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Variability studies in different accessions of Jamun (*Syzygium cumini* skeels) from Madhya Pradesh

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Abstract
A survey was carried out during 2016 in Madhya Pradesh, India to identify elite genotypes of jamun. Morphological qualitative, quantitative characteristics and biochemical attributes of sixteen genotypes were studied. The study revealed that there was a wide variation among the accessions. JJ-5 was the most promising genotype among the 16 accessions for average fruit weight (55.40 g), fruit length (27.78 mm), fruit width (22.01 mm), pulp weight (31.60 g) and seed weight (14.70g). This genotype can be used for table purpose as well for preparation of seed powder. The biochemical characteristics also showed high variability among all the accessions of jamun. Maximum TSS was found in JJ-4 (21.25°Brix) and JJ-3 (19.85 °Brix). Acidity was highest (0.53%) in JJ-9 and ascorbic acid in JJ-15 (42.30 (mg/100 g).

Keywords: Jamun, quantitative, qualitative, biochemical characters, Madhya Pradesh

1. Introduction
Syzygium cumini Skeels (Syn. *Eugenia jambolana, Eugenia cumini* and *Syzygium jambolana*) is a polyembryonic species belongs to family Myrtaceae and is commonly known as Jambul, Black Plum, Java Plum, Indian Blackberry, Jamblang and Jamun. This under-utilized fruit crop is indigenous to India and shows wider adaptability to a range of ecological regions, tropics as well as subtropics. It is mainly grown throughout South East Asia, Malaya, Burma, Nepal, Bangladesh, Pakistan, Srilanka, Philippines and Indonesia. It is an emerging fruit crop of the twenty-first century as it yields table fruit that could play an important role in meeting demand for nutritious natural fruit of high medicinal value as well as different plants parts possess varied uses to mankind. The plant has various medicinal uses in various traditional systems of medicine. All parts of the tree and importantly the seeds are used to treat a range of ailments, the most important being diabetes mellitus (Sagrawat *et al.* 2006) [16] The gallic acid and ellagic acid content play important in role in conversion of starch into sugar so that seed extracts minimize blood glucose level (Noomrio and Dahot, 1996) [9]. It is also effective in the treatment of inflammation, ulcers and diarrhea. Ripen fruits are very juicy, almost odourless, with a slightly astringent taste. The fruit pulp is used to make jams, jellies, juice, vinegar and puddings. The wood is very strong and resistance to water and termite attack. The leaves are used as fodder and also food for tassar silkworms in India. *Syzygium cumini* flowers are rich in nectar and are useful in the apiculture for their yield of high quality honey (Patel *et al.* 2010) [10]. There is a very high anthocyanin content in *S. cumini* fruits. These pigments can be a good source of natural food colourants for the food processing industries (Chaudhary and Mukhopadhyay, 2012) [3].
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. 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. 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 etc. Based on these charcters several studies in different states of India have been conducted like Goa (Devi *et al.* 2002) [4], Jharkhand (Patel *et al.* 2005) [11], Uttar Pradesh (Singh and Bajapi, [13], Maharashtra (Ghojage *et al.* 2011) [5] and Gujarat (Singh and Singh, 2012) [14] selection of better varieties.

This fruit occurs largely on roadsides, avenues and marginal lands across Madhya Pradesh. Hence, the present study was conducted to assess the quantitative, qualitative and chemical composition variation in fruits of different accessions of Jamun (*Syzygium cumini* Skeels) collected from various districts of Madhya Pradesh, India.

2. Materials and Methods

An extensive survey was undertaken across different districts of Madhya Pradesh, India during peak fruiting season of June, 2016 to identify elite types of germplasm among its population. Trees of seedling origin were selected for the study. Observations on the quantitative, qualitative and biochemical characters of fruits were recorded for 16 selected genotypes. Chemical analysis was done in the Post Harvest Laboratory, Department of Horticulture, College of Agriculture, JNKVV, Jabalpur. Three different lots of five fruits each were taken for physical and chemical analysis from each tree. Observation on traits *viz.,* fruit length (mm), fruit width (mm), fruit weight (g), volume of fruit (cc), seed length (mm), seed width (mm), seed weight (g), pulp weight (g), fruit colour, pulp colour, fruit firmness, Total soluble sugars (°Brix), titrable acidity % and Ascorbic acid content were recorded from randomly selected fruits from accession.

