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CHEMICAL COMPOSITION AND DISTRIBUTION OF THE GENUS AJANIA (REVIEW)

Resume: The review article presents the results of the analysis of scientific literature on the geographical distribution and level of study of the chemical composition of known representatives of the genus Ajania Poljakov. Out of the 37 known species, only 8 representatives of this plant genus have been studied. The structures of the encountered biologically active compounds (BAC) are presented, including flavonoids, terpenoids, phytosterols, lignans, alkaloids, and other nitrogen-containing compounds, organic acids, hydrocarbons, aldehydes, and phenolic compounds. In quantitative terms, the class of phenolic compounds predominates, among which terpenoids and flavonoids are dominant, some of which can be considered as chemotaxonomic markers. Within the territory of the Republic of Kazakhstan, two species are found: Ajania fastigiata and Ajania fruticulosa, the latter of which has pharmacopoeial significance.
Keywords: Ajania, Ajania fruticulosa, Ajania fastigiata, chemical composition, chemotaxonomy.

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AJANIA ТҰҚЫМЫНЫҢ ХИМИЯЛЫҚ ҚҰРАМЫ ЖӘНЕ ТАРАЛУЫ (ШОЛУ)

Түйін: Шолу мақалада Ajania Poljakov тұқымдасының географиялық таралуы белгілі, өкілдерінің химиялық құрамын зерттеу деңгейі бойынша ғылыми әдебиеттерді талдау нәтижелері келтірілген, оның ішінде, белгілі 37 тұқымдасының тек 8 өкілі зерттелген. Биологиялық белсенді заттардың құрылымдары кездесетін флавоноидтар, терпеноидтар, фитостериндар, лигнандар, алкалоидтар және құрамында азоты бар басқа қосылыстар, органикалық қышқылдар, көмірсутектер, альдегидтер, фенолды қосылыстар ұсынылды. Сандық тұрғыдан фенолды қосылыстар классы басым, олардың ішінде терпеноидтар және флавоноидтар басым мөлшерде, кейбіреуін химотоксонометриялық маркерлерге жатқызуға болады. ҚР аумағында 2 түрі Ajania fastigiata және Ajania fruticulosa өседі, соңғысы фармакопеялық болып табылады.
Түйінді сөздер: Ajania, Ajania fruticulosa, Ajania fastigiata, химиялық құрамы, химотаксономиясы.

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ХИМИЧЕСКИЙ СОСТАВ И РАСПРОСТРАНЁННОСТЬ РОДА AJANIA (ОБЗОР)

Резюме: В обзорной статье представлены результаты анализа научной литературы по географическому распространению, уровню изученности химического состава известных представителей рода Ajania Poljakov, из известных 37 видов изучены только 8 представителей рода данного растения. Представлены структуры встречающихся БАВ, относящихся к флавоноидам, терпеноидам, фитостеринам, лигнанам, алкалоидам и другим азотсодержащим соединениям, органическим кислотам, углеводородам, альдегидам и фенольным соединениям. В количественном отношении преобладает класс фенольных соединений, среди которых доминируют терпеноиды и флавоноиды, некоторые из них можно отнести к хемотоксонометрическим маркерам. На территории РК произрастает 2 вида Ajania fastigiata и Ajania fruticulosa, последний из которых является фармакопейным.
Ключевые слова: Ajania, Ajania fruticulosa, Ajania fastigiata, химический состав, хемотаксономия.

Introduction. Ajania Poljak. is a perennial herbaceous plant of the Asteraceae family, including about 30 species of herbs, shrubs and bushes. Plants are covered with bipartite trichomes, sometimes with an admixture of simple trichomes, without shortened (in the form of rosettes of root leaves) vegetative shoots, with erect, but at the base and in the inflorescence branched, abundantly lined stems and ordinary leaves. The plant has a strong root system to extract water from stony soil, and is able to grow on stony or rubbly slopes, steep cliffs and in steppe to the middle belt. It reproduces exclusively by seeds. The optimal phase for collecting raw materials is the beginning of flowering August - September, depending on the growing region. The above-ground part of the plant is of scientific interest [1-4].

General geographical distribution

The genus Ajania is named after the village of Ayan (Khabarovsk region), located on the shore of the Sea of Okhotsk. The species A. pallasiana was first described from its vicinity [3]. As an independent genus Ajania was separated from Artemisia in 1955 by Polyakov. The evolutionary development of the two genera proceeds from common ancestral forms close to the genus Dendrathema Des. Moid. Adaptation to habitat conditions in vast areas of steppes and deserts of Central Asia has created a significant external similarity of many Ajania species with species of the genus Artemisia. In this connection, in different years different sources give very different data on the composition of species of the genus Ajania [4]. In the 1961 Flora of the USSR, Tsvelev N. N. includes about 25 species in the genus and gives a description of 9 species growing in the territory of the former USSR countries, namely A. kokanica (Krasch.) Tzvel., A. Pallasiana (Fisch. ex Bess.) Poljak, A. Manshurica Poljak., A. fruticulosa (Ldb.) Poljak., A. gracilis (Hook. f. et Thorns.) Poljak, A. fastigiata (Winkl.) Poljak., A. tibetica (Hook. f. et Thorns.) Tzvel, A. Scharnhorstii (Rgl. et Schmalh.) Tzvel, A. trilobata Poljak. [4].

