

Morpho-chemical characterization of broccoli (*Brassica oleracea* var. *italica*)

P. KUNDU¹, A. MUKHERJEE, N. K. ADHIKARY* A. GHOSAL AND N.C. SAHU

^{1, 2, 4, 5} Sasya Shyamala Krishi Vigyan Kendra, Ramkrishna Mission Vivekananda University, Narendrapur-700103, West Bengal, India

Received: August, 2021; Revised accepted: September, 2021

ABSTRACT

The present study was carried out at Instructional farm, Ramkrishna Mission Vivekananda University, during two consecutive rabi seasons of 2018-2019 and 2019-2020 with the objective of varietal evaluation on the basis of morpho-chemical characterization. It can be opined that the variety, centauro recorded best yield and quality attributing characters. The variety, centauro documented highest head weight (375.0 g) whereas priya registered lowest yield (104.2 q ha⁻¹). Under different aspects based on quality evaluating factors, it can be inferred that centauro registered best performance in term of chlorophyll-a (2.8 mg g⁻¹), chlorophyll-b (5.7 mg g⁻¹), vitamin-C content (867.7 mg kg⁻¹) and also recorded best shelf life (5.7 days). Biochemical composition found best in florets, leaves and stalks in centauro according to protein, ash, total carbohydrate and crude fibre content. Out of six, the variety centauro has executed satisfactory yield attributing characters and biochemical properties, enhanced the nutritive security under the congenial agro-climatic conditions in coastal belt of south Bengal.

Keywords: Broccoli, bio-chemical property, growth parameter, qualitative character, variety, yield attribute

INTRODUCTION

Broccoli (*Brassica oleracea* var. *italica*), is significant as well as important vegetable as of recently preface in India. It is valued similarly as appreciated for its brilliant touchy taste, flavor and nutritive worth and has been addressed its foe of harm properties. Among the cole crops broccoli is more nutritious truly rich in carotene and ascorbic destructive and contains clear proportions of thiamin, riboflavin, niacin and iron (Thapa and Rai, 2012). Broccoli moreover contains glucoraphanin which can be managed into an adversary of damage compound sulforaphane (Mukherjee and Mishra, 2012). Openness of sensibly high yielding cultivars of broccoli may assist the ranchers with accomplishing more returns per unit region. Broccoli is a crop plant that is effortlessly developed on a wide range of soil types and is versatile to a wide range of climatic conditions (Erdem *et al.*, 2010). It is high in water content, fiber, protein, calcium and iron, and is a rich wellspring of nutrient A and nutrient C, among other wellbeing advancing and anticancer properties (Acikgoz, 2011; Mahn *et al.*, 2012; Ávila *et al.*, 2013). This vegetable is utilized in plates of mixed greens, as a new food thing, but

on the other hand is steamed with different vegetables as a prepared food thing. It is appropriate for preparing into frozen vegetable products. This study find out the best variety of broccoli for the field, which constitutes the largest volume of vegetable. The purpose of this study was to analyse the growth parameters, yield attributing characters of six cultivars and also determine the biochemical composition and physicochemical properties of three different flours obtained from broccoli crop remains: florets, leaves and stalks. This was done by identifying and quantitating their macronutrients (protein, lipids, total carbohydrate, crude fibre and ash) and performing analyses to determine physicochemical properties. In recent times broccoli alone was accumulated broad creation improvement in enormous scope which advocate new or frozen, in neighborhood and by and large business regions and frozen broccoli is the fundamental confirmation thing. In the field, up to 70% of the immovable load of the broccoli plant is discarded, making high extents of florets, leaves and stalks as assemble remaining parts. In any case, little information has been dissipated about the use of broccoli crop stays in the food business. The study identified four distinct factors like growth parameters, yield

³Institute of Agricultural Science, University of Calcutta, 51/2, Hazra Road, Kolkata-700019, West Bengal, India

*Corresponding author E-mail: nayan.bckv@gmail.com

attributing orientation, quality evaluating characters and bio-chemical compositions of different varieties to opt out the best ones for this region.

