BIOLOGICAL CHARACTERISTICS AND USEFUL PROPERTIES OF TARRAGON (*ARTEMISIA DRACUNCULUS* L.) (REVIEW)

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Translated from Khimiko-Farmatsevticheskii Zhurnal, Vol. 42, No. 2, pp. 31 – 35, February, 2008.

Original article submitted November 14, 2005.

This review systematizes published data on the chemical composition, biological activities, and uses of the above-ground part of tarragon (*Artemisia dracunculus* L., *Asteraceae* family). Analysis of the pharmacological properties of tarragon showed that the most interesting items from the medicinal point of view were its abilities to influence brain function and gastrointestinal tract function and the presence of a broad spectrum of antimicrobial activity. The complexity and variety of the chemical composition of tarragon generates the needs to identify the main groups of biologically active substances, to specify the main measures of quality and raw material standardization methods, and to perform further pharmacological studies with the aim of developing new tarragon-based medicinal agents.

Tarragon (*Artemisia dracunculus* L., *Asteraceae* family) has a variety of common names including dragon sage-wort, dragon wormwood, estragon, false tarragon [1] [Translator's note: the original gives five Russian common names; here I have given a selection of English-language common names which are inevitably not direct translations of the Russian common names]. Its therapeutic properties were noted by Abu Mansur, Avicenna, and Ibn Baitar, who demonstrated antipyretic and antifebrile effects, the ability to "clear the upper respiratory tract of phlegm and facilitate respiration" [2], "to douse the bitterness of medicines and aid good sleep" [3]. Tarragon was used in the Middle Ages in Armenia in malignant ulcers and as a juice (orally) during plague epidemics; in Europe it was used as a carminative, for stimulating the appetite, and for improving digestive processes, while an alcoholic tincture was used as a sedative and anticonvulsant in epilepsy and seizures and as a vitamin in scurvy and avitaminoses [4]. In folk medicine, fresh tarragon was used to make juices and infusions, while dried tarragon was used as a herb [5].

Biological Characteristics of the Plant

The origin of the species *Artemisia dracunculus* L. is geographically associated with the steppes of Eastern Siberia and Mongolia [6]. The species name *dracunculus* (from the Latin d*racunculus*, "little dragon") was assigned because of the shape of the leaves, which is reminiscent of a dragon′s tongue.

Tarragon is a perennial plant with a woody rhizome 0.5 – 1.5 cm thick, with a light covering of root hairs, sometimes having well-developed underground shoots; the whole plant is bald, smooth, and green, and young plants have only occasional branching. The stalks are straight, single or few in number, 150 cm high, ribbed, more or less branched, the lower branches not bearing flowers. The leaves are unitary, linear or almost linear lanceolate, of size 1.5 – 8.0 cm in length and 1 – 10 (14) mm in width; the lowest sometimes have trifoliate tips. Flower heads are numerous, spherical, sessile, 2 – 4 mm in width, gathered into clusters at the apexes of the stalk and branches, forming paniculate inflorescences; the bract leaves are smooth, the external ones being elongated almost to the lanceolate, the inner ones being round to oval, wide at the edge and covering the spadix. The marginal florets are pistillate and there are usually seven of them, with tubular corollas widened towards the base; the laminae of the stigma are narrow, linear, and slightly pointed, and extend from the tube divergently. The florets of the disk are staminate and are usually 11 – 14 in number, with conical, quinquedentate corollas, linear anthers, blunt-angled but slightly pointed terminal appendages, the basal ones being shorter and blunt; the stigma of the rudimentary pistil is unitary and is funnel-shaped at the apex. The seeds are small, 0.6 mm long, flattish, egg-shaped, finely grooved, and brown [6]. Seed weight is 0.3 – 0.5 g/1000 seeds [7].

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The plant flowers in July to August, massive flowering occurring in mid-July. Fruiting occurs in September-October. Seed germinating capacity lasts 2 – 3 years [2, 3].

