

Review Article

Plant Derived AlkaloidsRajandeep Kaur^{1*}, Tushar Matta², Harpreet Kaur³¹Louis Riel School Division, Winnipeg, Canada²CT Institute of Pharmaceutical Sciences, Jalandhar, India³Lovely Professional University, Phagwara, Punjab***Corresponding Author:**

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Abstract: Phytochemical study of medicinal plants is essential to determine the presence of active constituents in them. Alkaloids, the largest class, are the most important from medicinal point of view. Alkaloids are low molecular weight nitrogen containing compounds and are typically alkaline. Approximately more than 2000 alkaloids have been isolated so far. They are found in those plant parts where there is great vitality and growth. The medicinal use and their biological source along with family has been discussed in their review.

Keywords: Alkaloids, Phytochemical, Isolated, Biological, Family.

INTRODUCTION

Man is dependent on medicinal plants for health and food needs since ancient times. The traditional practice of medicinal plants for healing and averting illness has become predominant in almost every house hold [1]. It is necessary to study medicinal plants to advocate the use of herbal medicines and to regulate their possibility as a source for new drugs. Plants are an extensive source of medicines. Today abundance of drugs are derived from plants eg. Morphine from *Papaver somniferum*, Aswagandha from *Withania somnifera*, Atropine from *Atropa belladonna*, Reserpine from *Rauwolfia serpentina* etc. Medicinal plants are rich in secondary metabolites and essential oils of therapeutic importance, because of their safety; besides being economical, efficient and their effortless availability [2]. The secondary metabolites function as defense means and are present in plants only incidentally and are not of pre-eminent connotation for plant life [3]. The phytochemicals like alkaloids, flavonoids, tannins, steroids, terpenoids etc are known to show medicinal activity as well as exhibit physiological activity. Among 100 plant families approximately 2000 alkaloids have been isolated [4]. Alkaloids are a part of chemical defense in plants and are defined and cyclic compounds containing nitrogen in a negative oxidation state. About 60% of plant derived drugs are from alkaloids [5].

Properties of alkaloids [6]

Most alkaloids contain oxygen in their molecular structure & are usually colorless crystals at ambient conditions. Oxygen free alkaloids are volatile, colorless oily liquid eg. Nicotine; some alkaloids are colored eg. Berberine (yellow) and Sanguinarine

(orange). Most alkaloids are weak bases but some of the alkaloids such as Theophylline are amphoteric. Many alkaloids dissolve poorly in water but readily dissolve in organic solvents such as diethyl ether & chloroform. Alkaloids forms salts of various strengths & these salts are usually soluble in water & ethanol and poorly soluble in most organic solvents.

Classification of alkaloids [7]

The alkaloids are classified into number of modes and means:

Biosynthetic classification

The precursor from which alkaloids are produced in the plants biosynthetically ie. Alkaloids derived from same precursor but poses different taxonomic distribution and pharmacological activities.

Eg.

- Indole alkaloids derived from tryptophan
- Piperidine alkaloids derived from lysine
- Pyrrolidine alkaloid derived from ornithine
- Phenylethylamine alkaloids derived from tyrosine
- Imidazole alkaloids derived from histidine

Chemical classification

This is the most common and widely accepted mode of classification of alkaloids according to the presence of basic heterocyclic nucleus.

Eg.

- Pyrrolidine alkaloids ie hygrine
- Piperidine alkaloids ie Lobeline
- Pyrrolizidine alkaloids ie Senecionine
- Tropane alkaloids ie Atropine
- Quinoline alkaloids ie Quinine

- f) Isoquinoline alkaloids ie Morphine
- g) Aporphine alkaloids ie Boldine
- h) Indole alkaloids ie Ergometrine
- i) Imidazole alkaloids ie Pilocarpine
- j) Diazocin alkaloids ie Lupanine
- k) Purine alkaloids ie Caffeine
- l) Steroidal alkaloids ie solanidine
- m) Amino alkaloids ie Ephedrine
- n) Diterpene alkaloids ie Aconitine

Pharmacological classification

The alkaloids are also classified on the basis of pharmacological properties such as analgesics, antimalarials, anticholinergics.

Eg.

- a) Morphine as narcotic analgesic
- b) Strychnine as reflex excitability
- c) Lobeline as respiratory stimulant
- d) Boldine as laxative
- e) Aconitine as neuralgia
- f) Pilocarpine as miotic
- g) Ergonovine as oxytocic
- h) Quinine as antimalarial
- i) Ephedrine as bronchodilator

Taxonomic classification

Alkaloids are classified on the basis of their respective distribution in a variety of plant families.

Eg.

- a) Cannabinaceous alkaloids from *Cannabis sativa*
- b) Rubiaceous alkaloids from Cinchona species & *Mitragyna speciosa*
- c) Solanaceous alkaloids from *Atropa belladonna*, *Datura candida*, *Nicotiana glauca*, *Withania somnifera*.

In a present review article an attempt has been made to study the various alkaloids isolated from different plants and their pharmacological importance.

Table-1: List of alkaloids from different plants

Sr No	Plant	Common name	Family	Natural habitat	Alkaloids present	Biological activity	Reference
1	<i>Adhatoda vasica</i>	Vasaka	Acanthaceae	Asia	Vasicine; Vasicinol; Vasicinone; Adhatodine; Vasicinolone; Anisotine; Peganine	Antibacterial, antiulcer, antitubercular, antiallergic, respiratory conditions, rheumatic pain	[8]
2	<i>Aegle marmelos</i>	Indian bael	Rutaceae	S.E Asia	Aegeline; Marmeline; Shahidine; Skimmianine; Ethyl cinnamamide	Antiinflammatory, antimicro, anticancer, antioxidant	[9-12]
3	<i>Aframomun meleguata</i>	Melegueta pepper	Zingiberaceae	West Africa	10,12-dihydroxy-18-ethenyl-4-pyrido- β -carboline	Anti-inflammatory, antioxidant, antidiabetic, antimicrobial, neuroprotective	[13,14]
4	<i>Ageratum conyzoides</i>	Billy goat weed	Asteraceae	Tropical America	Lycopsamine; Dihydrolycopsamine; Acetyl-lycopsamine	Anti-inflammatory, antifungal, antibacterial, antipyretic, analgesic	[15]
5	<i>Ailanthus altissima</i>	Tree of heaven	Simaroubaceae	China, Taiwan	4-hydroxycanthin-6-one; 9-hydroxycanthin-6-one; 10-hydroxycanthin-6-one; 11-hydroxycanthin-6-one; Canthin-6-one; 1-methoxycanthin-6-one; 4-methoxy-1-vinyl- β -carboline	Antibacterial, antiviral, antioxidant, antiarrhoel, antiinflammatory, antipyretic, analgesic, anticancer, antiparasitic	[16-18]
6	<i>Ailangium lamarckii</i>	Sage leaved alangium	Alaniaceae	India	Proteometine; proteometinol; Alangine; Tubulosine; Alangiside; Isotubulosine; Psychotrine; Salsoline	Anti-inflammatory, analgesic, diuretic, rheumatism, leprosy	[19-21]
7	<i>Albizia gummifera</i>	Peacock flower	Fabaceae	Madagascar; Africa	Budmunchiamine K; Budmunchiamine G; 9-normethylbudmunchiamine K	Antimalarial, antimicrobial, cytotoxic, skin disorders, stomach disorders	[22,23]
8	<i>Ancistrocladus heyneanus</i>	Kardal	Ancistrocladaceae	India	Isoancistrocladine; Yaoundamine	Antimalarial, antimicrobial	[24-26]
9	<i>Annona squamosa</i>	Sugar apple	Annonaceae	Tropical America; Indonesia; Thailand	N-nitrosoxylopine; Roemerolidine; Duguevalline	Antitumor, antidiabetic, antimalarial, antipyretic, antiulcer, antiseptic, antidiabetic	[27,28]
10	<i>Argemone mexicana</i>	Flowering thistle	Papaveraceae	Widely distributed	Berberine; Protopine; sarguinarine; Optisine;	Antipyretic, analgesic, anti-inflammatory, antidiabetic,	[29,30]

