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Advancement in Sohiong *(Prunus nepaulensis)* to improve nutrition and food systems in NEH, India

Sohiong (*Prunus nepaulensis* (Ser.) Steud.) is an important underutilised indigenous fruit species native to Northeast India. Fruits are a valuable dietary source of nutrients, antioxidants, bioactive constituents and pigments, thereby representing a promising functional food with nutraceutical benefits. The fruits are consumed fresh and used in a range of value-added products, thus, play a significant role in the economy and traditional food systems in the region. The major scientific advances to improve the production and quality of Sohiong fruits are germplasm improvement, nutrient and bioactive compound profiling, standardisation of propagation techniques, sustainable orchard management, development of value-added products, and conservation strategies. Conservation and popularisation strategies are essential for sustainable utilisation, biodiversity conservation, livelihood enhancement, and strengthening climate-resilient food systems in Northeast India.

Keywords: Medicinal properties; Nutrition; Propagation; *Prunus nepaulensis*; Value additions

SOHIONG (*Prunus nepaulensis* (Ser.) Steud.) is a member of the rosaceae family and is also known as the Khasi cherry. It is an important indigenous fruit species native to the Eastern Himalayan region and widely distributed in the hill ecosystems of Northeast India, particularly Meghalaya. The fruit has deep cultural, nutritional, medicinal, and economic significance among the Khasi and Jaintia tribal communities. The fruits are consumed fresh and also used for various value-additions. The fruits are a valuable dietary source of many bioactive constituents and pigments, which also impart the characteristic colour and flavour of the fruit. Various scientific advancement for promotion, popularisation and conservation of this fruit crop has been attempted. The promotion of indigenous fruit species such as Sohiong can significantly contribute to sustainable food systems while supporting local livelihoods.

Botanical description and habitat: It is an evergreen or semi-evergreen tree that grows naturally in subtropical and temperate forest ecosystems. Trees are medium to large, deciduous, and 15-20 m high with grey bark, upright branches, and oblong-lanceolate leaves. The tree produces small, round fruits that turn deep purple to black upon ripening. The fruits possess a characteristic sweet-acidic flavour and are highly appreciated by local communities.

The species require low chilling hours, about 300 hours for good flowering and fruiting. The fruit tree species is believed to have originated in the foothills of the eastern Himalayas of India, particularly in the hills of Khasi and Jaintia. It is growing wild in the subtropical and temperate Himalayan regions at altitudes between 800 and 3000 m a.s.l.

Sohiong Tree

The major advancement in Sohiong

Germplasm improvement: The Sohiong genotypes are classified into two groups based on fruit size: The big-sized and small-sized fruits. Considerable variability was observed between the bigger and smaller fruit types. The bigger fruits are superior in size, carbohydrates, vitamin C, and minerals, while smaller fruits possess better pulp recovery and

Table 1. Organic and carbohydrates in the fruits of *Prunus nepaulensis*

Parameters	Value
Titratable acidity	1.15-3.32 %, fw
pH	3.53
Citric acids	335.0 mg/100 g fw
Total soluble solids	16.73-21.43% fw
Reducing sugar	4.26-4.89% fw
Total sugar	6.40-8.75% fw
Carbohydrate	14.90% fw
Glucose	1.52% fw
Fructose	1.62% fw
Sucrose	3.03% fw
Pectin	1.80-2.54% fw
Lignin	1.2% dw
Cellulose	14.4% dw
Hemi-cellulose	19.8% dw
Fibre	1.71-5.50% dw
Acid detergent fibre	16.5% dw
Neutral detergent fibre	36.3% dw

Table 2. Fats and protein composition in fruits of *Prunus nepaulensis* Ser.

Parameters	Value
Fat	2.68% fw
Total oil	0.66% fw
Protein	1.49-1.76% fw
Proline	3.08 µ moles/gm fw

Table 3. Mineral composition in fruits of *Prunus nepaulensis* Ser.

Parameters	Values
Nitrogen	69.95 - 70.01 mg/100 g dw
Phosphorus	70-115 mg/100 g dw
Potassium	485.01-530.00 mg/100 g dw
Calcium	1220 mg/100 g dw
Magnesium	217.7 mg/100 g dw
Sulphur	787.50-1362.52 mg/100 g dw
Iron	2.32 -10.70 mg/100 g dw
Copper	1.01-1.56 mg/100 g dw
Sodium	0.10 mg/100 g dw
Zinc	1.5-2.42 mg/100 g dw
Manganese	5.62-7.70 mg/100 g dw
Selenium	0.5 µg/100 g dw

FW, fresh weight; DW, dry weight

Table 4. Pigmentations and antioxidants composition in fruits of *Prunus nepaulensis* Ser.

