

Pharmacological and toxicological insights into *Datura* spp. – A review

Pallavi Mishra¹, Rubal Lathwal², Sahil Sharma³

¹Department of Forensic Science , Chandigarh University

²Research Scholar , Department of Forensic Science , Chandigarh University

³Associate Professor , Department of Forensic Science , Chandigarh University

Email- ¹pallavimishra442002@gmail.com , ²rubal.r211@cumail.in , ³sahilsharma.uiahs@cumail.com

Abstract: *Datura* is well-known for both its poisonous qualities and its trumpet-shaped blossoms. Due to the strong alkaloids these plants contain—like atropine, scopolamine, and hyoscyamine—they are extremely toxic and dangerous to both people and animals if consumed. As part of the phytoremediation process, which helps purify contaminated areas, it absorbs heavy metals from the soil. Regarding pharmacological and toxicological activities, it is significant. However, the plant's toxicity outweighs any potential ecological benefits. Because *Datura*'s alkaloids have been used in criminal investigations, it is significant for forensics. Because of its unique chemical makeup, *Datura* can help identify poisoning cases and provide important evidence for forensic toxicology.

Keywords: *Datura*, toxic plants, phytoremediation, forensic toxicology.

Introduction:

Datura, is a wild weed from the Solanaceae family, gets its name from the Sanskrit word "Dhutra," meaning divine intoxication, and is renowned for its healing properties. This remarkable plant boasts over thirty alkaloids, each influencing its medicinal and toxic properties. *Daturainoxia*, *Daturametel*, *Daturastramonium*, and *Daturawrightii* are some of the well known species that are grown as ornamental plants, known for their unique funnel-shaped and fragrant flowers that bloom at night. Fascinatingly, the Navajo tribe traditionally used dried *Datura* roots to reduce fevers, while the Zuni community applied poultices made from the plant to heal inflammation and bruises. In China, *Datura*, also known as "thorn apple, or "Indian apple" is highly valued for its ability to treat conditions such as asthma, convulsions, pain, and rheumatism. The clinical uses of *FlosDaturae* continue to be explored.[1,2]

It is commonly known that *Daturastramonium* L. has a very strong pharmacological action and is very useful in most traditional medicine. Previous reports on the presence of several secondary metabolites in its leaf extracts for instance, this plant contains tropane alkaloids, mainly in its seeds and flowers. These include scopolamine, hyoscyamine, and atropine. *Daturastramonium* L. is valued for its valuable medicinal properties, which include treating leukoderma, skin conditions, ulcers, bronchitis, jaundice, hysteria, insanity, heart illness, fever, and piles. These basic phytochemicals are present in the plant.[2,3]

To guarantee the accuracy and consistency of pharmaceutical and clinical research, as well as to comprehend the bioactivities and potential adverse effects of the active compounds through toxicity

evaluation protocols, it is imperative to ascertain the phytochemical constituents of plant extracts. Ethiopian traditional medicine uses *Daturastramonium* L. extensively, and it is well-known for treating germs. Therefore, the focus of this work is on the phytochemical investigation and assessment of *Daturastramonium* L. leaf extracts' antibacterial activity against certain human diseases [4-7].

Pharmacological Activity of *Datura* spp.

Datura, a genus within the Solanaceae family, demonstrates potent pharmacological activity primarily through its anticholinergic properties. Key alkaloids like atropine, scopolamine, and hyoscyamine block muscarinic acetylcholine receptors, resulting in various physiological and psychoactive effects including pupil dilation, tachycardia, and hallucinations. These properties have garnered interest in both traditional medicine and toxicology research. *Datura* exhibits promising antioxidant and anti-inflammatory activities attributed to phenolic compounds and alkaloids like atropine, respectively, offering potential in mitigating oxidative stress and inflammatory conditions. Additionally, its cytotoxic effects on cancer cells, bronchodilatory effects for asthma, antimicrobial potential, and analgesic properties indicate diverse therapeutic avenues for further exploration and development. [21-37].

Table 1: Pharmacological Activity of *Datura*

Pharmacological Activities	Species	References
Antioxidant Activity	<i>Daturastramonium</i> L.	[21, 22, 25]
Anti-inflammatory Activity	<i>Daturastramonium</i> L.	[24, 26, 27, 28, 29]
Anti Cancer Activity	<i>Daturastramonium</i> L.	[10, 30, 31, 32, 33]
Anti-Asthmatic Activity	<i>Daturastramonium</i> L.	[18, 19, 35]
Antimicrobial Activity	<i>Daturastramonium</i> L.	[34, 36]
Analgesic Activity	<i>Daturastramonium</i> L.	[37]

Toxicological Activity of *Datura*:

The *Datura* plant contains anticholinergic alkaloids such as tropane, leading to toxic effects on the nervous system. Symptoms of toxicity include fever, dry skin, hallucinations, convulsions, and even death. Despite safety up to a dose of 2000 mg/kg body weight for *D. fastuosa*, histological examinations show organ weight decrease and liver necrosis. *D. stramonium* should be avoided in conditions like glaucoma, enlarged prostate, and acute pulmonary edema due to its toxicity. Concentrations of seed extracts above 0.5% result in negative physiological changes. Despite its antidepressant properties at low doses, *Datura* extracts can induce adverse effects on the central nervous system, including memory loss, respiratory, and cardiovascular issues. [36-42]