Distribution

In the wild form, tarragon grows on alkaline meadows, near birch groves, on the meadow terraces of rivers, steep valley slopes and old fallow land, in wooded steppe and steppe zones, and on meadow slopes in hills and mountains. The range of wild-growing tarragon now includes Mongolia, northern China, Siberia, Central Asia, Asia Minor, the countries of the Near East, the Caucasus, the central band and European part of Russia, the Ukraine, the Crimea, the Balkans, The Baltic States, the Mediterranean countries, central Europe, northern Africa, and North America [6, 8, 9].

Tarragon is grown in the USA, Germany, France, Holland, Bulgaria, Hungary, Belarus, the Ukraine, in Russia (northern Caucasus, the central band, the Altai), Central Asia, Iran, and India. The essential oil of tarragon is produced by manufacturers in France, Holland, Hungary, and the USA (Linares). In Russia, the most widely cultivated varieties of tarragon are the Gribovskii variety from Russian stock and Frantsuzskii ("French") from western European stock [9 – 12].

An important point for successful cultivation of tarragon is that it grows well in any soils and it is not particular with respect to temperature and illumination. However, inadequate light decreases the quantity of essential oil formed, thus reducing the spicy fragrance [2, 3]. Tarragon tolerates spring and autumn frosts well. Spring regrowth in southern climes is seen at the end of February and the beginning of March. Three harvests can be obtained in good management conditions [1]. Tarragon propagates predominantly by seeds, but also by division of plants, cuttings, and root scions. Cultivation of tarragon for production of the essential oil is best performed using root cuttings, as seeds can give harvests with low contents [2, 3].

Chemical Composition of Tarragon

The most important classes of biologically active substances in the herbage and leaves are the essential oil, coumarins, flavonoids, and phenolcarbonic acids. Most research attention has been paid to the essential oil, its composition, dynamics, and variability [13 – 17], and a series of reports have addressed the coumarins [18], polyacetylene derivatives [19], and flavonoids [20]; occasional studies have reported on sesquiterpenoids, vitamins, tanning substances, and alkaloids.

The Essential Oil

Comparative studies of essential oil (EO) contents tarragon samples were reported in [15], where the ivnestigations dealt with samples of raw material, collected in the Altai Mountain Republic (AMR), Altai Region (AR), and the Novosibirsk and Tomsk areas, both native and introduced at the Central Siberian Botanical Garden (CSBG) and Siberian Botanical Garden (SBG).

Tarragon stands out from other members of the genus *Artemisia* in terms of the accumulation and composition of the essential oil, and is characterized by significant variations depending on the ecological niche occupied, this being associated primarily with the wide area in which it lives. Studies of the dynamics of EO accumulation during ontogenesis showed that there are two peaks of EO content during the process of plant growth and development - at the beginning of budding and at the start of flowering. Chemical varieties have been identified in terms of the qualitative composition of the EO.

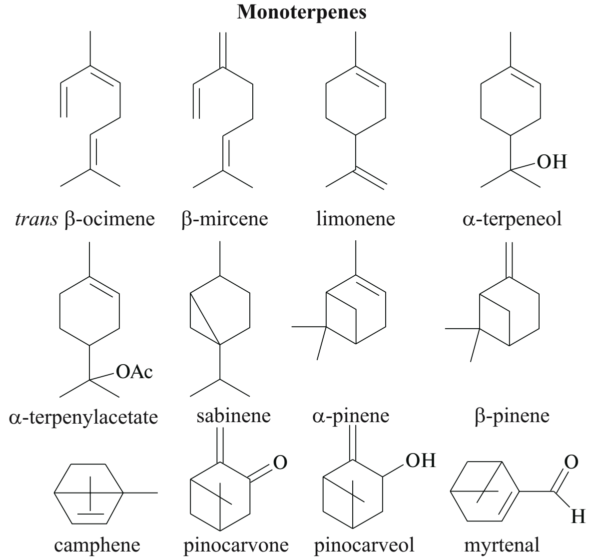
Samples of EO obtained by hydrodistillation were studied by gas-liquid chromatography and chromatographic mass spectrometry. Comparative analysis of EO from tarragon from different populations of the Siberian flora showed that its main components were non-terpenoid compounds: aromatic and acetylene compounds, isocoumarin derivatives, and fatty acids. The largest number of components in the EO is seen in the AMR population (176), of which the major substances (75) have been identified (SBG) [15]. These include all classes of compounds encountered in essential oils.

