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An Overview on *Datura stramonium* L. (Jimson weed):
A Notable Psychoactive Drug Plant

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Abstract

Purpose: People often make use of this notorious plant, *Datura stramonium* L. (Jimson weed) without rationale which subsequently leads to its abuse along the process. Thus, this paper seeks to compile detailed information regarding the toxicity and the safe usage of this plant in order to curtail its negative impact among individuals.

Methodology: A lot of literatures, reports, short communication etc. from print and electronic media were consulted during the course of preparation of the article.

Findings: The notorious weed, jimson weed (*Datura stramonium* L.) is a hallucinating plant with both poisonous and medicinal properties. The neurotoxicity of the plant is attributed to the presence of tropane alkaloids which contain a methylated nitrogen atom (N-CH₃) that block neurotransmitters in the brain. Ethno-medicinally, the frequent recreational abuse of *D. stramonium* has resulted in toxic syndromes. *D. stramonium*, consume in the form of paste or solution to relieve the local pain may not have a deleterious effect; however, oral and systemic administration may lead to severe anticholinergic symptoms which include dizziness, hallucination, loss of consciousness, nausea, hypertension, agitation, aggressiveness, photophobia, blurred vision and possibly coma which may last for several hours or days depending on the quantity consumed.

Unique contribution to Theory, Practice and Policy: The present comprehensive review was able to, underscores the botany, phytochemistry, intoxication, and precautionary measures for the safe and sound usage of *D. stramonium* among individuals. Sequel to that, it deems imperative for individuals, especially adolescents, to be acquainted of the toxic nature and potential risks associated with the use of this plant.

Key words: *Datura stramonium*, Hallucination, Intoxication, Botany, Substance abuse

Introduction

The genus “*Datura*” (Solanaceae) comprises of all the nightshades and agricultural plants, including potato, tomato, coffee and pepper. Classification of different species within *Datura* genus relies heavily on genetic markers, which suggests that this genus has huge variation due to mutation (Fornoni & Núñez-Farfán, 2000; Luna-Cavazos & Bye, 2011). *Datura stramonium*, the most common species within this family, is native to Asia, but is also found in the United States, Canada, and the West Indies. It is widespread with higher abundance in temperate, tropical and subtropical regions (Berkov, Zayed & Doncheva, 2006). Traditionally, *D. stramonium* has been used for mystic and religious purposes (Ajungla, Patil, Barmukh & Nikam, 2009), and as an herbal medicine with narcotic effects or to treat asthma (Dessanges, 2001). The seeds of *D. stramonium* is smoked to achieve hallucinogenic experiences and also become toxic when consumed improperly (Diker, Markovitz, Rothman & Sendovski, 2007). *D. stramonium* is toxic when consumed improperly. Accidental poisoning of humans and animals that consumed food sources contaminated with *D. stramonium* has been reported (Naudé, Gerber, Smith & Botha, 2005).

Jimson weed or Jamestown weed is a hallucinogenic plant that causes serious poisoning (Devi, Bawari, Paul & Sharma, 2011). Consumption of any part of the plant may result in a severe anticholinergic reaction that may lead to toxicity and occasionally cause diagnostic difficulties (Diker *et al.* 2007). It is used recreationally for its anticholinergic effects, resulting in hallucinations. Ingestion of any parts of this plant may all change the way people see, hear, taste, smell or feel, and affect mood and thought. At high doses, it may cause a person to hallucinate, or see, hear or feel things that are not really there.

All parts of Jimsonweed are toxic to humans and other mammals. The plants contain dangerous levels of the alkaloids classified as anticholinergic (block neurotransmitters) and have been used for its psychoactive effects. The concentration of toxins varies greatly from plant to plant making the risk of fatal overdose high (www.erowid.org). The anticholinergic compounds of *D. stramonium* are likely to produce delirium and stupor but rarely cause deep coma. The plant occurs indigenously in Southern Africa and distributed to other areas of the world. It was used by Red Indians for many years as euphoric agent and since the 1800’s, used as a therapeutic agent and in Great Britain (Dessanges, 2001). However over dosage can result to severe toxicity.