					Chelerytherine	antibacterial, antimalarial, anti HIV, antiasthmatic	
11	<i>Arisarum vulgare</i>	Friars cowl	Aracaceae	N. Africa; Europe	Bgugaine; Irniine	Antibacterial, antifungal	[31]
12	<i>Aristolachia manshuriensis</i>	Manchurian pipewine	Aristolochiaceae	China; Korea; Siberia	Manshurienine A & B	Antiinflammatory, diuretic, antibacterial, antineoplastic	[32-34]
13	<i>Altonia angustiloba</i>	Red leafed pulai	Apocynaceae	Indonesia; Malaysia;	Yohimbine; Cathafoline; Cabucraline; Vincamajine; Normacusine B; Lochnerine; Alstophylline; Macralstonine; Villalstonine	Febrifuge, Vermifuge, Skin diseases	[35-36]
14	<i>Alstonia scholaris</i>	White cheese wood	Apocynaceae	Indian sub continent	Echitamine; Tubotaiwine; Akuammicine; Echitamidine; Alstonamine; Rhazmanine; Strictamine	Anticancer, antiasthmatic, antiinflammatory, antifertility, antitubercular, antimalarial, imunostimulating, hepatoprotective,	[37]
15	<i>Aspidosperma williamsii</i>	-----	Apocynaceae	South & Central America	Ellipticine	Anticancer	[38]
16	<i>Aspidosperma ramiflorum</i>	Quebracho	Apocynaceae	Brazil	Ramiflorines A & B	Antibacterial	[39]
17	<i>Atropa belladonna</i>	Deadly nightshade	Solanaceae	Europe; N. Africa; West Australia	Scopolamine; Hyoscyamine; Tropine; Belladonnine; Apoatropine; Hydroxyhyoscyamine; Norhyoscyamine	Anti-inflammatory, antiasthmatic, analgesic, Neuralgia, rheumatism, peptic ulcer disorders	[40]
18	<i>Bacopa monneira</i>	Brahmi	India	Plantaginaceae	Brahmine; Herpestine; Hydrocotyline; Dihydrocotyline	Antidepressant, antiparkinson, antioxidant, anti-inflammatory, analgesic, antimicrobial, cardiovascular	[41,42]
19	<i>Berberis microphylla</i>	Magellan barberry	Argentina; Chile	Berberidaceae	Berberine; Allocryptopine; Calafatine; Palmatine; protopine; Reticuline; Scoulerine; Isocorydine; Thalifendine; jatrorrhizine	Antibacterial, antipyretic, anti-inflammatory, diarrhoea	[43,44]
20	<i>Berberis vulgaris</i>	Barberry	Berberidaceae	N.W. Africa; W.Asia;	Berberine; Jatrorrhizine; Palmatine; Berbamine;	Analgesic, antipyretic, antimalarial, antimicrobial,	[45,46]

				S.Europe	Berbanine	antiulcer, anticoagulant	
21	<i>Bleekeria vitensis</i>		Apocynaceae	Fiji	Ellipticine; 9-methoxyellipticine; Isoreserpiline; Carapanaubine	Anticancer	[47-49]
22	<i>Boerhavia diffusa</i>	Tarvine	Nyctaginaceae	Asia; Africa; S.America	Punarnavine; Tarvine	Anticancer, hepatoprotective, analgesic, antidiabetic	[38,50]
23	<i>Brassica oleracea</i>	Cabbage	Cruciferae	Europe	[pyrrolidine, 1-(1-cyclohexen-1-yl-)]	Anticancer, antidiabetic, antioxidant, antiasthmatic	[51,52]
24	<i>Bryophyllum pinnata</i>	Miracle leaf	Crassulaceae	Madagascar	Briofilin; O-methylsolanoscapine	Anticancer, antimicrobial, hepatoprotective, antihypertensive, antidiabetic, anti-inflammatory, wound healing activity	[53,54]
25	<i>Cannabis sativa</i>	Marijuana	Cannabaceae	Central & S.E.Asia	Cannabisativine; Anhydrocannabisativine	Antitumor, diuretic, antipyretic, analgesic, antiemetic, antiparasitic	[55-57]
26	<i>Cammellia sinensis</i>	Tea tree	Theaceae	SE Asia	Caffeine; Theobromine	Anticancer, antioxidant, antidiabetic	[58,58]
27	<i>Cananga odorata</i>	Ylang ylang; Perfume tree	Annonaceae	Indonesia; Malaysia; Phillipines	Sampangine; Liriodenine; Lysicamine; Copyrine	Antidiabetic, anti-inflammatory, antioxidant, antimicrobial, antiulcer, antipyretic, spermatotoxic	[60]
28	<i>Camptotheca acuminata</i>	Cancer tree	Nyssaceae	China	Camptothecin	Anticancer	[61,62]
29	<i>Capsicum annum</i>	Sweet peppers	Solanaceae	Central & S.America	Nonivamide; Capsaicin; Homocapsaicin; Dihydrocapsaicin	Asthma, cough, arthritis	[63,64]
30	<i>Carica papaya</i>	Pawpaw	Caricaceae	Tropical America	Carpaine; Pseudocarpaine	Antitumor, antimalarial, antiulcer, hepatoprotective, antifertility, antifungal, antihypertensive	[65-67]
31	<i>Casimiroa edulis</i>	White sapote	Rutaceae	Mexico; Central America	Edulein; Scopoletin methyl ether; Zapoterin; Casimiroedine; Isoimpinellin	Anticancer, antiepileptic, anticonvulsant, antihypertensive	[68,69]
32	<i>Cassytha filiformis</i>	Love wine	Lauraceae	S.E Asia; Australia; Africa	Actinodaphnine; cassythine; Dicentrine	Anticancer, antioxidant, diuretic	[70,71]
33	<i>Catharanthu</i>	Tiny	Apocynaceae	India; Sri	Catharanthine; Vindoline	Antioxidant, anticancer	[72,73]

	<i>s pusillus</i>	periwinkle		Lanka			
34	<i>Catharanthus roseus</i>	Madagascar periwinkle	Apocynaceae	Tropical & Subtropical regions of world	Vinblastine; Vincristine; Anhydrovinblastine; Vindoline; Catharanthine; Ajmalicine; Serpentine	Antitumor, antiviral, antidiabetic, antibacterial, antifungal, antihypertensive	[74]
35	<i>Centaurea Montana</i>	Mountain blue	Asteraceae	Europe; N.America	Montamine; Tryptamine; Moschamine; Cis moschamine; Cis centcyamine; Centcyamine	Anticancer	[75,76]
36	<i>Centaurea schischkinii</i>		Asteraceae		Schischkinnin; Montamine	Anticancer	[77,78]
37	<i>Cephalotaxus harringtonia</i>	Cowtail pine	Cephalotaxaceae	Japan	Harringtonine; Isoharringtonine; Homoharringtonine; Deoxyhomoharringtonine	Anticancer	[79,80]
38	<i>Chelidonium majus</i>	Swallow wort	Papaveraceae	Asia; Europe	Sanguinarine; Berberine; Stylophine; Protopine; Chelidonine; Coptisine; Chelerythrine	Antiulcer, antitumor, diuretic, antiviral, antibacterial, antifungal, antiasthmatic, bronchitis, jaundice	[81-83]
39	<i>Cinchona officinalis</i>	Cinchona bark	Rubiaceae	S. America	Quinine; Quinidine; cinchonine; Cinchonidine	Antimalarial	[84,85]
40	<i>Citrullus colocynthis</i>	Bitter apple	Cucurbitaceae	Asia	2-(nonan-8-one)-(1H)-4-quinoline; 2-(nonan-8-one)-4-methoxyquinoline	Anticancer, antipyretic, diuretic, antitubercular, antiulcer, antiasthmatic, hepatoprotective	[86,87]
41	<i>Cocculus hirsutus</i>	Broom creeper	Menispermaceae	India; Pakistan; Tropical Africa	Shaheenine; Cohirsinine; Hirsutine; Jaminine; Cohirsine; Cohirsitine; Haiderine; Isotriboline; D-triboline; DL-cocclaurine	Diuretic, analgesic, antidiabetic, anti-inflammatory, antimalarial, cardiostimulant, antimicrobial	[88]
42	<i>Cocculus laurifolius</i>	Snail tree	Menispermaceae	China; Japan	Isococculidine, isococculine, cocculvine, stepharine	Diuretic, vermifuge, muscle relaxant	[89,90]
43	<i>Cola acuminata</i>	Cola nut	Malvaceae	Africa	Theobromine; Caffeine; Kolatin	Anticancer, antimicrobial, anti-inflammatory	[91]
44	<i>Colchicum autumnale</i>	Meadow saffron	Colchicaceae	Europe	Colchicine, colchicoside	Muscle relaxant, treatment of gout	[92]
45	<i>Convolvulus arvensis</i>	Field bindweed	Convolvulaceae	Asia; Europe	Tropine; Pseudotropine; Tropinone; Hygrine; Cuscohygrine	Laxative, diuretic, purgative	[93,94]

