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Analgesic and Antiinflammatory Activity of Genus *Aconitum*: A Phytochemical and Ethnopharmacological Review

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Analgesic and Antiinflammatory Activity of Genus *Aconitum*: A Phytochemical and Ethnopharmacological Review

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Abstract
The genus *Aconitum* has been reviewed for distribution in the world, traditional use, isolated chemical constituents, and pharmacological activities of some common species. *Aconitum* species are traditionally used throughout Asia, particularly in China and Japan, as an analgesic and antiinflammatory medicine. Lappaconitine and Yunaconitine are common chemical constituents that may justify the use of these species as analgesic and antiinflammatory agents in Asian traditional medicine. The aim of the present paper is to further review the comprehensive knowledge of the plants of this genus including the traditional uses, chemical constituents, and pharmacology.

Keywords: *Aconitum*; Analgesic and antiinflammatory activity; Lappaconitine; Chinese traditional medicine; Ethnopharmacology.

1. INTRODUCTION

Aconitum, commonly known as aconite, monkshood, wolfbane, leopard's bane, Devil's helmet, or blue rocket belongs to the family Ranunculaceae and is widely distributed in the alpine and subalpine regions of the tropical parts of the Northern hemisphere [1, 2]. During our study, we observed that several *Aconitum* species are traditionally used, throughout Asia particularly in China and Japan as an analgesic and for antiinflammatory activity.

This review will cover almost all literature data on the ethnobotanical, phytochemical, and pharmacological activities.

2. BOTANY

About 250 species have been reported in *Aconitum*. Currently, more than 120 species of the plant have been found [1]. The genus *Aconitum* consists of more than 200 species in China [3]. Species of *Aconitum* differ in their medicinal properties and distribution pattern [4]. Species with the distribution of plant, flowering period, and their synonyms are mentioned in Table 1.

2.1. Traditional Uses of *Aconitum*

The most common use of *Aconitum* species is for the treatment of antirheumatism, as an analgesic, and for antiinflammatory purposes, as Tables 2 and 3 show. *Aconitum chasmanthum, Aconitum deinorrhizum, Aconitum falconeri, Aconitum palmatum, Aconitum rotundifolium, Aconitum koreanum (Lèvl.) Rapaics, Aconitum brachypodum Diels, Aconitum kirinense Nakai,* and *Aconitum kusnezoffii Rchb* possess antirheumatic properties whereas *Aconitum falconeri, Aconitum ferox, Aconitum heterophyllum, Aconitum luridum, Aconitum koreanum (Lèvl.) Rapaics, Aconitum taipeicum Hand-Mzt possess antiinflammatory properties. Aconitum bulleyanum, Aconitum orochryseum Stapf,* and *Aconitum finetianum Hand-Mazz* are used as antidotes in snakebites. Other pharmacological properties of different species are enlisted in Table 2.

2.2. Chemical Compounds Isolated from Genus *Aconitum*

Chemical constituents of *Aconitum anthora comprises* 3-O-((b-D-gluco pyranosyl-(1→3)-(4-O-(E-pcoumaroyl))-a-L-rhamnopyranosyl-(1→6)-b-D-galacto pyranoside))-7-O-a-L-rhamno pyranoside **(1a)**; kaempferol 3-O-((b-D-glucopyranosyl(1→3) -(4-O (E-p-coumaroyl))-a-L-rhamno pyranosyl-(1→6)-b-D galactopyranoside))-7-O-a-L rhamnopyranoside **(1b)**; quercetin 3-O-a-L-rhamno pyranosyl -(1→6)-b-D-galactopyranoside-7-O-a-L-rhamnopyranoside or cloven **(1c)**; kaempferol 3-O-a- Lrhamnopyranosyl-(1→6)-b-D-galactopyranoside-7-O-a-L-rhamno pyranoside or robinin **(1d)** [20]. Roots of *Aconitum barbatum var. puberulum consist of* Puberunine and puberudine [21]. Quercetin 3-O-β-D-glucopyranoside-7-O-(6-E-p-coumaroyl)-β-D-glucopyranosyl(1→3)-α-L-rhamnopyranoside **(2a)**; quercetin 3-O-β-D-glucopyranoside-7-O-β-D-glucopyranosyl -(1→3)-α-L-rhamnopyranoside **(2b)**; quercetin 3-O-β-D-glucopyranoside-7-O-(6-E-caffeoyl)-β-D-glucopyranosyl-(1→3)-α-L-rhamnopyranoside **(2c)** are the chemical constituents isolated from the aerial part of *Aconitum burnatii Gayer* [22]. Parvez and coworker isolate 14-O-Benzoyl-8-ethoxybikhaconine **(3a)**; 14-O-Benzoyl-8-methoxybikhaconine **(3b)**; Chasmaconitine methanol solvate **(4)**; 3-Bikhaconine Acetone Solvate **(5)** from *Aconitum chasmanthum* [23]. Roots of *Aconitum carmichaelii Debx* comprise Aconitine **(6a)**; mesaconitine **(6b)** and hypaconitine **(6c)** [24, 25]. Isolated constituents of *Aconitum cochleare* are Cochleareine, acoleareine, 14-acetyltalatisamine, and talatisamine from the aerial part of plant [26]. Other isolated constituents from the species of *Aconitum* are enlisted in Table 5.

Table 1: *Aconitum* species, synonyms, distribution and their flowering period.

Species	Synonyms	Distribution	Flowering period
Aconitum atrox	*Aconitum balfourii*	*The subalpine and alpine The Himalayas between 3,300 and 3,900 m*	–
Aconitum curvipilum	–	*Endemic to Chitral*	–
Aconitum chasmanthum	*Aconitum chasmanthum subsp. Aconitum kurramense Aconitum napellus L. Aconitum violaceum var. robustum Stapf*	*Swat and Chitral eastward to Kashmir, Nepal.*	*August*
Aconitum deinorrhizum	–	*Alpine regions of Chat-tadhar and Bhalesh ranges of Bhadarwah districts in Jammu and Kashmir*	–
Aconitum falconeri	–	*The subalpine and alpine zones of the Garhwal Himalayas.*	–
Aconitum ferox	–	*The alpine The Himalayas from Sikkim to Garhwal and Assam*	–
Aconitum heterophyllum var. bracteatum	*Aconitum atees Royle Aconitum cordatum Royle Aconitum ovatum Lindl.*	*Chitral, Kashmir eastward to Kumaon (Uttar Pradesh)*	*July-August*
Aconitum heterophyllum var. heterophyllum	*Aconitum heterophyllum subsp. Aconitum kashmiricum Stapf ex Coventry*	*Northwest Himalayas from Chitral eastward to Kashmir.*	*July-August*
Aconitum laciniatum	–	*The subalpine and alpine Himalayas of Sikkim betweenaltitudes of 3,300 and 4,200 m*	–
Aconitum laeve	*Aconitum lycoctonum auct. non L.*	*Chitral eastward to Kashmir, North India.*	*July-August*
Aconitum luridum	–	*The Himalayas from eastern Nepal to Chumbi at altitudes of 3,600-4,200 m*	–
Aconitum palmatum	*Aconitum bisma*	*The alpine Himalayas of Sikkim, Nepal, the adjoining parts of southern Tibet, between altitudes of 3,000 and 4,800 m*	–
Aconitum rotundifolium	*Aconitum napellus var. rotundifolium*	*Western Himalayas and Chitral.*	*August-September*
Aconitum soongaricum	–	*Central Asiatic provinces of the USSR (Tien-Shan, Dzungaria) and Turkestan*	–
Aconitum spicatum	–	*Himalayas of Sikkim and Chumbi.*	–
Aconitum violaceum var. violaceum	*Aconitum multifidum Royle Aconitum violaceum var. multifidum (Royle)*	*The Himalayas from Hazara and Kashmir eastward to Nepal*	*July-August*
Aconitum violaceum var. weileri	*Aconitum weileri Gilli*	*Known only from the type locality in the Karakorams.*	–

Table 2: *Aconitum* species with their common names, part use, and their traditional uses.

