Advances in Bioresearch
Adv. Biores., Vol 11 (5) September 2020: 01-05

Print ISSN 0976-4585; Online ISSN 2277-1573
Journal's URL:http://www.soeagra.com/abr.html
CODEN: ABRDC3
DOI: 10.15515/abr.0976-4585.11.5.15

Advances in Bioresearch

ORIGINAL ARTICLE

Flowering, Fruiting and Physio-chemical properties of Jamun (*Syzygium cumini* Skeels) grown in Nadia district of West Bengal

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ABSTRACT
A study was conducted to identify the elite jamun germplasm among its natural population from different locations of Nadia district of West Bengal. Jamun trees in 50 different locations were initially screened for their fruit quality characters out of which 12 elite germplasm were selected for detailed studies including flowering, fruiting and fruit bio-chemical properties. The 12 different elite class germplasm were evaluated for flowering characters like number of flowering flushes, peak flowering time, peak fruiting season, second flowering season, overall abundance of flowering, flower colour, number of flowers / inflorescence. Acc. 8 is known to have unique character of flowering and fruiting twice. Acc. 6 and Acc. 10 showed a very late flowering and fruiting. High number of flowers / inflorescence was observed in Acc. 7, Acc. 12 and Acc. 11. Long sized jamun accessions were Acc. 8, Acc. 6, Acc. 4 and Acc. 11. A very high pulp % of 76.61% was observed in Acc. 11 followed by Acc. 7. Acc. 8, Acc. 6 and Acc. 4. Considerably high yield of 45.24 kg/tree were observed in Acc. 10, Acc. 11, Acc. 8, Acc. 5, Acc. 4 and Acc. 1 respectively. Highest value of TSS was observed in Acc. 8 followed by Acc. 7 and Acc. 6. Highest value of titratable acidity (%) was observed in Acc. 10 followed by Acc. 2 and Acc. 9. Total sugar content in jamun fruits were maximum in Acc. 8, Acc. 7 and Acc. 6. Ascorbic acid content was highest in Acc. 8, Acc. 7, Acc. 2, Acc. 4, Acc. 1, Acc. 12 and Acc. 3. Anthocyanin was highest in Acc. 8 followed by Acc. 1, Acc. 11 and Acc. 10. Overall the Acc. 7 and Acc. 8 collected from Chakdah and Krishnanagar-1 were found to be possessing the most desirable qualitative characteristics and can be harnessed for conservation and further breeding purpose.
Keywords*: accessions, jamun, jamun germplasm, jamun characterization*

Received 12.04.2020 Revised 18.05.2020 Accepted 26.07.2020

How to cite this article:
M Alam, A Mani, S Mitra and F K Bauri. Flowering, Fruiting and Physio-chemical properties of Jamun (*Syzygium cumini* Skeels) grown in Nadia district of West Bengal. Adv. Biores., Vol 11 (5) September 2020: 01-05

INTRODUCTION

Jamun (*Syzygium cumini* Skeels) is also known as Indian black berry and Java Palm. Jamun is an underutilized but very promising and nutrient rich fruit originated from tropical and humid regions of India [1]. Jamun belongs to the family of Myrtaceae and is a very hardy fruit tree. Jamun can also survive and fruit efficiently in dry semi-arid regions. Jamun is known to grow in most type of climates and survive drought situation due to deep root system [2]. It is pack-house of nutrient and the fruit pulp and seeds are also rich in medicinal properties.

The fruits are excellent source of iron and proteins. Fruit of Jamun have a delicious sweet pulp and is also harnessed for the purpose of preparation of processed products including various types of beverages, jam and jelly. Jamun vinegar is reported to possess carminative, stomachic, diuretic, digestive and cooling properties [3]. Jamun seed powder is also known to stop conversion of starch to sugar [4]. The fruit is known to possess high amount of anthocyanins, total phenol, ellagic acid, glucoside, kaemferol, iso-quercetin and myrecetin [5]. Jamun is also known to have antiviral, antifungal, cardio-protective, anticancer, anti-allergic, anti-inflammatory, radio-protective and chemo-preventive properties [6].

