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COMPREHENSIVE STUDY OF *JUNIPERUS* SPP. GROWING IN ARMENIA: FROM GLOBAL EXPERIENCE TO LOCAL APPLICATION

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Species of the genus *Juniperus* have been used in traditional medicine since antiquity due to their wide ecological distribution and potent bioactivity. In Armenia, five species: *J. sabina*, *J. polycarpos*, *J. foetidissima*, *J. excelsa*, and *J. oblonga* are of ecological and pharmacological significance.

This review presents a comprehensive analysis of their taxonomy, pharmacognostic characteristics, essential oil composition, and pharmacological and toxicological activities. Based on approximately 60 scientific sources, the study identifies key bioactive compounds and the analytical methods used for their evaluation.

Special emphasis is placed on the Armenian species and their potential for further applied research and utilization.

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Introduction. *Juniperus* L. is one of the most taxonomically diverse genera within the cypress family (Cupressaceae), with its 75–80 accepted species spanning boreal forests, Mediterranean scrublands, desert steppes and alpine belts across the Northern Hemisphere. Members of the genus have played dual ecological and cultural roles for millennia: they stabilize fragile soils on rocky slopes, provide shelter and forage for wildlife, and serve humans as sources of timber, incense, flavourings, and herbal remedies [1–3].

The wide latitudinal and altitudinal amplitude of *Juniperus* has driven morphological plasticity, leading botanists to subdivide the genus into three traditionally recognised sections – *Juniperus*, *Sabina* and *Caryocedrus* – based on leaf type, cone morphology, and molecular markers. Section *Juniperus* is typified by needle-like juvenile and adult leaves and fleshy galbuli, whereas Section *Sabina* develops scale-like adult foliage adapted to arid habitats; Section *Caryocedrus*,

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represented solely by *J. drupacea*, exhibits an intermediate morphology and a lignified cone wall. Beyond morphology, chemotaxonomic data increasingly support sectional delimitations. Terpenoid fingerprints obtained by gas chromatography-mass spectrometry (GC-MS) reveal α-pinene/limonene dominance in Section *Juniperus* species such as *J. communis*, in contrast to the sabinene/cedrol-rich profiles of *Sabina* taxa. These essential oils constitute the pharmacognostic hallmark of the genus and underlie many of its reported biological activities. Systematic reviews indicate that antioxidant, antimicrobial and cytotoxic assays dominate the *in-vitro* evaluation portfolio, with assays such as DPPH radical-scavenging and MIC determination serving as routine analytical endpoints.

Armenia, situated at the biogeographical crossroads of Europe and South-Western Asia, harbours five *Juniperus* species: *J. polycarpos*, *J. foetidissima*, *J. excelsa*, *J. Sabina*, and *J. oblonga*. All but *J. oblonga* are included in the country's Red Data Book, reflecting localised distributions and mounting anthropogenic pressure. The Armenian highlands provide a unique natural laboratory for investigating altitudinal chemotypes; however, systematic phytochemical exploration of Armenian junipers remains fragmentary, with fewer than a dozen peer-reviewed studies published over the past three decades. Existing works focus principally on the monoterpenoid composition of essential oils derived from berries or needles, leaving phenolic and flavonoid fractions largely unexplored [4–6].

Given the growing international demand for natural antioxidants and antimicrobial agents, a critical assessment of Armenian *Juniperus* resources is timely [7, 8].

The present review aims to provide a comprehensive synthesis of global and regional literature on the genus *Juniperus*, with a particular emphasis on species occurring in Armenia. It evaluates their ecological distribution, phytochemical diversity, essential oil profiles, and pharmacological relevance. The purpose of this synthesis is to bridge the gap between traditional ethnomedicinal uses and modern pharmacognostic understanding, thereby supporting further research and bioprospecting of *Juniperus* species in the Armenian context (Tab. 1).

