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Phytopharmacognostic Study Development and Assessment of *Datura stramonium*

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Abstract

Datura stramonium, a member of the Solanaceae family, is widely known for its medicinal and toxicological significance. Native to Asia and the Americas, it has been utilized for both spiritual rituals and traditional medicine due to its potent psychoactive and narcotic properties. Historically, it has been employed to treat conditions, such as asthma, rheumatism, and inflammation, but its misuse, especially in religious contexts and recreational, often leads to toxic effects like hallucinations, confusion, and memory loss. The plant contains tropane alkaloids, including atropine, scopolamine, and hyoscyamine, which act on the central nervous system, making it both a valuable medicinal herb and a dangerous toxicant. Despite some therapeutic benefits, such as antispasmodic and bronchodilating effects, its toxic potential overshadows its medicinal uses. Extreme caution is required when handling or using Datura stramonium due to the risk of poisoning, particularly from ingestion.

Keywords: *Datura stramonium*, Phytochemistry, Ethnopharmacology, Ethano medical uses, hallucinations

INTRODUCTION

The genus "Datura" (Solanaceae) includes a variety of nightshades and agricultural plants, such as potato, tomato, eggplant, and pepper. This genus displays significant diversity, likely due to genetic mutations. *Datura stramonium*, the most well-known species within this family, is originally from Asia but is also found across the United States, Canada, and the West Indies, thriving particularly in temperate, tropical, and subtropical areas. Historically, *D. stramonium* has been utilized for mystical and religious purposes, as well as in herbal medicine for its narcotic effects. Its seeds are often smoked to induce hallucinogenic experiences. *D. stramonium* is highly toxic when consumed improperly, leading to acute poisoning incidents in both humans and animals that have ingested food contaminated with the plant. In regions where millet, wheat, rye, or corn are consumed, *D. stramonium* seeds have been reported as contaminants. In Ayurvedic medicine, *D. stramonium* is recognized for treating a variety of conditions, including ulcers, inflammation, rheumatism, and gastrointestinal disorders. Folk medicine also employs *D. stramonium* for its therapeutic properties. Within Hindu traditions, the seeds are associated with the deity Shiva, which can lead to their misuse during religious events, such as Shivaratri and Swasthani Puja. In contemporary medicine, while the therapeutic applications of *D. stramonium* are acknowledged, they are often overshadowed by its toxic effects. Consuming large quantities can negatively impact the central nervous system, resulting in confusion, erratic behavior, hallucinations, and memory loss. Although fatalities from *D. stramonium* poisoning are uncommon, recovery can take several days.

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Therefore, a comprehensive understanding of the pharmacological and toxicological properties of *D. stramonium* is essential. This review will explore the plant's botany, phytochemistry, pharmacology, toxicology, and ethnomedicinal uses [1–5].

HISTORICAL BACKGROUND

Datura stramonium, known for its potent psychoactive and toxic properties, has a long and complex history that intertwines with ancient medicine, shamanic practices, and folklore. Native to the Americas, Datura was widely used by indigenous peoples for spiritual and medicinal purposes. Shamans and healers utilized its hallucinogenic effects during rituals, believing it facilitated communication with the spirit world. The plant also played a role in treating physical ailments, such as asthma, pain, and inflammation, though it was always regarded with caution due to its toxicity [6].

When European explorers encountered Datura in the 16th century, they brought it back to Europe, where it became integrated into folk medicine. However, its use was often controversial because of its dangerous effects. During the colonial period in North America, Jimsonweed (a variant of *Datura stramonium*) gained infamy in Virginia in 1676, when British soldiers accidentally consumed it, leading to severe hallucinations and disorientation for days, an event now known as the "Jamestown Weed" incident [7–9].

In various cultures, Datura was both revered and feared. In India, it was associated with Lord Shiva and used in religious contexts, while in medieval Europe, it was linked to witchcraft and potions. The plant's powerful alkaloids – scopolamine, atropine, and hyoscyamine – became a subject of medical study, leading to modern medicinal applications but also caution about its toxic potential. Today, *Datura stramonium* is primarily known for its toxic properties rather than its medicinal use (Figure 1) [10].

Figure 1. *Datura stramonium* plant.

HABITAT

Datura stramonium, commonly known as Jimsonweed or Devil's Trumpet, is a wildflower that grows in many different parts of the world. Here is an overview of where it typically thrives:

Native Habitat

It originally comes from the Americas, particularly tropical and subtropical areas. It is commonly found in the southern United States, Mexico, and Central America. Where It's Been Introduced: Today, it can also be found in other parts of the world, such as: Europe (especially the Mediterranean region and Asia Minor) Asia (including India, China, and Southeast Asia) Africa (both North and South) Australia South America Environmental Preferences: Prefers full sun to partial shade Grows best in well-drained soils, including sandy, loamy, or clay types Can handle moist to dry conditions, and is drought-tolerant Thrives in temperatures between 64°F and 90°F.

