Valeriana officinalis (Valerian) – review

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of the article

Valeriana officinalis L. s.l. is a perennial herbaceous plant belonging to the *Valerianaceae* family. It is widely distributed in Ukraine and around the world. The official medicinal raw material derived from *Valeriana officinalis* consists of the dried, whole, or fragmented underground parts of the plant, including the rhizome along with the roots and stolons. To meet the standards outlined in the European Pharmacopoeia, this raw material must be standardized based on its essential oil content (a minimum of 4 ml/kg in dried preparations) and sesquiterpenic acids (a minimum of 0.17 percent by weight, calculated as valeric acid, in dried preparations).

The aim of the work was searching, systematizing, and generalizing information from the specialized literature on the chemical composition, biological activity and therapeutic use of *Valeriana officinalis*.

Valeriana officinalis has sedative, mild analgesic, hypnotic, antispasmodic, carminative, and hypotensive effects. Historically, it was used for hysterical conditions, hyperexcitability, insomnia, hypochondria, migraine, spasms, intestinal colic, rheumatic pains, dysmenorrhea, and especially for conditions accompanied by nervous excitability. The main classes of biological substances identified in *Valeriana officinalis* are valepotriates, iridolactones, alkaloids, phenolic acids, sesquiterpenes, flavonoids, terpene coumarins, lignans, terpene and flavonol glycosides. It has not yet been established which components of *Valeriana officinalis* are responsible for its pharmacological effects. Current opinion is that the overall effect of valerian is due to several different groups of components and their different mechanisms of action. Therefore, the activity of different preparations of valerian will depend on their content and concentration of several types of components.

Conclusions. Summarized and systematized original works related to pharmacognostic study, phytochemical analysis, and medicinal use of underground and aerial parts of various species of *Valeriana* genus. The analysis of the material shows that in recent years, scientists from all over the world have paid attention to the above-ground part of valerian and have chosen it as an object of in-depth study. This approach opens new possibilities for the use of the herb *Valeriana officinalis* in medicine.

Keywords: Valeriana officinalis L., Valerianaceae, chemical composition, therapeutic significance, biological activity.

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Valeriana officinalis (Valerian) – огляд

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Valeriana officinalis L. s.l. – багаторічна трав'яниста рослина з родини *Valerianaceae*, яка є дуже поширеною в Україні та світі. Офіцинальною лікарською сировиною *Valeriana officinalis* є висушені, цілі або фрагментовані підземні частини *Valeriana officinalis*, включаючи кореневище, оточене коренями та столонами. Сировина, відповідно до вимог Європейської фармакопеї, має бути стандартизована за вмістом ефірної олії (мінімум 4 мл/кг (висушений препарат)) та сесквітерпенових кислот (мінімум 0.17 відсотка m/m в перерахунку на валеренову кислоту (висушений препарат)).

Мета роботи – пошук, систематизація та узагальнення відомостей фахової літератури щодо хімічного складу, біологічної активності та терапевтичного застосування *Valeriana officinalis*.

Valeriana officinalis має заспокійливу, легку болезаспокійливу, снодійну, спазмолітичну, вітрогонну та гіпотензивну дії. Історично її використовували при істеричних станах, підвищеній збудливості, безсонні, іпохондрії, мігрені, спазмах, кишкових кольках, ревматичних болях, дисменореї, а особливо при станах, що супроводжуються нервовою збудливістю. Основними класами біологічних речовин, які ідентифіковано в *Valeriana officinalis*, є валепотріати, іридолактони, алкалоїди, фенольні кислоти, сесквітерпени, флавоноїди, терпенові кумарини, лігнани, терпенові та флавонолові глікозиди. Досі не встановлено, які саме компоненти *Valeriana officinalis* спричиняють її фармакологічні ефекти. Нині вважають, що загальний ефект валеріани зумовлений кількома різними групами компонентів з їхніми різними механізмами дії. Отже, активність різних препаратів валеріани залежатиме від складу та концентрації компонентів кількох типів.

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Висновки. Узагальнили й систематизували оригінальні роботи, що стосуються фармакогностичного вивчення, фітохімічного аналізу та застосування в медицині підземної та надземної частин різних видів роду *Valeriana*. Аналіз матеріалу показав, що останніми роками науковці з усього світу звернули увагу на надземну частину валеріани та обрали її об'єктом детального вивчення. Цей підхід відкриває нові перспективи для використання трави *Valeriana officinalis* у медицині.

Ключові слова: Valeriana officinalis L., Valerianaceae, хімічний склад, терапевтичне значення, біологічна активність.

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The skills of plant treatment developed in all peoples and are now preserved as traditional or folk therapy. *Valeriana officinalis*, which is successfully used in traditional therapy, is recognized and is an important medicinal raw material in modern medicine.

