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Biochemical variability of eggplant peel among Indian cultivars

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The vegetable production comes with a considerable amount of putrescible biowastes. Nowadays, biowaste production and its underutilizationis perceived as the primary concerns, due to the economic and environmental expenses associated with its disposal. Eggplant peel is discarded sometimes as a biowaste that leads to the substantial losses of organic substances which often have very high levels of crucial bioactive compounds. Here, we determined the biochemical composition of the eggplant peel of the important Indian eggplant cultivars. A high percentage of dry matter content, as well as high fruit phenolics, were determined in the eggplant peel. Interestingly a robust negative correlation was determined between the peel chlorogenic acid content and ascorbic acid content. Overall, this study highlights the biochemical composition of eggplant peel and this information can be targeted on the potential usage of eggplant peel as a natural component for industrial product formulation.

Keywords: Chlorogenic acid, Eggplant, Fruit, Indian cultivars, Peel, Phenolics, Phemol acids

The vegetable production comes with producing considerable worldwide quantities of putrescible biowastes. Nowadays, biowastes production and its underutilization are perceived as the central issue of social concern, because of the environmental and economic expenses associated with its production as well as its disposal[1]. The vegetable farms result in the significant losses of organic materials that sometimes contain high levels of valuable bioactive compounds.Consumers prefer eggplant varieties abundant in bioactive chlorogenic acid. For all the biochemical characteristics studied, the phenolics information in the fruit (total phenolics) is regarded as a highly important character. Eggplant fruits are highly abundant in the phenolic acids[2].

Eggplant fruits contain an ample supply of dietary supplements and health-promoting metabolites such as anthocyanins (delphinidin glycosides) and phenolics. Rendering to its high nutraceutical and antioxidant properties eggplant is also called as protective food[3, 4]. The main classes of bioactive compounds present in the vegetables include phenolics, carotenoids, and vitamins. In this direction, phenolic compounds, especially the phenolic acids, are the focus of many crop improvement programs because of their properties for human health. In comparison, eggplant fruits also contain several anti-nutritional compounds, like saponins and steroidal glycoalkaloids (SGA), which are responsible for the bitter taste and with potential toxic effects on humans[5].

The food industry is scurrying towards functional foods. The initiatives also involving vegetables for the enhancement of bioactive composition of vegetables to provide the vital nourishment and even as a medicine against chronic illnesses, for instance, diabetes, obesity, hypertension, and cardiac issues[6]. Eggplant with its large fruit size and shows an excellent build-up of these metabolites in its fruits and there is a significant variation among different eggplant cultivars an wild relatives for the composition of these bioactive compounds[7]. Nevertheless, the oxidation of phenolic acids results in the browning. In general, the identification of a suitable donor parent, evaluating the genetic variation as well as diversity is essential for vigorous breeding. Eggplant (*Solanum melongena* L.) is the third most consumed vegetable of the family Solanaceae.Eggplant has substantial beneficial consequences on human health because of its increased content of phenolic acids[8]. Besides, the wild relatives of eggplant typically have higher concentrations and diversity higher of phenolic acid content as opposed to the contemporary cultivated

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varieties. Hence, the aim of the current study was related to evaluating the composition of eggplant peel of the important eggplant cultivars from India.

Material and Methods

Plant material and growing conditions

Six extensively cultivated eggplant cultivars were used in the present study. The cultivars are different based on their fruit colour and fruit shape, as presented in (Table 1). The plants were grown under the open field conditions at the Department of Botany, Ranchi University, Ranchi Jharkhand, India. The plants were planted in a randomized complete block design in three replications with five plants in each replication. All plant production practices were followed based on package and practices define elsewhere (Anonymus 2002).

Sample Preparation and Characterization

Five fruits with each replication were collected and processed at a commercially ripe stage (physiologically immature) for the biochemical characterization. Peel of each fruit was carefully removed and obtained after eliminating the stylar end of the fruit. After that, the peel tissues were snap-frozen (with liquid nitrogen)and were further stored at the −20°C.

