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The adverse effect of toxic plant constituent found in India: Forensic approach

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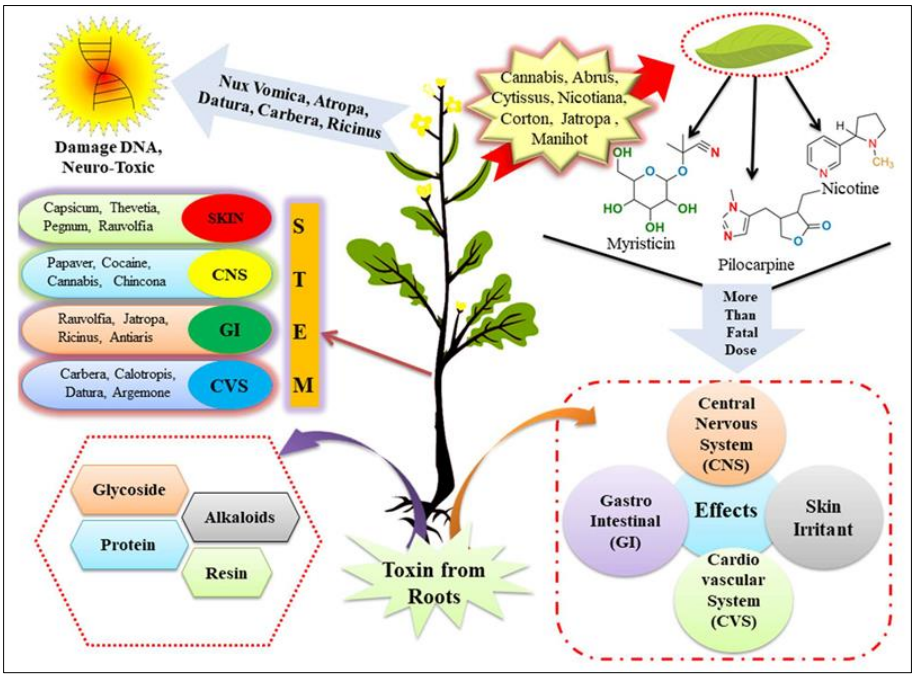
Abstract
There are various plant originated active chemical constituents which are toxicologically significant includes proteins, phenolic compounds, alkaloids, glycosides, and resins, etc. Out of these huge numbers of plants in the environment, few cause acute toxicity, severe illness if it is consumed. The diversity of active chemical constituent in plants is quite amazing. Natural poisons are those chemicals that kill without violence, mysteriously, secretly destroy life. Some of the common plant families and its toxic constituent are easily available like Euphorbiaceae (cleistanthin, toxalbumin, curcin), Solanaceae (capsicin, atropine, dutarin), Apocyanacae (uscharin, odolotoxin, neriodorin), Leguminosae (cytisine sparteine), Fabaceae (abrasine, diaminopropionic acid), Papaveraceae (narcotine, dihydrosangunarine). The natural poisons are also used by criminals for stupefying people that facilitate robbery, murder and other cases. These natural poisons are readily accessible and very cheap, so skilful poisoners prefer this toxic plant for a crime. In this work author revised literature related to the classification of plant's chemical constituents, its lethal dose and metabolic effects on the body. It has been thoroughly received and collected from journals and textbooks to make this review useful to all specialists of different discipline and it also has significant forensic importance.

Keywords: Natural poison, bioterrorism, alkaloids, toxic resin, biological significance

1. Introduction
A natural poison is the substances, which has the ability to produce adverse effect or death when it is absorbed by the body. Appropriate dosages can differentiate poison and also the remedial measures. All chemicals can produce injury, adverse effect or death under certain physiological conditions. Moreover, they are able to produce detrimental effects on a living organism. As a result, there may be a change in the structure of the substance or functional processes, which may produce injury or even death [1, 2]. In the court of law, the major difference between medicine and poison is the intention with which it is given. If any active chemical constituent has given for purpose to save a life, it is medicine but if it is given with the purpose to cause damage to health, it is a poison [3]. The father of toxicology Methieu Orfila (1787-1853) said in the sixteenth century, "Everything is poison, there is poison in everything, only the dose makes a thing not a poison [4]. An ideal poison should be cheap, easily available, colorless, odorless, tasteless, highly toxic, capable of painless death, signs and symptoms should resemble a natural death, capable of being administered easily either in food/ drink/ medicine and must be rapidly cleared from the victim's body that it could be made undetectable [5]. The toxic plants could be further classified by their origin (a) species of plants, bacteria, fungi, protists, and animals (natural poisons), (b) sedative drugs, chemicals, pesticides, alcohols and household poisons (synthetic chemicals) [6]. The prevalence of criminal poisoning in India among the topmost in the world and every year upwards 50000 people pass away because of toxic exposure [7]. The major causes of poisoning are many civilian, industrial, accidental and deliberate [8]. The toxic chemical compounds may be a single compound or a number of compounds in the same plants. The wide range of active chemical constituents of plant kingdom can be classified as primary metabolites and secondary metabolites. Toxic constituents in plants are secondary metabolites. Above 5000 species of toxic plants growing as herbs, shrubs and trees in the world. The plant product, proteins, enzymes, active chemical constituents such as alkaloids, glycosides, saponins, resinoids, oxalates photosensitizing compounds and mineral compounds are accumulated from the soil. Moreover, the overdose of plant extracts has adverse effect or acts as poisons. Plants containing alkaloids often produce unpleasant or dangerous reactions in the nervous system. Examples are paralysis (*Conium maculatum*), hallucinations (*Datura stramonium*) or cardiac

