

Forensic Applications of Indian Traditional Toxic Plants and their Constituents

Abstract

Poisonous plants contain various biologically active phytochemicals that may be harmful to living organism if come in contact. Due to the presence of wide number of phytochemicals constituents (including digitoxin, colchicines and atropine etc.) these poisonous plants have also been found to be useful in treating various diseases. There are number of toxicologically significant phytochemicals (including proteins, oxalates, glycosides, terpenes, phenolics, alkaloids, anthocyanins, proteins, glycosides and resins etc.). These plant derivatives are used as silent naturally occurring biological bioweapons which may destroy life mysteriously without any violence. Poisonous plants which cause serious problems or even death are considered as biological weapons. These are the first choice of professional poisoners in toxicological crime because of their easy availability and having no cost. These plant derived naturally occurring biological weapons were also used by criminals in burglary, rape and murder cases. In India, there are so many cases where criminals use these products by mixing in food material or/and contact to victim's body in the buses/trains. The toxic constituents of many of such plants need to be properly recorded to develop a perfect database to be utilized in forensic analysis and identification of specific causal agents. This review is an endeavour to present an updated account of forensically important Indian traditional toxic plants and their chemical ingredients commonly used by the criminals to commit different crimes.

Keywords: Biological weapons; Toxic plants; Forensic analysis; Forensic toxicology; Plant poisoning; Phytochemical constituents

Review article

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Introduction

In ancient times, the primitive human beings might have come across poisonous plants and learned to distinguish between toxic and non toxic plant species by hit and trial error. Poison is defined as a substance which has the capacity of acting deleteriously on human health. The poisonous plants have been used for the assassination, suicide, murder and execution since ancient time if a small quantity of its stem, leaves, seeds, fruits and roots are ingested [1,2]. Poisons could be categorised in two distinct divisions according to their origin:

- i. Natural poisons (produced by species of bacteria, fungi, protists, plants and animals) and
- ii. Synthetic chemicals manufactured by humans (pesticides, sedative drugs, chemicals, alcohols and household poisons) [3].

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. Poisoning was developed as an important tool/method for crime (murder and suicide). Criminals have used toxic or irritating plants to cause harm to their victims [4] and if victim left untreated it may lead to death [1,5,6]. The poisonous nature of whole plant or any part of it is due to production of

toxic substances [2]. Some plants are normally harmless, but they may become toxic when they are taken in excess [7] or for a long period of time [1]. Poisoned weapons were used as war tactics of ancient India [8]. Chanakya also known as Kautilya (350-283 BC), was adviser and prime minister to the first Maurya Emperor Chandragupta (340-293 BC), suggested the secret use of poisons / poisoned weapons for political gain [2]. As we know that Hemlock was an Athenian state-poison by which Socrates died. Susruta Samhita has elaborated several modes of poisoning and explained how the poisons were mixed with food, drink, honey, sprinkled over cloths, beds, shoes, garlands, jewellery and saddles of horses etc. in ancient India. Now a day, naturally occurring poisons are being frequently used for robbery of travelers, murder and suicide. In forensic work, it can be used as a truth serum. The toxic constituents of many of such plants need to be properly recorded to develop a perfect database to be utilized in the forensic analysis and identification of specific causal agents. A thorough survey of literature indicates that not much work has been carried out in this area of research. This review is an endeavour to present an updated account of forensically important Indian traditional toxic plants and their chemical ingredients commonly used by the criminals to commit different crimes.

Discussion

Phytochemical poisoning in India

In India, it was estimated that more than 50,000 people die every year from toxic exposure which was highest in the world

[1,9]. The administration of a poison is a criminal offence in India [5]. In law, the difference between a medicine and a poison is based on the intention with which it is given. If the intention is to save life, it is a medicine but if it is given with the intention to cause harm, it is a poison [2]. According to Paracelsus (1493-1541), the father of toxicology said "Everything is poison, there is poison in everything, only the dose makes a thing not a poison" [10]. Now a days, in India mostly poisons are used for robbery and suicidal purposes. The poisoning and robbing of travelers happen to be of frequent occurrence in India. There are more than 4000 species of medicinal plants growing as shrubs, herbs and trees in India;

many of which are poisonous when administered in large doses. Suicide in India is very common as poison can be easily obtained and many poisonous plants grow wild e.g. datura, oleanders, aconite, nux vomica, etc. A lot of work has been reported on toxicology of plants, but little work has been done on the study of chemical constituents of plants in terms of forensic context. In the present study, a review has been performed on most of the poisonous plants of India to report the basic details of the plants poisonous parts, toxic chemical constituents, botanical and family names. The salient features of some of the Indian traditional toxic plants have been summarized in Table 1.

Table 1: List of plants having toxic constituents.