46	<i>Coscinium fenestratum</i>	Yellow wine	Menispermaceae	S.E Asia	Palmatine; Jatrorrhizine; Calumbamine; berberine	Antitumor, antidiabetic, anti-inflammatory, hepatoprotective	[95,96]
47	<i>Crinum powellii</i>	Cape lily	Amaryllidaceae	Africa	Lycorine; 1-O-acetyl lycorine	Antitumor, antiviral, antimalarial, antifungal, antibacterial, analgesic	[97,98]
48	<i>Croton sylvaticus</i>	Forest fever berry	Euphorbiaceae	Africa	Julocrotine; Penduliflaworisin	Anti-inflammatory, Antipyretic	[99]
49	<i>Cryptolepis sanguinolenta</i>	Nibima	Periploaceae	W.Africa	Cryptolepine; Quindoline; Cryptolepinoic acid; Cryptolepinoate; Methyl cryptolepinoate	Hypotensive, antipyretic, antiviral, antibacterial, antimalarial, antidiabetic, anti-inflammatory	[100,101]
50	<i>Cynanchum komarovii</i>		Apocynaceae	Tropics & Subtropics	7-methoxytylophorine; 7-methoxytylophorinen-oxide	Analgesic, antifungal, anthelmintic, antidiarrheal	[102,103]
51	<i>Cynanchum paniculatum</i>	Paniculate swallow wort root	Apocynaceae	China; Korea; Japan	Antofine	Antitumor, anti-inflammatory, neuroprotective	[104]
52	<i>Cynanchum vincetoxicum</i>	White swallow wort	Apocynaceae	Tropics & Subtropics	13-alpha antofine; 13-alpha-6-O-desmethyl antofine	Anticancer	[105,106]
53	<i>Datura innoxia</i>	Downy thorn apple	Solanaceae	America, Asia, Africa	acetylcopine; Scopolamine; Hyoscyamine	Analgesic, antipyretic, antispasmodic, antiasthmatic, antidiarrheal	[107,108]
54	<i>Datura metel</i>	Devils trumpet	Solanaceae	India	Hyoscyamine; Hyoscyne; Littorine; Valtropine; Fastusine; Fastusinine; acetoxytropine	Antiviral, anticancer, antiulcer, antifungal, antimicrobial, antispasmodic, hypoglycemic	[109]
55	<i>Dichrostachys cinerea</i>	Sickle bush	Fabaceae	Africa	Bisnordihydrotoxiferine	Antibacterial, anthelmintic, anticonvulsant, diuretic, purgative, laxative	[110,111]
56	<i>Dictaminus albus</i>	Burning bush	Rutaceae	Asia; Europe; N.Africa	Haplopine; Robustine; Dictamine; γ -fagarine	Anticancer, diuretic, abortifacient, antiseptic, vermifuge	[112,113]
57	<i>Duboisia myoporoides</i>	Corkwood	Solanaceae	Australia	Hyoscyamine; scopolamine; Butropine; apoatropine; Valtropine; 6 β -hydroxyhyoscyamine	Cancer therapy, motion sickness	[114,115]
58	<i>Ephedra sinica</i>	Ma Huang	Ephedraceae	China	Ephedrine; Pseudoephedrine; Methylephedrine; Norephedrine;	Anti-inflammatory	[116,117]

					Norpseudoephedrine		
59	<i>Ervatamia heyneana</i>	-----	Apocynaceae	India	Camptothecin; Pericalline; Coronaridine; 9-methoxy camptothecin	Antibacterial, antifungal	-----
60	<i>Erythrina variegata</i>	Tigers claw	Fabaceae	East Africa; Indian sub continent; N. Australia	10,11-dioxoerythratidine	Antibacterial, antifungal, diuretic, anticonvulsant, antiangiogenic	[118]
61	<i>Evodia rutaecarpa</i>	Wu Zhu Yu	Rutaceae	China	Evodiamine; Rutaecarpine; Dehydroevodiamine; Evodiakine; 2-undecyl-4(1H)-quinolone	Antitumor, anticancer, uterotonic, anti-inflammatory, antinociceptive	[119-121]
62	<i>Ficus benjamina</i>	Weeping fig	Moraceae	Asia; Australia	Salsoline; Reticuline; Anabesine; Matridine; Ajamalicine; Columbamine; Laudanosoline; Isoclaurine	Anti-inflammatory, antimalarial, antimicrobial, antipyretic, antinociceptive	[122]
63	<i>Ficus hispida</i>	Gobla	Moraceae	Asia	Hispidacine; Hispaloscine; Ficushispimine A,B & C; Ficushispidine; O-methyl tylophorodinine	Antineoplastic, cardioprotective, anti-inflammatory, antibacterial, antiulcer, antidiabetic, antihepatitis	[123,124]
64	<i>Fissistigma latifolium</i>	-----	Annonaceae	Malaysia	Liriodenine; Oxoxylophine; (-)Asimilobine; (-)anonaine; Columbamine; Lysicamine; (-)Remerine	Antiplasmodial, antibacterial, anticancer, antifungal, antidepressant, antioxidant	[125,126]
65	<i>Fritillaria thunbergii</i>	Thunberg fritillary	Liliaceae	Asia	Dongbeinine; Dongbeirine; Zhebeinine	Antitussive, antiinflammatory	[127,128]
66	<i>Fumaria capreolata</i>	White ramping fumitory	Papaveraceae	Asia; Africa; Europe	Reticuline; Pallidine; Protopine; Coclaurine; Dehydrocheilanthifoline	Skin disorders, rheumatism, antioxidant, parkinsons	[127,130]
67	<i>Gentiana olivieri</i>	Griseb plant	Gentianaceae	Asia	Gentianine; Gentianadine	Antibacterial, antifungal	[131,132]
68	<i>Glaucium flavam</i>	Yellow horned poppy	Papaveraceae	Europe; mediterranean regions	Glaucine; Catalane; Oxoglaucine; Pontevedrine	Anticancer, antibacterial, antifungal, analgesic, antiinflamatory, antioxidant, hypotensive, antitussive	[133]
69	<i>Glaucium grandiflorum</i>	Red horned poppy	Papaveraceae	Europe; N Africa; SW &	Corydine; Isocorydine; Protopine; Methyl canadine;	Anticancer	[134,135]

