

Poisonous Plants of the Indian Himalaya

Subjects: Integrative & Complementary Medicine

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Indian Himalayan region (IHR) supports a wide diversity of plants and most of them are known for their medicinal value. Humankind has been using medicinal plants since the inception of civilization. Various types of bioactive compounds are found in plants, which are directly and indirectly beneficial for plants as well as humans. These bioactive compounds are highly useful and being used as a strong source of medicines, pharmaceuticals, agrochemicals, food additives, fragrances, and flavoring agents. Apart from this, several plant species contain some toxic compounds that affect the health of many forms of life as well as cause their death. These plants are known as poisonous plants, because of their toxicity to both humans and animals.

Keywords: Indian Himalaya ; pharmaceuticals ; poisonous plants ; bioactive compounds ; toxicity

1. Introduction

The documented use of plants is as old as the existence of human beings on earth ^[1], for both feeding and healing purposes ^{[2][3]}. As per the survey report published by the World Health Organization (WHO), it is estimated that about 80% of the population from developing countries depend on traditional medicine for primary health care ^{[4][5][6][7]}.

Medicinal plants are composed of a plethora of secondary metabolites, such as alkaloids, phenolics, flavonoids, terpenoids and glycosides, which act to protect them from adverse situations ^{[8][9][10][11][12]}. Most plant products are biologically and pharmacologically useful because of their therapeutic properties, while others are toxic to both humans and animals due to the presence of harmful by-products ^[1]. These plants are known as poisonous plants, because of their toxic nature, and are widely distributed around the world, being used by indigenous people for hunting, fishing and the treatment of different diseases ^{[13][14]}.

The toxic nature of a plant species vary from species to species, and depends on several factors, including chemical, physical, biological and environmental (presence of chemical substances, its concentration, age of plant, used part, ripening state of its fruits, soil type, temperature, humidity, etc.) ^[15]. The poisoning may result either from contact, which may cause skin irritation; ingestion, which may result in internal toxicity; absorption; or inhalation through the respiratory tract ^[16]. Plant toxins can be divided into several groups, such as gastrointestinal toxins, cardiovascular toxins, convulsive toxins, anti-cholinergic toxins, nicotine and nicotine-like alkaloids, calcium oxalate crystals and cellular respiration toxins ^[17] (**Figure 1**).

