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Jamun (Gulab Jamun/Java Plum): A low Investment - High return dry land fruit crop

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1. Introduction

Jamun (*Eugenia jambolana* or *Syzygium cuminii* Skeels, Myrtaceae family, Chromosome No. 2n = 40) is an important but under - exploited indigenous and originated fruit tree of India. It is a very common, large, evergreen beautiful tree of the Indian subcontinent. It belongs to the myrtaceae family. The other common names of jamun are java plum, black plum, jambul and Indian blackberry. Jamun has promising therapeutic value due to its various phyto-constituents such as tannins, alkaloids, steroids, flavonoids, terpenoids, fattyacids, phenols, minerals, carbohydrates and vitamins. Its pharmacological properties like hypoglycaemic, diuretics, analgesic, anti-inflammatory, antiplaque, antimicrobial, antidiarrhoel, antioxidant, gastro-protective and astringency have been proven on animal systems. Diabetes management through use of *Syzygium cuminii* has been demonstrated. Majority of the studies of *Syzygium cuminii* as anti-diabetic agent with its possible mechanism of action and delaying complications of diabetes such as cataract and neuropathy have been conducted but detailed studies on isolation of bioactive compounds and clinical trials followed by standardization are seriously required to know the full potential of plant and fruits. The pharmacological trials were mainly carried out using seeds of *Syzygium cuminii* but the potential of other parts of the tree need to be explored. Jamun fruit has considerable nutritive value. It is a good source of iron apart from being the source of minerals, sugars and other phytochemicals. The fruits have sub-acid spicy flavour and commonly used as dessert. Apart from eating as fresh, it can also be used for the preparation of delicious

Table: Chemical properties and minerals in pulp and seed of Jamun Fruit Property Pulp Seed

Sl. No.	Properties	Jamun Pulp	Seed
1.	Moisture (%wb)	79.21±2.27	52.24±3.17
2.	Ash (%)	1.03±0.08	3.13±0.16
3.	TSS (0B)	14.86±1.47	1.4±0.15
4.	TDS (ppm)	615±0.21	217±1.15
5.	TS (%)	20.33±0.34	47.75±3.17
6.	pH	3.87±0.01	2.5±0.1
7.	Total Carbohydrate (%)	97.59±0.09	89.68±0.29
8.	Total Sugar (%)	7.88±0.41	5.54±0.69 (%)
9.	Acidity (%)	2.65±0.21	0.04±0.001
10.	Pectin (%)	4.7±0.13	N/A
11.	Fat (%)	0.18±0.02	1.28±0.11
12.	Protein (%)	0.65±0.03	4.68±0.35
13.	Ascorbic Acid (mg/100g	49.78±2.17	1.84±0.14
14.	Polyphenol (mg GAE/g	203.76±9.84	386.51±10.25
15.	Antioxidant (%)	31.29±1.53	48.23±2.98
16.	Tannin (mg/100g)	94.52±9.19	388.99±7.34
17.	Fibre (%)	0.53±0.06	1.21±0.06
18.	Anthocyanin (mg/100g)	195.58±6.15	18.47±1.99
	Minerals		
20.	Sodium	11.73±1.70	43.86±12.09
21.	Potassium	172.4±17.23	606.46±69.37
22.	Calcium	81.4±11.15	135.86±26.81
23.	Zn	0.46±0.06	0.46±0.17
24.	Iron	4.66±0.81	4.2±0.80
25.	Mg	27.13±3.43	111.6±18.06
26.	Cu	1.8±0.41	2.13±0.86
27.	Mn	0.2±0.007	0.4±0.11
28.	Pb	0.33±0.13	0.66±0.06
29.	Cr	1.06±0.13	1.4±0.61

(Ghosh *et al., 2017)*

beverages, jelly, jam, squash, wine, vinegar and pickles.

