

Plant Poison Effect in the Human Body – A Review

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Manuscript details:

Available online on <http://www.ijlsci.in>

ISSN: 2320-964X (Online)

ISSN: 2320-7817 (Print)

Cite this article as:

Singh Riya, Shrutika Singla, Vaishnavi Puli, Vijay Panchal, Rakesh Mia (2022) Plant Poison Effect in the Human Body – A Review, *Int. J. of. Life Sciences*, Special Issue, A18: 1-8.

Article published in Special issue of 1st National Conference on Forensic Science & Digital Forensics 2022 organised by Applied Forensic Research Sciences From 18th to 20th March, 2022.



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ABSTRACT

Plant poisoning is found in any species of plant which when touch, smell or ingested in sufficient quantity can evoke toxic or fatal reaction to an organism is referred as poisonous plant. Some of the common poisonous plants are: Abrus precatorius, Castor bean, laurel, horse chestnuts, belladonna, rhubarb and many more. This research paper analyzes the various; both harmful as well as beneficial effects of plant poisons on the human body. The poisonous chemical found in plants are normal biochemical and have been developed as an evolutionary response for self-protection. The plant poisons may enter into the body either by inhalation, swallowing or by contact which can be based upon chemical constitutes which classifies plant poison into alkaloids, glucosidases, proteins, oxalates, anti-vitamins, tannins, volatile ether layers etc. The alkaloids by far are the most predominant Plant poisons. Plant poison shows both useful as well as harmful effects in human beings and animals as well. They show wide range of side effects from minor itching, nausea, vomiting to adverse effects like psychosis, paralysis, teratogenicity, arrhythmias but they can also be used be in the production of cosmetics, ulcers, menstrual cramps, cancer and in treatment of man ailments and diseases and many more. Our results showed that Plant poisons have positive as well as negative effects in the human body. The implications of this research paper could be used to study more about the sanguine effects and practical applications of the plant poisons on the human body.

Keywords: Plant, Poison, human body, effect, India.

INTRODUCTION

Poison is a substance that has some direct or indirect effect on the person taking it. Poisons which are extracted from the plants or plant parts are termed as plant poisons. Plant parts may include seeds, leaves, roots, stems or fruits. Plants are mainly used for the medicinal purpose in India but many times the use of plants lead to lethal toxicity and even death. The effect of plant poison depends on the concentration of plant part being taken, age of an individual, health of an individual, and many other factors. But, anything taken in excess could be poisonous including water. There are various plant poisons including

Abrus Precatorius, *Ricinus Communis*, *Croton Tiglium*, etc when taken in amount more than a critical value leads to harmful effects on individual. India is a tropical country in terms of flora and fauna, Most of the India's economy arises from urban areas. These urban areas have various kinds of flora and fauna. As there are many varieties and different species of plants and trees in India, there are more chances of accidental poisoning because the characteristics and toxicity of some of those plants are still unknown. Since the beginning of the mankind, plants are being used for making medicines for various purposes. But, the cases of its use for other purposes such as punishing the criminals, harming the animals, threatening the common people are known. Infact, in many cases it is observed that plants poisons are mixed with the food of animals to kill them.

Plant poisons can be classified under six categories- Neurotic (eg. *Papaver somniferum*), Spinal (eg. *Strychnous nux vomica*), Cerebral (eg. *Cannabis sativa*, *Datura fastusa*), Cardiac (eg. *Nicotiana tobacum*, *Digitalis purpurea*), Irritants (eg. *Croton tiglium*, *Abrus precatorius*) and miscellaneous (eg. *Ergot*, *Oleander*). Plant poisons are found involved in various cases of homicidal, suicidal and accidental poisoning. People use plant poison to kill someone as it can be easily mixed with the food without being identified or detected, for example, seeds of *Croton tiglium*. This plant is also known as Jamalghota or Naepala in India which leads to gastrointestinal irritation, diarrhea and vomiting. If it is applied on skin, it might lead to redness and itching. *Calotropis gigantea* is used as abortifacient. Odorless and colorless plant parts are chosen so that the person taking it is not able to identify it. *Capsicum annum* (Capsicum and Chillies) were used to punish the criminals and thieves. Plant poisons are also used as suicidal poison due to the knowledge of its toxicity of plants. *Cerbera odollam* plant is widely used for suicide as it is a perennial plant and in knowledge of everyone. It is also known as suicide tree.

