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A probe into biochemical potential of *Aconitum violaceum*: A medicinal plant from Himalaya

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ABSTRACT

Aconitum violaceum Jacq. ex Stapf belonging to family Ranunculaceae is an important medicinal plant of Himalaya regions. Its medicinal potential is due to the presence of pharmacologically active compounds such as At, aconitine, benzoic acid, aconine and flavanoids. This plant has notable antioxidant, anti-inflammatory and analgesic properties. Traditionally, this plant is used for the treatment of asthma, cough, neural disorders, cardiac diseases as well as for curing sciatica and joint pain. Due to remarkable medicinal values and commercialization, this plant is threatened and it is at high risk of extinction. Conservation practices and management techniques should be carried out to protect this important plant from extinction. Recent biotechnological approaches will be quite helpful for its conservation.

1. Introduction

From the ancient times, the people are relying on medicinal plants for curing their ailments. History of medicinal plants is as far old as human history. From centuries, the history of pharmacy and pharmacognosy is interlinked. Herbal drugs are utilized worldwide for the treatment of wide range of diseases, so medicinal plants play crucial role in world health. Despite of great advancement in modern medicines, people are still dependent on plants for health care. It is approximated that almost 25% of entire modern medicines are directly or indirectly derived from plants. Medicinal plants show distribution worldwide but they are more abundant in tropics. According to World Health Organization, 60%–80% population of developing countries depend on plants for their primary health care. From the last decades, the use of medicinal plants becomes so popular that many important plants are at risk of extinction due to over exploitation. Genus *Aconitum* of family Ranunculaceae has numerous pharmacologically vital groups of flowering plants. These species are rich in the alpine territory of Central Himalaya portrayed to the incidence of almost 90 species. The *Aconitum*

plants are distributed broadly all over the temperate alpine regions of world. *Aconitum violaceum* Jacq. ex Stapf (*A. violaceum*) is an ethnomedicinally important plant of Himalaya region. It has tremendous medicinal potential because of the presence of several alkaloids and flavonoids. Due to overexploitation, this plant is facing extinction issue. It is declared as threatened plant species[1–4].

2. Habitat/distribution

A. violaceum is called as violet monkshood in English and it is also known as “Mithatelia”, “Telikachnag” and “Tilla” in Hindi. This plant shows wide distribution on alpine pastures of Central Himalaya. This species grows in rhododendron forest margins, glacial riverine forest periphery and rocky moist areas, open grassy alpine slopes, shady moist alpine slopes, alpine dry scrub, moist rocks, *Quercus-Abies* forest borders and coupled with *Carex nubigena-Kobresia duthiei* communities. It grows on slopes in an altitude range of 3600–4800 m. It has a generation length of one year[5]

3. Taxonomic description

A. violaceum belongs to kingdom Plantae, division Tracheophyta, order Ranunculales and family Ranunculaceae. It is a small perennial herb and its geminate tubers with 1–1.5 m in height which bears dense spike of many dark or pale blue flowers (Figure 1).

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Stem (height of 10–30 cm), is glabrous (hairy) and lower at erect portion. Leaves with long petioles are present in form of a dense cluster near the base and hardly ever spread over the whole length, acute or sub-obtuse tip, glabrous. Size of upper leaves is much reduced. Inflorescence is dense and raceme is simple. Sepals are pubescent, violet, rarely blue or yellowish-green with blue veins. Petals (nectaries) are hairy with truncate recurved lips and hood is gibbous dorsally. Filaments are hairy in the upper but winged in the lower part and these wings end in tiny teeth[6].



Figure 1. Floral representation of plant[7].

4. Active constituents

A. violaceum contains tisane and indaconitine. Both can be simply differentiated from each other. It also contains diterpenes, flavonoids, fatty acids, aconitine, indaconitine and polysaccharide such as starch. The medicinal properties of this plant are attributed due to the presence of aconine, benzoic acid, sparteine, tannins and resins. The roots contain 4.3% indaconitine, aconitic acid and starch[3,8].

5. Biotechnological approach

Modern biotechnological techniques have been used to evaluate the effects of different growth regulators on indirect shoot organogenesis as well as different secondary metabolite production in *A. violaceum*. Callus culture and column chromatography are utilized for this purpose. Plant growth regulators such as 2.5 $\mu\text{mol/L}$ 2, 4-dichlorophenoxyacetic acid (2,4-D) and 0.25 $\mu\text{mol/L}$ kinetin enhance the frequency of callus production for indirect regeneration. 6-Benzyl aminopurine revealed significant effects promoting shoot regeneration and an important secondary metabolite production. Cytokines are growth factor and they also show concentration-dependent effects of secondary metabolite production. Moreover, auxin-cytokine interactions also enhance indirect shoot regeneration and the fabrication of secondary metabolites[9].

6. Medicinal uses

Different ethnic groups such as Darmese, Martolia and Bhotias and Johares of Himalayan region utilize *Aconitum* species for the treatment of asthma, neurological disorders, cough and inflammatory and cardiac diseases. Many species of *Aconitum* which are native to Europe subcontinent have been potentially utilized to cure neuralgia, antiulcer, gout, rheumatism and cardiac failures. *A. violaceum* has affluent secondary metabolites bestowed with fascinating biological activities due to the presence of C19 and C20 diterpenoid, alkaloid, flavonol, kaempferol, acylated flavonol glycosides and glycosides of

quercetin[4]. Crude extracts of underground parts of the plant acquire analgesic and antipyretic properties and are traditionally reported to cure renal pain, high fever, rheumatism, wounds, boils and edema. Due to antiseptic properties, this plant is quite useful in the treatment of scorpion and snake bites.