The fraction of change in weight before as well as after the lyophilization procedure was used as the degree of dry material content. The Folin Ciocalteu based spectrophotometric method was used to calculate the overall phenolics (mg/g of dw) of the eggplant peel as defined elsewhere[9]. The determination of CGA content was carried out with the help of high-performance liquid chromatography (HPLC) on a 1220 Infinity LC System (Agilent Technologies, CA, Santa Clara, USA). The calculations had been carried out by the OpenLAB CDS ChemStation Edition program (Agilent Technologies) based on the manufacturer's directions. The determination of ascorbic acid was carried using the HPLC instrument further using the protocol discussed by Kadivec *et al.* [10]. Soluble solids were estimated utilizing the refractometer (RA-130-KEM, Kyoto Electronics Manufacturing Co., Ltd. , Kyoto, Japan)at room temperature.

Table 1—List of eggplant cultivars used for the peel biochemical characterization

Variety	Fruit Shape	Fruit Color	Place*
Pusa Purple Long	Long Type	Purple	IARI, New Delhi
Arka Shirish	Long Type	Green	IIHR, Bangalore
Punjab Sadabahar	Long Type	Purple black	PAU, Ludhiana
PusaUpkar	Round Type	Purple black	IARI, New Delhi
Pusa Ankur	Round Type	Purple	IARI, New Delhi
Pusa Kranti	Oblong Type	Purple	IARI, New Delhi

*Where the cultivar is developed namely, Indian Agriculture Research Institute (IARI), Indian Institute of Horticultural Research (IIHR) and Punjab Agricultural University (PAU), respectively

Data Analysis

All data analysis was carried out with the assistance of the Statgraphics Centurion XVI software program (StatPoint Technologies, VA, Warrenton, USA). The regular (Unweighted Pair Group Method with Arithmetic Mean) UPGMA method of hierarchical clustering was with the R platform.

Results and Discussion

There were significant differences for most of the trait studied ($P \leq 0.05$) except for the chlorogenic acid and the ascorbic acid content (Table 2). The highest values of the

Table 2 — Variation in the means for the biochemical composition of eggplant peel

Cultivars	Dry matter (%)	Total phenolics (g/kg of dw)	Chlorogenic acid content (mg/g of dw)	Ascorbic acid (mg/kg of dw)	Soluble solids (°Brix)
Pusa Purple Long	8. 15ab	8. 40b	1. 67a	56. 33b	6. 43b
Arka Shirish	9. 80b	12. 10c	1. 90a	50. 23ab	6. 66b
Punjab Sadabahar	6. 84a	12. 23c	2. 15a	43. 22ab	5. 8bc
PusaUpkar	7. 14a	6. 22a	1. 83a	52. 34ab	3. 98a
Pusa Ankur	9. 60b	10. 45bc	2. 02a	38. 35a	4. 57ab
Pusa Kranti	9. 43b	9. 61b	1. 98a	50. 92ab	6. 05bc
Mean	8. 50	9. 84	1. 91	48. 57	5. 58
Standard Error	0. 53	0. 94	0. 07	2. 68	0. 44
*CV (%)	15. 34	23. 36	9. 31	13. 53	19. 20
F-ratio	6. 80	21. 12	0. 11	1. 76	4. 60
P-value	0. 01	0. 01	0. 98	0. 26	0. 04

*, coefficient of variation (CV %) estimated as the ratio of the standard deviation to the mean (average) × 100. Also, the symbol (a, b, c *etc*.) show significant differences amongwith respect to the Student-Newman-Keuls test

coefficient of variation were determined for the total phenolics, whereas the least values were determined for the chlorogenic acid content (Table 2). The highest dry matter content was established in the peel of Arka Shirish (9. 8%), and the least percentage of the dry matter content was determined in the skin of PusaUpkar (7. 14%). Total phenolics were highest in the peel of Pusa Ankur, and the highest chlorogenic acid content was in the peel of Punjab Sadabahar. Overall highest ascorbic acid content was present in the peel of Pusa Purple Long, and the top value for the soluble solids was estimated in the peel of cultivarArka Shirish (Table 2).

The UPGMA based clustering method was able to cluster the six eggplant cultivars based on the peel biochemical traits into two different clusters, the genotype Punjab Sadabahar and Pusa Ankur were cluster together (Fig. 1). The cophenetic correlations coefficient of clustering was 0. 85, pointing out an efficient clustering. The correlation among the different traits is provided in (Table3). There was only one highly significant and negative correlation determined between the chlorogenic acid content and the ascorbic acid content (Table 3). Principal component analysis (PCA) results are presented in (Table 4). PCA analysis clearly showed that the first two components together governed 80.81 % of the total variability (Table 4). In both the principal elements, the coefficients corresponding to the ascorbic acid were positive, followed by the dry matter content for component 1 was negative, whereas the component 2 was positive (Table 5).

