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Domestication Prospects and Value Addition Opportunities in Kaphal

Vivek Singh, *Khulakpam Naseeruddin Shahand and Deepak Kumar Rana
Department of Horticulture, HNB Garhwal University, Srinagar (Garhwal), Uttarakhand 246174, India
*Corresponding Author's email: naseer.ahmed56@gmail.com

Kaphal is an important wild fruit tree found in the mid-Himalayan region, growing naturally between 900 and 2,100 meters above sea level. This species plays a key role in local economies, nutrition, traditional medicine, and ecological health in Himalayan forests. The tree is evergreen and dioecious, producing highly perishable reddish to purplish fruits from April to June. These fruits are prized for their unique flavour and rich biochemical makeup. Kaphal fruits are a valuable source of phenolics, flavonoids, vitamin C, sugars, and natural antioxidants, which contribute to their health benefits, including antioxidant, anti-inflammatory, and antimicrobial properties. Different parts of the plant, such as the bark, leaves, flowers, and fruits, are widely used in indigenous medicine to treat respiratory issues, digestive problems, inflammation, skin diseases, and metabolic disorders.

The species grows well in well-drained, slightly acidic soils with moderate rainfall and distinct seasonal temperatures. It is usually propagated through seeds, though dormancy requires stratification. Vegetative methods such as cuttings, air layering, suckers, and micropropagation have also been tried with varying results. Despite its many uses and increasing scientific interest, Kaphal is still mainly found in wild or semi-managed areas, and the traditional knowledge about its use is quickly fading. Systematic domestication, better propagation methods, value addition, and conservation-focused cultivation strategies are vital to unlock its full horticultural and economic potential in the Himalayan region.

Keywords: Fruit; Himalayan; Medicinal; Kaphal and Underutilized.

Introduction

Kaphal formerly called Myrica esculenta, is an evergreen wild fruit tree from the Myricaceae family. It is the only naturally occurring Myrica species in India. The tree grows mostly in the mid-Himalayan region at elevations between 900 and 2,100 meters above sea level. The tree is found often in forests with *Pinus roxburghii, Quercus leucotrichophora*, and mixed oak species across several states in the Indian Himalayas **(Rawat et al., 2018).** Kaphal is a small to medium tree that can reach up to 18 meters tall. It produces unisexual flowers and dark red to purplish, oval-shaped fruits that ripen from April to July. These fruits are highly valued for their unique taste and nutritional benefits, playing a significant role in the seasonal income of local communities. Besides fruit, the species is also used for fuelwood, fodder, medicine, oil extraction, tanning, and dye production. Due to its ecological importance for forest stability and its economic, nutritional, and medicinal value, Morella esculenta is seen as an important underused fruit species in the Indian Himalayas. There is considerable potential for its sustainable use and conservation.

Origin And Distribution

The species is native to India and is found throughout the Himalayan region. This includes Himachal Pradesh, Uttarakhand, and the northeastern states like Assam, Arunachal Pradesh,

Sikkim, and Manipur (**Gaur, 1999; Kabra *et al.*, 2019**). It also commonly grows in the Khasi, Jaintia, Naga, and Lushai hill ranges of Meghalaya, thriving at elevations between 900 and 2,100 meters above sea level (**Jeeva *et al.*, 2011; Gusain & Khanduri, 2016**). Outside its native range in India, the species appears in several neighbouring and Southeast Asian countries, including Nepal, Pakistan, China, Japan, Singapore, and the Malayan archipelago. This shows its wide ecological adaptability (**Kabra *et al.*, 2019; POWO, 2024**).