S. No.	Name of plant	Common Name	Family	Toxic Parts	References
1	<i>Digitalis purpurea</i> linn	Yellow broom, fox glove	Terophularaceae	Seed, leaves and Twigs	[11,12]
2	<i>Plumbago rosea</i>	Rakta chitraka	Plumbaginaceae	Root	[13]
3	<i>Cerbera thevetia</i>	Yellow oleander and pila kaner	Apocynaceae	All parts especially leaves and fruits	[14]
4	<i>Calotropis procera</i>	Calotropis sps. and madar, akdo	Apocyanaceae	latex	[15]
5	<i>Nerium oleander</i>	White oleander and kaner	Apocynaceae	All parts	[14]
6	<i>Semecarpus anacardium</i>	Marking nut and bhilawa	Anacardiaceae	Juice	[16]
7	<i>Dieffenbachia</i> sp.	Dieffenbachia, dumbcane	Araceae	All parts	[17-19]
8	<i>Prunus amygdalus</i>	Almond, baadam	Rosaceae	Almond	[20]
9	<i>Nicotiana tabacum</i>	Tobacco and tambaku	Solanaceae	All parts except ripe seeds	[21-23]
10	<i>Atropa belladonna</i>	Deadly nightshade	Solanaceae	All parts	[24,25]
11	<i>Datura fastuosa</i>	Thorn apple and dhatura	Solanaceae	All parts especially seeds and fruit	[26]
12	<i>Erythroxylum coca</i>	Coke, snow	Linaceae	Leaves	[27]
13	<i>Papaver somniferum</i>	Opium poppy and afim	Papaveraceae	Petals, stem, seeds and ripe dried capsules	[28]
14	<i>Argemone mexicana</i>	Argemone and Sial-kanta	Papaveraceae	All parts especially seeds	[29-31]
15	<i>Strychnos nux vomica</i>	Poison nut and kuchila	Loganiaceae	All parts especially seeds of ripe fruits	[32,33]
16	<i>Gloriosa superb</i>	Superb lily, flame lily and kalihari	Liliaceae	Tubers and roots	[34]
17	<i>Abrus precatorius</i>	Jequirity, Indian liquorice, gunchi or rati	Leguminosae	Seeds (mainly), root and stem leaves	[35]
18	<i>Croton tiglium</i>	Croton tiglium, Jamal-gota	Euphobiaceae	Seeds and oil	[36]
19	<i>Ricinus communis</i>	Castor bean, erandi	Euphorbiaceae	Entire plant especially seeds	[37,38]
20	<i>Cannabis sativa</i> or <i>Cannabis indica</i>	Indian hemp, hashish	Cannabinaceae	Dried leaves and fruit (Bhang), flowers top of female plant (Ganja), resin of leaves and stems (Charas)	[39,40]
21	<i>Aconitum napellus</i>	Indian aconite, monkshood and mitha zahar	Ranunculaceae	All parts especially dried tuberous root	[41,42]
22	<i>Aesculus hippocastanum</i>	Horse - chestnut, conker	Hippocastanaceae	All parts especially seeds	[43,44]
23	<i>Alocasia macrorrhiza</i>	Giant taro, elephant ear	Araceae	All parts	[45,46]
24	<i>Antiaris toxicaria</i>	Upas tree, Antiaris	Moraceae	Leaves and bark	[47]
25	<i>Cerbera odollum</i>	Dabur , pilikibir	Apocynaceae	Fruit and seed	[48]

26	<i>Citrullus colocynthis</i>	Indian wild gourd, bitter cucumber	Cucurbitaceae	Fruit, root and dried pulp	[49,50]
27	<i>Cleistanthus collinus</i>	NA	Euphorbiaceae	Leaves and bark	[51,52]
28	<i>Conium maculatum</i>	Poison hemlock	Apiaceae	All parts	[53,54]
29	<i>Crotolaria spectabilis</i>	Jhunjhunja	Leguminosae		[55]
30	<i>Euphorbia helioscopia</i>	Sun spurge	Euphorbiaceae	Milky latex	[56,57]
31	<i>Lantana camara</i>	Lantana, bunch berry	Verbenaceae	Entire plant, especially the berries	[58,59]
32	<i>Myristica fragrans</i>	Nutmeg, mace tree	Myristicaceae	Seeds	[60,61]
33	<i>Parthenium hysterophorus</i>	Carrot grass	Compositae	Leaves and seeds	[3]
34	<i>Pegnum hermala</i>	Wild rue	Zygophyllaceae	All parts	[62,63]
35	<i>Semecarpus anacardium</i>	Marking nut and bhilawa	Anacardiaceae	Juice	[64]

Phytochemicals as bioweapons

The overuse or abuse of the phytochemical constituents of medicinal plants may be harmful [6]. The latex containing plants found in families of apocynaceae, araceae, asclepiadaceae, sapotaceae, euphorbiaceae and papaveraceae can be poisonous, may cause serious illness and death may occur if left untreated. Orthophosphoric acid containing plants after coming in contact with skin or mucous membrane cause painful irritation and eruption. Some plants or their part (*Annona squamosa* L. and unripe pineapple) when consumed induce abortion in pregnant women. The chemical analysis of different toxic plants has revealed that they contain different toxic ingredients with varying degrees of activities (Table 1).

