

Aconite Poisoning and its Status in India

Jasmine Kaur

How to cite this article:

Jasmine Kaur. Aconite Poisoning and Its Status in India. International Journal of Forensic Science. 2020;3(2):123–127.

Abstract

Aconites are the species under genus *Aconitum*. Though almost all these species are poisonous, *Aconitum ferox* (Indian *Aconitum*) is much more dangerous as compared to others and that is why also known as king of poisons. Despite their poisonous nature, some of them are being used in herbal medicines for the effective treatment of cold, fever, asthma, migraine, glaucoma, malaria, rheumatism, cut wounds, agitation, sweating, dysentery, alzheimer disease etc., after truncating their toxicity either through domestic decoction procedure or by soaking and boiling process. The poisonous nature of aconites is attributed to the presence of alkaloids mainly, aconitine in them. Higher levels of lethal alkaloids in roots make them highly poisonous. These alkaloids mainly affects the cardiovascular and nervous system as well as gastrointestinal tract causing symptoms like Paresthesia, numbness, hypotension, chest pain, sinus tachycardia, ventricular fibrillation, vomiting and palpitations. The least probability of getting detected makes aconite an imperative poison to forensics because the nature of metabolites produced by them is quite similar to those produced by human body. The current review provides a detailed description of biological and toxicological facets of various constituents of aconite, their detection in forensic and difficulties encountered in their detection.

Keywords: Aconite; Toxicity; Alkaloid; Forensic; Aconitine.

Introduction

Aconites are one of the most poisonous perennial herbs of the world and these species comes under genus *Aconitum* that belongs to family Ranunculaceae. These are also known as Monkshood, Wolf's bane, Leopard's bane, bikh, bish, nabe, dudhia, mithazahar, Women's bane, Devil's helmet, Friar's cap, Auld wife's huid or Blue rocket and is often marketed as 'Kiddie calmer'. Aconite is named as 'Ativisa' in old Hindu medicines.¹ In the Indian markets, it is being sold as 'Vatsanabha' or 'Vishu' which is a mixture of eight species of *Aconitum*.² *Aconitum Ferox* (Indian *Aconitum*) which is also known as 'king of poisons' is much more hazardous as compared to *Aconitum napellus* (European *Aconitum*). All the names

mentioned above have similar meanings "a poison which neutralizes the effect of other poisons".³

This aconite plant is commonly known for its poisonous nature and medicinal use. Some species of *Aconitum* are used in Ayurveda, Homoeopathic and Allopathic medicines due to their narcotic and depressant properties. The aconite plant can be used both externally and internally as antipyretic, antiperiodic, diaphoretic, febrifuge, sudorific, anthelmintic, anti-cancer agent, anti-diabetic drug, diuretic, mental and physical tonic, anodyne in neuralgia and rheumatism, narcotic, cardiotoxic, etc., The aconite can be used to treat numerous major ailments including cold, fever, asthma, headaches, migraine, glaucoma, malaria, bronchitis, rheumatism, inflammation, intestinal diseases, cut wounds, agitation, sweating, a subjective feeling

Author's Affiliation: Student, Department of Forensic Science, Dyal Singh College, Kurukshetra University, Karnal 132001, Haryana, India.

Corresponding Author: Jasmine Kaur, Student, Department of Forensic Science, Dyal Singh College, Kurukshetra University, Karnal 132001, Haryana, India.

E-mail: kaurj6828@gmail.com

of difficulty in breathing indigestion, dysentery, diarrhea, snakebite, neuralgia, throat pain and alzheimer disease.⁴ Consumption of low doses of plant for several days can also ameliorate the abnormalities related to heart, kidney, and various other organs. Additionally, mixture of dried roots of aconite with Cannabis flowers is smoked by Aghori, tantric, Shaivites to establish drug-induced altered state of consciousness. Marketed products of aconite include powder, pellets, capsules, tablets, and liquids. Other minor uses include there usage as rodenticide, insecticide and cosmetics in form of creams and lotions. In Nepal, it is used for securing invasions by infecting water in the routes to preclude the illegal entries. It is also used to kill wild carnivorous animals by applying poison on the flesh of goats and sheep. Despite the fact that it can be absorbed through skin even on accidental contact, it is used as horticultural plants to adorn the aesthetic of a place because of its fascinating blue to dark purple flowers.

