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1. LEARNING OUTCOMES

After studying this module, you shall be able to know about –

- The toxins of Botanical origin.
- General introduction of certain plant toxins
- Forensic significance of plant poisoning
- Screening tests for the identification of plant toxins

2. INTRODUCTION

The history of poisons and poisoning dates back several thousand years. Early poisons were almost exclusively plant and animal toxins, and some minerals. They were used mainly for hunting. Some were used as "**ordeal poisons**" which means 'Ingestion of these substances were believed to be lethal to the guilty and harmless to the innocent', for e.g. physostigmine from *Physostigma venenosum* (Calabar bean), and amygdalin from peach pits. One of the earliest classifications of poisons was done by the Greek physician **Dioscorides** (AD 40–80) who categorised poisons into 3 groups—Animal, Vegetable, and Mineral

An early treatise on plant poisons is *De Historia Plantarum*, by **Theophrastus** (**370–286 BC**). The ancient Indian text *Rig Veda* (**12th century BC**) also describes several plant poisons. The Greeks used some plant toxins as poisons of execution. **Socrates** (**470–399 BC**) was executed by the administration of hemlock.

3. FORENSIC ISSUES

Since India is a tropical country, it is host to rich and varied flora of thousands of plants, some of which are extremely poisonous. Most people in rural areas depend for their food upon farms and gardens. Cases of accidental poisoning occur not infrequently due to mistaken ingestion of toxic plant products or contamination of foodstuffs. Some cases are related to intake of harmful herbal remedies and traditional medicines. A substantial number of cases involve children for whom plants are accessible and attractive. In some Western countries, 5 to 10% of all human exposures reported to poison control centres involve plants. In India, the over-all percentage ranges from 6 to 15%, while if rural populations are taken in isolation, the percentage may be as high as 63%.

4. CLASSIFICATION OF PLANT POISONS

Plant poisons are categorized in following classes based upon their action:

4.1 **Neurotic:** They chiefly act on the Central Nervous System (CNS), Spinal cord, Symptoms usually consist of headache, drowsiness, giddiness, delirium, stupor, coma, and convulsion. E.g., Papaver somniferum, Strychnos nux vomica, Cannabis sativa, Erythroxylon coca, Atropa belladonna, Dhatura fastuosa, etc.

4.2 **Cardiac:** These affect functioning of heart. E.g., Nicotiana tabacum, Aconitum napellus, Digitalis purpurea.

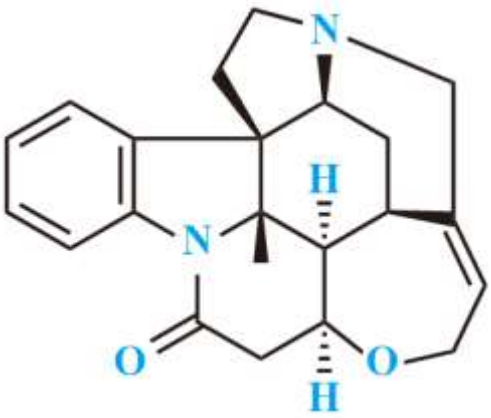
4.3 **Irritant:** These produce symptoms of pain in the abdomen, vomiting and purging. E.g., Abrus precatorius, Calotropis gigantea, Calotropis procera, Cytisus laburnum, Taxus baccata, Croton tiglium, Argemone mexicana, Gloriosa superba.

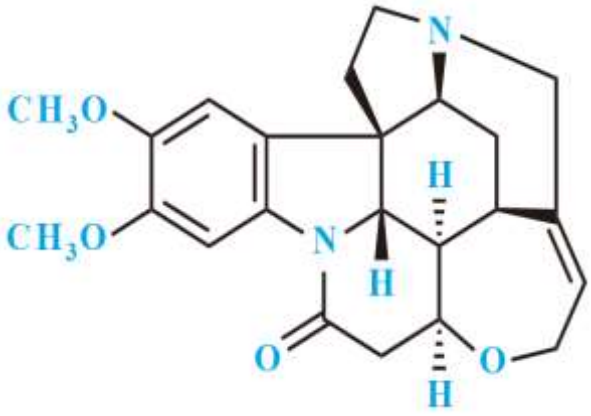
4.4 **Miscellaneous:** Cyanogenetic glycosides, Ergot *(Claviceps purpurea)*, Oleander (Glycoside)

5. SOME NOTABLE PLANT POISONS

5.1 STRYCHNINE:

Strychnine is the primary alkaloid in the strychnos plant (seeds), and is a powerful spinal stimulant. Its botanical name is Strychnos nux vomica. It is also known as Dog button, Poison nut. This is a tree belonging to family Logianaceae which grows well in South India, as well as in certain other parts of the country. The main alkaloid strychnine has been in use as a rodenticide since the 16th century. It is sometimes used for killing stray dogs (hence the name “dog buttons”).



