Miller GL. Use of Dinitrosalicylic Acid Reagent for Determination of Reducing Sugars. Analytical Chemistry. 1972; 32:426.
9. AOAC. Official Method of Analysis of Association of Official Analytical Chemists. 17th Edition. Washington, D.C.; 2000.
10. Slinkard K, Singleton VL. Total phenol analyses: automation and comparison with manual methods. American Journal of Enology and Viticulture. 1977;28:49.
11. Swain T, Hills WE. The phenolic constituents of *Prunus domestica*. i.—the quantitative analysis of phenolic constituents. Journal of the Science of Food and Agriculture. 1959;10:63.
12. Woisky RG, Salatino A. Analysis of Propolis: Some parameters and procedures for chemical quality control. Journal of Apiculture Research. 1998; 37:99.
13. Abdel-Aal ESM, Hucl P. A rapid method for quantifying total anthocyanins in blue aleurone and purple pericarp wheats. Cereal Chemistry. 1999;76:350.
14. Blois MS. Antioxidant determinations by the use of a stable free radical. Nature. 1958;181:1199–120.
15. Vani T, Rajani M, Sarkar S, Shishoo CJ. Antioxidant properties of the ayurvedic formulation Triphala and its constituents. International Journal of Pharmacognosy. 1997;35:313.
16. Hanson PM, Yang RY, Tsou SCS, Ledesma D, Engle L, Lee TC. Diversity on eggplant (*Solanum melongena*) for superoxide scavenging activity, total phenolics and ascorbic acid. Journal of Food Composition and Analysis. 2006; 19:594–600.
17. Kandoliya UK, Bajaniya VK, Bhadja NK, Bodar NP, Golakiya BA. Antioxidant and nutritional components of eggplant (*Solanum melongena* L.) fruit grown in Saurastra region. International Journal of Current Microbiology and Applied Sciences. 2015;4:806-813.
18. Khan IA, Habib K, Akbar R, Khan A, Saeed M, Farid A, Ali I, Alam M. Proximate chemical composition of brinjal, *Solanum melongena* L. (Solanales: Solanaceae), genotypes and its correlation with the insect pests in Peshawar. Journal of Entomology and Zoology Studies. 2015; 3:303-306.

19. Singh R, Singh J, Nandpuri KS. Chemical evaluation of some promising varieties of brinjal (*Solanum melongena* L.). Indian Journal of Horticulture. 1974:31:242-245.
20. Bajaj KL, Kaur G, Chadha ML. Glycoalkaloid content and other chemical constituents of the fruits of some eggplant (*Solanum melongena* L.) varieties. Journal of Plant Foods. 1979;3:163-168.
21. San José R, Sánchez MC, Cámara M, Prohens J. Composition of eggplant cultivars of the Occidental type and implications for the improvement of nutritional and functional quality. International Journal of Food Science and Technology. 2013;48:2490-24994.
22. Joel N, Idaresit E, Anselm O, Stella U, Ojinnaka MC. Impact of blanching pretreatment on the quality characteristics of three varieties of oven dried eggplant, International Journal of Agriculture and Biology. 2019;3:15-26.
23. Medina NG, Muy D, Gardea AA, Aguilar GAG, Heredia JB, Baez M, Cepeda JS, Velez R. Nutritional and nutraceutical components of commercial eggplant types grown in Sinaloa, Mexico. Notulae Botanicae Horti Agrobotanici Cluj-Napoca. 2014;42:538-544.
24. Sembring HS, Chin KB. Antioxidant activities of eggplant (*Solanum melongena*) powder with different drying methods and addition levels to pork sausages. Food Science and Animal Resources. 2021;41(4):715-730.
25. Kadhim NJ, Al-Rekaby LS, Redha AA, Chapell J. Chemical composition and antioxidant capacity of eggplant parts during vegetative and flowering stage. Journal of Physics: Conference Series. 2019;1294:092013. DOI:10.1088/1742-6596/1294/9/092013.
26. Medina GN, Orona VU, Rangel MD, Heredia JB. Structure and content of phenolics in eggplant (*Solanum melongena*) - a review. South African Journal of Botany. 2017;111:161-169.
27. Gajewski M, Katarzyna K, Bajer M. The influence of postharvest storage on quality characteristics of fruit of eggplant cultivars. Notulae Botanicae Horti Agrobotanici Cluj-Napoca. 2009;37:200-205.
28. Kaur C, Nagal S, Nishad J, Kumar R, Sarika. Evaluating eggplant (*Solanum melongena* L.) genotypes for bioactive properties: a chemometric approach. Food Research International. 2014;60:205–211.
29. Nisha P, Nazar PA, Jayamurthy P. A comparative study on antioxidant activities of different varieties of *Solanum melongena*. Food and Chemical Toxicology. 2009;47:2640-2644.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/90114