In most of the cases, plants are taken accidentally considering those as something else, for example, *Abrus precatorius* plant have red coloured seed looking similar to berries. Children ingest these seeds considering those cherries which then lead to toxicity and ultimately to death. Croton oil can also be lethal while taking oil as purgative in higher doses. Plant poison can be used for

chronic as well as acute poisoning. Acute poisoning results when poison is given in high amount in short period of time (Housecroft, 2020). Acute poisoning leads to ultimate death of the individual. Chronic poisoning is also known as slow poison when poison is given in small amount for longer period of time. It causes slow poisoning in the body which ultimately leads to lethality in individual.

Plant Poison in India

Plant poison can be classified in several ways- Neurotic (Welch, 2019), Spinal, Cerebral, Cardiac, Irritants and miscellaneous. They can also be classified on the basis of chemical constituents into- Alkaloids, Glycosidases, Toxic Proteins and Resins. These poisons can be further subdivided on the basis of chemical structure as follows:

A. Glycosidases-

- Steroidal glycosides
- Flavonoid glycosides
- Anthraquinone glycosides
- Cyanophoric glycosides
- Alcohol glycosides
- Lactone glycosides
- Aldehyde glycosides
- Phenolic glycosides
- Saponin glycosides.

B. Alkaloids-

- Pyridine-Piperidine
- Tropane alkaloids
- Quinoline alkaloids
- Isoquinoline alkaloids
- Indole alkaloids
- Imidazole alkaloids
- Steroidal alkaloids
- Alkaloidal Amines
- Purine Bases
- Lupine alkaloids.

C. Toxin Protein-

- Toxalbumins

D. Resin

Plant Poisons can be classified on the basis of their toxic effects:

- a. Plants that is poisonous to eat-Rosary pea, Aconite, Corn cockle, Locoweed, Belladonna, Akee, Marijuana, Water hemlock, Daphne, Larkspur, Huánuco cocaine, Barbados nut, Cassava, Opium poppy and Castor bean.

- b. Plants those are poisonous upon contact– Euphorbia spurge, Spurge nettle, Poisonwood, Strophanthus and Poison ivy.
- c. Plants that produce photosensitization– Buckwheat, St. John's Wort
- d. Plant that produce air borne allergies– Box elder

Plant Poisons can also be classified on the basis of function of the drug:-

- a) Stimulant– Cocaine, Amphetamines
- b) Hallucinogens– Mescaline, LSD, DMT, Cannabis, Solvent vapours
- c) Depressants– Opium, Morphine, Heroin, Methadonephedin, Barbiturates

Most widely known Plant Poison:

Rosary Pea or Jequirity Bean (*Abrus Precatorius*)

Family – Fabaceae

Principle – Plant that contains a protein called abrin which is highly toxic to humans as it causes toxicity through cell death.

Characteristics – Slender, perennial climber with long, pinnate-leafleted leaves that twins turns around trees, shrubs and hedges.

Symptoms – Nausea, vomiting, abdominal pain, diarrhea apart from these patients can also experience fast heart rate, headache, hallucinations, lethargy, seizures, and fever and organ failure.

Fatal period – Begins within few hours after ingestion and can be delayed up to 5 days.

Aconite or Monkshood (*Aconitum napellus*)

Family – Ranunculaceae

Principle – All parts of this plant contain toxins of which aconitine is most dangerous. It is known as a heart poison and a potent nerve poison.

Characteristics – It's a perennial plant growing to 1m tall, with hairless stem and leaves. The leaves are rounded 5-10cm diameter, palmately divided into 5-7 deeply lobed segments. The flowers are narrow along helmet-shaped.

Symptoms – The initial symptoms are tingling, burning sensation in tongue; throat & skin, restlessness, respiratory distress, muscular incoordination, vomiting, diarrhea, convulsions and possible death.

Fatal Period – Marked symptoms appears in one hour and with large dosage death is instantaneous. Death usually occurs within two to six hours in fatal poisoning.

Belladonna (*Atropa Belladona*)

Family – Solanaceae

Principle – The active components of belladonna act as competitive antagonists at muscarinic receptors and block the binding of acetylcholine to the central nervous system and parasympathetic muscarinic receptors. Characteristics – It is a branching perennial plant with height up to 2m having ovate leaves of 18 cm in length. The flower are bell shaped with green tings.

Symptoms – Minor symptoms are dryness of skin, mouth and throat, difficulty in swallowing, nausea, vomiting, coma and even major problems like cardiovascular diseases, gastrointestinal disorder and even psychiatric disorders and eventually death.

Marijuana (*Cannabis sativa*)

In local it is also famous in various other names like Ganja, Bhang, Marijuana, Majun or Charas which is also known as the purest form and also known as Hashish (Stegelmeier *et al.* 2020).

