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Research Article

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Performance of Okra Genotypes for Different Quality Parameters

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Abstract

The importance of quality parameters in okra is gaining new standards and has created an interest in many food industries. Okra mucilage is used in food, non-food goods, pharmaceuticals and for clarifying sugarcane juices. Its fibers can be used to produce paper, whereas the seed contains a high concentration of protein compared to other protein sources. Therefore, to explore and evaluate the genotypes for quality parameters in selecting better parents in any breeding program. Keeping in view, the study was conducted in the School of Agriculture, Lovely Professional University (Jalandhar, Punjab, India), during 2021-2022. Fifteen different genotypes were collected from NBPGR, New Delhi (India). The research was done in a completely randomized design with three replications. Observations were recorded from each genotype randomly per replication for chlorophyll content (mg/100 ml), acidity (%), ascorbic acid (mg/100 g), dry matter (%), iodine content (µg/100 g), crude protein (%), crude fiber (g/100 g), sodium (mg/100 g) and total soluble solids (TSS) (°Brix). The maximum chlorophyll content was noted in genotype IC 169453 (51.8 mg/ml), acidity in IC 169472 (0.28%), genotype IC 169459 recorded maximum ascorbic acid content 18.8 mg/100 g, dry matter in IC 128029 (29.2%), iodine in IC 169472 (3.29 µg/100 g), mucilage in genotype IC 169472 (16.7%), crude protein in IC 169470 (39.4%) which was at par with genotype IC 169451 (38.7%) and IC 169472 (38.1%), respectively. The highest crude fiber was recorded in genotype IC 169453 (6.13 g/100 g), sodium was noted under genotype IC 169472 (28.1 mg/100 g), and the maximum amount of TSS was recorded under genotype IC 169464 (3.97 °Brix). Genotypes such as IC 169472 and IC 169453 expressed their superiority in chlorophyll content, iodine, crude protein, crude fiber, sodium, and TSS of okra. Those genotypes can be used in the development of efficient hybrids.

Keywords

Okra, Iodine, Mucilage, Ascorbic acid, Crude protein, Crude fiber

Introduction

Abelmoschus esculentus L. is popularly known as okra and belongs to the Malvaceae family. The origin place of okra is Africa, and it is also cultivated in subtropical, tropical, and warm climate conditions. Okra can be cultivated in a wide range of soil, rainfed or irrigated conditions. Due to its heat tolerance nature and rusticity, okra does not require any high-level technology for its cultivation. Okra is essential to the human diet. It contains carbohydrates, minerals, vitamins, proteins, folic acid, phosphorus, magnesium, calcium, potassium, and other minerals that are usually deficient in a staple food [1]. Due to the antioxidant, antidiabetic, antimicrobial, and antitumor properties of mucilage in okra, it has been abundantly used in pharmaceutical industries [2].

In India, it is widely grown as a spring, summer, and rainy season crop in states like Bihar, West Bengal, Odisha, Gujarat, Jharkhand, Andhra Pradesh, Madhya Pradesh, Chhattisgarh, Haryana, and Assam. India produces about 64.16 lakh tons of okra from 5.23 lakh ha area. Tamil Nadu produces about 2.04 lakh tons of okra from 22.88 thousand ha area. It has enormous potential as one of the foreign exchange earner crops and accounts for 70% of the export of fresh vegetables [3].

In recent years, okra has attracted the food industry because of its quality fiber. In addition, it provides high-quality mucilage and oil from okra fruits [4]. The okra fruits are useful against chronic dysentery and genitor urinary disorders [5]. Nowadays, okra is used in manufacturing cardboard paper by using fruit, fibers, and fruit dry skin. The stem and roots are used in clearing can juice in jaggery preparation [6].

Considering the improvement of quality attributes of okra, the present study was carried out to evaluate the quality traits in different okra genotypes, which can be further used in breeding programs to advance specific characters.

Materials and Methods

Materials

The experiments were conducted at the Horticulture Laboratory, Department of Horticulture, School of Agriculture, Lovely Professional University (Punjab, India). Fifteen okra genotypes i.e., IC 128021, IC128023, IC 128024, IC 128028, IC 128029, EC 169451, EC 169453, EC 169455, EC 169459, EC 169462, EC169463, EC 169464, EC 169467, EC 169470, and EC 169472, respectively, were collected from NBPGR, New Delhi (India), and sown in completely randomized design with three replications and all the agronomical techniques were followed according to PAU Ludhiana.