The fruit size, is measured in terms of length and width. Fruit length was measured from the tip of the fruits to other end using digital Vernier-caliper with an accuracy of 0.01mm and it was expressed in millimetres. Fruit width was taken at the middle of the fruit across the fruit length using digital Vernier- caliper and was also expressed millimetres. The weight of a selected sample of fruits was determined by digital electronic balance having an accuracy of 0.1g. The volume of Jamun fruit was measured through measuring volume of displaced water directly in measuring cylinder. A measuring cylinder which was properly graduated and transparent but the representative sample of fruits could be easily and freely introduced in the cylindrical space. Seed length was measured from the tip of the seed to the bottom of the seed and expressed as millimetres. Seed diameter was taken at the middle of the seed with the help of caliper and expressed as millimetres. Seed weight was measured using electrical balance, it was expressed in grams. Pulp weight or the weight of consumable part was measured using the following formula:

$$\text{Pulp weight (g)} = \text{Weight of fruit (g)} - \text{seed weight (g)}$$

The percent consumable part of the fruit i.e. pulp was measured using the following formula:

$$\text{Pulp\%} = \frac{\text{Weight pulp (g)}}{\text{Weight of the fruit (g)}} \times 100$$

The percent non-edible part of the fruit i.e. seed was measured using the following formula:

$$\text{Seed\%} = \frac{\text{Weight Seed (g)}}{\text{Weight of the fruit (g)}} \times 100$$

Pulp to seed ratio was calculated using formula:

$$\text{Pulp to seed ratio} = \frac{\text{Pulp weight (g)}}{\text{Seed weight (g)}}$$

Firmness in Jamun fruit was measured by the Finger or hand-feeling method. It is an easy method where a person holds the fruit in palm and feels it firmness by giving the desired pressure. It was then expressed in terms such as very hard, medium hard, moderately soft, soft and extremely soft. Visual observations were made for determination of fruit colour and pulp colour. Total soluble solids were estimated in term of percent with the help of hand refractometer. Titrable acidity was estimated by titrating 10 ml juice against 0.1 N NaOH using phenolphthalein as indicator. The acidity was determined in terms of lactic acid. The volume of alkali used was noted and calculated using the following formula:

$$\text{\% Titrable acidity} = \frac{\text{Normality of NaOH} \times 0.009}{\text{Weight of sample (g))}} \times 100$$

Ascorbic acid content of fruits was determined using standardized 2, 6-dichlorophenol indophenol dye and expressed in mg per 100 g of pulp. The data collected on all the quantitative characters were subjected to basic Randomized Block Design analysis and following different statistical parameters were worked out using OP Sheoran Programmer, SPSS statistical software.

3. Results and Discussion

The data pertaining to quantitative and qualitative attributes of jamun fruits accessions is depicted in Table 1. Perusal of the information collected from the studies on genetic resources of Jamun in Madhya Pradesh revealed that the mean square estimates were significant for all the characters studied indicating sufficient diversity among the genotypes. The mean performance of the genotypes revealed a wide range of variability for all the traits. Among the 16 genotypes studied minimum fruit length (18.26 mm) was recorded in JJ-1 while it was maximum (27.78 mm) in genotype JJ-5 which was statistically at par with JJ-7 (27.53 mm) and JJ-8 (27.51 mm). Fruit width ranged from 22.71mm (JJ-13) to 15.25 mm (JJ-1). It was noted that JJ-13 had significantly more fruit width than JJ-5 (22.01 mm) and JJ-8 (21.14mm). Similar results were reported by (Srimathi *et al*. 2001) [15] in jamun for the characters of fruit length (2.10 cm) and fruit breadth (1.30 cm). The range of variation was very broad for character fruit weight (14.40 g in JJ-1 to 55.40 g in JJ-5). The genotype JJ-5 was found to be statistically superior to JJ-13 and JJ-11 with 49.50 g and 36.15 g fruit weight respectively. In jamun genotypes normally grown in North India was 16.5 g and (Ghojage *et al.* 2011) [5] among thirty selected jamun genotypes was 13.45 g which is less than that obtained in the present study (55.40 g). Higher fruit weight is a preferred as a character for selecting superior genotypes.