Even though this fruit have so many qualities to be leader among fruits till then it is not adopted for commercial cultivation. Hence the fruit is usually found growing wildly in homestead and roadside areas. The fruit trees have a prolonged bearing period and cultivation is scattered. There are negligible numbers

of standard Jamun varieties available in entire India. By natural selection and spontaneous mutation, some trees growing in roadside and homestead might have several desirable properties and marvelous fruit characteristics which the consumer wants in the market. In our study an attempt has been made to visit local villages and identify the Jamun trees with exceptional characters based on flowering, fruiting and bio-chemical properties of the fruit. Later the trees with superior traits can be multiplicated and conserved for future research.

MATERIAL AND METHODS

Initial survey was done in Nadia district of West Bengal to identify and select 25 trees from distinct locations. The trees were of age between 20 - 30 years and were vegetative vigorous. These trees were geographically tagged and in the 1st year fruits from 25 trees were collected. Out of the 25 different trees, 12 best accessions based on initial fruit quality were identified which were shortlisted for further studies about flowering, fruiting and detailed physio-chemical properties. The studies about flowering and fruiting properties were done in the location of the trees itself whereas the bio-chemical properties of the fruits were studied in Post Graduate Laboratory, Department of Post-harvest technology, BCKV, Mohanpur. Final studies on 12 best accessions were done in Haringhata, Ghoragacha, Karimpur, Ranaghat, Shantipur, Gede, Chakdah, Krishnanagar-1, Krishnanagar-2, Palashi, Nabadwip and Kalyani which were named as Acc-1, Acc-2 to Acc. 12 respectively. The design of the experiment was Randomized Block Design (RBD) with 12 accessions as 12 different treatments and 3 replications each. Number of flowering flushes / year, peak flowering time, second flowering season and overall abundance of flowering were determined based on researcher regular observation and opinion of local people. The flower colour was determined by visual observation. Number of flower / panicle, number of fruits / panicle and flower colour was determined by calculating average number of 10 panicles from different part of the tree. Total yield / tree was determined. The fruit dimension was measured by Vernier calipers. Fruit weight and seed weight was measured as average of 10 fruits by using electronic weighing balance. Pulp weight is obtained by subtracting pulp weight from seed weight. Total soluble solid (TSS) was estimated by using the hand refractometer. Bio-chemical assessment of the fruits like the titratable acidity (TA), Vitamin-C content, reducing sugar and total sugar (TS) was done by method suggested by Association of Analytical chemists [17]. Estimation of total anthocyanins in jamun fruit was done on dry basis using process given by Lees and Francis [8]. Jamun was blended with ethanolic HCl and the solution was then stored overnight at temperature (7 ± 1 °C). After that the mixture was centrifuged for 10 min and absorbance was noted at 535 nm. The total anthocyanins content was expressed as mg 100 g^{-1} DW.

RESULTS AND DISCUSSIONS:

Flowering characteristics:

Detailed study results about flowering characteristics of different Jamun accessions are highlighted in Table 1. It can be observed that the number of flowering flushes in all the accessions is only one. Whereas the accession no. 8 has a unique character of yielding fruits twice once in the peak season of May-June and again on early October. Peak flowering time is mid-March in case of Acc. 8; late March in case of Acc. 1, Acc. 2, Acc. 3, Acc. 5 and Acc. 11; early April in case of Acc. 4, Acc. 7, Acc. 9 and Acc. 12; mid-April in case of Acc. 6 and Acc. 10. Peak fruiting season is early June in case of Acc. 1, Acc. 2, Acc. 3, Acc. 5 and Acc. 11; mid-June in case of Acc. 4, Acc. 6, Acc. 9, Acc. 10 and Acc. 12; late-May in Acc. 8. Overall abundance of flowering is profuse in all the accessions except in Acc. 5 with moderate profuseness. Flower colour is creamy white in all accessions except Acc. 3, Acc. 4, Acc. 6, Acc. 8, Acc. 9, Acc. 11 and Acc. 12 where flower colour is yellowish white. The number of flowers/ inflorescence was maximum in Acc. 7 (55.33) followed by 53.67 in Acc. 12, 50.67 in Acc. 11, 49 in Acc. 6. Acc. 7 and Acc. 12 is at par with each other. Minimum number of flowers/ inflorescence was observed in Acc. 2 (33.67), Acc. 4 (42), Acc. 8 (44) and Acc. 1 (45.67). This result is similar to Mishra and Bajpai,[9].