Table 1

Comparative characteristics of global and Armenian Juniperus species

Feature	Global examples	Armenian examples
Species diversity	>75 species	5 native/naturalized species
Sections present	*Juniperus, Sabina, Caryocedrus*	Primarily *Sabina*, also *Juniperus*
Habitats	Boreal forests, arid mountains, Mediterranean zones	Subalpine dry forests, rocky slopes
Growth forms	Shrubs and trees	Tall trees (*J. polycarpos, J. foetidissima*), shrubs (*J. sabina*)
Essential oil profiles	α-pinene, limonene, sabinene, cedrol	cedrol-rich (*J. polycarpos*), sabinene (*J. sabina*)

Materials and Methods.

Integrative Review of Traditional Uses, Pharmacological Activities, and Toxicological Profiles of Juniperus Species. The genus *Juniperus* holds a long-standing position in traditional medicine systems across Eurasia and North America.

Several species, including *J. sabina, J. communis, J. oxycedrus, J. foetidissima*, and *J. polycarpos*, have been widely used in ethnomedicine for treating a broad spectrum of ailments, reflecting both pharmacological potential and cultural significance.

Fig. 1. *Juniperus sabina*.

Juniperus sabina* L. *(Savin Juniper). *J. sabina* L. *(Savin Juniper)* is a shrubby evergreen species commonly found on mountainous and rocky slopes (Fig. 1). In Armenia, it primarily grows along the dry slopes surrounding Lake Sevan, with concentrated populations in the Vardenis Region. The plant is characterized by a low-growing or spreading habit, with decumbent or ascending branches. Its leaves are small, dark green, and scale-like, closely appressed to the stems [9]. The fruit consists of globular cones, which turn dark bluish to black upon maturation.

Thanks to its rich natural composition, *J. sabina* has long been utilized in traditional and folk medicine. Various parts of the plant, especially the leaves and cones, have been incorporated into medicinal preparations. However, several of its constituents are known for their pronounced toxic effects, necessitating cautious use. The following section will provide a more detailed overview of its medicinal applications and toxicological profile.

Traditional Uses. In traditional Uyghur medicine, *J. sabina* has been widely used across parts of Central Asia and Western China for the treatment of musculoskeletal disorders such as rheumatoid arthritis, as well as for dermatological and auditory ailments, including pruritus, tinnitus, and partial deafness. Decoctions and topical applications derived from the plant's seeds, leaves, and branches are also used to alleviate urinary tract discomfort and menstrual irregularities.

In the Middle East, particularly in Iran and neighboring regions, *J. sabina* is historically recognized for its potent *abortifacient* and *uterine-stimulant* properties. As a result, it is strictly contraindicated during pregnancy. These traditional uses reflect centuries of empirical knowledge, though they also underline the need for careful dosing and awareness of potential toxicity [9–12].

Pharmacological Activities.

- *Anti-Inflammatory and Analgesic Effects*. Flavonoid-rich total fractions (JSTF) derived from the leaves of *J. sabina* have demonstrated significant reductions in paw swelling and inflammatory cytokine expression (TNF-α, IL-1β) in CFA-induced arthritis models in rats, suggesting efficacy against rheumatoid conditions [13–15].
- *Cytotoxic and Anticancer Potential*. Ethanolic and methanolic extracts from the aerial parts exhibit dose-dependent cytotoxicity on human breast cancer cell lines MCF-7 and MDA-MB-231, indicating their potential as antitumor agents [16, 17].
- *Antimicrobial and Wound-healing Effects. J. sabina* essential oil has been reported to possess strong antimicrobial activity against *Staphylococcus aureus* and *Candida albicans*, and has also accelerated wound closure in *in vivo* excision models [18–20].

• *Toxicological Profile and Safety Concerns of J. sabina. In vivo* experiments demonstrate that *J. sabina* essential oil, rich in sabinyl acetate (~50%), exerts marked reproductive toxicity when administered during early gestation (15–135 *mg* kg^{-1}, gestational days 0–4). These doses lead to >50% embryo resorption and complete implantation failure; the effect diminishes when treatment is delayed to mid-gestation. Trans-sabinyl acetate is identified as the principal uterotonic constituent, likely disrupting progesterone- or hCG-mediated signaling pathways that maintain endometrial receptivity and early pregnancy [9, 21, 22].