Observations recorded

The observations were recorded randomly per genotype in each replication for various quality parameters. The collected data was analyzed according to the procedure to determine various quality parameters among the okra genotypes.

Chlorophyll content (SPAD unit)

The chlorophyll content of the leaves was measured by digital SPAD meter.

Acidity (%)

0.1 N NaOH with 1-2 drops of 1% phenolphthalein were used as an indicator, end point of titration showed light pink color of the solution.

$$\text{Titratable acidity}(\%) = \frac{\text{Titre value x Normality of NaOH x Volume made up x Eqt. wt. of citric acid x 100}}{\text{Weight of the sample x Volume of sample taken x 1000}}$$

Ascorbic acid (mg/100 g)

The ascorbic acid content was estimated using 2,6-dichlorophenol indophenol visual titration method as given by Ranganna [7]. It was calculated by using the following formula.

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Titre x Dye factor x Volume made up x 100}}{\text{Aliquot of extract x Weight of sample}}$$

Dry matter (%)

Dry matter was estimated according to the procedure given by Arora et al. [8]. By using the formula where W2 is weight of dried sample and petri dish in gram, W1 is the weight of empty petri dish in gram and W is the sample wight in gram.

$$\text{Dry Matter (\%)} = \frac{W_2 - W_1}{W} \text{ x } 100$$

Iodine content (µg/100 g)

Elmslie Caldwell's technique, as modified by Diosady and Fitzgerald [9], was used to analyze the iodine content. The idea was based on the release of iodine during the catalytic reduction of thiosulphate to tetraoxosulfate. This process involves quantitatively titrating the released inorganic iodine through carbonation.

Mucilage content (%)

The mucilage was extracted according to the procedure given by Woolfe et al. [10] where W2 is the weight of filter paper and solid mucilage after drying in grams, W1 is the weight of filter paper in gram and W is the weight of the sample in gram.

$$\text{Mucilage (\%)} = \frac{W_2 - W_1}{W} \text{ x } 100$$

Crude Fiber (g/100 g)

For extraction of crude fiber chemicals are used i.e., 200 ml of 0.255 N H2SO4, 200 ml of NaOH (0.313 N), for acid digestion. The residue digester NaOH for a period of 30 min. The crucible with preheated hot air oven (110 °C) over night. The difference in weight of the crucible before and after ashing is reported as the crude fiber content of the feed taken.

$$\text{Crude fiber (\%)} = \frac{a - b}{c} \text{ x } 100$$

Where, c = Weight of the sample, a = Weight of crucible with dry residue, and b = Weight of crucible with ash.

Crude protein extraction

Crude protein was extracted by the procedure [11] and is expressed as:

$$\text{Protein (\%)} = \frac{(b - a) \text{ x } 0.1 \text{ x } 14.00 \text{ x } 100 \text{ x } 4.53}{W_s \text{ x } 1000}$$

Where, Ws = weight (g) or volume (ml) of sample, a = volume (ml) of 0.1 N H2SO4 used in blank titration, b = volume (ml) of 0.1 N H2SO4 used in sample titration, 14.00 = atomic weight of nitrogen, 1000 = the conversion of mg N/100 g to g N/100 g sample, 4.53 = the protein-nitrogen conversion factor for fish and its by-products.

Sodium extraction

Sodium atomized ions used as determination of quantitative 1 N ammonium-acetate solution (pH 7). Flame photometer for determination the sodium concentration in sample-ex-

tract can be calculated by slope calculation. With standard solution (10 - 100 ppm).

Content of Na in soil sample: Na as mg/100 g soil (at 105 °C).

TSS extraction

A refractometer measures TSS concentration based on the principle of refraction of light in °Brix refractometer, the refractive index is calibrated into °Brix readings.

Results and Discussion

The data revealed from table 1 stated that maximum amount of chlorophyll content among all 15 genotypes showed significant differences among them. The maximum chlorophyll content was noted in genotype IC 169453 51.8 SPAD unit significantly followed by genotype IC 16946446.0 SPAD unit and IC 169467 43.3 SPAD unit whereas, the mean chlorophyll content among all genotypes recorded was 40.1 mg/ml. The minimum amount of chlorophyll 33.4 SPAD unit was obtained from genotype IC 169472 (Figure 1). The maximum acidity percent was recorded in genotype IC 169472 i.e., 0.28% which was followed by genotype IC 128029 i.e., 0.26% and it was at par with genotype IC 169453 i.e., 0.25%. Then minimum acidity percentage was recorded for genotypes IC 128024, IC 169462, and IC 169467 was 0.16%, respectively.