Importance and Medicinal Uses of Kaphal (Morella esculenta)

- ✓ Kaphal is a valued wild fruit tree found in the Himalayan region. It is known for its edible fruits and its important medicinal uses among local communities in Uttarakhand and nearby areas (**Jeeva *et al.*, 2011; Kumar & Rana, 2012; Panthari *et al.*, 2012; Rana & Patel, 2016**).
- ✓ In traditional medicine systems like Ayurveda and Unani, nearly all parts of the tree—bark, leaves, fruits, and flowers—are used to treat various health issues. These include respiratory disorders, digestive problems, skin diseases, inflammation, and rheumatism (**Chatterjee & Pakrashi, 1994; Jeeva *et al.*, 2011**).
- ✓ The bark has antiseptic qualities and is traditionally used to clean infected wounds. It is also applied externally to treat rheumatism and used as a fish poison. Additionally, it is involved in tanning and making yellow dye (**Gaur, 1999; Jeeva *et al.*, 2011; Singh *et al.*, 2021**).
- ✓ Aqueous extracts from the bark have shown anti-hyperlipidemic, chemoprotective, and antioxidant effects. This suggests it may help in preventing metabolic and degenerative disorders (**Jeeva *et al.*, 2011**).
- ✓ The oil from the flowers is traditionally used as a tonic and is believed to help with earaches, diarrhea, inflammation, and paralysis (**Jeeva *et al.*, 2011**).
- ✓ The fruits of M. esculenta are rich in phenolics, flavonoids, and natural antioxidants. These compounds give them anti-inflammatory and antimicrobial properties and help reduce oxidative stress linked to chronic diseases (**Rymbai *et al.*, 2016**).
- ✓ Recent scientific studies have emphasized the anticancer, antimicrobial, antioxidant, and health-promoting potential of M. esculenta. This has increased interest in research, especially in pharmacognosy and natural product chemistry (**Bhatt *et al.*, 2023; Chauhan *et al.*, 2023; Joshi *et al.*, 2024; Shukla *et al.*, 2024**).
- ✓ Nutritionally, Kaphal fruits have good levels of total soluble solids (5.7–6.5%), acidity (2.5–4.8%), vitamin C (17.6–28.2 mg/100 mL pulp), reducing sugars (1.0–3.5%), and total sugars (3.0–7.7%). These qualities make them beneficial for health (**Rymbai *et al.*, 2016**).
- ✓ The fruits can be processed into pickles, syrups, jams, squashes, and refreshing drinks. This adds value and improves their market potential and shelf life (**Ksanbok *et al.*, 2014**).
- ✓ Besides their medicinal and nutritional uses, the plant is widely used for fuelwood, fodder, timber, agricultural tools, and traditional implements. This shows its important role in rural Himalayan livelihoods (**Kumar & Sinha, 2004; Jeeva *et al.*, 2011; Singh *et al.*, 2022**).
- ✓ Despite their long traditional use, knowledge about Kaphal is quickly fading due to modernization. This highlights the need to document and study usage trends, especially in the Garhwal Himalayan region (**Dhingra *et al.*, 2024**).

Botany

Kaphal (Myrica esculenta) is a small to medium-sized, evergreen, dioecious tree that grows to a height of 10 to 15 meters. Its trunk diameter ranges from 80 to 95 centimeters. The tree forms a compact canopy and only bears fruit after several years of growth. The bark is brownish to dark grey, rough and vertically cracked on the outside, and smooth and dark brown on the inside. It is traditionally valued for its astringent and antiseptic properties **(Lata et al., 2021).** The leaves are simple, alternate, and clustered near the tips of the branches. They are leathery and dark green on top, while the underside is pale. The leaves are

lanceolate to ovate in shape, with entire to finely serrated edges, and feature resinous dots on the lower surface that give off a distinct aroma.