Beyond its abortifacient action, *J. sabina* poses serious systemic hazards. The needles and young branches accumulate podophyllotoxin and structurally related lignans that destabilize microtubules, producing pronounced cytotoxicity. Documented outcomes include hepatocellular injury (elevated transaminases), nephrotoxicity, neurotoxicity, hematologic abnormalities (macrocytosis, agranulocytosis), and multi-organ failure. Case reports of podophyllotoxin poisoning describe acute neurological sequelae and fatal outcomes. Consequently, internal use of *J. sabina* preparations is contraindicated during pregnancy and in patients with hepatic or renal impairment, and requires extreme caution, or outright avoidance, in all other clinical contexts [23–25].

***Juniperus communis* L. *(Common Juniper)/ Juniperus oblonga* M. Bieb.**

Juniperus communis L. (*Common Juniper*) is the most widely distributed juniper species in the world, occurring throughout Europe, Asia, and North America (Fig. 2). In Armenia, a specific Caucasian variety, *Juniperus oblonga* M. Bieb., is mainly found in the Ijevan, Goris, and Kotayk Regions. The plant typically grows in meadows, rocky terrains, and mountainous slopes.

Fig. 2. *Juniperus communis* L.

It is characterized by an evergreen shrub or small tree habit, usually reaching 0.5–3.0 *m* in height, and under favorable conditions growing up to 10 *m*. The leaves are needle-like, stiff, and sharply pointed, arranged in whorls of three. The fruit consists of berry-like, dark bluish cones (galbuli), which contain up to 42% sugars and have traditionally been used in beer and wine production.

Thanks to their rich natural composition, *J. communis* and its Caucasian variant *J. oblonga* have long been employed in traditional and folk medicine. Various parts of the plant, particularly the fruits and young shoots, are used in medicinal preparations. Although these species are less toxic than *J. sabina*, the presence of biologically active constituents still warrants cautious use. A more detailed overview of their medicinal applications and pharmacological relevance will be presented in the following section [26, 27].

Traditional Uses. *Juniperus communis* has been extensively used in European, Central Asian, and North American ethnomedicine. The berries, needles, and essential oil from the plant have traditionally served as remedies for digestive disturbances (such as bloating, indigestion, and loss of appetite), urinary tract

infections, and respiratory conditions like bronchitis. In European folk medicine, especially in Scandinavian, Baltic, and Balkan Regions, decoctions of juniper berries were used as diuretics and for kidney detoxification. The essential oil was externally applied to relieve joint pain and muscle stiffness. Native American tribes employed the plant in spiritual rituals and for treating colds and fevers [26, 28, 29].

Pharmacological Activities.

- *Anti-Inflammatory and Antioxidant Activity*. Extracts from *J. communis* berries are rich in monoterpenes (especially α-pinene and limonene), flavonoids, and phenolic acids. These compounds reduce pro-inflammatory cytokines (e.g., IL-6, TNF-α) and suppress oxidative stress markers in both *in vitro* and *in vivo* models, providing scientific support for its traditional use in arthritis and respiratory inflammation [28, 30, 31].
- *Antimicrobial and Antifungal Activity*. *J. communis* essential oil exhibits significant antimicrobial effects against a wide spectrum of Gram-positive and Gram-negative bacteria (e.g., *E. coli*, *S. aureus*) as well as fungal species like *Candida albicans*. These properties are attributed to the high content of terpenoids, which disrupt microbial cell membranes [28, 32].
- *Metabolic and Hepatoprotective Properties.* Experimental studies indicate that juniper berry extracts may improve glucose metabolism, lipid profile, and exhibit hepatoprotective effects in diabetic and hyperlipidemic animal models. These benefits are linked to the activation of 5' adenosine monophosphate-activated protein kinase (AMPK) pathways and modulation of oxidative enzymes [28, 33, 34].

