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Chemical Characterization of the Essential Oil from Aerial Parts of Astragalus Maximus from Northwest of Iran

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Abstract

Purpose: The aim of the present study was to determine the chemical composition of essential oil of the aerial parts of Astragalus Maximus. Methods: The essential oil from the areal parts of Astragalus Maximus was isolated by hydrodistillation method and the composition of the volatiles was analyzed by gas chromatography (GC) method combined with flameionization detector (FID) and mass spectrometry (MS). Results and discussion: A total of 17 components accounting for 90.35% were identified using similarity searches between the mass spectra databases. The major components were identified as, Myristcin (29.4%), Benzaldehyde,3-methyl (15.3%), 1-Tridecanol (10.9%), Acetophenone (10.7%), 2-Pentadecanone, 6,10,14-trimethyl (7.9%) and Phytol (2.3%). All of the identified compounds are Non-terpenoids and Myristcin with 29.4% was found the most abundant component of the essential oil of the areal parts of Astragalus Maximus. Conclusion: In general, results of the present investigation revealed that essential oil of Astragalus Maximus contains higher quantities of Non-terpenoid compounds.

Keywords: Astragalus Maximus; Essential oils; Gas chromatography

Introduction

Plants and herbal medicines usually display pharmacological properties and have been used for thousands of years for the treatments of different diseases. However, herbal medicines are very complex and contain a large number of chemical components. Furthermore, chemical species are commonly changed due to the variations of the growth environments and pretreating processes. Therefore, qualitative and quantitative analysis of chemical components in plants is very challenging and important issue (1-3). Essential oils are highly concentrated natural oils extracted from plants, flowers, roots, wood, bark, or seeds; essential oils have been used for centuries in Iran and all over the world thanks to their definite pharmacological activities and low toxicity. They are widely used for different applications such as cosmetic including soaps, perfumes,

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aromatherapy, skin care products and medicinal purposes (4-6).

The genus of Astragalus (Papilionaceae) is a member of the Fabaceae or Leguminosae family which includes more than 2000 species. It is widely distributed over the temperate regions of the world, mainly Europe, Asia and North America. The genus Astragalus contains about 800 species of perennial and annual plants most of which are endemic to Iran (7-9).The pharmacological effects of Astragalus spp. are very different including immune-stimulant effects, anti-bacterial and antiviral properties, the ability to promote nucleic acid synthesis in the liver, hepatoprotective effects, anti-inflammatory activity, cardiovasculartonic effects such as hypotensive and vasodilatory action, as well as tonic, diuretic and anticancer properties. Additionally, gum tragacanth, which is a versatile food additive and used as pharmaceutical emulsifier, is a valuable and important derived product from Astragalus spp (9-16).

Chromatography is an important and a widely used separation technique of a complex mixture. Essential oils are mainly analyzed by gas chromatography (GC) combined with usually either flameionization detector (FID) or mass spectrometry (MS)(17,18).

A literature review showed that there are a few reports about the phytochemical work performed on Astragalus Maximus and to the best of our knowledge, there is no previous report dealing with any investigation of the volatiles of this species in the literature. The main purpose of this investigation was to perform compositional analysis of the volatiles isolated by hydrodistillation technique using gas chromatography (GC) method combined with flameionization detector and mass spectrometry.

Material and methods

Plant material

The aerial parts of Astragalus Maximus were collected during flowering stage in June 2011 from Arasbaran (East Azarbayjan province, northwest of Iran) and subsequently authenticated by authors. Voucher specimens have been deposited at the herbarium of the Department of Pharmacognosy, Faculty of Pharmacy, Tabriz University of Medical Sciences, Tabriz, Iran.

Essential oil isolation

Essential oil was obtained from air-dried plant material by hydrodistillation using a Clevenger-type apparatus. Distillation was continued for 2 hours and xylene was used as the absorbing medium. Distillation yield was very low. The oily layer obtained was manually separated using a pasture pipette and then dried over anhydrous magnesium sulphate to remove traces of water and stored in sealed glass bottles, covered with an aluminum foil, at 4 °C until analysis (19).

