



Aconitum heterophyllum-An Overview

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aconitum heterophyllum also known as aruna, family Ranunculaceae is used in ayurvedic formulations for the treatment of diarrhoea, hepatic issues etc. The phytochemicals in this plant consists of alkaloids, proteins, carbohydrates, saponins, amino acids, quinones, flavonoids, glycosides, terpenoids, etc. In the present paper, not only are the various therapeutic properties of this plant has been discussed but the profiling of its toxicological studies done on rats have also been elaborated upon. Unlike other species of *Aconitum*, *Aconitum heterophyllum* has shown beneficial activity on a rat model of toxicity. Firstly, the ethanolic extract of the plant was evaluated for its oral toxicity but it came out be safe. The ethanolic extract of the plant reversed the activity of castor oil. Moreover, this plant has shown good anti-bacterial activity. After summing up of all the pharmaceutical features of this plant, it could turn out to be valuable source of knowledge for the academia, practioners of traditional medicines & for the pharma industry.

Keywords: *Aconitum heterophyllum*; anti-bacterial role; castor oil; phytomolecules; rats; toxicity.

1. INTRODUCTION

Ayurveda is one of the ancient traditional medical systems of India & *Aconitum heterophyllum* is being used in many ayurvedic formulations till

date. Moreover, many species of *Aconitum* is being used in various traditional medicines of the nations of East Asia and the Himalayan nations. This plant in Sanskrit is known as aruna, in Urdu as atees & in Hindi as atis. *Aconitum*

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heterophyllum is from the kingdom plantae, division 'Magnoliophyta', family Ranunculaceae, genus Aconitum & species is Heterophyllum (Table 1). The tuberous roots of this plant are used for its various roles such as antidiarrheal, hepatoprotective etc [1,2].

Table 1. Botanical taxonomy regarding *Aconitum heterophyllum*; It's a widely used medicinal plant in Ayurvedic & the traditional Chinese medicines [1]

Botanical name	<i>Aconitum heterophyllum</i>
Family	Ranunculaceae
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Ranunculales
Genus	Aconitum

Aconitum heterophyllum is the most extensively used of the 76 species of the Aconitum genus used for medicinal reasons, with *Aconitum heterophyllum* being the most widely used plant [3]. The main and lateral roots of *Aconitum heterophyllum* are used in traditional medicine under the names "Chuanwu" and "Fuzi" (also known as "Bushu" in Japan), with Fuzi being favored in most formulations [4]. Collapse, rheumatic fever, aching joints, gastroenteritis, diarrhea, bronchial asthma, and edema are among the medicinal problems for which *Aconitum heterophyllum* root extract is used. Several kinds of neuropathic pain have been found to be relieved by Kampo medication formulations including "Bushu" [5][6].

The accumulation of a diverse range of bioactive C20-, C19-, and C18-type diterpene alkaloids, which can be broadly classified into three types: diester-diterpene alkaloids, monoester-diterpene alkaloids, and unesterified diterpene alkaloids, is thought to be responsible for *Aconitum heterophyllum*'s pharmacological properties. The bulk of the C19-type diterpene alkaloid skeletons, which make up the majority of *Aconitum heterophyllum* alkaloids, are produced from various aconitine skeleton replacements, yielding a total of 76 distinct alkaloids [7][8].

In Fig. 1, an image of this plant has been illustrated. This plant is found in the upper Himalayas. As many species of the plant has toxic properties hence one has to be careful while using this plant. The main objective of this review is to elaborate upon the medicinal role of this plant. For this purpose, the description of the

plant *Aconitum heterophyllum* has been elaborated that includes, the taxonomic classification of the plant, the morphological description of the *Aconitum heterophyllum* as in Table 2 and Table 3, the mode of cultivation of *Aconitum heterophyllum*, the pharmaceutical roles of *Aconitum heterophyllum* as detailed in Table 4, Amelioration of Castor Oil-Induced Diarrhoea by administration of *Aconitum heterophyllum*, Amelioration of Castor Oil-Induced Intestinal Fluid Accumulation by administration of *Aconitum heterophyllum*, Evaluation of the Antibacterial role of the Ethanolic extract of *Aconitum heterophyllum*. The objective of providing the entire gamut of the classification till the Anti-bacteria role of *Aconitum heterophyllum* is to ensure awareness of this plant that maybe used for treatment of myriad medical issues.