In Ayurvedic medicine, *D. stramonium* is described as a useful remedy for various human ailments including ulcers, wounds, inflammation, rheumatism and gout, sciatica, bruises and swellings, fever, asthma and bronchitis, toothache, etc. (Kirtikar & Basu, 1999). Many folk medicine remedies use *D. stramonium* therapeutically. The plant is a rich source of alkaloids and it is an analgesic herb. Seed extract has an analgesic effect in both acute and chronic pain (Khalili & Atyabi, 2004). Among its phytochemicals, atropine is found to have more exciting properties, while scopolamine has more relaxing and hallucinogenic properties (Weitz, 2003). It has been reported that all parts of the plant are poisonous if ingested by humans or livestock (Radford, Ahles & Bell, 1964). However, a small quantity of it is used for medicinal purposes (King, 1984; Mann, 1992). It is used frequently in anti-asthmatic treatment (Muller, 1998) and known for its hallucinogenic and euphoric effects (Ertekin, Selimoglu & Altinkaynak, 2005; Weitz, 2003). Other ethno-medicinal uses of the plant are its anti-inflammatory property in which all part of the plants are used (Spring, 1989), stimulation of the central nervous system (Guarov & Barajas, 1991; Manandhar, 1995), respiratory decongestion (Zagari, 1992), treatment of dental and skin infections

(Darias, Brovo, Barquin, Horrera & Fraile, 1986; De Foe & Senatore, 1993; John, 1984) and also in the treatment of toothache (Abebe, 1986) and alopecia (John, 1984).

In modern medicine, the therapeutic uses of *D. stramonium* were overshadowed by its acute toxic effects (Gaire & Subedi, 2013). The administration of large amounts of *D. stramonium* affects the central nervous system with symptoms such as confusion, bizarre behavior, hallucinations and subsequent amnesia. Though death by *D. stramonium* poisoning is rare, recovery may take several days (Norton, 2008). Therefore, rigorous knowledge and understanding of the acute toxicity effects of this plant is undoubtedly need to be accounted for. Thus, the present comprehensive review focused much emphasis on the botany, phytochemistry and psychoactive potency of *D. stramonium* on human behavior among others.

Botanical Classification and Description of *Datura stramonium* L.

Datura stramonium, commonly known as Jimson weed or Jamestown weed. Among Hausas in Northern Nigeria, it is called “**Zaqami**”. Other common names of *D. stramonium* include Estramonio (Brazil); Chan K’iue Tse (Chinese); Thorn apple, Jimson weed, Mad Apple (English); Chasse-taupe (French); and Trompetilla (Spanish). *D. inermis* Juss. ex Jacq., *D. chalybea* W. D. J. Koch and *D. tatula* (L.) Torr. are the synonyms of *D. stramonium*. It can be classified as Kingdom: Plantae – Plants; Subkingdom: Tracheobionta – Vascular plants; Super division: Spermatophyta – Seed plants; Division: Magnoliophyta – Flowering plants; Class: Magnoliopsida – Dicotyledons; Subclass: Asteridae; Order: Solanales; Family: Solanaceae – Potato family; Genus: *Datura* L.; and Species: *D. stramonium* (Gaire and Subeidi, 2013).

Jimson weed is an annual plant reaching 1-5 feet tall, branching in two equal forks. Stems are smooth, green to purplish with alternate, simple, coarsely toothed leaves 3-8 inches long. The flowers form white or pinkish, flaring, five-pointed trumpets three to four inches long and two inches wide from August to October. The fruits are short prickly capsules about one inch in diameter. The plant has a very pungent odor when crushed. All parts of the plant are poisonous if ingested. Poisonings have been reported from accidental overdose of the herbal medicine or by intentional ingestion for illicit drug use (Mountain, 1987).

Origin and Range of Distribution of *Datura stramonium*

D. stramonium is native to deserts of the North American Southwest, Central and South America, Europe, Asia, and Africa. It is mainly distributed in the Himalaya region from Kashmir to Sikkim up to 2 700 m, in the hilly district of central and south India (Khare, 2007).

Habitat

Jimsonweed can be found on moist soils but prefers nutrient-rich soils. Nitrogen rich soils favour growth (Weaver and Warwick, 1984). Being sub-tropical in origin; it prefers plentiful rainfalls but can survive on less. It can grow at sea level and has been recorded at 2750m in the Himalayas (www.cabi.org/isc).

Biology and Propagation

D. stramonium overwinters only as seeds. Plants produce from three capsules (about 1,500 seeds) to 50 or more capsules with 30,000 or more seeds. Seeds are dispersed three to twelve feet from the dry capsules. Dispersal is also accomplished by water, on farm machinery or as an impurity in crop seeds, hay and feed grains. Seeds can remain viable in the soil for decades.

Ecological threats

Datura stramonium is listed as a noxious weed in Pennsylvania due to its poisonous tropane alkaloids. Most animals avoid the plant due to its odor but livestock poisonings occur due to contaminated hay or feed. Jimsonweed is not typically found in undisturbed native plant communities (Mountain, 1987).