Gas chromatography-Mass spectrometry (GC-MS) analysis

The essential oils analysis was performed using a Shimadzu, QP 5050A gas chromatograph equipped with a FID detector and employing a DB-1 (methyl phenyl sylonane) capillary column (60 m × 0.25 mm i.d., 0.25 µm film thickness).

For GC-MS detection, an electron ionization system, with ionization energy of 70 eV was employed. Helium was the carrier gas, at a flow rate of 1.3 ml/min with linear velocity: 29.6 cm/s and split injection with split ratio of 1:29. The GC conditions were set as the follows: column temperature, 2 min in 60 °C, 50-260 °C at 3 °C/min; injector temperature, 240 °C, and 1 µL of volume injection of the essential oil. Finally, the MS operating parameters were as follows:

ionization potential, 70 eV; ion source temperature; 270 °C; quadrupole 100 °C, solvent delay 2 min, scan speed 2000 amu/s, scan range 30-600 amu and EV voltage 3000 volts.

No.	RT*	Compounds	Area (%)
1	16.216	Benzaldehyde	0.72
2	20.411	Benzeneacetaldehyde	1.1
3	21.815	Acetophenone	10.7
4	22.031	Benzaldehyde, 3-methyl-	15.73
5	22.708	M-Tolualdehyde	2.79
6	24.357	Benzaldehyde, 2-methyl-	2.01
7	24.619	Linalool	1.6
8	29.37	3-Cyclohexene-1-methanol	0.32
9	40.245	Dodecanal	0.33
10	42.134	5,9-Undecadien-2-one, 6,10-dimethyl	0.74
11	43.457	Tridecanol	10.95
12	43.78	3-Buten-2-one, 4-(2,6,6-trimethyl-1-cyclohexen-1-yl)-, (E)-	1.03
13	44.899	Myristcin	29.41
14	53.652	Hexadecanal	2.19
15	58.909	2-Pentadecanone, 6,10,14-trimethyl	7.85
16	62.908	Hexadecanoic acid	0.56
17	68.462	Phytol	2.32
Total			90.35

Table 1: Essential oil composition of aerial parts of Astragalus Maximus

*RI is the Retention Index relative to C8–C24 n-alkanes on the DB-1 column

Identification of the compounds

The components were identified based on the comparison of their relative retention times and mass spectra with those of standards, National Institute of Standards and Technology (Nist) 21 and 107 as well as Wiley 229 library data of the GC–MS system and literature data (20). Quantitative data were obtained electronically from FID area percent data.

Results and discussion

The total chromatogram of the essential oil extracted from the aerial parts of Astragalus Maximus is displayed in Figure 1.