Table 2: Toxicological Compounds of different parts of *Daturasp*

Plant Parts	Compounds	References
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Root	3 α , 6 β -ditigloyloxytropene, 3 α , 6 β -ditigloyloxytropan-7 β -ol, tigloidine, apohyoscyne, hyoscyne, 3 α -tigloyloxytropan, norhyoscyne, meteloidine, hyoscyamine, cuscohygrine and tropine	16, 30, 32
Pericarp	β -sitosterol, scopolamine and fastusine	16, 30, 32
Leaves	Scopolamine and a mixture of two unidentified alkaloids	16, 30, 32
Flowers, leaves, aerial parts, and roots	Hyoscyne and hyoscyamine	16, 30, 32
Fresh aerial parts	Daturanolone and daturadiol	16, 30, 32
Fruits	Scopolamine, atropine, fastunine, fastudine, fastusidine, daturanolone and fastusic acid	16, 30, 32
Seed	Scopolamine, atropine, fastunine, fastudine, fastusidine, daturanolone and fastusic acid	16, 30, 32
Seed oil	4 α -methylsterols-31-nprlanost-9(11) enol. 31-norcloartenol. Cycloeucalenol, 31-norlanost-8-enol. 31 norlanosterol; obtusifoliol, 4 α -methyl cholesta-8-enol, lophenol and citrostadienol	16, 30, 32

Atropine is an isomer of hyoscyamine and a tropane alkaloid. *Hyoscyamusniger*, *Daturastramonium*, *Brugmansiasuaveolens*, *Atropabella-donna*, and *Duboisiamyoporoides* all contain it, but in varying amounts. C₁₇H₂₃NO is the molecular formula. Atropine functions in two main ways. One of the activities stimulates the airways and has an impact on the central nervous system (CNS). Conversely, the smooth muscle and secretory glands that are innervated by the parasympathetic nervous system are depressed by this alkaloid. Atropine's primary effect in paralysis, agitation, and Parkinson's disease is sedative. The secretion of the respiratory glands, bronchial muscles, heart, gastrointestinal tract, and urine tract is specifically referred to as the peripheral effect of atropine.[23] When taken orally, atropine is quickly removed from the body and highly absorbed; the elimination process takes around 24 hours to finish. Oral or parenteral administration of 0.4 mg/day is the recommended standard dosage. A dosage over 3 milligrams may cause behavioral and mental abnormalities. L-phenylalanine is the first amino acid used in the production of atropine. The NH₂ group is transferred during transamination to generate pyruvic acid, which is then reduced to phenyl lactic acid. Through a sequence of reactions, tropine and litorin are created. The enzyme p450 then initiates a rearrangement that results in the formation of hyoscyamine aldehyde. Hyoscyamine is created via a dehydrogenation process, which then turns into atropine by racemization.[34,38]

Hyoscyamine (daturine) is an amino alcohol is an ester of tropic acid with atropine. This secondary metabolite is also present in *Daturastramonium* leaves. C₁₇H₂₃NO₃ is the molecular formula. The structural makeup of the plant changes when it dries out, and hyoscyamine passes through the levogirous isomer known as atropine. Hyoscyamine has 98% of atropine's anticholinergic potency and is an antagonist of muscarinic acetylcholine receptors. The location and process of hyoscyamine production in plants are comparable to those of atropine. Hyoscyamine is used to treat pancreatitis, cystitis, spasms, ulcers, and gastrointestinal issues. It is also used to treat cardiac issues and manage the symptoms of Parkinson's disease.[34,40]

Scopolamine: A poisonous alkaloid known as scopolamine (hyoscyne), it is found in several Solanaceae plants, including *Hyoscyamusniger*, *Brugmansiasuaveolens*, *Daturastramonium*, *Duboisiamyoporoides*, and *Atropabella-donna*. Scopolamine belongs to the class of alkaloids known as tropane alkaloids, which are formed from amino and include nitrogen in heterocycle form. $C_{17}H_{21}NO_4$ is the molecular formula. When used in large dosages, scopolamine is a hallucinogenic drug that can possibly cause coma or physical death. It has medicinal qualities; it is frequently used to treat motion sickness, is administered following surgery to avoid nausea and vomiting, and is also used as a sedative. It has recently been demonstrated to be effective as a detoxifier since it greatly lowers the desire to consume heroin and lessens its side effects. Scopolamine belongs to the class of medications used as adjuvants, anesthetics, gastrointestinal, anti-vertigo, and antiemetics. Transdermal absorption is the mode of entry into the body.[24,43,44]

Conclusion:

Datura's pharmacological properties, including its strong anticholinergic alkaloids (like atropine and scopolamine), have the potential to be beneficial in a number of different therapeutic contexts. These include actions that are analgesic, anti-inflammatory, anti-cancer, anti-asthmatic, and antibacterial, indicating their potential utility in medical applications. Its strong alkaloids can cause adverse effects that range from severe toxicity and even death to dry mouth, hallucinations, and other symptoms. This emphasizes the need for cautious use and more research into the safety and dosage ranges of the drug. To maximize its therapeutic potential while limiting harm, one must comprehend the balance between the pharmacological benefits and toxicological hazards associated with it. *Datura* consumption can induce severe hallucinations, confusion, and even potentially fatal outcomes due to its toxic properties. This paper focuses on the toxicological and pharmacological activity of *Datura* spp. Understanding the fundamental causes of both its positive and negative effects such as hallucinations, delirium and fatal poisoning will be helpful in maximizing the benefits of the *Datura* plant in clinical settings.

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