In the flora of Kazakhstan, A.A. Muldashev describes 27 species of the genus Ajania. There are 3 species in Kazakhstan – Ajania fruticulosa, Ajania fastigiata and understudied endemic Ajania korovinii Kovalevsk which is mentioned only in the Flora of the Republic of Kazakhstan and is not described in other scientific literature [5]. The dynamics of plant distribution in Kazakhstan is described in the works of Gemedzhieva N. A. fastigiata grows in the Trans-Ili Alatau, Kungei Alatau, Kyrgyz Alatau, it is noted that the plant is able to form wild bushes of commercial importance. [6, 7]. Data on the raw material base of A. fruticulosa are not available due to the ability of the plant to form thickets together with other wild plants, which makes it difficult to determine the amount of growing raw materials. In this regard, we conducted an introduction study of A. fruticulosa in the dry-steppe zone of Central Kazakhstan, the collection of plants for this purpose was carried out mainly in the eastern and southeastern part of the country (village Dogolan, Algabas, etc.). [2, 8, 9, 31]. According to The Plant List database, the genus Ajania has 37 species [10]. It should be noted that a group of Iranian scientists in 2013 isolated a new endemic species – A. semnanensis Sonboli about which The Plant List database does not include the information on [11]. As analysis of international citation databases shows, it is accepted by most authors that the genus Ajania has about 30 species [12]. Data analysis showed that information on the chemical composition of the majority of plant species of the genus Ajania is absent. There is information on phytochemical composition of only 8 species of plants in different degrees of study: A. achilleoides, A. fastigiata, A. fruticulosa, A. nematoloba, A przewalskii, A. salicifolia, A. semnanensis, A. tenuifolia. Data on the chemical composition of other species are practically absent. The prevalence of different Ajania species, presented in Table 1, was analyzed. It should be noted that the most widespread species is Ajania fruticulosa, the range of which covers the Tien-Shan, Pamir-Altai, Kazakhstan, Western Siberia, Mongolia and China. This species is also found in the Republic of Tyva (Central Tuva Basin, Russian Federation), but this plant is rare [2, 4, 8, 9]. A. achilleoides - endemic, grows only in Mongolia, for the study raw materials collected in the Gobi Desert were used [13]. The distribution range of A. fastigiata covers Kazakhstan, Mongolia, Kyrgyzstan, Tajikistan, and Afghanistan. A. nematoloba and A. salicifolia are found only in the East and Northeast of China. A. tenuifolia is distributed throughout China. A. przewalskii grows in Mongolia and China [12].

Study of the chemical composition of plants of the genus Ajania

As is known, the family Asteraceae, to which the genus Ajania belongs, is one of the most highly organized families of flowering plants. Phytochemical studies of the family Asteraceae have revealed the presence of various chemical compounds: the most frequently occurring classes of compounds of almost all its representatives are terpenoids (mainly sesqui-, di- and triterpenes, sesquiterpene lactones), phenolic compounds (flavonoids), and acetylene compounds. Many of these are considered important chemotaxonomic markers of both individual genera and the family as a whole, and sesquiterpene lactones and acetylene compounds are considered to be unique structural classes of Asteraceae. The most common sesquiterpenoids are sesquiterpenoids of guaiac type, eudesman type, eremophilan type, and germacran type, which are used as chemotaxonomic markers [14, 15].

Studies of biologically active substances (BAS) of the Ajania genus included polysaccharides, phenolic compounds, volatile substances, acetylenic compounds, terpenes, lignans, fatty acids and some other groups. Summarized information on the isolated, identified groups of BAS in different species of the genus Ajania is presented in Table 2.

Phenolic compounds

Flavonoids. The first works on the study of the chemical composition of Ajania genus plants started in 1973. Kazakh scientists Chumbalov T.K. and others isolated 4',5-Dihydroxy-3',7-dimethoxyisoflavone (velutin) from the aboveground part of A. fastigiata (Trans-Ili Alatau, Kazakh-

stan) by paper chromatography [16]. A great contribution to the study of chemical composition was made by scientists from China. In the work of Jun-Yu Liang (2020) and other co-authors, the component composition of A. fruticulosa was investigated by preparative HPLC method with subsequent structure determination by spectral methods; axillarin [17, 18, 20], cirsiliol [17, 19], pectolinarigenin [16, 19], 6-methoxytricin [17, 19], jaceosidin [17, 19] were found; the above flavonoids were isolated in other Ajania species. The flavonoids 5,7-dihydroxy-6,3',4',5'-tetramethoxyflavone, acacetin, 7-desmethylartemetin were found only in A. fruticulosa and can be considered as an additional chemotaxonomic marker [16].