Species	Common names	Part use	Traditional uses	Reference
Aconitum atrox	Vatsanaabha (Ayurvedic); Banwaa (Folk)	Roots	Poisonous and highly toxic	[5]
Aconitum chasmanthum	Indian Napellus (English); Visha, Shringika-Visha, Vatsanaabha (Ayurvedic); Mohri, Meethaa Zahar (Folk)	Roots	Sedative, antirheumatic, analgesic, antitussive, antidiarrheal	[5]
Aconitum deinorrhizum	Vatsanaabha (Ayurvedic); Bashahr-Mohra, Dudhiyaa, Bish, Safed Bikh (Folk)	Roots and leaves	Roots and leaves are used in rheumatism, rheumatic fever, and acute headache.	[5]
Aconitum falconeri	Vatsanaabha (Ayurvedic); Bikh, Bis, Meethaa Telia (Folk)	Roots	Sedative, carminative, antiinflammatory (used for the treatment of nervous system, digestive system; rheumatism,fever)	[5]

(*Continued*)

Table 2: *Continued*

Species	Common names	Part use	Traditional uses	Reference
Aconitum ferox	Vatsanaabha, Visha, Amrita, Vajraanga, Sthaavaravisha, Vatsanaagaka, Shrangikavisha, Garala (Ayurvedic); Bish, Bishnaag (Unani); Vasanaavi, Karunaab-hi (Siddha/Tamil); Bacchanaag, Bish, Mithaa Zahar, Telia Visha (Folk)	Roots	Narcotic, sedative, antileprotic, antiinflammatory. Extremely poisonous. (Roots possess depressant activity, but after mitigation in cow's milk for 2–3 days, they exhibit stimulant activity.)	[5]
Aconitum heterophyllum	Atis Root, Aconite (English); Ativishaa, Arunaa, Vishaa, Shuklakandaa, (Ayurvedic); Atees (Unani); Athividayam (Siddha/Tamil); Patis (Folk)	Roots	Often regarded as nonpoisonous, antiperiodic, antiinflammatory, astringent (used in cough, diarrhea, dyspepsia) tonic, febrifuge, antispasmodic (used in irritability of stomach and abdominal pains)	[5]
Aconitum laciniatum	Vatsanaabha (Ayurvedic); Folk Kaalo Bikhmo	Roots	Poisonous (found mixed with the roots of *A. ferox* and *A. spicatum*)	[5]
Aconitum palmatum	Prativishaa, Shyaamkan-daa, Patis (Ayurvedic); Bikhamaa(Folk)	Roots	Antiemetic, antidiarrheal, antirheumatic, antiperiodic	[5]
Aconitum luridum	Vatsanaabha (Ayurvedic)	Roots	Narcotic, sedative, antileprotic, antiinflammatory. Extremely poisonous	[5]
Aconitum leave	Maniree (Folk)	Roots	Medicinal use (unknown)	[6]
Aconitum spicatum	Nepal Aconite (English); Vatsanaabha (Ayurvedic)	Roots	Antipyretic, analgesic	[5]
Aconitum violaceum	Vatsanaabha (Ayurvedic); Tilia Kachnaag, Dudhia (Folk)	Roots	Nervine tonic	[5]
Aconitum rotundifolium	Bonkar, Pongtha (Folk)	Roots and whole part	Rheumatism, jaundice	[7]

Table 3: Other species with their traditional uses.

Species	Traditional uses	Reference
Aconitum bulleyanum	Influenza, rashes, and snakebite	[8]
Aconitum koreanum (Lèvl.) Rapaics	Cardialgia, facial distortion, epilepsy, migraine headache, vertigo, tetanus, infantile convulsion, and rheumatic arthralgia, antiarrhythmia, analgesic and antiinflammatory effects	[9]
Aconitum brachypodum Diels	Antirheumatic and analgesic properties	[11]
Aconitum finetianum Hand-Mazz	Enteritis, poisonous snakebites, and fractures	[12]
Aconitum orochryseum Stapf.	A common cough and cold, bilious fever, dysentery, as an antidote for snakebite, fevers associated with malaria infection, kidney malfunction, and stomach ulcer	[8]
Aconitum kirinense Nakai	Rheumatic arthritis, rheumatoid disease	[13]
Aconitum kusnezoffii Rchb	Analgesic and antirheumatic herbal medicine, treat heart failure congestion, neuralgia, rheumatism, gout, and so on. Homeopathy	[14, 15]
Aconitum taipeicum Hand-Mzt	Antiinflammatory and analgesic	[16]

Table 4: Methods of application of *Aconitum* species.

Species	Habit	Method of use and administration	Dose	Reference
Aconitum chasmanthum	Herb	-	10-15 mg powder.	[5]
Aconitum ferox	Herb	Dried root about 100 mg is chewed or the decoction of the root (10-15 ml) is taken 2-3 times for 2 days	100 mg or 10-15 ml	[17]
Aconitum heterophyllum	Herb	Dried roots are chewed. Grind root to a fine powder. Mix in one glass of water or milk to control fever	30.0 g 1 g	[18, 19]
Aconitum palmatum	Herb	Root decoction is taken with a cup of milk one time daily (after lunch) for 7–10 days	10-15 ml	[17]
Aconitum rotundifolium	Herb	Juice is extracted by crushing and is taken orally with an equal volume of water to cure jaundice. About 4–5 g root powder is taken with one glass of water once a day to cure joint pains	4-5 g	[7]

Table 5: List of chemical constituents in genus *Aconitum*.

Species	Part used	Chemical constituents	References
Aconitum anthora	–	3-O-((b-D-gluco pyranosyl -(1→3)-(4-O-(E-p-coumaroyl))-a-L-rhamnopyranosyl-(1→6)-b-D-galacto pyranoside))-7-O-a-L-rhamno pyranoside **(1a)**; kaempferol 3-O-((b-D-glucopyranosyl(1→3) -(4-O-(E-p-coumaroyl))-a-L-rhamno pyranosyl-(1→6)-b-D-galactopyranoside))-7-O-a-L-rhamnopyranoside **(1b)**; quercetin 3-O-a-L-rhamno pyranosyl -(1→6)-b-D-galactopyranoside-7-O-a-L-rhamnopyranoside or cloven **(1c)**; kaempferol 3-O-a- Lrhamnopyranosyl-(1→6)-b-D-galactopyranoside-7-O-a-L-rhamno pyranoside or robinin **(1d)**	[20]
Aconitum barbatum var. puberulum	Roots	Puberunine and puberudine	[21]
Aconitum burnatii Gayer	Aerial part	Quercetin 3-O-β-D-glucopyranoside-7-O-(6-E-p-coumaroyl)-β-D-glucopyranosyl(1→3) -α-L-rhamnopyranoside **(2a)**; quercetin 3-O-β-D-glucopyranoside-7-O-β-D-glucopyranosyl -(1→3)-α-L-rhamnopyranoside **(2b)**; quercetin 3-O-β-D-glucopyranoside-7-O-(6-E-caffeoyl)-β-D-glucopyranosyl-(1→3)-α-L-rhamnopyranoside **(2c)**	[22]
Aconitum chasmanthum	–	14-O-Benzoyl-8-ethoxybikhaconine **(3a)**; 14-O-Benzoyl-8-methoxybikhaconine **(3b)**; Chasmaconitine methanol solvate **(4)**; 3-Bikhaconine Acetone Solvate **(5)**	[23]
Aconitum carmichaelii Debx	Roots	Aconitine **(6a)**; mesaconitine **(6b)** and hypaconitine **(6c)**	[24, 25]
Aconitum koreanum	Roots	Alkaloids and diterpene alkaloid isomers in their roots.	[9, 10]
Aconitum cochleare	Aerial part	Cochleareine; acoleareine; 14-acetyltalatisamine and talatisamine	[26]
Aconitum delavayi	Roots	Delavaconitine F 1 **(7)** and delavaconitine G 2 **(8)**	[27]
Aconitum episcopale	Roots	Liaconitine A (N-ethyl-1a,6a,16b,18-tetramethoxy-13b-ol-2,3-dehydroaconitane-8-acetate-14-anisoylate) **(9a)**; Liaconitine B(N-ethyl-1a,6a,16b,18-tetramethoxy-13b-ol-2,3-dehydroaconitane-8,14-dianisoylate **(9b)** and Liaconitine C (N-ethyl-1a,6a,16b,18-tetramethoxy-8-ethoxy-13b-ol-2,3-dehydroaconitane-14-anisoylate) **(9c)**	[28]
Aconitum finetianum	Roots	Anthranoylly coctonine (inuline) **(10a)** and lycoctonine **(10b)**	[12]
Aconitum franchetti	Roots	Franchetine **(11)**	[29]
Aconitum hemsleyanium var. atropurpureum	Roots	3-hydroxyfranchetine **(12)** and asatropurpursine **(13)**	[30]
Aconitum hemsleyanum var. circinatum	Roots	Circinasines A, B, C,D,E,F,G; talatisamine; yunaconitine; senbusine A; sachaconitine; hemsleyanisine and isohemsleyanisine,	[31]
Aconitum heterophyllum	–	Heterophyllinine-A; heterophyllinine-B; dihydroatisine (14); lycoctonine (10b); atisine **(15)**; Atisenol; heteratisine **(16a)**; 6-acetylheteratisine **(16c)**; 6-benzoylheteracisine **(16b)** [hari]; heterophyllisine **(16d)**; heterophylline **(17b)**; heterophyllidine **(17a)**; atidine; F-dihydroatisine, hetisine **(18)**; hetidine; hetisinone.	[32-35]
Aconitum kirinense	Roots	Kirinines B **(19)** and kirinines C **(20)**	[13]
Aconitum karacolicum	–	8-O-azeloyl-14-benzoylaconine. **(21)**	[36]
Aconitum kusnezoffii Reichb	Roots	α-(1→3),(1→4)-D-Glucan **(22)**	[15]
Aconitum pendulum	–	N-deethyl-3-acetylaconitine **(23)**; N-deethyldeoxyaconitine **(24)**; secoaconitine **(25)**	[37]
Aconitum leave	Aerial part	Swatinine **(26)**; delphatine; lappaconitine; puberanine and N-acetylsepaconitine	[38]
Aconitum napellus subsp. Neomontanum	Flowers	Quercetin7-O-(6-trans-caffeoyl)-b-glucopyranosyl-a-rhamnopyranoside-3-O-b-glucopyranoside **(27a)**; kaempferol 7-O-(6-trans-caffeoyl)-b-glucopyranosyl-a-rhamno pyranoside-3-O-b-glucopyranoside **(27b)**; kaempferol 7-O-(6-trans-p-coumaroyl)-b-glucopyranosyl-a-rhamnopyranoside-3-O-b-glucopyranoside **(27c)**	[39]
Aconitum napellus sp. Lusitanicum	–	Quercetin-3-O-(6-transcaffeoyl)-β-glucopyranosyl-(1→2)-β-glucopyranosyl-7-O-α-rhamnopyranoside; quercetin-3-sophoroside-7-rhamnopyranoside	[40]
Aconitum nasutum	Aerial part	3-hydroxy talatisamine **(28)**	[41]
Aconitum naviculare	Aerial part	3-O-[b-D-glucopyranosyl-(4-O-trans-p-coumaroyl)-a-L-rhamno pyranosyl-b-D-glucopyranosyl]-7-O-[b-D-glucopyranosyl-a-L-rhamno pyranosyl] kaempferol; 3-O-[b-D-glucopyranosyl-(4-Otrans-p-coumaroyl)-a-L-rhamnopyranosyl-b-D-glucopyranosyl]-7-O-[b-D-gluco pyranosyl-a-L-rhamnopyranosyl] quercetin; 7-O-[b-D-glucopyranosyl-a-L-rhamno pyranosyl] quercetin [43]	[42]