arrest (*Taxus baccata*). Generally, use of plant poisons in suicide, homicide, robbery and other crimes are common in the world as many poisonous plants grow in wild, e.g. Ricinus, Jatropa, Datura, Oleanders, and Nux vomica etc. Many articles have been reported on the principle of plant toxicology, but no work has been done especially on the study of active chemical constituents of plants in terms of the forensic context.



Graphical Abstract

1.1 Criminal Offences in Indian Panel Code (IPC)

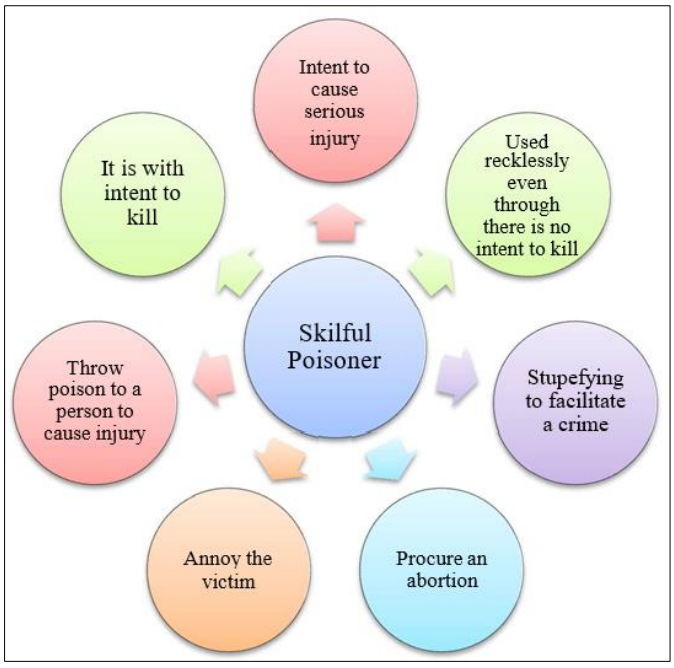


Fig 1: The strategy of poison in criminal cases by a skilful poisoner

The major section of Indian penal code (1860) comes under adulteration of food and use of toxic chemical are IPC section 272, 273,274, 276, 277, 278, 328. At present day's toxic plants such as Datura, Nerium, Atropa, and Corton are frequently used for robbery, murder and suicidal purposes. Cases of robbery (in bus, trains), using stupefying poisons such as Datura, Jatropha, Cannabis is very common in cities. Such chemical constituent has been frequently detected in the vomit of the victims. Capsicum annum (chili) powder is commonly used in the robbery or a confession of some guilt by introducing it into the nostrils, eyes, urethra, vagina, or rectum. Conium maculatum (Hemlock) is an Athenian state of poison used for the death of Socrates. Hyoscyamus niger is used in war to control shell-shock. In Crippen cases, the overdose of plants active constituent act as poisons. In the field of forensic science, the active constituent of toxic plants acts as a truth serum.

