



**THE THIRD REVIEW ON THE CONSTITUENTS AND BIOLOGICAL ACTIVITIES OF
IRANIAN *ARTEMISIA SPECIES*.**

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Article Received on 26/08/2016

Article Revised on 15/09/2016

Article Accepted on 05/10/2016

ABSTRACT

Plants have been one of the important sources of medicines. Even since the down of human civilization. In spite of tremendous development in the field of allopathy during 20th century, plants still remain one of major sources of drug in modern as well as traditional system of medicine throughout the world. The genus *Artemisia* are considered of one of state of art. Chemical laboratories capable of biosynthesizing number of biomolecules of different chemical classes. The present review describes the third review of the chemical and biological activities of Iranian *Artemisia* species namely: *A. absinthium* L., *A. armeniaca* Lam., *A. incana* (L.) Druce, *A. khorasanica* Podl., *A. scoparia* Waldst.& Kit, *Artemisia sieberi* Besser and *A. vulgaris* L.

KEYWORDS: Iranian *Artemisia* species, Secondary metabolite, Biological activities.

INTRODUCTION

Artemisia is a a large diverse genus of plants with between 400 and 500 species belonging to the daisy family Asteraceae. Common names for various species in the genus include mugwort wormwood, and sagebrush. *Artemisia* comprises hardy herbaceous plants and shrubs, which are known for the powerful chemical constituents in their essential oils. *Artemisia* species grow in temperate climates of both hemispheres, usually in dry or semiarid habitats.

Notable species include *A. vulgaris* (common mugwort), *A. tridentata* (big sagebrush), *A. annua* (sagewort), *A. absinthium* (wormwood), *A. dracunculus* (tarragon), and *A. abrotanum* (southernwood). The leaves of many species are covered with white hairs. Most species have strong aromas and bitter tastes from terpenoids and sesquiterpene lactones, which discourage herbivory, and may have had a selective advantage. The small flowers are wind-pollinated. *Artemisia* species are used as food plants by the larvae of a number of Lepidoptera species.

The 500 species of *Artemisia* are mainly found in Asia, Europe and North America. They are mostly perennial herbs and dominating the vast steppe communities of Asia. Asia seems to show the greatest concentration of species with 150 accessions for China ^[1], 174 in the ex U.S.S.R. ^[2], about 50 reported to occur in Japan ^[3] and 35 species of the genus are found in Iran, of which two are endemic: *A. melanolepis* and *A. kermanensis* ^[4].

In morphology, the *Artemisia* genus is endowed with head-like inflorescences and is considered to be one of the most evolutionary taxa in the Dicotyledonae. This advancement in taxonomy may increase the chemical diversity as the advance increase the chemical diversity as the advance species may synthesize more complex (cyclized, rearranged and/or oxygenated) secondary metabolites. ^[5]. We have already published two reviews about Iranian *A. dracunculus* L., *A. fragrans* Wild, *A. hassknechtii* Boiss, and *A. persica* Boiss. ^[6,7].

***Artemisia absinthium* L.**

Artemisia absinthium (absinthium, absinthe wormwood, wormwood, common wormwood, green ginger or grand wormwood) is a species of wormwood, native to temperate regions of Eurasia and northern Africa.

It is a herbaceous, perennial plant with a hard, woody rhizome. The stems are straight, growing to 0.8-1.2 m (rarely 1.5 m) tall, grooved, branched, and silvery-green. The leaves are spirally arranged, greenish-grey above and white below, covered with silky silvery-white trichomes, and bearing minute oil-producing glands; the basal leaves are up to 25 cm long, bipinnate to tripinnate with long petioles, with the cauline leaves (those on the stem) smaller, 5–10 cm long, less divided, and with short petioles; the uppermost leaves can be both simple and sessile (without a petiole). Its flowers are pale yellow, tubular, and clustered in spherical bent-down heads (capitula), which are in turn clustered in leafy and branched panicles. Flowering is from early summer to

early autumn; pollination is anemophilous. The fruit is a small achene; seed dispersal is by gravity.

It grows naturally on uncultivated, arid ground, on rocky slopes, and at the edge of footpaths and fields. The plant's characteristic odor can make it useful for making a plant spray against pests. It is used in companion planting to suppress weeds, because its roots secrete substances that inhibit the growth of surrounding plants. It can repel insect larvae when planted on the edge of the cultivated area. It has also been used to repel fleas and moths indoors.

It grows in large numbers along fences, roadsides, and on wastelands, Wormwood is easy to cultivate as a garden plant. The entire plant has a strong, pungent, and aromatic odor. It contains no less than 0.2 % (v/w) volatile oil, the chief constituent of which is absinthol (thujol). The other chief constituents include sesquiterpene lactone bitters (mainly absinthin and anabsinthin), flavones, ascorbic acid, and tannins. The bittering effect greatly predominates, and wormwood has bittering power of a least 15000.