Parameters	Values
Pigmentations	
Total carotenoids	15.72 mg/100 g fw
β carotene	0.22 mg/100 g fw
Total anthocyanin	293.33-341.70 mg/100 g fw
Total Flavonoid	4.93 mg QE/100 g fw
Total flavonol	2.77 mg QE/100 g fw
Antioxidant activities	
Ascorbic acid	46.03-52.3 mg/100 g fw
Total Tannin	143.6 mg TAE/100 g dw
Reduced glutathione	3.68 µM/g fw
Total phenols)	86.93-1131.30 mg GAE / 100 g fw
DPPH	0.27-0.67 IC_{50} mg/mL
FRAP	10.19 mg AAE/g fw

other antioxidant properties. These traits are valuable for germplasm conservation, breeding, nutritional improvement, and value-added product development.

Nutritional, pigmentation and bioactive compound profiling: Sohiong fruits can be highlighted as a nutrient-dense functional fruit due to its rich sources of nutrients, antioxidants and bioactive compounds. The nutritional and bioactive compounds of Sohiong fruits vary by fruit type and maturity stage. The fruits are a good source of organic acids and carbohydrates, as indicated in Table 1. In addition, the structural polysaccharides found in fruits are pectin (1.80–4.6%), lignin (1.2%), cellulose (14.4%), and hemicellulose (19.8%). Elevated levels of cellulose, hemicellulose, and pectin improve texture, firmness, and dietary fibre. The fibre content ranges from 1.71–7.2%, with high acid- and neutral-detergent fibre, which benefits health by protecting against metabolic and colonic disorders.

The fruits of Sohiong are also sources of protein (1.49–1.76%), fat, proline, and total edible oil (Table 2).

Sohiong fruits are known as a source of excellent health supplements due to their high nutrient and mineral content (Table 3). The ash content in Sohiong fruits varies with genotype and fruit type while nitrogen, phosphorus, potassium, sulphur, and sodium are fairly high with a substantial amount of iron.

The vitamin and antioxidant content are also fairly high, as shown in Table 4. The other bioactive compounds, such as tannic acid, purpurin, reserpine, methyl gallate, catechin, rutin, quinic acid, quercetin, scopoletin, palmitoleic acid, and naringenin, are also present in the fruit of Sohiong. In addition, 16 polyphenolic compounds were identified in an optimised extract of Khasi cherry.

Standardisation of propagation techniques

Sohiong plants are traditionally propagated from seed, resulting in inferior fruit quality. The gestation period exceeds seven years, and the canopy is extensive. The ICAR Research Complex for the North East Hill (NEH)

Quality planting materials of Sohiong

Region has developed the 'Tongue' grafting technique for the rapid multiplication of Sohiong.

Raising of rootstocks: Fully ripened fruits were harvested and collected in September and October for seed extraction. The fruits should be soaked in water for 3-4 days to ferment, facilitating the removal of pulp adhering to the seeds. Subsequently, the seeds should be washed with water and shade-dried for 24 hours. Stratification was conducted in moist sand, with seed coat rupture observed after 3-4 weeks. These ruptured seeds should be sown in polythene bags containing equal parts of soil, sand, and farmyard manure (FYM) at a depth of approximately 5 cm. Seed germination generally commences between 20 to 30 days post-sowing, with an observed rate of 95%. Additionally, soaking seeds in 100-150 ppm GA_3 or 0.5% Thiourea overnight has been shown to enhance germination.

***Grafting*:** The mother tree should be precocious, high-yielding, and free from pests and diseases, with the fruit of superior quality. Scion material for grafting should be selected from five- to six-month-old shoots that are pencil thick, 25–30 cm long, and have 3–4 internodes. Grafting should be performed using one-year-old rootstocks with a pencil-thickness of 0.5 to 1.0 cm. The optimal period for grafting extends from the second week of September to the second week of October, coinciding with the dormancy of both the stock and scion. Two grafting techniques, namely Tongue grafting and Wedge grafting, have been successfully adopted in Sohiong. Notably, Tongue grafting demonstrated a superior success rate, ranging from 80% to 85%. Additionally, grafting conducted within a shade-net polyhouse has yielded higher success rates than in open-field conditions.

Sustainable orchard management

The practices standardised to improve fruit productivity, quality, climate resilience, and sustainability of cultivation systems are:

***Planting system*:** The land should be cleared, and pits measuring 0.75 x 0.75 x 0.75 m should be dug. While digging, the topsoil and subsoil should be kept separate. The pits should be exposed to sunlight for 15 days to destroy harmful microorganisms and insects. The pits should be filled with topsoil mixed with 15 kg of FYM. The plants should be planted at a spacing of 7 x 7 m. The best time for planting Sohiong is at the onset of the monsoon. If there is no rain after planting, light irrigation should be given.

