



Podophyllum hexandrum- A High Value Endangered Medicinal Plant

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Podophyllum hexandrum commonly known as Bankakri, Himalayan May Apple is a valuable medicinal plant, distributed in the lower elevations of Himalayan zone at altitudes ranging between 2000 to 4500m. The genus *Podophyllum* has two species that are the most commercially exploited sources of podophyllotoxin; the *Podophyllum hexandrum* is commonly distributed in the Himalayan regions of Asian continent popularly called as Himalayan Mayapple and the *Podophyllum peltatum* commonly distributed in Atlantic North America popularly called as American May apple (Chaurasia *et al.*, 2012). The roots and rhizomes of *Podophyllum hexandrum* have been found to be the source of podophyllotoxin lignan that has numerous biological activities. This lignan has been used in the production of clinically viable anticancer drugs. The demand for podophyllotoxin has increased immensely in global market against its limited supply due to both intensive collection and lack of cultivation. Due to this reckless harvesting from wild the species has come up in the list of 'critically endangered' species as per IUCN criteria. It is therefore, important to initiate steps for its large-scale multiplication and developing cultivation packaging.

Distribution

Podophyllum hexandrum is believed to be originated from the Himalayan region. It is distributed from Indian Himalayas to Bhutan, Pakistan, Afghanistan, Nepal, Taiwan and China. In India, it is grown in the Himalayan regions between 2000-4500m in restricted locations in Zaskar, Suru valley of Ladakh, Kashmir region in Jammu and Kashmir, Lahaul Spiti, Chamba, Shimla, Mandi, Kinnaur in HP between 2000-4000. In Kumaon and Gharwal in Uttarakhan, Sikkim and Arunachal Pradesh, the herb is distributed between 2000-4000m.

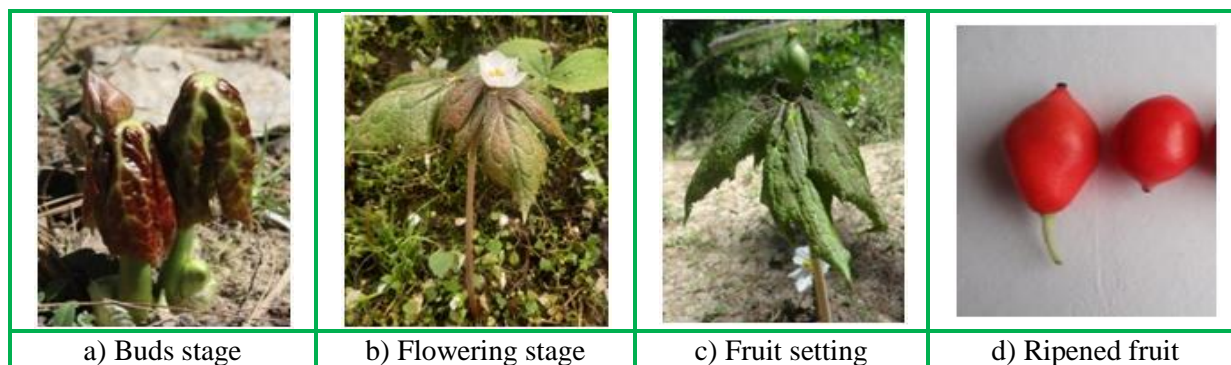
Importance and uses

The plant is used in various traditional systems of medicines because of its extensive therapeutic potential. Underground part i.e. rhizome and roots of the plant yield podophyllotoxin, an active ingredient used as a starting compounds for the chemical synthesis of clinically viable anticancer drugs *viz.*, etoposide, teniposide, and etopophos that are effective in treatment of lung cancer, a variety of leukemias, and other solid tumor (Ardalani *et al.*, 2017). The Indian species *Podophyllum hexandrum* contains three times more podophyllotoxin than the American species. Traditionally, dried rhizomes of the plant are mixed with liquid and taken as a laxative or to get rid of intestinal worms. Powder of the rhizome is also used as a poultice to treat warts and tumorous growth on skin. Rhizome/root preparations of *Podophyllum hexandrum* are commonly used by tribal people of the Indian Himalayan Region to cure a range of ailments, such as hepatic disorders, gastric ulcer, gangrene and constipation. Podophyllin obtained from the plant is cholagogue, purgative, alterative, emetic and bitter tonic and is given in conjunction with *Belladonna* and

Hyoscyamus (Allevi et al., 1993). It is used in veterinary medicine as a cathartic for dogs and cats, also used in removing warts in animals. *Podophyllum hexandrum* is a source of various biologically important metabolites and possess anti-oxidant, antiinflammatory, antifungal, cytotoxic and radioprotection activity. Podophyllin is toxic and strongly irritant to skin and mucous membranes. Large doses cause severe vomiting and diarrhoea.