Wormwood is a typical bitter tonic. It also has significant carminative and choleric action. In contrast to its toxic thujone-containing oil, wormwood's bitter principle is largely nontoxic. Wormwood oil is used to manufacture absinthe, an alcoholic liqueur that is quite popular, especially in France.

The manufacture of absinthe has been banned in Germany by the Absinthe Act (Absinthgesetz) since 1923, because prolonged ingestion of absinthe can result in toxic central nervous system (CNS) effects. The wormwood oil concentration in conventional herbal medicines is so low that no injurious effects are to be expected. It is also interesting to note that, in addition to the action of its bitter principles, wormwood also acts as a CNS stimulant with a so-called psychedelic effect. The effect caused by the low doses in conventional preparations may sometimes be desirable. It is a rather balancing and regulating effect. In this respect, wormwood distinguishes itself from other bitter-containing drugs. The additional effect makes wormwood a valuable herbal drug.

Chemical constituents and biological activities

Various secondary metabolites and other products have been isolated from *Artemisia absinthium*, perhaps the most important being the bitter essential oil obtained from glands on the leaves and flowering tops. Other compounds include: 13 tetrahydrofuranlignans extracted from the root system of *A. absinthium*^[8]; several flavonoglucosides in the leaves including quercetin 3-rhamnoglucoside, quercetin 3-glucoside, isorhamnetin 3-glucoside and patuletin 3-glucoside^[9]; oligosaccharides (non-reducing oligofructosides) identified in the root system^[10]; Merck Index (1983) The chief bitter principle of wormwood as absinthin, a C₃₀ H₄₆ O₆

(Figure 1) compound with a molecular weight of 496.62, isolated by chromatography.^[11] The major constituent of wormwood oil is thujone, sometimes present as thujylalcohol and thujyl acetate, present at level of approximately 40-70% of the oil.^[12] Other constituents present at significant levels include myrcene (<25%) (Figure 1), α -pinene (6%) (Figure 1) and nerol (3%) in wormwood oil of Russian origin^[13]; camphor (6%) (Figure 1), p -cymene (4%), limonene (4%) and α -pinene (4%); β -phellandrene (10%), α -humachalene (7%) and β -caryophyllene (5%)^[14] found cis-chrysanthenol as major component in the oil of plants grown in central France while thujane and camphane, along with monoterpenes, were found to be the major constituents in Indian *Artemisia* species.^[15]

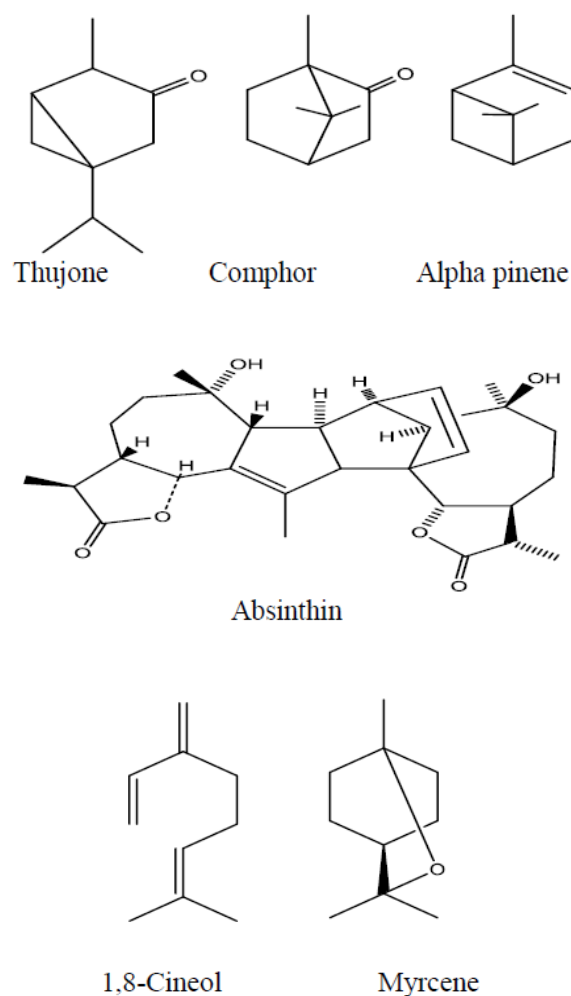


Figure1: Some of chemical constituents of

Artemisia absinthium

The essential oil, having a very strong odour and acrid taste, is described as neurotoxic due to the high thujone content^[16] and its use is proscribing in most countries.^[17] The structure of thujone (Figure 1) has been compared to that of tetrahydrocannabinol and it has been postulated that thujone and tetrahydrocannabinol interact with common receptor in the central nervous system.^[18] In addition,^[19] have reported that *A. absinthium* may contain

potentially toxic levels of photoactive di- and ter-thiophenes.^[20] Undertook chiral gas chromatography analysis of enantiomerically pure (-)-fenchone from *A. absinthium* oil, while^[21] suggested a taxonomic scheme utilising oil composition data to partition *Artemisia* species into two sub-groups: one group, containing *A. absinthium*, was characterized by the presence of camphor and 1,8-cineole (Figure 1); the second smaller group all contained α -thujone. In addition to these constituents,^[22] isolated, for the first time from aerial parts of several *Artemisia* species, the following phenolic acids: vanillic, *p*-hydroxy-benzoic, neochlorogenic, ferulic and *p*-coumaric acids. Earlier,^[23] showed the presence of several novel coumarins, scopoletin, umbelliferone, esculetin and esculin from flowering *A. absinthium*.