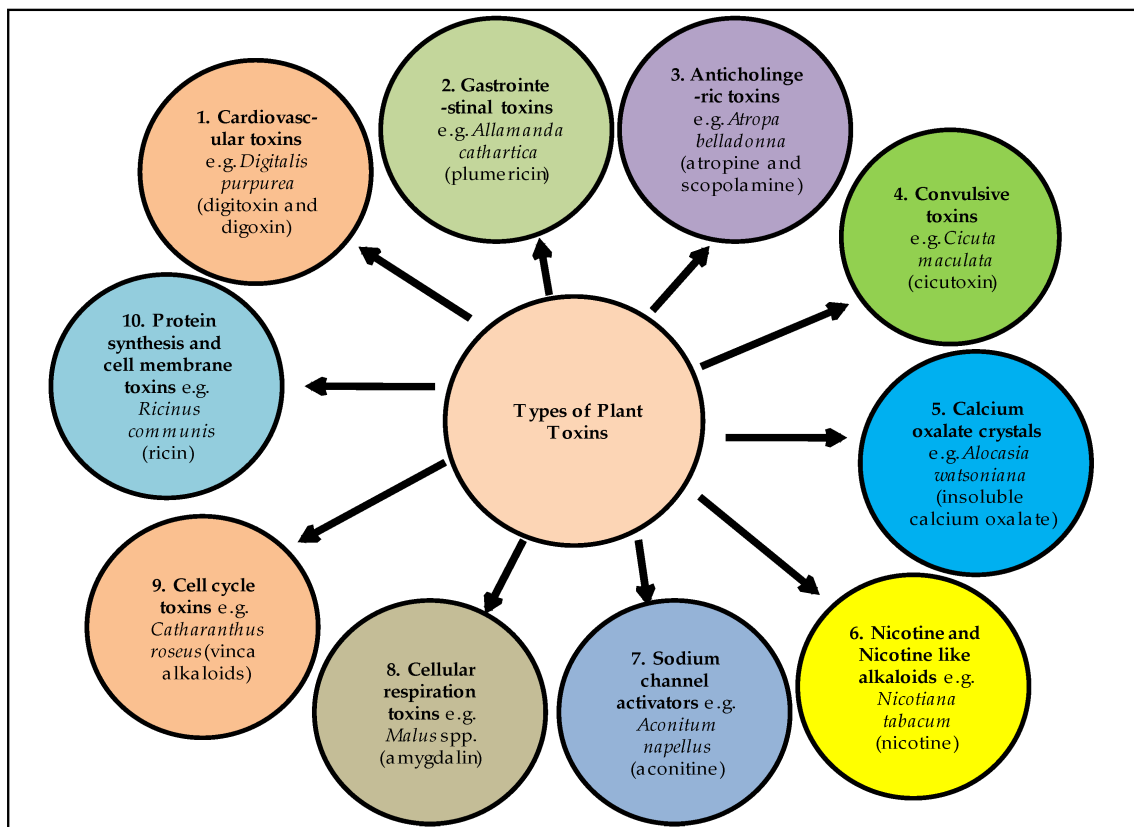


Figure 1. Types of plants toxins and their mode of actions.

Most poisonings cases are characterized by irritations of the gastrointestinal tract, such as vomiting, nausea or severe diarrhea, and others by dermatological discomfort, such as dermatitis (**Figure 2**). However, there are more severe cases of poisonings, in which the central nervous system or cardiorespiratory function can be affected, and death can even occur [18]. Plant toxins are closely related to human and animal health aspects [19], and some toxic compounds might even be applied as effective treatments for human diseases [20].