1.2 Distribution of Toxic Plants in India

India has a vast occurrence of forests like tropical forest, temperate forest, evergreen forest, Western Ghats from where the toxic plants belong. Generally, the toxic plants belong to the families of Euphorbiaceae, Solanaceae, Fabaceae, Apocyanacae and a host of other toxic families. The active constituents of plants contain Crotonic acid, Tiglinic acids, Cleistanthin, Curcin, Cyanogenic Glycoside, Atropine, Scopolamine, Hyoscyamine, Belladonnine, Solanine Steroidal Glycoside, Cerberin, Cerberoside, Odollin, Odolotoxin, Thevetin and Cerapain types of chemical. These plants mainly cover the northeastern part of Uttar Pradesh, Madhya Pradesh and coastal part of western India. Lantana camara, Mucuna pruriens, Solanum virginianum, Erythrina stricta, Crotalaria pallida, Cassia alata, Arisaema tortuosum, Datura innoxia, Cestrum nocturnum, Amorphophallus paeoniifolius are found in Western Himalaya ascending to 1350-4350 meter altitude. The Himalayan belt includes Chlorophytum breviscapum, Polygonatum brevistylum, Smilacina oleracea and Tupistra nutans to altitudes between ranges of 350-4350 meter. From Kashmir to Sikkim at an altitude of 4000-5550 meter Lantana camara, Ipomea batatas, Nerium olender are usually found. Alangiaceae, Balanitaceae, Cuscutaceae, Dioscoreaceae, Liliaceae, Ulmaceae, Meliaceae occurs in the Deccan Peninsula and Central India. Papilionaceae, Cannabaceae, Apocynaceae, Cucurbitaceae, Euphorbiaceae, Dioscoreaceae are distributed in the South of Deccan in Nilgiri at 550-900 meter altitudes. Ricinus communis, Croton tiglium, Atropa belladonna, Capsicum annum, Datura fastuosa, Calotropis gigentea, Abrus precatorius, Argemone mexicana are distributed throughout India. The review of all the toxic plants summarised in table 1 according to their toxic constituent, toxic parts, that provide a fundamental database for the forensic community.

Table 1: List of toxic plants with their families, toxic parts, the active constituent, fatal dose and fatal period

Name of Plant	Family*	Toxic Parts	Toxic Constituents	Fatal Dose	Fatal period	Chemical constituents	Ref
Cleistanthus collinus	Eup	Leafs, Bark	phyllamyricin, justicidin B, Diphyllin	0.5 mg/kg (animals)	3-7 days	Cleistanthins	[9,10]
Croton tiglium (Jamal-gota)	Eup	Seed, oil	Tiglinic acids, Crotonic acid	4 - 6 seeds, 1 - 2 mL of oil	6 h to 3 days	Toxalbumines	[11]
Euphorbia helioscopia (Sun spurge)	Eup	Milky latex	Non-Haemolytic Saponin and Phasin	2g/kg	2-3 months	Diterpenoid	[12,13]
Jatropha multifida (Bherenda)	Eup	Foliage, fruits	Curcin	>30mg/kg	15-20 days	Diterpenoid	[14]
Manihot esculenta (Sakarkanda)	Eup	Tubers	Cyanogenetic glycosides	1mg/kg	2-4 hours	Cyanogenic Glycoside	[15]
Manihot utilissima (Cassava, tapioca)	Eup	Root, leafs	Linamarin a Cyanogenic Glycoside	300 g (adult) 125 g (child)	4-6 hours	Cyanophoric, Cyanogenetic glycosides	[16]
Ricinus communis (Erandi)	Eup	Entire plant	Ricin and Ricinine	6 mg of ricin (10 seeds)	2 to several Days	Pyridine-piperidine alkaloid	[17,18]
Atropa belladonna (*Deadly nightshade*)	Sola	All parts	Atropine, Scopolamine, Hyoscyamine, Belladonnine	120 mg (atropine) 30 mg (hyoscine)	24 h	Tropane alkaloid	[19,20]
Capsicum annum (Chillies and Mirch)	Sola	Fruit	Capsaicin, Capsicin	110-150 mg/kg (oral)	6-7 days	Alkaloids	[21]
Datura fastuosa (Thorn apple and datura)	Sola	All parts especially seeds and fruit	Atropine, Hyoscyamine, Hyoscine and Dutarin	0.6 - 1 gram	24 h	Tropane alkaloid	[22]
Hyoscyamus niger (Henbane)	Sola	All parts	Atropine, Hyoscine and Hyoscyamine	125mg (hyoscyamine)	24 h	Alkaloid Hyoscyamine	[23]
Nicotiana tabacum (Tobacco and tambaku)	Sola	All parts except ripe seeds	Nicotine	60 - 100 mg	5 - 15 min	Senecio alkaloids (Pyrrolidine group)	[24,25]
Solanum nigrum (Black nightshade)	Sola	Immature berries	Solanine and Steroids	3-6 mg/kg	8-12 h	Pyridine-piperidine alkaloids	[26]
Calotropis gigantea (*M*adar, akdo)	Apocy	Juice, roots	Uscharin, Calotropin, Calactin	0.12 mg/kg calotropin	12 to 24 h	Steroidal glycosides Cardiac glycosides	[27]
Cerbera odollam (Dabur)	Apocy	Fruit, seed	Cerberin, Cerberoside, Odolin, Thevetin	Kernel of one fruit	1 - 2 days or more	Steroidal glycosides Cardiac glycosides	[28]
Cerbera thevetia (Pila kaner)	Apocy	All parts especially leaves & fruits	Thevetin, Thevetoxin, Nerifolin, Peruvoside	8 - 10 seeds,15 - 20 g of the root, 5 to 10 leaves	Depend upon Quantity	Steroidal glycosides Cardiac glycosides	[29]
Nerium odorum (Kaner)	Apocy	All parts	Neriodorin, Neriodorein, Oleandrin	15 - 20 g root	24 - 36 hours	Steroidal glycosides Cardiac glycosides	[30]
Rauwolfia serpentina	Apocy	Roots	Reserpine, Serpentine	200-300mg/ day	2-3 weak	Steroidal glycosides Cardiac glycosides	[31]