Phytochemistry

Phytochemical studies of *D. stramonium* have been conducted since the early 1930s (Gaire and Subedi, 2013). The major phytochemicals isolated from *D. stramonium* are tropane alkaloids, atropine and scopolamine (Jakabová *et al.*, 2012). It is reported that the whole plant contains 0.26% alkaloids. Seeds of *Datura* contain the alkaloid daturine, first isolated, purified and crystallized by Geiger and Hesse, in 1833. The seeds contain fatty oil (25%), from which a new fatty acid, daturic acid (C₁₇H₃₄O₂), was isolated. Dohme concluded that the stems contain more alkaloids (0.3% to 0.4%, volumetrically) than even the seeds (0.25% to 0.29%), and the seeds contain more alkaloid than the leaves (0.21% to 0.23%, and 0.27% for green leaves) (Khare, 2007).

Sixty-four tropane alkaloids have been detected from *D. stramonium* (Devi *et al.*, 2011). Two new tropane alkaloids, 3-phenylacetoxy-6, 7-epoxynortropine and 7-hydroxyapoatropine were tentatively identified. The alkaloids scopoline, 3-(hydroxyacetoxy) tropane, 3-hydroxy-6-(2-methylbutyryloxy) tropane, 3-tigloyloxy-6-hydroxytropane, 3,7-dihydroxy-6-tigloyloxytropane, 3-tigloyloxy-6-propionyloxytropane, 3-phenylacetoxy-6,7-epoxytropane, 3-phenylacetoxy-6-hydroxytropane, aponorscopolamine, 3,6-ditigloyloxytropane and 7-hydroxyhyoscyamine are reported for the first time for this species (Strahil Berkov *et al.*, 2006).

The toxins in Jimson weed are tropane belladonna alkaloids, which possess strong anticholinergic properties. These alkaloids include: hyoscyamine (leaves, roots, seeds), hyoscyne (roots); atropine (d,l-hyoscyamine) and scopolamine (l-hyoscyne), as well as sitosterol and proteins (Friedman and Levin, 1989; Chang *et al.*, 1999). It is reported that hyoscyamine is the predominant alkaloid in *D. stramonium* from the line of flowering (Bruni In, 1999; Evans, 1989; Oshima, Sagara, Tong, Zhan & Chen, 1989).

Intoxication and Mode of Action

Consumption of *D. stramonium* interferes and obstructs the action of neurotransmitters in the nervous system. *Datura* toxins cross the blood-brain barrier and inhibit acetylcholine (the main neurotransmitter used by the parasympathetic nervous system). Children are especially vulnerable to atropine poisoning, and their prognosis is likely to be fatal. From 1950–1965, the State Chemical Laboratories in Agra, India, investigated 2,778 deaths that were caused by ingesting *Datura*. Symptoms likely to be produced by tropane alkaloids such as scopolamine, hyoscyamine, and atropine include urinary retention, dry mouth, throat, and skin, blurred vision, headache and nausea, dizziness, convulsions, fever, euphoria, hallucinations, short-term memory loss, delirium,

hyperthermia, rapid heartbeat, agitation, including bizarre, inexplicable, and possibly violent behavior, and severe hyper-dilation of the eye pupil, with resultant painful photophobia that can last several days, unconsciousness and coma(Diker *et al.*, 2007) . Pronounced amnesia is another commonly-reported effect. The sap may cause contact dermatitis. If not fatal, the effects of *Datura* poisoning may last several days. Although research is scarce, taking hallucinogens during pregnancy may affect the development of the baby, and increase the chance of miscarriage.

Psycho-activity of Jimson weed: A Review of some Reported Cases

Substance abuse is a common problem in adolescents who deliberately ingest a variety of substances for their mind-altering properties. Intentional ingestion of the seeds may result in poisoning due to the anticholinergic properties of the plant.

Below are some of the reported cases that emanates as a result of *Datura* ingestion which is mostly among adolescents.

A 13-year-old boy was brought by emergency medical services and police to the Children's Hospital Emergency Room (ER) with combativeness and visual hallucinations. The day before his admission, he had ingested Angel's Trumpet seeds and had visual hallucinations that had resolved. On the day of admission, the patient was again hallucinating and was combative. Due to his agitation and combativeness, he was placed in four-point restraints and given two doses of 2 mg Intra Muscular (IM) lorazepam and a dose of methotrimeprazine. He was admitted to the hospital for two days, during which time he had two outbursts requiring security to be called. The patient had a history of attention-deficit hyperactivity disorder and substance abuse, and was not currently on treatment (Wiebe, Sigurdson &Katz, 2008).

Furthermore, a 16-year-old boy was brought to the Children's Hospital emergency room (ER) with disorientation, hallucinations and combativeness. He had ingested 49 Angel's Trumpet seeds the night before. Initially his vital signs were temperature 36.3°C, pulse rate 80 beats/min, respiratory rate 14 breaths/min, blood pressure 122/68 mmHg and oxygen saturation 98% on room air. He was sluggish and responded to his name but was otherwise disoriented. He became agitated and aggressive He had an uneventful stay in the pediatric intensive care unit for 12hours and was transferred to the ward and discharged home 36hours later. The patient had a history of mental health problems, polysubstance abuse and contact with Child and Family Services.