Chlorophyll is an essential pigment responsible for photosynthesis. According to Kjeldahl [12] chlorophyll helps in the absorption and assimilation of minerals from the soil. It builds linkage between climate and soil, which directly influences chlorophyll and minerals in plants, thus chlorophyll might be an indicator for response of plant health. More accumulation of food directly influences the growth and fruit setting. In the study of Habtemariam [13], at 75 cm row spacing chlorophyll content was obtained higher than 50 cm row spacing. Chlorophyll content was higher at 150 kg N as compared with 50 and 100 kg N/ha. As per study of Sampaio et al. [14], less spacing leads to increase in height of plant results in suboptimal crop production. At 2 weeks after planting, the highest (5.54 mg/g) mean chlorophyll content found in 300 g PBA treatment application [15].

Ascorbic acid is an essential element of plant antioxidant system, which is also referred to as complex redox networks include metabolites and enzymes with their mutual interaction and synergetic effects. In present study, genotype IC 169459 recorded maximum ascorbic acid content 18.8 mg/100 g which was significantly followed and at par with genotypes IC 169464 17.7 mg/100 g and genotype IC 16946716.6 mg/100 g All the genotypes under studied showed significant variation for ascorbic acid content. The minimum amount of ascor-

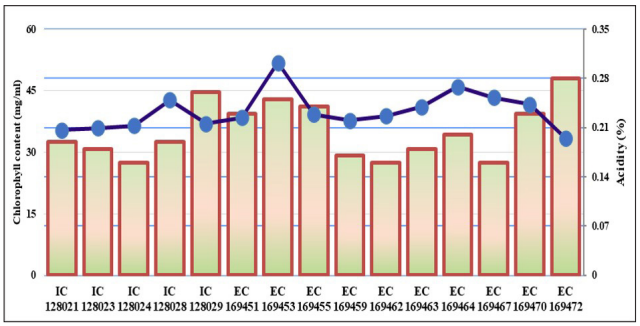


Figure 1: Chlorophyll content (mg/ml) and crude protein (%).

Table 1: Quality parameter of fifteen genotypes under studies.

Genotype	Chlorophyll content (SPAD unit)	Acidity (%)	Ascorbic acid (mg/100 g)	Dry matter content (%)	Iodine content (µg/100 g)	Mucilage content (%)	Crude protein (%)	Crude fiber (g/100 g)	Sodium (mg/100 g)	TSS (°Brix)
IC 128021	35.4	0.19	12.3	19.7	1.25	12.1	29.5	3.04	20.1	3.61
IC 128023	35.9	0.18	12.3	18.9	1.24	12.3	25.1	3.83	18.2	3.28
IC 128024	36.5	0.16	10.5	21.7	2.2	8.51	23.7	4.55	17.4	2.99
IC 128028	42.7	0.19	15.7	16.9	1.25	10.6	32.8	3.21	20.6	3.36
IC 128029	37	0.26	13.4	29.2	2.26	5.35	34.2	5.84	19.3	3.64
EC 169451	38.4	0.23	10.7	24.4	3.11	12.3	38.7	4.86	27.9	3.88
EC 169453	51.8	0.25	16.4	18.7	2.18	8.25	31.1	6.13	25.7	2.87
EC 169455	39.2	0.24	14.6	26.1	1.75	10.3	28.3	3.59	21.4	3.55
EC 169459	37.8	0.17	18.8	20	1.46	6.5	37.1	5.53	23.7	3.77
EC 169462	38.8	0.16	12.6	23.4	2.11	7.3	26.2	2.92	16.8	2.73
EC 169463	41.1	0.18	15.6	17.7	1.75	11.6	30.4	4.12	18.8	3.12
EC 169464	46	0.2	17.7	19.8	2.63	6.6	36.3	6.07	24.2	3.97
EC 169467	43.3	0.16	16.6	18.7	3.06	7.14	35.7	4.76	22.1	3.48
EC 169470	41.7	0.23	15.5	17.6	2.01	12.6	39.4	5.26	26.3	3.71
EC 169472	33.4	0.28	11.5	26.3	3.29	16.7	38.1	5.71	28.1	3.82
SE(m)±	0.4538	0.0081	0.1513	0.7476	0.0648	0.2377	0.8557	0.3717	0.5791	0.3284
CD @5%	1.05	0.018	0.35	1.73	0.15	0.55	1.98	0.86	1.34	0.76

bic acid was noted in genotype IC 128024 10.5 mg/100 g. Ascorbic acid take part in synthesis of ethylene and hormonal signaling in different phase of plant growth and development in response to environment. The variation present in ascorbic acid within genotypes will be useful in trait heritability in breeding programs such as hybrid development (Table 1). Ascorbic acid impacts on increasing tolerance towards abiotic stress along with protein and proline content of leaves [16]. Hassan and Ali [17], revealed that fermented okra seed had higher amounts of ascorbic acid along with phenolics and flavonoids.