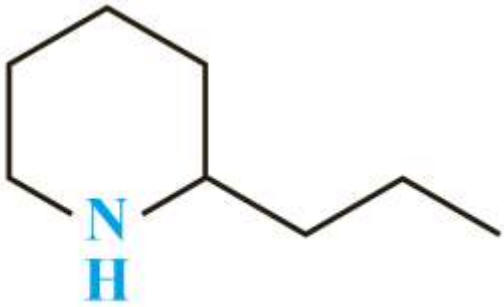


Strychnine ***Brucine***

The toxic parts of this tree are Leaves, fruits, and seeds. Strychnine and Brucine are the principal alkaloids, of which the former is much more powerful. It is a basic alkaloid and can be extracted from the seeds as an odourless, bitter-tasting, white crystalline material. The Fatal Dose is about 30 to 50 mg for strychnine and about 1 to 3 grams for strychnos seeds.

5.2 POISON HEMLOCK:

Greeks chiefly employed Hemlock, for suicidal purposes and as State poison as a form of capital punishment. *Socrates* was found guilty of corrupting the youth of Athens with his philosophical teachings and in 402BC was made to drink the State poison that is Hemlock. Its botanical name is Conium maculatum. Hemlock belongs to the family Umbelliferae of genus Cicuta, and is a biennial herb that grows erect to an average height of 1 to 3 metres. Several cases of poisoning have occurred, hemlock having been mistaken for parsley, fennel, asparagus, and parsnip. The leaves of the plant have a peculiar mousy odour, which is intensified when they are rubbed in a mortar with some caustic potash.

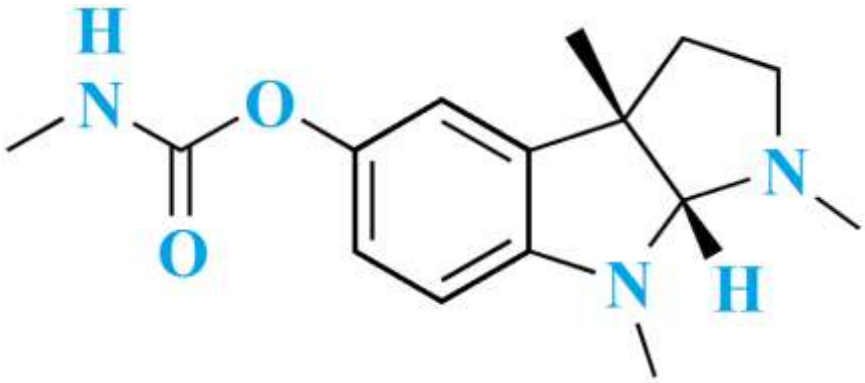


Coniine

The poisonous properties reside in piperidine alkaloids, coniine and gamma- coniceine. They are structurally similar to nicotine and possess similar clinical features in toxicity.

5.3 CALABAR BEAN

Its botanical name is Physostigma venenosum of family Leguminaceae, this plant is, sarcastically, used on the West Coast of Africa as a test of innocence in cases of suspected witchcraft. The poisonous alkaloid is physostigmine or eserine.

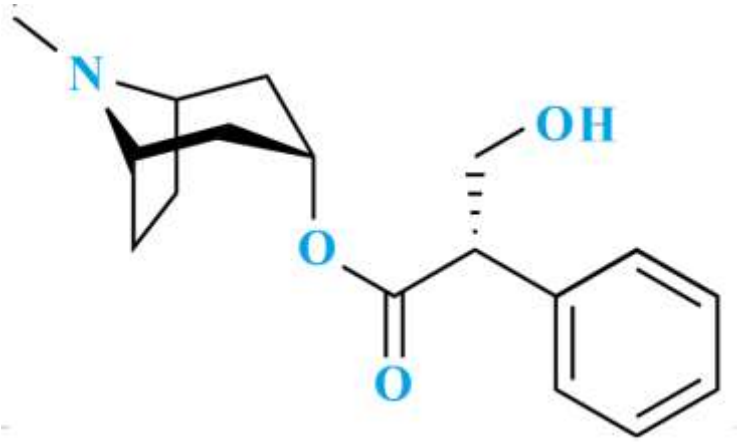


Physostigmine

The symptoms of physostigmine poisoning are vomiting, giddiness, irregular action of the heart. The mental faculties are unaffected. The eyes are bright and the pupils contracted; in which latter it differs most strikingly from atropine, hyoscyamine, and daturine, where dilatation of the pupil is the rule.

