Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(4): 300-303
Received: 16-05-2019
Accepted: 19-06-2019

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Physico-chemical characterization of Jamun (*Syzygium cumini* Skeels) seedling genotypes

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Abstract
Jamun seedling genotypes were evaluated to study the naturally existing variations. The genotypes were classified in to early, mid and late season genotypes and their bearing potential wise grouped in to heavy, average and poor bearers. Further, fruits of all the genotypes subjected for physic-chemical characterization. There exists lot of variations for physical parameters like fruit length, diameter and weight, seed length, diameter and weight, pulp weight, pulp to seed ratio, per cent pulp and per cent seed and also for chemical characteristics like pH, titrable acidity, vitamin C, reducing and non-reducing sugars, total sugars, total protein and phenol content of jamun fruits.

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

Introduction
Jamun (*Syzygium cuminii* Skeels) is an indigenous tropical fruit tree of India, commonly known as black plum or Indian black berry, belonging to family myrtaceae. It is a large evergreen tree widely distributed in the forests of India, Sri Lanka, Malaysia and Australia, which is cultivated for its edible fruits. The tree bears dark purple delicate fruits with prominent seeds. Almost all parts of the plant such as bark, leaf, fruit and seed are known to possess medicinal properties.

Fresh fruits of jamun are mostly used for dessert purpose and can be utilized to convert in to value added delicious beverages including fermented ones. Ripen fruits are very juicy, near to odourless with astringent in taste. They are rich in anthocyanin pigments and are good source of natural food colourants (Choudhary and Mukhyopadhyay, 2012) [4]. Jamun fruit is generally acknowledged to be very high quality for its curative function chiefly against diabetes because of its effect on pancreas. Jamun seeds are known to contain jamunin, an alkaloid and trioxide jambolia which reduces or stop diastatic conversion of starch to sugar. Seeds also contain albumen, fat, glycosides, an alkaloid; jambosine3, resin, ellagic acid, quercetin, gallic acid as well as elements of zinc, vanadium, chromium, sodium and potassium. β -sitoterol is present in unsaponifiable material of seed fat (Ali *et al.,* 2013) [2].

For these reasons, off late, jamun fruits have become popular and are sold at Indian Rs. 150-200 per kilogram depends on size and quality. As a result, there is lot of demand for the planting material across the country, while there are no such genotypes with superior characters like tree bearing bold fruits, fruits with high TSS, availability for longer duration, better keeping quality and so on available for farmers to cultivate.

Jamun being highly cross pollinated exhibit enormous variability among the progenies with respect to morphological characters, fruit characters – physico-chemical and quality traits. There is a need to improve upon exploiting the existing natural variability to encourage commercial orcharding. Therefore, a study on evaluation of available jamun seedling genotypes has been planned and executed though this experiment to assess their variability and to identify superior accessions that prompts early selection of elite genotypes and of course, is the simplest method of crop improvement particularly in perennials.

Material and methods
The present investigation was carried out with 25 seedling progenies of jamun planted at sector 9, Navanagar, UHS, Bagalkot. Individual tree has been numbered from 1 to 25 and they were evaluated for their bearing habits: early, mid and late and heavy, medium and poor. Further, ripe fruits free from blemishes were collected from the trees to study various physico-chemical characteristics. Observations on physical parameters such as fruit weight, length, width, pulp weight, seed weight, seed length and width, pulp to seed ratio, per cent pulp and per cent seed were recorded. The pulp extracted from freshly harvested ripen fruits were subjected to chemical evaluation for the parameters like pH, titrable acidity, ascorbic acid, total sugars, reducing and non-reducing sugars, total protein and phenol content.

Physical parameters like fruit length, seed length, fruit diameter and seed diameter was measured using vernier callipers and expressed in terms of centimetre. Fruit weight and seed weight determined using digital weighing balance and expressed in gram. The pulp separated from the fruit was quantified and pulp and seed weight was measured separately and expressed in per cent pulp and per cent seed and their ratio was also calculated using the following formulae.