MATERIALS AND METHODS

Six promising broccoli varieties, Fiesta, Princes, Sultan, Centauro, Priya and Packmen were taken under the study. The experiment was conducted at Instructional Farm of Ramakrishna Mission Vivekananda University, Arapanch, South 24 Parganas district (Latitude: 22°26'27.15"N; Longitude: 88°25'28.69"E) of West Bengal during two consecutive rabi seasons of 2018-2019 and 2019-2020. The investigation was spread out in randomized block design with four replications. To get significant effects of growth and yield of broccoli application of 120 kg N+ 60 kg P₂O₅+ 40 kg K₂O+ 15 kg B ha⁻¹ were done. Seed was treated with biocontrol agent, *Trichoderma viride* @ 5 g/kg to avoid damage of seedlings from disease. Thirty days old seedlings of uniform stature were chosen and transplanted in the field with the separating of 50 cm row to row push and 45 cm plant to plant. Five haphazardly chose plants were taken for recording of biometrical characters like plant tallness, plant spread, leaves/plant, days taken to apparent curd inception, maturity, curd weight and curd yield. Quality parameters as like content of chlorophyll, ascorbic acid, reducing and total sugar content were determined as proposed by Saini *et al.* (2001). The chlorophyll content was assessed by

the technique for Rangana (1977), the protein content was assessed by Lowry *et al.* (1951). Data were gathered from the experiment statistically analyzed through Duncan Multiple Range Test (DMRT) using IBMSPSS software version 20.0.

RESULTS AND DISCUSSION

Growth attributes

The six distinctly different varieties of broccoli moved basically in vegetative turn of events. The height of the plants changed from 33.5 to 43.4 cm (Table 1). The results revealed that the variety centauro recorded essentially most fundamental plant stature that mean tallness of the plant (43.4 cm). The plants of centauro variety were reasonably intensely and logically fiery as isolated and various varieties and were tallest with denser leaves. Prevalence of centauro plants vegetative improvement may be a fast postponed result of its possible heredity. Being a flavor strategy it grants higher opportunities for holding and development of soil enhancements to the vegetative parts. Other than its higher photosynthetic new turn of events and higher likely freedoms for metabolites development reflects higher vegetative development rate. Then again Sultan variety recorded the least plant height (33.5 cm). For the most part diminished plant height found a few different groupings may be an aftereffect of its trademark genotypic qualities or for the collections in agro-climatic conditions.

Table 1: Growth and floral attributes of different varieties of broccoli (pooled data)

Variety	Plant Height (cm)	Plant Spread (cm)	Leaves plant ⁻¹	Stem diameter (cm)	Stem length (cm)	Days to head initiation	Days to harvest
Fiesta	39.7	50.9	21.0	3.6	30.2	67.7	80.5
Princes	34.5	67.4	13.0	3.9	23.5	60.4	76.2
Sultan	33.5	49.9	11.5	3.5	22.2	59.2	72.0
Centauro	43.4	55.7	19.0	3.7	28.8	64.2	79.5
Priya	37.5	59.6	15.5	3.7	28.7	61.5	73.7
Packmen	36.2	47.8	13.3	3.7	24.2	59.0	77.2
S.Em. (±)	0.71	0.18	0.65	0.07	0.60	1.09	0.84
CD 5 %	2.04	0.51	1.87	0.21	1.75	3.17	2.42

The varieties related with the evaluation showed a normal conventional varieties of 11.5 to 21.0 leaves plant⁻¹. The most unbelievable number that proposes most noteworthy number of leaves plant⁻¹ (21.0) was recorded in the

varietal occasion followed by centauro (19.0) and priya (15.5). This wide detachment in vegetative advancement of the distinctive kind of groupings recorded by number of researchers in the previous times (El-Helaly, 2006). Basically P.

indistinguishable kind of results were recorded several experts moreover (Sharma, 2003; Siomos *et al.*, 2004). Increase in number of leaves may have decreased the head size and totally inside and out head weights due to progressive supplement assimilation by the leaves.

The extent of plant spread was 47.8 to 67.4 cm. Most extraordinary plant spread was procured with variety princess (67.4 cm) followed by priya (59.6 cm) and least plant spread with packmen (47.8 cm) in field condition. The most fundamental stem diameter was discovered commonly fundamentally essential in the variety princess (3.9 cm) followed by priya (3.7 cm). Incidentally least estimation of stem diameter was gotten in variety Sultan (3.5 cm). In regard

of commencement of curd initiation and days expected to first harvesting, cultivars under field condition study were found significant. Low temperature and high soil alkalinity can maintain the yield similarly as nature of developing broccoli. The average number of days to curd initiation or commencement transformed from an extent of 59 to 68. Curd commencement happen significantly prior in packmen (59.0 days) and much late in celebration (6.7 days). Though among the assortments which were attempted for the investigation, it can be uncovered that the assortment Sultan was collected a whole lot sooner than others (72.0 days) and it was noticed that the assortment party was gathered a lot later (80.5 days) than others with ideal and attractive yield.

