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Evaluation of Jamun (*Syzigium cuminii* Skeels.) genotypes for flowering and yield attributes

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Abstract
An investigation on morphological and Physico-chemical characters of 10 elite jamun genotypes was undertaken at Department of Fruit Science, Horticultural College and Research Institute, Periyakulam. Ten jamun genotypes *viz*., SC-01 to SC -10 showed wide range of variation with respect to morphology, plant growth, flowering and yield traits of fruit. Among 10 genotypes observed, two were found to be of early bearer, six mid and two were of late bearing habit. Genotype SC-04 recorded significantly higher fruit weight (17.05 g), fruit length (3.95 cm), fruit breadth (2.43 cm), pulp weight (14.71 g), pulp per cent (86.28%) and pulp to seed ratio (6.29). High TSS was recorded in SC-04 (16.50 °Brix) while lowest in SC-09 (7.62 °Brix). Significant differences were observed for total, reducing and non-reducing sugar content among the genotypes. Lowest acidity was recorded in SC-04 (0.59%) and highest in SC-09 (1.06%). Highest TSS: acid ratio was recorded in SC-04 (27.97). Comparative results of ten jamun germplasm evaluation, the result showed that SC-04 genotype was better in terms of morphology of fruit, fruit yield and other physicochemical characters.

Keywords: Jamun, *Syzygium cumini*, variability, genotypes evaluation, Physico-chemical characters

Introduction
Jamun (*Syzygium cuminii* Skeels.) is an important under-exploited indigenous fruit tree of India. It is a large, evergreen tree of Indian sub-continent belonging to the family, Myrtaceae. The other name of jamun are Indian blackberry, java plum, jambu, black plum and jambul *etc*. (Sartaj Ali *et al*., 2015) [21]. It is widely grown in many parts of India from Indo-Gangetic plains in the North to Tamil Nadu in the South (Singh and Srivastava, 2000) [23]. India ranks second in the jamun production and Uttar Pradesh is the largest producer followed by Maharashtra, Tamil Nadu, Gujarat and Assam. The plant is rich in compounds containing anthocyanins, glucoside, ellagic acid, isoquercetin, kaemferol and myrecetin. The seeds are claimed to contain alkaloid, jambosine, and glycoside jambolin or antimellin (Swamy *et al*., 2012) [25].

S. cumini is naturally spread and the enormous variability has been reported in due to cross pollination and predominance of seed propagation creating a lot of variation in their field population with respect to tree height, fruiting behaviour, yield and quality characters. Jamun is a very large evergreen tree of the Indian subcontinent. Flowering and fruiting takes place in March-April and bear fruits from May to July. Inflorescences are arise from the leaf axils of branchlets. Flowers exhibit bisexual nature and light yellow in colour. Some jamun varieties put forth to second season in October (Hemavath *et al*., 2019) [7]. Jamun is cross pollinated tree. The tree bears fruits in round or oblong, often curved, long and usually turn from green to light magenta, then dark-purple or nearly black as they ripen. The pulp is purple or white, very juicy and normally encloses a single, oblong, green or brown seed and some are seedless.

The assessment of genetic variability is considered vital tool for formulating conservation strategies of this underutilized fruits. Genetic variability is considered vital tool for identification of superior accessions and conservation of this under-exploited fruit species. Phenotypic variability of plant organs such as leaves, flowers, fruits and seeds are most commonly used traits (Jabbar *et al*., 1994; Morton, 1987) [10, 14]. Earlier studies on *S. cumini* indicated a lot of variation in respect of fruit shape and size, pulp colour, TSS, acidity, earliness, taste, fruiting period, maturity of fruits (Hyland, 1983) [8]. Advantages of these variations can be taken to evolve selections of superior quality. Hence, the present study aimed to characterize the ten selected jamun genotypes to select promising genotypes for further crops improvement programme.

Materials and Methods

Plant material

Twenty six genetically diverse jamun genotypes were *viz*. SC-01 to SC-10 were evaluated with respect to growth, yield and quality traits of fruit at Department of Fruit Science, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakulam on well-established eighteen years old jamun germplasm trees planted at 8.0 x 8.0 m spacing.