2. Uses and composition

Fruits are eaten when fully ripen, processed in to beverages, jellies, jam, squash, vinegar, pickles and wine. The fruits are good source of sugar, protein (0.7%), fat (0.1%) carbohydrates

(19.7%), Iron and other mineral matters. Jamun juice mixed with mango juice is very good for diabetics. The extracts from bark, seeds, leaves and fruits are used against diabetics and also moderately antibacterial. The volatile oil from the jamun fruits can also be extracted (Vijayanand et al., 2001). Fruits are used as an effective medicine against diabetes, heart and liver trouble (Singh *et al.*, 2011 and Singh and Singh., 2012) Jamun vinegar is good for curing stomach disorder. The fresh bark / stem extract is used for prevention of dysentery by mixing with other concentrate and used as good animal food. The wood (Timber) is used for railway sleeper equipment. The flowers are an important source of honey. Jamun tree can withstand prolonged period of drought and flood (Patil *et al.*, 2009) and is ideally suited for windbreaks and roadside plantations.

3. Jamun species

The genus *Syzygium* is having about 400 – 500 species of which a few provide edible fruits like,

1. *S. Jambos* (Rose apple or safed Jamun): The tree is ornamental, the fruits are light yellow –white in colour. The seeds are polyembryonic. It is grown in Assam, Bihar, Andhra Pradesh, Tamil Nadu, West Bengal, Maharashtra & Gujarat.
2. *S. fruitecosum* – The trees are suitable for wind break, fruits are edible, small in size.
3. *S. Javanica* (Water apple): This species is found in South India and West Bengal.
4. *S. densiflora* – It is used as a root stock for *S. cuminii*. It is resistant to attack of termites.
5. *S. uniflora* (Surinam cherry or pitanga cherry): It is small tree bears small sized, bright red with aromatic flavour fruits.
6. *S. Zeylanica* – Small tree, bears edible fruits in Western ghats of India.

4. Climate

Due to wider adaptability jamun can be grown successfully under tropical and subtropical climates. It is hardy and can tolerate both short periods of drought as well as heavy rainfall and can also withstand floods. It can be grown successfully in semi-arid subtropical regions with an annual rainfall varying from 350 to 500 mm. It is also found growing in the lower ranges of the Himalayas up to an altitude of 1300 meters. However, in early periods of growth, protection from frost is needed. Its cultivation can be introduced in arid and semiarid, resource-poor and wasteland areas where other crops are difficult to grow. It requires dry weather at the time of flowering and fruit setting. In subtropical areas, early rain is beneficial for proper development of fruit size, colour, maturity and taste.

5. Soil

Jamun can be grown on wide range of soils. Vigorous growth and high yield, however, could be obtained only when grown on deep loam and well drained soils but have the

capacity to retain good soil moisture. It tolerates sodic and saline soils and can also be grown in ravines and degraded lands. Plants are reported to survive even in alkali soils up to 10.5 pH. Plantations in very heavy and light soils should be avoided.

6. Varieties / Cultivars

Wider genetic variation with regard physico-chemical fruit characters of jamun fruit of U.P. and Jharkhand, Karnataka and Goa was observed (Patel *et al.*, 2005 ; Inamdar *et al*., 2002 ; Prabhuraj *et al.*, 2003) and West Bengal (Kundu *et al.,* 2001). Jamun is an open pollinated fruit crop and predominantly propagated by seed to raise new plantations (Srivastava *et al*., 2012 and Raju, 2020). Selection from these seedlings can be used to obtain superior genotypes with respect to tree morphology, fruit yield and quality.

Goma Priyanka (GJ - 2): This variety was released from CHES, Godhra (CIAH-ICAR), Gujarat (Singh and Singh, 2012). It is semi-dwarf, spreading growth habit, dense foliage and drooping branches, early, precocious bearer (starts flowering in 4th year) and suitable for high density planting. It starts flowering in the month of March, ripens in the fourth week of May and recorded 19.86 g average fruit weight, with 85.06 per cent pulp. Fruits are good in taste having 16.80^{o}Brix TSS, 0.38% titratable acidity, 12.10% total sugar, 6.11% reducing sugar, 45.44 mg/100 g vitamin C. It recorded 43.80 kg fruit yield during 8th year of orchard life under rainfed conditions of hot semi-arid ecosystem. Jamun fruits packed in perforated polythene bags can be stored well up to 3 weeks at low temperature 8-10°C and 85-90% relative humidity. Corrugated fiberboard box with news paper liner was found to be most suitable and economically viable packing container during transportation of jamun fruits under ambient conditions and may be followed for the benefits of both consumers and processors.