Pulp weight (g) = Fruit weight (g) - Seed weight (g)
Per cent pulp (%) = Weight of the pulp (g) / Weight of the fruit (g) x 100
Per cent seed (%) =Weight of the seed (g) / Weight of the fruit (g) x100
Pulp to seed ratio = Pulp weight (g) / Seed weight (g)

Since 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, 1967).
The same samples were used to study chemical characterisation also. The pH of fruit juice was determined by using pH meter (Systronics µpH system 362). Acidity was determined by titrating with standard sodium hydroxide solution using phenolphthalein indicator (AOAC, 1990) [3]. Ascorbic acid content of fruit was determined by using 2, 6-dichlorophenol indophenol dye as per the modified procedure of AOAC (1990) [3]. Reducing and total sugars were estimated following by Dinitro Salicylic Acid (DNS) Method and Anthrone method respectively. Also, protein and phenol content were estimated by Lowry's method and Folin-Ciocalteu reagent (FCR) method given by Sadasivam and Manickam (2005) [11] respectively. Further, these observations were subjected to statistical analysis following Completely Randomized Design (Panse and Sukhatme, 1967).

Results and discussion

Bearing habit

It is evident from the table 1 that accession numbers 03, 17, 18, 19, 20, 24 and 25 have had come to bearing early in the season, accessions like 07, 08, 16, 21 and 22 were grouped in to mid season bearers and accessions 05, 06, 10, 13 and 14 were 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 accessions like 08, 18, 19, 20 and 22 were categorized as heavy bearers, while, accessions 05, 06, 07, 17, 21, 24 and 25 were of average in bearing and the rest are 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 concerned; it is directly influenced by many yield contributing parameters like fruit and seed length, diameter and weight. Most of the accessions evaluated were bear medium sized fruits. However, accessions 07, 19, 22 and 25 were produced bigger sized fruits and accession 13 with smaller fruits. Similarly, shape of the fruits was oblong or elliptical in almost all the seedling progenies except in accessions 07, 19 and 25, they were bit longer to other progenies in shape. 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) [12].

Table 1: Bearing habit of jamun seedling genotypes

Accession No.	Bearing season	Bearing potential	Fruit size	Fruit shape
3	Early	Heavy	Medium	Oblong
4	Late	Average	Medium	Oblong
7	Mid	Average	Big	Long
10	Late	Poor	Medium	Oblong
13	Late	Poor	Small	Oblong
14	Late	Poor	Medium	Oblong
16	Mid	Poor	Medium	Oblong
17	Early	Average	Medium	Oblong
18	Early	Heavy	Medium	Oblong
19	Early	Heavy	Big	Long
20	Early	Heavy	Medium	Oblong
21	Mid	Average	Medium	Oblong
22	Mid	Heavy	Big	Oblong
24	Early	Average	Medium	Oblong
25	Early	Average	Big	Long

Physical parameters

The physical properties of fruits in general, is important in designing and fabricating for handling, transporting, processing, storage and also for assessing behavior of the product quality. Data from table 2 presents significant differences with respect to fruit length, diameter and weight of jamun genotypes. Fruit weight, among the 15 different genotypes studied ranged from 3.80 to 8.30 g. Maximum fruit weight of 8.30 g was observed in accession 19 (Plate 1), followed by accession 25 (7.38 g), while it was minimum in accession 13 (3.80 g) followed by accession 24 (4.15 g). Fruit diameter also maximum in accession 19 and 22 (6.93 cm) followed by accession 25 (6.77 cm) whereas, it was minimum in accession 13 (5.27 cm) followed by accession 24 (5.43 cm). However, longer fruit length was observed in accession 07 and 25 (3.00 cm), which was on par with accession 19 (2.93 cm) and shorter fruit length was registered in accession 24 (2.13 cm) followed by accession 13 (2.43 cm).
Greater variability among the jamun genotypes were also reported by Jai Prakash *et al*., (2010) [5]. Similar observations on fruit length, width and weight of jamun were reported by (Shahnawaz and Sheikh, 2011) [12]. 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 fruit girth is taken in to account to judge the maturity status of fruits through ring tests. Weight on the other hand is an important factor in judging its compactness, maturity, juice content and level of chemical constituents.
In domestic markets, consumers have a preference to select large sized fruits and accordingly the price of those fruits goes higher. Therefore, higher fruit weight is a preferred character for selecting superior genotypes and accession 19 stands a much preferable one having higher fruit weight and diameter.
Data pertaining to seed characters; maximum seed weight was registered in accession 14 (1.52 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 minimum in accession 24 (1.02 g), followed by accession 13 (1.17 g). Seed diameter ranged from 3.07 to 3.53 cm. Greater seed diameter of 3.53 cm was noticed in accession 25 (Plate 2) followed by accessions 04 and 20 (3.43 cm). While, minimum seed diameter was recorded in accessions 19, 16 and 13 (3.07 cm). However, seed length was shorter with 1.73 cm in accession 24 followed by 1.83 cm

in accession 13, while longer seed length was observed in accession 19 (2.20 cm) followed by accession 10 (2.17 cm).