Flowering occurs from October to December. The tree produces small, white, unisexual flowers on separate male and female trees. Male flowers appear as reddish branched catkins, while female flowers grow in slender spikes. Fruiting begins after six to eight years. The fruits ripen between April and June. They are globose to ovoid, succulent drupes that turn reddish-purple when mature. Each fruit weighs between 5.1 and 12.6 grams and measures 2.2 to 3.2 centimeters by 1.7 to 2.8 centimeters, yielding about 30 to 40% juice. The seeds are triangular and enclosed in a hard endocarp. They have an astringent taste and weigh between 0.82 and 2.02 grams, which aids in propagation; however, germination is slow and needs suitable conditions

Climate and Soil

The species prefers well-drained soils, ranging from shallow loamy brown forest soils to deeper loamy or clayey red lateritic soils. Slightly acidic soils with a pH of 5.5 to 6.5 are ideal. The plant needs moderate rainfall of 500 to 1,500 millimetres each year and thrives in warm summers with temperatures from 25 to 35 °C, along with cool winters ranging from 2 to 12 °C.

Propagation Techniques of Kaphal

Seed Propagation

Propagating through seeds involves extracting seeds from fully mature fruits. The seeds go through cold stratification for about three months in refrigerated conditions to break dormancy. After stratification, seeds are sown in nursery beds or plastic bags during spring to germinate. When seedlings reach a height of 10 to 15 cm, they are transplanted to the field in late spring for further growth.

Propagation through Cuttings

Vegetative propagation using cuttings involves collecting softwood or semi-hardwood cuttings that are 5 to 8 cm long during July and August. The cuttings are treated with IBA at 3000 ppm and planted in trays or polybags. Higher rooting success has been observed when shoot cuttings were treated with 10,000 mg L^{-1} indole-3-butyric acid, especially in spring; however, the overall rooting percentage is still relatively low.

Micropropagation

In vitro propagation has been attempted using shoot tip explants. A high concentration of cytokinin's (2.5 to 5.0 mg L^{-1}) along with a low level of auxin (0.05 mg L^{-1}) has been effective for inducing multiple shoots, producing about 10 to 12 shoots per explant. However, rooting of regenerated shoots in vitro has shown limited success, with only about 30 percent rooting reported.

Air Layering

Air layering is considered a more efficient method of vegetative propagation in Kaphal. This technique is most effective when performed in summer, achieving a success rate of approximately 40 to 42 percent. This method allows for the clonal multiplication of elite plants and ensures better establishment.

Propagation through Suckers

Suckers can also be used for propagation when separated during the dormant season. These suckers are planted directly at the desired site and allowed to establish naturally. Although this method is simple, it is limited by the availability of suckers.

Sowing Time

The best time for propagation through seeds is during spring, specifically March to April, when temperature and moisture support germination. To boost germination, seeds can be treated with hot water to break dormancy. Sowing takes place in well-prepared nursery beds or containers, using a mix of forest soil and sand to ensure proper drainage and aeration.

Cultivation Practices

Healthy seeds are chosen and grown in nursery beds with regular watering and some shade until the seedlings emerge. When the seedlings are strong enough, they are moved to the main field with a spacing of 4 to 5 meters to allow enough space for canopy development. Regular practices like weeding, mulching, and light pruning help maintain plant health and support better growth and fruiting.

Harvesting and Yield

Kaphal trees generally start bearing fruits 6–8 years after planting, with flowering occurring during October to December and fruits maturing 5–6 months after fruit set, resulting in ripening between April and June (**Patel & De, 2006; Shukla *et al.*, 2017**). Fruits are harvested at full maturity when they attain a reddish to deep-red colour, whereas green fruits are preferred for pickle preparation due to their comparatively higher acidity (**Prashar & Patel, 2018**). Harvesting is carried out manually, preferably during the early morning hours, as the fruits are highly perishable. To reduce mechanical injury and moisture loss, fruits are traditionally collected in bamboo baskets or cloth bags and covered with leaf bunches during transportation to local markets (**Kayang, 2007; Barua *et al.*, 2021**).

A mature *Kaphal* tree yields approximately 30–40 kg of fruits per year, depending on tree age and site conditions (**Patel & De, 2006; Shukla *et al.*, 2017**). The fruits are consumed fresh or processed into jams, jellies, squashes, and beverages, and their sale in local markets provides an important seasonal source of income for hill communities (**Kayang, 2007; Barua *et al.*, 2021**).

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