GJ - 8 : Selection made at CHES, Godhra. Peak period of flowering is in the month of March. It ripens in the second week of June and recorded 17.00 g average fruit weight, 81.82 per cent pulp, 14.20 per cent TSS, 0.39 per cent acidity, per cent 11.35 per cent total sugar and 45.10mg/100g vitamin C.

GJ - 19 : Selection made at CIAH, Bikaner. Peak period of flowering is in the first week of March. It ripens in the first week of June and recorded 20.50 g average fruit weight, 82.86% pulp, 11.100 Brix TSS, 0.36% acidity, 8.93% total sugar and 44.00 mg/100g vitamin C.

GJ - 23 : Selection made at CIAH, Bikaner. It ripens in the middle of June with an average fruit weight of 20.00 g, 84.45% pulp, 12.000 Brix TSS, 0.32% acidity, 9.03% total sugar and 44.00 mg/100 g pulp vitamin C.

GJ - 40 : Selection made at CIAH, Bikaner. It ripens in the fourth week of June and

recorded 16.00 g average fruit weight, 82.0% pulp, 14.00% TSS, 0.39% acidity, 11.00% total sugar and 46.10mg /100g pulp vitamin C.

Katha Jamun : Selection made at CIAH, Bikaner. It ripens in the middle of June and recorded 8.00 g average fruit weight, 70.0% pulp, 9.00 Brix TSS, 0.42% acidity, 34.00 mg/100 g pulp vitamin C, such types are preferred for processing purpose.

Narendra Jamun 6 : Selection made at NDUAT, Faizabad. Improved selection with better fruit qualities. The fruit is oblong type, higher fruit weight and higher pulp: seed ratio

Krian Duat : It has larger, thicked leaves and red inner bark. Fruits with purple flesh are more astringent than the white fleshed types.

Paras : This was released from GAU. It is seedling selection from Gujrat known for its large sized sweet and juicy fruits.

Konkan Bahdoli : Selection made at KKV, Dapoli. It has heavy and cluster bearing habit with bold fruits, small seeds, high pulp to seed ratio, better table and processing qualities.

Rajendra Jamun - 1: This was released from Bihar Agricultural College, Bhagalpur, Bihar. It is early (MayJune), high yielding (450 kg/ tree), TSS 18.200 Brix, acidity 0.31%, fruit weight 12.86 g with 88.40% pulp.

Ra Jamun : This is a common cultivar grown under north Indian condition. It produces fruits of big size having fruit length of 2.5 to 3.5 cm and diameter 1.5 to 2.0 cm. Fruits are oblong with deep purple or bluish black colour at full ripe stage. Fruit is juicy with small seed size and ripens in the month of June-July.

CISH J - 37 : Selection made at CISH, Lucknow. This seedling selection has superiority due to its bold large sized fruits with attractive deep purple colour. It has high pulp:seed ratio (90-92%) and TSS (16-170 Brix). Fruits are rich in ascorbic acid (49.88 mg/100g) and total antioxidant value (38.30 mg AEAC/g). The fruit is oblong and has average weight of 24.05 g, length 3.90 cm, diameter 3.03 cm. This is a mid season variety and fruits mature during second week of June. Yield potential is 200–300 kg/ plant.

CISHJ - 40 : It is promising genotype collected at CISH, Lucknow. It ripens in the month of June and recorded 17.23 g fruit weight, 91.00%) pulp, 12.400 Brix TSS, 0.76% acidity, 5.02% total sugar and 29.54 mg/100g vitamin C.