As can be seen from the literature analysis, the phytochemical composition of the species A. potaninii was studied by researchers from China Jun-Yu Liang (2019) and other co-authors. As a result, 10 flavonoid compounds such as: artemetin, casticin, axillarin, centaureidin, jaceosidin, cirsiliol, 6-methoxytricin, pectolinarigenin were found in the above-ground part of the plant by preparative column chromatography with subsequent determination of the structure of the isolated substances by NMR - spectroscopy. Eriodictyol and 3,3'-di-O-methyl-quercetin are considered as additional chemotaxonomic marker for in A. potaninii [17 -24].

Zhuan-Ning Shi (2017) et al. (2017) identified centaureidin and jaceosidin by silica gel column chromatography, followed by analysis of substances by spectral methods in the plant A. salicifolia, they consider the flavone derivative luteolin-3',4'- dimethyl ester as the marker compound [24]. The presence of previously identified flavonoid groups was confirmed in Ajania nematoloba and Ajania przewalskii, A. tenuifolia [17, 25, 26, 27].

Coumarins. The content of coumarins in plants of the genus Ajania is poorly studied, in particular they are found in species of A. achilleoids, A. przewalsk, A. salicifolia, A. nematoloba. Studies on the isolation of coumarins from other plant species are lacking and remains promising. Column chromatography with a 3-component system was predominantly used for the isolation of coumarins. Isoscopoletin, scoparone, fraxetin, "baihuaqianhuside", 6,8-dimethoxy-7-[[[(2e)-3,7-dimethyl-2,6-octadienyl]oxy]couma-

Table 1 - Geographical distribution of plants of the genus Ajania

Species of Ajania	Kazakhstan	China	Kyrgyzstan	Mongolia	Russia	Tajikistan	India	Iran	Nepal	Japan
A. achillaeoides (Turcz.) Poljakov	-	-	-	+	-	-	-	-	-	-
A. aureoglobasa (W.W. Sm. & Farr.) Muldashev	-	+	-	-	-	-	-	-	-	-
A. fastigiata (Winkl.) Poljakov	+	+	+	+	-	-	-	-	-	-
A. fruticulosa (Ledeb.) Poljakov	+	+	+	+	+	-	-	-	-	-
A. gracilis (Hook. f. & Thomson) Poljakov	-	+	+	-	-	+	+	-	-	-
A. grubovii Muldashev	-	+	-	-	-	-	-	-	-	-
A. junnanica Poljakov	-	+	-	-	-	-	-	-	-	-
A. khartensis (Dunn) C. Shih	-	+	-	-	-	-	-	-	-	-
A. kokanica (Krasch.) Tzvelev	-	-	+	-	-	-	-	-	-	-
Ajania korovinii Kovalevsk	+	-	-	-	-	-	-	-	-	-
A. myriantha (Franch.) Y. R. Ling	-	+	-	-	-	-	-	-	-	-
A. nana (Krasch.) Muldashev	-	+	-	-	-	-	-	-	-	-
A. nematoloba (Hand. – Mazz.) Ling	-	-	-	+	-	-	-	-	-	-
A. nubigena (Wall.) C. Shih	-	-	-	+	-	-	-	-	+	-
A. Pacifica (Nakai) K.Bremer &Humphries	-	-	-	+	-	-	-	-	-	+
A. pallasiana (Fisch. ex Besser) Poljakov	-	+	-	-	+	-	-	-	-	-
A. parviflora (Grun.) Ling	-	+	-	-	-	-	-	-	-	-
A. potaninii (Krasch.) Poljakov	-	+	-	-	-	-	-	-	-	-
A. przewalskii Poljakov	-	+	-	+	-	-	-	-	-	-
A. purpurea C. Shih	-	+	-	-	-	-	-	-	-	-
A. remotipinna (Hand. – Mazz.) Y.Ling & C. Shih	-	-	-	+	-	-	-	-	-	-
A. roborowskii Muldashev	-	+	-	-	-	-	-	-	-	-
A. rupestris (Matsum. & Koidz.) Muldashev	-	-	-	-	-	-	-	-	-	+
A. scharnhorstii (Regel & Schmalh.) Tzvelev	-	+	-	-	-	-	-	-	-	-
Ajania semnanensis Sonboli	-	-	-	-	-	-	-	+	-	-
Ajania salicifolia (Mattf.) Poljakov	-	+	-	-	-	-	-	-	-	-
Ajania tenuifolia (Jacquem. ex Besser) Tzvelev	-	+	-	-	-	-	-	-	-	-
A. tibetica (Hook. f. & Thomson) Tzvelev	-	+	+	-	-	-	+	-	-	-
A. trilobata Poljakov	-	+	+	-	-	-	-	-	-	-
A. Trifida (Turcz) Tzvel	-	-	-	+	-	-	-	-	-	-

rin, sabandinin, scopolin, 7-(3-methyl-2-butenyloxy)-6-methoxycoumarin were identified [18, 25 – 28].

Phenylpropanoids and lignans. From the above-ground parts of A. achilleoids, A. przewalskii, A. salicifolia, A. nematoloba, A. fruticulosa, lignans (cedrusin, larisiresinol, sesamin, syringaresinol, evofolin B), phenylpropanoids (ferulic acid, coniferaldehyde, methylferulat, methyl-p-coumarate, methyl coffeate, abietin, syringoside, butyl ester of chlorogenic acid, caffeic acid) were isolated.