The family *Valerianaceae* includes 13 genera, which have about 400 species. The genus Valeriana includes about 150 perennial herbaceous plants [1]. The most important species used in European therapy is valerian (*Valeriana officinalis* L.) [2]. On the territory of Ukraine, the collective species *Valeriana officinalis* L. includes 13 species: *Valeriana dioica* L., *Valeriana tuberosa* L., *Valeriana tripteris* L., *Valeriana transsilvanika* Schur, *Valeriana sambucufolia* Mikan, *Valeriana rossica* P. Smirn., *Valeriana tanaitica* Worosch., *Valeriana collina* Wallr., *Valeriana simplicifolia* (Reichenb.) Kabath, *Valeriana exaltata* Mikan, *Valeriana nitida* Kreyer, *Valeriana grossheimii* Worosch., *Valeriana stolonifera* Czern [3].

The natural range of plants of the Valeriana species is located in the temperate and boreal zones of Europe and Asia and spreads in the eastern part of North America. *Valeriana officinalis* is a species used in Europe. *Valeriana fauriei* is commonly used in traditional Chinese and Japanese medicine. *Valeriana capensis* is a species used in African traditional medicine, *Valeriana edulis* is popular in Mexico, and *Valeriana wallichii* is used in India [4].

Valeriana officinalis is a herbaceous perennial plant, but in its early life, it behaves like a winter annual. The first year is characterized mainly by vegetative growth. Eventually, the plants fall into hibernation together with the underground parts (rhizome) and young vegetative buds of the shoots. The first generative phase occurs after vernalization, in which shoot buds are induced. The following spring, basal leaves (rosette) appear, starting in February and stretching the internodes. By stretching the internodes, rosettes form a shoot that is covered with leaves, and at the end of which there is an inflorescence. After flowering and seed ripening, the inflorescence and basal leaves die, after which new basal leaves and underground shoot buds are formed until the plant goes dormant. This process allows valerian to renew itself repeatedly over several years [5].

The morphology is quite diverse, thanks to the complex taxonomy. Representatives of the species *Valeriana officinalis* have a densely branched tap root system, the main and lateral roots are thick and strong, and the additional roots are branched. As a result of growth on wide areas and in different types of soil, the color of the roots is different – brown, dark brown, yellowish brown, brownish yellow, yellow. An anatomical study of *in vitro* roots grown on media of different compositions revealed significant differences in the structure and size of cells, the thickness of the cell wall, and especially in the presence and number of starch grains in the cells of the parenchyma cortex [6]. Stems are herbaceous, cylindrical, hollow, grooved, and striped with clear ribs and grooves, height from 10 to 150 cm. Leaves are simple, terminal, petiolate, opposite-cross, wither during fruiting but do not fall. The leaves differ in the shape of the blade, apex, base, and their attachments, core, color, and size. In young plants, the leaves are green or pale green, in adult plants – yellowish-green or yellowish-brown. The flowers are hermaphrodite, complete, asymmetric, small, fragrant, collected in dichasia, forming a shield-shaped panicle. Calyx in the form of teeth that grow during fruiting. The corolla is tubular-funnel-shaped, the bend is five-lobed, sympetalous (the tube in the lower part of the corolla with a one-sided sac-like swelling), sac-shaped or pointed at the base. The color of the corolla is from pink to pink white. Filamentous stamens from one to three, they are attached to the corolla tube. The ovary is lower and three-nested (three carpels). The gynoecium is syncarpous, the fruit is a simple dry, unopened achene, which is formed from the lower ovary of one flower, with one seed, often crowned with a persistent calyx (with a feathery fringe). The shape of the fruit is narrowly ovoid, oblong, compressed, and slightly curved, with three narrow shallow slits (grooves) at the back and two wide shallow slits at the front; from yellow to brown-yellow or straw color [1].

The yield of air-dried roots of *Valeriana officinalis* in the second and third years of the growing season, with higher yields being formed in weather that is more favorable conditions of the growing season. The yield of the aboveground mass of valerian in all years of research significantly increased in the second, then in third years of vegetation, and then significantly decreased in the fourth and fifth years of vegetation. On average, over the years of research, the same regularity was observed, from which it could be concluded that the highest yields of green mass of medicinal valerian are formed in the second and third years of plant vegetation [7].

Aim

The aim of the work was searching, systematizing, and generalizing information from the specialized literature on the chemical composition, biological activity and therapeutic use of *Valeriana officinalis*.

