REVIEW ARTICLES

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- Morphology, chemical composition, and biological activities 2
- of Aconitum balfourii: a comprehensive review of important Himalayan 3
- and highly exploited medicinal plant 4

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9 Abstract

10 The Himalayan region of India, known for its rich biodiversity, includes numerous medicinal plants such as Aconitum balfourii Stapf. This review critically examines A. balfourii, focusing on its classification, distribution, medicinal significance, AO1 12 and the pressing need for conservation. A comprehensive literature review was conducted using databases like PubMed, 13 Google Scholar, and Web of Science. Studies on the taxonomy, geographical distribution, medicinal applications, and 14 conservation status of A. balfourii were included, incorporating both in vitro and in vivo research, as well as ethnobotanical AQ2 and conservation studies. Predominantly found in Uttarakhand, A. balfourii contains key alkaloids such as pseudoaconitine, 16 aconitine, picroaconitine, haemonepellene, and benzylaconitine. These compounds exhibit diverse pharmacological activities, 17 including antioxidant, anti-inflammatory, analgesic, cardiotonic, and vermifuge properties. Despite its medicinal potential, A. 18 balfourii is declining due to overexploitation, climate change, and insufficient regeneration rates. Traditionally, A. balfourii 19 has been used to treat fever, swelling, sciatica, rheumatic pain, neuralgia, and other ailments. Recent research has identified 20 new norditerpenoid alkaloids, expanding their pharmacological profile. Studies on the plant's adaptability to different altitudes 21 and elevated CO_2 levels highlight its growth and secondary metabolite production. Micropropagation techniques and efficient 22 DNA isolation protocols have been developed to preserve its genetic diversity. This review underscores the necessity for 23 both in-situ and ex-situ conservation strategies for A. balfourii. Coordinated efforts among governmental bodies, research 24 institutions, and local communities are vital for its sustainable use and long-term preservation. Enhancing awareness of its 25 medicinal value and ecological significance is essential to ensure its conservation, thereby supporting the biodiversity of the 26 Himalayan region and traditional medicinal practices.

27 **Keywords** Alkaloids · Agrotechniques · Conservation strategies · Medicinal properties · Phytochemicals

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Introduction

India boasts an extensive and diverse natural biodiversity, home to many medicinal plants crucial for ecological balance and human health (Chandra et al. 2021). This biodiversity is notably concentrated in the Himalayan region, particularly in Jammu and Kashmir, Himachal Pradesh, and Uttarakhand, known for their abundant flora (Chandra et al. 2021). Uttarakhand, nestled within the Himalayas, stands out for its remarkable plant diversity, especially those with medicinal properties. Among the globally identified 300 species of Aconitum, 33 are found in the vast Himalayan region of India (Gowthami et al. 2021). A. balfourii Stapf, one of these species, holds special importance as a highly prized medicinal herb renowned for

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