Dry matter represents the total inorganic and organic matter in the tissue. The advancements of dry matter at the vegetative phase are the main breeding objective in most crops, in those vegetables where all plant or plant parts are. Significantly, the mean value of dry matter content was 20.4% recorded from all genotypes. The maximum dry matter was obtained in genotype IC 128029 at 29.2%, which was significantly followed by genotype IC 169472 at 26.3%. The lowest amount of dry matter was noted under genotype IC 169470, 17.6% (Table 1). Iodine is one of the influential components of okra. In the present investigation, the maximum amount of iodine was found in genotype IC 169472 3.29 µg/100 g, which was significantly followed by genotype IC 169451 3.11 µg/100 g and genotype IC 169467 3.06 µg/100 g. The lowest amount of iodine was noted in genotype IC 128023 1.24 µg/100 g. The average amount of iodine among all genotypes understudy was 1.98 µg/100 g. Iodine is an essential component of thyroid hormones such as thyroxin and triiodothyronine, which play a crucial role in the growth of the human body. Nowadays, most problems regarding physiological malfunctioning and health are due to a deficiency of iodine.

Among all the vegetables, okra is the finest and readily available source of iodine. The advancement of this trait will be helpful in the breeding of okra. Gemede et al. [18] and Elkhalifa et al. [19] found that okra is a rich source of protein, carbohydrates, minerals, iodine, and dietary fibers. The study provides evidence to support the beneficial impact of okra in lowering the risk of chronic disease. Okra is used by people suffering from leukorrhea and weakness, along with a cure for control of goitre disease [20]. Zhu et al. [21] stated that the increase in dry matter was due to a settled toot system, which increases height along with branching and leaves. In okra, mucilage is valuable due to its potential health benefits. The okra mucilage comprised natural polysaccharides, consisting of L-rhamnose, monosaccharide D-galactose and galacturonic acid linked with proteins and minerals. The mucilage contains zinc and calcium higher than that of minerals present in whole okra fruit. The polysaccharides obtained from mucilage had biological importance as immunomodulators and anti-inflammatories.

The tenderness of okra mostly depends upon the mucilage content present in it. The data revealed from table 1 (Figure 2) indicated that maximum mucilage content was recorded in genotype IC 169472 16.7% which was significantly followed by genotype IC 169470 12.6% and genotype IC 16945 112.3%. The mean value for mucilage content was 9.9%. The lowest amount of mucilage was found in genotype IC 169459 6.5%. Olawuyi and Lee [22], studied thermal stability and emulsifying capacity and higher antioxidant capacity than polysaccharide obtained from mucilage of okra pods. Fauza et al. [23] and Romdhane et al. [24] put their same opinions and stated that okra pods are mucilaginous, and nutritionally rich along with a good source of edible dietary fibers. Studies have shown that they contain important bioactive compounds also.

The highest amount of crude protein was recorded in genotype IC 169470 39.4% which was at par with genotype IC 169451 38.7% and IC 169472 38.1%, respectively. The mean value of crude protein content was 32.4% and genotypes IC 128028 (32.8%), IC 128029 (34.2%), IC 169459 (37.1%), IC 169464 (36.3%), and IC 169467 (35.7%) where found upgraded value of crude protein then mean. The lowest crude protein was recorded under genotype IC 169459 6.5% (Table 1 and figure 1). Okra is well known for high quality protein especially in context of essential amino acid, relative to other plant proteins sources in study of Gerrano [25]. The amino acid in okra had similar composition as compared to soybean and possess higher protein efficiency ratio. The various genotypes understudied contain good amounts of crude protein evaluates by Rindiani and Kumalasari [26]. Wahyuningsih et al. [27] found that, higher amount of crude protein 21.55% in fruits of Clemson spineless as compared to dwarf long green.

The highest crude fiber was recorded in genotype IC 169453 6.13 g/100 g, which was at par with genotype IC 169464 6.07 g/100 g. The mean value for crude fiber was recorded at 4.63 g/100 g. The minimum amount of crude fiber was noted under genotype IC 169462 2.92 g/100 g (Figure 2). The fiber present in okra helps to stabilize blood sugar by regulating the sugar absorption rate from intestinal track. The okra fruit fiber also helps to avoid kidney diseases when consumed in daily diet as per the studies of Daliu et al. [28]. Nowadays, okra fiber is also used in many food industries, which lightens the importance of fiber content in okra. Genotypes understudied possess good amount of fiber in it which can be used for the improvement in parental line [29].

