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Morpho-biochemical characterization of jamun (*Syzygium cumini*) varieties for nutrition and livelihood security

Kanupriya Chaturvedi*, Arivalagan M, Sankaran M and Tripathi P C*

ICAR–Indian Institute of Horticultural Research, Bengaluru, Karnataka-560089, India

Abstract

Three farmers' varieties of jamun, *Syzygium cumini* (L.) Skeels., Patel Jumbo, Patel Samruddhi and Patel Akal, identified from Nagadasanahalli village (Bengaluru Rural district, Karnataka) were characterized morphologically and biochemically, following DUS descriptors by ICAR-IIHR, Bengaluru, during 2024-25. The varieties displayed distinctiveness in fruit weight (7.1–12.65 g), pulp colour (pinkish-white to purple), total soluble solids (10.79–14.02 °Brix), acidity, and anthocyanin content. Patel Jumbo exhibited the highest fruit weight and pulp sweetness, Patel Samruddhi showed unique purple pulp with high productivity, while Patel Akal extended the fruiting season into July–August. Morphological traits including fruit shape, size, and pulp characteristics showed clear divergence among all the varieties. Biochemical profiling confirmed variation in TSS, acidity, phenolics, and anthocyanins. The results provide scientific validation for their distinctiveness, uniformity, and stability (DUS) and support their suitability for PPV&FRA registration. The study highlights the value of farmer-led germplasm development for climate-resilient dryland horticulture.

Key words: Biochemical, Fruit weight, Farmers' varieties, Pulp colour, TSS

Jamun, *Syzygium cumini* (L.) Skeels., a member of the Myrtaceae family, is an underutilized yet highly valuable indigenous fruit species widely distributed across the Indian subcontinent. Its fruits are purple, fleshy, and seed-rich, and the volatile oils extracted from them are traditionally used to manage diabetes, cardiac ailments, and liver disorders (Vijayanand *et al.,* 2001; Singh, 2001). Owing to its medicinal attributes and utility as a windbreak species, demand for jamun has steadily increased, highlighting the need for high-yielding, superior-quality planting material. Despite its potential, systematic improvement in jamun remains limited. Most trees across India are of seedling origin, leading to considerable variability in morphology, reproductive behaviour, fruiting patterns, and physico-chemical properties (Tripathi *et al.,* 2025). This diversity is primarily a consequence of its sexual mode of reproduction and highly cross-pollinated nature. While such variation represents a rich resource for selection, it also underscores the need for structured evaluation to identify elite genotypes suited for horticultural expansion, processing industries, and pharmaceutical applications (Prakash *et al.,* 2010; Singh *et al.,* 2022).

For the formal recognition, protection, and dissemination of such elite material, scientific validation using Distinctiveness, Uniformity and Stability (DUS) descriptors is essential. Registration under the Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA) provides legal acknowledgement, safeguards breeders' or farmers' rights, and supports wider adoption of improved germplasm. However, farmer-identified jamun types remain largely undocumented in scientific literature, limiting their integration into national germplasm repositories and breeding programmes. The present study addresses this gap by providing a comprehensive morpho-biochemical characterization of elite jamun varieties collected from Nagadasanahalli village, Bengaluru Rural district, Karnataka, India.

MATERIALS AND METHODS

Elite jamun trees, viz. Patel Jumbo, Patel Samruddhi and Patel Akal were evaluated during 2024-25 at ICAR-IIHR, Bengaluru. The trees (more than 12 years old) were selected and maintained under uniform field conditions without supplemental irrigation or external nutrient inputs. Morphological characterization was conducted following PPVFRA DUS guidelines. Ten fully mature fruits /tree were sampled, and observations were recorded for fruit weight (g), fruit length and width (cm), seed weight (g), pulp percentage (%), pulp and fruit colour, and fruit shape including apex and stalk-end characteristics. Measurements were taken using digital Vernier callipers, and colour attributes were assessed using the RHS colour chart. Biochemical analysis was carried out on fresh fruit samples to estimate total soluble solids (°Brix), titratable acidity (%), and anthocyanin content (mg/100 g). Total soluble solids were measured using

***Corresponding author :** prakaashtripathii2000@yahoo.co.in

Table 1: Qualitative characteristics of jamun genotypes

Genotype	Fruit shape	Pulp color	Taste and TSS	Special traits	Harvesting time
Patel Jumbo	Elliptical	Pinkish-white	Sweet, no astringency	Large size, high yield, premium market appeal	June (regular season)
Patel Samruddhi	Elliptical	Purple	Tangy, astringent	Heavy bearer, vibrant color for processing	June
Patel Akal	Oblong	Pinkish-white	Sweet-acidic, mild astringency	Late fruiting, extends jamun season	July–August
Dupdal	Oblong	Pinkish-white	Sweet, no astringency	premium market appeal	May-June