Genotypes 19, 24, 13 were of small seeded type which is a desirable character for jamun. The variation in seed traits among the genotypes may be due to fact that these species exposed to wide range of climatic conditions. (Srimathi *et al.,* 2001) [13] concluded that good and viable seeds are always having higher sinks. Hence, seed weight can be taken as one of the useful criteria for selection of superior genotypes. The genotypes with higher seed weight may be selected from the point of medicinal and nutritional properties and that may find its application in preparation of other food by products (Shahnawaz and Sheikh, 2011) [12]. One good example is that jamun seed powder is being used for controlling Type 2 diabetes.

There were significant differences among the genotypes with respect to pulp weight and pulp to seed ratio. Maximum pulp weight was recorded in accession 19 (6.85 g) followed by accession 25 (5.94 g). Whereas, minimum pulp weight noticed in accession 13 (2.63 g) followed by accession 24 (3.06 g). Pulp to seed ratio was also maximum in accession 19 (4.74) followed by accession 22 (4.43), while it was minimum in accession 13 (2.38) followed by accession 14 (2.40). However, per cent pulp was higher in accession 21 (82.86 %) followed by accession 19 (82.46 %), while it was minimum in accession 14 (69.84 %) followed by accession 16 (72.00%). Obviously on the other hand, per cent seed was minimum in accession 21 (17.14%) followed by accession 19 (17.54%) whereas, it was higher in 14 (30.16%) followed by 16 (28.00%). These results are in conformity with that of Patel *et al*. (2005) [8] and Agarwal *et al*. (2017) [1]. Per cent pulp content of 53 to 87% was also registered by Ningot *et al*. (2017) [6] in jamun.

The fruits grown from lower altitudinal source were found superior over high altitudinal area probably due to more favourable environmental conditions (Rakesh and Shivanna, 2015) [10]. Higher pulp to seed ratio is an essential character for table purpose in jamun and it is preferable to select pollen parent with high pulp to seed ratio.

Table 2: Physical properties of jamun seedling genotypes

Accessions	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Seed length (cm)	Seed diameter (cm)	Seed weight (g)	Pulp weight (g)	Pulp to seed ratio	Per cent pulp (%)	Per cent seed (%)
3	2.67	6.17	5.03	1.93	3.17	1.23	3.79	3.10	74.99	25.01
4	2.70	6.67	6.69	2.00	3.43	1.46	5.23	3.59	78.20	21.80
7	3.00	6.53	7.07	2.13	3.40	1.49	5.58	3.69	78.34	21.66
10	2.83	6.07	6.25	2.17	3.27	1.43	4.82	3.40	76.94	23.06
13	2.43	5.27	3.80	1.83	3.07	1.17	2.63	2.38	76.91	23.09
14	2.73	5.70	5.11	2.10	3.37	1.52	3.59	2.40	69.84	30.16
16	2.67	5.77	5.07	2.00	3.07	1.38	3.65	2.66	72.00	28.00
17	2.50	6.37	6.41	2.00	3.40	1.36	5.13	3.78	79.93	20.07
18	2.73	6.57	6.95	2.10	3.40	1.42	5.45	3.88	78.38	21.62
19	2.93	6.93	8.30	2.20	3.07	1.45	6.85	4.74	82.46	17.54
20	2.73	6.43	6.89	2.07	3.43	1.32	5.58	4.26	80.65	19.35
21	2.83	6.87	7.02	2.03	3.37	1.38	5.64	4.23	82.86	17.14
22	2.57	6.93	7.14	1.93	3.23	1.33	5.81	4.43	80.84	19.16
24	2.13	5.43	4.15	1.70	3.20	1.02	3.06	3.10	74.89	25.11
25	3.00	6.77	7.38	2.13	3.53	1.44	5.94	4.19	80.46	19.54
C.D. @5%	0.301	0.439	1.216	0.214	NS	0.237	1.231	1.242	NS	NS
S. Em. ±	0.103	0.151	0.419	0.073	-	0.082	0.425	0.428	-	-

Chemical characteristics

There were a lot of significant differences among jamun seedling genotypes for chemical characteristics (Table 3). The maximum pH was noticed in accession 16 (3.60) followed by accessions 14, 10 and 17 (3.50), while it was minimum in accession 03 (3.20). Titrable acidity was minimum in accession 07 (1.03%) followed by accession 10 and 19 (1.13%) whereas, it was maximum in accession 20 and 22 (1.80%). Similar values of pH and amount of acidity was reported by Shahnawaz and Sheikh (2011) [12] and acidic nature of fruits may contribute to astringency. In addition, lower pH of sample is favourable for higher shelf life. Significant difference was also observed in jamun progenies for Vitamin C content. Higher vitamin C (44.67 mg/100g and 42.00 mg/100g) content was noticed in accession 25 (Plate 2) followed by accession 07 respectively (Plate 3), while it was minimum in accession 20 (22.67 mg/100g). 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) [6].