Results

Valeriana officinalis in official phytotherapy. The official medicinal raw material of *Valeriana officinalis* consists of the dried, whole, or fragmented underground parts, including the rhizome surrounded by roots and stolons. According to the requirements outlined in the eighth edition of the European

Pharmacopoeia, this raw material must be standardized based on the content of essential oil (a minimum of 4 ml/kg of dried preparation) and sesquiterpenic acids (a minimum of 0.17 percent m/m, calculated in terms of valeric acid). The European Pharmacopoeia also features monographs on dry aqueous and dry hydroalcoholic extracts of valerian, as well as tincture of valerian derived from the underground organs (Valerian root). The standardization process is based on the content of sesquiterpene acids, calculated in terms of valeric acid [8].

Pharmacotherapeutic action. *Valeriana officinalis* is known for its sedative, mild analgesic, hypnotic, antispasmodic, carminative, and hypotensive effects. Traditionally, it was employed to address conditions such as hysteria, increased excitability, insomnia, hypochondria, migraine, spasms, rheumatic pains, dysmenorrhea, and especially for conditions accompanied by nervous excitability [9]. In contemporary times, there is a renewed interest in *Valeriana officinalis*, particularly for its sedative and hypnotic properties.

A monograph approved by the Committee for Herbal Medicinal Products of the European Medicines Agency outlines the following therapeutic uses for valerian root: it is traditionally employed in herbal medicine to alleviate mild symptoms of mental stress and to enhance sleep quality [10]. It is worth noting that valerian typically requires 2–3 weeks of use before its hypnotic effects become noticeable [11].

The sedative and hypnotic properties of *Valeriana officinalis* have been attributed to some valerian root and rhizome preparations, as observed in both preclinical and clinical studies. However, it remains unclear which specific components of *Valeriana officinalis* are responsible for these sedative and hypnotic effects [9]. Initially, attention was directed toward the volatile oil, and subsequently, to the valepotriates and their breakdown products. Nevertheless, it was discovered that the volatile oil alone could not account for the entirety of the drug's effects, and the valepotriates, which degrade rapidly, are unlikely to be present in finished drug products at significant concentrations. Current consensus suggests that *Valeriana officinalis's* overall effects are likely attributed to several distinct groups of components, each with their unique mechanisms of action. Consequently, the activity of Valerian preparations depends on the content and concentration of these various components within the chemical composition.

It is interesting to note that one of the potential mechanisms of action of *Valeriana officinalis* extract has been identified in a study evaluating its effectiveness as a treatment for Parkinson's disease. Active components present in the extract, including valeric acid, hydroxyvaleric acid, acetoxyvaleric acid, and volvalerenone, were found to interact with GABA receptors, influencing the excitability of the cerebral cortex. These components also formed a complex with SUR1, a protein that regulates potassium ions in the pancreas by interacting with KIR6.2. This interaction led to a change in the activity of the enzyme thyroxine hydrolase, ultimately resulting in an increase in dopamine levels [12].

The study conducted by Kousuke Harada, and colleagues focused on investigating the effects of valerian on adipocytes using 3T3-L1 adipocytes. The researchers aimed to determine whether valerian could potentially serve as a functional agent for type 2 diabetes. Their findings indicated that the methanolic extract of valerian root can induce adipocyte differentiation and stimulate adiponectin secretion. This effect is thought to be mediated through direct binding to PPARγ (peroxisome proliferator-activated receptor gamma) [13].

The study led by Daeyoung Roh and colleagues conducted a randomized, double-blind, placebo-controlled trial using electroencephalography to investigate whether valerian root extract affects changes in resting state connectivity and whether these changes are associated with clinical symptoms. The results revealed that the group receiving valerian root extract exhibited significantly greater increases in frontal brain alpha coherence between the four electrode pairs compared to the placebo group. Additionally, these changes in frontal brain alpha coherence were found to be significantly correlated with reduced anxiety, or anxiolysis. The experimental group also displayed significantly greater reductions in theta coherence across the other four electrode pairs. In summary, the research demonstrated that valerian root extract has the potential to alter the functional connectivity of the brain in relation to anxiety [14].

Phytochemical profile. *Valeriana officinalis* indeed has a diverse chemical composition. Various classes of biological substances have been identified in this plant through numerous studies. These compounds include valepotriates, iridolactones, alkaloids, phenolic acids, sesquiterpenes, flavonoids, sesquiterpenoids, terpene coumarins, lignans, and terpene and flavonol glycosides [15].

Essential oil. The essential oils of *Valeriana officinalis* are indeed complex mixtures of natural compounds with a variety of pharmacological effects. These oils primarily consist of volatile components, including lipids, terpenoids, ketones, phenols, and oxygen derivatives *(Table 1)*. It is important to note that the composition of valerian root oil can vary significantly due to factors such as geographical location, cultivation methods, seasonal variations, the physiological age of the plant, and the oil extraction method [16].