				Central Asia	Isocorytuberine		
70	<i>Helotropium indicum</i>	Indian heliotrope	Boraginaceae	Asia	Helindicine; Lycopsamine	Antibacterial, antitumor, antifertility, uterine stimulant, anti-inflammatory, diuretic	[136,137]
71	<i>Hernandia nymphaeifolia</i>	Lantern tree	Hernandiaceae	Throughout tropics	S-ovigerine; S-N-methyl ovigerine; S-magnoflorine; S-hernovine; S-N-hydroxy ovigerine	Antiplasmodic	[138]
72	<i>Hippeastrum puniceum</i>	Easter lily	Amaryllidaceae	Central & S. America; West Indies	3-O-acetyl-narcissidine, Lycorine, Pancratistatin, Nasciclasine	Antitumor, antiviral, antimalarial	[139]
73	<i>Hippeastrum vittatum</i>	Bulb mave	Amaryllidaceae	Brazil	Homolycorine; Hippeastrine; Montanine; Vittatine; Ismine, Lycorine, vittacarboline, Pancracine; Hippadine	Antitumor, antidepressant	[140,141]
74	<i>Holarrhena floribunda</i>	Kurchi bark	Apocynaceae	Africa	Holarrhesine; Holadienne; Conessine	Antimalarial, antidiarrhoeal, antidiabetic, antidyentery	[142,143]
75	<i>Hydrastatis Canadensis</i>	Golden seal	Ranunculaceae	Canada, United States	Berberine; Canadine; Hydrastine; Hydrastinine; Palmatine	Antifungal, anti-inflammatory, anticancer, hepatoprotective, antiparasitic	[144,145]
76	<i>Hyoscyamus muticus</i>	Egyptian henbane	Solanaceae	Asia; Europe	Hyoscyamine; Scopolamine; atropine; homatropine; littorine; tropine; pseudotropine; hygrine; norhygrine	Analgesic, antispasmodic, acaricidal	[146,147]
77	<i>Hyoscyamus niger</i>	Henbane	Solanaceae	Asia; N. America	Hyoscyamine; Scopolamine	Hypotensive, vasodilator, analgesic, anticholinergic, spasmolytic, bronchodilatory,	[148,149]
78	<i>Jatropha curcus</i>	Purging nut	Euphorbiaceae	Mexico, Central America	5-hydroxypyrrolidin-2-one; Pyrimidine-2,4-dione	Antiviral, antiHIV, antitumor, antifungal, antiulcer, wound healing activity	[150,151]
79	<i>Lantana camara</i>	Wild sage	Verbenaceae	Asia; S. America	Lantanine; Lantadine; Camerine; Micranine; Isocamerine	Antimicrobial, antipyretic, antioxidant, wound healing, antihyperglycemic	[152]
80	<i>Ligularia hodgsonii</i>	Golden queen; Leopard	Compositae	East Asia	Ligularine; Clivorine	Anticancer, diuretic	[153]

		plant					
81	<i>Lindera megaphylla</i>	Spice bush	Lauraceae	Asia	Dicentrine; Dicentrinone; reticuline; Northalifoline; N-methyl nandigerine	Antiplatelet activity	[154,155]
82	<i>Litsea glutinosa</i>	Brown beach	Lauraceae	India; China; Malayasia; Australia	Boldine; Litseglutine A & B; Lauroitsine	Antidiarrhoel, antidyentery, wound healing activity	[156,157]
83	<i>Lycopodium clavatum</i>	Ground pine	Lycopodiaceae	Asia; America; Europe; Africa	Clavolonine; Lycopodine; Dihydrolycopodine; Lycoflexine; Acetyl dihydro lycopodine	Hepatoprotective, anti-inflammatory, analgesic, antiviral	[158]
84	<i>Lycoris radiate</i>	Hurricane lily	Amaryllidaceae	East Asia	Lycoramine; lycorine; Tazettine; Ismine; Homolycorine; Lycoramine N-oxide; Caranine; Galanthamine; Ungerine; Hippeastrine	Expectorant, emetic, anticancer	[159]
85	<i>Macleaya cordata</i>	Plume poppy	Papavaraceae	China; Japan	Cryptopine; Protopine; Chelidimerine; Macleayine; Norsanguinarine; Sanguidimerine; Dihydrosanguinarine	Antimicrobial, anti-inflammatory, antitumor, anticancer	[160,161]
86	<i>Mahonia manipurensis</i>	Takeda	Berberidaceae	N.E. India	Berberine; Jatrorrhizine; Palmatine; Oxyacanthine	Anticancer, antimicrobial, antioxidant, antiproliferative, anti-inflammatory	[162]
87	<i>Meiogyne virgata</i>	-----	Annonaceae	S.E. Asia	Oxoaporphines; Liriodenine; Lanuginosine; Asimilobine; Lysicamine; Anonaine; Remerine; Nornuciferine	-----	[125]
88	<i>Mitragyna speciosa</i>	Kratom, Thang	Rubiaceae	S.E Asia	Corynoxine; Mitragynine; Speciogynine; Paynantheine; Corynoxine B	anti-inflammatory, analgesic, muscle relaxant	[163,164]
89	<i>Morinda citrifolia</i>	Indian mulberry	Rubiaceae	S.E. Asia	Prexeronine	Anticancer, antidiabetic, antitubercular, antibacterial	[165,166]
90	<i>Murraya koenigii</i>	Curry tree	Rutaceae	India; Sri Lanka	Murrayacine; Murrayazolidine; Mahanimbine; Isomahanine; Girinimmahanine; Koenimbine	Anticancer, antimicrobial, antiinflamatory, antidiarrhoel, antioxidant	[167,168]
91	<i>Nauclea orientalis</i>	Bur tree	Rubiaceae	S.E. Asia; Australia	Naucleficine; Naucleactonine; Naucleorals A & B	Antimalarial	[169,170]
92	<i>Nicotiana glauca</i>	Tree tobacco	Solanaceae	S. America	Anabasine; Nornicotine	Antibacterial	[171-173]

93	<i>Ochorasia elliptica</i>	Elliptic yellow wood	Apocynaceae	Australia	Ellipticine; Methoxy ellipticine; Elliptinine; Isoreserpiline; Cathenamime; Pleiocarpamine; Apparicine; Epchrosine; Tetrahydroalstonine	Anticancer	[174,175]
94	<i>Pachysandra procumbens</i>	Allegheny	Buxaceae	SE United states	Pachysamine H; Pachysandrine B	-----	[176]
95	<i>Papaver rhoeas</i>	Red poppy	Papaveraceae	Europe; N. Africa; W. Asia	Rhoeadine; Isocorydine; Coptisine; Stylopine; N-methylasimilobine	Antimutagenic, anti-inflammatory, antidiarrhoeal, analgesic, antiulcer	[177,178]
96	<i>Papaver somniferum</i>	Opium poppy	Papaveraceae	Eastern Mediterranean	Morphine; Codeine; Noscapine	Analgesic, antitussive	[179,180]
97	<i>Passiflora caerulea</i>	Blue passion flower	Passifloraceae	S. America	Harmol; Harmine	-----	[181]
98	<i>Passiflora incarnata</i>	Apricot vine	Passifloraceae	United States	Harmine; Harmol	Anxiotic disorders	[181]
99	<i>Peamus boldus</i>	Boldo	Monimiaceae	S.America; N. Africa	Reticuline; Sinoacutine; N-methyl coclaurine	Anti-inflammatory, antipyretic, anticancer, antioxidant, hepatoprotective	[182,183]
100	<i>Peganum harmala</i>	Wild rue	Zygophyllaceae	S. Asia	Harmine; Harmaline; Harmalol; Harmol; Tetrahydroharmine	Antitumor, anti-inflammatory, antiparasitic, hepatoprotective, analgesic, antimicrobial	[184,185]
101	<i>Peganum nigellastrum</i>	Luo Tuo Hao	Nitrariceae	China	Luotonins C & D; Harmine; 3-phenylquinoline; Pegamine β -D-glucopyranoside; 2-deoxypeganylacetic acid	Antileishmanial	[186]
102	<i>Physalis minima</i>	Ground cherry	Solanaceae	India, Australia	Withaminimim; Phygrine	Diuretic, analgesic, antipyretic, antimalarial, antiulcer	[187]
103	<i>Piper longum</i>	Long pepper	Piperaceae	India	Piperine; Methylpiperine; Piperlongumine; Piperlonguminine; Piperettine; Asarinine	Hepatoprotective, antiasthmatic, anti-inflammatory, cardiovascular	[188]
104	<i>Piper nigrum</i>	Black pepper	Piperaceae	S. India; Tropical regions	Piperine; Paprazine; Cepharadione A; Pellitorine; Sylvamide	Antimicrobial, aphrodisiac, carminative, stomachache, antiseptic, diuretic	[189,190]
105	<i>Plumeria alba</i>	Pigeon wood	Apocynaceae		Curine; Evonine; Voacamine; Tubocurarine chloride; Syrosingopine	Purgative, cardiotoxic, hypotensive, diuretic, antimicrobial	[191,192]