5.4 DATURA

This is a small coarse shrub of *Datura species* with a strong and rather unpleasant smell, belonging to family Solanaceae which grows wild all over the Indian countryside. Other Common Names are Jamestown weed; Jimson weed; Thorn apple; Stinkweed; Devil's weed; Angel's trumpet. The Toxic Principles of Datura are Hyoscine (scopolamine), hyoscyamine, and traces of atropine, together referred to commonly as belladonna alkaloids.

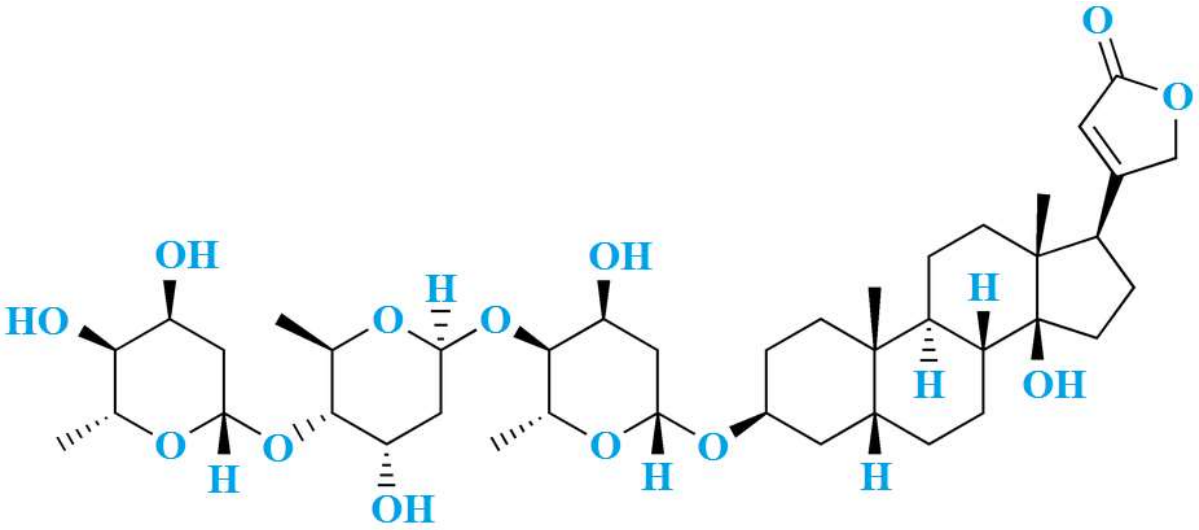


Hyoscyamine

Belladonna alkaloids competitively inhibit the muscarinic effects of acetylcholine. Sites of action are at the autonomic effectors innervated by postganglionic cholinergic nerves or on smooth muscles that do not contain cholinergic innervation. Central Nervous System effects result from their central antimuscarinic actions, i.e. vagal stimulation and decrease in heart rate. Usual Fatal Dose is about 50 to 100 Datura seeds and about 10 to 100 mg of atropine (usually 60 to 75 mg).

5.5 DIGITALIS

Digitalis purpurea, the common name of this plant is foxglove, and it grows well in the hilly regions of Darjeeling, Nilgiris, and Kashmir. It is a biennial or perennial herb belonging to family Scrophulariaceae, growing upto 1 to 1.5 metres in height. Leaves are hairy, ovate, toothed, and grey-green in colour, while the flowers are tubular and pink or white in colour. There is a related species, *Digitalis lanata*, which is also rich in cardiac glycosides. Leaves constitute the main source of glycosides which are Digoxin and Digitoxin; which is the most widely used cardiac glycosides.