Table 1: Flowering characteristics of different Jamun accessions

Accessions	Number of flowering flushes	Peak flowering Time (onward)	Peak fruiting season	Second flowering season	Overall abundance of flowering	Flower colour	Number of flowers / inflorescence
Acc. 1	1	Late March	Early June	No	Profuse	Creamy white	45.67
Acc. 2	1	Late March	Early June	No	Profuse	Creamy white	33.67
Acc. 3	1	Late March	Early June	No	Profuse	Yellowish white	47.67
Acc. 4	1	Early April	Mid-June	No	Profuse	Yellowish white	42.00
Acc. 5	1	Late March	Early June	No	Moderate	Creamy white	47.67
Acc. 6	1	Mid April	Mid-June	No	Profuse	Yellowish white	49.00
Acc. 7	1	Early April	Mid-June and late June	No	Profuse	Creamy white	55.33
Acc. 8	2	Mid March	Late May and early June	Late July	Profuse	Yellowish white	44.00
Acc. 9	1	Early April	Mid June	No	Profuse	Yellowish white	47.00
Acc. 10	1	Mid April	Mid and late June	No	Profuse	Creamy white	48.67
Acc. 11	1	Late March	Early and mid June	No	Profuse	Yellowish white	50.67
Acc. 12	1	Early April	Mid-June	No	Profuse	Yellowish white	53.67
S.Em.(±)	-	-		-	-	-	3.30
CD (p<0.05)	-	-		-	-	-	9.74
C.V.	-	-		-	-	-	12.14

Fruiting characteristics:

Table 2 represents the fruiting characteristics of different jamun accessions. It can be observed from the table that fruit length in cm was highest in Acc. 7 (2.34 cm). Long jamun fruits were also observed in Acc. 8 (3.13 cm), Acc. 6 (3.07 cm), Acc. 4 (3.03 cm) and Acc. 11 (3.03 cm). Tiniest sized fruits were observed in Acc. 9 (2.37 cm), Acc. 5 (2.43 cm), Acc. 10 (2.5 cm), Acc. 3 (2.53 cm) and Acc. 12 (2.63 cm). Fruit of high thickness were observed in Acc. 7 (2.34 cm), Acc. 11 (2.21 cm), Acc. 8 (2.18 cm), Acc. 4 (2.15 cm) and Acc. 2 (2.00 cm). Fruit shape is more or less oblong in nature. Fruit weight was maximum in case of Acc. 7 (9.68 g), followed by Acc. 8 (9.55 g), Acc. 11 (9.41 g), Acc. 6 (9.39 g) and Acc. 4 (9.26 g). Acc. 7 is at par with Acc. 8 (9.55 g). Lowest fruit weight was observed in Acc. 9 (7.17 g) followed by Acc. 10 (7.32 g), Acc. 5 (7.88 g) and Acc. 3 (7.98 g). A higher seed weight depicts a very big size seed and a very high fruit: pulp ratio. Highest seed weight was observed in Acc. 10 (2.64 g) followed by Acc. 3 (2.6 g), Acc. 9 (2.59 g), Acc. 5 (2.58 g), Acc. 12 (2.56 g), Acc. 1 (2.46 g), Acc. 2 (2.42 g) and Acc. 6 (2.29 g). Comparatively a very small weighed seeds were observed in Acc. 8 (1.97 g) followed by Acc. 11 (1.99 g), Acc. 7 (2.1 g) and Acc. 7 (2.19 g). Pulp weight was maximum in Acc. 8 (7.37 g) followed by Acc. 7 (7.35 g) and Acc. 11 (7.21 g). Minimum pulp weight was observed in Acc. 9 (4.37 g), Acc. 10 (4.49 g), Acc. 5 (5.08 g), Acc. 3 (5.20 g) and Acc. 12 (5.53 g). A very high pulp %of 76.61% was observed in Acc. 11 followed by 75.93%, 75.17%, 73.27% and 72.86% in Acc. 7. Acc. 8, Acc. 6 and Acc. 4. Moderate pulp %of 69.55%, 69.43% and 66.69 %was observed in Acc. 1, Acc. 2 and Acc. 12 respectively. A lower pulp %was observed in Acc. 9 (60.97 %) and Acc. 10 (61.34 %) respectively.

