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Relationship between pod colour and nutritional traits in diverse promising genotypes of Okra (*Abelmoschus esculentus* L.)

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Abstract

The present investigation evaluated the nutritional composition of twenty diverse okra (*Abelmoschus esculentus* L.) genotypes to determine genotype-specific superiority and its possible correlation with pod colour. Significant variation was observed for key nutritional parameters including carbohydrate, crude protein, fat, fibre, carotenoids and phenols. Among the genotypes JOL-20-02 (dark green pod) recorded the highest carbohydrate (13.75 g/100 g) and phenol levels. While JOL-12-13 (red pod) exhibited the highest protein (8.69 g/100 g) and carotenoid content, while, indicating their superior nutritional potential. Pusa Swarni (green pod) was the richest in dietary fibre, whereas GJO-3 showed maximum fat content. Overall, red and dark green pods were generally associated with enhanced nutritional attributes; however, exceptions highlighted that pod colour alone cannot be a definitive predictor of biochemical composition. These findings provide valuable insights for breeding programs targeting nutritionally enriched okra cultivars for fresh consumption and industrial applications.

Keywords: Okra (*Abelmoschus esculentus* L.), nutritional composition, pod color, genotypic variability

Introduction

Okra (*Abelmoschus esculentus* L. Moench), commonly known as lady's finger or bhindi, is a widely cultivated vegetable crop in tropical, subtropical, and warm temperate regions around the world. It belongs to the family *Malvaceae* and is believed to have originated in Africa, from where it spread to Asia and the rest of the world (Siemonsma, 1982; Hamon & Koechlin, 1991) [14] [9]. In India, okra is one of the most popular and economically important vegetable crops due to its adaptability, relatively short growth cycle, and high market demand. Among Indian states, Gujarat ranks as one of the top producers, contributing significantly to the country's total okra output (APEDA, 2022) [3].

Nutritionally, okra pods are an important source of dietary fiber**,** carbohydrates**,** vitamins and essential minerals such as calcium, magnesium, iron, and zinc (Aashima *et al*., 2025; Gopalan *et al.*, 2007) [1] [8]. Given the wide genetic diversity among okra genotypes in India, particularly those grown under diverse agro-ecological zones, there is a pressing need to explore and document their biochemical composition. Understanding this variability is crucial for crop improvement programs**,** especially those focused on nutritional enhancement**,** value-added product development**,** and functional breeding for improved quality traits. Therefore, the present study was undertaken to evaluate the proximate nutritional composition of 20 promising okra genotypes with the aim to identify nutrient-rich and biochemically superior lines. These findings can serve as a baseline for future breeding programs**,** food product development, and strategies aimed at enhancing nutritional security through vegetable consumption.

Materials and Methods

The present study was conducted using twenty genetically diverse okra (*Abelmoschus esculentus* L.) genotypes cultivated at the Vegetable Res Station, Junagadh Agricultural University, Junagadh, Gujarat, India. All genotypes were grown under uniform agronomic conditions during the cropping season of 2022–23, following standard cultivation and management practices to minimize environmental variation. Mature pods were harvested at the marketable stage for the assessment of nutritional traits and analyzed at Department of Biochemistry, Junagadh Agricultural University, Junagadh, Gujarat, India.

For the biochemical evaluation, proximate analysis was performed on freshly harvested pods to determine key nutritional parameters. Total carbohydrate content was determined by the phenol-sulphuric acid method as described by Dubois *et al.* (1956) [6], using glucose as a standard**.** Crude protein was analyzed following the Kjeldahl method, where nitrogen content was converted to protein using a factor of 6.25 (AOAC, 2005) [2]. Total fat content was assessed through Soxhlet extraction using petroleum ether as a solvent. Crude fibre content was determined by the acid-alkali digestion method as per the procedure outlined in AOAC (2005) [2], which includes boiling the sample with dilute acid and alkali followed by filtration and drying. Carotenoid content was assessed through petroleum ether determined according to De-Carvalho *et al.* (2012) [5]. Total phenol was estimated by using suitable aliquot from methanol extract as per described by Bray and Thorpe, 1954 [4].

All analyses were performed in triplicate to ensure accuracy and reproducibility. The resulting data were subjected to statistical analysis using analysis of variance (ANOVA) to assess the significance of differences among genotypes at the 5% probability level, as per the procedure described by Gomez and Gomez (1984) [7].

Results and Discussion

Pod pigmentation is an easily scorable morphological trait in okra and is genetically regulated. Interestingly, it also appears to correlate—though variably—with certain biochemical traits, particularly mineral accumulation. In this study, the pod colors observed among the 20 okra genotypes included light green, green, dark green, red, purple, and variegated types. When analyzed different biochemical traits, clear trends emerged linking it with certain pod colors.