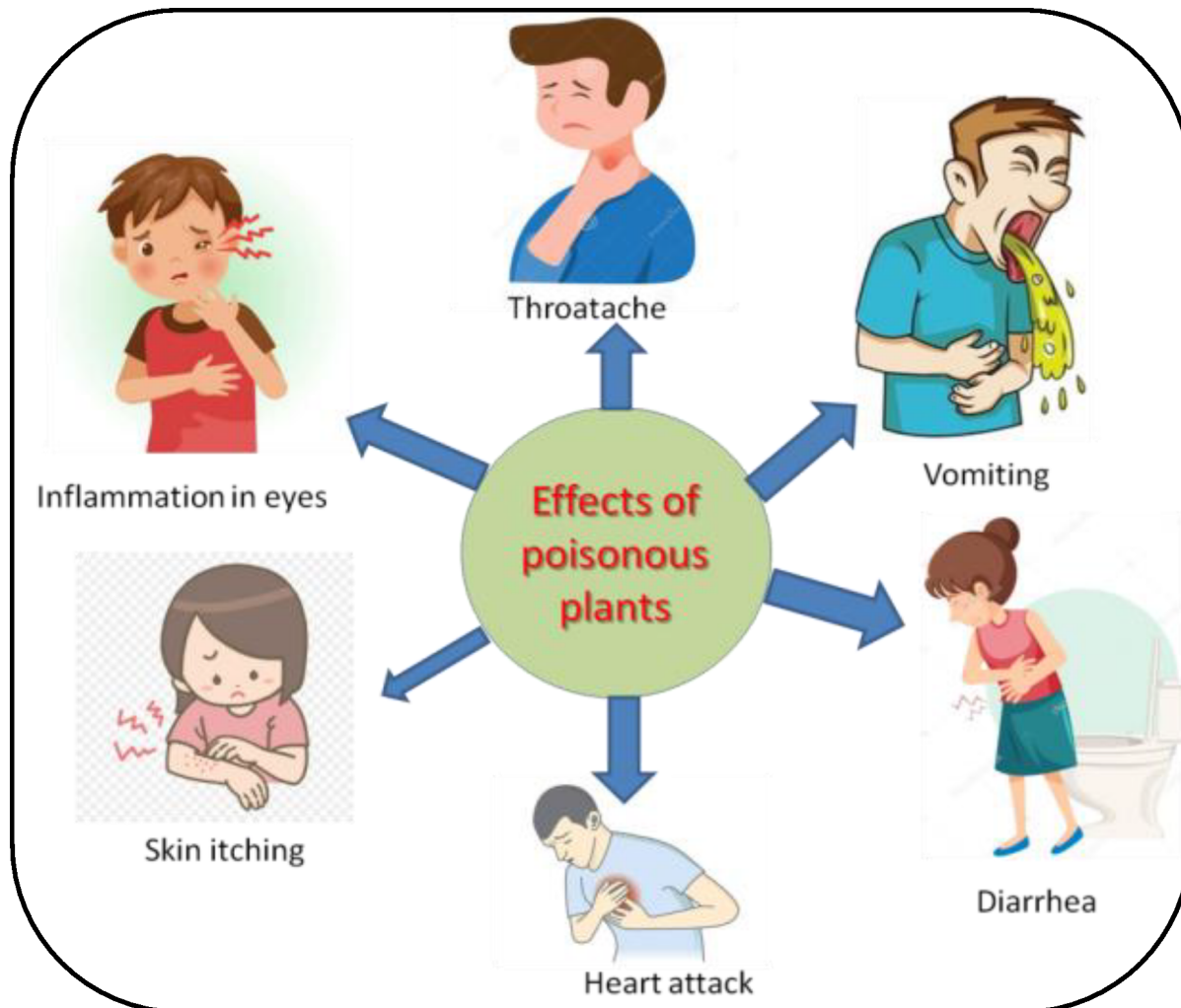


Figure 2. General symptoms of the poisonous plants in humans after touching and ingestion.

The toxicity of poisonous plants in some cases resides in whole plant, while in other cases in some parts of the plant, such as the shoot, leaves, flower, seeds, bark or even latex ^[21]. The continuous research and development in plant knowledge has promoted a marked increase in the awareness and usefulness of plants for medicinal purposes ^[22], as well as on their toxicological profiles ^{[23][24]}.

Most individuals are not familiar with the toxicity of most plants found around them, an aspect that is potentially harmful if they establish a direct contact or even ingest them. In animals, most poisonous plants cause poisoning when they are accidentally grazed by them ^[25]. Despite local elderly people passing the knowledge of poisonous plants from one generation to the next one, it is very important to provide general awareness regarding their toxicological profiles ^[26]. Thus, the best approach for minimizing accidental intoxication with poisonous plants is to make people aware of plants' toxicity and their harmful effects on them and other animals. This information should be dispersed in general by the population, childhood educators and official entities that together can play a special role in this sense.

2. Poisonous Plants of Indian Himalaya

The Indian Himalayan region (IHR) homes a huge variety of plant species that have been used in several ways, i.e., emergency food/nutraceutical, medicinal, pharmaceutical purposes, etc. ^[27]. The IHR has a large diversity of plants and most of them are known for their medicinal properties, with some of them being known for their toxicity. Poisonous plants of the IHR produce a variety of toxins that have negative effects on human and animal health, ranging from mild allergies to serious medical complication and even death. In India, it is estimated that more than 50,000 people die from toxic exposure every year, which is the highest number in the world, and plants account for 1.7% of all toxic exposures ^[28], and are mostly used for robbery and suicidal purposes. Poisoning is the fourth most common cause of mortality in India ^[29]. Poisonous plants most often affect grazing livestock, which is a major concern for both farmers and veterinarians. Grazing is considered a common routine in livestock management, but it exposes animals to a variety of poisonous plants, especially when there is a lack of fodder availability ^[30]. Animals that are already experiencing nutritional stress are more vulnerable to plant toxicity. The Indian subcontinent has the biggest population of the livestock in the world, accounting for about 7% of its income ^[31]. Sometimes, the lack of knowledge and unawareness from inhabitants means that they use