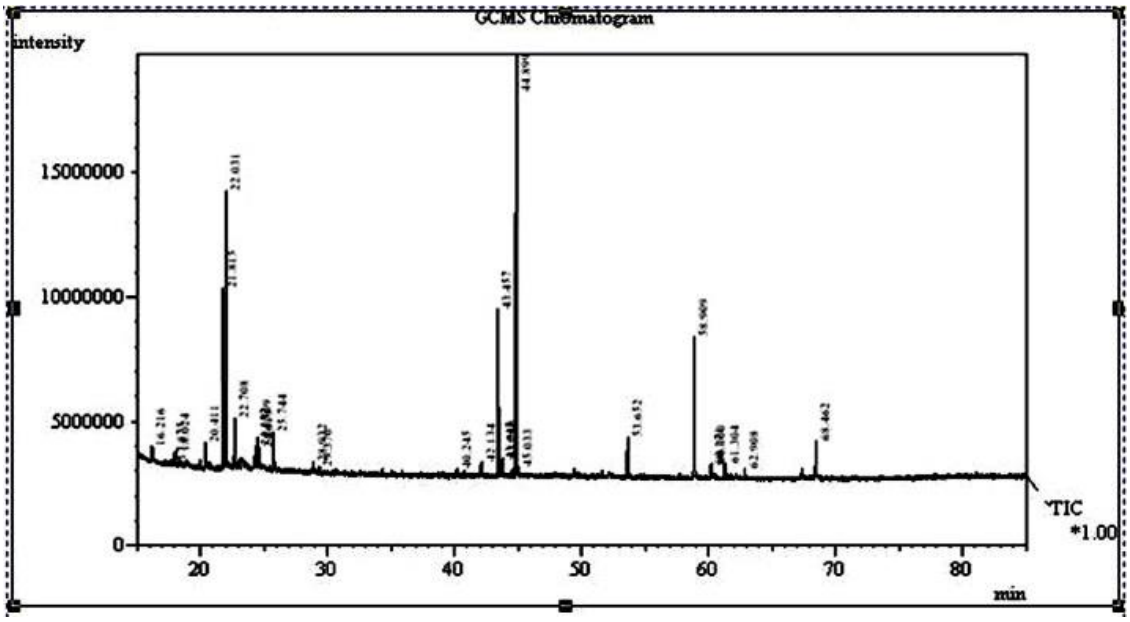

Figure 1: Chromatogram of essential oil composition of Astragalus Maximus

The essential oil of the aerial parts of the Astragalus Maximus, obtained by hydrodistillation method, was analyzed by GC–MS technique and 17 different components were recognized. All of the identified components were arranged in order of their retention time in the DB1 column and their fraction were shown in Table 1.

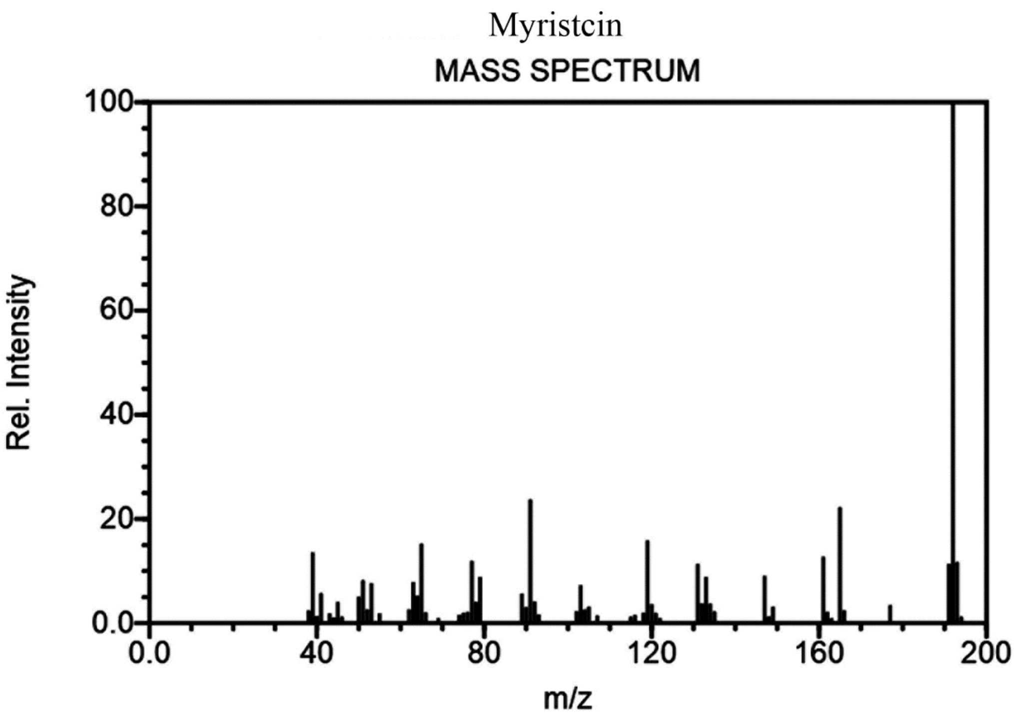

Figure 2: Mass spectrum of Myristcin

It was found that the essential oil of Astragalus Maximus was a complex mixture of mainly non-terpenoids (90.35%). Myristcin with 29.4%, Benzaldehyde, 3-methyl (15.3%), 1-Dodecanol (10.9%), Acetophenone (10.7%), 2-Pentadecanone, 6,10,14-trimethyl (7.9%) and Phytol (2.3%) were the more materials identified as non-terpenoids compounds of the essential oil.