The major component of the EO is methylchavicol, otherwise known as estragol; the content of this compound varies from 40 to 60% depending on the variety and habitat [21 – 23]. Sabinene is present in significant quantities (up to 35%0, as is methyleugenol (more than 25%) [15].

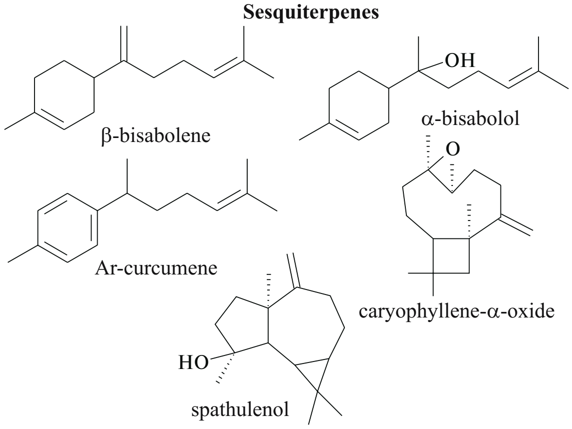
Analysis of the composition of EO from tarragon from the Siberian flora identified a number of characteristics and features. For example, there were differences in the contents of a number of compounds depending on habitat, soil salinity, and plant age. The extensive range of tarragon results in the appearance of a number of chemical varieties, of which there are at least two. One is characterized by the accumulation of compounds with several triple bonds - polyacetylenes and methylchavicols (the AMR population), while the other includes isocoumarins (the Tomsk, Novosibirsk, and Altai populations). Samples of EO from the AMR tarragon population (1500 – 3000 m above sea level) are characterized by the absence of isocoumarins and the presence of polyacetylenes: capillene, 1-phenyl-2,4-hexadiene, and 1-phenyl-2,4-hexadien-1-one. The formation of these substances is regarded as a characteristic of the mountain steppe populations. EO samples from plants of the AR population, growing in habitats with increased soil salt levels, and populations of the Novosibirsk and Tomsk areas, do not contain compounds with triple bonds. Introduced plants from these areas also do not contain polyacetylenes, but contain stereoisomers of 3-(1Z-butenyl)isocoumarin and 3-(1E-butenyl)isocoumarin. There is a consistent accumulation of trimethoxyallylbenzene: levels increase with increases in plant age and soil salinity.