Fig. 1. Image of the plant *Aconitum heterophyllum*. It is used in many Asian traditional medicine preparation; It belongs to the family Ranunculaceae Figure courtesy [1]

2. DESCRIPTION

Aconitum heterophyllum's tapering roots have grey colour, 7 cm in length & width at 1.5 cm. It's a small plant having a straight, simple, branched and green coloured stem having a height of 20 cm. It bears flowers of yellow/blue colours starting from the months of August till September. The leaves have dark green colour with upper regions having aamplexicaul structure & the lower parts are petioler [9][10]. This plant is arranged spirally with the macroscopic & the microscopic features are tabulated in Tables 2 & 3.

2.1 Cultivation

Aconitum heterophyllum is grown in the upper Himalayan regions having moist soil & moderate rainfall. This plant is either germinated from the seeds or from the tuberous roots from March till

April. In the autumn, 2 daughter tuberous roots are collected when the shoots have undergone senescence, only to be replanted in the spring season. The newly germinated plant shows leafy growth in the 1st year with the blooming of flowers occurring in the 2nd year of growth [11].

Table 2. Morphological features of *Aconitum heterophyllum*; It's a short plant with dark green leaves and tapering roots [1]

Stems	Simply branched Height is 30 cm Colour is green Short heighted plant having straight stem Branches may occur
Leaves	Dark green heteromorphous Amplexicaulad upper parts Petiolated lowest parts
Roots	5 cm in length Paired Tapering at end

Table 3. Microscopic features regarding *Aconitum heterophyllum*. Root section shows cells with thin walls [1]

Mature roots' transverse section	
Roots	Tabular brown cells Tangentially elongated cells with thin walls Cork cambium Parenchymatous cells having thin walls

2.2 Pharmaceutical Roles of *A. heterophyllum*

Aconitum heterophyllum when taken up with ginger powder, nutmeg &/bel has been reported to have antidiarrheal role. This plant acts as an expectorant upon mixing its root's juice with milk with its seeds acting as a diuretic. Moreover, this plant has pro-fertility roles and has hepatoprotective, analgesic roles among others. *Aconitum heterophyllum*'s phytochemicals have been identified by the use of a high-performance liquid chromatography coupled to an ultraviolet-photodiode array detector (HPLC-UV-DAD) assay. Heights of peaks were found to be linear with respect to the concentration of aconite. This assay is not only rapid but also reproducible leading to the concentration based detection of aconitine, hypaconitine, mesaconitine, benzoylmesaconine, benzoylaconine & benzoylaconine. The medicinal uses of various *Aconitum* species have been tabulated in Table 4

[12][7]. These phyto-molecules with their chemical names have been tabulated in Table 5 & 6. In Fig. 2 & Fig. 3 various phyto-molecules of this plant has been illustrated.

It can be used for identifying which species of this genera is useful for which disease & the chemical structures of the phyto-molecules could be used for developing various lead agents.

Table 4. Medicinal uses of different *Aconitum* species; Most of species of this genera are poisonous [6]

Species of Plant	Uses in traditional pharmaceutical formulations
<i>Aconitum heterophyllum</i>	Dyspepsia, cough
<i>Aconitum kirinense</i>	Rheumatoid disease
<i>Aconitum bulleyanum</i>	Rashes, Snake bite
<i>Aconitum orochryseum</i>	Snake bite, dysentery
<i>Aconitum carmichaeli</i>	Diuretics, analgesic
<i>Fuzi</i>	Traditional east Asian medicines
<i>Aconitum brachypodium</i>	Analgesic

2.3 Evaluation of Oral Toxicity of *Aconitum heterophyllum*

Aconitum heterophyllum's ethanolic extract (EAH) was observed for its acute oral toxicity for 48 h and observed for any neurological & behavioural deviations. However no toxicity for the amount of 2g/Kg was observed. Rats grouped in group 1 were fed with carboxy methyl cellulose (CMC), group 2 were fed with the ethanolic extract of *Aconitum heterophyllum* (EAH) at 50 mg/kg with CMC, group 3 were fed with the ethanolic extract of *Aconitum heterophyllum* (EAH) at 100 mg/kg with CMC, group 4 were fed with the ethanolic extract of *Aconitum heterophyllum* (EAH) at 200 mg/kg with CMC, group 5 were fed with loperamide. The faecal pellets excreted out by the rats from the 1st to the 7th hours were collected, weighed, and were dried for 24 hours at 40°C to obtain the wet: dry proportion. The rats fed with EAH showed progressive inhibition of faecal extraction with loperamide completely stopping it [7].