these plants for food, fodder and medicinal purposes, or are even subjected to accidental exposure, which is sometimes life-threatening to both humans and animals. Poisonous plants are harmful for livestock and causes of economic loss to the livestock sector. Some of the major poisonous plants of the IHR are further described below (**Table 1**).

2.1. *Abrus precatorius* Linn.

The seeds of *Abrus precatorius* (Indian licorice, Fabaceae) are highly toxic and contain some active compounds, such as abrine, abrasine, abraline, abrin, abricin, abrusgenicacid, etc. [32]. Abrin is more toxic than the other active compounds, which is a toxalbumin that inhibits protein synthesis and causes cell death [33]. Even consuming one of its seeds can be fatal for both children and adults. The lethal dose or (LD₅₀) of abrin toxin for human is 0.1–1 µg/kg body weight [34].

2.2. *Aconitum ferox* Wall. Ex Ser. (Syn *Aconitum Atrox* Walp)

Aconitum ferox (Indian aconite, Ranunculaceae), is an erect and perennial herb whose distribution ranges from temperate to alpine regions of India, Nepal, Bhutan and China [35][36][37]. It is a rhizomatous poisonous herb, but with great pseudoaconitine, veratroylbikhaconine, medicinal properties when used after vigorous purification and in the right amounts. Bikhaconitine, veratroylpseudoaconine, norditerpenoid alkaloids and quinolinones are some active compounds present in the whole plant [38][39]. The plant is used as poison for arrow heads [40]. The lethal dose of aconitine in human is 2 to 6 mg/kg body weight [41].

2.3. *Aconitum hookeri* Stapf.

Aconitum hookeri (Hooker's Monkshood, Ranunculaceae) extends its distribution from India, Nepal, Bhutan and China [37]. The whole plant is reported as poisonous, but its rhizomes are used as a medicine [42].

2.4. *Aconitum lethale* Griff. (Syn *Aconitum Balfourii* Stapf.)

Aconitum lethale (Balfour's Monkshood, Ranunculaceae) is an erect glabrous herb, whose main distribution is in Himalayan region. Aconitine, pseudoaconitine [43], balfourine [44][45], norditerpenoid alkaloids [46] are some active compounds found in this species. The whole plant is reported as toxic for humans and other animals.

2.5. *Aconitum napellus* Linn.

Aconitum napellus (Violet Monkshood, Ranunculaceae) is a biennial plant, with geminate tubers. Stems are usually simple, erect in the lower part, glabrous or hairy [47]. It is generally distributed in the Himalayan region of Nepal, India, China, and Pakistan [48]. The primary toxin of *A. napellus* is aconitine, which is distributed throughout the plant, but its concentration is highest in its roots and leaves [17].

2.6. *Aconitum spicatum* (Brühl) Stapf.

Aconitum spicatum (Nepal Aconite, Ranunculaceae) is a shrub species, usually sparsely pubescent and simple [36]. The root tubers of this species contain some active compounds such as aconitine, mesaconitine, bikhaconitine, deoxyaconitine, hyaaconitine, spicatine A and B [49]. *A. spicatum* is highly toxic and used as arrow poison in Nepal Himalaya [50].

2.7. *Aquilegia pubiflora* Wall. Ex Royle

Aquilegia pubiflora (Himalayan Columbine, Ranunculaceae) is another important herb widespread in the Himalayan region of India, Pakistan and Afghanistan [51]. Isovitexin, isoorientin, vitexin, chlorogenic acid, orientin, cumeric acid, sinapic acid, ferulic acid are some active compounds found in this species [52].