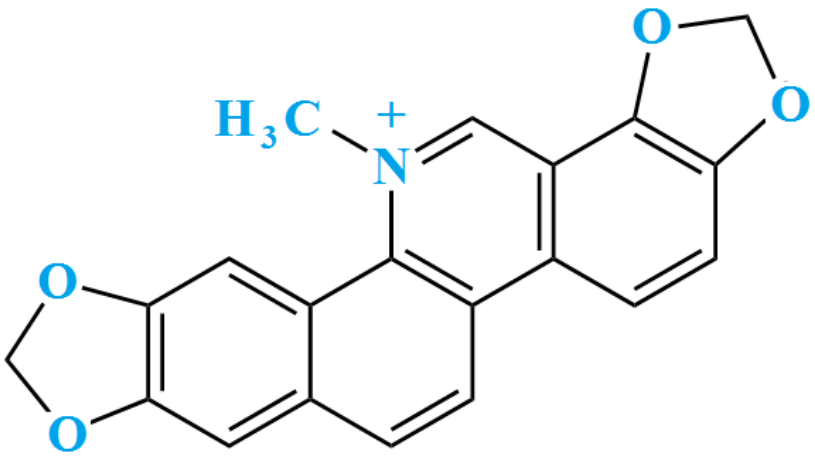
Digitoxin

Other less commonly used glycosides include Gitoxin, Gitalin, Digitonin, Digitin, Lanatoside C, and Deslanoside.

5.6 ARGEMONE MEXICANA

Other common names are Prickly Poppy, Yellow poppy, Mexican poppy. This is a robust, prickly, annual or perennial herb belonging to family Papaveraceae, which grows up to 4 feet in height, bearing thistle-like leaves and yellowish flowers. There is no legitimate use for argemone seeds or the oil extracted from them. In India, mustard oil and other vegetable oils are often adulterated deliberately with argemone oil. Sometimes the dark variety of mustard seeds is adulterated with argemone seeds. Toxic Part Seed and expressed oil are quite toxic. Leaves are also toxic (to a lesser degree). The Toxic Principles of Argemone are:

1) Sanguinarine
2) Dihydrosanguinarine.



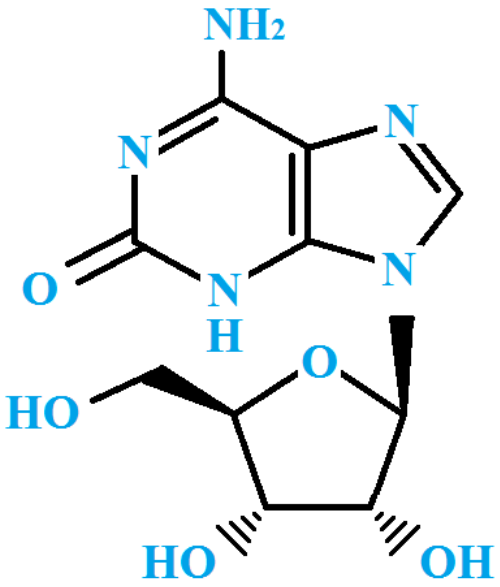
Sanguinarine

Both of them are physiologically active benzophenanthridine alkaloids. In addition, other alkaloids of lesser importance are present, such as protopine, berberine, chelerythrine, isoquinoline, and coptisine. Berberine and protopine are found throughout the entire plant, while sanguinarine and dihydrosanguinarine are found in the seeds. Liver, heart, kidneys, and lungs are the target organs of argemone alkaloids, and it is postulated that membrane destruction is the probable mode of action. The exact mechanism is not well understood.

5.7 CROTON

Croton tiglium, belonging to family *Euphorbiaceae*, grows well in Assam, Bengal, and the Western Ghats. It is a small evergreen tree with ovate or elliptical leaves which are narrow-pointed, toothed, and 2 to 4 inches long, varying in colour from metallic green to bronze, orange, or yellowish. The seeds, oil, and root extract are used as a drastic purgative in traditional medicine. The Toxic Principles of croton are:

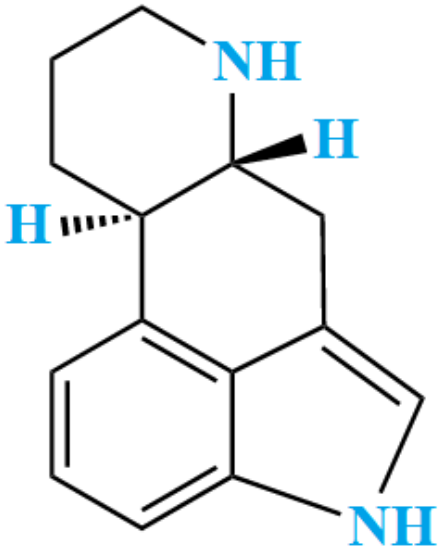
1) Crotin (toxalbumen).
2) Crotonoside (glycoside).