106	<i>Plumeria rubra</i>	Crows flower	Apocynaceae	Mexico; Central America	Plumericidine, Plumerinine	Antibacterial, anti-inflammatory, antifungal, antipyretic, bronchitis	[193,194,195]
107	<i>Prosopis juliflora</i>	Bayahonda blanca	Leguminosae	Mexico; S.America	Juliflorine; Julifloridine; Julifloricine; Juliflorinine; Juliprosinene; 3-oxojuliprosine	Antibacterial, antitumor, antifungal	[196,197]
108	<i>Prunus persica</i>	Peach	Rosaceae	India; China; Nepal; Japan; Korea	Persicaside	Anthelmintic, insecticidal, sedative, diuretic, expectorant, antipyretic	[198,199]
109	<i>Psychotria colorata</i>		Rubiaceae	Brazil	Calycanthine; Isocalycanthine; Chimonanthine; Hodgkinsine; Quadrigemine C	Analgesic	[200,201]
110	<i>Rauwolfia serpentina</i>	Indian snakeroot	Apocynaceae	East Asia	Reserpine; Yohimbine; Sarpagine; Serpentine; Deserpidine; Ajmalicine; Ajmaline; Ajmalidine	Antihypertensive, cholera, epilepsy, stimulate uterine contractions	[202,203]
111	<i>Rauwolfia vomitoria</i>	Poison Devils pepper	Apocynaceae	Tropical Africa; China; Bangladesh	Sarpagan; Picrinine; Akuammiline; Heteroyohimbine; Yohimbine; Aricine; isoreserpiline; Rauvoxine; Rauvoxinine	Antimalarial, antipsychotopic, coughs, skin infections	[204-207]
112	<i>Rhizoma coptidis</i>	Huang Lian	Ranunculaceae	China	Berberine, Palmatine, Epiberberine, Coptisine, Jatrorrhizine, Magnoflorine	Antihypertension, antihyperglycemia, anti-inflammatory	[208,209]
113	<i>Rouwolfia caffra</i>	Quinine tree	Apocynaceae	Tropical & S. Africa	Strictamine; Sarpagan; Akuammicine; Indolenine; Corynane; Peraksine; Yohimbine; Suaveoline; Heteroyohimbine; Oxindole	Antimycobacterial	[207,210]
114	<i>Samanea saman</i>	Monkey pod	Leguminosae	America	Pithecolobine 1,2	Antibacterial, antifungal, antimycobacterial	[211,212]
115	<i>Sanguinaria Canadensis</i>	Blood root	Papavearceae	N. America	Sanguinarine; Chelerythrine; Sanguilutine; Chelilutine; Allocryptopine; Sanguirubine; Chelirubine; Protopine;	Antibiotic, anticancer	[213,214]
116	<i>Senecio cineraria</i>	Silver dust	Asteraceae	Mediterranean region	Senecionine; Seneciphylline; Jacobine; Otsenine; Jacoline; Jaconine; Usaramine; Doronine; Senecionine	Anticancer	[215]
117	<i>Sida acuta</i>	Wireweed;	Malvaceae	Pantropical	Quindoline; Cryptolepine	Anticancer, antipyretic,	[216,217]

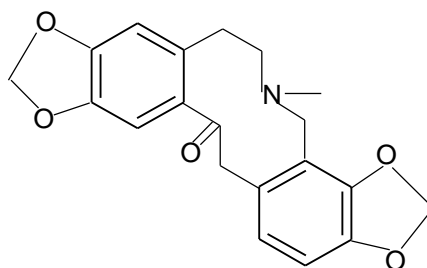
		Kharenti		distribution		antiulcer, antibacterial, antimalarial, anti-inflammatory	
118	<i>Sida cordifolia</i>	Flannel weed	Malvaceae	India	Ephedrine; Pseudoephedrine; Vasicinol; Vasicinone; N-methyl-tryptophan	Analgesic, anti-inflammatory, hypotensive, hepatoprotective, hypoglycemic	[218]
119	<i>Skimmia japonica</i>	Japanese skimmia	Rutaceae	Japan, China; S.E Asia	Skimmianine	Sedative, anticonvulsant	[219]
120	<i>Solanum dulcamara</i>	Bittersweet	Solanaceae	Asia; Europe; N. America	Solanine; Solasodine; β -solamarine	Cytotoxic, antibacterial, antiviral, antiallergic	[220,221]
121	<i>Solanum khasianum</i>	Love apple	Solanaceae	Asia	Solasonine; Solamargine; Khasianine	Anti inflammatory, anthelmintic	[222,223]
122	<i>Solanum nigrum</i>	Petty morel; Black night shade	Solanaceae	Asia; Africa; Europe	Solasodine	Anti-inflammatory, diuretic, antipyretic, antibacterial, antitumor	[224,225]
123	<i>Solanum pseudocapsicum</i>	Winter cherry plant	Solanaceae		Solacasin	Anticancer, antiviral, antihypertensive, hepatoprotective, antimicrobial	[226]
124	<i>Solanum torvum</i>	Turkey berry	Solanaceae	Asia; Africa; Australia; America	Solasodine; Solasonine; Solamargine	Analgesic, anti-inflammatory, antidiabetic, antihypertensive, antibacterial, antiulcer	[227,228]
125	<i>Solanum xanthocarpum</i>	Yellow berried nightshade	Solanaceae	Asia	Solasodine; Solasonine; Solasurine; Solanine; Solanidine	Anti-inflammatory, anticancer, anti allergic, antifertility	[229]
126	<i>Sophora flavescens</i>	Shrubby sophora	Fabaceae	Asia	Matrine; Sophocarpine; Sophoridine; Isomatrine; Mamanine; Sophoranol; Oxymatrine	Antitumor, antiviral, antiarthritis	[230,231]
127	<i>Stemona aphylla</i>	-----	Stemonaceae	S.E Asia	Stemocurtisine; Oxystemokerrine	Anticancer	[232]
128	<i>Stephania cepharantha</i>	-----	Menispermaceae	Japan	Berberine; Aromoline; Cepharadione A & B; Liriodenine; Lysicamine; Isoboldine	Antiviral	[233]
129	<i>Stephania glabra</i>	-----	Menispermaceae	Asia; Australia	Stephanine; Glabridine; Palmatine; Stepharine; Dehydrocorydalmine	Antimicrobial, hypotensive, analgesic, antipyretic, anticancer, antidysentery	[234]