Thirty-seven different compounds were identified in the essential oil of Valeriana officinalis, with eight compounds being the dominant ones. These dominant compounds included bornyl acetate (18.44–36.94 %), valerianol (8.69–22.89 %), valeranone (7.17–13.59 %), intermediol (0.00–11.84 %), camphene (1.04–11.18 %), myrtenyl acetate (3.38–6.77 %), agarospirole (3.50–8.71 %), and γ-eudesmol (1.17–5.37 %). Among these, bornyl acetate was the most dominant compound in all the studied samples [16].

The study of valerian roots cultivated in the south-eastern region of Poland provides further insights into the composition of the essential oil of *Valeriana officinalis*. The analysis identified 71 essential oil compounds, reflecting the richness and diversity of this plant's volatile components. The predominant substance in the essential oil was bornyl acetate, accounting for 15.42 % of the oil. Additionally, several other compounds were present in significant quantities, including elemol (8.01 %), *β*-gurjunene (6.20 %), camphene (5.43 %),

Table 1. Component content of *Valeriana officinalis* essential oil

No.	The name of the component	Contents, %	References	No.	The name of the component	Contents, %	References
1	α-Fenchene	0.0–5.8	2, 16, 19	41	Camphor	0.0–0.1	19
2	β-Pinene	0.00–1.76	2, 16, 19	42	Caryophyllene oxide	0.2–0.7	2
3	(E)-Carveol	0.1–1.7	19	43	*cis*-Carveyl acetate	0.0–0.4	19
4	(Z,E)-Farnesol	0.0–0.2	19	44	*cis*-Pinocarvyl acetate	0.1–0.5	2, 19
5	**(Z)-valernylacetate**	**4.5–6.5**	**17**	45	*cis*-Sesquisabinene hydrate	1.24	2
6	10-epi-γ-Eudesmol	0.00–0.84	16	46	*cis*-Valerenyl acetate	0.0–1.6	19
7	2,5-Dimethoxy-*p*-cymene	0.00–0.45	16	47	Cubebol	0.48–1.88	16
8	2,6-Dimethoxy-*p*-pymene	0.0–0.2	19	48	Dihydroisolongifolene	0.0–1.0	19
9	3-Methylvaleric acid	0.0–0.2	19	49	**Elemol**	**0.00–8.01**	**16**
10	7-Epi-sesquithujene	0.00–0.22	16	50	*epi*-α-Muurolol	0.44	2
11	**8-*a*-Acetoxyelemol**	**3.71**	**2**	51	Epibicyclosesquiphellandrene	0.1–0.9	19
12	8-Amorphene	0.09	2	52	Epiglobulol	0.2–0.6	19
13	8-Cadinene	0.60–1.14	2, 19	53	**epoxy-allo Alloaromadendrene**	**0.24–7.6**	**2, 19**
14	8-Cedren-13-ol acetate	0.21	2	54	Eremoligenol	0.49	2
15	8-Elemene	1.32	2	55	Geranyl valerate	0.0–0.5	19
16	8S.14-Cedranediol	2.01	2	56	Geranylisovalerate	0.0–0.3	19
17	**9-epi-(E)-Caryophyllene**	**3.82–4.77**	**2**	57	Germacrene B	0.43–0.92	2, 16
18	**Acetoxivalerenone**	**5.6–9.6**	**17**	58	Germacrene D	0.00–2.36	2, 16, 19
19	**Acetoxivalerenic acid**	**0.89-24.20**	**25**	59	Germacrene D-4-ol	0.00–0.68	16
20	α-Acoradiene	0.16	2	60	Germacrone	4.57	2
21	α-Bisabolol	0.2–0.7	19	61	Globulol	0.08	2, 19
22	α-Cadinene	0.08	2	62	Guaia-6,9-diene	0.00–0.39	16
23	α-Copaene	0.40–0.45	2, 19	63	hydroxy-α-Muurolene	0.07	2
24	**α-Farnesene**	**0.3–23.0**	**19**	64	**Hydroxyvalerenic acid**	**0.34–4.25**	**25**
25	α-Guaiene	0.0–0.3	19	65	**Intermedeol**	**0.00–11.84**	**16**
26	α-Gurjunene	0–1.5	19	66	Isoamylisovalerate	0.0–0.1	19
27	α-Humulene	0.3–2.2	19	67	Isopenthylisovalerate	0.06	2
28	α-Terpineol	0.0–0.5	19	68	Isopenty1-2-methyl butanoate	0.06	2
29	α-Thujene	0.0–0.1	2, 19	69	**Isovaleric acid**	**0.0–41.8**	**19**
30	**Agarospirol**	**3.50–8.71**	**16**	70	Kessane	0.0–1.5	2, 19
31	Aristolone	0.08	2	71	Kessanyl acetate	0.0–2.0	16,19
32	Aromadendrene	0.06–0.20	2, 19	72	Kessyl acetate	0.4–2.3	19
33	β-Curcumene	0.1	2	73	Kessyl alcohol	0.0–1.2	19
34	β-Ionone	0.0–3.7	19	74	Khusimone	0.84	2
35	β-Panasinsene	0.22	2	75	Khusinol acetate	0.2	2
36	**Bicyclogermacrene**	**0.00–6.45**	**16**	76	Ledol	0.2–1.7	19
37	**Borneol**	**0.36–2.41**	**16**	77	Limonene	0.00–1.04	16
38	**Bornyl acetate**	**2.30–37.57**	**2, 16, 19**	78	Linalylisovalerate	0.7–3.0	19
39	Bornylisovalerate	0.2–2.0	19	79	Longicyclene	1.00	2
40	**Camphene**	**1.04–11.18**	**16**	80	Longifolene	3.07	2, 19