CISH J - 42 : Selection made at CISH, Lucknow. Its uniqueness lies in seedlessness (rudimentary seed) with high pulp content (97-98%). The fruit is round shaped and has average weight 6.87 g with a length of 2.57

cm. Fruits are good in test having 14-16 TSS 0 Brix. Fruits are rich in Vitamin C (34.14 mg/100g) and total antioxidant value 15.54 mg AEAC/g of fresh weight and shelf life of 5-7 days at ambient temperature. Yield potential is 180-250 kg/ tree. Fruits mature during second week of June.

Selection 1 : Selection made at Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. In Varanasi conditions the 'Selection 1' was observed most promising for fruit weight (14.55g), minimum seed weight (1.73g), higher pulp percent (90.05), higher total soluble solid (21.23%) and total sugar (20.24%). Therefore, Selection-1 is suitable for further perpetuation for commercial and systematic orcharding of jamun (Prakash *et al.*, 2010).

There is no named varieties and lot of variation exist in this fruit. However, local types at several places are superior (Mishra *et al*., 2014). A large fruited local types in Gujarat is known as 'Paras'. The most common cultivars grown are

7. Propagation:

The Jamun is propagated by seeds and vegetative methods as well.

- **Seed**: Fresh seeds can be sown within 3-4 weeks and germinated in 10 – 15 day, seedlings are ready during February to March
- **Vegetative Methods**:
- **Budding**: It is done on one year old seedling stocks during July to August in low rainfall area.
- **Air Layering**: It is done in spring – about 60% rooted air layers are obtained when 500 ppm IBA in lanolin paste is used.
- **Cuttings**: Cuttings treated with 2000ppm IBA gave higher rooting.
- In grafting or budding, *S. densiflora* is used as root stock to impart resistance to termite attack.

8. Planting:

Land is prepared by usual ploughing, harrowing and leveling. There should be a gentle slope to facilitate proper irrigation and drainage to avoid water stagnation during the rainy season. Jamun could also be grown under different cropping systems, i.e., either as pure crop or as a component of horti-silvi pastoral models or as a hedgerow. It is an excellent candidate as a windbreak when established on the periphery of any orchard. It is usually spaced at 8 x 8 m (156 plants ha-1) in square system and planted in pits of 90 x 90 x 90 cm which are usually dug during summer months. No standard spacing is available for recommendation as exclusive commercial plantings are non-existent. The plants of jamun were planted at a distance of 10 x 5 m (200 plants/ha) and 5 x 5 m (400 plants/ha) for studies on canopy development, flowering, fruiting pattern and

yield at CISH, Lucknow. The plants of CISH J-37 have also been planted under high density planting system at 2.5 x 2.5 m (1600 plants/ha) with canopy management for higher productivity

9. Manuring:

About 20 kg FYM/Plant every year. This much quantity of organic matter suffices the requirement for growth, flowering and fruiting.

10. Irrigation:

Jamun is a hardy plant, usually 8 – 10 light irrigations are required during the early age of the plant. Bearing trees should not be given irrigation in Sept – Oct to encourage fruit bud formation. Similarly withholding irrigation in Feb – March enhances flowering & fruiting depending upon climatic condition.

11. Inter & Mixed cropping:

Upto pre-bearing period fruit crops like Guava, Kagzilime & Fig can be grown as filler crop. Legumes, onion, peas, gram, mung, etc. are good inter crops.

12. Canopy management:

Jamun since is a vigorous tree, canopy management is required for ensuring maximum utilization of light, avoidance of the build-up of microclimate congenial for diseases and pests, ease of cultural operations and maximizing the productivity and quality. Basically, it starts with training as a potential tool, right from initial stage of planting to manage the canopy architecture of the plant. Young plants should be allowed 3-5 well spaced scaffold branches above 60 cm from the ground level to develop the main framework. It is followed by pruning to regulate tree size and shape to achieve a desired architecture of the canopy with a network of primary, secondary and tertiaries and also to reduce the foliage density by removing the unproductive branches. Regular pruning of jamun plant, however, is not required, restricting the operation to only removal of dry, weak and diseased branches. Two systems of initial training, i.e., open center, palmette system and Y shape, have been adopted at CISH, Lucknow for evaluation.