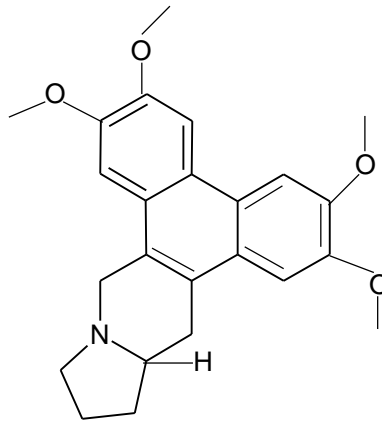
130	<i>Stephania japonica</i>	Snake vine	Menispermaceae	S.E. Asia; Australia	Jatrorrhizine; Stepasunoline; 16-oxoprometaphanine; 16-oxohasubanonine	Antispasmodic, antiasthmatic, kidney disorders, antidiarrhoel	[235]
131	<i>Stephania tetrandra</i>	Han Fang Ji	Menispermaceae	China; Japan	Tetrandrine; Fangchinoline	Anti-inflammatory, antitumor	[236,237]
132	<i>Tabernaem divertica</i>	Pin wheel flower	Apocynaceae	S.E. Asia	Cononitarine B; Conophylline	Anti-inflammatory, antimalarial, antidiarrhoel, antidysentery, analgesic, antipyretic	[238]
133	<i>Tabernaem ontana corymbosa</i>	Pinwheel flower	Apocynaceae	S.E. Asia	Jerantinine A,B,C,D,E,F; Lirofolines A,B; Criofoline; Ervachinine A,B,C,D; Vabosidine A,B,C	Anticancer, antimicrobial, antifungal	[239]
134	<i>Thalictrum foliolosum</i>	Leafy meadow rue	Ranunculaceae	SE Asia	Thalfoliolosumines A & B	Diuretic, antiseptic, antibacterial, stomachache	[240-242]
135	<i>Thalictrum minus</i>	Lesser Meadow Rue	Ranunculaceae	S.W. Asia; Europe; S. Africa	Desoxythalidastine; Isothalisopavine; Thaliadine; Thalicthuberine	Antibacterial	[243,244]
136	<i>Tinospora cordifolia</i>	Giloy	Menispermaceae	India; Sri Lanka; Myanmar	Berberine; palmatine; Magnoflorine; Tinosporin; Tembetarine; Isocolumbin; Tetrahydropalmatine	Antidiabetic, antispasmodic, anticancer, antimalarial, antiallergic	[245]
137	<i>Toddalia asiatica</i>	Orange tree	Rutaceae	Asia; Africa	Nitidine; Magnoflorine; 1-demethyl dicentrinone; Isointegriamide; 8-acetyl norchelerythrine; 8-methoxynitidine	Antimalarial, stomachache, bronchial pains	[246-248]
138	<i>Tridax procumbens</i>	Tridax daisy	Asteraceae	Tropical America	Akuamidine; Voacangine; Echitamine; Angustifoline; Crinamidine; Echitamidine; Nitidine; Trigonelline; Ellipicine	Hepatoprotective, antidiabetic, anti-inflammatory, hypotensive, wound healing	[249]
139	<i>Tylophora indica</i>	Indian ipecac	Asclepiadaceae	Asia; Africa; Australia	Tylophorine; 3-O-demethyl tylophorinidine	Antiasthamatic, anti-inflammatory	[250]
140	<i>Tylophora tanakae</i>		Asclepiadaceae	Asia; Africa; Australia	13- α -tylophorine; 13- α -7-O-desmethyl tylophorine	Anticancer	[251]
141	<i>Uncaria tomentosa</i>	Cats claw	Rubiaceae	S & Central America	Pterodine; Isomitraphylline; Uncarine F; Mitraphylline; Isopteropodine	Antiinflamatory, antineoplastic, antimicrobial, antioxidant	[252,253]
142	<i>Voacanga africana</i>	Diola	Apocynaceae	Africa	Voacafrine; Voacafricine; Voacamine; Vobtusine;	Anti-inflammatory, antigonorrhoeal, antifungal	[254,255]

					Vobasine; Voacangine; Epiibogaine; Voacangine hydroxyindolenine		
143	<i>Withania somnifera</i>	Indian ginseg	Solanaceae	India; China; Nepal	Tropine; Pseudotropine; Withanine; Withananine; Visamine; Withasomnine; Pseudowithanine	Anti-inflammatory, diuretic, hypnotic, aphrodisiac, uterine tonic	[256]

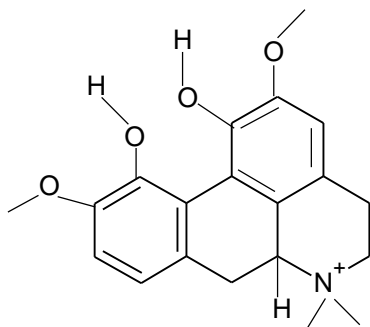
Table-2: Classes of different alkaloids

Sr No.	Class	Alkaloid
1.	Quinazoline alkaloids	Vasicine, Vasicinone, vasicinol, vasicinolone
2.	Quinoline alkaloids	Skimmianine, Psychotrine, Punarnavine, Camptothecin, Quinine, Quinidine, Cinchonine, Cinchonidine, Haplopine, Robustine, Lantanine, Luotonin C, Luotonin D,
3.	Pyrrolizidine alkaloids	Lycopsamine, Echinatine, Helindicine, Ligularine, Clivorine, Senecionine, Jacobine, Usaramine
4.	Pyrrolidine alkaloids	Bgugaine, Irniine, Hygrine,
5.	Tropane alkaloids	Hyoscyamine, Belladonnine, Apoa tropine, Litorine, Fastusine
6.	Isoquinoline alkaloids	Alangine, Tubulosine, Alangiside, Salsoline, Yaoundamine, Isoancistrocladine, Berberine, Jatrorrhizine, Columbamine, Calafatine, Palmatine, Protopine, Reticuline, Scoulerine, Berbamine, Berbanine, Sanguinarine, Stylopine, Chelidonine, Coptisine, Shaheenine, Cohirsine, Hirsutine, Jaminine, Haiderine, Liriodenine, Coclaurine, Catalane, Pontevedrine, Oxoglucine, Corydine, Hydrastine, Norsanguinarine, Camerine, Asimiboline, Anonaine, Coptisine, Noscapine, Curine, Aromoline, Tetrandrine, Fangchinoline, Thalidasine, Thaliadine
7.	Indole alkaloids	Yohimbine, Normacusine B, Alstophylline, Tubotaiwine, Alstonamine, Rhazmanine, Bleekerine, Catharanthine, Serpentine, Montamine, Moschamine, Centcyamine, Schischkinnin, Cathenamine, Voacamine, Calycanthine, Chimonanthine, Yohimbine, Reserpine, Sarpagine, Akuammicine, Lirofolines A & B, Criofolinine, Vabosidine A-C, Ervachinine, Akuammidine, Vobasine
8.	Steroidal alkaloids	Dongbeirine, Zhebeinine, Dongbeinine, Holadiene, Holarrhesine, Conessine, Pachysamine B & H, Khasianine, Solasodine, Solanidine, Solacasine
9.	Aporphine alkaloids	Roemerolidine, Duguevalline, N-nitrosoxylopine, Isocorydine, Liriodenine, Lysicamine, Cassythine, Dicentrine, Magnoflorine, Dicentrinone
10.	Glyco alkaloids	Solanine
11.	Amine alkaloids	Tryptamine, Ephedrine
12.	Beta Carboline alkaloids	Harmaline, Harmalol, Harmine, Tryptoline