Thevetia peruviana (Suicide tree Pila kaner)	Apocy	Seeds and milky juice	Thevetin A and Thevetin B	Kernel of 1- fruit, 7-8 leaf	24-36 h	Steroidal glycosides Cardiac glycosides	[32]
Crotalaria spectabilis (Jhunjhunia)	Legu	seeds	Mono-crotaline	65 mg/kg (chicken)	24 h	Pyrrolizidine alkaloids	[33]
Cytisus scoparius (Yellow broom)	Legu	Seed, leaves and twigs	Cytisine and Sparteine			Pyridine-piperidine alkaloids	[34]
Mucuna prurita (Velvet bean)	Legu	Seeds	Mucunain, Serotonin	2g/kg	10-14 days	Imidazole Alkaloids	[35]
Abrus precatorius (Crab's eyes, Gunji)	Legu	Roots, seeds and leaves	Abrin, Abrine	1 - 2 seed, 90-120 mg/kg (Abrin)	3 – 5 days	Toxalbumines	[36]
Lathyrus sativus (Gross pea, Khesari)	Faba	Seeds	β-Cyanoalanine, 2,4-diaminobutyric acid, Selenium	1-10 mg/kg	3-5 days	Cyanophoric glycosides	[37]
Argemone Mexicana (Sial-kanta)	Papa	All parts especially seeds	Dihydro-Sanguinarine	10 mg/kg		Isoquinoline alkaloids	[38-40]
Papaver somniferum (Opium poppy)	Papa	Ripe and dried capsules, petals and seeds	Papaverine, narcotine, narceine	2 gm (opium) 0.2gm(mor-phine),0.5 gm (codeine)	2 to 6 h	Steroidal alkaloids	[41]
Lobelia nicotianifolia (Indian lobelia and dhawal)	Cam	All parts	Lobeline	10 mg (Lobeline), 3.75 g (leafs)	30 min to a day	Alkaloids	[42]
Plumbago zeylanica (Ceylon leadwort and chitrak)	Plu	Root	Plumbagin	5 gm	Few days	Steroidal glycosides Cardiac glycosides	[43]
Aconitum napellus (Monkshood and mitha zahar	Ran	All parts	Aconitine, Pseudo Aconite, Aconine	1 - 2 gram (root) 1 - 2 mg Aconotine	2 to 6 h	Alkaloids	[44,45]
Antiaris toxicaria (Upas tree, Antiaris)	Mor	Leaves and bark	α- Antiarin	LD - 0.116 mg/kg *i.v.* α-antiarin	2 – 3 days	Glycoside	[46]
Myristica fragrans (Nutmeg, Mace tree)	Myr	Seeds	Myristicin and Elemicin	1-3 nut-megs(adult) 2 nutmegs (child)	3-6 h	Alkaloids	[47,48]
Prunus amygdalus (Almond, Badam)	Ros	Almond	Amygdalin	20 almonds (adult) 10 almonds (Child)		Cyanophoric glycosides Cyanogenetic glycosides	[49]
Alocasia macrorrhiza (Giant taro, Elephant ear)	Ara	All parts	Cyanogenic Glycosides and Calcium oxalate	1/30 to 1/15 of a grain	15 min	Cyanophoric glycosides	[50,51]
Gossypium sp. (Kapas)	Mal	Seed oil	Gossypol	2.57 g/kg (Rat)		Phenolic glycosides	[52]
Ochrocarpus longifolius (Naag kesar)	Gut	All parts	Surangin A and Surangin B	LD - 9 mg/kg surangin A 1 mg/kg surangin B (Cats		Alkaloids	[53]
Peganum harmala (Wild rue)	Zyg	All parts	Harmaline, Harmine, Harmane, Harmalol, Vasicinone	Harmaline-120 mg/kg (rat), Harman-200 mg/kg (rabbit)		Alkaloids	[54,55]
Strychnos nux-vomica (Poison nut and kuchila)	Log	All parts especially seeds	Strychnine, Brucine and Vomicine	15 – 20 mg/kg (1 seed - Oral)	1 – 2 h	Indole alkaloids.	[56,57]
Cinchona officinalis (Cinchona)	Rub	Bark	Quinine, Cinchonine and Cinch-onidine	8 - 10 g	2 h to 2 days	Quinoline alkaloids	[58]
Gloriosa superba (Flame lily and Kalihari)	Lili	Tubers and roots	Colchicine, Gloriosine	6mg/kg	12-72 h	Alkaloidal amines	[59]
Digitalis purpurea (Foxglove)	Ter	Roots, leaves and seeds	Digitoxin, Digitalin Digitalein and Digitonin	15-30 mg (Digitalin) 4 mg (Digitoxin)	1 h to 24 h	Steroidal glycosides Cardiac glycosides	[60,61]