Carbohydrate Content

Total carbohydrate content varied significantly among genotypes, with JOL-20-02 recording the highest value at 13.75 g/100g**.** Carbohydrates play a major role in determining sweetness and calorific value of the vegetable. High carbohydrate levels enhance energy availability and may contribute to consumer preference in taste.

Interestingly, JOL-20-02, a dark green pod genotype**,** also demonstrated high chlorophyll content, which aligns with the findings of Rusea *et al*. (2014) [15], who reported that green genotypes tend to accumulate more carbohydrates during early pod development. This could be attributed to higher photosynthetic activity and efficient assimilate partitioning in dark green genotypes.

Crude Protein Content

Protein content ranged from 4.82 g/100g in JOL-13-03 to 8.69 g/100g in JOL-12-13**.** The superior protein content in JOL-12-13**,** a genotype with red pods**,** highlights the nutritional richness of pigmented okra types. Similar observations were reported by Ndangui *et al.* (2010) [12], who found that pigmented seeds and pods tend to have higher protein and oil content compared to green counterparts. Protein-rich genotypes like JOL-12-13 could serve as potential candidates for dietary protein fortification.

Total Fat Content

The fat content among okra genotypes was generally low, consistent with previous studies (Savello *et al.*, 1982) [13], but GJO-3 exhibited the highest fat content at 3.61 g/100g. Though GJO-3 is a green pod genotype, its fat richness suggests unique biochemical attributes, potentially linked to seed development within the pods. High fat content, albeit rare in okra, is beneficial for caloric enhancement and has implications for okra seed oil extraction**,** where oleic and linoleic acids are dominant (Ndangui *et al*., 2010) [12].

Fibre Content

Dietary fibre, essential for digestive health and glycaemic control, showed substantial variation, with Pusa Swarni (a green pod genotype**)** registering the highest value at 3.87g/100g. Previous studies by Kabir and Pillu (2011) [10] support the observation that green and intermediate-coloured pods generally exhibit higher fibre content than red or variegated types. This could be due to differences in pod wall thickness, cellulose deposition, and mucilage composition. High-fibre genotypes are desirable for developing low-calorie, high-satiety dietary products.

Total Carotenoid

Carotenoids are a group of pigments that are responsible for the vibrant colors of various fruits, vegetables, and plants. Carotene plays a crucial role as a photosynthetic pigment there by important for photosynthesis. It does not actively contribute in photosynthesis, but it transmits the energy, it absorbs by chlorophyll, and also plays a protective role as chlorophyll being a powerful antioxidant that protects organic molecules from being destroyed by oxidation. Total carotenoid contains of 20 promising genotypes of okra determined according to De-Carvalho *et al*. (2012) [5]. Total Carotenoid content were ranged between 0.99 mg/g in JOL-20-02 to 1.64 mg/g in JOL-12-13 (Table 5). This shows that red pod genotypes have high content of carotenoid compared to other groups of pods because in the case of red okra, the vibrant red colour is indicative of the presence of carotenoids.

Total phenol

Phenolic compounds are plant secondary metabolites those constitute one of the most common and widespread groups of substances in plants. Plants need phenolic compounds for pigmentation, growth, reproduction, resistance to pathogens and for many other functions. Total Phenol content of 20 promising genotypes of okra determined according to Bray and Thorpe (1954) [4] which was given in Table 6. Total phenol content ranged between 2.03 mg/100g in JOL-12-10 (lowest) and 2.25 mg/100g in GO-6 and JOL-20-02(highest) with the mean of 2.16 mg/100g. This range supported finding of Kumar *et al* (2021) [11]. The highest value was found in JOL-20-02 (2.25) and GO-6 (2.25) which remain at par with second highest genotype JOL-21-09(2.23).

Table 1: Total Carbohydrate content (g.100g^{-1}) in promising okra genotypes.

Sr No	Name of Genotype	Total Carbohydrate g.100g-1	Sr No	Name of Genotype	Total Carbohydrate g.100g-1
	Light Green Pod			Variegated Pod	
1	GJO-3	11.72	11	JOL-09-03	10.47
2	JOL-18-12	11.12	12	JOL-09-06	10.39
3	JOL-18-07	11.43	13	JOL-13-03	10.76
4	JOL-20-04	11.42	14	JOL-11-12	10.23
5	PUSA SWARNI	11.69	15	AOL-03-01	10.08
	Mean	11.47		Mean	10.39
	Dark Green Pod			Red Pod	
6	GO-6	13.37	16	JOL-12-08	9.59
7	JOL-20-06	13.15	17	JOL-12-09	9.22
8	JOL-20-02	13.75	18	JOL-12-10	9.35
9	JOL-21-02	13.58	19	JOL-12-12	9.36
10	JOL-21-09	13.68	20	JOL-12-13	9.59
	Mean	13.51		Mean	9.42
	S. Em±	0.20			
	C.D.at 5%	0.58			
	C.V.%	3.15			