2.8. *Aesculus indica* (Wall. Ex Camb.) Hoof. f.

Aesculus indica (Indian horse-chestnut or Himalayan horse chestnut, Hippocastanaceae) is widely distributed in low-temperature regions of the world, and is commonly found in North Western Himalaya in the Indian context [53]. *A. indica* is large sized deciduous and perennial tree species that attains a height of up to 20 m. It is widely used in traditional medicine systems to treat many diseases. *A. indica* is poisonous to humans and other animals due to the presence of a saponin-class toxin called escin or aesculin [54][55]. After ingestion, aesculin enters the blood and destroys red blood cells. The young leaves and flowers of this plant species are more toxic than mature leaves. The bark and seeds also contain small amounts of escin [55]. *A. indica* poisoning can cause fatigue, paralysis, coma, and even death. The lethal dose or LD₅₀ was observed to be 10.6 mg/g body weight for chicks with a single dose of the seed extract (*A. indica*) and 10.7 mg/g body weight with hamster. Administration of *A. indica* for 2 consecutive days showed 6.5 mg/g LD₅₀ [54].

2.9. Cannabis sativa Linn.

Cannabis sativa (Hemp or bhang, Cannabaceae) is one of the most important industrial crops distributed at global level [56] for its psychoactive resins. The native distribution of the species is in Central Asia, Siberia, China and the Himalayas [56]. *C. sativa* contains more than 400 active compounds, but the major psychoactive toxic constituents are 9-tetrahydrocannabinol (THC) and cannabidiol (CBD) [27]. The lethal dose or LD₅₀ of THC is not determined in humans, but in cattle, it was observed to be 40 to 130 mg/kg body weight [57].

Table 1. Poisonous plants of Indian Himalayas.

S. No.	Plant Species	Family	Toxic Compound	Symptoms	Reference
1	<i>Abrus precatorius</i> Linn.	Fabaceae	Abrin	In humans, it causes vomiting, nausea, difficulty in swallowing, throat pain, high fever, weakness irritation in eyes, severe diarrhoea and even death. After ingestion by livestock it causes nasal discharge, salivation, severe diarrhoea, abortion and eventual death in pregnant animals.	[14]
2	<i>Aconitum chasmanthum</i> Stapf ex Holmes	Ranunculaceae	Aconitine, diterpenoid alkaloid	Cardiotoxins and neurotoxins, skin contact cause numbness.	[27][58]
3	<i>Aconitum ferox</i> Wall. ex Ser.	Ranunculaceae	Pseudoaconitine and bikhacoinitine	Cardio and neurotoxicity.	[38][39]
4	<i>Aconitum lethale</i> Griff.	Ranunculaceae	Pseudoaconitine and aconitine, balfourine	Cardio and neurotoxicity.	[43][44]
5	<i>Aconitum laeve</i> Royle	Ranunculaceae	8-methyllycaconitine, 14-demethyllycaconitine, and N-deethyllycaconitine-N-aldehyde	Cardio and neurotoxicity.	[59][60]
6	<i>Aesculus indica</i> (Wall. Ex Camb.) Hoof. f.	Hippocastanaceae	Escin or aesculin	After consumption it causes gastro-intestinal problems, dizziness, nausea, vomiting, headache, fatigue and pruritus, while excessive consumption may cause paralysis and death.	[54]
8	<i>Ageratum conyzoides</i> Linn.	Asteraceae	Pyrrolizidine alkaloids	Due to contact with the plant, it causes skin problems such as as itching and rashes in susceptible individuals. Animals usually avoid browsing it, but accidental consumption causes very high fever, diarrhoea, anorexia and finally death within few hours.	[61]
9	<i>Aloe vera</i> (L.) Burm.f.	Xanthorrhoeaceae	Aloin or barbaloin an anthraquinone glycoside	Excessive consumption may cause nausea, abdominal pain, vomiting, hyperkalemia and cardiac dysrhythmias.	[17]
10	<i>Anagallis arvensis</i> Linn.	Primulaceae	Primin	Consumption of the plant causes an acute headache, nausea, unconsciousness, anorexia, body pains, general weakness, bloody diarrhoea, sudden drop in body temperature and eventually death.	[14][62]