Semecarpus anacardium (Marking nut And bhilawa)	Ana	Juice	Semecarpol and Bhilawanol	5 – 10 gm	12 – 24 h	Flavonol glycosides	[62]
Cannabis sativa (Indian hemp Hashish)	Cann	Bhang, Ganja- flowers Charas- resin leaves stems	Cannabin, Cannabinol	10 gm/kg b.wt.-bhang, 8 gm-ganja, 2 gram–charas	5 – 8 Days	Cannabidiolic acid	[63,64]
Erythroxylum coca (Coke, snow)	Lin	Leaves	Cocaine, Procaine, Butacaine and Dibucaine	1 - 1.5 g Cocaine (Oral)	15 min to 10 h	Tropane alkaloid	[65]
Citrullus Colocynthis (bitter cucumber)	Cuc	Fruit, root, dripped pulp	Cucurbitacins Saponins colocynthin	1.3 g/kg (rats)		Triterpene alkaloids Glycosides	[66,67]
Conium macukatum (Poison hemlock)	Api	All parts	Coniine N-methylconiine conhydrine	0.1g of coniine (1 seed oral)		Piperidine alkaloids	[68]

*(Families: Eup (Euphorbiaceae), Sola (Solanaceae), Apocy (Apocyanacae), Legu (leguminosae), Faba (Fabaceae), Papa (Papaveraceae), Cam (Campanulaceae), Plu (Plumbaginaceae), Ran (Ranunculaceae), Mor (Moraceae), Myr (Myristicaceae), Ros (Rosaceae), Ara (Araceae), Mal (Malvaceae), Gut (Gutiferae), Zyg (Zygophyllaceae), Log (Loganiaceae), Rub (Rubiaceae), Lili (Liliaceae), Ter (Terophularaceae), Ana (Anacardiaceae), Cann (Cannabinaceae), Lin (Linaceae), Cuc (Cucurbitaceae), Api (Apiaceae)

2. Chemical classification of toxic phytochemicals

The chemical constituent of plants formed through their cell activity is organic in nature. Each plant has enzymes that convert simple substances into complex compounds. It is necessary to be aware of the fact that overdose of plant extracts can cause harmful effects [68]. The chemical constituent of toxic plants are alkaloids, glycosides, proteins, resins etc. Depending upon their chemical composition, toxic plants are mainly categorized into four groups, which are further subdivided on the basis of their pharmacological action and chemical structure.

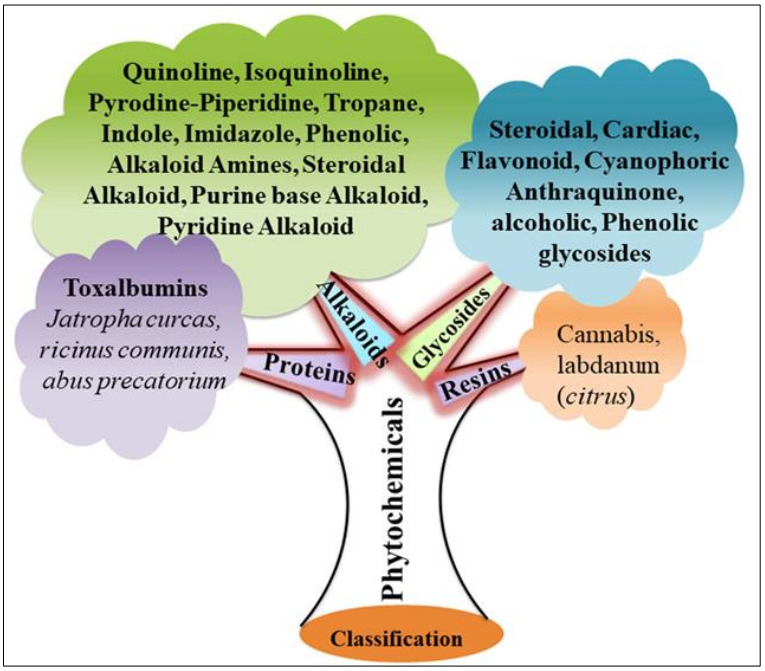


Fig 2: The classification of phytochemical present in Indian plants on the basis of there chemical components and active constituents