Number of fruits / panicle at the final day of harvest was highest in Acc. 7 (69.33) followed by Acc. 6 (65.46), Acc. 11 (62.09), Acc. 9 (60.96) and Acc. 12 (60.72). A very low number of fruits /panicle at the final day of harvest were observed in Acc. 3 (48.56), Acc. 2 (43.91), Acc. 4 (43.78), Acc. 10 (45.55) and Acc. 1 (48.48). A higher number of fruits / panicle indicates a higher number of fruit set in the particular accession. A considerably high yield of 45.24 kg/tree, 43.19 kg/tree, 42.12 kg/tree, 41.45 kg/tree, 41.12 kg/tree and 40.12 kg/tree were observed in Acc. 10, Acc. 11, Acc. 8, Acc. 5, Acc. 4 and Acc. 1 respectively.

Lowest yield was observed in Acc. 9 (29.29) followed by Acc. 7 (35.43), Acc. 12 (36.40), Acc. 6 (38.14), Acc. 2 (39.38) and Acc. 3 (39.45). These results are similar to the findings of Devi *et al*., [10].

Table 2: Fruiting characteristics of different Jamun accessions

Accessions	Fruit length (cm)	Fruit breadth (cm)	Fruit shape	Fruit weight (g)	Seed weight (g)	Pulp weight (g)	Pulp (%)	Number of fruit / panicle (at harvest)	Flowering to fruit set (%)	Yield per tree (kg)
Acc. 1	2.72	1.98	Oblong	8.74	2.46	6.08	69.55	23.02	48.56	40.12
Acc. 2	2.93	2.00	Oblong	8.70	2.42	6.04	69.43	17.15	43.91	39.38
Acc. 3	2.53	1.93	Oblong	7.98	2.6	5.20	65.18	24.08	43.78	39.45
Acc. 4	3.03	2.15	Oblong	9.26	2.19	6.87	72.86	21.31	45.55	41.12
Acc. 5	2.43	1.96	Oblong	7.88	2.58	5.08	64.47	26.15	58.06	41.45
Acc. 6	3.07	2.15	Oblong	9.39	2.29	6.88	73.27	27.16	65.46	38.14
Acc. 7	3.23	2.34	Oblong	9.68	2.1	7.35	75.93	32.89	69.33	35.43
Acc. 8	3.13	2.18	Oblong	9.55	1.97	7.37	75.17	26.21	58.60	42.12
Acc. 9	2.37	1.94	Oblong	7.17	2.59	4.37	60.97	26.82	60.96	29.29
Acc. 10	2.50	1.84	Oblong	7.32	2.64	4.49	61.34	28.08	48.48	45.24
Acc. 11	3.03	2.21	Oblong	9.41	1.99	7.21	76.61	28.91	62.09	43.19
Acc. 12	2.63	1.99	Oblong	8.29	2.56	5.53	66.69	29.83	60.72	36.40
S.Em. (±)	0.08	0.03	-	0.06	0.00	0.00	0.35	2.68	0.00	0.01
CD (p<0.05)	0.25	0.09	-	0.19	0.01	0.00	1.05	7.92	0.01	0.04
C.V.	5.15	2.75	-	1.27	0.29	0.03	0.89	17.89	0.01	0.05