This property of this plant thereby prompts a belief that diarrhoeal diseases can be reversed following treatment by this plant.

2.4 Amelioration of Castor Oil-Induced Diarrhoea

Rats fasted for about 18 hours were divided into group 1 fed with CMC, group 2 were fed with CMC & castor oil, group 2 were fed with EAH 50 & castor oil, group 2 were fed with EAH 100 & castor oil, group 3 were fed with EAH 200 & castor oil, group 6 were fed with loperamide [7][14].

Table 5. Various phytomolecules isolated from *Aconitum heterophyllum*. These phytomolecules are responsible for its therapeutic activities [13]

Class	Leaf	Stem	Root
Alkaloids	+	+	+
Carbohydrates	+	+	+
Amino acids & Proteins	+	+	+
Saponins	+	+	+
Glycosides	+	+	+
Quinones	-	+	+
Flavonoids	+	+	+
Terpenoids	-	+	+

This property of this plant thereby prompts a belief that diarrhoea can be reversed following treatment by this plant.

2.5 Amelioration of Castor Oil-Induced Intestinal Fluid Accumulation

Rats were fasted for 18 hours and were divided into group 1 fed with CMC, group 2 fed with only castor oil, group 3 fed with EAH 100 mg/Kg with castor oil and group was fed with loperamide with castor oil. After sacrifice, the intestinal fluid was collected & ions were detected. Castor oil induced a loss of sodium & potassium ions which was greatly inhibited by the action of EAH 100. Upon sole feeding with castor oil there was an increase in nitric oxide (NO) production & loss of carbohydrates which were greatly inhibited & reversed by EAH 100. Upon feeding with EAH 100, the levels of DNA & total protein showed increase along with recovery in the levels of liver functional enzymes like catalase (CAT), superoxide dismutase (SOD) & lipid peroxidation, determined by measurement of the thiobarbituric acid reactive substances (TBARS) [7] [15].