Table 2: Yield attributes of different varieties of broccoli (pooled data)

Variety	No. of sprout plant ⁻¹	Sprout weight plant ⁻¹ (g)	Head diameter (cm)	Head weight (g)	Yield (q ha ⁻¹)
Fiesta	3.8	26.2	22.0	293.7	108.6
Princes	4.8	46.8	20.9	342.7	121.6
Sultan	4.0	52.7	20.0	276.9	106.6
Centauro	3.4	57.1	23.6	375.0	145.5
Priya	5.5	43.7	20.2	263.9	104.2
Packmen	4.7	40.9	19.1	279.6	111.6
S.Em. (±)	0.13	1.02	0.79	3.15	3.01
CD at 5%	0.38	2.93	2.27	9.09	8.70

Yield attributes

Most significant number of sprouts (spears) were moreover recorded in the variety priya (5.5) followed by princess (4.8). The most diminished amounts of sprouts were seen from centauro variety (3.4). The differentiations in number of sprouts among the varieties might be their own personal direct acquired inherited characterized results also as similar with the temperature receptivity. From the perceptions it tends to be inferred that there were essential contrasts in the sprout weight among the varieties (Table 2). The most raised sprout weight was acquired from centauro (57.1 g) trailed by sultan (52.7 g). The data unquestionably showed that the variety centauro superseded in giving the best sprout yield/plant and the base was found in variety fiesta (26.2 g) developed in open field condition.

It has been found from the test results that the most basic head diameter was evaluated in variety centauro (23.6 cm) followed

by fiesta (22.0 cm). Besides the higher site in assessment of head was seen with variety princess (20.9 cm), priya (20.2 cm) and sultan (20.0 cm). From the Table 2, certainly among of recently mentioned varieties there were critically significant differences or contrasts among themselves. Rest of various varieties indisputably and particular out and out from the recently alluded one. In the study, the least diameter of head was gotten with variety packmen (19.1 cm). This closeness and difference among the varieties in head diameter might be credited to the alterability in their natural heritability character. This indicated the cultivars speak to a decent scope of hereditary assorted variety accordingly of stem length. The best and mostly elevated head weight of (375.0 g) was documented with centauro variety. The groupings or like was the variety which moderately made more relative head weight are to be specific in princes, fiesta, packman, sultan and priya. The most noteworthy head weight may be expected to come about because of the

most elevated head distance across of the individual variety. The most minimal head weight of (263.9 g) was gained with priya variety. There was a basically critical and valuably beneficial results of various varieties on head yield (q ha^{-1}), centauro played out the most raised results in head yield (145.5 q ha^{-1}) trailed by princes (121.6 q ha^{-1}) and the other three varieties indicated factually comparable outcomes (108.6 q ha^{-1} , 106.6 q ha^{-1} and 104.2 q ha^{-1}). It demonstrates that close to packmen (111.6 q ha^{-1}), there varieties, fiesta, sultan and priya have capacity to created great head yield.

Quality evaluation

Among the all varieties most noteworthy measure or highest content of chlorophyll-a found in the variety centauro (2.8 mg g^{-1}) trailed by fiesta (2.8 mg g^{-1}). The most decreased amounts of chlorophyll-a content were seen from princes varieties (2.3 mg g^{-1}) grown in field condition. From the study it very well may be

reason that the variety fiesta advanced with most extreme amount of chlorophyll-b (5.7 mg g^{-1}) where the most lower content of chlorophyll-b (4.2 mg g^{-1}) found in the cultivar princes. Total chlorophyll was discovered most extreme content (5.9 mg lit^{-1}) in variety fiesta. It has been found from the test outcomes that the most significant total sugar and reducing sugar was content assessed in variety centauro (3.7% and 3.2% respectively) trailed by fiesta (3.3% and 2.8% respectively). It very well may be deduced from the examination that the variety centauro have generally high amount of ascorbic acid of (867.7 mg kg^{-1}) in contrast with different varieties. The current analysis uncovered that generally maximized amount of carotene content recorded in the variety centauro ($2.1 \mu\text{g } 100 \text{ g}^{-1}$). It tends to be advocated from the examination that the variety centauro additionally exceptionally enhanced with highest quantity of total soluble solid (TSS) content (11.0° Brix), portrayed in the Table 3.