S. No.	Plant Species	Family	Toxic Compound	Symptoms	Reference
11	<i>Aquilegia pubiflora</i> Wall. ex Royle	Ranunculaceae	Isovitexin, isoorientin, vitexin, chlorogenic acid, orientin, cumeric acid, sinapic acid, ferulic acid	Cardiogenic toxins cause gastroenteritis and heart palpitations.	[63]
12	<i>Argemone Mexicana</i> Linn.	Papaveraceae	Sanguinarine and dihydrosanguinarine alkaloids present in Argemone oil.	Seeds are toxic and cause nausea, intense headaches, vomiting, severe diarrhoea, oedema of legs and feet.	[14][64]
13	<i>Arisaema tortuosum</i> (Wall.) Schott	Juncaceae	Raphide (Calcium oxalate)	Intake of tubers causes irritation of the skin and mucous membrane, mouth and body pain, slow breathing and suffocation.	[65]
14	<i>Arisaema triphyllum</i> (L.) Schott	Araceae	Raphide (Calcium oxalate)	Irritation of the skin and the mucous membrane and body pain.	[65]
15	<i>Artemisia nilagirica</i> (C.B. Clarke) Pamp.	Asteraceae	Lactones	Ingestion of large doses by animals causes headaches, nausea, vomiting and abortion of pregnant animals as a result of contraction of the uterus.	[14][66]
16	<i>Atropa belladonna</i> Linn.	Solanaceae	Atropine and Scopolamine	Plant ingestion may cause vomiting, nausea, diarrhea and abdominal cramps.	[17]
17	<i>Calotropis procera</i> (Aiton) W.T.Aiton	Asclepiadaceae	Uscharin, Calotoxin, Calotropin, Calactin, and Calotropage	The milky latex of this plant act as the skin and mucous membranes irritant, that causes blisters in both humans and animals. Accidental exposure to latex can cause eye swelling and redness. Both the leaves and the latex cause diarrhea in livestock and abortion of pregnant animals.	[14][67]
18	<i>Caltha palustris</i> Linn.	Ranunculaceae	Protoaneminin	Poison severity of this plant is low but this plant can be toxic, and ingesting large amounts of the plant's leaves can lead to burning of the throat, vomiting, bloody diarrhea and gastric illness. Poisonous to human beings in mature stages.	[68][69]
19	<i>Cannabis sativa</i> Linn.	Cannabaceae	Cannabidiol, 9-tetrahydrocannabinol (THC)	Skin allergy.	[27]
20	<i>Capsicum chinense</i> Jacq.	Solanaceae	Capsaicin	Consuming excessive amounts may cause stomach irritation.	[17]
21	<i>Cassia occidentalis</i> Linn.	Fabaceae	Achrosin, aloe-emodin, emodin	Accidental intake of pods causes nausea, vomiting, restlessness, high fever, purging and ataxia in adult humans, whereas the accidental intake of seeds in childhood causes severe brain disease. In animals it causes gastroenteritis.	[14][70][71]
22	<i>Celtis australis</i> Linn.	Ulmaceae	Not reported	Regular consumption of leaves causes weakness and increase in body temperature in animals.	[14]