(*Continued*)

Table 5: *Continued*

Species	Part used	Chemical constituents	References
Aconitum orientale	–	Demethyl appaconitine **(29)**; 7, 11, 14-trihydroxy-2, 13-dioxohetisane **(30a)**; 6, 13, 15-trihydroxyhetisane **(30b)**; N-deethyldelphatine lappaconitine **(31)**; lycoctonine **(10b)**; browniine	[43]
Aconitum racemulosum Franch	–	Racemulosine **(32)**	[44]
Aconitum septentrionale Koelle	*Roots*	8-O-methyllycaconitine (1); 6-O-acetylacosepticine (2); acoseptrigine (3); acoseptriginine (4); lappaconine (5); N-acetylsepaconitine (6); puberaconitine (7); lappaconitine (8); N-deacetyllappaconitine (9); lycoctonine (10), and lapaconidine (11).	[45]
Aconitum sinomontanum	–	Lappaconitine; ranaconitine; N-deacetyllappaconitine; N-deacetylranaconitine	[46]
Aconitum sungpanense	Leaves	Trans-2,2V,4,4V-tetramethyl-6,6V-dinitroazobenzene **(33)**	[47]
Aconitum tanguticum	–	6-Benzoylheteratisine	[48]
Aconitum taipeicum	Roots	3-isopropyl-tetrahydropyrrolo [1, 2-a] pyrimidine-2, 4 (1H, 3H)-dione **(34)**; 1-acetyl-2, 3,6-triisopropyl-tetrahydropyrimidin-4(1H)-one **(35)**	[16]
Aconitum transsectum	–	Transconitine A **(36)**; Transconitine B **(38a)**; Transconitine C **(37)**; Yunaconitine **(38b)**; Crassicauline A **(38c)**; Foresaconitine **(38d)**; Talatisamine **(38e)**; S-deacetylyunaconitine **(38f)**; Geniconitine **(38g)**; Indaconitine **(38h)**; Forestine **(38i)**; 14-acetyltalatisamine **(38j)**; Chasmanine **(38k)**	[49]
Aconitum variegatum	–	16b-hydroxycardiopetaline **(39a)**; 8-ethoxysach aconitine **(39b)**; genicunine B **(39c)**; 14-acetylgenicunine B **(39d)**; 14-Dehydrogenicunin B **(40)**; N-deethyl-N-19-didehydrosachaconitine;15-veratroyldictizine **(41a)**; 15-veratroyl-17-acetyldictizine **(41b)**; 15-veratroyl-17-acetyl-19-oxodictizine **(41c)**; N-ethyl-1a-hydroxy-17-veratroyldictizine **(42)**; variegatine **(43)**; sachaconitine,14-O-acetylsachaconitine; karakoline; talatizamine; hydroxytalatizamine; sachaconitine,14-O-acetylsachaconitine; karakoline; talatizamine; hydroxytalatizamine; 14 acetyltalatizamine; 14-acetyl-10-hydroxytalatizamine; N-methyl armepavine; pengsheninB; delsoline; dihydro delsoline; delcosine	[50]
Aconitum vulparia	Flower	Quercetin 3-glucoside-7-rhamnoside; kaempferol 3-glucoside-7-rhamnoside; quercetin 3,7-di-rhamnoside **(44a)**; kaempferol 3,7-di-rhamnoside; kaempferol 7-rhamnoside **(44b)** [42]	[51]

Table 6: List of chemical nature of compounds isolated from genus *Aconitum*.

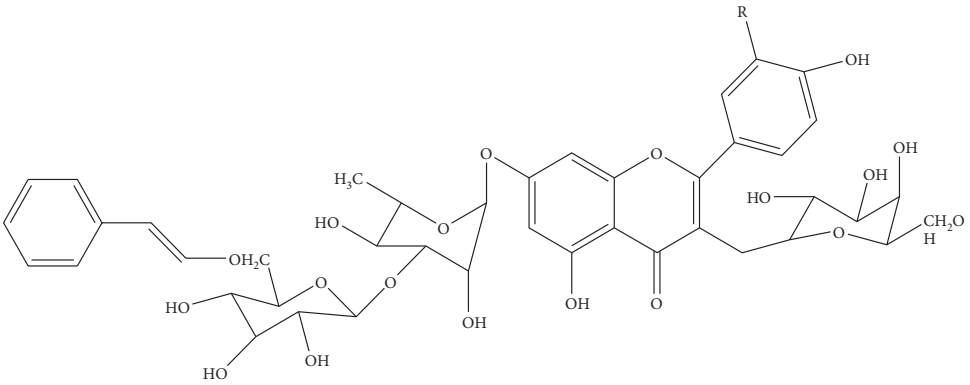
Chemical Nature	Compounds present
Flavonoid	3-O-((b-D-gluco pyranosyl -(1→3)-(4-O-(E-p-coumaroyl))-a-L-rhamnopyranosyl-(1→6)-b-D-galacto pyranoside))-7-O-a-L-rhamno pyranoside; kaempferol 3-O-((b-D-glucopyranosyl(1→3) -(4-O-(E-p-coumaroyl))-a-L-rhamno pyranosyl-(1→6)-b-D-galactopyranoside))-7-O-a-L-rhamnopyranoside; Quercetin 3-O-a-L-rhamno pyranosyl -(1→6)-b-D-galactopyranoside-7-O-a-L-rhamnopyranoside or clovin; kaempferol 3-O-a-Lrhamnopyranosyl-(1→6)-b-D-galactopyranoside-7-O-a-Lrhamno pyranoside or robinin; quercetin 3-O-β-D-glucopyranoside-7-O-(6-E-p-coumaroyl)-β-D-glucopyranosyl(1→3) -α-L-rhamnopyranoside; quercetin 3-O-β-D-glucopyranoside-7-O-β-D-glucopyranosyl -(1→3)-α-L-rhamnopyranoside; quercetin 3-O-β-D-glucopyranoside-7-O-(6-E-caffeoyl)-β-D-glucopyranosyl-(1→3)-α-L-rhamnopyranoside; Quercetin7-O-(6-trans-caffeoyl)-b-glucopyranosyl-a-rhamnopyranoside-3-O-b-glucopyranoside; kaempferol 7-O-(6-trans-caffeoyl)-b-glucopyranosyl-a-rhamno pyranoside-3-O-b-glucopyranoside; kaempferol 7-O-(6-trans-p-coumaroyl)-b-glucopyranosyl-a-rhamnopyranoside-3-O-b-glucopyranoside; Quercetin-3-O-(6-transcaffeoyl)-β-glucopyranosyl-(1→2)-β glucopyranosyl-7-O-α-rhamnopyranoside; quercetin-3-sophoroside-7-rhamnopyranoside; 3-O-[b-D-glucopyranosyl-(4-O-trans-p-coumaroyl)-a-L-rhamno pyranosyl-b-D-glucopyranosyl]-7-O-[b-D-glucopyranosyl-a-L-rhamno pyranosyl] kaempferol; 3-O-[b-D-glucopyranosyl-(4-Otrans-p-coumaroyl)-a-L-rhamnopyranosyl-b-D-glucopyranosyl]-7-O-[b-D-gluco pyranosyl-a-L-rhamnopyranosyl] quercetin; 7-O-[b-D-glucopyranosyl-a-L-rhamno pyranosyl] quercetin
Diterpenoid alkaloids	Aconitine; mesaconitine; hypaconitine; Liaconitine A (N-ethyl-1a,6a,16b,18-tetramethoxy-13b-ol-2,3-dehydroaconitane-8-acetate-14-anisoylate); Liaconitine B(N-ethyl-1a,6a,16b,18-tetramethoxy-13b-ol-2,3-dehydroaconitane-8,14-dianisoylate and Liaconitine C (N-ethyl-1a,6a,16b,18-tetramethoxy-8-ethoxy-13b-ol-2,3-dehydroaconitane-14-anisoylate); Anthranoylly coctonine (inuline); lycoctonine; 3-hydroxyfranchetine; asatropurpursine; kirinines B; kirinines C; Demethyll appaconitine; 7, 11, 14-trihydroxy-2, 13-dioxohetisane; 6, 13, 15-trihydroxyhetisane; N-deethyldelphatine lappaconitine; lycoctonine; browniine; Lappaconitine; 3 ranaconitine; N-deacetyllappaconitine; N-deacetylranaconitine; 6-Benzoylheteratisine; 15-veratroyldictizine; 15-veratroyl-17-acetyldictizine; 15-veratroyl-17-acetyl-19-oxodictizine; N-ethyl-1a-hydroxy-17-veratroyldictizine; variegatine