In this experiment, we determined the biochemical compositions of the eggplant peel. Concerning the elements used for distinction of phenolic compounds in eggplant, we identified polyphenols belonging to chlorogenic acids[11]. Based on earlier observations, chlorogenic acid was the predominant monomeric phenol compound detected, accounting for up to 90 percent of total polyphenols focus of the eggplant pulp[12]. Despite that, as previously reported, we found considerable differences among cultivars for this particular variable, that had been large as a result of the genotype-dependent disparities in 5-O-caffeoylquinic acid[13].

Stommel and Whitaker (2003), identified the presence of 14 hydroxycinnamic acids conjugates using HPLC-MS and NMR spectroscopy in seven commercially eggplant cultivars. In this specific investigation, experts divided the phenolic acid food items into five groups. All the modifications, as mentioned earlier, gave results that are interesting from the perspective of eggplant peel utilization for industrial uses[14]. These varietal differences might be exploited for a far better valorization of the raw material, on the foundation of many specific requests by the manufacturing processors[15]. The phytochemicals yield determined in this particular study suggests that the residual misuse of eggplant fruits may be viewed as an exploitable tool of extremely valuable phytochemicals, at a minimum concerning caffeoylquinic acids and glycoalkaloids[16]. This proposes that these parameters, after cultivar specific calibrations, could represent non-destructive and rapid means to determine the best better harvest time to optimize the phytochemical gain from the eggplant fruits[17]. On the other hand transgenics and genome editing methods can be used for the overexpression of genes related to production of useful phythochemicals in the plant tissues[18].

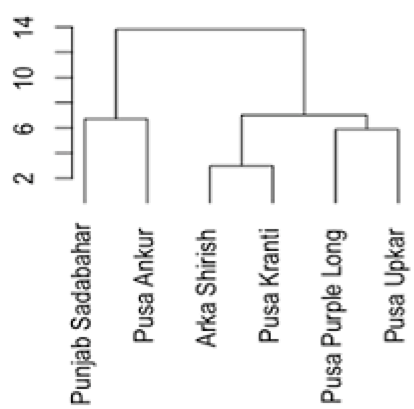

Fig. 1 — Clustering of eggplant cultivars with the Unweighted Pair Group Method with Arithmetic Mean (UPGMA) method. The cophenetic correlation coefficient of clustering is 0.85

Table 3—Pearson's correlation coefficients for the critical traits in the eggplant peel estimated in the six eggplant cultivars from India

Traits	Total phenolics (g/kg of dw)	Chlorogenic acid content (mg/g of dw)	Ascorbic acid (mg/kg of dw)	Soluble solids (°Brix)
Dry matter (%)	0.322	−0.048	−0.135	0.321
Total phenolics (g/kg of dw)		0.640	−0.538	0.552
Chlorogenic acid content (mg/g of dw)			−0.811*	−0.136
Ascorbic acid (mg/kg of dw)				0.358

*indicate significant at P <0. 01

Table 4— Eigen vectors and eigen values for the first two components

Component	Eigenvalue	Percentage of Variance	Cumulative Percentage
Component 1	2.37	47.48	47.48
Component 2	1.66	33.33	80.81

Table 5— Correlation of the components and the traits

Trait	Component 1	Component 2
Ascorbic acid (mg/kg of dw)	0.56	0.31
Dry matter (%)	−0.18	0.46
Chlorogenic acid content (mg/g of dw)	−0.57	−0.24
Total phenolics (g/kg of dw)	−0.55	0.33
Soluble solids(°Brix)	−0.06	0.71

Conclusion

Vegetable production has a significant quantity of putrescible biowastes. Nowadays, biowastes generation and its underutilization are in fact seen as the main concerns, on account of the environmental and economic expenses linked with its disposal. Eggplant peel is discarded often as a biowaste which results in the sizable losses of organic things that usually have high levels of essential bioactive compounds.In this work, we identified the biochemical structure of the eggplant peel of the necessary Indian eggplant cultivars. A top percent of dry matter and increased fruit phenolics were driven in the eggplant peel. This particular study highlights the biochemical structure of eggplant peel this info is usually specific over the possible use of eggplant peel like an all-natural part for manufacturing product formulation.

Conflict of interest

All authors declare no conflict of interest.

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