***Artemisia armeniaca* Lam.**

Artemisia armeniaca was described in 1753 by Jean Baptiste de Monnet de Lamarck. The name is considered as validly published. *Artemisia armeniaca* is a species in the genus *Artemisia* (sagebrush) which grow perennials to a height of approximately 0,3 meters. The leaves are arranged opposite one another. The flowers are many-petaled and yellow. The plants bloom from August to September. The fruits are achenes. *Artemisia armeniaca* is native to the Caucasus. *Artemisia armeniaca* prefers a sunny site and can withstand temperatures down to -28, 2° C. It grows best in soils that are dry to moderately moist.

Some of the most common uses of *A. armeniaca* are: *Althaea armeniaca*, a herb species, *Amanita armeniaca*, a mushroom species in the genus *Amanita*, *Amara armeniaca*, a beetle species and *Artemisia armeniaca*, an abortifacient species in the genus *Artemisia*.^[24]

The first chromosome count for *A. armeniaca* Lam., the basic number $x=9$ and polidy level ($x2$) are the most common in the section and genus.^[25] Further investigation of the chromosome number of this species is $2n = 2x = 18$ and its karyotype formula is $16m + 2sm$. *A. armeniaca* is a very polymorphic species and it has a wide distribution.^[26] However, the only previous study on the chromosome number of this species as reported.^[27] This count is the second record and the first karyotype analysis for this taxon.

Chemical Constituents

Essential oils

The aerial parts of *A. armeniaca* (170g) which were collected during the flowering stage in Kalibar region, province of East Azarbaijan, Iran, were subjected to hydrodistillation using a Clevenger-type apparatus for 3 h. After decanting and drying over anhydrous sodium sulfate, the corresponding yellowish colored oil was recovered in yields of 0.12% w/w.

Eighteen compounds, representing 98.6% of the total constituents in the oil of *A. armeniaca*, were

characterized by α -pinene (41.9%) and 1,8-cineole (20.6%) as the major compounds, followed by spathulenol (6.7%) and limonene (5.6%).

Monoterpene hydrocarbons constitute the major fraction of the oil (61.5%), while sesquiterpene hydrocarbons accounted to 2.2%. Oxygenated monoterpenes and oxygenated sesquiterpenes amounted to 25.2% oil.

Armenin and Isoarmenin

The reversed-phase preparative HPLC analyses of the MeOH extract of the aerial parts of *Artemisia armeniaca* yielded four prenylated coumarins, 7-hydroxy-8-(4-hydroxy-3-methylbutoxy) coumarin (armenin), 8-hydroxy-7-(4-hydroxy-3-methylbutoxy) coumarin (isoarmenin) (Figure 2), lacarol, and deoxylacarol, together with five other compounds, including three flavonoid glycosides, quercetin 3-O- β -D-glucopyranoside, rutin, and kaempferol 3-O- β -D-glucopyranoside, chlorogenic acid, and tryptophan. (10E, 12Z) - 9-Hydroxyoctadeca-10, 12-dienoic acid (β -dimorphecolic acid) was isolated from the CH₂Cl₂ extract. Armenin and isoarmenin were new coumarins. Their structures were determined on the basis extensive spectroscopic methods.^[28]

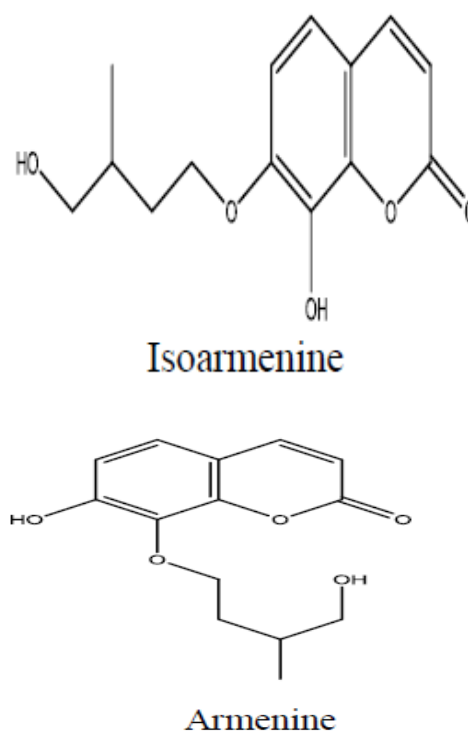


Figure 2: Structures of Armenin and Isoarmenin.