Observation of characters

Observation was made on growth characters such as height of plant (m), spread of plant (m), girth of stem (cm) and yield contributing characters *viz*., size of fruit (cm), weight of pulp (g), weight of seed per fruit (g), number of fruit per plant, weight of fruit (g) and yield (kg/plant) and physical and chemical characters like colour of fruit skin, colour of pulp, shape of fruit. Total soluble solids were determined with the help of digital refractometer. Acidity was determined by titrating with standard sodium hydroxide solution using phenolphthalein indicator (AOAC, 1990) [2]. Ascorbic acid content of fruit was determined by using 2, 6-dichlorophenol indophenol dye as per the modified procedure of AOAC (1990) [2]. Reducing and total sugars were estimated following by Dinitro Salicylic Acid (DNS) Method and Anthrone method respectively. The study was based on single plant evaluation, the samples were collected for observations from fruits all over the tree in triplicate. Data obtained on physical parameters were subjected to statistical analysis following Randomized Block Design (Panse and Sukhatme, 1985) [17].

Result and Discussion

Bearing habit

Data showed (Table 1, 2 and 3) that genotypes differed significantly with respect to their growth, yield and physicochemical attributes. The morphological characteristics of trees are one of the important aspects for a fruit breeder. The variability in canopy shape, tree growth habit, bearing season, fruit size, fruit shape and colour of the fruit depict the enormity of variation present in the germplasm evaluation (Table 1). Among 10 genotypes observed, five were found to be pyramidal shape of canopy, two genotype of oval shape and two genotypes having semi spreading shape of canopy. Among 10 genotypes, one upright growth, four genotypes were found to have spreading growth habit while five twelve were found to have semi-spreading growth habit. The leaf shape varied with genotype.

It is evident from the table 1 that genotype SC-02 and SC-03 have had come to bearing early in the season, genotypes like SC-01, SC-04, SC-05, SC-06, SC-07 and SC-10 were grouped in to mid season bearers and genotypes SC-08 and SC-09were late bearers. It is an established fact that early bearing types always fetches good price in the market and obviously, they are chosen for commercial cultivation. Bearing potential of these genotypes is an important factor that reflects the yield levels and the genotypes like SC-01, SC-02, SC-03, SC-04, SC-08 and SC-09 were categorized as heavy bearers, while, genotypes SC-05, SC-06 and SC-07 were of average in bearing and the rest of one grouped under poor bearers. Bearing potential is the actual genetic makeup that brings up good returns to the farmers at the end and thus is a major trait that could be looked out while selecting a superior genotype. The size of fruit is very important and concerned for selection of better genotype. It is directly influenced by many yield contributing parameters like fruit and seed length, diameter and weight. Most of the genotypes were bear medium sized fruits. However, genotypes SC-02, SC-03 and SC-04 were produced bigger sized fruits and genotypes 3 with smaller fruits. Similarly, shape of the fruits was oblong or ellipsoid in almost all the genotypes and long fruit shapes. According to genotype or variety and growth conditions jamun fruits vary in size, shape and weight as well. Normally they are elliptical and ovoid though certain varieties may reach a near round shape (Shahnawaz and Sheikh, 2011) [22]. Ashraf (1987) [3] reported that fruits shape in jamun varied from round to oblong and oblong types had more fruit weight and relatively less seed weight.

Physical parameters

The physical properties of fruits in general, is important in designing and fabricating for handling, transporting, processing, storage and also for assessing behaviour of the product quality. Data from table 2 presents significant differences with respect to fruit length, diameter and weight of jamun genotypes. The fruit length of all genotypes ranged from 2.32cm to 3.95cm. Maximum fruit length was recorded in the genotype SC-04 (3.95cm) while minimum fruit length was recorded in the genotypes SC-09 (2.32cm). Highest fruit width was observed in SC-04 (2.43cm) while lowest fruit width was observed in SC-09 (1.46 cm). Similar kind of work was carried out by Vartika *et al*. (2010) [26], Ghojage *et al*. (2011) [6] and Shahnawaz and Sheikh (2011)[22]. Fruit weight, among the 10 different genotypes studied ranged from 17.05 to 3.60 g. Maximum fruit weight of 17.05 g was observed in genotype, while it was minimum in genotype SC-09 (3.60 g). Greater variability among the jamun genotypes were also reported by Prakash *et al*., (2010) [20]. Variations in fruit weight were reported by Devi *et al*. (2002) [4], Inamdar *et al*. (2002) [9], Prabhuraj *et al*. (2003) [19], Patel *et al*. (2005) [18] and Kundu *et al*. (2001) [13] in jamun. Similar observations on fruit length, width and weight of jamun were reported by (Shahnawaz and Sheikh, 2011) [22]. Further they stated these length and diameter are the two important factors ultimately decide whether fruit has completely grown and ready for harvest. In many countries size is taken in to account to judge the maturity status of fruits. In the market, the consumers have a preference to select the large sized fruits and accordingly the price of those fruits goes higher with size