Table 2: Crude Protein content (g.100g-1) in promising okra genotypes

Sr No	Name of Genotype	Crude Protein g.100g-1	Sr No	Name of Genotype	True Protein g.100g-1
	Light Green Pod			Variegated Pod	
1	GJO-3	5.35	11	JOL-09-03	7.81
2	JOL-18-12	7.29	12	JOL-09-06	5.23
3	JOL-18-07	7.32	13	JOL-13-03	4.82
4	JOL-20-04	5.83	14	JOL-11-12	7.58
5	PUSA SWARNI	6.17	15	AOL-03-01	5.74
	Mean	6.39		Mean	6.23
	Dark Green Pod			Red Pod	
6	GO-6	6.26	16	JOL-12-08	8.20
7	JOL-20-06	6.18	17	JOL-12-09	6.90
8	JOL-20-02	6.72	18	JOL-12-10	6.82
9	JOL-21-02	5.58	19	JOL-12-12	5.04
10	JOL-21-09	4.88	20	JOL-12-13	8.69
	Mean	5.92		Mean	7.12
	S. Em±	0.206			
	C.D.at 5%	0.592			
	C.V.%	2.782			

Table 3: Total Fat content (g.100g^{-1}) in promising okra genotypes.

Sr No	Name of Genotype	Total Fat g.100g-1	Sr No	Name of Genotype	Total Fat g.100g-1
	LightGreen Pod			Variegated Pod	
1	GJO-3	3.615	11	JOL-09-03	1.935
2	JOL-18-12	3.162	12	JOL-09-06	1.893
3	JOL-18-07	3.477	13	JOL-13-03	1.913
4	JOL-20-04	3.072	14	JOL-11-12	1.855
5	PUSA SWARNI	3.006	15	AOL-03-01	1.900
	Mean	3.23		Mean	1.89
	Dark Green Pod			Red Pod	
6	GO-6	2.385	16	JOL-12-08	1.625
7	JOL-20-06	2.299	17	JOL-12-09	1.648
8	JOL-20-02	2.609	18	JOL-12-10	1.493
9	JOL-21-02	2.610	19	JOL-12-12	1.481
10	JOL-21-09	2.727	20	JOL-12-13	1.489
	Mean	2.450		Mean	1.50
	S. Em±	0.064			
	C.D.at 5%	0.182			
	C.V.%	4.840			

Table 4: Fibre content (g.100g-1) in promising okra genotypes

Sr No	Name of Genotype	Fibre g.100g-1	Sr No	Name of Genotype	Fibre g.100g-1
	Light Green Pod			Variegated Pod	
1	GJO-3	3.401	11	JOL-09-03	2.051
2	JOL-18-12	3.716	12	JOL-09-06	1.716
3	JOL-18-07	3.205	13	JOL-13-03	2.101
4	JOL-20-04	3.427	14	JOL-11-12	1.991
5	PUSA SWARNI	3.879	15	AOL-03-01	2.049
	Mean	3.45		Mean	2.02
	Dark Green Pod			Red Pod	
6	GO-6	2.253	16	JOL-12-08	1.801
7	JOL-20-06	2.439	17	JOL-12-09	1.738
8	JOL-20-02	2.661	18	JOL-12-10	1.921
9	JOL-21-02	2.614	19	JOL-12-12	1.896
10	JOL-21-09	2.409	20	JOL-12-13	1.788
	Mean	2.60		Mean	1.80
	S. Em±	0.107			
	C.D.at 5%	0.307			
	C.V.%	7.502			

Table 5: Total carotenoid (mg/g) in promising okra genotypes.

Sr No	Name of Genotype	Total Carotenoid mg/g	Sr No	Name of Genotype	Total Carotenoid mg/g
	Light Green Pod			Variegated Pod	
1	GJO-3	1.14	11	JOL-09-03	1.47
2	JOL-18-12	1.08	12	JOL-09-06	1.51
3	JOL-18-07	1.13	13	JOL-13-03	1.51
4	JOL-20-04	1.11	14	JOL-11-12	1.49
5	PUSA SWARNI	1.11	15	AOL-03-01	1.52
	Mean	1.11		Mean	1.5
	Dark Green Pod			Red Pod	
6	GO-6	1.03	16	JOL-12-08	1.62
7	JOL-20-06	1.02	17	JOL-12-09	1.60
8	JOL-20-02	0.99	18	JOL-12-10	1.63
9	JOL-21-02	1.02	19	JOL-12-12	1.60
10	JOL-21-09	1.02	20	JOL-12-13	1.64
	Mean	1.01		Mean	1.61
	S. Em±	0.017			
	C.D.at 5%	0.050			
	C.V.%	2.297			

Table 6: Total Phenol content (mg/100g) in promising okra genotypes.