***Artemisia incana* (L.) Druce**

Essential Oil

The essential oil of the aerial parts of *A. incana*, collected from Arasbaran area (East Azarbaijan province, Iran) was extracted by hydrodistillation and analyzed by GC-MS. In total, 40 constituents were identified and quantified in the oil of *A. incana* representing 84.6% of the oil, respectively.

The essential oil of *A. incana* was dominated by oxygenated monoterpenes (41.6%) with camphor (20.4%), 1, 8-cineol (10.3%), Z-verbenol (8.7%), β -thujone (8.3%) and α -thujone (5.6%), as major components. The essential oil was also subjected to general toxicity assay using brine shrimp lethality method. The toxicity profile of the oil indicated some degree of toxicity in comparison with podophyllotoxin.^[29]

The oil obtained by hydrodistillation from the aerial parts of *Artemisia incana* (L.) Druce from Turkey was analyzed by GC/MS. Sixty-three compounds were characterized, representing 97.2% of the total components detected, and camphor (19.0%), borneol (18.9%), 1,8-cineole (14.5%), bornyl acetate (7.8%), camphene (4.9%), and α -thujone (4.8%) were identified as predominant components. The essential oil was also tested for its antimicrobial activity against 44 different foodborne microorganisms, including 26 bacteria, 15 fungi, and yeast species tested. However, the oil showed lower inhibitory activity against the tested bacteria than the reference antibiotics.^[30]

The essential oils obtained by hydrodistillation from the flower, leaves and stems of *Artemisia incana* (L.) Druce was analyzed by GC and GC/MS. The flower, leaf and stem oils of *A. incana* were found to be rich in α -thujone (28.7%, 28.1% and 22.2%), 1, 8-cineole (20.5%, 22.1% and 25.5%) and camphor (10.5%, 10.1% and 12.6%), respectively.^[31]

Artemisia khorassanica

Essential Oil

Artemisia khorassanica Podl. (Asteraceae) is a common perennial herb growing wild in northeastern parts of Iran. The essential oil of *A. khorassanica* was isolated by hydrodistillation in 1.25 (v/w) yield. The chemical composition of the essential oil was examined by gas chromatography and gas chromatography-mass spectrometry. Thirty-one compounds were identified, representing 79.6% of the total oil. The major constituents were 1, 8-cineol (17.7%), camphor (13.9%), davanone (12.2%), and isogeraniol (5.7%). Minimum inhibitory concentration was determined using agar dilution method against eight bacteria and two fungal strains. The essential oil indicated a moderate antimicrobial activity.

To compare the essential Oil composition of the two *Artemisia* species from Iran, the aerial parts of *A. Sieberi* and *A. khorassanica* were collected at flowering stage. The essential oils were obtained by means of hydro-distillation and their chemical Components were identified by GC-MS. The main constituents of their essential Oils were as follows: *A. Sieberi*, β -thujone (19.79%), α -thujone (19.55%), camphor (19.55%) and verbenol (9.69%), *A. khorassanica*, davanone (36.4%), p-cymene (16.55%), (Z)-citral (8%) and β -ascaridol (5.95%).^[32]

Biological activity

Inflammation is characterized by the release of pro-inflammatory cytokines such as tumor necrosis factor- α (TNF- α) and interleukin-1b (IL-1b), as well as inflammatory mediators, including nitric oxide (NO) and prostaglandin E2 (PGE2), which are synthesized by inducible nitric oxide synthase (iNOS) and cyclooxygenase-2 (COX-2). In macrophages, they are induced by bacterial endotoxin lipopolysaccharide (LPS) and inflammatory cytokines. This inflammatory cytokines and mediators are involved in the causation of many human diseases including rheumatoid arthritis. Nuclear transcription factor- κ B (NF- κ B) activates pro-inflammatory genes encoding iNOS, COX-2, TNF- α and IL-1b and its aberrant activity is associated with various inflammatory diseases. Members of the *Artemisia* genus (Astraceae) are important medicinal plants throughout the world and have a vast range of biological effects including anti-inflammatory activity. Here, we prepared a sesquiterpene lactone fraction from *Artemisia khorassanica* and evaluated its effect on LPS-induced inflammation in macrophages as a model of inflammatory model in vitro.^[33]

Artemisia scoparia Waldst

Artemisia scoparia (Persian local names of Terekh and Jaroooy e Mashhadi) is a faintly scented very slender branched biennial herb [34]. In Iranian traditional medicine, the aerial parts of the plant have been widely used for their hyperlipemic, hypoglycemic, anti-inflammatory and diuretic activities.^[35] Also, fresh leaves are consumed as a vegetable and dried leaves are used as a spice by local peoples of Khorasan province of Iran. The plant extract is used as a purgative, to treat earache and fever^[36] A hydro-methanolic extract of the plant has also been shown hepato protective activity against acetaminophen-induced hepatic damage.^[37] It is reported that a chemical 'scoparone' found in *A. scoparia* which useful for the development of better immunosuppressive agents with vasco relaxant actions which use against transplantation rejection and autoimmune disease.^[38]