2.1 Alkaloids

Alkaloids are heterocyclic organic compounds containing nitrogen atoms and mainly produced by plants. Some of the alkaloids are not present in the heterocyclic form such as ephedrine, mescaline, colchicine, hordenine. The alkaloids are found in various forms like root (Rauwolfia), seed (Strychrios), leaves (Belladonna), fruits (Piper). The alkaloid includes α-propyl piperidine, pyridine- piperidine and derivative of nicotinic acid (Nicotine, Labaline, Piperidine, Ricinine). Quinoline is a basic ring structure obtained from the barks of cinchona species (*Cinchona officinalis*) contains cinchonine, cuspareine. Isoquinoline structure of alkaloids obtained from Papaver somniferum, Argemone mexicana (opium, morphine, codeine, thebaine) contains benzylisoquinoline, papaverine, narcotine, narceine. Tropane is a bicyclic structure that contains tropic acid, benzoic acid (Belladonna, Hyoscyamme, cocaine). Indole nucleus of alkaloid chemical structure is obtained from Rauwolfia, Vinca, Ergot, Nux vomica, Brucine. Steroidal alkaloids containing the imidazole ring represents by pilocarpus (phenanthrene group). Alkaloid amines contain derivatives of phenylethylamine (Ephedra, Colchium corn). Senecio alkaloids have heterocyclic rings of pyrrolizidine (Seneciohylline). Purine bases as nucleus structure is present in caffeine, theophylline and theobromine (tea leaves, coffee seeds).

2.2 Glycosides

The condensation product of sugar (including polysaccharides) and non-sugar parts of glycosides (aglycone) in form of Steroidal glycosides, Cardiac glycosides, Flavonoid glycosides, Anthraquinone glycosides, Cyanophoric glycosides. The glycosides consist of hydrogen, carbon, oxygen (some contain nitrogen and sulfur) [69]. The yellow-colored pigments called flavinoid glycosides are widely distributed in higher plants contain rutin, quercetin and citrus (bioflavonoids). The steroidal, cardiac glycosides are present in Calotropis, Oleander, Strophanthus and Convallana. The orange-colored pigments called anthraquinone glycosides, contain derivatives of polyhydroxy -anthraquinone. On hydrolysis, hydrocyanic acid produces cyanogenic glycoside (*Brassica alba*). Glucovanillin and glucovanillin alcohol on hydrolysis forms glucose and vanillic acid, after oxidation it converts into vanillic aldehyde. Phenolic glycosides (Arbutin) are found in Chimaphila, a citrus fruit, and in the barks of Rosaceous plants.