Typical Growing Areas

1. Disturbed land, such as vacant lots or construction sites.
2. Roadsides and highways.
3. Abandoned fields and farms.
4. Stream and riverbanks.
5. Edges of woodlands or clearings.
6. Urban areas like parks and vacant spaces.
7. Coastal areas, such as beaches or sand dunes.

Growth Characteristics

It is an annual plant that can grow up to 6 feet (1.8 meters) tall. It usually germinates in the spring, blooms in the summer, and produces seeds in the fall [11–15].

Invasive Nature

In many areas, it is considered an invasive weed because it spreads quickly and outcompetes native plants.

It is toxic to both humans and animals, making it a danger to livestock and wildlife. If you are considering growing or managing Jimsonweed, keep in mind that local rules and environmental factors may vary, so it is always a good idea to check with local experts or authorities [16–20].

PROPAGATION

Datura stramonium is typically propagated through seeds. It is a hardy, fast-growing plant commonly found in a variety of environments across the globe. These seeds can remain viable for several years when properly stored. Generally, the plant germinates within 10 to 20 weeks under suitable conditions.

PHARMACOLOGICAL FEATURES

Botanical Description

1. *Family:* Solanaceae.
2. *Leaves:* Broad, ovate, with irregular, toothed margins.
3. *Flowers:* Trumpet-shaped, white to purple, with a distinct unpleasant odor (Figure 1).

Macroscopic Characteristics

- *Color:* Green leaves, white flowers, and spiny green fruits.
- *Odor:* Strong and unpleasant, especially from the leaves. Taste: Bitter and pungent. *Datura stramonium* contains a range of alkaloids, including atropine and scopolamine, known for their anticholinergic and bronchodilating effects. These compounds block muscarinic receptors (especially in airway smooth muscles and submucosal gland cells), which dilates bronchial smooth muscle and helps relieve asthma symptoms. Charpin et al. reported that smoking *D. stramonium* as an antiasthmatic aid effectively acts as a bronchodilator in patients with mild airway obstruction. However, exposure to *D. stramonium* during pregnancy can trigger a continuous release of acetylcholine, leading to the desensitization of nicotinic receptors, potentially causing lasting fetal harm [21–24].

Epilepsy

Although *D. stramonium*'s antiepileptic activity has not been directly reported, combining it with other herbs appears protective against status epilepticus. In an experimental model, male rats were induced into status epilepticus using lithium and pilocarpine. Rats treated with a herbal mix containing *D. stramonium*, *Scutellaria lateriflora* (Skullcap), and *Gelsemium sempervirens* (Gelsemium) showed no seizures post-treatment, indicating that combining *D. stramonium* with specific herbs could be beneficial as a supplementary approach to epilepsy treatment.

Organophosphate Poisoning

Given its anticholinergic properties, *D. stramonium* serves as a potential treatment for organophosphate (OP) poisoning. Bania et al. studied the positive effects of Datura seed extracts in severe OP poisoning cases. By preparing a solution with 15 mg/mL atropine from heated Datura seeds and administering it to male rats before dichlorvos exposure, they observed a significant increase in survival rates in rats with severe OP poisoning.

Antimicrobial Activity

Methanol extracts from the aerial parts of *D. stramonium* demonstrated bactericidal effects against Gram-positive bacteria in a dose-dependent manner but showed limited or no antibacterial activity against Escherichia coli and Pseudomonas aeruginosa. Ethanol extracts had the strongest inhibitory effect on *Klebsiella pneumoniae*, followed by Staphylococcus aureus, with minimal effect on Salmonella typhi. The aqueous extract showed activity only against S. aureus, while Neisseria gonorrhoeae was resistant to both extracts. *D. stramonium* was also very effective as a bactericide against various strains of Vibrio cholerae and Vibrio parahaemolyticus, with the minimum inhibitory concentration (MIC) value of acetone extracts falling within the range.

CHEMICAL CONSTITUENT AND THEIR TEST

The primary constituents responsible for its pharmacological effects are alkaloids. The major alkaloids present include:

1. *Atropine:* Anticholinergic properties; used as a muscle relaxant.
2. *Hyoscyamine:* Antispasmodic and central nervous system depressant effects.
3. *Scopolamine:* Sedative and antiemetic properties.

TESTS FOR CONSTITUENT OF DHATURA

Alkaloid Test (General)

Mayer's Test: Adding Mayer's reagent (potassium mercuric iodide) to the Dhatura extract will yield a cream-colored precipitate if alkaloids are present. Drage Dorff's Test: Adding Drage Dorff's reagent (potassium bismuth iodide) will produce an orange or reddish-brown precipitate.

Specific Tests

Vitali-Morin Test (for Atropine): Dissolve a small amount of Dhatura extract in fuming nitric acid, evaporate it to dryness, and add acetone followed by alcoholic potassium hydroxide. A violet color indicates the presence of atropine. Schiff's Test (for Hyoscyamine): Treating the extract with sodium nitrite and then sulfuric acid; a blue color that fades indicates the presence of hyoscyamine.