Chemical constituents and biological activities

Essential oils

Variation in the quantity and quality of the essential oil of *Artemisia scoparia* Waldstet Kit al different developmental growth stages including vegetative, floral and reported. The oils were obtained by hydro distillation of air-dried samples. The yields of oils (w/w%) in different stages were in the order of: flowering (0.9%) floral budding (0.7%)>vegetative (0.4%). The oils were analyzed by GC and GC/ MS. In total, 25, 23 and 18 constituents were identified and quantified in the oils of vegetative, floral budding and flowering plants, representing 98.4%, 98.5%, and 98.7% of the oils, respectively. α and β -thujone and 1,8-cineole were the main compounds in all samples. α -Thujone was lower in the vegetative stage and increased in the subsequent harvesting times to reach maximum in flowering. In contrast β -Thujone, was higher in the vegetative stage

and decreased during flowering. Oxygenated monoterpenes were the main group compounds in flowering (97.9%), floral budding (96.6%) and vegetative (93.4%) stage.

Several phytochemical investigations on *A. scoparia* have been conducted and some flavonoids^[39], coumarins^[40], vanilline^[41], ρ -hydroxyacetophenone and lanostene-type triterpenes^[42] have been reported. The oils isolated from three different samples of *A. scoparia* collected from China have already been analyzed and here different chemotypes as 1,8-cineol, capillene and eugenol have been characterized.^[43] The oil constituents of *A. scoparia* leaves cultivated in India has been analyzed and γ -terpinene and eugenol were found as the main components. Chemical composition of the oil of *A. scoparia* from different localities of Iran (Gilan, Mazandaran and Khorasan provinces) have previously been investigated and capillen, champhor and 1-phenyl-penta-2,4-diyne were reported as principal constituents, respectively.^[44,45,46] Methyl eugenol was reported as the major constituent in the oil of *A. scoparia* collected from Kazakhstan.^[47] The oil composition of *A. scoparia* was reported from India and South Korea and some of the major compounds were identified as myrcene, γ -terpinene and ρ -cymene^[48] or 1,8-cineol and camphor.^[49] The headspace- SPME and hydrodistillation of *A. scoparia* were also reported from Turkey.^[50] The chemical composition of *A. scoparia* species depends largely on the individual genetic variability, seasonal variation, climatic condition and site of plant growth.^[51, 52, 53, 54]

It seemed likely that different developmental stages of *A. scoparia* would have different oil, compositions because *A. molinieri*^[55] and *A. annua*^[56] contained different mixtures of volatile components at different growth stages.

The essential oil from the aerial parts of *A. scoparia* was obtained by hydrodistillation and analyzed by gas chromatography-mass spectrometry. A total of 32 compounds were identified representing 98.0% of the total oil composition. *A. scoparia* oil was dominated by the diacetylenes 1-phenyl-2,4-pentadiene (34.2%) and capillene (4.9%). Other major components were beta-pinene (21.3%), methyl eugenol (5.5%), alpha-pinene (5.4%), myrcene (5.2%), limonene (5.0%) and (E)-beta-ocimene (3.8%). The oil was tested for in-vitro cytotoxic activity against MCF-7 cells, but was inactive.

The three possible isomeric structures of the sabandin coumarin were published by Reyes and Gonzalez in 1970. The isolated compounds sabandins A and B from *A. scoparia* were distinguished by NOE difference NMR measurements.

***Artemisia sieberi* Besser**

Artemisia sieberi Bess. (syn. *A. dumosa*) is a typical desert plant growing from Anatolia to central Asia and

Afghanistan.^[57] The aerial parts of the plant were collected 50 km north Tehran at an altitude of 2000 m (Dashte Mountains). The oil smells fresh herbaceous, camphoraceous, borneol-like, earthy, mugwort-like and rosemary-like, with a fruity, dried plum-like background.

Artemisia sieberi is widely distributed in desert areas of Iran.^[58,59,60]

This dwarf shrub plant, which is named locally dermaneh, is a dominate species in majority step rangelands of Iran.^[61]

This plant not only has forage value but also it has medicine, *Artemisia sieberi* is useful for spasmolytic effects.^[62,63] Production of secondary in plants are affected by different ecological conditions.^[64]

Chemical constituents and biological activities

Essential oils

Essential oil of *A. sieberi* from Semnan province of Iran have been studied and the main components found to be camphor (49.3%), 1,8- cineol (11.1%) and bornyl acetate (5.8%).^[65]

The aerial parts were collected in July 1989 and July 1990. Hydro distillation (2 h) of half-dried aerial parts of *A. sieberi* Bess. Yielded the essential oil (0.7%). July 1990: 26 g, July 1989, 6 g.