Cont of Table 1.

No.	The name of the component	Contents, %	References	No.	The name of the component	Contents, %	References
81	Maali alcohol	0.00–1.86	16	105	Valencene	0.00–4.05	16
82	Myrtenol	0.00–1.46	16	106	Valencene ketone	0.4–3.0	19
83	Myrtenyl acetate	2.0–7.2	16	107	**Valeranone**	**0.50–14.28**	16, 19
84	Myrtenylisovalerate	1.1–2.5	19	108	**Valerenal**	**0.0–14.7**	19
85	*n*-Hexyl isovalerate	0.1–0.3	19	109	**Valerenic acid**	**0.0–11.8**	19, 25
86	Neryl isovalerate	0.0–0.4	19	110	Valerenol	0.0–0.8	19
87	Palmitic acid	1.0–1.3	19	111	**Valerianol**	**0.30–22.89**	16
88	Rosifoliol	0.00–1.37	16	112	Vetiselinenol	0.00–0.96	16
89	Sabinene	0.23	2, 19	113	Viridiflorene	0.66	2
90	Selina-diene alcohol	0.0–0.3	19	114	Viridiflorol	0.1–0.6	2, 19
91	Sesquiterpenoic acetate	0.0–4.1	19	115	*γ*-Gurjunene	3.62	2
92	Spathulenol	0.0–4.1	16	116	*γ*-Amorphene	0.25	2
93	*β*-Elemene	0.30–0.63	2	117	*γ*-Cadinene	0.06–1.10	2, 19
94	*β*-Eudesmol	0.0–1.1	19	118	*γ*-Terpinene	0.0–0.3	19
95	*β*-Longipinene	0.21	2	119	Z-Lanceol acetate	0.06	2
96	*β*-Phellandrene	0.70–3.04	2, 19	120	Zingiberene	0.1–1.5	19
97	T-Muurolo	0.1–1.6	19	121	*α*-Caryophyllene	0.00–1.53	16
98	Terpinen-4-ol	0.00–0.54	16	122	*α*-Pinene	0.0–3.6	16
99	Terpinyl acetate	0.4–1.1	2, 19	123	*β*-Bisabolene	0.00–0.59	16
100	Thuja-2,4(10)-diene	0.06	2	124	*β*-Gurjunene	0.0–6.2	2, 16, 19
101	Thujopsadiene	1.69	2	125	γ-Curcumene	0.00–1.32	2, 16, 19
102	*trans*-Valerenyl acetate	0.0–0.8	19	126	**γ-Eudesmol**	**1.17–5.37**	16
103	*trans*-Valerenylisovalerate	0.0–1.1	19	127	*δ*-Elemene	0.0–1.8	2, 19
104	Tricyclene	0.0–0.1	19				

9-epi-E-caryophyllene (4.77 %), bicyclohermacrene (4.61 %), hermacrone (4.57 %), myrtenyl acetate (3.90 %), caryophyllene (3.82 %), 8-*α*-acetoxylemol (3.71 %), and *γ*-gurjunene (3.62 %).

The content of sesquiterpenes valerenic and acetoxyvalerenic acids in the studied valerian raw material was 0.0519 % and 0.0677 %, respectively [2].

The researchers studied the composition of the essential oil obtained from the roots of wild samples of *Valeriana officinalis* L. from Iran. The main components of the extracted essential oil were isovaleric acid (18.7–41.8 %), valerenic acid (8.2–11.8 %), acetoxyvaleranone (5.6–9.6 %), (Z)-valernyl acetate (4.5–6.5 %), bornyl acetate (2.3–7.7 %) and valerenol (3.7–5.2 %) [17].