***Nutrition management*:** Application of 10 kg FYM/plant each year, along with 150 g: 50 g: 150 g NPK/plant per year, yields optimally. Alternate-year application of 0.5 kg lime for up to 7 years, and thereafter 1.5–2 kg in alternate years, is helpful.

***Pest and disease management*:** Sohiong is a resilient plant, and very minimal pests and diseases were observed in this crop under field conditions. However, under polyhouse conditions in the nursery, leaf blight and powdery mildew have been observed.

***Leaf blight*:** The disease is caused by Cladosporium oxysporum. Initial symptoms manifest at the leaf margins and gradually progress towards the midrib. In the advanced stages, entire leaves exhibit necrosis, accompanied by prominent sporulation on the underside of the leaves. Such sporulation is seldom observed on the upper leaf surfaces. Necrotic lesions are typically encircled by a yellow halo. Significant defoliation of affected leaves is also noted, with symptoms being more pronounced on immature foliage. Application of Mancozeb (2.5 g/l) is recommended for effective disease control.

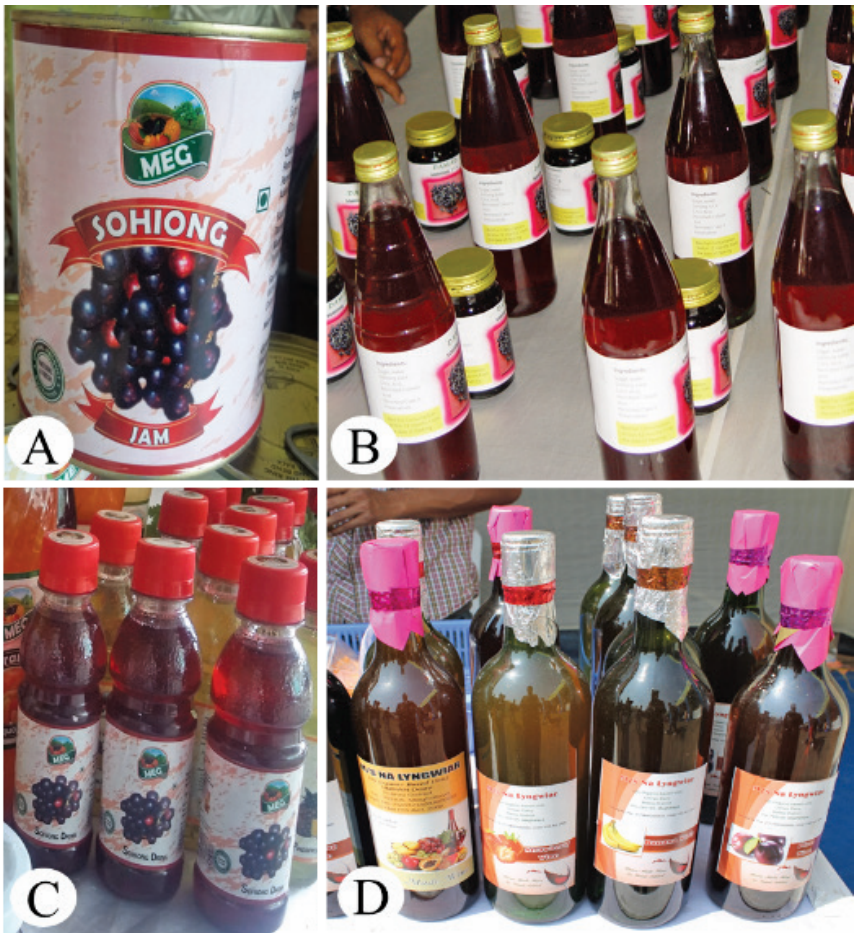
***Powdery mildew*:** The disease is caused by *Podosphaera* spp. Symptoms include whitish, irregular patches on the lower leaf surface, with corresponding yellow lesions on the upper surface. Symptoms occur on both young and mature leaves. Heavy infection leads to severe defoliation. Spraying with wettable sulphur (3 g/l) may effectively control the disease.

Season of availability and fruit colour

The tree of seedling origin begins bearing fruit within 7-10 years of planting, depending on the age of the seedling. Flowering occurs in October-November, and the fruit ripens in August–September.