Table 3: Quality evaluation of broccoli under different varietal performance (pooled data)

Variety	Chlorophyll a (mg g^{-1})	Chlorophyll b (mg g^{-1})	Total chlorophyll (mg g^{-1})	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)	Vitamin C (mg kg^{-1})	Carotene content ($\mu\text{g } 100\text{g}^{-1}$)	T.S.S. ($^\circ\text{Brix}$)	Shelf life (days)
Fiesta	2.8	5.7	5.9	2.8	0.4	3.3	830.9	2.0	9.7	4.6
Princes	2.3	5.3	4.2	2.6	0.3	2.9	828.8	1.9	9.3	4.7
Sultan	2.7	5.4	5.0	2.3	0.4	2.7	833.7	2.0	9.5	5.2
Centauro	2.8	5.7	4.9	3.2	0.4	3.7	867.7	2.1	11.0	5.7
Priya	2.6	5.5	5.5	2.3	0.3	2.6	828.1	2.0	9.9	4.7
Packmen	2.5	5.3	5.2	2.2	0.3	2.5	820.4	2.0	10.0	4.7
S.Em. (\pm)	0.05	0.06	0.08	0.12	0.03	0.12	104.28	0.06	0.29	0.28
CD at 5%	0.14	0.19	0.22	0.33	0.08	0.33	301.13	NS	0.84	NS

It is simply shown that in Table 3 that highest shelf-life likewise reported in the variety centauro trailed by sultan. Critical patterns were found in the vast majority of the quality traits with expanding trends entirely of the varieties of broccoli in field condition. Among these varieties for most elevated creation alongwith great qualitative characters, centauro was discovered to be viable for fruitful development of broccoli in the South 24 Parganas region of West Bengal. The current trial uncovered that the yield and yield crediting characters alongwith the quality parameters altogether contrasted inside the various varieties. Based on execution of varieties identified with head yield and concerning yield crediting characters and quality parameters, centauro likewise thought to be reasonable for

positive reaction for boosting more excellent maximized yield.

Bio-Chemical Composition

It very well may be expected from the investigation that, the protein content went from $7.8 \text{ g}/100 \text{ g}$ dry load in stalks to $22.4 \text{ g}/100 \text{ g}$ dry load in florets (Table 4), which are comparable with those of high-protein food sources or sustenances. it will in general be uncovered that the protein content found in supported sum in the assortment centauro than the others. The florets flour showed the most raised protein content, beating by 44% and 60% that of the leaves flour and stalks flour, autonomously. Moreover, in like way the whole

Table 4: Biochemical composition of the broccoli flours (pooled data)

Variety	Sample	Protein	Ash	Total lipid	Total carbohydrate	Crude fibre
Fiesta	Florets	20.4	6.7	3.5	62.1	10.4
	Leaves	11.1	13.5	6.0	64.2	11.8
	Stalks	7.5	8.4	5.8	73.6	14.7
Princes	Florets	21.7	6.6	4.0	61.2	11.0
	Leaves	11.2	11.4	6.0	64.7	11.9
	Stalks	7.8	8.1	5.9	72.7	14.8
Sultan	Florets	20.9	7.2	4.5	64.1	11.2
	Leaves	11.6	11.1	6.4	63.9	11.6
	Stalks	8.6	8.3	6.2	73.6	14.9
Centauro	Florets	22.4	7.9	4.6	65.2	11.8
	Leaves	12.1	14.7	6.8	66.7	12.9
	Stalks	8.8	9.3	6.6	75.6	15.9
Priya	Florets	20.8	7.1	4.3	63.1	11.2
	Leaves	7.9	14.0	6.6	64.9	12.0
	Stalks	8.5	9.0	6.3	72.8	15.3
Packmen	Florets	20.2	6.5	4.1	62.8	10.8
	Leaves	11.9	14.0	6.4	65.3	12.0
	Stalks	8.1	9.1	6.3	72.4	15.1

protein level surveyed in entire plant flour (23.2 to 32.0 g/100 g dry weight) of six cultivars of broccoli. Lipid substance in the flours were open in a scope of 3.5-6.8 g/100 g dry weight (most noteworthy measure of lipid content recorded in the assortment centauro); these sums were lower than those revealed for different items leafy foods deposits.