Toxicological Profile and Safety Concerns of Juniperus communis. Although generally regarded as safe in culinary and low-dose medicinal applications, *J. communis* may exhibit toxicity when consumed in excessive quantities or over prolonged periods. Large doses of essential oil can induce gastrointestinal irritation, nephrotoxicity, and convulsions. Its diuretic action, while beneficial in moderation, may exacerbate dehydration or electrolyte imbalance. In pregnant individuals, internal use is discouraged due to mild uterotonic effects attributed to terpene constituents like sabinene and myrcene, though the risk is significantly lower compared to *J. sabina.* Chronic exposure to high concentrations of *J. communis* oil has been associated with renal epithelial damage in animal studies, warranting caution in patients with preexisting renal conditions. The plant lacks the podophyllotoxin derivatives that render *J. sabina* highly cytotoxic, but caution is still advised in therapeutic use due to its potent bioactivity [35–37].

Juniperus oxycedrus* L. *(Prickly Juniper). *Juniperus oxycedrus* L. (*Prickly Juniper*) is a shrubby to small tree-like evergreen species native to the Mediterranean Region (Fig. 3). It typically grows in dry, rocky habitats, hillsides, and open pine forests, often forming dense thickets. In Armenia, it is sporadically found in the Southern and Southeastern Regions, particularly in dry montane zones.

The plant is characterized by a rigid, often spiny habit with sharp, needle-like leaves arranged in whorls of three. It usually reaches heights of 1–5 *m*, though taller forms are also observed. The fruits are reddish to brownish globular cones (galbuli), typically ripening in their second year [5, 38, 39].

Thanks to its rich content of essential oils and phenolic compounds, *J. oxycedrus* has long been used in traditional and folk medicine. Its tar, known as

"cade oil," is especially valued for dermatological applications. However, the plant also contains potent constituents, including sesquiterpenes and phenolics, which require careful dosage. A detailed overview of its ethnopharmacological relevance and pharmacological properties will be provided in the following section [39, 40].

Traditional Uses. *Juniperus oxycedrus* has been a key element of traditional medicine across the Mediterranean Basin, especially in Spain, Italy and North Africa. The essential oil derived from its wood, known as "cade oil," has been widely used topically for the treatment of chronic skin diseases such as eczema, psoriasis, and fungal infections, as well as for wound care and parasitic skin conditions. Decoctions from its leaves and berries are traditionally employed for respiratory complaints, rheumatism, and digestive disorders. In Anatolian folk medicine, the fruit is also used for its diuretic and stomachic properties [41–43].

Fig. 3. *Juniperus oxycedrus* L.

Pharmacological Activities. The essential oil and extracts of *J. oxycedrus* exhibit strong antimicrobial and antifungal activity against various pathogens, including *Staphylococcus aureus*, *Candida albicans* and dermatophytes, due to the high content of phenolic compounds (such as guaiacol and creosol), as well as α-pinene, β-pinene, and cadinene. The oil also possesses anti-inflammatory, analgesic, and antioxidant properties, which support its traditional use in inflammatory skin conditions. Experimental studies have shown that topical application of *J. oxycedrus* extracts accelerates wound healing and reduces inflammation in animal models. Additional research has revealed smooth muscle relaxant effects and potential hypotensive activity [44–46].

Toxicological Profile and Safety Concerns. Despite its therapeutic value, *J. oxycedrus*, especially in the form of cade oil, has been associated with serious toxicity in both humans and animals. Acute poisoning due to ingestion or excessive dermal exposure can result in severe hypotension, hepatotoxicity, nephrotoxicity, respiratory distress, and central nervous system depression. Documented cases include acute renal failure and fatal outcomes following cade oil exposure. In neonates and infants, even topical application has resulted in toxic shock and death due to systemic absorption. Subacute studies in rodents have revealed elevated liver enzymes and histological evidence of hepatic and renal damage after oral administration of aqueous extracts. As such, the internal use of *J. oxycedrus* preparations requires strict caution, and topical use should be medically supervised, particularly in vulnerable populations [47–50].