Crotonoside

5.8 ERGOT

Ergot is produced by a fungus, *Claviceps purpurea*, which infests certain types of grain, especially rye. The spores of the fungus are carried by insects or wind to young rye where they germinate into hyphae (filaments). The hyphae penetrate deep into the grain and harden into a purplish structure called sclerotium, which particularizes a number of ergot alkaloids. During wet seasons, *Claviceps purpurea* can infest wheat, barley, rye (most common), Oats, Wheatgrass, Quackgrass, Smooth Bromegrass, Wild Rye and Bluegrasses. Examples of ergot alkaloids include Dihydroergocornine, Dihydroergocristine, Dihydroergosine, Dihydroergotamine, Dihydroergotaxime, Ergobasine, Ergocornine, Ergocristine, Ergocryptine, Ergosine, Ergometrine or Ergonovine, Ergotamine, Ergotaxime, Methylergonovine, Bromocriptine, Lergotrile, Lisuride, Lysergol, Metergoline, Methylergonovine, and Methysergide. All these are derivatives of 6-methylergoline, a tetracyclic compound.



Ergolin Structure

There have been more than 350 chemicals identified, but less than 10 are used therapeutically. Natural ergot is also the source of the potent hallucinogen lysergic acid diethylamide or LSD.

5.9 ACONITE

This plant belongs to family *Ranunculaceae* and grows well in the hilly regions of Northern and Eastern parts of India, extending from Assam to Kashmir. The tuberous part of this plant is very popular in Chinese medicine for the treatment of various ailments. The root is usually processed by drying, soaking, or boiling, which significantly reduces its toxicity. Raw aconite roots are highly toxic. Herbal decoctions of aconite are generally prepared by soaking the roots in water or saturated lime water and then boiling. This causes hydrolysis of aconite alkaloids to less toxic benzylaconine and aconine derivatives. Aconite is also used in Indian folk remedies. It is also used as an antipyretic in Ayurvedic medicine, after "detoxification". Aconite is sometimes used as an abortifacient.

Fatal Dose of Aconite is about 9 to 18 grams of root and about 3 to 5 mg of aconitine, while about 10 to 15 ml of tincture. However, deaths have been reported with as little as 1 grams of root, 0.2 mg of aconitine, and 5 ml of aconite tincture. It has been estimated that an adult lethal dose is generally about 1 grams of plant part (root), 5 ml of a prepared tincture, or 2 mg of pure aconite.

6. EXTRACTION OF PLANT POISONS

Extraction is important for analysis as the detection and identification. Different methods which are classical and instrumental in nature are solely dependent on the efficiency of extraction, which is dependent on a number of factors viz., analytical requirement, nature of sample and nature of poison (whether alkaloid or glycoside). The plant materials like root, stem, leaves and seeds (non-biological matrices) are required to be extracted.

Plant Poison	Fraction in Stas – Otto method
Papaver somniferum Linn.	Basic – Chloroform extract
Strychnos nux vomica Linn.	Basic – Chloroform extract
Canabis sativa Linn.	Acidic – Ether extract
Erythroxylon coca Linn.	Basic – Chloroform extract
Atropa belladonna	Basic – Chloroform extract
Datura fastuosa Linn.	Basic – Chloroform extract
Aconitum napellus Linn.	Basic – Chloroform extract
Digitalis purpurea Linn.	Acidic – Ether extract
Abrus precatorious Linn.	Acidic – Ether extract
Calotropis gigantea or Procera	Acidic – Ether extract
Cystisus laburnum	Basic – Chloroform extract
Taxus baccata Linn.	Basic – Chloroform extract
Croton tiglium Linn.	Acid– Ether or Basic- Chloroform extract
Claviceps purpurea	Alkaline – Ether–Chloroform (3:1) extract
Oleander	Acidic – Ether extract

7. PRESUMPTIVE TESTS: ACTIVE ELEMENTS OF PLANT TOXINS

The purified extracts of samples of plant materials or other materials (biological and non-biological) are subjected to analysis by various colour tests for their preliminary identification.

7.1 Tests for Opium Alkaloids

7.1.1 Marquis Test:

To the dried residue of extract in a porcelain basin (flat type), 1 drop of Marquis Reagent is added. A purple red colour is produced which changes to violet and finally blue.

7.1.2 Husemann's Test:

To a little dried extract in a porcelain basin, 2-3 drops of conc. Sulphuric Acid is added and heated on a water bath for 30 minutes over a small flame for a few minutes until white fumes appear. A reddish or reddish-brown or black colour appears. It is cooled. One drop of conc. nitric acid and a crystal of Potassium Nitrate are added. A reddish violet colour appears which immediately changes to blood red and then to reddish yellow and finally fades away.

7.1.3 Frohde's Test:

To the dried residue of extract, a few drops of Frohde's reagent are added. A violet colour changing to green and finally blue is observed.