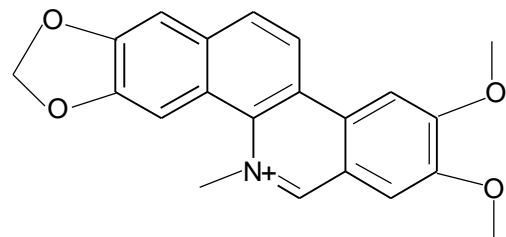
Structures of Alkaloids:**Protopine**



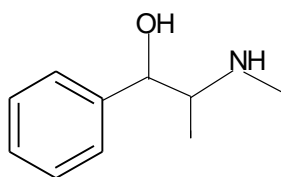
Tyloforine



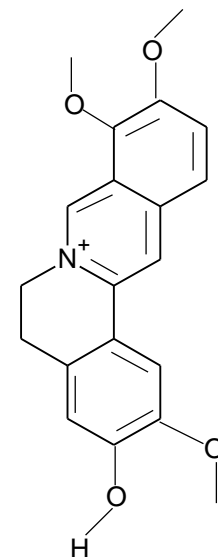
Magnoflorine



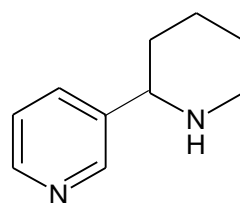
Nitidine



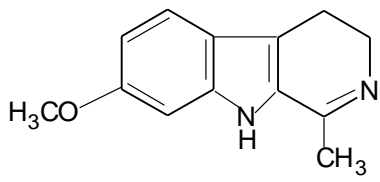
Ephedrine



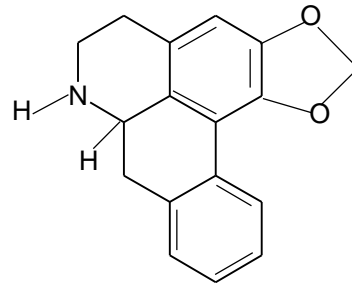
Jatrorrhizine



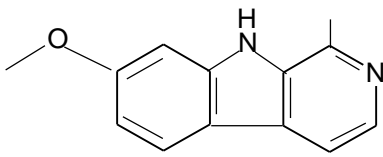
Anabesine



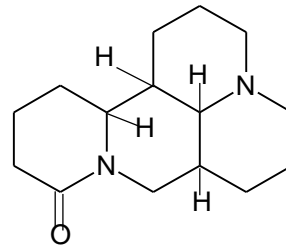
Harmaline



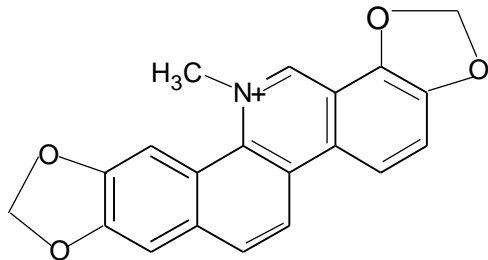
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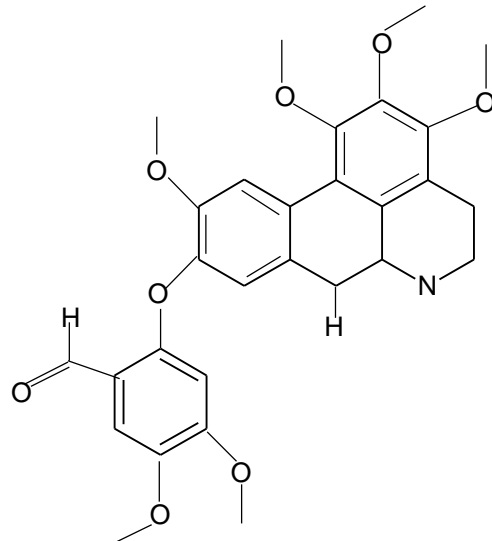
Harmine



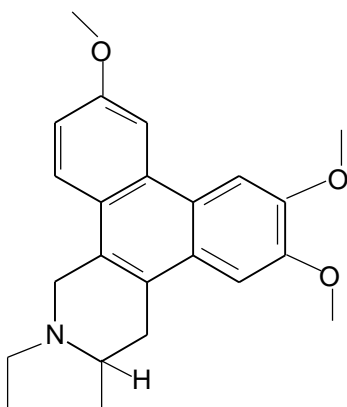
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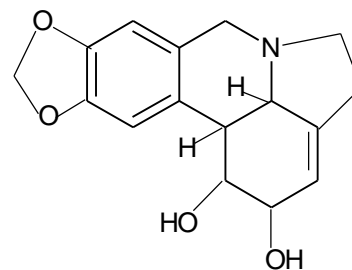
Sanguinarine



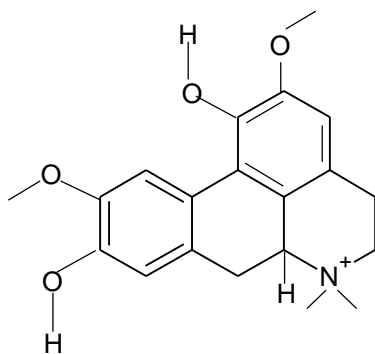
Thaliadine



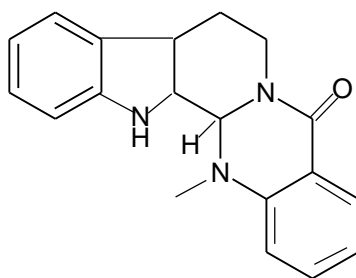
Antofine



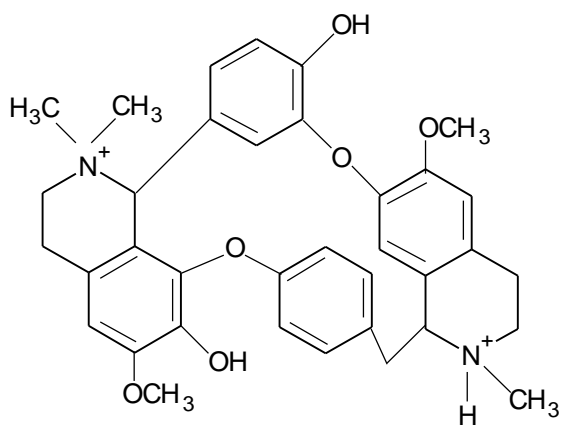
Lycorine



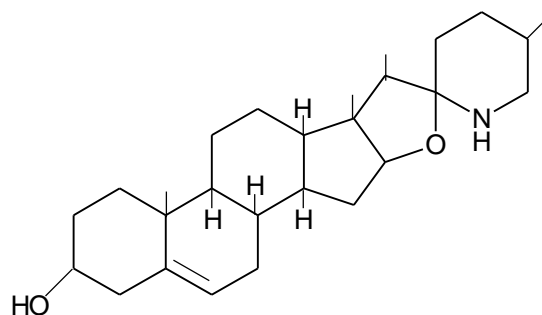
Laurifoline



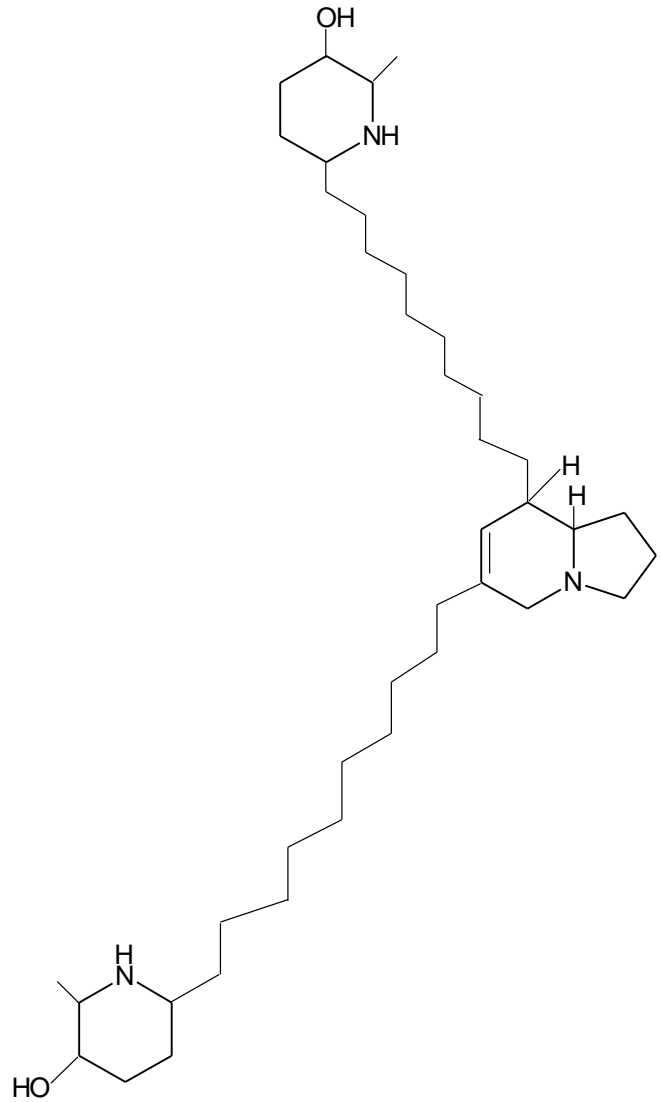
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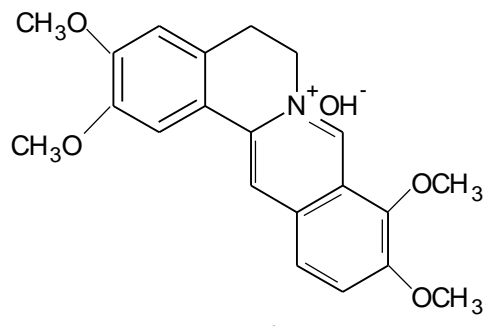
Tubocurarine