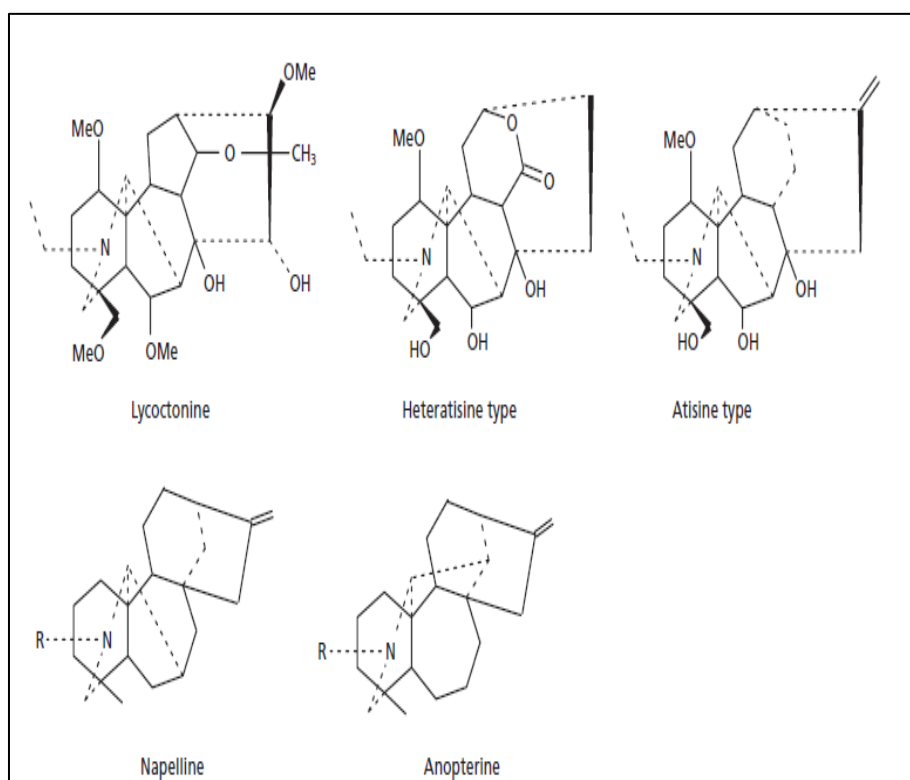


Fig. 2. Chemical structures of some of the phytomolecules isolated from *Aconitum heterophyllum*. They are Lycoctonine, Heteratisine type, Atisine type, Napelline & Anopterine
Figure courtesy [3]

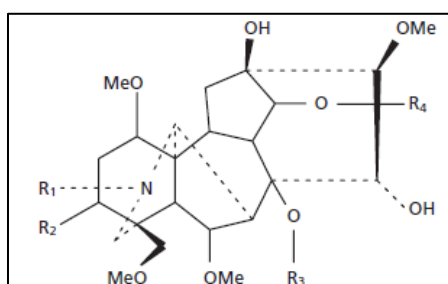


Fig. 3. Chemical structure of Aconitum. The genera Aconitum is derived from this alkaloid, Aconitum. The alkaloid Aconitum has been blamed for inducing cardiac tachycardia Figure courtesy [3]

Table 6. Phytochemical composition of *Aconitum heterophyllum*. Knowing the chemical structures of these compounds would help in designing of effective lead agents [7]

Chemical composition
12-secohetisan-2-ol
N-succinoylanthranilate
Atesinol 6-benzoylheterastine
N-diethyl-N-formyllaconitine
Methyl aconitine
Aconitine
Anthorine

This property of this plant thereby prompts a belief that loss of nutrients following an onset of diarrhoea can be reversed following treatment by this plant.

2.6 Evaluation of the Antibacterial role of the EAH

A variety of bacteria were cultured on standard bacterial culture medium and EAH was treated which showed greater inhibition towards gram +ve bacteria compared to the gram -ve bacteria. The Minimum Inhibitory Concentration (MIC) in milligram/millilitre (mg/ml) was lowest for *B.cereus* and showed nil activity for *E. faecalis*. This indicates that *Aconitum heterophyllum* can be utilized for developing anti-bacterial agents [7].

3. CONCLUSION

Aconitum heterophyllum is being used in ayurvedic formulations & other traditional systems of medicines for the treatment of diarrhoea, hepatic issues etc. This plant is mainly grown in the Himalayas & is known for its toxicity. The phytochemicals responsible for this toxicity is owing to alkaloids, proteins, carbohydrates, saponins, amino acids, quinones, flavonoids, glycosides, terpenoids, etc. In the present paper,

not only are the various therapeutic properties of this plant has been discussed but the profiling of its toxicological studies done on rats have also been elaborated upon. Unlike other species of Aconitum, *Aconitum heterophyllum* has shown beneficial activity on a rat model of toxicity.

Firstly, the oral toxicity was evaluated for its ethanolic extract of this plant however it showed no toxicity. The castor oil induced diarrhoea was reversed by administration of the ethanolic extract of the plant. Also, this plant has shown good anti-bacterial activity. After summing up of all the pharmaceutical features of this plant, it could turn out to be valuable source of knowledge for the academia, practioners of traditional medicines & for the pharma industry.

3.1 Future Scope of Work Regarding *Aconitum heterophyllum*

The study highlights the efficacy of *Aconitum heterophyllum* that is an important plant used in the ayurvedic system of medicine that is considered as a traditional system of medicine in India. This ancient concept should be carefully evaluated in the light of modern medical science and can be utilized partially if found suitable. The modern methods of molecular sequencing of the genes responsible for the pathway involved in biosynthesis of the chemical constituents of the *Aconitum heterophyllum* and the bulk production of the same via bioprocess technology may help in further utilization of the medicinal properties of *Aconitum heterophyllum*.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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