7.1.4 Urotropine Test:

To a little dried extract in a porcelain basin, a few drops of aqueous solution of Urotropine is added and warmed slightly. A purple colour changing to blue and then green is observed.

7.2 Test for Porphyroxine

2 drops of acetic acid solution of the residue of extract is taken in a porcelain basin followed by addition of a few drops of dilute Hydrochloric Acid. It is warmed over a low flame. A pink or rose red colour is produced.

7.3 Test for Meconic Acid

A few drops of neutral solution of Ferric Chloride are added to 1-2 ml. of an aqueous extract (extract obtained after separation of Meconic acid). A blood red colour is produced which is not destroyed by boiling or by adding Hydrochloric Acid or Mercuric Chloride solution.

7.4 Tests for Strychnine

7.4.1 Mandelin's Test:

First of all it is necessary to separate Strychnine from Brucine. The chloroform extract (basic fraction) containing Strychnine and Brucine is evaporated to dryness. 2 ml. of dilute Sulphuric Acid is added followed by 2 drops of conc. nitric acid. It is allowed to stand for 30-60 minutes at 10-20^{o}C, thereafter made alkaline with NaOH solution and extracted several times with chloroform. The chloroform extract is combined, washed and evaporated to dryness. The residue does not contain Brucine.

To the Brucine-free residue, one drop of Mandelin's Reagent (1% solution of Ammonium Vanadate in conc. Sulphuric Acid) is added. A deep violet-blue or deep purple colour appears which finally changes to yellow on long standing.

7.4.2 Play of Colours Test:

To the Brucine-free residue of extract in a porcelain dish, 1 drop of pure conc. Sulphuric Acid is added. No colouration is observed. A crystal of potassium dichromate is drawn by a glass rod through Sulphuric Acid. A play of colours is observed – first a momentary blue changing to a violet colour which gradually changes to reddish purple, red or orange and finally to yellow.

7.5 Tests for Brucine

7.5.1 Nitric Acid Test:

To the dried residue of the extract, one drop of conc. nitric acid is added. A blood red colour appears which changes to reddish yellow and finally to pure yellow. To this a few drops of stannous chloride solution is added. An intense purple colour develops which is destroyed by adding a few drops of conc. HNO_3.

7.5.2 Vitali's Test:

To a little dried residue of the extract in a porcelain dish, 1-2 drops of fuming or conc. nitric acid is added. It is evaporated to dryness on a water bath. It is allowed to cool. A few drops of freshly prepared alcoholic caustic potash solution is added. A fine violet colour is produced which changes to orange red or red and then disappears. On adding a few drops of excess alcoholic caustic potash solution, the colour reappears.

7.6 Test for *Cannabis sativa*

7.6.1 Fast Blue B Test:

A small amount of residue of the extract is placed in a test tube and a very small amount solid Fast blue B reagent (solid Fast blue B: anhydrous Sodium sulphate:**:** 2.5 : 100) is added. One ml. of chloroform is then added and shaken. It is kept for two minutes. The chloroform layer becomes purple red in colour.

7.6.2 Duquenois-Levine Test:

A small amount of residue of the extract is placed in a test tube. It is shaken with 2 ml. of a reagent containing acetaldehyde and vanillin (5 drops of acetaldehyde and 0.4 gm. of vanillin dissolved in 20 ml. of 95% ethanol) for one minute. 2 ml. of conc.

Hydrochloric Acid is added, shaken and allowed to stand for 10 minutes. If a colour develops, 2 ml. of chloroform is added. The lower (chloroform) layer becomes violet.

7.7 Tests for Cocaine

7.7.1 Scott Test:

The residue of the extract is taken in a test tube. 5 drops of 2% cobalt thiocyanate solution (prepared by dissolving 2 gms. of cobalt thiocyanate in water and diluted with 96% glycerine in the proportion water: glycerine:: 1 : 1). The mixture is shaken and a blue colour develops at once which indicates the presence of cocaine. (Methaqualone also gives positive reaction).

If a blue colour develops, one drop of conc. Hydrochloric Acid is added. The blue colour disappears and a clear pink colour appears. If a blue colour does not disappear, one drop of conc. Hydrochloric Acid is added. Then a few drops of chloroform are added and shaken. The chloroform layer becomes intense blue.

7.7.2 Gold Chloride Test:

One drop of 5% gold chloride solution in water is added to a few drops of extract. A precipitate is formed which appears as delicate rosette or long rod shaped crystal under microscope. The precipitate is also insoluble in dilute Hydrochloric Acid.

