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AGRICULTURE TECHNIQUES IN CULTIVATION AND CONSERVATION OF SWERTIA CHIRAYITA (ROXB. EX FLEM.)

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ABSTRACT

Swertia chirayita, one of the herbs classified under *Karyadravas*, is a popular medicinal herb indigenous to the temperate Himalayas. It is used in traditional medicine to treat numerous ailments and is reported to have a wide spectrum of pharmacological properties. Its medicinal usage is well-documented in Indian pharmaceutical codex and in different traditional medicine including Ayurveda. The increasing high usage of Swertia chirayita combined with its habitat destruction has resulted in a drastic reduction of its populations and has brought this plant to the verge of extinction. The implication of losing this plant species due to extinction lies not only in the loss of genes useful for plant development or in the biosynthesis of new compounds but also the loss of potentially novel compounds of pharmaceutical or nutraceutical benefit. In view of the above there is a felt need for development of new Agriculture techniques and use of biotechnology for cultivation and conservation of this important herb. The present review emphasizes on the latest agricultural techniques for cultivation of Swertia chirayita, and its role along with biotechnological methods in preservation of its natural habitat.

KEYWORDS: Swertia chirayita, Biotechnology, Tissue culture techniques, Conservation, Cultivation.

INTRODUCTION

Swertia, a genus in the family Gentianaceae includes a large group of annual and perennial herbs. In India, there are 40 species of Swertia chirayita (SC). It was first described by Roxburgh under the name of Gentiana chyrayita in 1814.[1] Botanically it is known by the

name of Swertia Chirayita and in Aryurvedic literature it is named as *Kiratatikta*. Natural habitat of SC is sub temperate mountainous region of North India. It is available from Kashmir in India to Bhutan 1200 - 3000 m above mean sea level.

SC is among the 32 most highly prioritized medicinal plants of India and the conservation status of SC as per International Union for Conservation of Nature has been categorized "critically endangered". Due to its wide medicinal properties and corresponding demand, there has been reduction in its natural population and the herb is on the verge of extinction. Following are the reasons which can be attributed for the endangered status of the herb.[2]

- **Extrinsic factors**

✓ Growing demand for raw materials of medicinal plants by the pharmaceutical companies and their depleting resource base.
✓ More number of households depending economically on this herb for income generation through commercial collection.
✓ Lack of knowledge about sustainable harvesting and Good agriculture and collection process (GACP).
✓ Habitat destruction due to construction of roads, overgrazing and local endemics like landslides, forest fire is identified as the main threat to its diversity.

- **Intrinsic factors**

✓ It takes three years to complete its life cycle and can be propagated through sexual means only i.e. through seeds.
✓ Due to its slow growth, it cannot compete with other plants for nutrition in the wild.
✓ The seeds harvested also possess a problem of low viability and low germination percentage.
✓ This herb is highly, location and temperature specific as per our observation and can grow suitably only above 1200m altitude and difficult to acclimatise in lower elevations.

To fulfil the high demand of this herb and save it from extinction novel Agriculture techniques in cultivation and conservation are required.

METHODS

A systematic review of the literature available online in various medical repositories including Google Scholar and PubMed was undertaken regarding novel Agriculture

techniques in cultivation and conservation of SC. Information obtained from online resources was carefully and thoroughly examined, analysed and incorporated in the present review.

RESULTS

Novel Agriculture techniques in cultivation and conservation of SC can be classified under two broad headings that is in-situ and ex-situ. Various techniques which can be used under these broad heading are enumerated in Table 1 below.

Table 1: Methods of Cultivation and Conservation of swertia chirayita.

In-situ	Ex-situ
Good agriculture and collection process	Nursery technique
Wild nursery	Micro-propagation/ Biotechnology
Natural reserve	Natural alternative habitat
	Seed banks

DISCUSSION

For conservation of SC and to prevent its extinction, efforts are required via multi model approach by all the stake holders involved in its harvesting, cultivation, processing and use. In the following paragraphs we will be discussing various methods of Cultivation and Conservation of SC in brief.

Good Agriculture and Collection process (GACP)

WHO developed the Guidelines on good agricultural and collection practices (GACP) for medicinal plants, providing general technical guidance on obtaining medicinal plant materials of good quality for the sustainable production of herbal products classified as medicines.[3] With respect to SC we have to develop and provide guidelines and training on GACP to the inhabitants dwelling near the natural habitat of SC and those who depend their livelihood for sustainable harvest. Already National Medicinal Plants Board (NMPB) is playing an active role in this aspect via Central Sector Scheme on Conservation, Development and Sustainable Management of Medicinal Plants, however it requires more concerted effort at the ground level.