Analysis of the above discussed compounds shows that lignans (cedrusin, larisiresinol), phenylpropanoids (ferulic acid, coniferaldehyde, methylferulat, methyl-p-coumarate, abietin, syringosidi) have not been isolated from other species of the genus, suggesting that they can be used to distinguish A. salicifolia from other species of the plant [17-28].

Naphthoquinones. 1,4-naphthoquinone was isolated from A. salicifolia [25, 28]. Additionally, other phenolic compounds were identified from A. przewalskii and A. salicifolia: 3,4-dihydroxybenzaldehyde, vanillin, methyl 4-hydroxybenzoate, cannabichromeorcin, 5-Heneicosylresorcin, 4-acetonyl-3,5-dimethoxy-p-quinol.

Alkaloids. A single alkaloid, lappaconitine, has been isolated from A. potaninii.

Terpenoid compounds

This broad class of natural compounds in plants of the genus Ajania is represented by mono-, sesqui-, tri- and terpenoids.

To date, sixty-eight mono- and sesquiterpenoids (46-113) have been identified in six plant species of the genus Ajania (Table 2) [19-21]. The main components that determine the properties of essential oils are terpenoids.

Essential oil. The most preferred method of essential oil production is the hydrodistillation method, the essence of which is the distillation of water in the presence of plant material [29-33]. The main components of the essential oil from A. potaninii (Gansu Province, China) were 1,8-cineole (22.19%), (+)-camphor (12.84%), (-)-verbenol (13.84%), borneol (12.67%) and 2,6,6-trimethyl-bicyclo[3.1.1.1]hept-2-en-4-ol acetate (6.24%). The major components of the essential oil from A. fruticulosa (Gansu Province, China) were 1,8-cineole (41.40%), (+)-camphor (32.10%) and myrtenol (8.15%) [29]. The main compounds of essential oil from A. semnanensis (Shahmirzad-Chashm, Semnan province, Iran) were 1,8-cineol (32.5%), boronyl acetate (19.1%), camphor (18.9%), lavandulyl acetate (7.4%) and terpinen-4-ol (5.4%) [30]. Adekenov and co-authors identify 1,8-cineole (6.45%-32.02%) and hamazulene as the main components of essential oil from A. fruticulosa (Central Kazakhstan), the amount of which increases (up to 45% of the sum of oil components) [30]. It should be noted that 1,8-cineole was the most abundant compound in the essential oil of 3 species collected in China, Iran and Kazakhstan. As a chemotaxonomic marker for the Kazakhstan species A. fruticulosa, a high content of hamazulene should be emphasized.

In the essential oil from A. fruticulosa growing in Mongolia (Gobi desert), α- and β-thujones (24.33 %), thymol (18.04 %), camphor (9.38 %), 1,8-cineole (9.27 %), and cis-chrysanthenol (5.59 %), which has not been previously detected in other Ajania species, were identified as the main components. Cis-chrysanthenol should be identified as a chemotaxonomic marker for the Mongolian species A. fruticulosa. The composition of essential oil from A. fruticulosa collected in Mongolia differs significantly from that of oils from other countries [29-32].

The chemical composition of essential oil from A. trifida (Gobi, Mongolia) is very similar to that of A. achillaeoides (Gobi, Mongolia). Camphor (41.16% and 58.25%), 1,8-cineole (12.52% and 10.41%) and borneol (6.91% and 4.98%) are identified as the main components for both essential oils [32].

The major component in the essential oil from A. nubigena is linalyl acetate (75.8%), 6-ethyldihydro-2,2,6-trimethyl-2npyran-3(4H)-one 4.6%), β-farnesene (2.9%), epoxylinalool (2.8%), germacrene D (1, 4%), bisabolol oxide A (1, 2%), (E)-2-(2,4-hexadienylidene)-1,6-dioxaspiro[4,4]non-3-ene (1%), (Z)-2-(2,4-hexadienylidene)-1,6-dioxaspiro[4,4]non-3-ene (1%) [33]. Camphor (14.8%) and borneol (41.0%) in A.fastigiata (China), 1,8-cineol (26.0%), and camphene (21.1%) in A. przewalskii (China) [34].

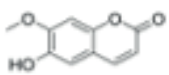
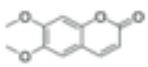
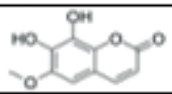
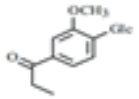
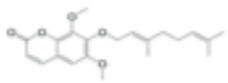
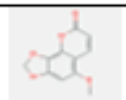
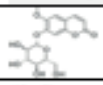
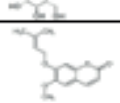
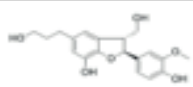
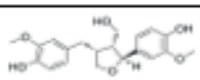
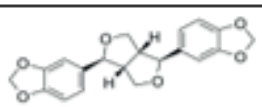
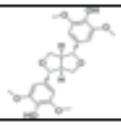
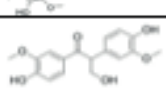
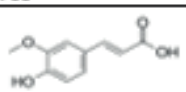
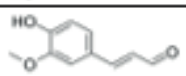
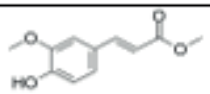
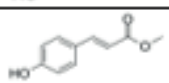
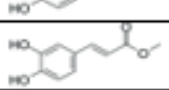
Thus, the differences in the chemical composition of essential oils may have been due to the place of growth, time of collection of raw materials, and analytical methods. Nevertheless, 1,8-cineole and camphor may be characteristic components for Ajania species.