7.8 Test for *Atropa belladonna*

7.8.1 Vitali's Test:

A portion of residue of the extract is treated with a few drops of fuming nitric acid in a porcelain basin. It is evaporated to dryness on a water bath. The residue is cooled and moistened with a few drops of freshly prepared alcoholic caustic potash solution when a violet colour is produced, which soon changes to red and finally disappears. The colour may be made to reappear by adding more alcoholic caustic potash solution.

7.8.2 Gerrard's Test:

1-2 ml. of 2% Mercuric Chloride solution in 50% of alcohol is added to a portion of residue of the extract. A red colour develops immediately. Hyoscyamine produces a yellow colour which becomes red on burning, while hyocine does not produce any change of colour.

7.9 Test for *Dhatura fastuosa*

7.9.1 Vitali's Test:

A portion of residue of the extract is treated as above when violet colour is produced which immediately changes to red and then disappears. On adding a few drops of alcoholic KOH, the colour reappears.

7.10 Tests for *Nicotiana tabacum*

7.10.1 Mayer's Test:

(Potassium mercury iodide prepared by dissolving 1.357 gm. of Mercuric Chloride and 5 gms. of potassium iodide in 100 ml. of water).

The dried residue of extract is acidified with acetic acid followed by addition of 2 drops of reagent. A white or yellowish precipitate is obtained.

7.10.2 Phosphomolybdic Acid:

To the dried residue of the extract, a few drops of phosphomolybdic acid is added and warmed. A yellowish white precipitate is obtained.

7.10.3 Silicotungstic Acid:

To the dried residue of the extract, a few drops of Silicotungstic acid are added. A white precipitate is obtained.

7.11 Tests for *Aconitum napellus*

7.11.1 Palet's Reaction:

To the purified extract of the residue, a few drops of a mixture consisting of 2.5 gm. syrupy phosphoric acid and 0.1 gm of Sodium Molybdate is added and heated over a small flame until vapours appear. A violet colour develops.

7.11.2 Alvarez Reaction:

To the purified residue in a porcelain dish, 5-10 drops of pure bromine is added and evaporated to dryness on a water bath. 1-2 ml. of conc. nitric acid is added and evaporated to dryness (a few drops of bromine are to be added if nitric acid loses its colour). To the yellow oxidation product, 1 ml. of saturated alcoholic solution of Sodium hydroxide is added and again evaporated to dryness.

A red or brown residue is obtained. It is allowed to cool. 5-6 drops of a 10% copper sulphate solution is added. A green colour develops.

7.12 Tests for *Digitalis purpurea*

The dried residue of the extract is taken in a small porcelain basin. To this 5 drops of a 1:1 mixture of ethanol and chloroform is added and stirred. The organic solvent extract is spotted on No.1 filter paper in varying amounts and sprayed with a 10% solution of Antimony Pentachloride in chloroform. The development of yellow colour changing to purple is observed. On warming the spotted paper in hot air for 5 minutes, the colour of spot changes to black.

7.13 Test for *Abrus precatorius*

7.13.1 Fast Blue B-Potassium Hydroxide Test:

To the dried residue of the extract in a porcelain basin, a few drops of 5% ethanolic solution of Fast Blue B salt is added followed by 2 drops of aqueous KOH solution. A red to orange colour is observed.

7.13.2 Marquis Reagent:

To the dried residue of extract, 2 drops of Marquis Reagent (prepared by mixing 1 volume of formalin or formaldehyde solution with 9 volumes of concentrated Sulphuric Acid) is added. A pink colour is formed.

7.13.3 Van Urk Reagent:

To the dried residue of the extract, one drop of Van Urk Reagent (prepared by dissolving 1 gm. of p-amino benzaldehyde in 100 ml. ethanol and adding 10 ml. of Hydrochloric Acid). A green colour changing to blue is observed.

7.13.4 Special Test (Agglutination Test):

Two drops of the aqueous solution of residue of the extract are added to 2 ml. of defibrinated blood (undiluted) in a small test tube. The red blood corpuscles agglutinate into a mass like that of sealing wax.

7.14 Colour Test for *Calotropis* species

7.14.1 Conc. Hydrochloric Acid:

To a small portion of residue of the extract, a few drops of conc. Hydrochloric Acid is added and slightly warmed. A greenish-blue colour is formed.

7.14.2 Conc. Sulphuric Acid:

To a small portion of residue of the extract, a few drops of conc. Sulphuric Acid are added. A pink to purple colour develops after a few minutes.