Juniperus Foetidissima* Willd *(Stinking Juniper). *J. foetidissima* Willd is a large, long-lived evergreen conifer native to the Eastern Mediterranean and Western Asia (Fig. 4). In Armenia, it is primarily distributed in the Northern Regions, including the forested areas of Dilijan, Alaverdi, and Ijevan. The species typically grows in mountainous and rocky habitats, often at elevations ranging from 800 to 2000 *m.*

Fig. 4. *Juniperus foetidissima* Willd.

It is characterized by a tall, tree-like growth habit, often reaching up to 16 *m* in height. The bark is thick, fibrous, and brownish-gray, while the crown is broad and irregular. Mature plants bear scale-like leaves, whereas young shoots may carry needle-like foliage. The fruits are spherical, berry-like cones that transition from green to dark bluish-black upon ripening. The plant emits a strong resinous and somewhat unpleasant odor, which is the origin of the common name "stinking juniper."

Thanks to its content of essential oils, resins, and terpenoids, *J. foetidissima* has been used in traditional medicine, particularly for respiratory ailments, dermatological conditions, and wound care. However, due to its strong odor and more limited geographic availability, its medicinal use is less widespread than that of other juniper species. The following section will provide a more detailed discussion of its ethnopharmacological relevance and bioactive constituents [5, 51, 52].

Although detailed phytochemical studies on Armenian populations are limited, essential oils extracted from *J. foetidissima* in neighboring regions have shown a rich composition of monoterpenes and sesquiterpenes with known antimicrobial and antioxidant properties. Its traditional uses include treatment of respiratory and inflammatory conditions, although pharmacological data remain scarce. Due to its limited distribution and ecological importance, *J. foetidissima* is listed in Armenia's Red Data Book as a species of conservation concern.

Traditional Uses. *J. foetidissima* is distributed mainly in the Eastern Mediterranean, Caucasus, and parts of the Middle East. Although not as widely documented in ethnobotany as other junipers, it has traditionally been used in Armenia and Iran to treat bronchial and hepatic ailments, and is sometimes burned as incense for respiratory relief. The strong-smelling leaves and berries have also been used as antiseptics and in the management of parasitic skin diseases [53, 54].

Pharmacological Activities. Phytochemical analyses reveal that the leaves and berries of *J. foetidissima* are rich in α-pinene, sabinene, α-cedrol, limonene, and myrcene, contributing to its biological activity. Extracts from the aerial parts have demonstrated antimicrobial effects against both Gram-positive and Gram-negative bacteria, as well as fungi. Moreover, ethanol extracts have shown significant cytotoxicity against multiple human cancer cell lines, including MDA-MB-468 and HeLa, in *in vitro* assays, with IC_{50} values often below 5 $\mu g/mL$. These effects are likely mediated by monoterpenes and sesquiterpenes, which are known for their ability to disrupt cellular membranes and induce apoptosis [55–57].

Toxicological Profile and Safety Concerns. Although no comprehensive clinical toxicity reports exist for *J. foetidissima*, the presence of potent monoterpenes and cytotoxic activity *in vitro* suggests the need for careful use, especially for internal or high-dose applications. No evidence indicates the presence of podophyllotoxin or its analogs, but given the chemotaxonomic proximity to other toxic junipers, caution is warranted. Further toxicological studies are necessary to fully assess its safety profile [54, 58].

Juniperus Polycarpos* K. Koch *(Persian Juniper). *J. polycarpos* K. Koch *(Persian Juniper)* is a high-mountain evergreen conifer species distributed across the Caucasus, Northeastern Iran, and parts of Anatolia (Fig. 5). In Armenia, it is primarily found in the Southern Regions, especially in the areas of Vedi, Meghri, and Akhta, where it grows on arid mountain slopes and subalpine zones at elevations ranging from 1000 to 2400 *m* above sea level.

Fig. 5. *Juniperus polycarpos* K. Koch.

This species is arboreal, typically reaching a height of 10 to 15 *m*. It possesses thick, fibrous bark and a pyramidal to irregular crown structure. The leaves are scale-like and tightly appressed to the twigs, while juvenile shoots may exhibit needle-like foliage. The fruiting bodies are small, berry-like cones (galbuli), which are initially green and ripen to bluish-brown or reddish-brown over a two-year period.