(*Continued*)

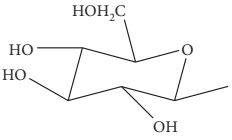
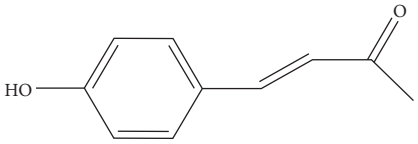
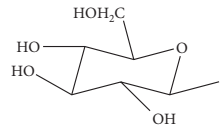
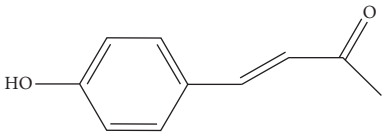
Table 6: *Continued*

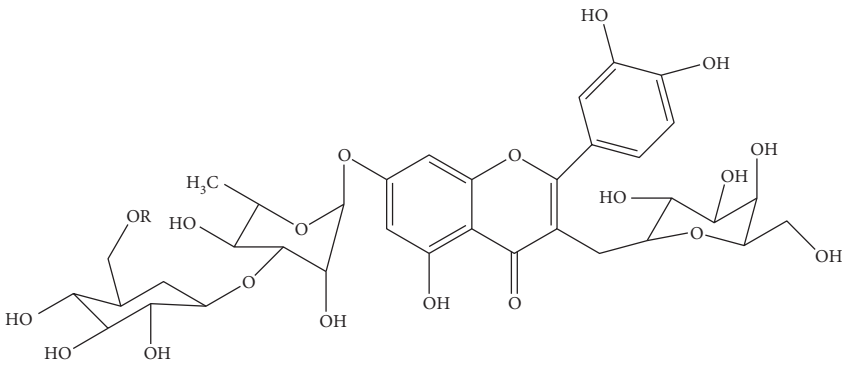
Chemical Nature	Compounds present
Norditerpenoid alkaloids	Delavaconitine F 1; delavaconitine G 2; Franchetine; Swatinine; delphatine; lappaconitine; puberanine; N-acetylsepaconitine; 3-hydroxy talatisamine; 1-epi-chasmanine; talatisamine; isotalatizidine; vilmorrianine D; nevadenine; pseudaconine; viresenine; lycoctonine; hordenine; Transconitine A; Transconitine B; Transconitine C; Yunaconitine; Crassicauline A, Foresaconitine; Talatisamine; S-deacetylyunaconitine; Geniconitine; Indaconitine; Forestine; 14-acetyltalatisamine; Chasmanine; 16b-hydroxycardiopetaline; 8-ethoxysach aconitine; 14-acetylgenicunine B; N-deethyl-N-19-didehydrosachaconitine
Amide alkaloids	3-isopropyl-tetrahydropyrrolo [1, 2-a] pyrimidine-2, 4 (1H, 3H)-dione; 1-acetyl-2, 3,6-triisopropyl-tetrahydropyrimidin-4(1H)-one
Other Alkaloids	Sachaconitine,14-O-acetylsachaconitine; karakoline; talatizamine; hydroxytalatizamine; sachaconitine,14-O-acetylsachaconitine; karakoline; talatizamine; hydroxytalatizamine; 14 acetyltalatizamine; 14-acetyl-10-hydroxytalatizamine; N-methyl armepavine; pengsheninB; delsoline; dihydro delsoline; delcosine; genicunin B

Figure 1: Chemical constituents isolated from the genus *Aconitum*.

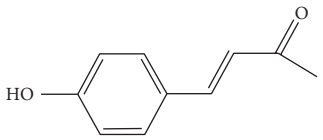
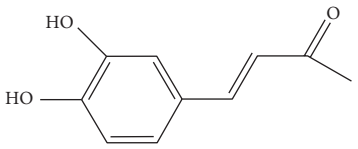


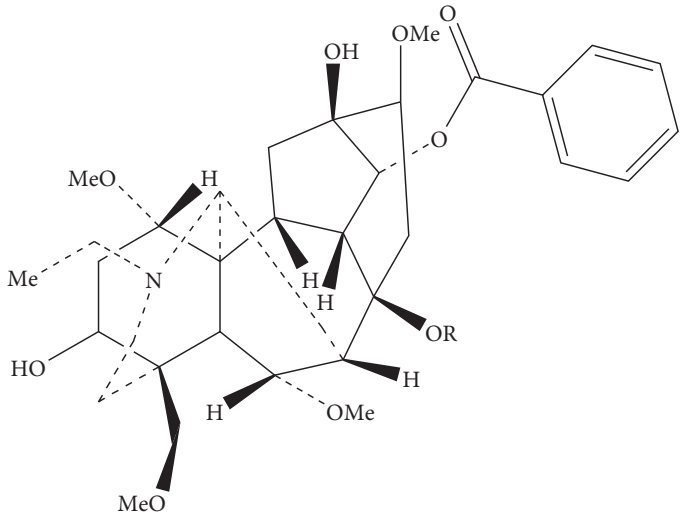
(1)

Compounds	R	R_1	R_2
1a	OH		
1b	H		
1c	OH	H	H
1d	H	H	H



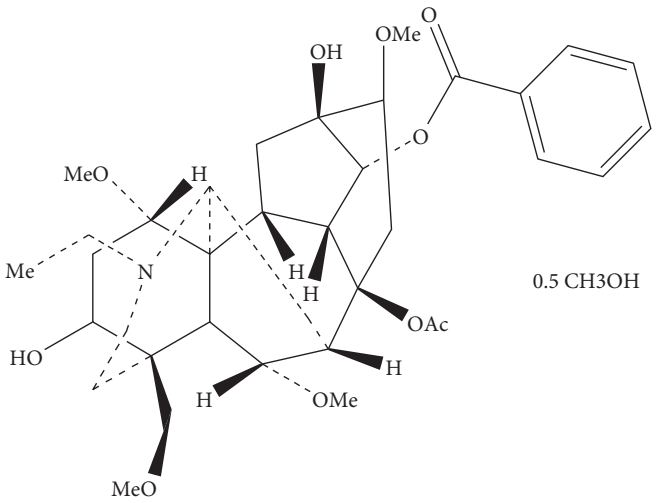
(2)

Compounds	R
2a	
2b	H
2c	



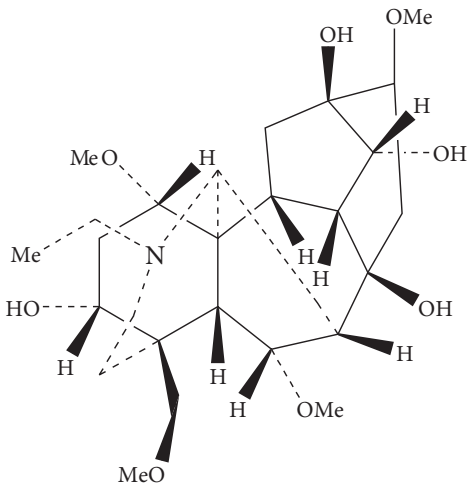
(3)