Analysis of the volatile oil content of eleven experimental samples of *Valeriana officinalis* of different origins from Romania, Poland, and Germany was carried out in Brasov, Romania. As a result of research, it was established that in the group of varieties, which includes three varieties of *Valeriana officinalis*, created in the process of selection and improvement – variety MAGURELE 100 (M-100), variety MUNKA-Polonia, variety POLKA-Polonia, the essential oil content is 0.84 ml/100 g, 1.19 ml/100 g and 0.16 ml/100 g, respectively. In a group of Valeriana species obtained from Germany, the essential oil content is 0.94 ml/100 g for *Valeriana collina*, 0.63 ml/100 g for *Valeriana rossica*, and 0.69 ml/100 g for *Valeriana wolgensis*. The last group includes five species of *Valeriana officinalis* grown in Bucharest. In these samples, the essential oil content ranged from 0.34 to 0.45 ml/100 g [18].

Determination of variations in the composition of the essential oil of the roots of five samples of *Valeriana officinalis* grown in Estonia was carried out by the methods of gas chromatography and gas chromatography with mass spectrometry. The yield of essential oil for five samples of valerian roots from Estonia ranged from 0.28 % to 1.16 % [19].

In the study of the essential oil composition of *Valeriana pilosa*, researchers identified a total of forty-seven compounds. The major compounds fell into the classes of sesquiterpenes (37.7 %) and monoterpene hydrocarbons (9.5 %). Among these, oxygen-containing sesquiterpenes were the most predominant (26.6 %) compared to oxygen-containing

Table 2. Quantitative content of phenolic compounds (mg/1 g of dry matter)

No.	The name of the component	Contents, mg/g	References
1	Gallic Acid	0.11–7.36	25, 27, 28
2	Chlorogenic Acid	0.09–38.16	25, 27, 29
3	Rutin	0.09–1.54	26, 28
4	Caffeic Acid	0.17–13.71	25, 26, 27
5	3-Hydroxybenzoic acid	0.07–4.96	26, 27
6	Ferulic acid	0.20–4.97	27
7	*m*-coumaric acid	0.11–15.90	27
8	*p*-coumaric acid	0.26–5.94	27
9	Protocatechuic Acid	0.46–1.20	25
10	4-Hydroxybenzoic acid	2.06–3.22	26
11	Salicylic acid	2.79–3.31	26
12	*p*-Coumaric acid	1.84–1.93	26
13	Apigenin	32.50	26
14	Hesperetin	0.32–0.54	26
15	Quercetin	43.76	26

monoterpenes (8.3 %). Additionally, the oil contained other compounds in lower concentrations (5.7 %) [20].

The Institute of Biodiversity and Ecosystem Research in Sofia conducted research on the underground organs of *Valeriana officinalis* cultivated *in vitro*. In this study, the main compounds identified from the class of essential oils included isovaleric acid (55.2 %) and squalene (19.7 %). Additionally, several other compounds were detected, such as spatulenol (4.2 %), valerenal (2.3 %), and caryophyllene oxide (1.4 %). Minor compounds, each at less than or equal to 1 %, included 3-methylpentanoic acid, bornyl acetate, viridiflorol, valerenyl acetate, geranyl isovalerate, trans-valerenyl isovalerate, patchouli alcohol, and some unidentified sesquiterpene alcohols. Furthermore, the research included the study of cultures grown *in vitro*. The analysis of the essential oil from these cultures revealed the main identified compounds to be the monoterpene citronellol (18.1 %) and the sesquiterpene ketone valeranone (17.2 %). Smaller amounts of geraniol (6.0 %), viridiflorol (1.4 %), and valeranal (1.3 %) were also detected [6].

Valepotriates. Valepotriates are esters formed by the combination of organic acids and triterpene tertiary alcohols. They are primarily found in the roots and rhizomes of *Valeriana officinalis*. The main valepotriates in *Valeriana officinalis* include valtrate, isovaltrate, IVHD-valtrate, didrovaltrate, and acevaltrate [21]. These compounds are notable for their sedative and anxiolytic properties, and as such, they are frequently utilized as natural remedies for managing anxiety and sleep disorders.

The precise mechanisms by which valepotriates exert their effects are not entirely elucidated, but there is a belief that they enhance the activity of the neurotransmitter gamma-aminobutyric acid (GABA) within the brain. GABA is an inhibitory neurotransmitter that plays a crucial role in regulating brain activity and promoting relaxation.

Chunguo Wang and colleagues developed a method for the qualitative and quantitative analysis of valepotriates in *Valeriana jatamansi* using high-performance liquid chromatography. In the underground organs of the studied plants, they identified 92 compounds from the class of valepotriates and established their structural formulas [22].