Morphology

Podophyllum hexandrum is a perennial herb which is about 15-40 cm tall. The stem is cylindrical, smooth, fleshy and green coloured with purple tinge at collar region. Leaves are 10-25 cm long, deeply cut into 3 ovate, toothed lobes, sometimes further lobed. Upper portion of leaf is smooth, dark green while lower portion is light green in colour and veins are covered with shiny hairs. They completely unfurl after the plant has bloomed and are dark green splotched with brown. In the spring, white or pale pink flowers are borne at stout stem followed by fleshy, oval, red berries. The flowers have six petals and six stamens. Fruit is a large scarlet or reddish berry; orange in colour (later becoming scarlet or reddish on maturity) consisting many seeds embedded in pulp. The herb produces a solitary flower which blooms in May and sets berry like single fruit in September-October. In *Podophyllum hexandrum*, considerable morphological variation in plant height, leaf characteristics, fruit weight, seed weight and colour and other traits has been observed.



Chemical constituents

The rhizomes and roots of the plant contain anti tumor lignans such as podophyllotoxin, 4'-demethyl podophyllotoxin and podophyllotoxin 4-O-glucoside. Among these lignans, podophyllotoxin is most important for its use in the synthesis of anti-cancer drugs etoposide, teniposide and etophos. These compounds have been used for the treatment of lung and testicular cancers as well as certain leukemias. In addition, podophyllotoxin is also the precursor to a new derivative CPH 82 that has been tested for rheumatoid arthritis and other derivatives for the treatment of psoriasis and malaria (Lerndal and Svensson, 2000).

Cultivation practices

Podophyllum hexandrum can be propagated by seeds as well as from sections of rhizomes. It grows well in organic rich black soils with sufficient moisture. Partially shaded places favour survival and growth of the plants at lower altitudes. The species thrives best as undergrowth as well as in forests in temperate and subalpine zones. Seeds are sown in the month of October and November at altitudes ranging from 1800-2500m. However, seed germination in *Podophyllum hexandrum* is highly erratic and poor with low rate of seedling survival (Nautiyal et al., 1987; Bhadula et al., 1996). The germination percentage of seeds ranges from 41-45%. Treating seeds with 80 ppm GA₃ can enhance seed germination upto 70% in *Podophyllum hexandrum*. Seeds are to be sown along with pulp for better germination. Approximately 7.0-8.0 kg seeds are required for raising nursery of one hectare land. The seedlings remain in nursery for one year and next year they are transplanted in main field at

45x45cm distance. The plants remain in vegetative stage during the first year and flowering start from second and third year onwards. Seed and rootstocks raised plant are harvested after 5-6 and 3-4 year, respectively. Resin content in rootstock is high during May month but they should be harvested after seed ripening during July-August for obtaining higher production of rootstock.

Vegetative propagation

Due to delayed and poor seed germination, multiplication of *Podophyllum hexandrum* is preferred through rhizome cuttings. The youngest top portion of the rhizome cuttings consisting of 3-4 buds lead to better sprouting in *Podophyllum hexandrum*. Rhizome cuttings are dipped in 300 ppm of IBA solution before 24 hrs of planting to hasten the rooting in cutting. Treated cuttings are then planted in June-July in well prepared soil at a spacing of 45x45cm.

Conclusions

The over exploitation of *Podophyllum hexandrum* from the Himalayan region has posed a potential threat to this species. Thus, it is important to initiate attempts for its *in-situ* as well *ex-situ* conservation. Since the species has high cash value and commercial demand both at domestic and international markets, systematic cultivation practices need to be standardized for commercial cultivation.

References

1. Chaurasia OP, Ballabh B, Tayade A, Kumar R, Kumar GP and Singh SB. 2012. An endangered and anticancerous *Podophyllum* medicinal plant-An overview. *Indian Journal of Traditional Knowledge*, (2): 234-241.
2. Ardalani H, Avan A and Ghayour-Mobarhan M. 2017. Podophyllotoxin: A novel potential natural anticancer agent. *Avicenna Journal of Phytomedicines*, (7):285-294.
3. Allevi P, Anastarin M, Claffrede P, Begati E and Macdonald P. 1993. Sterioselective glucosidation of *Podophyllum* lignans - A new simple synthesis of etoposide. *Journal of Organic Chemistry*, (58): 4175 - 4178.
4. Lerndal T and Svensson B. 2000. A clinical study of CPH 82 vs. methotrexate in early rheumatoid arthritis. *Rheumatology* (Oxford), 39: 316.
5. Nautiyal MC, Rawat AS, Bhadula SK and Purohit AN. 1987. Seed germination in *Podophyllum hexandrum*. *Seed Research*, 15: 206-209.
6. Bhadula, SK, Singh A, Lata H, Kuniyal C P and Purohit AN. 1996. Genetic resources of *Podophyllum hexandrum* Royle, an endangered medicinal species from Garhwal Himalaya, India. *Plant Genetic Resources Newsletter*. 108: 26-29.