Compounds	R
3a	Me
3b	Et



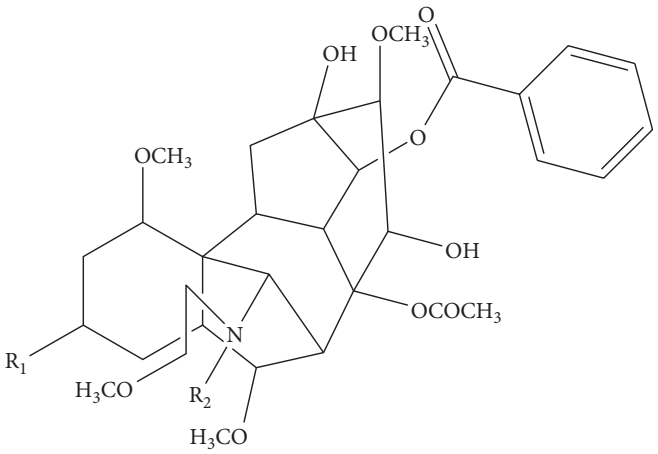
0.5 CH3OH

(4)



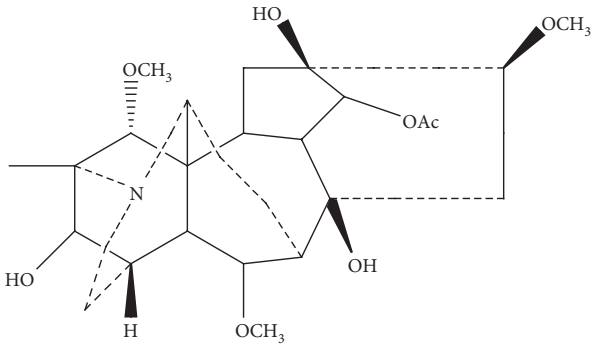
$(CH_3)_2CO$

(5)



(6)

Compounds	R_1	R_2
6a	OH	C_2H_5
6b	OH	CH_3
6c	H	CH_3



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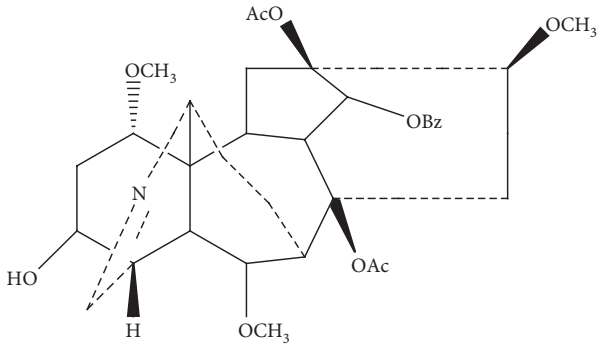

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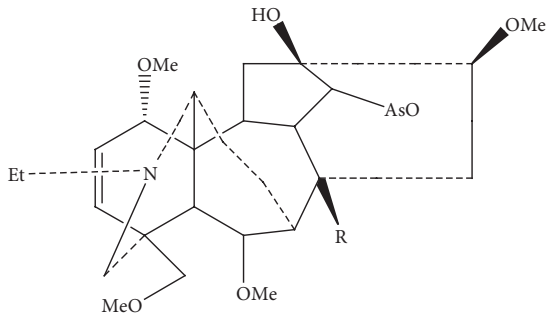

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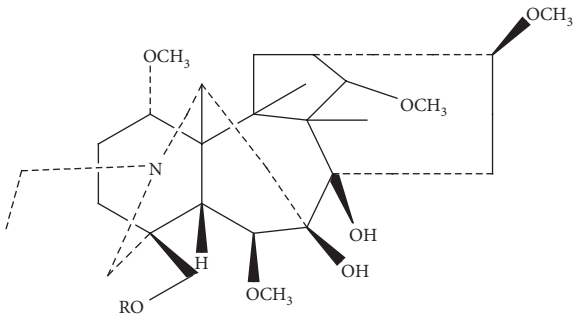
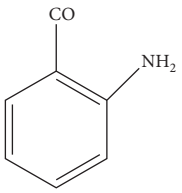
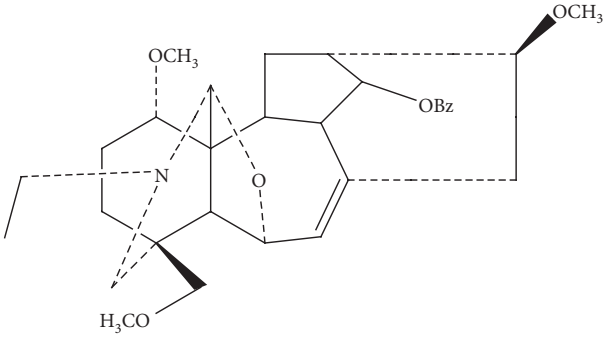


(10)

Compounds	R
9a	OAc
9b	OAs
9c	OEt

Compounds	R
10a	
10b	H



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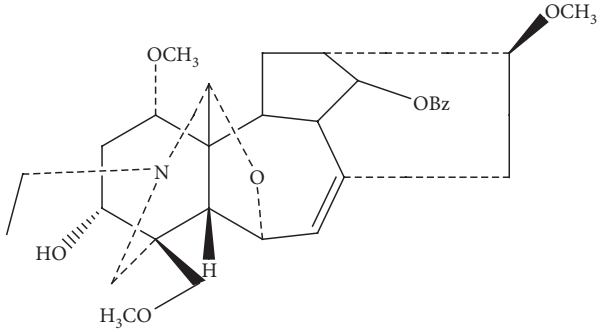

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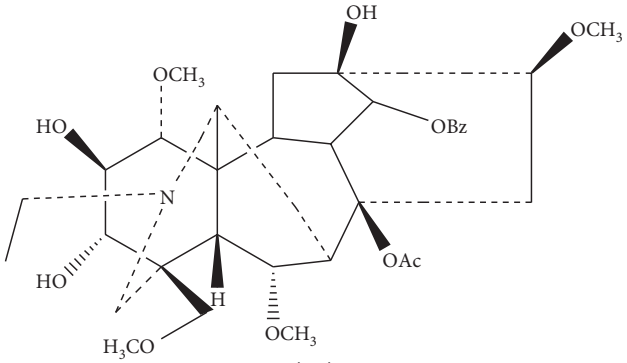

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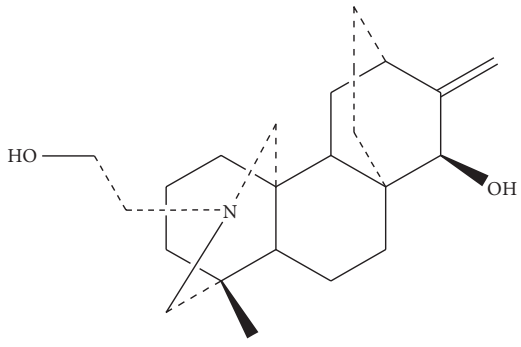

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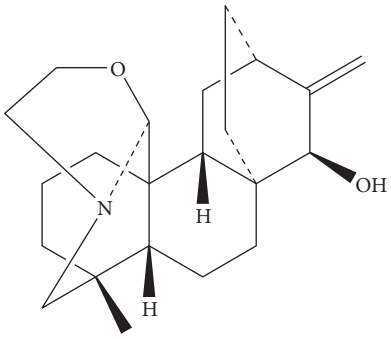

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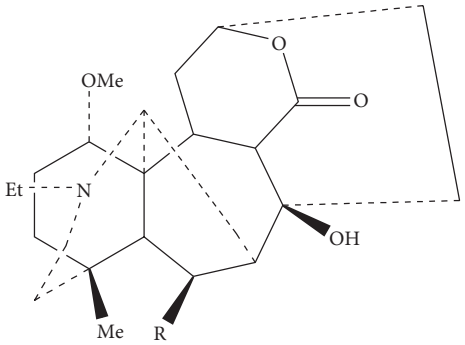
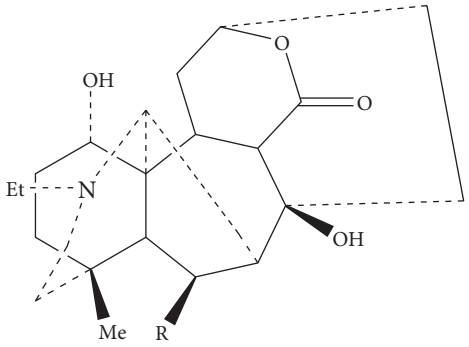


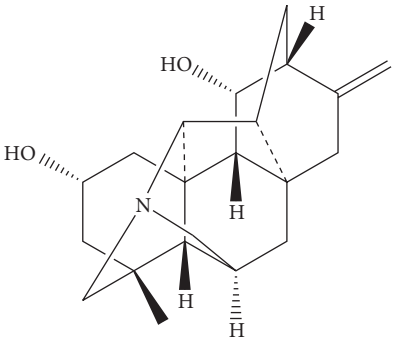
(16)