13. Flowering and Fruiting:

Seedling trees come to flower at 8 – 10 years and grafted trees in 6-7 years. Flowers are borne in the axils of leaves on branchlets, flowering starts from March to April. The flowers are sessile, small (7-12 mm), white in color and with thin membranous petals. They are arranged mostly in threes and appear usually from the scars of the fallen leaves (Warrier *et al*., 1996). The flower length varied from 9.25-13.21 mm being maximum in GJ-25. The stamen and style length varied from 5.20-9.00 mm and 7.25-8.90 mm respectively being at the top in GJ-21 (Singh *et al.*, 2007). The hermaphrodite flowers are light yellow in colour. Anthesis and dehiscence occurs between 10 am to 12 noon. Stigma receptivity is maximum one

day after anthesis. Honey bees, house flies and wind are responsible for cross pollination. The total flowering phase culminating in fruit set and later ripening lasted for 119 to 126 days with long phase of flower bud initiation, lasting for 45-50 days. Natural pollen transfer in the species was efficient and fruit set following open-pollination was quite high. Inspite of synchronous nature of anther dehiscence and stigmatic receptivity, selfing in a flower was found to coexist in nature with cross-pollination due to pollinator efficiency and pollen grain size. Selfing was promoted by geitonogamous mode and the species was suited to insect and wind pollination. It was found that reproductive phenology in jamun under Lucknow conditions was largely governed by seasonal climatic variables (Bajbai *et al*, 2012).

There is a heavy drop of flowers and fruit (50-60%) within 3-4 weeks of flowering. A large number of fruits drop off at very young stage during 5-8 weeks after blooming. The flower and fruit drop can be reduced with the help of two sprays of GA_3 @60 ppm first at full bloom and second spray, 15 days after initial setting of fruit. There are 3 phases of fruit growth and development i.e. I phase from 15 to 52 days after fruit set, having slow growth of fruit. The II phase from 52 to 58 days after fruit set having fast growth and the III phase and last phase from 58 to 60 days after fruit set, having slow growth.

14. Harvesting:

Harvesting The seedling plants start bearing after 8-10 years, while grafted ones after 4-5 years of planting. The fruits ripen in the month of June –July depending upon the variety and agroclimate. The ripe fruit at full size is deep purple or black in colour and picked immediately once ripens, as it cannot be retained on the tree at that stage. The fruits are delicate and picked singly by hand and care should be taken to avoid any possible damages to fruits. For harvesting, the picker climbs on the tree with a bag of cotton on the shoulder. When the bag is full, either the picker comes down from the tree and empties it into baskets or with the help of rope lowers the bag down to the ground and person standing below the tree empties the bag into baskets gently. The fruits are generally harvested daily and delivered to markets on the same day as they have very low shelf life. The average annual yield of fruit from a full-grown (20 years) seedling tree is about 80-100 kg and from a grafted one (10 years) it is around 60-70 kg.

15. Yield: The fully grown seedling Jamun tree produces on an average 100 -150 kg fruits. Whereas, it is about 60-70 kg from vegetative propagated tree.I kg of jamun fruit cost Rs.150/-. And fetches very good demand.

16. Post harvest handling and storage

The fruits of Jamun are highly perishable in nature, fruits are generally harvested daily

and sent to market on the same day. They cannot be stored more than 3-4 days under ordinary conditions. However, pre-cooled fruits packed in perforated polythene bags can be stored well upto 3 weeks at low temperature (9 ± 1°C) and 85-90% RH.

17. Conclusion

It is concluded that the above-mentioned novel techniques for jamun is scientifically proven that are highly potential enough to improve the crop productivity. The ultimate aim is to increase the productivity per unit area with the effective utilization of optimum inputs.

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