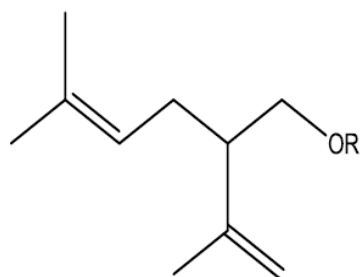
After GC analysis showed the same peaks and nearly the same percentages areas, the essential oil samples (1989 and 1990) were combined.

25 g of the essential oil of *A. sieberi* were distilled (Kugelrohr) up to 1000 C/0.2 Torr giving 22 g of a monoterpene fraction and 2.5 g of a residue. The residue was separated by flash chromatography (FC) on ICN silic32-63 (light petroleum [PE]/ increasing amounts of Et₂O up to 50%) into three fractions.

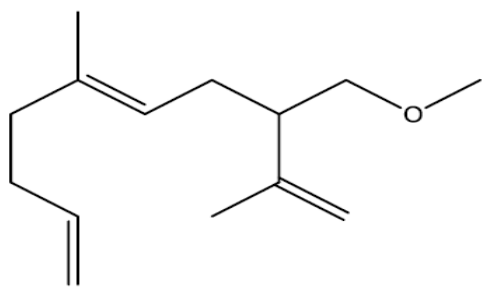
1.0 g of non-polar compounds, 1.3 g of medium-polar to polar compounds.

In the essential oil of *A. sieberi* more than 160 constituents identified representing 99% of the total amount. The oil consists of 15% of monoterpene hydrocarbons, 78% of oxygenated sesquiterpenes.

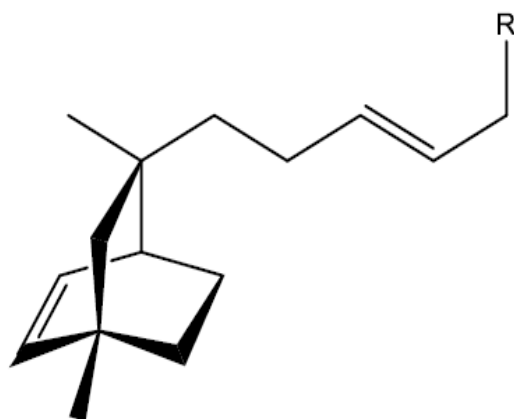
The oxygenated sesquiterpenes are dominated by bisabolene derivatives, e.g. dehydro-1,8- sesquicineole as major compound (1.2%), dehydro- 1,8-sesquicineole-12yl esters, α -bisabolol, sesqui-phellandren-7-ol, gossonorol and bisabola-2,11- dien-(10), 7(10)-acetal.^[66] (Fig 3).



Lavndulol R = H
 Lavandulyl isobutyrate R = COiPr
 Lavandulyl isobutyrate R = COBu

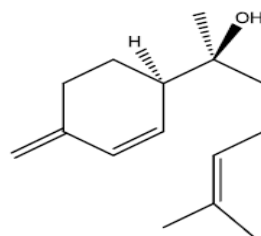


Trans-sesquilavandulol

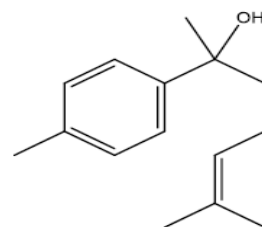


Dehydro – 1, 8 - sesquicinele

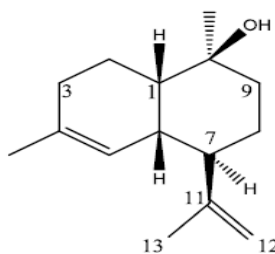
(E)-Dehydrosesquicineole-12-yl-acetate
 R= H
 (E)-Dehydrosesquicineole-12-yl-propinoate
 R= OCOMe
 (E)-Dehydrosesquicineole-12-yl-isobutyrate
 R= OCOEt
 (E)-Dehydrosesquicineole-12-yl-butyrate
 R= OCOiPr
 (E)-Dehydrosesquicineole-12-yl-isovalerate
 R= OCOiBu
 (E)-Dehydrosesquicineole-12-yl-valarate
 R= OCOBu



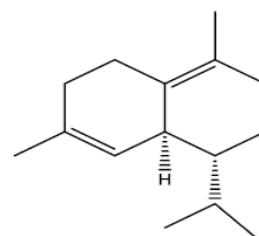
Sesquiphellandren-7-ol



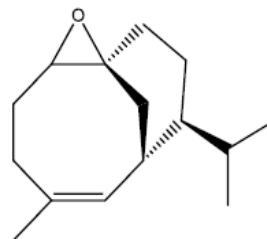
Gossonorol



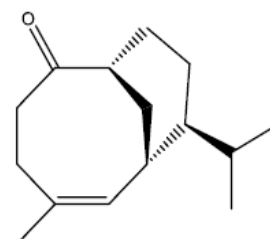
Muurola-4,11-dien-10B-ol



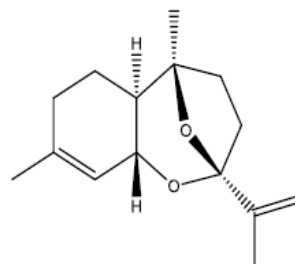
Cadina-4,1(10)-dien-8B-ol



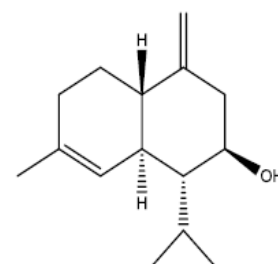
Salsolene oxide



Salsolene ketone



Bisabola-2,11-dien-1(10), 7(10)-acetal



Cadina-4,10(14)-dien-8B-ol

Figure3. Constituents of the essential oil of *Artemisia sieberi* Bess.