Classification of poisonous plants on the basis of chemical constituents

Plants containing alkaloids and glucosides are used as medicines. There are more than 20 groups of chemical constituents (alkaloids, glycosides, saponins, resinoids and mineral compounds) accumulated from the soil, which make a plant or its part to be poisonous. According to their chemical constituents, plant poisons are broadly classified in four groups:

a. Alkaloids

- b. Glycosides
- c. Toxic proteins and
- d. Resins

Which are further sub-divided on the basis of their chemical structure and pharmacological actions (Figure 1). The plants having toxic properties which may be used as biological weapons are listed in Table 1.

Types of poisonous phytochemicals

Plant poisons are the chemical constituents of organic nature, which are naturally synthesised in the plants through their individual cellular activities with the help of enzymes. On the basis of their effect on the body, the plant based poisons are broadly classified in three major groups such as

- i. Systemic
- ii. Corrosive and
- iii. Irritant

Which are sub-divided according to their chemical composition and site of action [1,2,10] that are summarized in Figure 2.

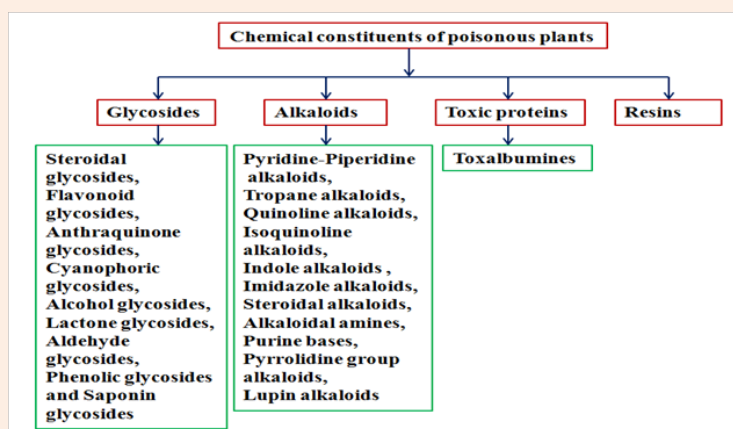


Figure 1: Classification of poisonous plants on the basis of chemical constituents.

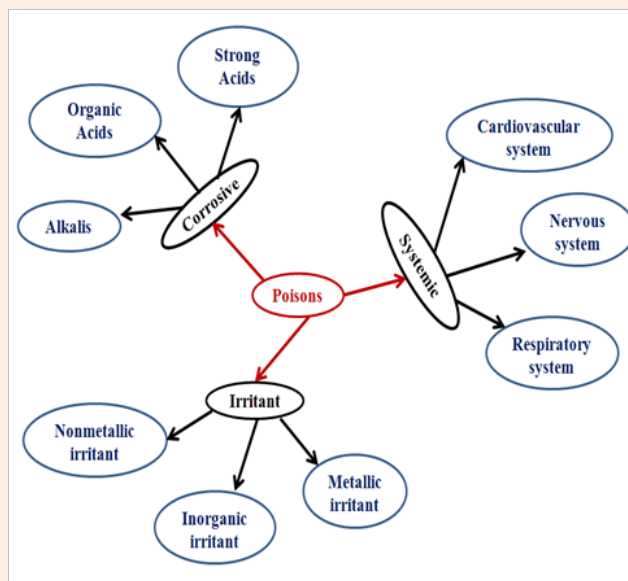


Figure 2: Types of poisons according to nature of poisoning.

Conclusion

Many species of toxic plants has been reported from different plant families. Mostly the poisonous parts of toxic plants have been reported to be seeds, latex, root, root bark, fruits, stem, stem bark, tubers, bulbs and sometimes whole plant. The data regarding family of poisonous plants, its poisonous part and its active chemical constituents, may be useful in the classification of poisonous plants. There are some plants which have neither medicinal value nor edible. Allergic or less poisonous plants are used in burglary purpose in buses / trains. On crime spot, forensic experts can get evidence related to suicidal, accidental or homicidal poisoning by chemical analysis of plant based poisons. Moreover, symptoms of poisoning may help an investigator to lead the investigation in right direction. This review may be useful to the researchers, scientists and the forensic investigators in detecting and determining the specific plant based principle/material during autopsy material or on the crime spot.

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