In another development, a 14-year-old boy was brought by emergency medical services to the Children's Hospital ER due to hallucinations. His mother stated that he ingested Angel's Trumpet seeds three days earlier. He had been hallucinating, picking things out of the air and talking to people who were not there. He was not agitated in the ER, but 12 hours after being admitted to the ward, he became extremely agitated. A code white for behavior disturbance was called by staff. Security arrived and the patient was restrained and given 2 mg of IM lorazepam. The patient kicked out the glass in a door, and began to spit and swear at staff. His agitation lasted approximately 12 h, during which he continued to scream, swear and tried to remove his restraints. He received a total of four doses of 2 mg IM lorazepam (Wiebe *et al.*, 2008).

Toxicity Studies

D. stramonium is mostly studied for its toxicological properties. *Datura* poisoning is very common in India, usually involving the seeds. Many cases of unintentional poisoning by *D. stramonium* have been reported when taken accidentally, or as decoction prepared from herbal prescription (Hirschmann & De Arias, 1990). Symptoms of poisoning include agitation, delirium, hallucination, unconsciousness, hypertension and coma among others. Dugan *et al.* (1989) have reported that ingestion of *D. stramonium* seed at concentrations of 0.5% or more in the diet produced adverse physiological changes in rats.

More so, Binev, Valchev & Nikolov (2006) investigated the effects of *D. stramonium* poisoning in horses. Based on their findings, the patho-morphological studies showed a toxic liver dystrophy and extensive dystrophic and necrotic changes in the kidneys and myocardium. Bouzidi, Mahdeb, & Kara (2011) reviewed the acute, sub-acute and chronic toxicity studies of alkaloids from the seeds of *D. stramonium*. According to them, single dose acute toxicity of 100 mg/kg *D. stramonium* includes decreases in the weight of the liver, spleen and brain, and significant increases in the levels of red blood cells (RBC), hematocrit (HCT), hemoglobin (HGB) and white blood cells (WBC). Similarly, RBC, HGB, HCT and platelet levels were increased in 4-week sub-acute toxicity studies. However, the 120-day chronic toxicity study of *D. stramonium* alkaloids showed decreased levels of RBC, HCT, HGB and WBC, with a significant increase in liver enzymes. Fatal dosages of *D. stramonium* toxins occurred with amounts exceeding 10 mg for adults, and 4 mg for children. The amount needed to poison an adult is about 20 seeds, and the estimated LD in an adult is >10 mg atropine or >2 to 4 mg scopolamine (Norton, 2008).

Precautionary Measures and Safety Use

Almost all the parts of *D. stramonium* are reported to have toxic effects, and the toxicity of this plant is mainly due to the tropane alkaloids. Each part varies in the concentrations of alkaloids and other active substances. For this reason, it is very important for individuals, especially young people, to be aware of the toxicity and potential risks associated with the “recreational” use of this plant. *D. stramonium* in the form of a paste or solution can be used to relieve local pain and may not have a deleterious effect; however, oral and systemic administration of the *D. stramonium* may lead to severe anticholinergic symptoms. Various cases of toxic delirium and psychiatric symptoms have been reported after ingestion of *D. stramonium* (Karadaş *et al.* 2011; Kurzbaum, Simsolo, Kvasha & Blum, 2001; Oberndorfer, Grisold, Hinterholzer & Rosner, 2002; Spina & Taddei, 2007), indicating the necessity of extreme precaution while using this plant.

Conclusion and Recommendations

Datura stramonium is a hallucinogenic plant and consumption of any part may lead to poisoning. It interferes with parasympathetic nervous system thereby blocking neurotransmitters and symptoms likely to be produced by tropane alkaloids such as scopolamine, hyoscyamine, and atropine present in the plants include urinary retention, dry mouth, throat, and skin, blurred vision, headache and nausea, dizziness, convulsions, fever, euphoria, hallucinations, short-term memory loss, delirium, hyperthermia, rapid heartbeat, agitation, including bizarre, inexplicable, and possibly violent behavior, and severe hyper-dilation of the eye pupil, with resultant painful photophobia that can last several days. Despite its detrimental effects, when used in small

concentration, jimson weed is used in ethno-therapy to treat various ailments especially in Ayurveda traditional medicine. The adverse effects of *D. stramonium* can be extremely severe and detrimental. Therefore, even in light of its many beneficial effects, the risk-benefit ratio should be always taken into consideration before using *D. stramonium*.

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