The antimicrobial activity of *A.sieberi* essential oil as evaluated against different microorganism including Gram positive bacteria, Gram negative bacteria, yeast and fungi by disc diffusion method and micro broth dilution assay.

The oil was obtained from Barij Essence pharmaceutical Company, Kashan (central of Iran).The oil ingredients were analyzed by gas chromatography (GC) at Barij Essence pharmaceutical industries (kashan, Iran). The antimicrobial activity of *A.sieberi* essential oil and their

potency were qualitatively assessed by determining the MIC and IZ diameter.

The analysis of oil showed that this oil had some antimicrobial activity against different microorganisms and varied according to the type of pathogen. The inhibitory zones significantly increased in dose dependent manner. Gram positive bacteria and fungi were more sensitive than Gram negative bacteria. The antimicrobial activity of oil was comparable with antibiotics. *B. cereus* and *L. monocytogenes* were sensitive among Gram positive bacilli. *S. mutans* were more sensitive than other Gram positive cocci. No clear correlation between MIC values and inhibition diameter was found. Inhibition diameter of some Gram negative bacteria is larger than Gram positive ones but MIC values of Gram positive ones were smaller or MIC values of *S. mutans* did not correlate with inhibition diameter. These results show that these two methods are not necessarily comparable. MBC values of *B. subtilis*, *A. niger* and *A. flavus* were several fold to MIC values. This oil showed inhibitory effect against these microorganism.^[67]

Artemisia vulgaris

Artemisia vulgaris (mugwort or common wormwood) is one of several species in the genus *Artemisia* commonly known as mugwort, although *Artemisia vulgaris* is the species most often called mugwort. This species is also occasionally known as felon herb, chrysanthemum weed, wild wormwood, old Uncle Henry, sailor's tobacco, naughty man, old man or St. John's plant (not to be confused with St John's wort). Mugworts are used medicinally and as culinary herbs.^[68]

It is native to temperate Europe, Asia, northern Africa and Alaska and is naturalized in North America, where some consider it an invasive weed. It is a very common plant growing on nitrogenous soils, like weedy and uncultivated areas, such as waste places and roadsides. It is a tall herbaceous perennial plant growing 1–2 m (rarely 2.5 m) tall, with a woody root. The leaves are 5–20 cm long, dark green, pinnate, with dense white tomentose hairs on the underside. The erect stem often has a red-purplish tinge. The rather small flowers (5 mm long) are radially symmetrical with many yellow or dark red petals. The narrow and numerous capitula (flower heads) spread out in racemose panicles. It flowers from July to September.^[69]

Use

Mugwort oil contains thujone, which is toxic in large amounts or under prolonged intake. Thujone is also present in *Thuja plicata* (western red cedar), from which the name is derived. Mugwort herb contains a very small percentage of oil, so is generally considered safe to use. Pregnant women, though, should avoid consuming large amounts of mugwort. The species has a number of recorded historic uses in food, herbal medicine, and as a smoking herb.^[70]

Food

The leaves and buds, best picked shortly before mugwort flowers in July to September, were used as a bitter flavoring agent to season fat, meat and fish. Mugwort has also been used to flavor beer before the introduction of or instead of hops.^[71]

Medicinal

The mugwort plant contains essential oils (such as cineole, or wormwood oil, and thujone), flavonoids, triterpenes, and coumarin derivatives. It was also used as an anthelmintic, so it is sometimes confused with wormwood (*Artemisia absinthium*). The plant, called nagadamni in Sanskrit, is used in Ayurveda for cardiac complaints as well as feelings of unease, unwellness and general malaise.^[72]

In Traditional Japanese, Korean and Chinese Medicine, Chinese mugwort (*Folium Artemisiae argyi*) is used for moxibustion, for a wide variety of health issues. The herb can be placed directly on the skin, attached to acupuncture needles, or rolled into sticks and waved gently over the area to be treated. In all instances, the herb is ignited and releases heat. Not only is it the herb which is believed to have healing properties in this manner, but it is also the heat released from the herb in a precise area that heals. There is significant technique involved when the herb is rolled into tiny pieces the size of a rice grain and lit with an incense stick directly on the skin. The little herbal fire is extinguished just before the lit herb actually touches the skin.^[73]

Allergen

Mugwort pollen is one of the main sources of hay fever and allergic asthma, in North Europe, North America and in parts of Asia. Mugwort pollen generally travels less than 2,000 meters. The highest concentration of mugwort pollen is generally found between 9 and 11 am. The Finnish allergy association recommends tearing as a method of eradicating mugwort. Tearing mugwort is known to lessen the effect of the allergy, since the pollen flies only short distance.^[74,75] Cooking is known to decrease the allergenicity of mugwort.