Table 2: Morphological characteristics of fruits from jamun genotypes

Genotype	Fruit weight (g)	Fruit length (mm)	Fruit width (mm)	Fruit length:width	TSS (oBrix)	Seed width (mm)	Seed length (mm)	Pulp weight (g)	Pulp (%)
Patel Jumbo	12.65	2.99	2.13	1.40	14.02	1.21	1.65	11.31	89.41
Patel Samruddhi	7.1	2.08	1.13	1.84	10.79	1.02	1.41	6.05	85.21
Patel Akal	11.35	3.18	2.36	1.35	13.3	1.14	1.08	10.21	89.96
Dhupdal	12.76	3.26	2.05	1.59	16.83	0.96	2.08	10.6	83.09

Table 3: Biochemical characteristics of fruits from jamun genotypes

Genotype	Titratable acidity*(%)	Total sugars (g)	Reducing sugars (g)	Anthocyanin (mg C3GE)	Total phenolic content (mg GAE)	Total flavonoids content (mg CE)	FRAP (mg TE)	DPPH (mg TE)
Patel Jumbo	0.59	10.49	7.64	94.85	140.90	67.85	272.60	355.35
Patel Samruddhi	0.56	8.18	6.17	198.75	404.60	120.45	911.55	733.85
Patel Akal	0.65	8.08	5.82	107.60	244.90	78.25	534.55	524.50
Dhupdal	1.31	8.8	6.06	84.35	146.51	68.57	307.78	629.79

*Titratable acidity measured as % citric acid equivalent
DPPH and FRAP values are expressed as mg trolox equivalent/100 g pulp
C3GE – Cyanidin-3-glucoside Equivalent, GAE - Gallic Acid Equivalent, CE- Catechin Equivalent, TE- Trolox Equivalent

a portable hand refractometer, acidity was determined through standard titration procedures, and anthocyanin content was quantified using spectrophotometric methods as per protocols of AOAC, 2006.

RESULTS AND DISCUSSION

The jamun genotypes namely, Patel Jumbo, Patel Samruddhi, Patel Akal and the check Dhupdal showed clear morphological variation in fruit shape, pulp colour, taste, and harvesting time, consistent with broad diversity reported earlier (Singh *et al.,* 2020; Alam *et al.,* 2020). Fruit shape ranged from elliptical to oblong, while pulp pigmentation varied from purple in Patel Samruddhi to pinkish-white in the remaining genotypes, aligning with earlier observations that darker fruits tend to be less common but biochemically richer (Ghosh *et al.,* 2017; Verma *et al.,* 2019). Taste differences such as sweet (Patel Jumbo, Dhupdal), tangy-astringent (Patel Samruddhi), and sweet-acidic (Patel Akal) also matched the flavour diversity documented in previous evaluations (Patel *et al.,* 2005; Devi *et al.,* 2019). Harvest windows differed substantially, with Dhupdal ripening early and Patel Akal extending the season into July-August, supporting earlier conclusions on the value of late-fruiting genotypes for market continuity (Singh *et al.,* 2020).

Quantitative traits reinforced this differentiation. Fruit weight and size were highest in Dhupdal and Patel Jumbo, comparable to large-fruited types (Alam *et al.,*2020). The TSS ranged widely (10.79-16.83°Brix), reflecting genetic variability in sweetness (Agrawal *et al.,* 2017; Singh *et al.,* 2016). Pulp percentage was highest in Patel Akal and Patel Jumbo, echoing findings that high-pulp genotypes such as Konkan Bahadoli are preferred for processing (Patel *et al.,* 2005; Devi *et al.,* 2019). Seed traits, though less variable, aligned with previous reports highlighting their relevance for medicinal extraction due to high polyphenolic content (Ayyanar & Subash-Babu, 2012; Megha *et al.,* 2017).

Biochemical parameters showed the strongest discrimination among genotypes. Patel Samruddhi stood out with exceptionally high anthocyanins, phenolics, flavonoids, and antioxidant activity-values consistent with pigment-rich jamun types reported by Verma *et al.,* (2019), Talang *et al.,* (2017), and Suradkar *et al.,* (2017). Total phenolics in this genotype were 2-3 times higher than the check, comparable to the upper ranges previously reported in jamun and other antioxidant-rich fruits (Singh *et al.,* 2016; Megha *et al.,* 2017). Sugar composition followed expected patterns, with higher sugars in sweet genotypes and lower sugars in tangier types, consistent with earlier biochemical characterizations (Alam *et al.,* 2020). Dhupdal showed moderate antioxidant capacity and acidity, aligning with values typical of widely grown traditional cultivars (Shahnawaz and Sheikh, 2011).

The results highlight the functional complementarity of the evaluated genotypes. Patel Jumbo combines premium size, sweetness, and high pulp recovery; Patel Samruddhi is a nutraceutical-rich, pigment-dense genotype suited for functional foods and natural colourants; Patel Akal provides season extension and high pulp yield; and Dhupdal serves as a suitable check with stable but moderate biochemical attributes. The observed morphological and biochemical diversity, underscores the potential of elite selections for breeding programs focused on fruit quality, pigment enhancement, antioxidant capacity, and year-round supply within jamun value chains.

CONCLUSION

The documented distinctiveness and stability provide a scientific basis for germplasm registration, wider dissemination, and future breeding initiatives. By integrating farmer-led selection with formal characterization, this study supports the systematic promotion of elite jamun varieties with high nutritional value and strong economic potential.

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