Compounds detected in tarragon EO

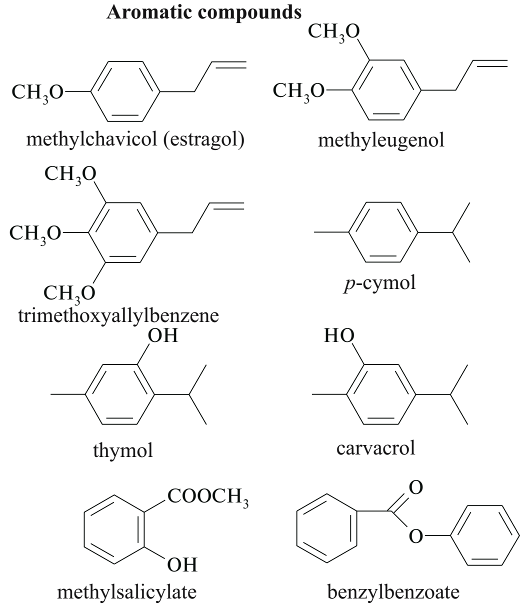
Monoterpenes



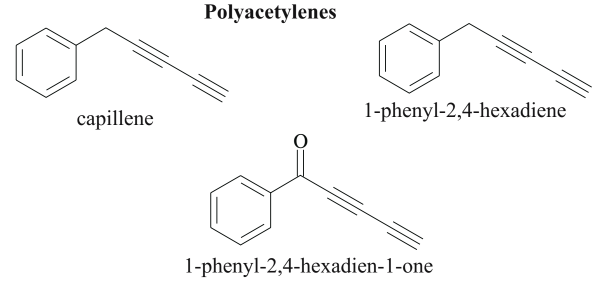
Sesquiterpenes



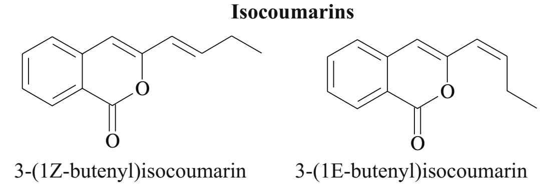
Aromatic compounds



Polyacetylenes



Isocoumarins



When derivatives of the acetylene and isocoumarin series are present simultaneously in tarragon EO, an inverse relationship between their contents was observed [15]: the higher the content of acetylenes, the lower the content of isocoumarins, and vice versa. Comparative analysis of EO obtained from the initial wild-growing populations and introduced plants showed that the introduction conditions did not affect the qualitative composition of the EO. This is evidence for genetic determination of the synthesis of an EO of a particular qualitative composition. The most similar qualitative EO compositions were seen in introduced plants aged four years.

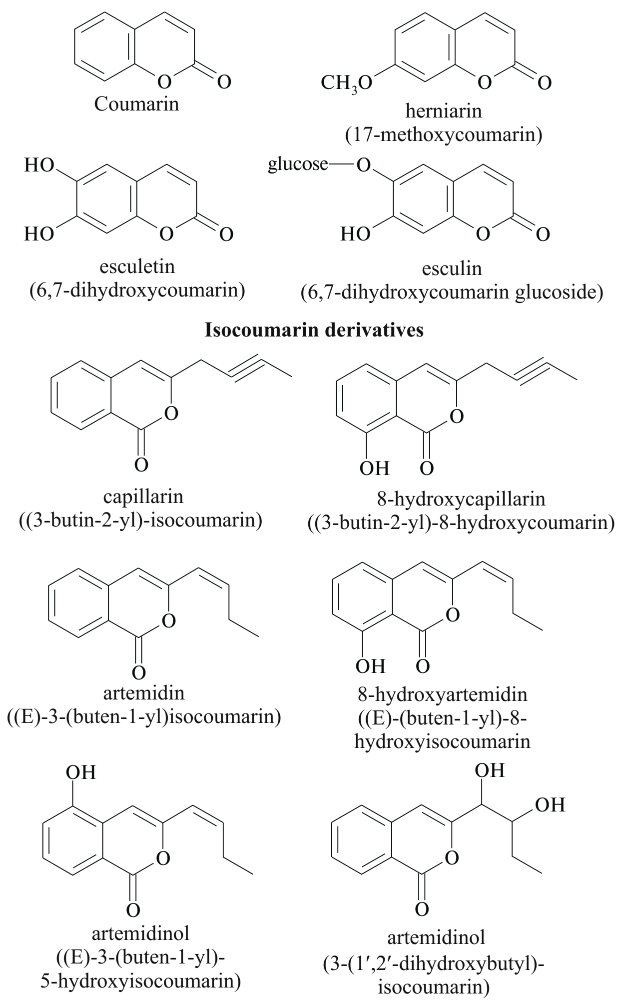
Coumarins

A. dracunculus L. is a member of the group of coumarin-containing *Artemisiae* containing more than 1.0% coumarins. Synthesis of coumarins starts at the earliest stages of development and levels can reach 1.3% by the age of three months. Peak coumarin contents in tarragon are seen at the age of five years (up to 6.6%), after which there is a gradual decline [15]. The biochemical characteristics affecting the accumulation of coumarins are genetically determined and persist when tarragon is grown in cultivation conditions.