J. polycarpos typically grows in dry, sunny mountain habitats, often forming sparse forests or isolated tree groups. It plays a critical role in mountain ecosystems by stabilizing soil and providing shelter for various wildlife species. Due to its ecological resilience and longevity, it is considered an important structural element of high-altitude vegetation belts in Armenia and neighboring regions.

A detailed discussion of its ethnobotanical relevance, traditional use, and phytochemical characteristics will be provided in the following section [59, 60].

***Traditional Uses*.** A high-altitude juniper native to the Caucasus, Iran, and parts of Eastern Anatolia, *J. polycarpos* has long been used in regional folk medicine for the treatment of respiratory conditions, digestive disorders, liver dysfunction, and urinary tract issues.

Decoctions from the berries and leaves are consumed as diuretics, expectorants, and antiseptics.

In Armenian and Georgian ethnomedicine, the species is used for wound healing and to manage chronic coughs and colds [61, 62].

***Pharmacological Activities*.** The essential oil of *J. polycarpos* contains α-pinene, β-pinene, sabinene, myrcene, and limonene, contributing to its antimicrobial, antioxidant, and anti-inflammatory activities. Studies have shown that both the essential oil and ethanolic extracts possess broad-spectrum antimicrobial effects, particularly against *Escherichia coli*, *Bacillus subtilis*, and *Candida* species. Furthermore, *in vitro* cytotoxicity studies have demonstrated significant inhibition of cancer cell viability, including HepG2, HeLa, and KB cell lines, with IC_{50} values ranging from sub-microgram to low milligram per milliliter levels. This suggests potential for anticancer drug development, although more research is needed *in vivo* [63–65].

***Toxicological Profile and Safety Concerns*.** Toxicological studies specific to *J. polycarpos* are limited. However, due to its essential oil composition and demonstrated cytotoxicity, excessive or internal use may pose risks similar to those

observed in other *Juniperus* species. The absence of highly toxic lignans, such as podophyllotoxin, indicates lower systemic toxicity compared to *J. sabina*, but its strong bioactivity necessitates cautious use, particularly in patients with liver or kidney impairment, and in pregnant individuals [66, 67].

Phytochemical Composition of Juniperus Species. The genus *Juniperus* includes numerous species that produce a diverse spectrum of bioactive phytochemicals. These secondary metabolites, particularly terpenes, flavonoids, lignans, and coumarins, are distributed variably across different species and plant parts (berries, needles, wood, roots). The following section summarizes the key phytochemical classes, associated species richness, plant part localization, and biological activities.

Monoterpenes (Tab. 2). Monoterpenes dominate the essential oil fractions of *Juniperus* berries and leaves. In wild Caucasian populations of *J. communis* and *J. oxycedrus* α-pinene and sabinene can jointly account for 60–80% of total volatiles, while β-pinene and limonene usually remain below 20%. These molecules exert broad-spectrum antibacterial activity and attenuate LPS-induced inflammation through MAPK/NF-κB suppression (Juniper EO microneedle model). Seasonal chemotype shifts urge the need for standardisation in herbal preparations [62, 68–70].

Table 2

Monoterpenes composition of Juniperus Species

Compound	Found in Species	Bioactivity
α-Pinene	*J. communis, J. oxycedrus*	antibacterial, anti-inflammatory
β-Pinene	*J. communis, J. polycarpos*	antiseptic, expectorant
Sabinene	*J. sabina, J. communis*	antioxidant, diuretic
Myrcene	*J. communis*	analgesic, anti-inflammatory
Limonene	*J. oxycedrus*	antioxidant, antibacterial

Sesquiterpenes (Tab. 3). Sesquiterpenes concentrated in wood and needle oils provide anti-inflammatory, sedative and antimicrobial benefits. β-Caryophyllene selectively activates CB2 receptors, suppressing cytokine release and conferring gastro- and neuro-protection. Cedrol exhibits sedative and anxiolytic effects in both animals and humans, shortening non-REM (Rapid eye movement) sleep latency after inhalation [9, 62, 71].