In another study, researchers found valepotriates including 5-hydroxy-5,6-dihydrovaltrate hydrin (5-hydroxy-5,6-dihydrovaltrate chlorohydrin), 5,6-dihydrovaltrate hydrin (5,6-dihydrovaltrate chlorohydrin) in the underground organs of *Valeriana jatamansi*. Additionally, 5-hydroxy-5,6-dihydrovaltrate and valtrate hydran (valtrate chlorohydrin) were identified [23].

Valepotriates, including compounds like isodihydrovaltrate (18.99 %), homovaltrate (13.51 %), 10-acetoxy-valtrate hydrin (4.00 %), and valtrate (1.34 %), were identified using chromatographic methods in the roots of *Valeriana edulis* [24].

Phenolic compounds. All parts of *Valeriana officinalis* are rich in flavonoids, which are a group of phenolic compounds with antioxidant activity *(Table 2)*.

Cheng-Rong Wu and colleagues quantified phenolic compounds in Valeriana officinalis roots and rhizomes. The total content of phenolic compounds in terms of gallic acid in the root extract ranges from 19.33 to 33.16 mg/g, depending on the extraction method, and from 15.44 to 26.78 mg/g in the rhizomes. Phenolic acids such as gallic, protocatechuic, chlorogenic, caffeic, and rosmarinic acids were also identified. The content of these studied substances in the roots ranged from 1.66 to 3.09 mg/g, and in the rhizomes from 1.08 to 2.14 mg/g [25].

In a study focused on new sources of bioactive phenolic compounds from the Western Balkan Mountains, it was found that the content of apigenin and quercetin in the extract of *Valeriana montana* flowers is approximately 32.50 ± 0.94 mg/g and 43.76 ± 2.12 mg/g, respectively. The total amount of phenolic compounds in the flowers of *V. montana* is measured at 8.61 mg/g, while in the leaves, it's approximately 1.15 mg/g [26].

A three-way analysis of variance was conducted on *Valeriana jatamansi*, revealing that variations in phytochemical content were influenced by lighting conditions, season, plant parts, and their interactions. The study determined that among the different parts of the plant, the leaves contained the highest total amount of phenols (9.6 mg/g), flavonoids (10.5 mg/g), and tannin (5.4 mg/g) compared to other parts (root, rhizome, and stem). Out of the twelve phenolic compounds examined, five compounds – vanillic acid, 4-hydroxybenzoic acid, rutin, phloridin, and *o*-coumaric acid – were found in very low amounts in some seasons. Specifically, vanillic acid and 4-hydroxybenzoic acid were detected only in leaves during the summer and autumn seasons, rutin was found in leaves in summer, phloridin was found in leaves and rhizomes in summer and winter, and o-coumaric acid was detected only in part of the rhizome in the winter, spring, and summer seasons.

Among other phenolic compounds, it was found that chlorogenic acid was the largest phenolic compound in all parts of the plants over all seasons.

The highest content of chlorogenic acid (38.160 μg/g) and 3-hydroxybenzoic acid (4.967 μg/g) was detected in leaves during the autumn and spring seasons. *p*-Coumaric acid accumulated the most (5.937 μg/g) during the autumn season in the stem. Halic acid (992 μg/g) was most abundant during the winter season in rhizomes, and it continued to accumulate during the sprouting season. During the summer season, the highest concentrations were found for m-coumaric acid (15.903 μg/g), cavoic acid (13.711 μg/g), and ferulic acid (2.453 μg/g) in the leaves.

The majority of phytochemical substances accumulate most significantly during the summer season. Additionally, various types of phytochemicals are more likely to accumulate in low-light conditions, especially in shaded areas [27].

Research on phenolic compounds, flavonoids, and hydroxycinnamic compounds in six different species of the Valerian genus that grow in Argentina revealed high levels of phenolic compounds ranging from 125.52 to 890.25 mg of gallic acid per 100 mg of dried rosemary syrup, with the following ranking: *Valeriana effusa* < *Valeriana ferax* < *Valeriana macrorhiza* < *Valeriana clarionifolia* < *Valeriana officinalis* < *Valeriana carnosa.* Furthermore, all the studied species exhibited flavonoids instead of hydroxycinnamic acids. In all species, the presence of hesperidin and chlorogenic acid was identified. In all species that were studied, the presence of hesperidin and chlorogenic acid was identified, in extracts of *Valeriana clarionifolia* and *Valeriana macrorhiza* the presence of diosmetin and 6-methylapigenin was identified. The levels of rutin in the preparations ranged from 8.82 to 81.98 mg per 100 mg of dry rosehip, and chlorogenic acid ranged from 50.83 to 1449.54 mg per 100 mg of dry rosemary. The highest content was found in *Valeriana carnosa* [28].