Wild nursery

It is a lucrative and economical option in which reintroduction of the species to its natural habitat is done which will strengthen the efforts on recovery of the species in the areas which have faced extinction risk. The cultivation will help maintain its balance in nature as well as provide sustainable income to the farmers.

Natural reserve

This is the clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem. With respect to SC, development of such reserves having minimum human interference and close monitoring will ensure better growth and regeneration of this herb in its natural habitat.

Nursery technique/ Agro-techniques

This is the one of the important techniques because it permits us to cultivate plant even in its non-natural habitat with rapid propagation. The first step in this technique involves raising planting stock in nursery in the month of July till September through stem and root cuttings with or without using root-promoting hormones. The next step involves Planting in field with soil enriched with FYM (farmyard manure) in the month of August and September. Minimum two-and-a-half years is required for root maturity. Harvest Management: Harvesting may be done in December and January. Careful harvesting of root in the month of December and January, leave some part of root in the ground for regeneration. And the harvested roots are washed, dried in shade, and stored in moisture-free pack in cool and dry places.

Micropropagation/Biotechnology

Micropropagation is the artificial process of producing plants vegetatively through tissue culture or cell culture techniques. This is a multistage process consisting of preparatory stage in which explant is collected followed by its surface disinfection and culture media preparations. The stages following this are summarized in Table 2 below.[4]

Table 2: Steps of micropropagation.

Stage	Nomenclature	Description
I	Establishment of axenic cultures	Introduction of the surface disinfected explants into culture, followed by initiation of shoot growth.
II	Multiplication	Shoot proliferation and multiple shoot production.
III	Root formation	Shoot elongation and rooting.
IV	Acclimatization	Transfer of regenerated plants to soil under natural environmental conditions

Various advantages of micropropagation as compared to conventional agricultural techniques is its enhanced multiplication rate, easy storage and transportation of small-sized propagules, maintenance of genetic uniformity of the propagules, and more over the technique is season

independent. Different micropropagation tissue culture techniques have been used with respect to SC including regeneration, direct shoot regeneration, somatic embryogenesis, axillary multiplication, direct shoot multiplication, shoot organogenesis and callus culture.

Synthetic seed technology

Synthetic seeds are artificially encapsulated plant propagation material, along with artificial nutrient and growth hormones, which can be somatic embryos, shoot buds, cell aggregates, or any other tissue that we can use as a seed for propagation. It primarily involves encapsulating somatic embryos in a protective coating. These seeds have the potential to develop into a whole plant in vitro as well as in ex vitro conditions and retain this potential even after storage. This technique offers various advantages including capability for long term storage and maintenance of genetic and clonal identity of new plant. Also, this technique is useful and economical method for mass cultivation.[5]

Hairy root technology

Many plants' secondary metabolites are in roots, but harvesting of these organs is destructive. A molecular mechanism of hairy root development, is based on the transfer of Agrobacterium rhizogenes T-DNA into the plant genome, which result in production of pharmaceutical lead compounds. Attempts have been made to standardize A. rhizogenes transformed root cultures for production of active secondary metabolites under in vitro conditions of SC.[6]

Natural alternative habitat

Nursery technique can be used to introduce wild SC in alternative habitat. Studies show that ex-situ cultivated SC at an altitude of 800 ± 10 m above msl in tropical hills of Sikkim Himalayan region is feasible.[7]

Circa-situm conservation

Circa-situm conservation falls between in-situ and ex-situ conservation methods. This includes the deliberate encouragement and the retention of SC in and around the agricultural field or the home gardens during the land clearing or weed removal process for agricultural purpose or the gardening purposes. Such type of conservation practices can also be encouraged along or near to the road side, where SC was found to be growing well.[8]

CONCLUSION

Due to multiple uses of SC the demand in both national and international markets is constantly on the rise. Over exploitation combined with habitat destruction has resulted in the drastic reduction of its population. For the successful commercialization of this critically endangered medicinal plant any proposed research must be viewed in a wider context that includes conservation practices and sustainable supply of raw plants. This will require innovative tools, which utilize biotechnological interventions, including micropropagation, cryopreservation, and synthetic seed technology for raising commercial production. Additionally, in the near future, hairy root technology can be used as a model system and will also provide plant biotechnologists with powerful tools to improve the valuable phytochemicals of SC.

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