However, little excess of aconite can pose serious health problems, life-threatening heart rhythm changes; thus, may be fatal to the consumer. Also, its intentional or accidental ingestion may leads to multiple deaths and other fatal complications all across the globe. So, the main focus of current review is to provide a detailed description of biological and toxicological aspects of various constituents of aconite, their detection in forensics and difficulties encountered in their detection.⁴

About the Plant and its Major Constituents

Total twenty-four species of aconite are found in India. Out of them, thirteen possess considerable potency. John Stapf has classified Indian aconites on the basis of root's life span and internal/external phenotypes of the individual aconite species.³ Aconite has a bittersweet taste due to the presence of alkaloids which are its active and/or toxic constituents. The most hazardous alkaloid present in the aconite plant is aconitine and its abundance determines the severity of adverse effects. The most parts of aconite plant such as flowers, pollens, stem, and leaves contains aconitine but their levels is found to be highest in roots, making them highly poisonous. Additionally, other alkaloids such as mesaconitine, yunaconitine, jeaconitine, lappaconitine, hyaconitine, caffeine, nicotine, strychnine, etc. are also detected in aconite plant. Ingestion of wild plant produces severe cardio toxicity mainly due to aconitine. Moreover, hyaconitine also contributes in aconite toxicity

due to its neuromuscular transmission blocking activity. Further, other alkaloids present in the plant can also aggravate the condition of the body leading to death.⁵ Details on aconite poisoning are explained in further sections.

Detoxification of Aconite Plant

Before using aconite plant as medicine, it is vital to eliminate the toxic components of the plant. For the purpose, various processes such as domestic decoction, soaking or boiling are exploited which can mitigate the toxicity up to 90%. Historically, various other procedures have also been employed to detoxify the plant. For example, Hillmen used to preserve the aconite roots in cow's milk or urine for several days in an earthen pot. The solvent was replaced each day and the process was repeated 8 times for the same residues. On the eighth day, plant remains were washed with fresh water and placed in sunlight for dryness.³ Another process called 'Sodhna' involves boiling of the dried plant, where the toxins gets converted into nectar. This process should be carried out accurately so that only the desired alkaloids remain in the product. This detoxified product contains the alkaloids such as benzylaconine, benzylmesaconine, hyaconine, aconine, mesaconine, hyaconine derivatives, etc. Apart from the process of detoxification, the nature of the processed products is also affected by other factors such as species, environmental conditions, soil, etc.²

Pharmacological Aspects of Aconite

Mechanism of Action

The aconite acts through excitable tissues such as myocardium, nerves, and muscles where alkaloids target the voltage-sensitive sodium channels of the cell membranes. Specifically, aconitine has great tendency to bind the open state of sodium channels with high affinity leading to their activation, whose ramifications depolarize the sustained sodium influx that leads to inexcitability.⁶

Pharmacokinetics

The aconite can be administered by various routes such as topical, oral, subcutaneous or intramuscular. After absorption into the gastrointestinal tract, aconite undergoes metabolism by esterases and cytochrome P450 (CYP) enzymes resulting in the production of metabolites of alkaloids.

Additionally, carboxylesterases enzymes present in organelles like endoplasmic reticulum and cytosol of some tissues such as kidney, liver, etc., also hydrolyze the esters and amides bonds of alkaloids to generate their free acids.⁴ The resulting metabolites get poorly distributed in body, enabling detection of their trace levels in body fluids. Further, these metabolites get eliminated in urine. Thus, hydrolyzed and demethylated metabolites such as 16-O-demethylaconitine, 16-O-demethylhypoconitin, benzoylaconine, aconine, 16-O-demethylbenzoylaconine and 6-O-demethylaconine can be detected in urine. Body discharges from other organs such as kidney, liver, bile, and ileum also show the presence of such metabolites. The level of these metabolites reduces with time in blood as evident from their higher concentrations in the samples collected in initial hours and undetectable levels in samples taken after 1-2 days.^{5,6}

Toxicological Aspects of Aconite

Aconite poisoning: its signs and symptoms

The prevalence of aconite poisoning is highest in Asia, especially in India. However it is observed in many other parts of the world as well. It is the one of most common cause of herbal poisoning in Hong Kong. Few cases of aconite toxicity have also been reported in western countries due to consumption of the plant itself. Considering the incidences of aconite toxicities, some of its species such as *Aconitum chasmanthum*, are prevented from being available in the market in any form. In India also all species of *Aconitum* are named in the Negative List of Exports by the government of India.³

Aconite exerts its toxicological effects mainly by affecting the cardiovascular system, nervous system, and gastrointestinal tract. Initially, it stimulates and then paralysis the central nervous system. Common signs and symptoms of aconite poisoning include Paresthesia (feeling of pins and needle on the skin), numbness of various parts of the body, and cardiovascular and gastrointestinal complications such as hypotension, chest pain, palpitations, bradycardia, sinus tachycardia, ventricular ectopic, ventricular tachycardia, ventricular fibrillation, nausea, vomiting, arrhythmias, abdominal pain, diarrhea, burning sensation in mouth and tongue.⁵