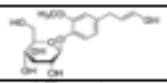
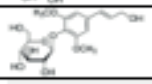
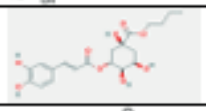
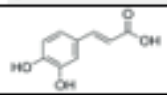
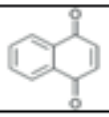
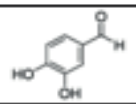
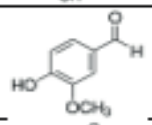
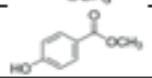
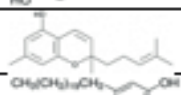
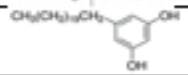
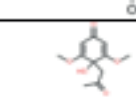
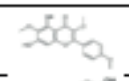
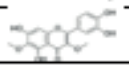
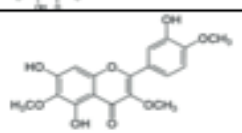
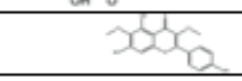
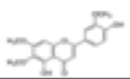
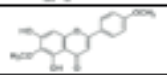
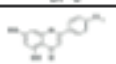
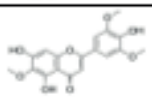
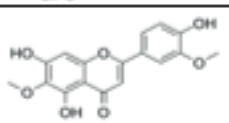
Triterpenoids. The study of extracts from A. fruticulosa, A. potaninii, A. nematoloba, A. salicifolia, and A. przewalsk by HPLC method showed the presence of triterpenoids: stigmasterol, daucosterol, taraxerol, betulin, 3-β-friedelinol, friedelin, β-sitosterol, sitostenone, ergosterol peroxide, ergosta-4,6,8,22-tetraen-3-one, α-amyrin, β-amyrin, 4-epitasanin cerevisterol.

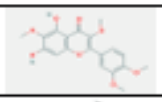
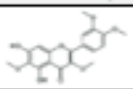
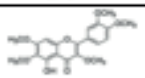
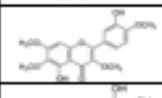
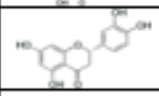
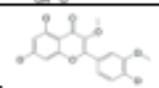
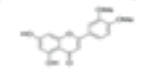
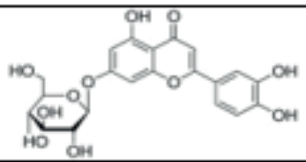
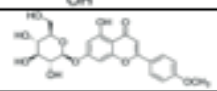
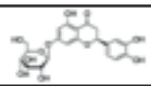
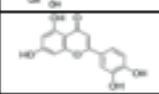
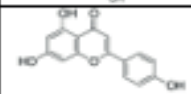
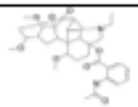
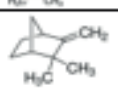
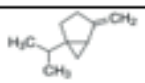
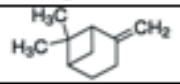
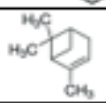
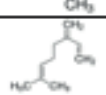
Conclusion. The analysis of literature data has shown that the genus Ajania includes 30 species of plants. The most widespread and studied is the plant Ajania fruticulosa with the area of distribution China and Central Asia. There is information that on the territory of the Republic of Kazakhstan was carried out introduction of this plant species. In 2013 Iranian scientists discovered a new species A. semnanensis Sonboli, which is an endemic. Plants of the genus Ajania include various classes of compounds such as: terpenoids (mainly sesqui-, di- and triterpenes, sesquiterpene lactones), phenolic compounds (flavonoids), acetylenic compounds. Many of these are considered important chemotaxonomic markers of both individual genera and the family as a whole, and sesquiterpene lactones and acetylene compounds are considered to be unique structural classes of Asteraceae. The most common sesquiterpenoids are sesquiterpenoids of guaiac type, eudesman type, eremophilan type and germacran type, which are used as chemotaxonomic markers.