Compounds	R
16a	OH
16b	OCOPh
16c	OAc
16d	H



(17)

Compounds	R
17a	**OH**
17b	**H**



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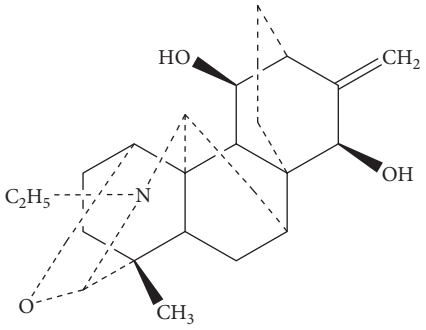

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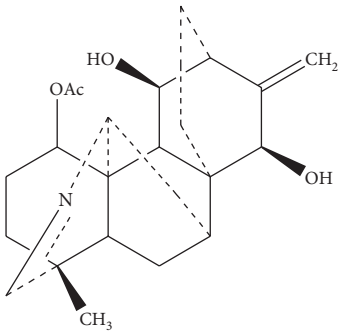

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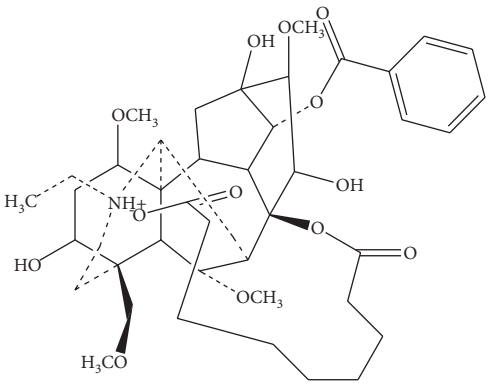
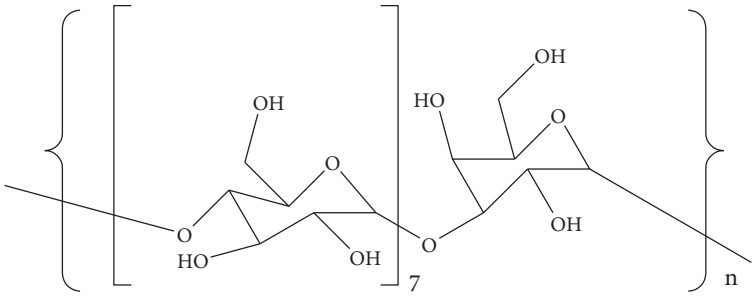


(21)

 dx.doi.org/10.18639/RABM.2016.02.338815



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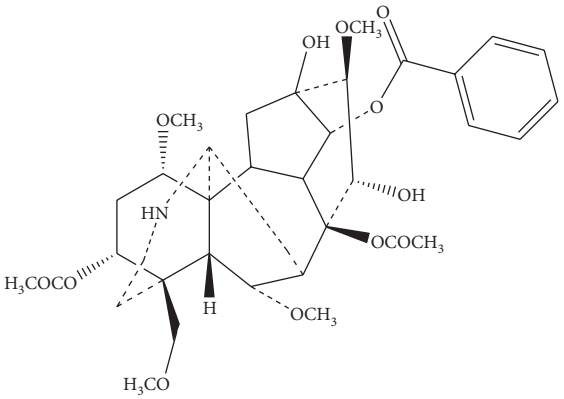

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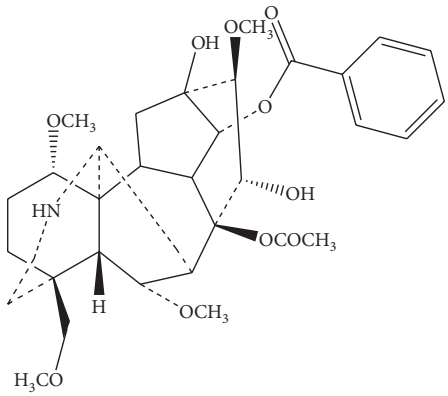

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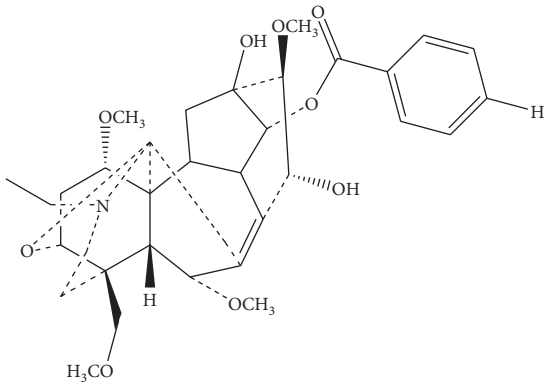

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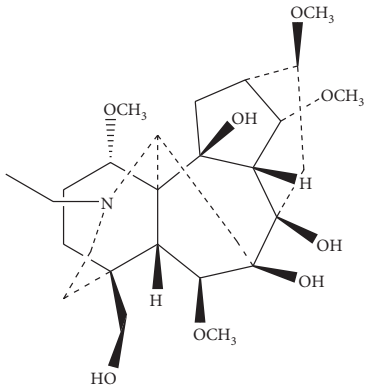

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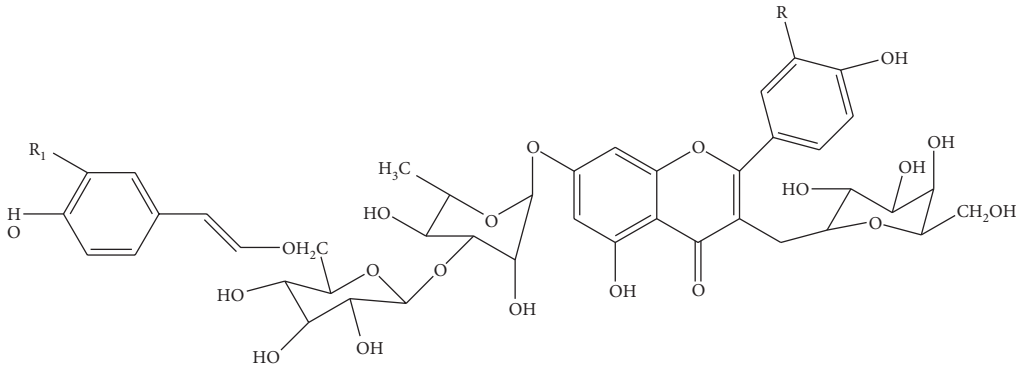
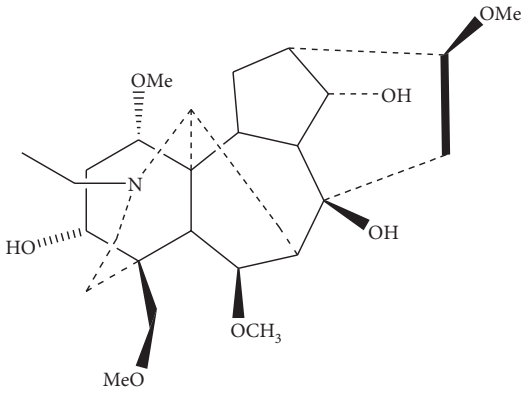


(27)

Compounds	R	R_1
27a	OH	OH
27b	H	OH
27c	H	H



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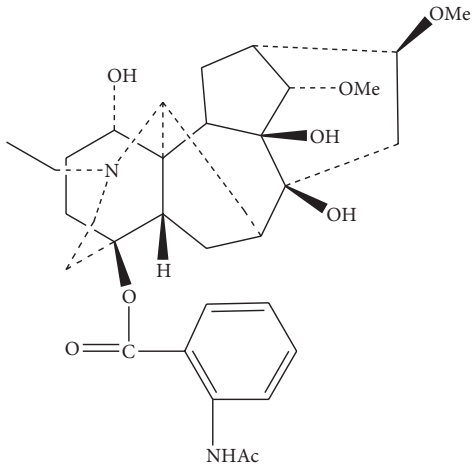

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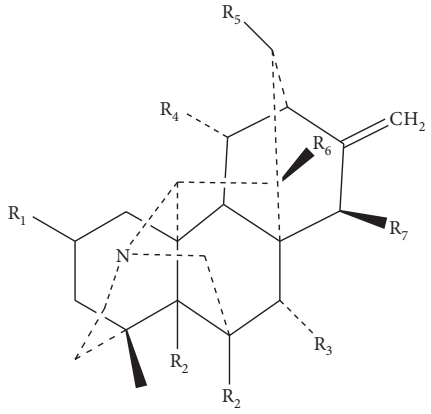