Fatal dose

It is a fast-acting poison, with rapid onset of action. Symptoms usually occur within minutes to

few hours of swallowing. The fatal dose for pure aconitine, aconite tincture, and the wild plant is ascertained to be 2 mg, 5 ml, and 1 g, respectively. However, processed products show fatalities only when taken more than the recommended amount viz., 10 to 16 g. The half-life of aconitine varies among different individuals depending on route of administration, form, dose, health condition etc. Moreover, the severity of the poisoning gets increased with time of exposure.^{3,5}

Management of aconite poisoning

As there is no specific antidote for this poison, management of aconite poisoning is usually supportive and symptomatic. Doctors prefer to monitor blood pressure and pulse rate normalization. Atropine is generally used to control the bradycardia, while cardiac arrhythmias are managed by intravenous injection of 50 ml of 0.1 % Novocain, though digitalis or strophanthin can also be used. Anything that seems quite abnormal could pose a life-threatening problem and is thus given the required treatment. The primary causes of deaths are refractory ventricular arrhythmias and asystole for which antiarrhythmic drugs such as amiodarone and flecainide are preferably used as the first-line treatment for blocking sodium channels. Blood flow and oxygen supply can be maintained by percutaneous cardiopulmonary bypass in some patients according to their condition.⁵

Prevention of aconite poisoning

The severe effect of toxic herbs entails the need for awareness about their lethal action in the society. Do not use aconite unless prescribed. People who are fond of natural things and herbs are more prone to such poisoning and thus, there is a need for the awareness of its excessive use and effect. The inviolability of proper decoction before use must be acknowledged when recommendations are made for such herbs. The quality of products needs to be maintained to preclude the menace produced. The accreditation and registration for herbalists and other people involved should be mandated, from the prescription giving person to the supplier. Women who are pregnant and feed their babies are suggested to not use any product containing aconite residues.^{3,5}

Forensic Aspects of Aconite Poisoning

Examination

The diagnosis of aconite poisoning is suspected in cases where there is a history of consumption

of herbal medicines for some treatments or if the post mortem features resemble the cardio or neurotoxicity. Usually, the access to the plant or herbal residues that are left after decoction and biological samples are investigated. Written prescriptions of the doctor are also reviewed for the nature of specific plants involved and their recommended doses.⁵

Extraction

The poison from plant parts such as roots, leaves, etc., is generally extracted by direct solvent extraction method after properly drying and crushing them. While the extraction from food products (milk, cereals, etc.) and biological materials (visceral, stomach content), is usually carried out by either of three processes viz., Stas-Otto process, Ammonium sulphate method or miscellar method. The extraction from blood involves deproteinization extraction by Stas-Otto method or micellar method.⁷

Method of Detection of aconitine

Preliminary examination of aconitine (most toxic alkaloid of aconite) is done by color tests. The major tests are discussed below.

Palet's test in which a mixture of 2.5 g syrupy phosphoric acid and 1.5 g sodium molybdate is added to the acetic acid solution and warmed over a low flame. The appearance of violet color indicates the presence of aconitine. Another test is Alvarez reaction in which few drops of pure bromine are added to the extract placed in a porcelain dish. The mixture is then evaporated on a water bath to dryness. Then after, 2 ml of nitric acid is added and heated again to dryness; at this stage, yellow-colored oxidation product gets formed. To this, add 2 drops of sodium hydroxide solution saturated with alcohol and heat is provided to evaporate to dryness again. Red or brown color is obtained which is allowed to cool. In the last step, appearance of green color upon addition of few drops of 10% copper sulphate solution indicates the presence of alkaloids of aconitine.

The crystal test of aconitine involves usage of a reagent (gold chloride) which makes amorphous precipitate which on further addition of alcohol gives rectangular prisms or golden yellow needle-shaped crystals.

The identification of plant involves examination of its macroscopically and microscopically properties by using the latest testing equipments and techniques. It can also be identified by comparing

with reference by thin-layer chromatography, gas chromatography- selected ion monitoring, liquid chromatography-tandem mass spectroscopy (MS), IR and UV spectroscopy.

According to MS data, molecular weight for aconitine is 646 and eight peak indexes for aconitine identification is 105, 554, 540, 43, 45, 77, 31 and 29.

In UV spectrometry, within an aqueous acidic medium, aconitine shows maximum absorbance at wavelength of 234 and 275 nm.

In IR spectrometry, aconitine shows principle peaks at wave number (cm⁻¹) 1092, 1273, 1713, 1235, 710 and 1020 (KBr disk).