Table 3

Sesquiterpenes composition of Juniperus Species

Compound	Found in Species	Bioactivity
β-Caryophyllene	*J. foetidissima, J. communis*	anti-inflammatory, CB2 agonist
Cedrol	*J. oxycedrus*	sedative, antibacterial

Phenolic Diterpenes (Tab. 4). Phenolic abietanes, such as totarol and ferruginol, accumulate in the roots and heartwood. Totarol disrupts bacterial membranes and inhibits efflux pumps in MRSA [65, 72, 73], while ferruginol demonstrates cardioprotective and anticancer actions via reactive oxygen species (ROS) scavenging.

Table 4

Phenolic diterpenes composition of Juniperus Species

Compound	Found in Species	Bioactivity
Totarol	*J. communis*	broad-spectrum antimicrobial, antioxidant
Ferruginol	*J. thurifera*	cytotoxic, cardioprotective

Lignans (Tab. 5). Podophyllotoxin (PPT) and deoxypodophyllotoxin are hallmark lignans of *J. sabina*, with PPT levels up to 4.9 $mg \cdot g^{-1}$ DW (dry weight). These compounds are precursors for the anticancer drugs etoposide and teniposide and exhibit direct antiviral and acaricidal effects [9, 74, 75].

Table 5

Lignans composition of Juniperus Species

Compound	Found in Species	Bioactivity
Podophyllotoxin	*J. sabina*	cytotoxic, anticancer, antiviral
Deoxypodophyllotoxin	*J. sabina*	antitumor, antiparasitic

Flavonoids and Bioflavonoids (Tab. 6). Leaves and young shoots are rich in flavonols such as quercetin and rutin, contributing to antioxidative defence. *J. foetidissima* accumulates the biflavonoid amentoflavone, a potent butyrylcholinesterase (BChE) inhibitor with antiviral potential. Total flavonoid content in *J. oxycedrus* needles exceeds 10 mg QE$\cdot g^{-1}$ DW [9, 76–79].

Table 6

Flavonoids and bioflavonoids composition of Juniperus Species

Compound	Found in Species	Bioactivity
Quercetins	*J. communis, J. foetidissima*	antioxidant, anti-inflammatory
Rutin	*J. communis*	vasoprotective, antioxidant
Amentoflavone	*J. foetidissima*	antiviral, cholinesterase inhibitor

Esters and Ketones (Tab. 7). Sabinyl acetate constitutes up to 60% of *J. sabina* oil and is responsible for its uterotonic activity; thujone in *J. phoenicea* modulates GABA-A receptors, explaining neuro-excitatory effects at high doses. Regulatory frameworks limit thujone content in food and herbal products [9, 22].

Table 7

Esters and ketones composition of Juniperus Species

Compound	Found in Species	Bioactivity
Sabinyl acetate	*J. sabina*	uterotonic, abortifacient
α/β-Thujone	*J. phoenicea*	neuroactive, antimicrobial

Although the genus *Juniperus* has been extensively studied worldwide, data on the chemical composition and biological activity of species growing in

Armenia remain limited. Below is a summary of key quantitative and phytochemical characteristics of several Armenian species. These data are crucial for identifying species-specific bioactive traits and guiding future phytochemical and pharmacological studies. *Juniperus sabina* L. the needle-like leaves contain 2–5% essential oil, with some reports indicating yields as high as 17%. The principal active compound is sabinol ($C_{10}H_{15}OH$), a monoterpene alcohol known for its uterine-stimulating and abortifacient effects. Phytochemical analysis indicates a complete absence of tannins in the foliage. *Juniperus oblonga* M. Bieb – the fruits are rich in sugars (up to 42%) and are traditionally used in beer and wine production. Branches contain small amounts of pyrocatechin-type tannins, and the species is known for its diuretic properties in traditional medicine. *Juniperus foetidissima* Willd. – essential oil yield from needles reaches up to 2.26%, with α-pinene and cedrol as dominant compounds. Vitamin C levels range between 154.0–421.9 *mg*%, while vitamin E content can reach 30.01 *mg*%; carotenoids are also present. Compared to other regional junipers, this species is less xerophilous and shows better development on soils with moderate cover. *Juniperus polycarpos* K. Koch – the average essential oil yield is up to 2.4%, dominated by α-pinene and cedrol. Needles contain up to 203.8 *mg*% vitamin C and 70.4 *mg*% vitamin E, along with significant levels of carotenoids. Trace amounts of pyrocatechin tannins have been detected in the branches. Notably, the foliage gives a positive reaction to alkaloid reagents, whereas the response in the fruits is significantly weaker [5, 7, 8, 80].