The leaves flour showed the most raised grouping of debris (14.7 g/100 g dry burden in the combination centauro), with sums upto half for all intents and purposes indistinguishable and practically identical to the attributes aquired on florets and stalks flour. The most unimportant extent of debris was displayed by the flour of florets. What's more, it has been addressed that the flotsam and jetsam content moved because of differentiations in mineral status of the dirt, the species, and the piece of the plant comparatively as the time of gather (Gidamis *et al.*, 2003).

The rough fiber content went from 10.4 to 15.9 g/100 g dry load in the three sorts of flours from six unique assortments of broccoli and the most vital sum was recorded in the assortment centauro. The flours of stalks have higher

extents of rough fiber than various flours of florets. The substance of non-underlying carb substance in the three flours, beating or outperforming 61 g/100 g dry weight, were directed by qualification. The characteristics obtained for the whole of the flours are outside the run of the mill go after most green vegetables (Gidamis *et al.*, 2003); those non-underlying sugars as such glucose, fructose, sucrose and starch can appear at unions or convergences of 300-400 mg/g dry weight. From the assessment it very well may be uncovered raised measure of absolute carb was recorded the assortment centauro.

The study construes that horizontal expansion of scientific innovative technologies, another critical key factor for outlining the dispersion of scientific broccoli cultivation. Centauro played out the most elevated head yield among different varieties are additionally viewed as reasonable for positive reaction for boosting better return. It can also be opined from the assessment that centauro revealed best outcomes in aspects of bio-chemical parameters.

REFERENCES

- Acikgoz, F.E. (2011) Influence of different sowing times on mineral composition and vitamin C of some broccoli (*Brassica oleracea* L. var. *italica*) cultivars. *Scientific Research and Essays* 6(4): 760-765.
- Ávila, F.W., Faquin, V., Yang, Y., Ramos, S.J., Guilherme, L.R.G., Thannhauser, T.W. and Li, L. (2013) Assessment of the

- anticancer compounds Se-methylselenocysteine and glucosinolates in Se-biofortified broccoli (*Brassica oleracea* L. var. *italica*) sprouts and florets. *Journal of Agricultural and Food Chemistry* **61**(26): 6216-6223.
- El-Helaly, M.A. (2006) Studies on growth and development of broccoli. Ph. D thesis, Faculty of Agriculture, Cairo University, Egypt. pp. 791-798.
- Erdem, T., Arin, L., Erdem, Y., Polat, S., Deveci, M., Okursoy, H. and Gültaş, H.T. (2010) Yield and quality response of drip irrigated broccoli (*Brassica oleracea* L. var. *italica*) under different irrigation regimes, nitrogen applications and cultivation periods. *Agricultural Water Management* **97**(5): 681-688.
- Gidamis, A.B., Panga, T.T., Sarwatt, S.V., Chove, B.E. and Shayo, N.B. (2003) Nutrient and antinutrient contents in raw and cooked young leaves and immature pods of *Moringa oleifera*, Lam. *Ecology of Food Nutrition* **42**: 399-411.
- Lowry, O.H., Rosenberg, N.J., Farr, A.L. and Randall, R.J. (1951) Protein measurement with the folin-phenol reagent. *Journal of Biological Chemistry* **19**: 265.
- Mahn, A. and Reyes, A. (2012) An overview of health-promoting compounds of broccoli (*Brassica oleracea* L. var. *italica*) and the effect of processing. *Food Science and Technology International* **18**(6): 503-514.
- Mukherjee, V. and Mishra, P.K. (2012) Broccoli an underexploited nutraceutical. *Science Research Reports* **2**(3): 291-294.
- Rangana, S. (1977) Manual for analysis of fruit and vegetable products. Tata McGraw Co. Pvt. Ltd., New Delhi.
- Saini, R.S., Sharma, K.D., Dhankhar, O.P. and Kaushik, R.A. (2001) Laboratory Manual of Analytical Techniques in Horticulture. Agrovbios: India.
- Sharma, D.K. (2003) Studies on evaluation and commercialization of exotic vegetables for sustainable agriculture production in Himachal Pradesh. *Haryana Journal of Horticultural Sciences* **32**(1/2): 130-133.
- Siomos, A.K., Papadopoulou, P.P. and Dogras, C.C. (2004) Compositional differences of stem and floral portions of broccoli heads. *Journal of Vegetable Crop Production* **10**(2): 107-118.
- Thapa, U. and Rai, R. (2012) Evaluation of sprouting Broccoli (*Brassicaceae oleraceae* var. *italica*) genotypes for growth, yield and quality. *International Journal of Agricultural Sciences* **4**(7): 284-286.