Volume of fruit is also a very important character. In the present study significant variation in relation to volume of fruit was observed in the present study. Highest fruit volume of 1.01cc was recorded in JJ-1 which was significantly superior to other genotypes. It was followed by JJ-15 with 1.65 cc, whereas it was lowest in genotype JJ-2 (1.01 cc) against mean value of 1.32cc. (Garnayak *et al*. 2008) [7] also reported that volume of fruit is another important factor like that of its weight in determining quality. 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. Seed weight ranged from 4.90g in JJ-1 to 14.70g in JJ-5. Highly significant variation was recorded in between JJ-5 and JJ-13 with 14.77g and 10.70 g seed weight respectively. However, JJ-3 (9.60g) and JJ-8 (9.55g) were at par. Seed length was highest (25.10 mm) in genotype JJ-5 which was significantly superior to JJ-8 with 21.55 mm. However,

lowest seed length was recorded in JJ-1 (12.99 mm). Data pertaining to seed width revealed that it ranged from 15.43 mm in JJ-5 to 8.01mm in JJ-4. Genotype JJ-5 recorded the maximum width (15.43 mm) which was significantly followed by JJ-14 with 11.96 mm. Whereas, genotypes JJ-4 (8.01 mm), JJ-15 (8.57 mm) and JJ-6 with 8.95 mm were small seeded which is a desirable character for jamun. From this result it can be concluded that seed sources with higher seed length and width possessed higher seed weight. This variation in seed traits among the different genotypes may be due to fact that this species grown over a wide range of climatic condition rainfall, temperature and soil type. (Srimathi *et al.* 2001) [15] concluded that good and viable seeds are always having higher sinks. Hence, seed weight can be used as one of the useful criteria for early selection of superior genotypes. The genotypes with higher seed width is used for medicinal, nutritional and preparation of other by products. Recently, the jamun seed powder are being used for controlling Type 2 Diabetes.

Highest pulp weight of 31.90g was recorded in JJ-9 and JJ-13 which was at par with 31.60 g in JJ-5 and 27.25 g in JJ-11. However, genotype JJ-1 recorded lowest pulp weight of only 9.00g. 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) [16] in genotypes collected from Uttar Pradesh (Varanasi) and Uttarakhand (Pantnagar). Seed percent varies from 19.36 in JJ-9 to 34.07 in JJ-1. Perusal of data on pulp per cent revealed no significant difference among the genotypes which was contrary to the results obtained by (Kumar *et al.* 2013) [8] in aonla However, it was maximum (85.28%) in genotype JJ-16 and minimum (57.60%) in genetype JJ-5. Significant difference was recorded among all the genotypes in relation to seed per cent. Maximum seed per cent was recorded in genotype JJ-1 (34.07) which was at par with JJ-14 (33.49) and JJ-16 (30.94) whereas, it was minimum in JJ-9 with 19.36%. The seed per cent fully depends on fruit weight and pulp per cent. If pulp per cent is more, definitely seed per cent will be less and *vice-versa*. 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) [6]. The data also indicate that pulp: seed ratio of fruits varied significantly. JJ-9 genotype had the maximum ratio of 4.05 which was at par to JJ-2 and JJ-11 with 3.76 and 3.43 respectively. JJ-14 reported the lowest pulp: seed ratio of 1.81 against the mean value of 2.73. 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. These results are in consonance with that reported by (Patel *et al.* 2005) [11] for genotypes collected from Uttar Pradesh and Jharkhand.

The chemical properties of Jamun fruit cultivars were also analysed and the data was depicted in Table 2 revealed wide variation in chemical composition of fruits of all selected 16 genotypes. Total solids are measure of the amount of material dissolved in water. This material can include carbonate, bicarbonate, chloride, sulfate, phosphate, nitrate, calcium, magnesium, sodium, organic ions, and other ions (American Public Health Association, 1998) [2]. JJ-4 was recorded to be the sweetest with TSS value 21.25 °Brix followed significantly by JJ-3 with 19.85 °Brix while it was lowest in JJ-13 (7.70°Brix). Even though JJ-4 fruits were the sweetest but fruit size was small with 17.42 mm fruit width. Acidity ranged from 0.30% in JJ-11 to 0.53% JJ-9 which was significantly followed by 0.47% in JJ-9 genotype. This result is in consonance with that reported by Srivastava *et al.* (2010) who reported maximum acidity in VJ-20 (1.14%) whereas, minimum in genotype VJ-5 (0.37%). The genotypes with higher TSS i.e. JJ-4 and JJ-3 recorded low acidity 0.36% and 0.39% respectively. 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) [8]. Ascorbic acid values on the other hand ranged from 21.75 (mg/100 g) in JJ-10 to 42.30 (mg/100 g) in JJ-15 which was significantly followed by 38.10 (mg/100 g) in JJ-14.