Table 3: Bio-chemical properties of different Jamun accessions

Accessions	TSS (°B)	Titratable acidity (%)	Total Sugar (%)	Reducing Sugar (%)	Ascorbic acid (mg $100g^{-1}$)	Anthocyanin (mg $100g^{-1}$) dry weight
Acc. 1	12.80	0.53	11.49	0.01	21.02	162.42
Acc. 2	14.00	0.61	12.89	0.02	22.17	151.39
Acc. 3	13.17	0.45	12.65	0.02	20.11	145.34
Acc. 4	13.40	0.44	12.81	0.02	21.12	135.89
Acc. 5	14.14	0.53	13.89	0.02	18.98	147.91
Acc. 6	15.23	0.42	14.29	0.02	19.47	135.32
Acc. 7	15.53	0.47	14.50	0.02	24.12	154.20
Acc. 8	16.53	0.48	15.36	0.01	27.17	171.24
Acc. 9	13.47	0.61	12.98	0.02	19.25	155.31
Acc. 10	14.17	0.64	13.48	0.02	19.02	158.37
Acc. 11	14.17	0.48	13.78	0.02	18.12	160.24
Acc. 12	14.07	0.53	13.82	0.02	20.24	129.36
S.Em.(±)	0.18	0.00	0.04	0.00	0.01	0.06
CD (p<0.05)	0.53	0.00	0.13	0.00	0.02	0.18
C.V.	2.17	0.31	0.58	2.40	0.06	0.07

Bio-chemical characteristics

Bio-chemical properties of different Jamun accessions are described in Table 3. From the table we can find that highest value of TSS was observed in Acc. 8 followed by Acc. 7 and Acc. 6 which was 16.53°B, 15.53° B and 15.23 °B respectively. Comparatively lower TSS was observed in Acc. 1 followed by Acc. 3, Acc. 4 and Acc. 9 which were 12.80 °B, 13.17 °B, 13.40 °B and 13.47 °B respectively. Highest value of titratable acidity (%) was observed in Acc. 10 followed by Acc. 2 and Acc. 9 which was 0.64 %, 0.61 % and 0.61% respectively. Comparatively lower titratable acidity (%) was observed in Acc. 6 followed by Acc. 4, Acc. 3, Acc. 7, Acc. 8 and Acc. 11 which were 0.45%, 0.44%, 0.42%, 0.47%, 0.48% and 0.48% respectively. Total sugar content in jamun fruits were maximum in Acc. 8, Acc. 7 and Acc. 6 which were 14.29 %, 14.5 % and 15.36 % respectively. Very low total sugar content was observed in Acc. 1, Acc. 3, Acc. 4 and Acc. 2 which were 11.49 %, 12.65 %, 12.81 % and 12.89 % respectively. Very low value of reducing sugar was also observed. Ascorbic acid content (mg/100g) was highest in Acc. 8, Acc. 7, Acc. 2, Acc. 4, Acc. 1, Acc. 12 and Acc. 3 which were 27.17, 24.12, 22.17, 21.12, 21.02, 20.24 and 20.11

respectively. Anthocyanin (mg/100 g) DW were highest in Acc. 8 followed by Acc. 1, Acc. 11 and Acc. 10 which were 171.24 followed by 162.42, 160.24 and 158.37 respectively. Lowest anthocyanin (mg/100 g) was observed in Acc. 12 followed by Acc. 6 and Acc. 4 which were 135.89, 135.32 and 129.36 respectively. These results are similar to the findings of Singh e*t al*., [11].

CONCLUSION

After evaluation of 12 elite class jamun germplasm for flowering, fruiting and physiochemical properties, it can be concluded that Acc. 7 and Acc. 8 from Chakdah and Krishnanagar-1 were found to be possessing the most desirable qualitative characteristics and can be harnessed for conservation and further breeding purpose. Hence it can be concluded that Acc. 7 and Acc. 8 collected from Chakdah and Krishnanagar-1 were found to be the most desirable qualitative characteristics and can be harnessed for conservation and further breeding purpose.

ACKNOWLEDGEMENT

The research work would not have been able to get accomplished without help of local people in the respective location. Thanks to entire Department of Post-harvest Technology and HOD for allowing us to complete the work in stipulated time frame.

CONFLICT OF INTERESTS

The authors have declared no conflict of interests exist.

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