Thin Layer Chromatography (TLC)

For Scopolamine and Hyoscyamine: Using specific solvents, scopolamine and hyoscyamine can be separated on a TLC plate and identified by their Rf values and color reactions with Dragen Dorff's reagent. Important Note on Toxicity While Dhatura has medicinal uses, it is highly toxic if not used with caution. Only trained practitioners should handle and prepare it for medicinal purposes. Dhatura's alkaloids primarily act on the central nervous system and parasympathetic nervous system, so they must be used carefully to avoid severe toxic effects.

MEDICINAL PROPERTIES OF *DHATURA STRAMONIUM*

Antispasmodic

The plant has been used to relieve muscle spasm, especially in the treatment of asthma and respiratory conditions, by relaxing the muscles in the airways.

Pain Relief

Historically, Datura has been used as a pain reliever, particularly for conditions, like neuralgia and rheumatism, due to its analgesic effects.

Sedative

Some traditional practices use Datura as a sedative, helping with insomnia or anxiety. Its calming effects come from the alkaloid scopolamine.

Anti-Inflammatory

It is sometimes used to reduce inflammation in conditions like arthritis and joint pain.

Treatment of Respiratory Conditions

Datura smoke or its extracts have been used in folk medicine to treat respiratory issues, including bronchitis and asthma, by inhalation.

PRECAUTION AND SAFETY OF USAGE

All parts of the plant are highly toxic due to the presence of tropane alkaloids like atropine, scopolamine, and hyoscyamine. Overdose can cause hallucinations, confusion, dry mouth, blurred vision, and in severe cases, death. Therefore, any medicinal use should be strictly supervised by a professional.

Almost all parts of *Datura stramonium* are known to have toxic effects, primarily due to the presence of tropane alkaloids. The concentration of these alkaloids, along with other active compounds, varies across different parts of the plant. As a result, it is crucial, particularly for young people, to be aware of the plant's toxicity and the risks associated with its recreational use. While applying *Datura stramonium* as a paste or solution for localized pain might not cause harm, ingesting or using it systemically can lead to severe anticholinergic effects. Numerous cases of toxic delirium and psychiatric symptoms have been reported following its ingestion, underscoring the importance of exercising extreme caution when handling or using this plant.

CONCLUSIONS

Datura stramonium stands out as a plant with a complex blend of historical significance, medicinal potential, and significant toxicological risks. Its use spans centuries, with roots in ancient shamanic, spiritual, and medicinal practices across various cultures, from Native American rituals to Indian Ayurvedic medicine. Historically, it has been valued for its analgesic, antispasmodic, sedative, and anti-inflammatory properties, particularly in the treatment of respiratory conditions, such as asthma. Its association with mystical and religious traditions, as seen in Hinduism where its seeds are linked to Lord Shiva, highlights its cultural importance as well. However, despite its potential benefits, *Datura stramonium* is widely recognized for its high toxicity due to the presence of tropane alkaloids like atropine, scopolamine, and hyoscyamine.

These alkaloids have a profound effect on the central nervous system and parasympathetic nervous system, which can lead to severe anticholinergic symptoms if consumed improperly. The plant's toxicity varies across its different parts, making it unpredictable and dangerous, particularly when used recreationally. Ingesting the seeds, leaves, or other parts of the plant can lead to toxic delirium, hallucinations, confusion, erratic behavior, and in severe cases, life threatening poisoning. Numerous incidents of acute poisoning have been reported in both humans and animals, especially when the plant has been accidentally ingested through contaminated food sources like millet, wheat, rye, and corn. Even in traditional medicine, where *Datura stramonium* is applied topically or smoked for respiratory relief, its use is always accompanied by caution due to the narrow margin between a therapeutic and toxic dose.

Modern medicine acknowledges the pharmacological potential of *Datura stramonium*, particularly for its anticholinergic properties, which can be helpful in conditions like organophosphate poisoning and respiratory disorders. However, its toxic effects often overshadow its medicinal uses, with its powerful alkaloids being more commonly associated with risks than therapeutic benefits. The plant's psychoactive properties have also led to its misuse in both historical and modern contexts, with recreational use posing serious risks, especially among younger individuals unaware of its potency.

In agricultural and ecological contexts, *Datura stramonium* is considered invasive in many parts of the world, outcompeting native plants and presenting a danger to livestock due to its toxicity. Its hardy nature and ability to thrive in various environments, from disturbed land to roadsides, make it difficult to control. Propagated mainly by seeds that remain viable for years, the plant's spread poses both environmental and health challenges.

Overall, while *Datura stramonium* holds a notable place in traditional medicine and cultural practices, its use in contemporary settings requires a deep understanding of both its pharmacological properties and its toxic potential. Public awareness about the dangers associated with this plant is critical, particularly in areas where accidental ingestion or recreational misuse may occur. The medicinal applications of *Datura stramonium* should only be explored under the guidance of trained professionals, as improper use can lead to severe and often unpredictable consequences. Therefore, any therapeutic use must be balanced with a clear recognition of the risks involved, ensuring that caution is exercised at every step.

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