It can be concluded that there was a significant variation in morphological characters, fruit yield and quality characters of all the 25 selected jamun genotypes. JJ-5 was most promising genotype among the 16 accessions for average fruit weight (55.40 g), fruit length (27.78 mm), fruit width (15.43 mm), pulp weight (31.60 g) and seed weight (14.70g). This genotype can be used for table purpose as well for preparation of seed powder.

Table 1: Quantitative and Qualitative attributes of sixteen Jamun genotypes from Madhya Pradesh

Germplasm	Fruit Weight (g)	Fruit Length (mm)	Fruit width (mm)	Volume of fruit (cc)	Seed weight (g)	Seed length (mm)	Seeds Width (mm)	Pulp weight (g)	Pulp%	Seed %	Pulp : seed ratio	Fruit colour	Pulp colour	Fruit firmness
JJ 1	14.40	18.26	15.25	2.34	4.90	12.99	9.78	9.00	62.36	34.07	1.842	Black	Deep Purple	Soft
JJ 2	28.50	24.73	18.86	1.01	5.75	16.41	11.00	21.50	75.37	20.20	3.758	Black	Purple	Soft
JJ 3	34.40	26.52	17.73	1.40	9.60	21.50	11.17	22.30	64.76	27.93	2.337	Purple	Purple	Soft
JJ 4	19.25	22.59	17.42	1.48	5.55	16.87	8.01	12.40	64.23	28.77	2.231	Black	Deep Purple	Firm
JJ 5	55.40	27.78	22.01	1.17	14.70	25.10	15.43	31.60	57.00	26.54	2.153	Black	Purple	Firm
JJ 6	33.80	27.06	18.01	1.18	7.75	17.94	8.95	23.40	69.23	22.93	3.020	Deep purple	Whitish Purple	Firm
JJ 7	35.85	27.53	19.65	1.14	8.85	19.57	10.19	25.40	70.84	24.72	2.878	Deep purple	Whitish Purple	Firm
JJ 8	38.85	27.51	21.14	1.09	9.55	21.56	11.20	26.25	67.48	24.87	2.737	Deep purple	Whitish Purple	Firm
JJ 9	40.85	25.56	19.97	1.14	7.90	18.59	10.75	31.90	78.11	19.36	4.049	Deep purple	White	Firm
JJ 10	29.05	26.41	17.13	1.06	8.05	20.87	8.82	20.15	69.32	27.69	2.505	Deep purple	White	Soft
JJ 11	36.15	24.32	17.77	1.26	7.95	14.47	11.79	27.25	75.37	21.98	3.433	Black	Purple	Soft
JJ 12	32.55	25.98	16.35	1.29	7.80	19.83	11.14	21.75	66.78	23.98	2.795	Deep purple	Purple	Soft
JJ 13	49.50	26.57	22.71	1.20	10.70	21.05	9.48	31.90	64.39	21.61	2.976	Deep purple	Whitish Purple	Soft
JJ 14	25.65	22.74	17.96	1.26	8.60	17.74	11.96	15.50	60.42	33.49	1.807	Purple	Purple	Soft
JJ 15	29.70	22.89	17.90	1.65	8.10	18.27	8.57	20.20	67.92	27.24	2.492	Purple	Purple	Soft
JJ 16	24.60	22.05	17.38	1.42	7.60	15.77	11.30	20.90	85.28	30.94	2.721	Purple	Purple	Soft
Mean	33.03	24.90	18.58	1.32	8.33	18.66	10.59	22.59	68.68	26.02	2.73			
CD at 5%	4.23	2.69	2.37	0.25	1.27	1.79	2.05	6.17	NS	4.47	0.67			

Table 2: Chemical Composition of sixteen jamun genotypes from Madhya Pradesh

Germplasm	T.S.S. (^{O}Brix)	Acidity (%)	Ascorbic acid (mg/100 g)
JJ 1	18.250	0.330	27.150
JJ 2	18.800	0.316	28.200
JJ 3	19.850	0.393	28.950
JJ 4	21.250	0.361	26.250
JJ 5	13.750	0.371	23.550
JJ 6	17.400	0.416	33.750
JJ 7	8.500	0.384	27.300
JJ 8	9.400	0.426	27.600
JJ 9	10.300	0.534	24.850
JJ 10	8.900	0.474	21.750
JJ 11	16.150	0.300	37.650
JJ 12	9.350	0.409	33.900
JJ 13	7.700	0.336	33.150
JJ 14	9.400	0.419	38.100
JJ 15	9.500	0.390	42.300
JJ 16	19.150	0.410	36.750
Mean	13.60	0.39	30.70
CD at. 5%	0.952	0.048	1.640

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