The best time for harvesting is 270-285 days after fruit set, when the colour changes from light purple to dark purple. Dry matter content, acidity, antioxidants, ascorbic acid, TSS, ash, anthocyanins, reducing sugars and total sugars were found to be higher during 270–285 days. Harvesting immature or overripe fruit adversely affects quality. The fruit should be harvested when fully ripe, with the colour darkening to purple or blackish (Figure 2). The whole bunch should be harvested with a sharp knife. A fully mature tree yields about 70-125 kg of fruit

Ripe fruits of Sohiong



Different products developed from the fruits of Sohiong. A – Jam, B – Squash, C- Juice, D – Wine

per tree every year. These fruits have appealing pigments in both the peel and the juice, as evidenced by significant variation in the L*, a* and b* values of the peel and juice colour. The peel pigmentation was L* (15.8±1.30), a* (2.6±0.44), and b* (-0.7±0.71). The juice colour was L* (8.2±1.21), a* (14.1±2.15), and b* (4.3±1.90).

Development of value-added products

The fruits of Sohiong are highly perishable and have a very short shelf life, about 4-5 days. During the harvesting season, a glut in the market leads to distress sales. Therefore, the incorporation of fruits in value addition may reduce post-harvest losses and enrich the nutrition and economics of the growers. A protocol has been developed for the preparation of various processed products from fruits of sohiong, such as Sohiong ready-to-serve (RTS), Sohiong squash, Sohiong candy, Sohiong powder, Sohiong jam, Sohiong jelly, Sohiong wine, Banana-*Sohiong* mixed leather and Sohiong fruit powder (Figure 3). A dairy-free probiotic drink and a probiotic powder were developed for lactose-intolerant people by incorporating *Lactobacillus plantarum* into Sohiong fruit juice for fermentation. The pretreatment of Sohiong with ultrasound, centrifugation, and fruit-juice enzymes prior to microfiltration increased juice yield and quality. The Sohiong slices pretreated with citric acid (0.55%), followed by drying at a microwave power (400 W) and vacuum pressure (690 mmHg), yielded the highest quality dried fruits. The value-added products prepared from this fruit had a very attractive flavour with a stable purple colour. Advances in post-harvest processing and value addition improve shelf life, consumer acceptability, market value, and opportunities for rural entrepreneurship.

Market development and entrepreneurship

Efforts are underway to promote Sohiong fruits and its products through branding, Farmer producer organisations (FPOs), Agri-startups, women entrepreneurs, and agri-exhibitions. There are market development opportunities for Sohiong fruits, considering its anthocyanin-rich extracts can be used as natural edible pigments. The fruit is rich in nutrients, antioxidants, vitamins, and minerals and can be formulated into antioxidant-rich probiotic-fermented beverages and processed into value-added products. The gross return generated is about ₹8,400-13,000 per mature tree, which may create opportunities for entrepreneurship and livelihood improvement.

Conservation and popularisation

Conservation and popularisation are essential for sustainable utilization and biodiversity preservation.

Conservation strategies

In-situ conservation and habitat protection

- Protect the native habitats such as national parks
- Conserve forests, community reserves and sacred groves
- Promote community-led conservation and stewardship
- Implement eco-restoration and habitat enrichment

Ex-situ conservation

- Seed Banks
- Germplasm Repositories
- Botanical Gardens

Domestication and improvement

- Selection of superior genotypes
- Standardised ppropagation technique
- Orchard management
- Conservation of genetic diversity

Popularisation strategies

Awareness and extension

- Training programmes, workshops, field days
- Demonstrations and exposure visits
- Educational campaigns and IEC materials
- Engage researchers, farmers, students and entrepreneurs

Value addition and processed products

- Develop processed and value-added products
- Improves shelf life
- Enhances nutritional value and consumer acceptability
- Reduces post-harvest losses
- Encourages local enterprises and rural livelihoods

Market development

- Branding and promotion of Sohiong products
- Establish producer groups and cooperatives
- Link producers with markets and processors
- Participate in exhibitions, organic markets and online platforms
- Develop standardization and quality certification

Research and policy support

- Research on improvement, nutrition, propagation and market potential
- Policy support for conservation, cultivation, processing and marketing

Future prospects

Future advancement areas include:

- Genome characterisation and molecular breeding,
- Development of improved cultivars,
- Large-scale commercial cultivation,
- Export-oriented processing,
- Functional food and nutraceutical industries,
- Inclusion in government horticulture missions and biodiversity programmes.

SUMMARY

Sohiong fruit is a nutritionally rich and economically significant indigenous fruit species, with substantial potential to enhance nutrition, health, livelihood security, and sustainable food systems. Recent scientific advancements in sohiong, including germplasm characterisation, propagation techniques, orchard management, post-harvest handling, and value addition, have opened new avenues for commercial cultivation and entrepreneurial development. The promotion and expansion of the commercial cultivation of these crops, along with their utilisation, may provide additional sources of income, employment opportunities, and improvements to nutritional and food systems in the hill ecosystem.

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