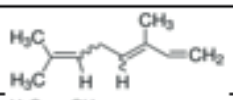
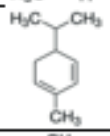
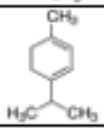
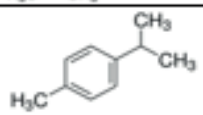
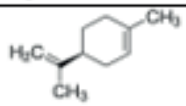
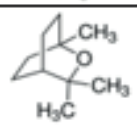
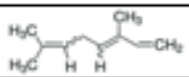
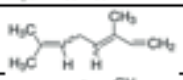
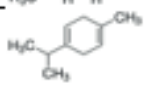
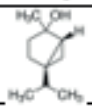
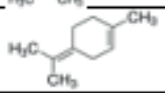
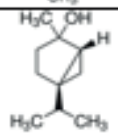
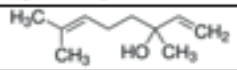
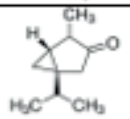
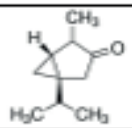
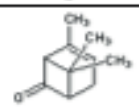
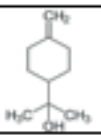
The results of the analysis of literature data show that the genus Ajania is poorly studied

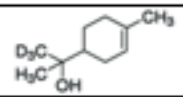
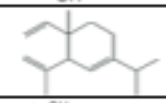
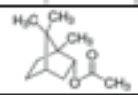
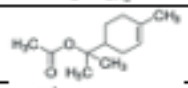
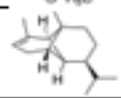
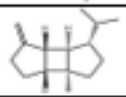
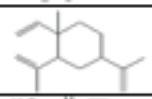
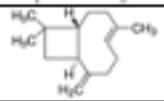
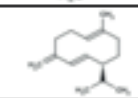
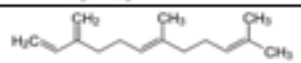
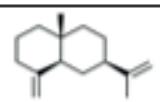
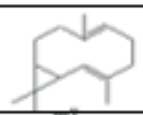
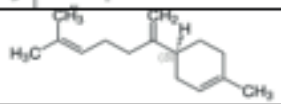
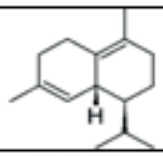
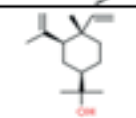
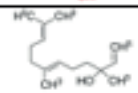
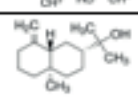
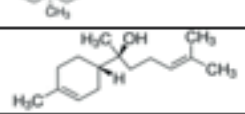
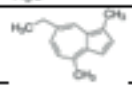
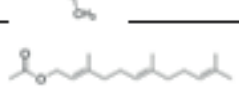
Table 2 - Chemical composition of plants of the genus Ajania

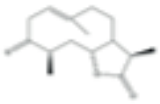
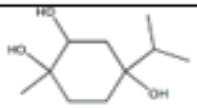
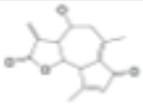
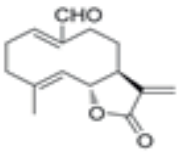
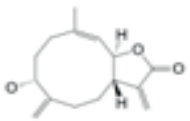
No.	Metabolite name	Structural formula	Plant species	Reference
1	2	3	4	5
Phenolic compounds				
Coumarins				
	Isoscopoletin		A. achilleoids	[18]
			A. przewalskii	[27]
			A. salicifolia	[25]
	Scoparone		A. salicifolia	[25]
			A. przewalskii	[27]
	fraxetine		A. salicifolia	[25]
			A. przewalskii	[27]
	Baihuaqianhuside		A. nematoloba.	[26]
	6,8-Dimethoxy-7-[[(2E)-3,7- dimethyl -2,6-octadienyl] oxy] coumarin		A. salicifolia	[28]
			A. przewalskii	[27]
	Sabandinin		A. przewalskii	[27]
	Scopolin		A. przewalskii	[27]
	7-(3-methyl-2-butenyloxy)-6-methoxycoumarin		A. przewalskii	[27]
Lignans				
	Kedrusin		A. salicifolia	[25]
	Larisiresinol		A. salicifolia	[25]
	Sesamin		A. fruticulosa	[24]
			A. salicifolia	[25]
			A. przewalskii	[27]
	Syringaresinol		A. salicifolia	[25]
	Evopholine B		A. salicifolia	[25]
Phenylpropanoids and their derivatives				
	Ferulic acid		A. salicifolia	[25]
	Coniferaldehyde		A. salicifolia	[25]
	Methyl ferulate		A. salicifolia	[25]
	Methyl-p-coumarate		A. salicifolia	[25]
	Methyl coffeate		A. przewalskii	[25, 27]
			A. salicifolia	[25]