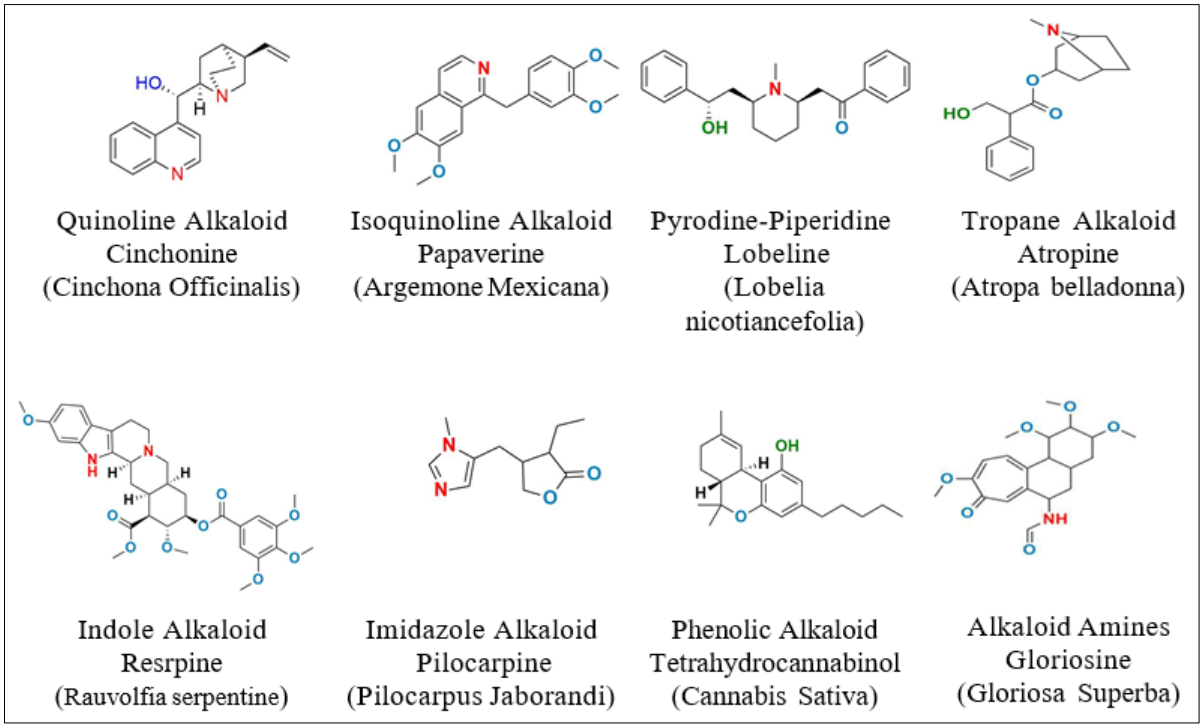
2.3 Toxic proteins

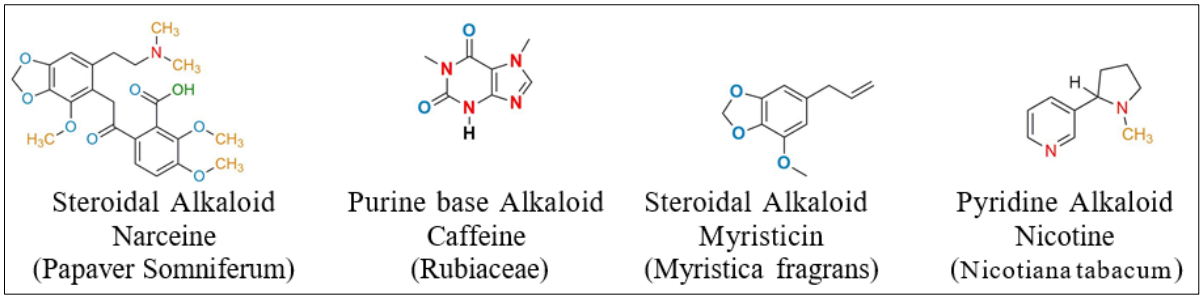
Jatropha curcas, Ricinus communis, Abrus precatorius, and Croton tiglum are some of the common plants containing a toxic protein called toxalbumins. These Toxalbumins leads to precipitation and agglutination of red blood cells. The toxic protein of plants comes from the group of phytotoxins, which modifies the 28S rRNA-60S ribosomal subunits and protein synthesis is also affected in eukaryotic cells.

2.4 Resin

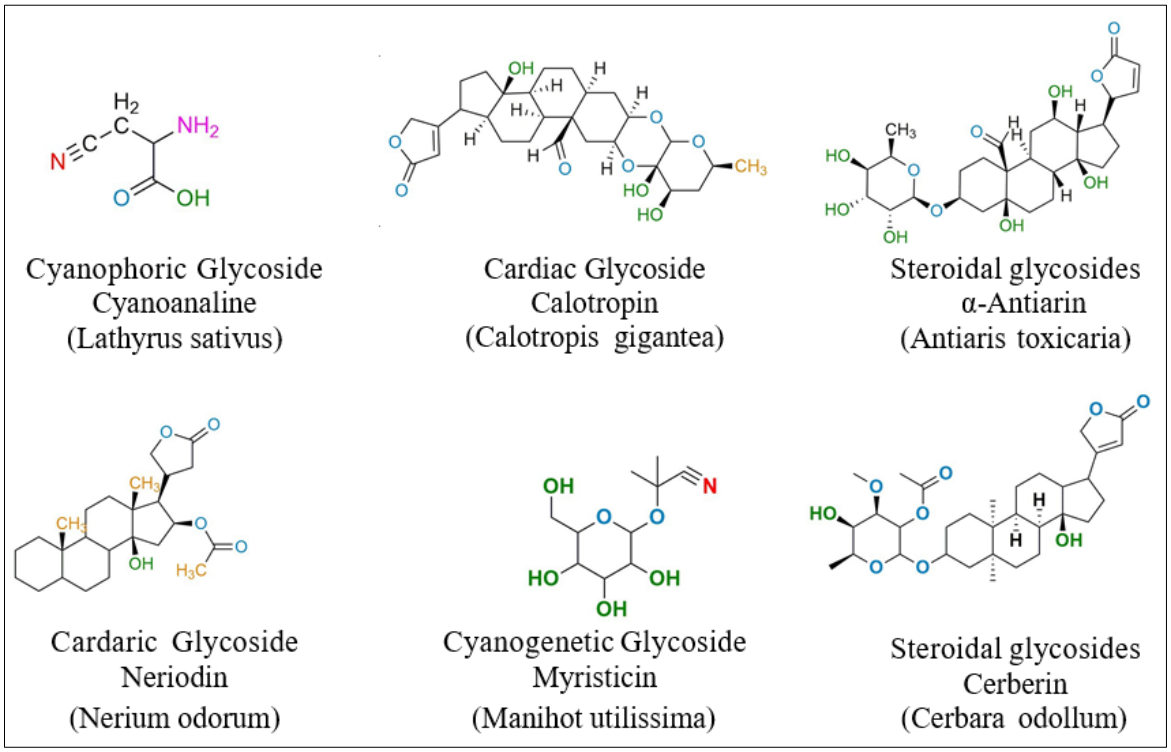
Resin is a semisolid organic substance secreted by most of the plants composed mainly of terpenes and its derivatives. Some resins also contain a large number of resin acids e.g., hashish (*Cannabis resin*) from Cannabis indica, labdanum from the Mediterranean species of Cistus. The seeds of Ricinus communis plants are highly toxic in nature. Triglyceride of ricinoleic acid and purgative oil are incorporated in the seeds of Ricinus plants.