The maximum amount of sodium was noted under genotype IC 169472 28.1 mg/100 g which was significantly followed and at par with genotype IC 169451 27.9 mg/100 g. The mean value for sodium content in okra was 22.0 mg/100 g. The lowest amount of sodium was recorded under genotype IC 169462 16.8 mg/100 g. Cahyana and Kam [30] studied that, sodium maintains proper fluid balance in the body and reduce the pressure on cardiovascular system by relaxing the

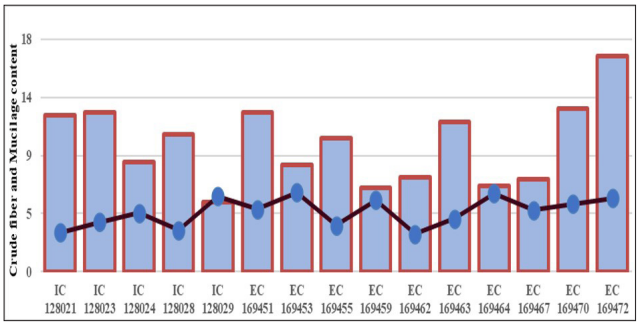


Figure 2: Crude fiber (g/100 g) and mucilage content (%).

arteries and blood vessels which reduce blood pressure. The regulation of blood pressure helps to prevent blood clotting and atherosclerosis. Some genotypes contained a good quantity of sodium which can be utilized for trait advancement.

TSS is one of the important parameters of food quality. The TSS value affects the flavor and taste of the fruit. TSS is dominated by sugar content along with a small proportion of soluble proteins and organic materials. The data depicted in table 1 indicated that the mean quantity of TSS in different genotypes of okra was 3.45 °Brix. The maximum amount of TSS was recorded under genotype IC 169464 3.97 °Brix significantly followed by genotype IC 169451 3.88 °Brix. The genotypes IC 128021 (3.61 °Brix), IC 128029 (3.64 °Brix), IC 169455 (3.55 °Brix), IC 169459 (3.77 °Brix), IC 169467 (3.48 °Brix), IC 169470 (3.71 °Brix), and genotype IC 169472 (3.82 °Brix) were found to have upgraded values than mean. The lowest amount of TSS was recorded for genotype IC 169462 2.73 °Brix (Figure 3). The TSS value can be helpful in a variety selection, harvesting and other aspects of production which include post-harvest management [31]. As per studies of Arjun et al. [32] recorded higher values of TSS (2.19 and 2.39 °Brix) obtained in the combination of 100% RDF + 25 kg $ZnSO_4$/ha and 100% RDF + 50 kg $FeSO_4$/ha.

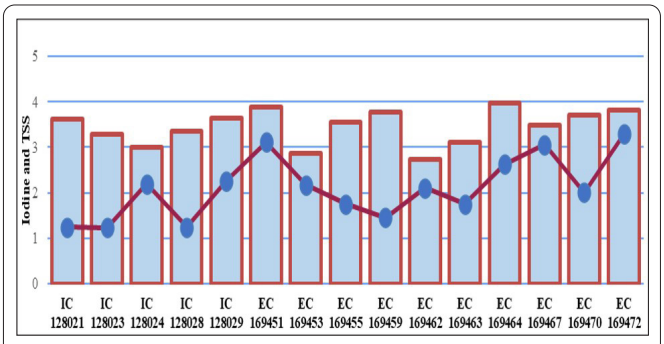


Figure 3: Iodine and TSS content.

Conclusion

Crude protein and fiber are important components of okra, but the mucilage present in okra is also gaining importance in the industrial sector. Among genotypes understudy in the experiment possesses potential to transfer the genes responsible for character expression. Genotypes such as IC 169472 and IC 169453 expressed their contribution in quality parameters such as chlorophyll content, iodine, crude protein, crude fiber, sodium, and TSS of okra. The other genotypes are also used as germplasm to transmit traits into parental line. The genes responsible for expression of quality attributes such as iron and protein, along with sodium content can be used to upgrade a high yielding hybrid. Nowadays people's move towards healthy and nutritious food, and this could be better option to provide healthier food comes from superior hybrid within build quality traits.

Acknowledgements

None.

Conflict of Interest

None.

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