The plant extract has potential to cure digestive disorders including inflammation of the intestines, contagious infections and disorders of gall bladder as well. Tubers of the plant contain aconitine, which is a neurotoxin, so this plant is helpful in improving brain function and can cure many neurological disorders. Plant tubers are moreover used for the treatment of tonsillitis as well as sore throat, debility and gastritis because these are anti-inflammatory and anti-oxidative. Anti-proliferative activity of this plant has also been reported because of its alkaloids against human tumor cell lines, colon and ovarian adenocarcinoma. Half tea spoon root extract twice a day acts as tonic, used to treat fever and also for the treatment of cardiac diseases. Root powder is used in relieving sciatic pain because it possesses analgesic properties[4,6,7,10].

7. Ethnobotanical uses

In Kohistan Valley, Pakistan, this plant is locally called as “Zaharmora”. Pills are made by mixing root powder and mother milk, and given to infants to treat cold, cough and stomach-ache by local people of Kohistan[2]. This plant is locally called as “Mohand” in “Kashmir”. In Kashmir Himalaya, the flower petals are dried, crushed and mixed with sugar. This mixture is then kept in air tight jars for almost 10–15 days for fermentation process. The resultant fermented mixture is locally called as “Khambir” which is used for the treatment of cough, fever, cold, stomach and liver disorders. Small root pieces are chewed for 1 min to relieve tooth-ache and also prevent tooth cavity. Root powder is mixed with oil and a paste is formed which is applied to treat painful joints and boils[11].

8. Toxic effects

Wild consumption of this plant leads to toxic effects due to misidentification, adulteration, miss-processing and contamination. Toxic symptoms appear rapidly within 20 to 30 min. The fingers and toes occur itchy or burning sensation followed by chills and sweats. Large quantity consumption causes paresthesia (feeling of dryness and roughness in the mouth), lack of the sensation and feeling of intense cold, colicky diarrhea, cardiac rhythm disturbances, violent vomiting, skeletal muscle paralysis and severe pain. Ventricular arrhythmias and cardiovascular collapses are the major causes of death in aconite poisoning. In Rasa Vagbhata, eight stages called “Asta-vegas” of aconite poisoning are reported. Changes in skin color followed by tremor, burning sensation on entire body, bubbles from mouth, vikratavastha, drooping of shoulders, comatose and finally death. Nevertheless, *Aconitum* toxicity can be diminished by using diverse techniques before using it for pharmacological aspects. Novel techniques and approaches should be employed for toxicological and chemical scrutiny to improve its safety as well as quality[12].

9. Conservation and management

A. violaceum is much harvested because of its tubers. Unfortunately, it has been inferred as well as observed that the inclination of unsustainable collection practice is continuing. Inference is drawn by observing the decline in area of occupancy as well as habitat quality based on studies and circumstantial evidence.

This plant species has a substantial market demand owing to its commercial use as a plant drug that's why the level of its exploitation is quite high. It was collectively agreed by experts that more than 40% of the wild population in the Indian region had declined over the previous 10 years. This species was assessed as vulnerable in conservation assessment and management prioritization workshop at Shimla in 2003. This plant is endemic to Himalayan region of Northern Pakistan to Jammu and Kashmir, Himachal Pradesh in India and extending up to Nepal. The preponderance of the wild population is in Indian Himalaya.

The current situation of species in India is judged as representative of the worldwide population of the species. This particular plant species is threatened as a result of habitat loss and over exploitation. It needs instantaneous consideration in terms of managing its habitat as well as sustainable collection practices. Active *in situ* conservation should be in these areas, where some of the subpopulations are present. Monitoring and surveying need right through the known historic range of the taxon to determine the conditions of all recorded subpopulations. Intensive studies on population trend, propagation techniques and reproductive biology must be carried out to sustain conservation action programs. In earlier times, this plant was used to prepare herbal formulations by local people in minute quantities. Now, commercialization of plant-based drugs in recent years has boosted the demand and consequential exploitation of this plant.

The unrestrained collection and lack of organized cultivation lead to the immense depletion of natural germplasm of this medicinally important plant species. Consequently, modern biotechnological techniques must be adopted to protect this natural germplasm from extinction to fulfill the rising demand of the plant material. *In vitro* propagation techniques have contributed notably to the progress of pharmaceutical industry over the past decades in a number of ways including varietal expansion. The utilization of *in vitro* techniques for rapid mass propagation plays a key role in recovery of endangered species, in consequence overcoming the threat of extinction[13]. Another technique of conservation is cryo-storage or normal storage of important plant species under *in vitro* condition to preserve germplasm. Another common technique of *in vitro* storage is the utilization of alginate encapsulation of explants to produce synthetic seeds[14,15].

10. Conclusion

A. violaceum shows wide distribution on alpine pastures of Central Himalaya. In traditional medicine system, this plant is used for curing many diseases such as cough, cardiac diseases, neural disorders, neuralgia, articular pain, gout, rheumatism and cardiac failure as well. Mostly root and tubers of the plant are medicinally utilized in herbal formulations. Active constituents of this plant include atisine, indaconitin, aconitine, indaconitine, flavonoids, starch, sparteine, tannins, resins, benzoic acid and aconitic acid. Wild consumption of this plant leads to toxic effects due to misidentification, adulteration, miss-processing and contamination. Toxic symptoms appear rapidly within 20 to 30 min. Due to over exploitation, this plant is facing risk of extinction. Modern biotechnology techniques such as cryo-storage and freezing of entire plant and synthetic seeds can play important role in protection, management and conservation of this plant.

As it is endemic to a geographically limited part of the Himalayas so habitat management practices is also adopted for the conservation of this precious plant.

Conflict of interest statement

We declare that we have no conflict of interest.

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