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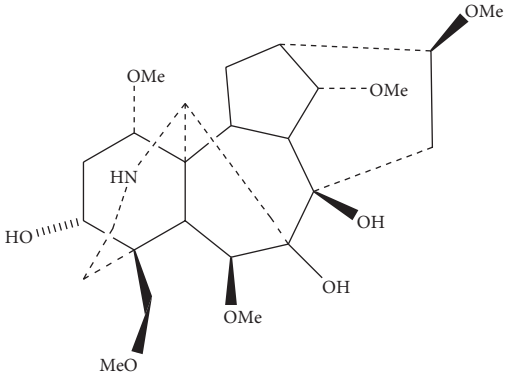
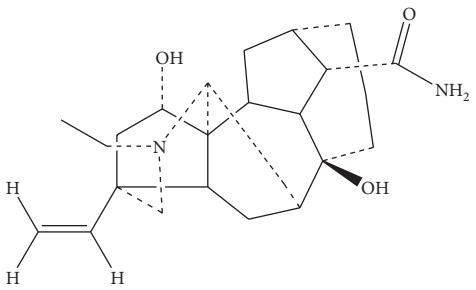


(31)

Compounds	R_1	R_2	R_3	R_4	R_5	R_6	R_7
30a	O	H	OH	OH	O	OH	H
30b	O	H	OAc	OAc	O	OH	H



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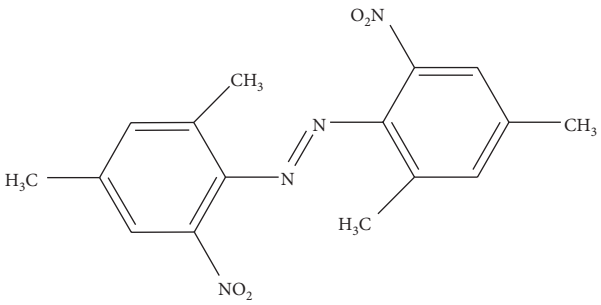
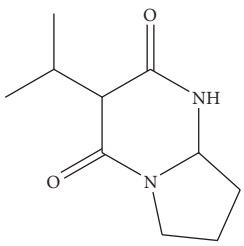


(33)

dx.doi.org/10.18639/RABM.2016.02.338815



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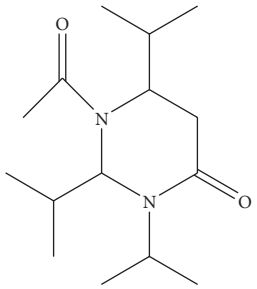

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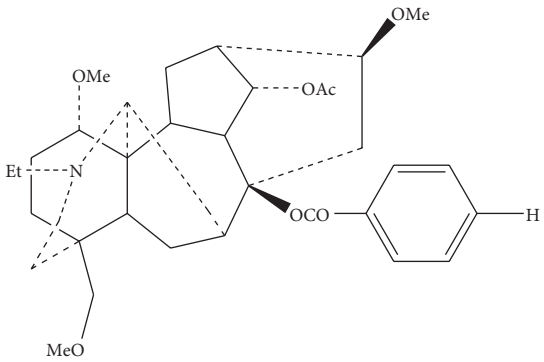

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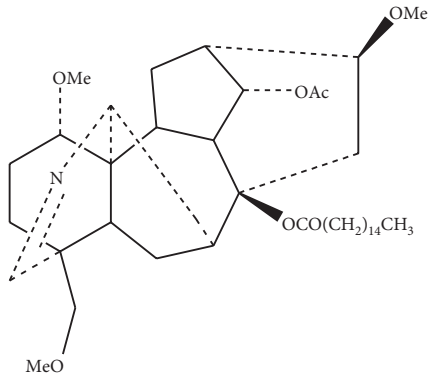

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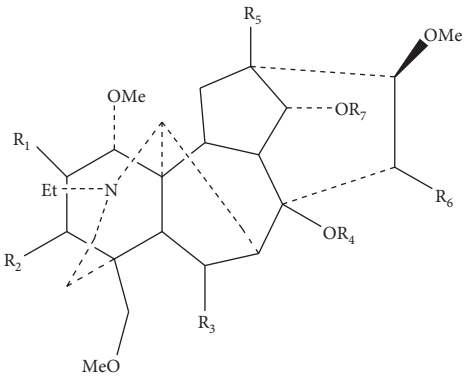
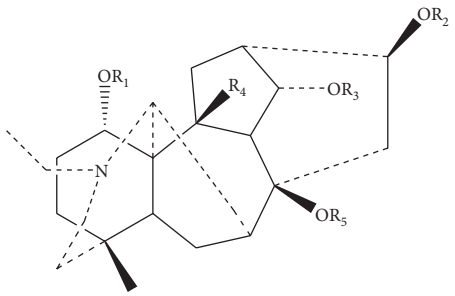


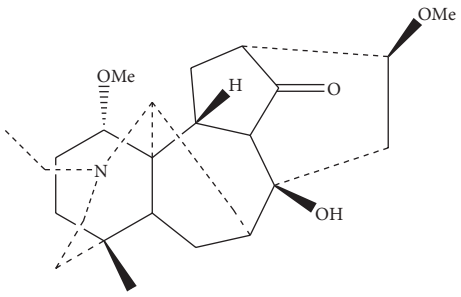
(38)

Compounds	R_1	R_2	R_3	R_4	R_5	R_6	R_7
38a	OH	OH	OMe	Ac	OH	H	As
38b	H	OH	OMe	Ac	OH	H	As
38c	H	H	OMe	Ac	OH	H	As
38d	H	H	OMe	Ac	H	H	As
38e	H	H	H	H	H	H	H
38f	H	OH	OMe	H	OH	H	As
38g	H	H	OH	H	H	H	As
38h	H	OH	OMe	Ac	OH	H	Bz
38i	H	H	OMe	H	OH	H	As
38j	H	H	H	H	H	H	Ac
38k	H	H	OMe	H	H	H	H



(39)

Compounds	R_1	R_2	R_3	R_4	R_5
39a	**H**	**H**	**H**	**H**	**H**
39b	**Me**	**Me**	**H**	**H**	**Et**
39c	**Me**	**Me**	**H**	**H**	**OH**
39d	**Me**	**Me**	**Ac**	**OH**	**H**



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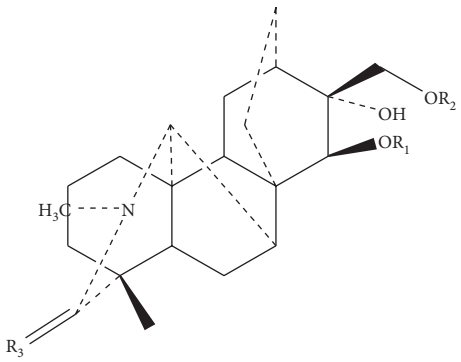

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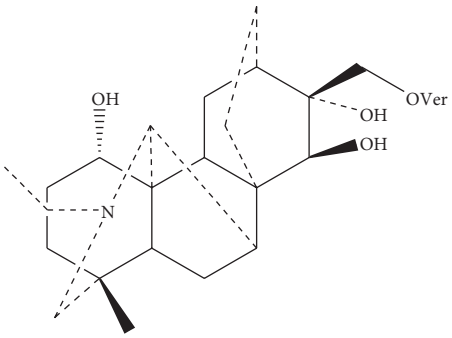
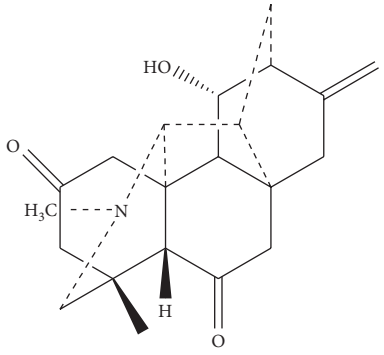
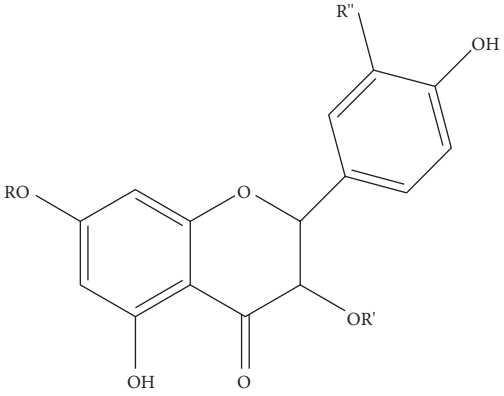


(42)

Compounds	R_1	R_2	R_3
41a	Ver	H	H_2
41b	Ver	Ac	H_2
41c	Ver	Ac	O



(43)



(44)

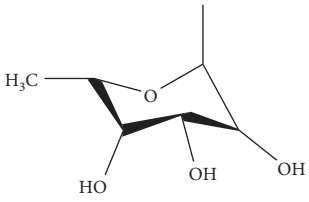
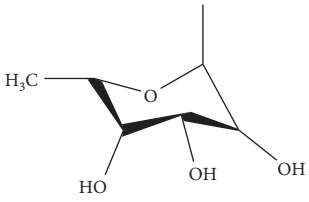
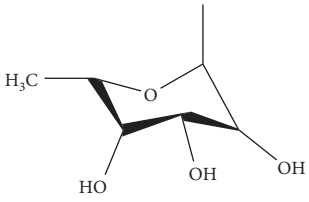
Compounds	R	R′	R″
44a			OH
44b		H	H

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Table 7: List of pharmacological activities studies.