7.14.3 Frohde's Reagent:

To a small portion of residue of the extract, 2 drops of Frohde's reagent is added. A deep green colour changing to blue and finally to green colour develops.

7.15 Colour Test for *Taxus baccata*

7.15.1 Conc. Sulphuric Acid:

To the residue of extract, one drop of conc. Sulphuric Acid is added. A violet colour is produced which disappears on addition of water.

7.15.2 Nitric Acid:

The solution of residue of extract is prepared in Sulphuric Acid using a few drops of acid. To the acid solution in small quantity, one drop of conc. nitric acid is added. A rose-red color is formed.

7.15.3 Molybdic Acid in Sulphuric Acid:

To the residue of extract, two drops of molybdic acid in conc. Sulphuric Acid are added. A rose-red colour is produced.

7.16 Test for Croton tiglium

7.16.1 Test 1:

2 ml. of concentrated extract of residue in ethanol is added to an equal volume of 40% Sodium hydroxide solution in a small test tube. A brownish red or reddish violet ring is developed at the junction of the two liquids. (The colour formation is rapid by warming).

7.16.2 Test 2:

2 ml. of concentrated ether extract of residue is taken in a porcelain basin and the solvent is evaporated off. To the residue, an alcoholic solution of 1% solution of p-dimethyl amino benzaldehyde in rectified spirit acidified with 1 ml. of conc. Sulphuric Acid is added drop by drop. A transient red colour is observed. On evaporating to dryness on hot water bath, the residue becomes brownish red to purple in colour which changes to pale blue on adding an excess of reagent.

7.17 Test for *Argemone mexicana*

7.17.1 Nitric Acid:

A few drops of oil are mixed with an equal volume of concentrated nitric acid, when a crimson orange colour appears.

7.17.2 Cupric Acetate:

When 1 ml. of glacial acetic acid and 2 ml. of Cupric Acetate solution are added to 5 ml. of oil sample in a test tube and then boiled on a water bath for 15 minutes, greenish discoloration occurs.

7.17.3 Ferric Chloride:

2 ml. of conc. Hydrochloric Acid is added to 4 ml. of oil, mixed thoroughly and warmed on a boiling water bath for 4-5 minutes. 1 ml. of Ferric Chloride solution (prepared by dissolving 10 gms. of fresh Ferric Chloride in 10 ml. of conc. Hydrochloric Acid and making up the volume to 100 ml. by distilled water) is added and again heated on a water bath for 10 minutes. A precipitate of reddish brown colour appears. The precipitate is acicular or needle shaped when observed under microscope.

7.18 Test for Ergot

7.18.1 Marquis Reagent:

To a portion of dried residue of the extract, one drop of reagent is added. A brown colour develops.

7.18.2 Vitali's Test:

Procedure for the test has been given earlier. A play of colours from dull orange to yellow and then purple is observed with the residue of the extract.

7.18.3 Mandelin's Reagent:

To a portion of the dried residue of the extract, one drop of reagent is added. Purple brown colour develops.

7.18.4 Frohde's Reagent:

To a portion of dried residue of the extract, 1 ml. of reagent (prepared by dissolving 0.5 gm. of Ammonium Molybdate in 100 ml. of water) is added. A colour change from deep green to red, grey and finally blue is observed.

8. SUMMARY

- Phytotoxicology is expression used to signify the study of plants that produce or evoke explicit deleterious effects on human.

- Poisons originating from plant are known as Plant Poisons. The toxins may be present in any part of the plant like leaves, stem, seeds, roots, bark, etc.

- Plant poisoning is more accidental in nature due to unintentional consumption of poisonous berries, fruits or plant bodies, but homicidal activities may also be encountered many instances.

- The ancient Indian text Rig Veda (12th century BC) also describes several plant poisons. The Greeks used some plant toxins as poisons of execution. *Socrates* (470–399 BC) was executed by the administration of hemlock.

- *De Historia Plantarum*, by Theophrastus (370–286 BC) contains the description of plants having poisonous characteristics.

- The *Ebers Papyrus* (Circa 1500 BC) contains information pertaining to many recognized poisons, including hemlock (the state poison of the Greeks), aconite (a Chinese arrow poison), and opium (used as both a poison and an antidote).

- The plant kingdom contains potentially 300,000 species, and the toxic effects of plants serve primarily as defense mechanisms against natural predators.

- Toxicity in humans can result from simply touching as well as ingesting plants to cause a truly wide array of deleterious effects. Toxic effects on humans can range from simple hay fever caused by exposure to plant pollen all the way to serious systemic reactions caused by ingestion of specific plants.