Family – Hemp, cannabaceae

Principle – The active principle are cannabiniol, cannabidiol, tetrahydrocannabinol (THC) and cannabidiolic acid but only THC is responsible for its physiological activities.

Characteristics – These plants have long and thin leaves that are light in color. Buds are long and wispy and feature red and orange coloring. It is a stout, aromatic and erect annual herb.

Symptoms – It shows both mental and physical signs like euphoria, altered state of mind, difficulty in concentration impaired body movement and ingestion in large quantities can cause death by cardiac depression (Chen *et al.* 2016).

Fatal Period – Onset of effects is felt within minutes when smoked but may take up to 90 minutes when eaten. The effect lasts for 2 to 6 hours.

Barbiturates

Family - synthetic derivative of barbituric acid

Principle - The effect by increasing the duration (Clayton *et al.* 2020) of chloride Ion channel opening at GABAA receptor which depresses the central nervous system and suppress the functioning of all body's tissue

Characteristics - Barbiturates are derivatives of Barbituric acid. The variations are found due to the substitution of hydrogen atoms by alkyl, aryl or other group. Barbiturates can be identified as it gives blue colour with 1% solution

of Cobalt Nitrate in alcohol and a palette of sodium hydroxide or using thin layer and gas chromatography.

Symptoms - altered or decreased consciousness, clouded thinking, perspiration, nausea, slow heart rate, lack of balance or vertigo, slurring of speech, incoherence and decreased urine output & others.

Fatal period - these are swallowed or injected up to 50mg to 100mg and symptoms are seen within 1 to 2 days after intake.

Opium (*Papaver somniferous*)

Family - poppies

Principle - opium works basically due to alkaloids like majorly morphine and codeine; in the opium reside, which is one of the important component as it reduces physical activity by its depressive effect on the central nervous system.

Characteristics - poppy flowers typically have four to six petals. Poopy foliage are easy to identify, leaves are lobed or dissected, appearing lacy, frilly or fern-like. Poppies generally release a sticky sap that looks like milk when they are cut. The flowers are four to six petaled with numerous stamens surrounding the ovary.

Symptoms - It effects the central nervous system, respiratory and cardiovascular systems, the recognizable symptoms are euphoria, sleep, physical dependence, pain, cramps, nervousness, perspiration and death in acute cases.

Fatal period - It is generally smoked, eaten or injected and the dose can vary. The fatal period is about 6 to 12 hours.

Morphine (C₁₇H₁₉N₃O₃)

Family - One of opium alkaloids

Principle - Morphine is a phenathrene opioid receptor agonist, its main effect is binding to and activating the u-opioid receptor (MOR) in the central nervous system.

Characteristics - morphine is solid, white, prism-shaped crystalline alkaloid; sometimes even small rhombic prism which are odorless, bitter and insoluble in water. It is found naturally in dark brown, resinous form from poppy plant.

Symptoms - decreased respiratory effect, vomiting, nausea, low blood pressure, pain, cramps, euphoria, drowsiness and constipation.

Fatal period - Its maximum effect is reached after about 20 minutes when taken intravenously, 60 minutes when taken by mouth while the duration of effect is 3-7 hours.

Heroin

Family - from morphine

Principle - same as morphine; effects the central nervous system. One of the strongest sedatives, depresses all the body functions

Characteristics - heroin is found mainly in white, brown powder or black sticky substance

Symptoms - slow breathing & heart rate, low blood pressure, constipation, pale body color, less oxygen intake, drowsiness, slurred speech, impaired mental-physical coordination & depressed reflexes.

Fatal period - short term effect appears soon after single dose that is 150mg is taken and disappears in few hours.

Cocaine (Coca plant)

Family - Erythroxylaceae

Principle - cocaine acts as an indirect sympathomimetic by blocking the dopamine transporter, serotonin transport and norepinephrine transporter which derives the effect of arousal, consciousness, emotions activating the central (Karunarathne *et al.* 2021) nervous system and acting as stimulant.

Characteristics - cocaine is extracted from coca plant which is a tropical shrub whose leaves are the source of cocaine. The branches of plant are straight and the leaves are thin, opaque, oval and less tapering at the extremities. The plant grows to height of 2-3 m. the recognizable characteristics of leaf are areolate portion bound by two longitudinal curved lines.

Symptoms - increase in psychological activity [Mootosamy *et al.* 2014] like blood pressure, pulse rate, respiration; reduces sleep, appetite, causes constipation, thirst, infection, blood poisoning, headache, nausea, cramps, and delirium & creates an anesthetic effect on tongue & throat. It also stimulates the central nervous system, mental and physical process making the person hyperactive

Fatal period - the effect begins within seconds to minutes after intake and lasts between five to ninety minutes depending on the amount of dose taken.