	Abietin		A. salicifolia	[25]
	Syringoside		A. salicifolia	[25]
	Chlorogenic acid butyl ester		A. przewalskii	[27]
	caffeic acid		A. przewalskii	[27]
Naphthaquinones				
	1,4- naphthoquinone		A. salicifolia	[28]
Other phenolic compounds				
	3,4-dihydroxybenzaldehyde		A. salicifolia	[25]
	Vanillin		A. przewalsk	[25]
			A. salicifolia	[25]
	Methyl 4-hydroxybenzoate		A. salicifolia	[25]
	Cannabichromeorcin		A. salicifolia	[25]
	5-Heneicosylresorcin		A. salicifolia	[25]
	4-acetonyl-3,5-dimethoxy-p-quinol		A. salicifolia	[25, 28]
Flavonoids				
Flavonols				
	Santin		A. fruticulosa	[24]
	Axillarin		A. fruticulosa	[16,17,20 22,25]
			A. potaninii	[19]
	Centaureidine		A. fruticulosa	[25]
			A. salicifolia	[[25]
			A. nematoloba	[19]
			A. potaninii	[19]
	5,7,4'-Trihydroxy-3'6-dimethoxyflavone		A. fruticulosa	[19]
Flavones				
	Cirsilineol		A. fruticulosa	[17], [18]
			A. potaninii	[19]
			A. nematoloba	[26]
	Pectolinarigenin		A. potaninii	[19]
			A. fruticulose	[17]
	Acacetin		A. fruticulosa	[17]
	6-methoxytricin		A. fruticulosa	[17]
			A. potaninii	[19]
			A. tenuifolia	[17]
	Jaceosidine		A. fruticulosa	[17]
			A. potaninii	[19, 25]
			A. tenuifolia	[17]
			A. nematoloba	[26]

	5,7-dihydroxy-6,3',4',5'-tetramethoxyflavone		A. fruticulosa A. nematoloba	[17] [26]
	7-desmethylartemetin		A. fruticulosa	[17]
	Artemetin		A. fruticulosa A. przewalskii	[17] [19]
	Casticin		A. fruticulosa A. przewalskii	[19] [19, 21]
	Eriodictyol		A. potaninii	[19]
	3,3'-di-O-methyl-quercetin		A. potaninii	[19]
45.	Luteolin-3',4'- dimethyl ester		A. salicifolia	[25]
46.	Luteolin 7-O-β-D-glucoside		A. nematoloba	[26]
47.	Acacetin 7-glucoside		A. nematoloba	[26]
48.	Eriodictyol 7-O-β-D-glucopyranoside		A. nematoloba	[26]
49.	luteolin		A. nematoloba	[26]
50.	apigenin		A. nematoloba	[26]
Alkaloids				
51.	Lappaconitine		A. potaninii	[19]
Terpenoids				
Mono-, sesqui,- diterpenoids, polyterpenes and their derivatives, aldehydes, ketones				
	Tricyclen		A. Trifida	[13]
	α-Tuyen		A. fruticulosa	[13], [30]
	Camphene		A. fruticulosa A. Trifida A. Achileoides	[13], [30] [13] [13]
	(+)-Sabinen		A. fruticulosa A. Trifida	[13] [13]
	(+)-β-Pinene		A. fruticulosa A. Trifida	[13], [30] [13]
	α -Pinene		A. fruticulosa A. Trifida	[13] [13]
	Myrcene		A. fruticulosa A. Achileoides	[30] [13]

	Ocimene		A. fruticulosa	[30]
	α-Fellandren		A. fruticulosa	[13], [30]
	α-Terpinen		A. fruticulosa	[13], [30]
	n-Cymene		A. fruticulosa A. Trifida A. Achileoides	[13], [30] [13] [13]
	(S)-(−)- Limonene		A. fruticulosa	[30]
	1,8-cineole		A. fruticulosa A. Trifida A. Achileoides Ajania potaninii	[13], [30] [13] [13] [13]
	cis-β-Ocimene		A. fruticulosa	[13],
	trans-β-Ocimene		A. fruticulosa	[30],
	γ-Terpinene		A. fruticulosa	[30], [13]
	trans-Sabinene hydrate		A. fruticulosa A. Trifida	[30] [13]
	Terpinolene		A. fruticulosa A. Achileoides	[30] [13]
	cis-Sabinene hydrate		A. fruticulosa A. Trifida A. Achileoides	[30] [13] [13]
	Linalool		A. fruticulosa A. Achileoides	[30] [13]
	β -Thujone		A. fruticulosa A. Trifida A. Achileoides	[13] [13] [13]
	α-Tuyon		A. fruticulosa A. Trifida A. Achileoides	[13] [13] [13]
	Chrysanthenone		A. fruticulosa A. Trifida A. Achileoides	[13] [13] [13]
	δ-Terpineol		A. fruticulosa	[30]

	α-Terpineol		A. fruticulosa	[30]
	Elemene		A. fruticulosa	[30]
	Bornyl acetate		A. fruticulosa	[30]
	α-Terpenyl acetate		A. fruticulosa	[30]
	α-Copaene		A. fruticulosa	[30]
	β-Bourbonene		A. fruticulosa	[30]
	β-Element		A. fruticulosa	[30]
	Caryophyllene		A. fruticulosa	[30]
	Hermacren-D		A. fruticulosa	[30]
	β-Farnesene		A. fruticulosa	[30]
	β-Selinen		A. fruticulosa	[30]
	Bicyclogermacren		A. fruticulosa	[30]
	β-Bisabolene		A. fruticulosa	[30]
	δ-Cadinene		A. fruticulosa	[30]
	Elemol		A. fruticulosa	[30]
	trans-Nerolidol		A. fruticulosa	[30]
	β-Eudesmol		A. fruticulosa	[30]
	α-Bisabolol		A. fruticulosa	[30]
	hamazulene		A. fruticulosa	[30]
	Farnesyl acetate		A. fruticulosa	[30]