Analysis of the dynamics of accumulation and component composition of coumarins in *A. dracunculus* L. Showed that qualitative changes in composition occur during the pregenerative period. Coumarin contents are maximal during the generative period, the composition remaining stable during this time; something changes affect only component ratios. Analysis of coumarin composition by plant organ showed that the most diverse qualitative composition is characteristic of the inflorescences, the least diverse being seen in the stalks. In terms of the qualitative composition, *A. dracunculus* L. is characterized by significant levels of isocoumarin derivatives.

Coumarins are present in the above-ground parts of tarragon.

Coumarin derivatives

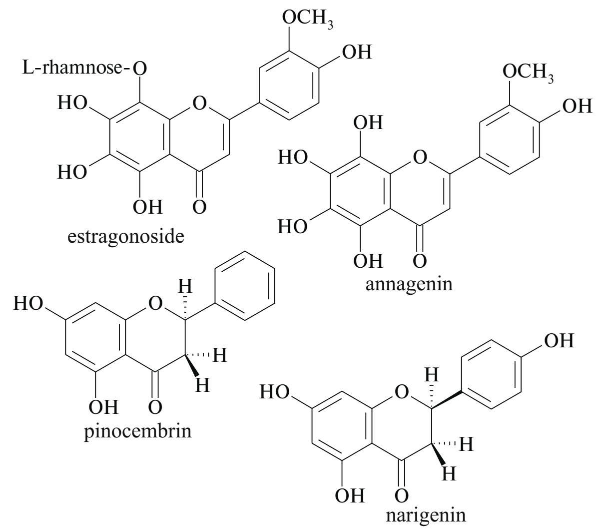


Flavonoids

Studies of tarragon cultivated in the Novosibirsk Region and the Altai and prepared at the massive flowering phase in July-August 1995 yielded the observation that the herbage contains up to 3.2% flavonoids, including quercetin, luteolin, camphorol, isorhamnetin, and their glycosides. Samples of wild-growing plants were also found to have flavonoid contents varying from 0.5% to 1.9%, while levels in cultivated plants could reach 4.9% [24].

A number of studies [20, 25, 26] presented more detailed analyses of the flavonoid compositions of the above-ground parts of tarragon, Gribovskii variety, cultivated in the Samara area. Three flavonoid compounds were extracted and identified. Of these, narigenin (5,7,4′-trihydroxyflavonone) had been observed previously. New compounds for tarragon were pinocembrin (5,7-dihydroxyflavonone) and the new natural compound which the authors named estragonoside C. UV, NMR, and mass spectrometry data showed that the estragonoside was 8-O-α-L-rhamnopyranoside 5,6,7,8,4′-pentahydroxy-3′-methoxyflavone. The aglycone of estragonoside, 5,6,7,8,4′-pentahydroxy-3′-methoxyflavone, was also discovered and was named annagenin by the authors.

It has been suggested that the presence of pinocembrin and estragonoside can be used as a characteristic chemical marker for the raw material and phytopreparations from tarragon [26].



Peroxidase and Nitrogenous Bases

The roots, stems, leaves, and inflorescences of tarragon contain the enzyme peroxidase [27]. The dynamics of peroxidase and oxidase activities during vegetation phases in different organs of the tarragon plant were studied, and maximal activity was seen in the flowering phase. Correlational relationships were found between peroxidase activity and the maximal accumulation of phenol compounds. Tarragon peroxidase was able to manifest peroxidase activity (pH optimum 5.2) and oxidase activity (pH optimum 7.0 – 8.5). The minimal conditions for the appearance of oxidase activity were the presence of two hydroxyl groups in the *ortho* position and the absence of a carboxyl group as a substituent in the benzene ring.

Tarragon peroxidase activity was studied in relation to quercetin. The enzyme acted on quercetin to produce seven substances. The oxidation products included hexahydroxyflavanone, fluoroglucinecarbonic acid, and protocatechic acid [27].

Some reports have addressed nitrogen-containing substances in tarragon. An extract of tissue cultures grown from *A. dracunculus* L. cells was found to have positive influences on human brain benzodiazepine receptors. HPLC separation of the extract produced benzodiazepine derivatives, which were identified: delorazepam and temazepam, levels of which in the cellular tissues of *A. dracunculus* L. reached 100 – 200 mg/g [28].