In gas-chromatography at conditions specified as follows: column- 5'X 1/8 8" (I.D.) stainless steel column packed with 60-80 mesh Chromosorb W; carrier gas- nitrogen at a flow rate of 30.7 ml/min; oven temperature - 230 °C; injector temperature- 30 degree above the oven temperature; detector- flame ionization, aconitine shows a retention time of 10.6 min.

Thin layer chromatography of aconitine performed using methanol: water (70:30) as solvent system and Dragendorff's reagent as the spraying reagent, results in orange/red or orange/brown color spot. The area around the spot is scraped out and put in a beaker containing acetone. The latter is allowed to be evaporated to dryness, then, one drop of 0.01 N hydrochloric acid and 2 drops of 5% sodium carbonate solution are added. Appearance of rosettes shaped crystals confirmed the presence of aconitine.⁷

Problems in detection of aconite poisoning

The least chances of detection make it an imperative poison to forensics because the nature of metabolites produced by them is similar to that produced by the human body, which gives the same chemical reactions. Further, with the decomposition of tissues, aconite undergoes chemical change which poses a predicament for the examination.⁷

Discussion of Types of Reported Cases of Aconite Poisoning in India

A 30-year female intentionally consumed dry woody roots with suicidal intent. The patient was anxious, puked twice and had a feeling of suffocation and restlessness. Based on the information provided by attendants and ectopics diagnosed, aconite poisoning was identified. Doctors were successful in the management, by providing cardiac care and she got discharged from the hospital after 5 days.⁸

A 66-year-old woman with no history of heart disease, suffering from osteoarthritis, was instructed to drink herbal aconite tea. After about one hour, she developed numbness on extremities and face, later followed by nausea, weakness, and pressure on the chest. Refractory ventricular tachycardia was found. She was treated for 4 hours with drugs and electrical shocks, after which normalization to heart rhythm was restored.⁹

A 21-year-old man who was a sufferer of anxiety got the aconite plant after reading the book. He grounded the roots for himself and made capsules of it with some dried material. He then swallowed one capsule daily for several months. One day he took three capsules to get more relief and then he got asleep. Later he awoke with painful symptoms and spent 48 days in hospital.¹⁰

An 81-year-old couple ate a salad of aconite herbs. After about half an hour the woman had severe vomiting and her husband collapsed. They both got treated for abnormal heart rhythms and other deviations.¹¹

A 39-year man was assassinated by his ex-lover in the UK who bought the poison 'Indian aconite' from India. This poison was laced in curry. His girlfriend also ate the same meal, but she survived after the clinched management by doctors.¹²

References

1. Chakravarti HL and Chakravarti D. Indian aconites. Springer on behalf of New York Botanical Garden Press 1954; 8:366-376.
2. Sarkar PK, Prajapati P and Chauhan MG. Pharmacognosy of aconite sold under the name Vatsanabha in Indian market. *Indian Journal of Traditional Knowledge* 2012; 11(4):685-696.
3. Selvam ABD. Indian Aconites: Boon or Bane? *Journal of Pharmacognosy and Natural Products* 2015; 1:104.
4. Chan TVK Aconite poisoning. *Clinical Toxicology* 2009; 47:4.
5. Puri HS. Uses of aconite. *Journal d'agriculture tropicale et de botanique appliquée* 1974; 21:7-9.
6. Friese J, Gleitz J, Gutser UK, Heubach JF et al. Aconitum sp. alkaloids: the modulation of voltage-dependent Na⁺ channels, toxicity and antinociceptive properties. *European Journal of Pharmacology* 1997; 337:165-174.
7. Directorate of Forensic Science, MHA <Govt. of India. Laboratory procedure manual- Forensic Toxicology.
8. Sharma M, Kumar S, Prashar A and Sharma A. Case Report: An interesting case of suicidal poisoning. *Online Journal of Health and Allied Sciences* 2010; 8(4):14.
9. Lowe L, Matteucci MJ, Schneir AB. Herbal aconite tea and refractory ventricular tachycardia. *New England Journal of Medicine* 2005; 353:14.
10. Moritz F, Compagnon P, Kaliszczak IG, Kaliszczak Y, Caliskan V, Girault C. Severe acute poisoning with homemade Aconitum napellus capsules: toxicokinetic and clinical data. *Clinical Toxicology (Phila)* 2005; 43:873-6.
11. Munnecom THC, Van Kraaij DJW, Van Westreenen JC. Case report: Arrhythmia a deux: A poisonous salad for two. *International Journal of Cardiology* 2005; 152:e37-e39.
12. Bonnici K, Stanworth D, Simmonds MSJ, Mukherjee E, Ferner RE. Flowers of evil. *Lancet* 2010; 376:1616.