S. No.	Plant Species	Family	Toxic Compound	Symptoms	Reference
23	<i>Chelidonium majus</i> Linn.	Papaveraceae	Chelidonine	Ingestion causes the severe irritation of oral mucosa.	[14]
24	<i>Colchicum luteum</i> Baker	Liliaceae	Colchicine	Prolonged consumption may cause salivation with frothing in the mouth, colic, polydipsia, fetid diarrhea, dizziness and eventually death in a few cases.	[14]
25	<i>Commelina benghalensis</i> Linn.	Commelinaceae	n-octacosanol, n-triacontanol, n-dotriacontanol	The plant is bitter in taste and after ingestion it causes stomach irritation in animals.	[14]
26	<i>Convallaria majalis</i> Linn.	Asparagaceae	Cardenolides	Neurotoxic, ingestion may cause cardiac dysrhythmia and hyperkalemia.	[27][72][73]
27	<i>Cuscuta reflexa</i> Roxb.	Cuscutaceae	Cuscutin, cuscutatin, beta-sitosterol, luteolin, bergenin and kaempferol	It causes vomiting, stomach ache, anorexia and purgation in animals, and its consumption can cause abortion in pregnant animals.	[14]
28	<i>Daphne oleoides</i> Schreb	Thymelaeaceae	Not reported	Berries and leaves consumption creates mouth sensation, nausea, vomiting, diarrhoea, restlessness, numbness and unconsciousness.	[14]
29	<i>Datura innoxia</i> Mill.	Solanaceae	Atropine	In humans the strong pungent smell of the leaves causes nausea and severe headaches. Contact with the leaves causes several skin problems. Unintentional consumption of the seeds by humans and animals causes dryness and sensation of the mouth and throat, stomach ache, numbness, anorexia, mydriasis, polydipsia and restlessness.	[14]
30	<i>Datura stramonium</i> Linn.	Solanaceae	Atropine	Accidental ingestion of the leaves or seeds by either humans or animals may cause drowsiness, dryness and sensation of the mouth and throat, bulging of the eyeballs, mydriasis, blurred vision, startling movements, convulsions, unconsciousness and finally death.	[14]
31	<i>Delphinium brunonianum</i> Royle	Ranunculaceae	Diterpenoid, alkaloids, Methyllycaco-ninite	Skin allergy.	[27]
32	<i>Digitalis purpurea</i> Linn.	Plantaginaceae	Digitoxin and Digoxin	Ingestion of the plant may cause nausea, vomiting, abdominal pain, excessive urination, abnormal heartbeats and finally death.	[17]
33	<i>Ephedra sinica</i> Stapf.	Ephedraceae	Ephedrine	Plant ingestion may cause nausea, vomiting, abdominal pain, hyperkalemia and cardiac dysrhythmias.	[17]

S. No.	Plant Species	Family	Toxic Compound	Symptoms	Reference
34	<i>Eupatorium adenophorum</i> Spreng.	Asteraceae	2-deoxo-2-(acetyloxy)-9-oxoageraphorone, 9-oxo-10, 11-dehydroageraphorone, 10H β -9-oxoageraphorone, and 10H α -9-oxo-ageraphorone	Ingestion of the plant may cause coughing, increased respiratory effort and weight loss in horses.	[74][75]
35	<i>Gloriosa superba</i> Linn.	Colchicaceae	Colchicine	Every part of this plant is poisonous, especially the tuberous rhizome, and after ingestion it may cause nausea, abdominal pain, vomiting, numbness, burning in the throat and bloody diarrhea, which leads to dehydration.	[76]
36	<i>Heracleum canescens</i> Lindl.	Apiaceae	Furanocoumarins	Skin contact with furanocoumarins caused sensitization when exposed to sunlight or UV light. Furanocoumarins enter to the nucleus and binds with DNA and causes cell death and inflammation.	[77]
37	<i>Hedera nepalensis</i> K.Koch	Araliaceae	Saponins	When the skin comes in contact with the leaves it causes skin problems such as rashes and severe swelling in susceptible individuals. Consumption of leaves is poisonous for animals, causing paralysis and finally death.	[14]
38	<i>Hyoscyamus niger</i> Linn.	Solanaceae	Tropane alkaloids	Ingestion causes dry mouth, dysphonia, tachycardia, dysphagia, mydriasis, headache, urinary retention and confusion.	[27]
39	<i>Hypericum perforatum</i> Linn.	Hypericaceae	Hypericin, pseudohypericin, and hyperforin	Plant intake during flowering phases causes itching, photosensitization and inflammation of affected areas of skin, dry cough, trembling of limbs, extreme body pains, cold sweat and intense fatigue are some other symptoms after ingestion.	[14]
40	<i>Ichnocarpus frutescens</i> (L.) W.T. Aiton	Apocynaceae	Not reported	Consumption of leaves by animals' causes indigestion, sour belching, vomiting and stomach irritation.	[14]
41	<i>Lantana camara</i> Linn.	Verbenaceae	Lantadenes	Jaundice, diarrhea, weakness, lethargy, loss of appetite, photosensitivity and hepatotoxicity in grazing animals.	[78]
42	<i>Melia azedarach</i> Linn.	Meliaceae	Tetanortriterpenes (meliatoxins)	Neurotoxin, gastrointestinal.	[27][79]
43	<i>Nerium indicum</i> Mill.	Apocynaceae	Oleandrin	Consumption of this plant causes mild to severe symptoms such as increased blood pressure and heart rate, sweating and vomiting. Its excessive consumption leads to heart attack and sudden death.	[14]