Total sugar content was maximum in accession 14 (7.80 mg/g) followed by accession 18 (7.60 mg/g), while it was minimum in accession 17 (4.20 mg/g). Also, higher amount of reducing sugars found in accession 14 (7.34 mg/g) followed by accession 16 (6.48 mg/g), and lesser amount of reducing sugar was in accession 17 (3.64 mg/g). However, non reducing sugars were maximum in accession 16 (0.82 mg/g) and it was minimum in accession 18 (0.42 mg/g). Huge variations were registered among the seedling progenies with respect to total protein and phenol content of jamun fruits. Total protein content was higher in accession 16 (132.00 mg/100g) followed by accession 18 (125.00 mg/100g) and it was lesser in accession 21 (41.00 mg/100g). Total phenol content was lesser in accessions 14 (88.00 mg/100g) and 20 (89.00 mg/100g) while it was greater in accession 16 (157.00 mg/100g).

Variation between genotypes for physic-chemical characteristics might be due to differences in the genetic makeup of these genotypes. The natural existence of variations was reported previously by many scientists including Patil *et al*. (2009) [9]. Phenolic compounds are responsible for imparting astringency to the fruits, in general. Higher the phenol greater the astringency and lesser the taste and with the maturity phenolic level reduces and bring changes in sugar acid level and add flavor and taste to the fruits.

Table 3: Chemical characteristics of jamun seedling genotypes

Accession No.	pH	Acidity (%)	Vit. C (mg/100g)	Total sugar (mg/g)	Reducing sugar (mg/g)	Non-reducing sugar (mg/g)	Protein (mg/100g)	Phenol (mg/100g)
3	3.20	1.60	33.00	5.40	4.63	0.77	63.33	102.00
4	3.30	1.60	37.00	5.80	5.32	0.48	67.00	142.00
7	3.30	1.03	42.00	6.20	5.56	0.64	53.00	121.00
10	3.50	1.13	30.33	5.20	4.64	0.56	67.00	103.00
13	3.40	1.60	25.00	6.40	5.82	0.58	74.00	103.00
14	3.50	1.85	28.00	7.80	7.34	0.56	62.00	88.00
16	3.60	1.40	32.00	7.20	6.48	0.82	132.00	157.00
17	3.50	1.23	40.33	4.20	3.64	0.56	78.00	108.00
18	3.30	1.40	40.00	7.60	5.18	0.42	125.00	118.00
19	3.40	1.13	32.00	5.90	5.43	0.47	70.00	100.00
20	3.40	1.80	22.67	5.90	5.22	0.58	70.00	89.00
21	3.30	1.30	26.00	6.30	5.83	0.56	41.00	128.00
22	3.30	1.80	38.33	5.30	4.74	0.56	110.00	105.00
24	3.30	1.20	33.00	6.20	5.64	0.56	82.00	115.00
25	3.40	1.70	44.67	5.40	4.63	0.77	81.34	111.00
CD @5%	0.173	0.182	3.301	0.166	1.540	0.176	2.438	1.727
S. Em. ±	0.060	0.063	1.136	0.057	0.530	0.061	0.842	0.596

Plate 1: Jamun fruits and seeds of accession 19

Plate 2: Jamun fruits and seeds of accession 25

Plate 3: Jamun fruits and seeds of accession 7

Conclusion

It can be concluded from above results that there was a significant variation in bearing habit and physic-chemical characteristics of jamun fruits of all 15 seedling progenies. Among the 15 genotypes evaluated, accession numbered 19 having come to bearing early with big sized fruits and heavy bearing, registered higher higher fruit weight and diameter, greater seed length and weight, pulp weight, per cent pulp and pulp to seed ratio may be selected as one of the elite genotype. On the other side, accession numbers 07 and 25 with higher amounts of ascorbic acid and fair amounts of reducing and total sugars with less acidity signify their nutritional quality and with better sugar acid ratio that favours taste and acceptability. And hence, these are the other two progenies may be considered for selection as superior genotypes.

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