Antioxidant activity

Recent investigations have shown that the antioxidant properties of plants could be correlated with oxidative stress defense and different human diseases. In this respect flavonoids and other poly phenolic compounds have gained the greatest attention. The present study was undertaken to evaluate the in vitro and in vivo antioxidant activities of aqueous extract of *Artemisia vulgaris*.

The plant extract was tested for DPPH (2, 2-diphenyl, 2-picryl hydrazyl) radical scavenging, nitric oxide radical scavenging, reducing power assays, total phenol, flavonoid and flavonol content. Determination of serum ascorbic acid level, blood glutathione level and

superoxide dismutase activity in rats treated with 100 mg/Kg of *Artemisia vulgaris* extract.

The extract exhibited scavenging potential with IC₅₀ value of 11.4 µg/ml for DPPH, the value were found to close to those of standard rutin (10 µg/ml). On the other hand *Artemisia vulgaris* extract exhibited nitric oxide scavenging activity with IC₅₀ value 125 mg/ml. The reducing power of the extract depends on the amount of extract. The content of phenolic compounds (mg/g) in aqueous extract was found 19 ± 0.16 mg/g plant extract and expressed in gallic acid equivalents (GAE). The flavonoidal and flavonol contents were found to be 7.96 ± 0.76 and 3.4 ± 0.0 respectively mg/g plant extract in rutin equivalent. The treatment of rats with aqueous extract of *Artemisia vulgaris* resulted in a significant increase in blood glutathione level, superoxide dismutase activity and serum ascorbic acid level as compared to their corresponding controls. The results obtained in the present study indicate that aqueous extract of *Artemisia vulgaris* is a potential source of natural antioxidants.^[76]

Chemical Composition

The chemical composition of the essential oils of *Artemisia vulgaris* L. growing in Northern Lithuania has been studied. The wild growing plants were collected in seven localities at the early flowering stage in 2004 and 2005; oils were prepared by hydrodistillation of mugwort overground parts and analyzed by GC/MS. Germacrene D has been found as the first principal component in three oils (10.6–15.1%), in two oils as the second (12.1 and 13.4%) and in one oil as the third (10.3%). trans-Thujone was determined as the first major constituent in one oil (20.2%) and cis-thujone as the second dominant compound in one oil (12.9%). Chrysanthenyl acetate prevailed in one oil (23.6%). 1,8-Cineole was the predominant constituent in two oils (16.7 and 17.6%). Among the other major compounds were sabinene, pinene, *artemisia* ketone, caryophyllene. Eighty one identified components formed up 81.9–96.8% of the total oil content.

Oxygenated monoterpene made up 17.1–48.7%, while sesquiterpenes 17.1– 44.1% of the oils.^[77] The major constituents of the oil from plants collected from different places were reported to be α-thujone, β-caryophyllene, caryophyllen oxide, δ-cadinene, 1,8-cineole and camphor. However, an oil of Indian *A. vulgris* had been found to contain 1,8-cineole, camphor, borneol, limonene and camphonene as main constituents.^[78] A few other investigations were carried out in which myrcene was found to be the major component varying from 9-70 % depending upon the maturity of the plant^[79]. The oil obtained from the flowers was reported to contain sabinene (15.9%) as the major constituent followed by myrcene (13.7%), allo-aromadendrene, β-cubene and δ-guaiene^[80]

CONCLUSION

As mentioned in this review constituents and biological activities of some Iranian *Artemisia* species^[3] including

A. absinthium L., *A. armeniaca* Lam., *A. incana* (L.) Druce, *A. khorasanica* Podl., *A. scoparia* Waldst. & Kit., *Artemisia sieberi* Besser and *A. vulgaris* L. *Artemisia* species produce at least three classes of compounds: Terpenoids especially Sesquiterpene lactones, Flavonoids and Polyacetylenes. Most attention has been focused on sesquiterpene lactones. As we mentioned in our previous reviews^[6,81] artemisinin or qinghaosu which was found to be responsible for the antimalarial activity of *Artemisia annua*. Also a new type of Sesquiterpene lactone (Tehranolide) with the endoperoxide group that probably has the same effect of artemisinin which has been isolated from *A. diffusa*^[82] In morphology, the *Artemisia* genus with head-like inflorescences and is considered to be one of the most evolutionary taxa in the Dicotyledonae. This advancement in taxonomy may increase the chemical diversity as the advance species may synthesize more complex (cyclized, rearranged and / or oxygenated) secondary metabolites.^[5]

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