	Ketopelenolide B		A. fruticulosa	[17], [23], [20],
	1,2,4-Cyclohexantriol		A. potaninii.	[17],
	11,13-dehydrodesacetylmatricarine		A. fruticulosa	[17],
	14-oxomelampolide		A. fruticulosa	[20], [21], [23], [30], [34]
			A. fastigiata	[33]
			A. achilleoides	[35]
			A. salicifolia	[24]
			A. tenuifolia	[24]
			A. przewalsk	[26]
			A. nubigena	[31]
	Artemorin		A. fruticulosa	[20], [21], [23], [30], [34]
			A. fastigiata	[33]
			A. salicifolia	[24]
			A. achilleoides	[35]
			A. tenuifolia	[24]
			A. przewalsk	[26]
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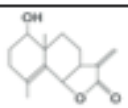
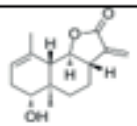
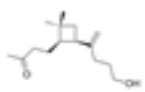
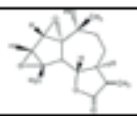
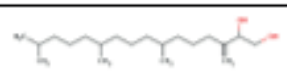
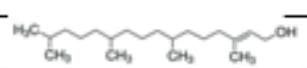
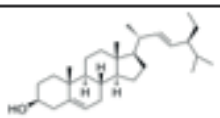
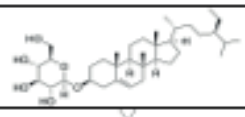
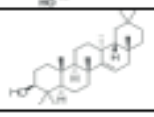
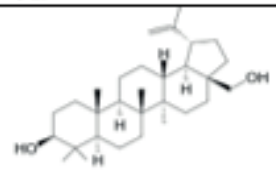
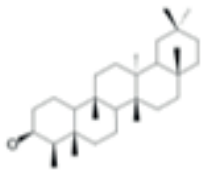
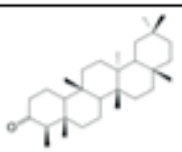
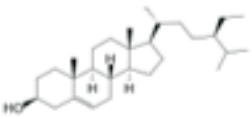
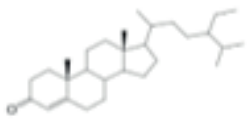
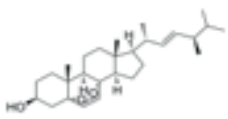
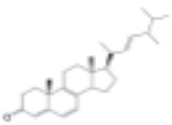
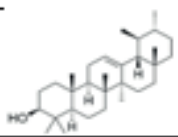
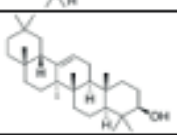
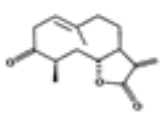
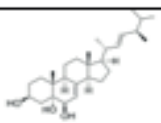
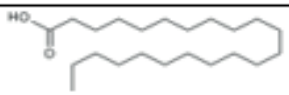
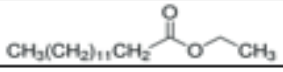
	Magnolialide		A. tenuifolia	[24]
			A. salicifolia	[24]
	Santamarin		A. fruticulosa	[24], [23]
			A. achilleoides	[35]
			A. salicifolia	[24]
	5-hydroxy-5,6-secocaryophyllene-6-one		A. tenuifolia	[24]
			A. salicifolia	[24]
	Artecanin		A. fruticulosa	[17],
			A. fastigiata	[33]
Diterpenoids and their derivatives				
	phytene-1,2-diol		A. salicifolia	[24]
	Phytol		A. salicifolia	[24]
Triterpenoids and their derivatives				
	Stigmasterol		A. fruticulosa	[17], [23]
			A. potaninii	[17]

	Daucosterol		A. fruticulosa	[17], [23]
			A. potaninii	[17]
			A. nematoloba	[26]
	Taraxerol		A. potaninii	[17]
	Betulin		A. salicifolia	[24]
	3-β-friedelinol		A. przewalsk	[24]
			A. salicifolia	[24]
	Friedelin		A. salicifolia	[24]
	β-Sitosterol		A. fruticulosa	[23]
			A. salicifolia	[24]
			A. nematoloba	[26]
	Sitostenone		A. salicifolia	[24]
	Ergosterol peroxide		A. salicifolia	[24]
	Ergosta -4,6,8,22- tetraene -3-one		A. salicifolia	[24]
			A.nematoloba.	[26]
	α-amyrin		A. fruticulosa	[30]
	β-amyrin		A. fruticulosa	[30]
	4-epitansanine		A. fruticulosa	[20]
	Cerevisterol		A.nematoloba.	[26]
Fatty acids, aldehydes and their esters				

	Docosanic acid		A. fruticulosa	[17]
			A. salicifolia	[24]
			A. przewalskii	[17]
	Ethyl myristate		A. fruticulosa	[17]
	tetradecanoic acid		A. potaninii	[17]
	palmitic acid		A. nematoloba	[26]
Hydrocarbons and their functional derivatives				
	n-nonyl mercaptan		A. potaninii	[17]
	Ichthyoterheol		A. salicifolia	[24]

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