Sr No	Name of Genotype	Total phenol mg/100g	Sr No	Name of Genotype	Total phenol mg/100g
	Light Green Pod			Variegated Pod	
1	GJO-3	2.17	11	JOL-09-03	2.13
2	JOL-18-12	2.16	12	JOL-09-06	2.13
3	JOL-18-07	2.12	13	JOL-13-03	2.17
4	JOL-20-04	2.17	14	JOL-11-12	2.10
5	PUSA SWARNI	2.19	15	AOL-03-01	**2.07**
	Mean	2.16		Mean	**2.12**
	Dark Green Pod			Red Pod	
6	GO-6	2.25	16	JOL-12-08	2.08
7	JOL-20-06	2.24	17	JOL-12-09	2.06
8	JOL-20-02	2.25	18	JOL-12-10	2.03
9	JOL-21-02	2.24	19	JOL-12-12	2.19
10	JOL-21-09	2.23	20	JOL-12-13	2.21
	Mean	2.24		Mean	**2.11**
	S. Em±	0.016			
	C.D.at 5%	0.046			
	C.V.%	1.274			

Conclusion

The present study highlighted considerable genotypic variability nutritional traits among twenty okra genotypes. Among the tested genotypes, JOL-12-13 - characterized by its red pod colour - stood out for its exceptionally high crude protein and carotenoid content. Similarly, JOL-20-02**,** a dark green pod genotype**,** demonstrated superior nutritional traits including the highest carbohydrate content and elevatedlevels of phenols. Dark green pigmentation often reflects photosynthetic activity and greater assimilate accumulation, contributing to increased carbohydrate and phytochemical synthesis. This diversity in nutritional composition linked to pod colour categories—dark green, light green, red, and variegated—suggests that pod pigmentation can serve as a useful phenotypic indicator for certain nutritional traits, although not universally predictive.

References

1. Aashima Khajuria, UK Kandoliya, MV Parakhiya, HP Gajera, AG Vala. Nutritional morphological diversity in promising okra (*Abelmoschus Esculentus* L.) genotypes: linking pod pigmentation to mineral content, International Journal of Agriculture Plant Science,2025:7(4):97-100.
2. AOAC. Official Methods of Analysis of AOAC International (18th ed.). Association of Official Analytical Chemists, Gaithersburg, MD, USA, 2005.
3. APEDA. Export Statistics for Okra. Agricultural Processed Food Products Export Development Authority, Government of India, 2022.
4. Bray HG, Thorpe WV. Analysis of phenolic compounds of interest in metabolism. Methods of Biochemical Analysis, 1954, 1(1).
5. De-Carvalho LMJ, Gomes PB, De Oliveira Godoy, Pacheco RLS, Do Monte PHF, De-Carvalho JLV, *et al*. Total carotenoid content, αcarotene β-carotene, of landrace pumpkins (Cucurbit amoschata Duch): A preliminary study. Int. Food Res. J,2012:47(2):337-340.
6. Dubois M, Gilles KA, Hamilton JK, Rebers PA, Smith F. Colorimetric method for determination of sugars related substances. Analytical Chemistry,1956:28(3):350–356.

7. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research (2nd ed.). John Wiley & Sons, New York, 1984.
8. Gopalan C, Sastri BVR., Balasubramanian SC. Nutritive Value of Indian Foods. National Institute of Nutrition, Indian Council of Medical Research, 2007.
9. Hamon S, Koechlin J. Evolution and genetics of the Abelmoschus species. Plant Systematics and Evolution,1991:176(1):55–70.
10. Kabir J, Pillu A. Evaluation of biochemical traits in different okra cultivars. Plant Archives,2011:11(2):983–986.
11. Kumar HD Y K, Padhi J, Rath LK, Sahu GS, Kumari M. Evaluation of biochemical parameters of okra germplasm for resistance against jassids, amrasca biguttula biguttula (ishida). 23(2):258-264
12. Ndangui CB, Kimbonguila A, Nzikou JM, Matos L, Pambou-Tobi NP, Desobry S. Nutritive composition and properties of seeds and oil from okra (*Abelmoschus esculentus*) grown in Congo-Brazzaville. Research Journal of Environmental and Earth Sciences,2010:2(1):49–54.
13. Savello PA, Martin FW, Hill JM. Nutritional composition of okra seed meal. Journal of Agricultural and Food Chemistry,1982:30(5):980–982.
14. Siemonsma JS. West African okra—morphological and cytogenetical indications for the existence of a natural amphidiploid of *Abelmoschus esculentus* (L.) Moench and A. manihot (L.) Medikus. Euphytica,1982:31(1):241–252.
15. Rusea G, Nwachukwu CE, Nulit R. Nutritional and biochemical properties of Malaysian okra varieties. Advancement in Medicinal Plant Research,2014:2(1):16-19.