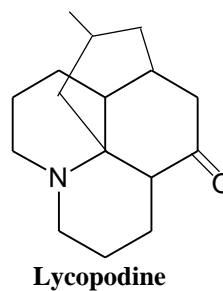
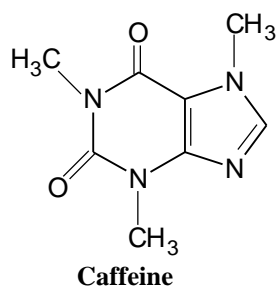
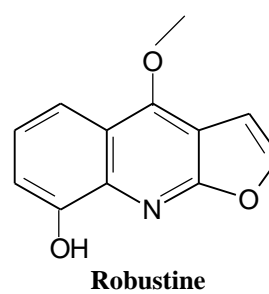
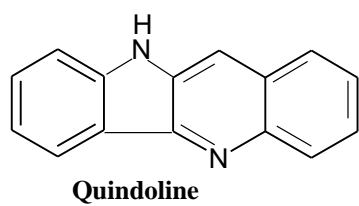
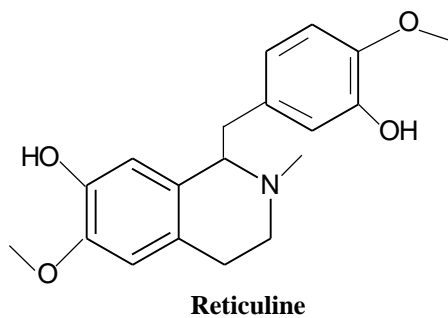
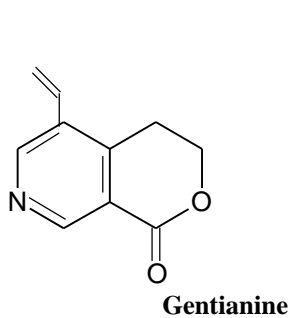
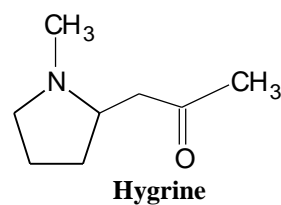
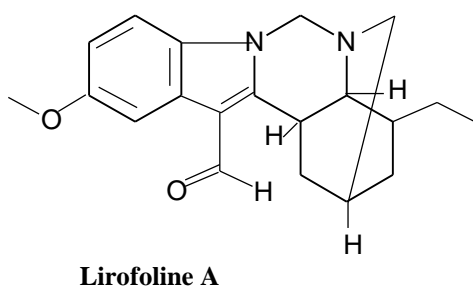
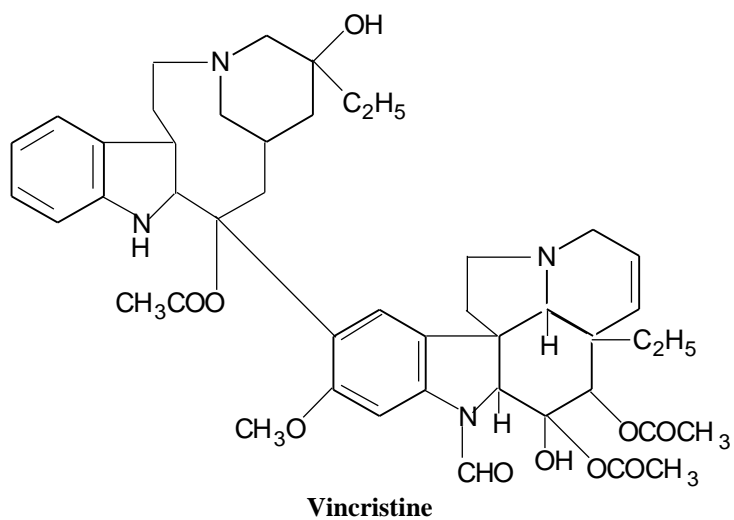
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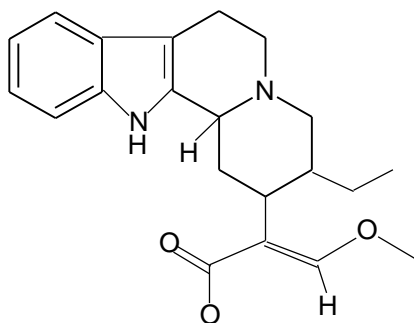


Juliflorine

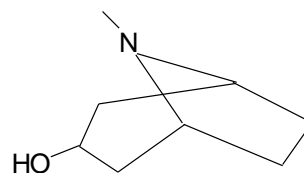


Palmatine

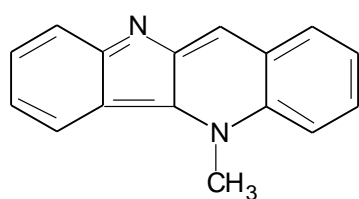




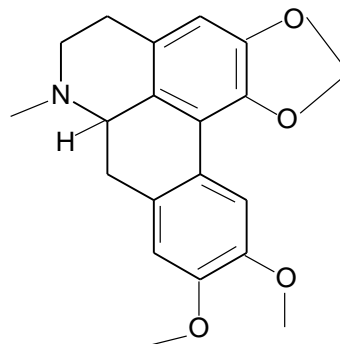
Hirsutine



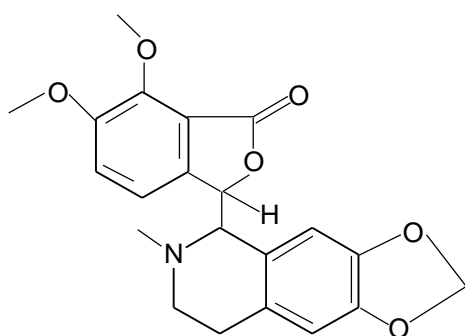
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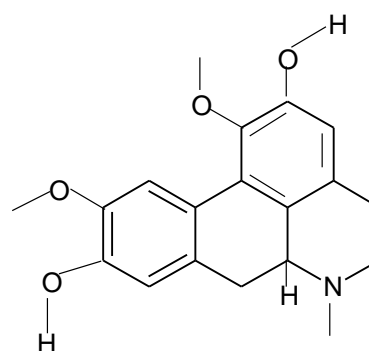
Cryptolepine



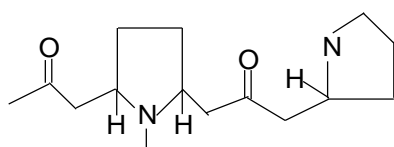
Dicentrine



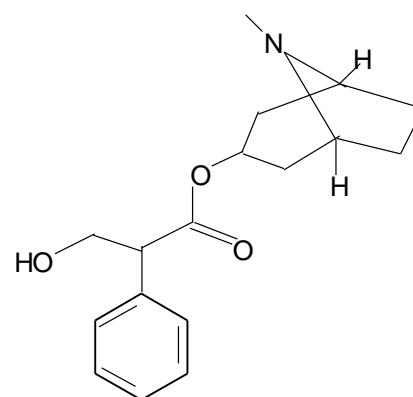
Hydrastine



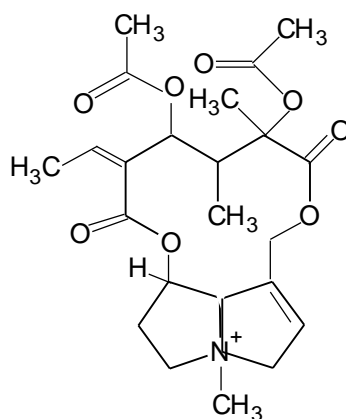
Boldine



Phyrine



Hyocyamine



Ligularine

CONCLUSION

Alkaloids are large diverse group carrying broad range of activities of great importance with significant pharmacological properties. The presence of alkaloids indicates that plant could serve as lead for development of novel agents. Naturally occurring substances derived from plants will continue to have important role in the process of drug discovery, particularly in the development of new synthetic drugs.

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