Benzedrine

Family - first product of amphetamine

Principle - amphetamine works in the brain to increase levels of dopamine and norepinephrine which is

responsible for feelings of pleasure and others. It does this by increasing the monoamine and excitatory neurotransmission in the brain.

Characteristics - It is liquid at room temperature and its boiling point is 197°C. It can be identified using sulphuric acid and formaldehyde drug which changes the color from orange to brown or through thin layer and gas chromatography.

Symptoms - The drug stimulates the central nervous system arousing the sensation of pleasure, alertness, it prevents sleep & reduces fatigue, it reduces appetite, irritation, confusion and aggressiveness, increased heart rate & blood pressure, psychosis, dizziness, dry mouth, Raynaud's syndrome and sexual problems.

LSD (Lysergic Acid Diethylamide) or Colloquilly

Family - Obtained from fungus growth on rye grain and prepared in lab.

Principle - LSD binds with dopamine receptors in addition to serotonin receptors and blocks the action of serotonin amine transmitter of nerve in brain tissue.

Characteristics - It is a white powder which is tasteless and odorless with melting point 80-85°C. It has characteristic TLC and GLC chromatograms. It can be identified by testing with sulphuric acid and formaldehyde and gives grey color.

Table 1:

Name of the test	Test performed for	Methods and Results
Frohde's Test	Opium Alkaloids	Blue colour is observed after adding Frohde's reagent to the plant extract.
	<i>Calotropis gigantea</i>	Green colour developed after adding Frohde's reagent to the residue of the extract from the sample.
Marquis Test	Opium Alkaloids	Blue or Violet colour is observed after adding Marquis reagent to the dried plant extract.
	<i>Abrus precatorius Linn</i>	Pink colour is observed after adding reagent to the plant extract.
	<i>Ergot</i>	Brown colour develops after addition of the reagent to the extract.
Mandelin's Test	Strychnine	Deep violet- blue color is observed when 1 drop of Mandelin's reagent was added to the plant extract which turns into yellow on long standing.
Fast Blue B Test	<i>Cannabis sativa Linn</i>	Solid Fast Blue B reagent and 1 ml of chloroform was added to the plant extract. The chloroform layer turns red purple in the presence of THC.
Scott Test	Cocaine	Few drops of 2% cobalt thiocyanate solution was added to the plant extract. Sample turning blue indicates the presence of cocaine.
Vitali's Test	<i>Atropa Belladonna,</i>	Fuming nitric acid is added followed by its dryness. Then alcoholic caustic potash is added giving re colour which disappears after sometime.
	<i>Dhatura fastusa Linn</i>	
Mayer's Test	<i>Nicotiana tabacum Linn</i>	Acetic acid and few drops of Mayer's reagent was added to the plant extract. White or yellow ppt appears confirming the presence of Nicotine.
Antimony Pentachloride	<i>Digitalis purpurea Linn</i>	Few drops of ethanol chloroform mixture (1:1) was added to the plant extract, followed by the spotting on No. 1 filter paper 'sprayed with 10% Antimony Pentachloride solution. The spot turns black confirming the presence of digitoxin and digitalin.
NaOH Test	<i>Croton tiglium Linn</i>	2 ml of extract in ethanol was added to 40% NaOH solution. A reddish brown ring is seen at the junction of 2 liquids.

Symptoms – experiencing vivid hallucinations in perception of sound, color and other visual distortions, loses the sense of time and space, unable to discriminate between right and wrong, loss of sense of cause and effect that changes mood and behavioral hallucinations, panic, extreme anxiety and mental depression.

Fatal period – The drug acts within 30 to 60 minutes and the effect lasts for 8 to 10 hours and some effects may even persist for several days.

Effects of Plant Poison on Human Body:

Plant poison directly or indirectly affect the body systems including cardiovascular system, CNS, digestive system. The Central nervous system gets affected and leads to stimulation (Braun *et al.* 2015), depression, paralysis, abnormal behaviour, hallucination, tremors, convulsions and abnormal behaviour. The Cardiovascular system shows severe dysrhythmias and conduction disturbances occur through the myocardium that lead to decreased flow following death. In Gastrointestinal tract, tract disease, gastroenteritis, and other miscellaneous or multisystemic diseases are caused by the plant poison. The digestive system has been associated with diarrhoea, vomiting, convulsions, muscle tremor, rhoea, dyspnoea and so on. On skins, allergies, dermatitis, irritation, inflammation, and pruritus are caused.