S. No.	Plant Species	Family	Toxic Compound	Symptoms	Reference
44	<i>Physalis minima</i> Linn.	Solanaceae	Solanine	Consumption of unripe berries causes abortion in pregnant animals.	[14]
45	<i>Prunus persica</i> (L.) Batsch	Rosaceae	Cyanide	Excessive consumption of the newly developed leaves affects brains and causes severe symptoms, i.e., seizures, loss of consciousness, abdominal pain, convulsions, choking, and finally death within a few hours in animals.	[14]
46	<i>Ranunculus arvensis</i> Linn.	Ranunculaceae	Protoanemonin	This plant may cause skin inflammation and injury of mucous membranes. The fresh leaf juice causes cracks, itching and sores in the skin of humans and animals.	[14][80]
47	<i>Ranunculus sceleratus</i> Linn.	Ranunculaceae	Protoanemonin	When the skin or mucosa comes in contact with the injured part of the plant, it causes itching and skin rashes and blisters. Poison ingestion may cause dizziness, nausea, vomiting, acute hepatitis, jaundice and finally paralysis.	[81][82]
48	<i>Rhamnus triquetra</i> Wall.	Rhamnaceae	Rhamnetin, quercitin and rhamnazin	Fruits and leaves of this species are highly toxic for livestock and excessive consumption affects the working ability of their brain resulting in loss of mental balance.	[14]
49	<i>Rhododendron campanulatum</i> D.Don	Ericaceae	Andromedotoxin	After ingestion of flowering buds and leaves by livestock it causes salivation, diarrhea, loss of energy and finally death.	[83][84]
50	<i>Ricinus communis</i> Linn.	Euphorbiaceae	Ricin	In humans, it causes mild to severe symptoms after ingestion, i.e., pain in throat, inflammation in eyes, high fever, profuse cold sweat, difficulty in swallowing, vomiting, diarrhoea, nausea, weakness, trembling of hands, inability to stand and finally death.	[17]
51	<i>Solanum xanthocarpum</i> Schrad. & H. Wendl.	Solanaceae	Solasonine and solamargine	After ingestion it causes headaches, nausea, vomiting, diarrhea, stomach ache, burning of the throat, itching, eczema, thyroid problems and pain and inflammation in the joints.	[85]
52	<i>Taxus baccata</i> Linn.	Taxaceae	Taxanes or Taxines, Taxol	Seeds and leaves are highly toxic, causing nausea, vomiting, abdominal pain bradycardia and respiratory muscle paralysis.	[86]

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