Data pertaining to seed characters, minimum seed weight was registered in genotype SC-09 (1.02 g) which was on par with accession 07 (1.49 g), 04 (1.46 g), 19 (1.45 g) and 25 (1.44 g), while it was maximum in SC-02 (3.36 g). Pulp weight ranged from 2.58 to 14.71g. Greater pulp weight of 14.71g was noticed in genotype SC-04 (Plate 2) while, minimum pulp weight was recorded in genotype SC-09 (71.67g). Higher pulp weight is a desirable character for table purpose jamun and for breeding quality fruits. Similar variability was also reported by (Srivastava *et al*. 2010) [24] in jamun. The pulp percent varies from 71.67 to 86.28g. Perusal of data on pulp per cent revealed significant difference among the genotypes. It was maximum (86.28%) in genotype SC-04 and minimum (71.67%) in genotype SC-09. The pulp per cent fully depends on fruit weight and seed per cent. These results are in conformity with that of Patel *et al*. (2005) [18] and Agarwal *et al*. (2017) [1]. Per cent pulp content of 53 to 87% was also registered by Ningot *et al*.(2017) [15] in jamun. The pulp: stone

ratio is an important aspect for selection of superior genotype by breeder. Similar results were also reported by (Garanade *et al*. 1998) [5]. The data also indicate that pulp: seed ratio of fruits varied significantly. SC-04 genotype had the maximum ratio of 6.29. SC-09 reported the lowest pulp: seed ratio of 2.53. Higher pulp: seed ratio is a necessary character for table purpose jamun hence, pollen parents should be selected as a genotype having high fruit pulp:seed ratio (Patel *et al*. 2005) [18]. The yield per was highest observed in the genotypes SC-04 having 82.11 kg/tree while lowest in SC-09 (21.65kg/tree).

Table 1: Tree morphological characters of different jamun genotypes

Genotype	Shape of canopy	Tree growth habit	Leaf shape	Bearing season	Bearing potential	Fruit size	Fruit shape	Fruit Colour
SC-01	Broadly pyramidal	Semi spreading	Lanceolate	Mid	Heavy	Medium	Ellipsoid	Deep Purple
SC-02	Pyramidal	Semi spreading	Broadly ovate	Early	Heavy	Big	Oblong	Bluish block
SC-03	Pyramidal	Spreading	Broadly ovate	Early	Heavy	Big	Ellipsoid	Bluish block
SC-04	Broadly pyramidal	Semi spreading	Lanceolate	Mid	Heavy	Big	Ellipsoid	Bluish block
SC-05	Irregular	Spreading	Lanceolate	Mid	Average	Medium	Oblong	Deep Purple
SC-06	Pyramidal	Spreading	Lanceolate	Mid	Average	Medium	Ellipsoid	Deep Purple
SC-07	Oval	Upright	Lanceolate	Mid	Average	Medium	Long	Deep Purple
SC-08	Pyramidal	Spreading	Lanceolate	Late	Heavy	Small	Round	Deep Purple
SC-09	Pyramidal	Semi spreading	Lanceolate	Late	Heavy	Small	Round	Deep Purple
SC-10	Oval	Semi spreading	Lanceolate	Mid	Poor	Small	Round	Deep Purple

Table 2: Physical characters of jamun genotypes

Genotype	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Seed weight (g)	Pulp weight (g)	Per cent pulp (%)	Pulp to seed ratio	Yield/tree (Kg)
SC-01	3.11	1.94	10.72	1.50	9.22	86.00	6.15	78.64
SC-02	3.83	2.10	14.91	3.36	11.55	77.46	3.44	60.17
SC-03	3.65	2.14	14.37	2.19	12.18	84.76	5.56	71.90
SC-04	3.95	2.43	17.05	2.34	14.71	86.28	6.29	82.11
SC-05	3.40	2.28	10.43	2.65	7.78	74.59	2.94	40.54
SC-06	3.27	2.25	8.13	1.65	6.48	79.70	3.93	62.75
SC-07	3.16	1.80	10.76	1.84	8.92	82.90	4.85	55.60
SC-08	2.67	1.88	6.93	1.91	5.02	72.44	2.63	34.33
SC-09	2.32	1.46	3.60	1.02	2.58	71.67	2.53	21.65
SC-10	3.88	2.35	15.86	2.28	13.58	85.62	5.96	64.05
S.Ed	0.11	0.06	0.40	0.07	0.33	2.61	0.57	1.99
CD (P=0.05%)	0.22	0.14	0.83	0.14	0.69	5.44	0.31	4.15