Nitrogenous bases were extracted from the above-ground parts of *A. dracunculus* L.: the previously studied compound pellitorin and two new compounds, neopellitorin A and neopellitorin B, which had insecticidal activity [29].

Uses of Tarragon

Domestic and industrial uses. Tarragon EO prepared by distillation with water vapor is used in perfumery. There are no restrictions to the use of this material as it is an EO of the non-toxic class and does not produce irritation or sensitization [30].

Industrial processing of tarragon is used in the production of the refreshing drink "Tarkhun" [31] and in meat and vegetable preserves, where it acts as an aromatizing agent, spice, and conservant [7]. Tarragon is included in "Stolovaya" mustard, as well as in a number of confectionery products and cheeses [31].

As a conservant and spice, tarragon is used in domestic cooking (vegetable preserves, marinades), in the preparation of fruit, refreshing, and alcoholic drinks, infusions, vinegars, and mustards. Fresh leaves are used as hors d-oeuvres and as garnishes for meat dishes and in vegetable salads [5].

In France, tarragon is used in the preparation of beef; in Hungary, Georgia, and Azerbaidzhan it is used in the preparation of mutton as well as cheese. In the Ukraine, fresh tarragon leaves are combined with cheers and sour milk; in Belarus it is pickled for winter [5].

Medicinal uses. Existing literature sources on the use of tarragon in folk medicine reflect some of the main trends in its biological and pharmacological actions - cosmetology, treatment and prophylaxis, bracing, and therapeutic [32]. Experience of folk medicine and experimental studies have identified the following properties of tarragon:

– vitamin properties in scurvy and night blindness, associated with its ascorbic acid content, flavonoids, and carotenoids;

– an alcoholic tincture has calming and anticonvulsant actions on the nervous system; tarragon is used in epilepsy, neuroses, and in Tibetan medicine in neurasthenia and impotence. The effects of tarragon on the nervous system are associated with the content of nitrogenous bases (alkaloids and benzodiazepine derivatives) present at therapeutically significant concentrations [28, 29];

– actions on gastrointestinal tract function - appetite-stimulating, spasmolytic, carminative, relaxatory [33]; a liquid extract normalizes gastric juice acidity, particularly in hypo- and anacidic gastritides, and stimulates gastric juice and bile secretion [31];

– the diuretic action of tarragon is used for the treatment of edema and in kidney stone disease [7];

– in Tadzhik folk medicine, aqueous extracts of tarragon are used in the treatment of chronic cholecystitis [2]; a liquid extract has a cholagogic action [33];

– an anti-inflammatory effect is seen with the foliage and extracts of tarragon, used to promote wound and ulcer healing [4], and is useful in the treatment of mouth diseases (stomatitides, gingivitides, etc.), in burns, and in joint diseases (arthritides, rheumatism, radiculitides). The anti-inflammatory effect is accompanied by an antipyretic action [33];

– some studies have yielded indications that tarragon has antitumor activity [4, 34]. Thus, an alcoholic extract decreased the harmful effects of tumors in tumor-bearing rats;

– the antibiotic activity of tarragon is very significant and extremely interesting, and is characterized by a wide spectrum of action, including antibacterial, antiprotozoal, repellent, algicidal, and other activities [33, 35]. In Tibetan medicine, tarragon is used in the treatment of pulmonary tuberculosis, pneumonia, and chronic bronchitis [7]; externally applied tarragon is effective in scabies; a water-alcohol extract of tarragon was found experimentally to stop the growth of yeasts [4].

It should also be noted that tarragon has some hormonal activity in menstrual cycle disturbances [4] and experimental diabetes [36]. Infusions of the herbage in rat experiments had protective actions, greater than those of *Eleutherococcus*, in dry hypothermia [4]. Tarragon roots are effective in toothache [33] and the herbage may be a correcting agent decreasing the bitterness of medicines [7].

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