Conclusions and Perspectives. This review provides a multidisciplinary synthesis of five *Juniperus* species native or naturalized in Armenia (*J. sabina, J. polycarpos, J. foetidissima, J. excelsa*, and *J. oblonda*), focusing on their taxonomic placement, essential oil profiles, and pharmacological relevance.

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ՀԱՅԱՍՏԱՆՈՒՄ ԱՃՈՂ ԳԻՀՈՒ (*JUNIPERUS* SPP.) ՏԵՍԱԿՆԵՐԻ ՀԱՄԱՊԱՐՓԱԿ ՈՒՍՈՒՄՆԱՍԻՐՈՒԹՅՈՒՆ՝ ՀԱՄԱՇԽԱՐՀԱՅԻՆ ՓՈՐՁԻՑ ԴԵՊԻ ՏԵՂԱԿԱՆ ԿԻՐԱՌՈՒԹՅՈՒՆ

Գիհու (*Juniperus* spp.) ցեղի ներկայացուցիչները վաղնջական ժամանակներից օգտագործվել են ժողովրդական բժշկության մեջ՝ պայմանավորված իրենց լայն տարածվածությամբ և հարուստ կենսաբանական ակտիվությամբ: Հայաստանում աճող հինգ տեսակները՝ *J. sabina, J. polycarpos, J. foetidissima, J. excelsa* և *J. oblonga*, ընդգրկված են էկոլոգիապես կարևոր տեսակների ցանկում: Սույն ուսումնասիրությունը ներկայացնում է համապարփակ վերլուծություն՝ ընդգրկելով այդ տեսակների տաքսոնոմիական դասակարգումը, դեղաբուսաբանական հատկությունները, եթերայուղերի քիմիական կազմը և դեղաբանական ու թունաբանական ակտիվության տվյալները: Հիմնվելով շուրջ 60 գիտական աղբյուրների վրա՝ առանձնացվել են կենսաբանորեն ակտիվ միացություններն ու դրանց վերլուծության մեթոդները: Հատուկ ուշադրություն է դարձվում Հայաստանի տարածքում աճող տեսակների խտացված ուսումնասիրմանն ու հետագա կիրառական ներուժի բացահայտմանը:

А. Г. МКРТЧЯН, Т. О. САРГСЯН, А. Р. КЕШИШЯН,
А. М. ОВАННИСЯН, Х. С. АКОПЯН

КОМПЛЕКСНОЕ ИССЛЕДОВАНИЕ ВИДОВ МОЖЖЕВЕЛЬНИКА (*JUNIPERUS* SPP.), ПРОИЗРАСТАЮЩИХ В АРМЕНИИ: ОТ МИРОВОГО ОПЫТА К МЕСТНОМУ ПРИМЕНЕНИЮ

Представители рода можжевельника (*Juniperus* spp.) с древнейших времен использовались в народной медицине благодаря их широкой экологической

распространенности и выраженной биологической активности. В Армении произрастают пять видов – *J. sabina, J. polycarpos, J. foetidissima, J. excelsa* и *J. oblonga*, имеющие важное экологическое значение. Настоящее исследование представляет собой комплексный обзор их таксономии, фармакогностических свойств, химического состава эфирных масел, а также фармакологической и токсикологической активности. На основе анализа около 60 научных источников выделены биологически активные соединения и аналитические методы их изучения. Особое внимание уделено видам, произрастающим в Армении, и перспективам их дальнейшего прикладного использования.