Table 2: Show the chemical structure of active chemicals constituent of different class of alkaloids and glycosides founds in plants Alkaloids





Glycosides



3. Metabolic effect of Toxic chemical constituent on the living organism

3.1 Cardiovascular system

Two healthy patients ingested extract of Celeistanthus collinus to commit suicide. It was found that both patients were affected by severe complications such as cardiac arrhythmias, hypokalemia, hypotension, and neuromuscular weakness [70]. The fruit of Citrus Aurantivam contains Synephrine which has adverse cardiovascular effects (hypertension, cardiac arrhythmias) [71]. Cannabis (*Cannabis sativa*) causes a multiorgan effect on peripheral vascular, cerebrovascular system and occurrence of arrhythmias, increase the risk of myocardial infarction and atrial fibrillation [72]. A 60-year-old man consumed the seeds of Thevetia nereifolia that caused cardiovascular symptoms. About an hour after ingestion, there were major changes his body including ECG change, sweating, burning sensation, diarrhea, and vomiting [73].

3.2 Effect on Central Nervous System

The leaf extract of Cerbera Odollam (Apocynaceae) contains cerberin which causes disruption in heartbeat. It is also found in the study that it decreases motor activity in mice. It reduces the effective duration of pentylenetetrazole induced tonic seizures, mortality and generates a hypnotic affect [74]. Root parts of Calotropis gigantea extract effect on locomotors activity and has sedative, analgesic effects on albino rats at the dose of 250-500mg/kg bodyweight [75]. All parts of Atropa belladonna contain atropine alkaloids which cause anticholinergic syndrome, disorientation, short-term memory loss, confusion and psychosis [76]. The overdose of Datura fastuosa leaf extract serves hallucinogenic effect and cause damage in CNS [77]. Datura fastuosa contains tropane alkaloids, even small dose can cause acute confusion, fever, tachycardia, dilated pupils, urinary retention, delirium, rapid and weak pulse.

3.3 Gastrointestinal effect

The toxic protein of Croton seeds causes gastrointestinal edema by increasing gastrointestinal permeability [78]. Fruit of Jatropha multifida containing toxalbumin resin, cause dehydration, vomiting, renal and hepatic impairment [79]. Pathology revealed that castor beans (*Ricinus communis*) inhibit protein synthesis, cause gastroenteritis, hepatic necrosis and acute tubular necrosis in kidney [80]. It is now known that alkaloids of the Rauwolfia serpentine effect proximal tube cells of the kidney [81]. Extracts of croton oil, castor oil, colocynth, juice of calotropis cause irritation of colon may produce hyperemia and contraction of uterus can cause abortion.

3.4 Effect on other body parts

Abrin of Abrus precatorius contains two subunits of protein A and B. 0.1-1µg/kg fatal dose of protein A and B inhibit protein synthesis by inactivating 26S subunit of the ribosome. The ingestion of leaves, seeds and sprouts of Aesculus hippocastacanum effects on muscle system and may cause paralysis, dilated pupils and stupor [83]. The Cleistanthus collinus leaves cause cardiac arrhythmias [84] hypertension, hypoxia [85], vasodilation [86-88] neuromuscular weakness. The fatal period of 6 hours with a dose of 20-40ml of Aconitum ferox extract has a severe effect on gastrointestinal and cardiovascular organs. It causes a sign of vomiting, diarrhea, burning sensation, sweating, headache and confusion. It may cause the death of a person due to ventricular arrhythmias, paralysis of the heart [89]. Gloriosa superba has a high content of colchicine and it is used to commit suicide, murder and to kill animals [90]. After a few hours of ingestion, the person may experience vomiting, electrolyte imbalance, respiratory distress abdomen pain and burning in the throat [91].

4. Conclusion

In the present review, the author reported more than 70 poisonous plant species belonging to different families. The majority of the active constituent of poisonous parts comes from roots, latex, barks, and seeds. Besides these, the minority of poisons comes from parts of fruits, tubers, bulbs and sometimes whole plants. This report also contains toxic constituent and their metabolic effects on human beings as well as livestock. Significance of this review article on such toxic

plants provides helpful information for forensic investigators. Further, these active chemical constituents are found in viscera as well as in the crime scene. On the basis of plants active constituent found in viscera, forensic experts can predicate whether it is a case of suicide, homicide or accidental with the help of this article.

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