Table 3: Quality parameters of jamun genotypes

Genotype	TSS (ºBrix)	Total sugar (%)	Reducing sugars (%)	Non-reducing sugars (%)	Titrable acidity (%)	Ascorbic acid (mg/100g)	Anthocyanin (mg/100g)	TSS acid ratio
SC-01	16.00	13.47	6.50	6.98	0.67	35.65	155.66	23.88
SC-02	12.80	12.28	3.7	8.65	0.80	49.82	180.10	16.00
SC-03	14.98	12.86	4.10	8.61	0.92	38.00	158.43	16.28
SC-04	16.50	13.60	4.90	9.15	0.59	52.40	197.56	27.97
SC-05	14.36	12.55	3.71	8.80	0.90	44.02	143.30	15.96
SC-06	10.70	10.91	5.34	5.62	0.85	36.73	170.41	12.59
SC-07	12.53	11.47	5.95	5.76	0.78	40.22	152.90	16.06
SC-08	9.66	9.57	2.55	7.28	0.98	37.81	137.20	9.86
SC-09	7.62	9.80	2.49	7.10	1.06	41.44	146.07	7.19
SC-10	16.20	12.50	3.82	8.90	0.61	40.58	174.98	26.56
S.Ed	0.431	0.38	0.14	0.28	0.027	1.338	5.19	0.57
CD (P=0.05%)	0.898	0.80	0.30	0.52	0.057	2.79	10.84	1.20

Biochemical characters

The bio-chemical properties of Jamun fruit cultivars were also analysed and the data was depicted in Table 2 revealed wide variation in bio-chemical composition of fruits of all selected 10 genotypes. Taste is a complex character which is contributed by TSS, acidity, TSS: acid ratio and other biochemical constituents. Significantly high TSS was recorded in the genotype SC-04 (16.50 °Brix) and low TSS of 7.62 °Brix in the genotype SC-09. In the present study, total sugar, reducing and non-reducing sugar content recorded significant differences among the 10 genotypes. This may be due to the variability in the genetic makeup of the genotypes (Shahnawas and Sheikh, 2011) [22]. Similar observations were noticed by Ghojage *et al*. (2009) [6], Prakash *et al*. (2010) [20] and Srivastava *et al*. (2012) [10] in jamun.

Highest total sugar and reducing sugar was recorded in the genotype. This may be due to its high TSS content and genetic makeup of the genotype. The highest non reducing sugar content of 19.15 per cent was recorded in the genotype SC-04 (Table 3). Shahnawas and Sheikh (2011) reported that fresh extract of Jamun fruit is highly acidic and may be responsible for astringency in taste. Noomrio and Dahot (1996) [16] authenticated the same view point on acidity of Jamun fruit. Acidity recorded significant differences among the 10 genotypes. Significantly lower acidity was recorded in the genotype SC-04 (0.59%) and maximum in the genotype

SC-09 (1.06%). This result is in consonance with that reported by Srivastava *et al.* (2010) [24] who reported maximum acidity in VJ-20 (1.14%) whereas, minimum in genotype VJ-5 (0.37%). This is a fact in many fruits that if total soluble solids increases then definitely acidity decreases, these findings were partially supplemented by (Devi *et al.* 2002) [4] and (Kumar *et al.* 2013) [12].

Ascorbic acid values on the other hand ranged from 35.65 (mg/100 g) in SC-01 to 52.40 (mg/100 g) in SC-04. Similar amount of ascorbic acid in the range of 21 to 42 mg was reported by Agarwal *et al*. (2017) [1] and a maximum of 52.74 mg ascorbic acid was reported by Ningot *et al*. (2017) [15]. Anthocyanin recorded significant differences among the 10 genotypes. Significantly higher Anthocyanin was recorded in the genotype SC-04 (197.56 mg/100g) and minimum in the genotype SC-05 (143.30mg/100g). There was significant difference among the genotypes for TSS: acid ratio also.

Conclusion

It can be concluded that there was a significant variation in morphological characters, fruit yield and quality characters of all the 10 selected jamun genotypes. SC-04 was most promising genotype among the 10 genotypes for average fruit weight (17.05 g), fruit length (3.95 cm), fruit width (2.43 cm), pulp weight (14.71 g), pulp percent (86.28%) and yield (82.11 kg). This genotype can be recommended to the farmer to get maximum yield.

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