Examination of Plant Poison

We have looked in the plant poison and how these can affect human or animal life. It's very important to know the methods and tests for the detection of these plant poison. These tests help in detection of the active principle of the plant poison.

There are 2 methods for the examination of plant poison:

Preliminary Test- These tests gives an idea about the presence of poison present in the sample. Preliminary tests mainly include microscopic tests, colour tests and crystal tests.

First of all, the pure plant material is extracted from the given sample and with the help of different reagents available, colour tests and crystal tests are performed.

Some of these tests are explained in the table 1.

Crystal tests can also be performed for the detection of these plant poison. For example, when morphine containing biological material is treated with 5% Mercuric chloride gives tuft shaped- crystals; and with Potassium

mercuric iodide, it gives Needle shaped crystals. When *Nicotiana tabacum Lin* is treated with Potassium tri-iodide, nail shaped crystals are formed. We can detect the plant poison by looking at these crystals under the microscope. But presence of crystal is not a confirmation of the presence of plant poison. We need to perform confirmatory tests for that which is explained in the next section .

Confirmatory Tests- These tests basically involve instrumentation and spectroscopic techniques to confirm the presence of organic and inorganic materials in the given sample. Different techniques which are used include UV and IR spectroscopy, TLC, GC and HPLC.

Pre- existing data are there for the active constituent using different solvents and spraying agents. Some of these data are given below:

Thin Layer Chromatography: Thin Layer Chromatography is a techniques used for the separation of components from a given mixture. The separation is based on the adsorbitivity of the component by the silica gel G. More the adsorption, more slowly the component will move.

Solvent System- Xylene: Butanone: Methanol: Diethylamine : 40:40:6:2

Spraying Reagent: Acidified potassium iodoplatinate

Colour of the spot- violet/ blue/ purple

Plant poison can be detected by this method- Opium derivatives

Cocaine- Rf1- 60 and Rf2- 37,

Papverine- Rf1- 85 and Rf2- 70.

Solvent System- n- Hexane: Dichloromethane: Acetone : : : : 84:6:60

Spraying Agent- Fast Blue B

Colour of spot- Bluish Violet

Plant poison that can be detected- THC- Rf1- 35 and Rf2- 63.

UV data for Plant Poison:

UV is most commonly used for the detection [Sofowora A *et al.* 2013] of plant poison. This method follows the principle of Beer- Lambert's Law i.e., more the concentration of any component, more will be its absorptivity.

For example, Morphine when diluted with alkali shows highest peak at 298, strychnine shows at 255 and 278, Δ^9 -THC shows at 278. Different peaks are observed when these plant poisons are diluted with acids, for example Aconitine shows at 234 and 275, Cocaine shows at 233 and brucine shows at 265 and 306.

Infrared Data: Infrared spectroscopy is used for the detection of hydrocarbons in any compound. Active constituent of plant poison shows many peaks in the chromatogram by which we can detect the organic compound present in the sample and can also compare it with pre-existing chromatogram to know the compounds. For example, Strychnine shows peaks (in terms of wave number, cm^{-1}) at 1664, 764, 1050, 1110, 1282, 775; Cannabidiol shows at 1585, 1630, 1020, 1210, 1240, 1050, and so on.

Gas Chromatography: The extract from the biological (Tiwari, 2016) material already run in TLC is scraped and injected into the GC for its detection.

There are many conditions for column, gas used for carrying and flow rate detector, column temperature which gives us a particular retention time. Retention time is the time for which the component was in the column.

For example- for *Cannabis sativa* Linn.

- Column Condition and Packaging- 6'X 4 mm (ID) Glass column packed with 3% OV- 17 on Chromosorb W HP, 80/100 mesh.
- Carrier gas- N_2
- Flow rate- 60 mL/ min
- Column Temperature- 240°C
- Detector Temperature- 270 °C
- Injection Temperature- 270 °C
- Detector- Flame Ionisation Detector (FID)
- Retention Time:
 - Cannabidiol- 6.0
 - THC- 8.0
 - Cannabinol- 11.0
 - N- triacontane- 14.0

CONCLUSION

We have known plants for their medicinal and fodder purpose, but these plants also contain some harmful chemicals known as active constituent which affects

humans and animals in some way leading to respiratory and cardiovascular damages. The poison can be ingested accidentally due to its relevancy with other fruits and plants and can be given to other person for revenge as these are odorless, tasteless and cannot be detected easily. Different plants have been divided into various category depending on the effects in the body. Many methods has been discussed for the examination of these poisons using colour reagents and instrumentation.

Conflicts of interest: The authors stated that no conflicts of interest.

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