Dominika Srednicka-Tober et al. studied the effects of cultivation system and year of cultivation on the content of phenolic compounds, phenolic acids, and flavonoids in dried valerian roots. Valerian roots did not exhibit differences in phenolics, phenolic acids, or flavonoids based on the growing system (organic vs. conventional). However, there was a significant effect of the year, with higher levels of phenolic compounds, specifically phenolic acids, observed in the first year compared to the second year of the experiment.

In the 1960s, scientists from the Department of Pharmacognosy, Pharmacology, and Botany at Zaporizhzhia State Medical and Pharmaceutical University initiated a comprehensive study of Valeriana species. Kornievskyi Yu. I. had conducted a pharmacognostic investigation of *V. stolonifera's* underground organs. Trzetsynskyi S. D. had examined domestic Valeriana species and their pharmacological activity. Kornievska V. H. had compared *V. stolonifera* with *V. exaltata* through a pharmacognostic study. Shkrobotko P. Yu. had analyzed the elemental composition and biologically active substances in various Valeriana species, and S. V. Panchenko had conducted a comparative pharmacognostic study involving *V. grossheimii* and other Valeriana species.

Conclusions

Valeriana officinalis raw material is extensively employed in the medical practices of numerous countries. Recent professional studies on the biological activity of its extracts have reaffirmed its traditional use in phytotherapy. These studies confirm its valuable effects, including sedative, mild pain-relieving, hypnotic, antispasmodic, carminative, and hypotensive properties.

Interest in *Valeriana officinalis* arises not only from its global prevalence but primarily due to its medicinal value. The diverse chemical composition of the raw material, including valepotriates, iridolactones, alkaloids, phenolic acids, sesquiterpenes, flavonoids, sesquiterpenoids, terpene coumarins, lignans, glycosides, terpene glycosides, and flavonol glycosides, underlies its valuable medicinal properties.

Officially, *Valeriana officinalis* roots with rhizomes are recommended as a phytotranquilizer for various conditions, including hysteria, increased excitability, insomnia, hypochondria, migraine, spasms, rheumatic pains, dysmenorrhea, and conditions characterized by nervous excitability.

Much of the scientific research on *Valeriana officinalis* is centered on phytochemical analysis, which includes the examination of extracts from various plant parts and essential oil. These studies have revealed that differences in chemical composition are influenced by factors such as the plant's origin, composition, extraction methods, and the polarity of solvents used.

Many authors have analyzed the pharmacological properties of *Valeriana officinalis* plant extracts, including herbs, leaves, and roots. However, it is still unknown which components of *Valeriana officinalis* are responsible for certain properties. Future research should aim to establish associations between the mechanism of biological activity and particular compounds.

A study on the effects of valerian on adipocytes was conducted using 3T3-L1 adipocytes to investigate whether valerian has the potential to be a functional agent for type 2 diabetes. As a result, it was found that valerian root methanolic extract induces adipocyte differentiation and adiponectin secretion, possibly through direct binding to PPARγ.

Daeyoung Roh and colleagues conducted a randomized, double-blind, placebo-controlled trial using electroencephalography to investigate the impact of valerian root extract on resting brain functional connectivity and its association with clinical symptoms. In comparison to the placebo group, the valerian root extract group exhibited significantly greater increases in frontal brain alpha coherence between the four electrode pairs, and these changes were significantly correlated with reduced anxiety. The experimental group also showed notable reductions in theta coherence across the other four electrode pairs. This study suggests that valerian root extract can modulate brain functional connectivity in relation to anxiety.

All the mentioned studies pertain to mechanisms crucial for addressing civilization-related diseases, such as obesity and Parkinson's disease. Nevertheless, they are still at a consi-

derable distance from transitioning from in vitro experiments to practical applications in human treatment.

The contemporary usage of *Valeriana officinalis* is rooted in its longstanding traditional use. However, there is a need for further evaluation of the efficacy, potency, and dosage of the plant material and its extracts.

Traditionally considered less valuable than the underground organs, the above-ground part of *Valeriana officinalis* has become the focus of recent research, particularly due to its high flavonoid content. Flavonoids, known for their antioxidant, anti-inflammatory, and antiviral properties, play a vital role in maintaining health. Additional research is essential to confirm the potential and establish optimal methods for utilizing the aerial parts of *Valeriana officinalis* in medicine.

The study of *in vitro* cultures of *Valeriana officinalis* holds great promise. In the future, with further optimization, they may serve as an alternative source for obtaining biologically active compounds valuable in medicine, food production, and cosmetics.

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