Pharmacological and toxicological studies	Species	Extract/ fraction/ isolate	Dose tested/ Route of administration	Bioactive dose	Positive control	Negative control	Animals	Experimental model (In Vivo / In Vitro)	Results	Reference
Antinociceptive and antiinflammatory activities	*Aconitum carmichaelii*	–	–	–	–	–	Mice	Carrageenan–induced paw edema; formalin test	**A**	[52]
Antihepatocarcinoma	*Aconitum koreanum*	Crude polysaccharides	–	–	–	–	Female mice	MTT assay (In-Vitro); solid tumor-bearing mice model (In-vivo); ascites tumor-bearing mice model	**B**	[53]
Antifungal activity	*Aconitum chasmanthum*	Methanolic extract futher fractional with chloroform	50 mg/5 ml	–	Griseofulvin	–	–	Agar diffusion Method (In-Vitro)	**C**	[54]
Antibacterial activity	*Aconitum chasmanthum*	Stock solution with DMSO	1 mg/ml	–	ampicillin amoxicillin cefuroxime	–	–	Agar diffusion Method (In-Vitro)	**D**	[54]
Cytotoxicity	*Aconitum chasmanthum*	Crude extract	10, 100, 100 µg/ml	–	–	–	–	Brine shrimp lethality test(In-vitro)	**E**	[54]
Insecticidal activity	*Aconitum chasmanthum*	Methanol extract	5, 50, 500 ppm	–	Atropine			Contact toxicity method (In-vitro)	**F**	[54]
Antiinflammatory acitivity	*Aconitum heterophyllum*	Ethanolic extract	225, 450, 900 mg/kg p.o	–	Diclofenac Sodium	–	Rats	Cotton-pellet-induced graanu-loma in rats	**G**	[55]
Hypoglycaemic activity	*Aconitum napellus*	Methanol and aqueous extract	100, 200 and 400 mg/kg p.o.	–	Glibenclamide	–	Wistar albino rats	Alloxans-induced hyperglycaemic rats	**H**	[56]
Antianxiety activity	*Aconitum napellus*	6 cH, 12 cH, and 30 cH in 30% cereal alcohol	–	–	Diazepam	Saline	Wistar Rats	Anxiety-induced model	**I**	[57]
Antioxidant activity	*Aconitum taipeicum*	Ethanol extracts	–	–	–	–	–	In-vitro bioassay	**J**	[58]

A = The aqueous extracts of *Aconitine carmichaeli* exhibits antinociceptive activity and antiinflammatory effect probably due to the presence of high content of mesaconitine; **B** = Results suggested that crude polysaccharides exhibited significant antitumor activity, and it possessed great potential for developing novel antitumor drug; **C** = All fractions exhibited significant antifungal activity against Tricophyton mentagrophyte especially ethyl acetate; **D** = At high concentration (200 µg) it shows weak inhibition of gram-negative microorganism; **E** = The brine shrimp lethality test is carried out with methanolic extract showing that LD_{50} is > 1000 µg; **F** = The insecticidal activity is present at high concentration (500 ppm) as compared to standard drug; **G** = It possess antiinflammatory activity as compared with standard Diclofenac sodium; **H** = Among the tested extracts, the aqueous extract was found to produce promising results that are comparable to that of the reference standard glibenclamide; **I** = Dilution 12 cH and 30 cH produce strong anxiolytic effects on the CNS in animal experimental model; **J** = Strong antioxidant activity exist.

Table 8: Pharmacological activities of isolated consitituents of *Aconitum*.

Pharmacological properties	Species	Chemical constituents isolated	Procedure for isolation	In Vitro/ In Vivo	Results	Reference
Antiinflammatory, anti-oxidant and tyrosinase inhibition activities	*Aconitum laeve*	Swatinine, delphatine lap-paconitine, puberanine, and N-acetylsepaconitine	The powdered plant material was first extracted with n-hexane and the remaining plant material was extracted with 90% ethanol and was concentrated and acidified wit 0.5 N H_2SO_4 and extracted with chloroform. The acidic aqueous solution was basified wit 10% KOH and extracted with chloroform to obtain crude alkaloidal mixture	In-vitro bioassay	**A**	[38]
Antiplasmodial activity	*Aconitum orochryseum*	Atisinium chloride	Acid/base extraction procedure; then atisinium chloride was recrystallised from methanol/diethyl ether	In-vitro bioassay	**B**	[8]
Cytotoxic acitivity	*Aconitum carmichaeli*	Aconitine, chasmanine, crassicauline A, oxonitine, deoxyaconitine,hypaconitine, mesaconitine, senbusine A, songoramine and 15-cetylsongoramine.	Percolation with 0.05 mol/L HCl. The aqueous acidic solution were basified with 10% aqueous ammonia and then extracted with ethylacetate	In-vitro bioassay	**C**	[59]
Cytotoxic activity	*Aconitum richardsonianum*	Delelatine, isodelphe-line, 3-acetylaconitine, isoatisine, nordhagenine A, yunaconitine	Chopped plant material was extraacted with 90% ethanol three times and dried under vaccum. The extract was treated with 5% HCl and then the acidic solution was basified with ammonium hydroxide and extracted wit chloroform to give crude alkaloid	In-vitro bioassay	**D**	[60]
Analgesic and antiin-flammatory acitivity; immunomodulating actions	*Several Aconitium species*	Yunaconitine	–	In-vivo bioassay in rats and mice	**E**	[61, 62]
Analgesic activity	*Aconitum sinomontanum*	Lappaconitine	–	In-vivo Rat tail-flick test	**F**	[63]

A = Lappaconitine and puberanine exhibit antiinflammatory activity and tyrosine inhibition. Swatinine and delphatine possess strong antioxidant activity; **B** = The diterpenoid alkaloid atisinium chloride was shown to have moderate antiplasmodial activities against *Plasmodium falciparum*; **C** = Aconitine, hypaconitine, mesaconitine and oxonitine were found to strongly inhibit the growth of HePG2 cell line; **D** = Delelatine showed significant cytotoxic activities against human tumor cell line P388; **E** = Yunconitine possess strong Analgesic, antiinflammatory acitivity and immunomodulating actions; **F** = It possess strong analgesic activity

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2.3. Pharmacological Activities

The aqueous extracts of *Aconitine carmichaeli* exhibit antinociceptive activity and antiinflammatory effect probably due to the presence of high content of mesaconitine [52]. Crude polysaccharides extract of *Aconitum koreanum* exhibited significant antitumor activity and it possessed great potential for developing novel antitumor drugs [53]. All fractions of *Aconitum chasmanthum* exhibited significant antifungal activity against Tricophyton mentagrophyte especially ethylacetate [54] *Aconitum chasmanthum* shows weak antibacterial activity at high concentration (200 µg) [54] The insecticidal activity of *Aconitum chasmanthum* is present at high concentration (500 ppm) as compared to the standard drug [54]. *Aconitum heterophyllum* showed antiinflammatory properties when tested on Rats [55] *Aconitum napellus* shows hypoglycaemic activity and antianxiety activity [56,57]. List of pharmacological activities are reported in Table 7.

If we discuss the pharmacological activities of isolated consitituents of *Aconitum,* we find that Lappaconitine and puberanine exhibit antiinflammatory activity and tyrosine inhibition [38]. Swatinine and delphatine possess strong antioxidant activity [8]. The diterpenoid alkaloid atisinium chloride was shown to have moderate antiplasmodial activities against *Plasmodium falciparum* [59]. Aconitine, hypaconitine, mesaconitine, and oxonitine were found to strongly inhibit the growth of HePG2 cell line [60]. Delelatine showed significant cytotoxic activities against human tumor cell line P388 [61]. Yunconitine possesses strong analgesic, antiinflammatory properties, and immunomodulating actions [62]. Lappaconitine possess strong analgesic properties [63]. Pharmacological activities of isolated consitituents of *Aconitum* are listed in Table 8.

3. CONCLUSION

Generally, the species of the genus *Aconitum* have shown a number of components isolated. The class of compounds present in the highest frequency was the flavonoids, but the most important chemical constituents in this species that have medicinal properties are diterpenoid alkaloids and norditerpenoid alkaloids. In-vitro pharmacological studies of isolated constituents on *Aconitum* have been performed, but we never know their activity on animal models (preclinical studies). The mechanism of biosynthesis of these chemical constituents is also undetermined. It is important for drug design and their synthesis.

Author Contributions
Each author has contributed equally in the preparation of the manuscript.

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Conflict of Interest
None.

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