The mass spectrum of the more abundant components of the essential oil of the Astragalus Maximus including Myristcin, Benzaldehyde, 3-methyl, 1-Dodecanol, Acetophenone, 2-Pentadecanone, 6,10,14-trimethyl and Phytol were displayed in figures 2, 3, 4, 5 and 6, respectively.

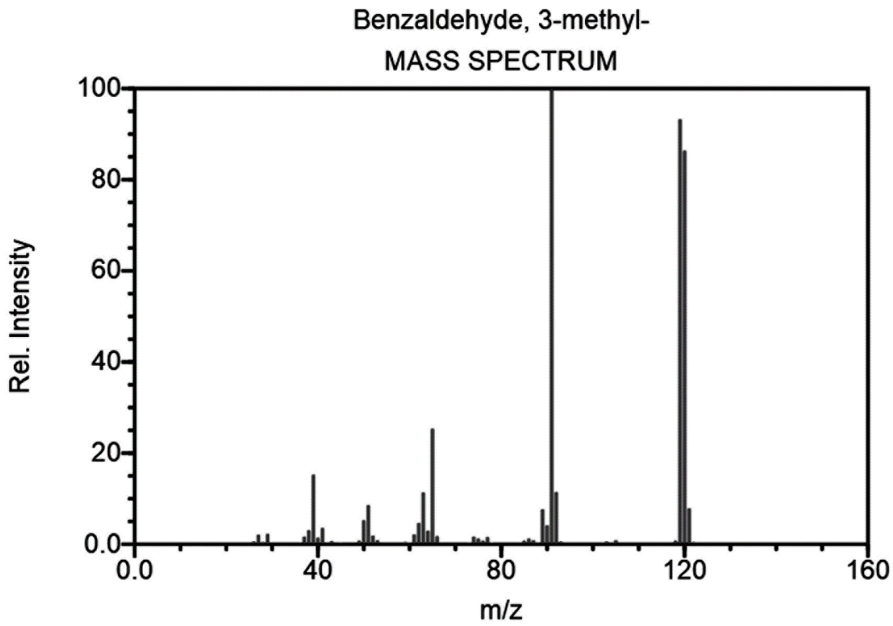

Figure 3: Mass spectrum of Benzaldehyde, 3-methyl

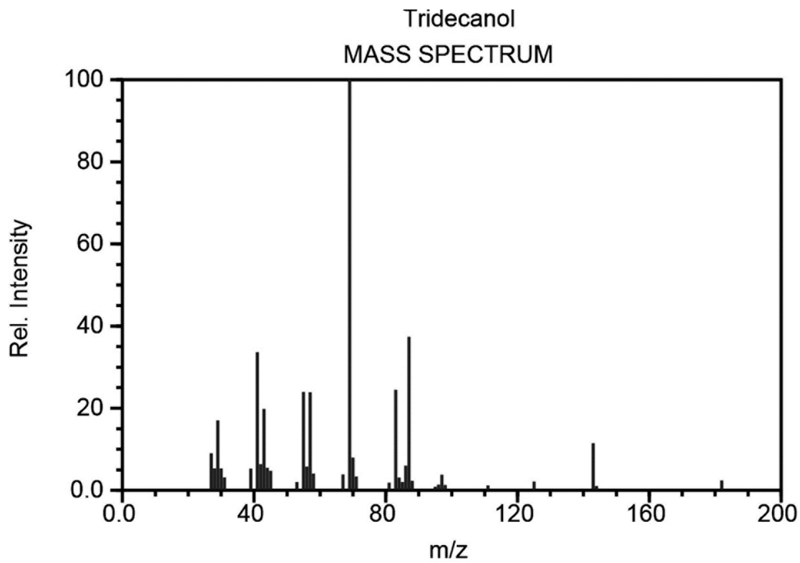

Figure 4: Mass spectrum of Tridecanol

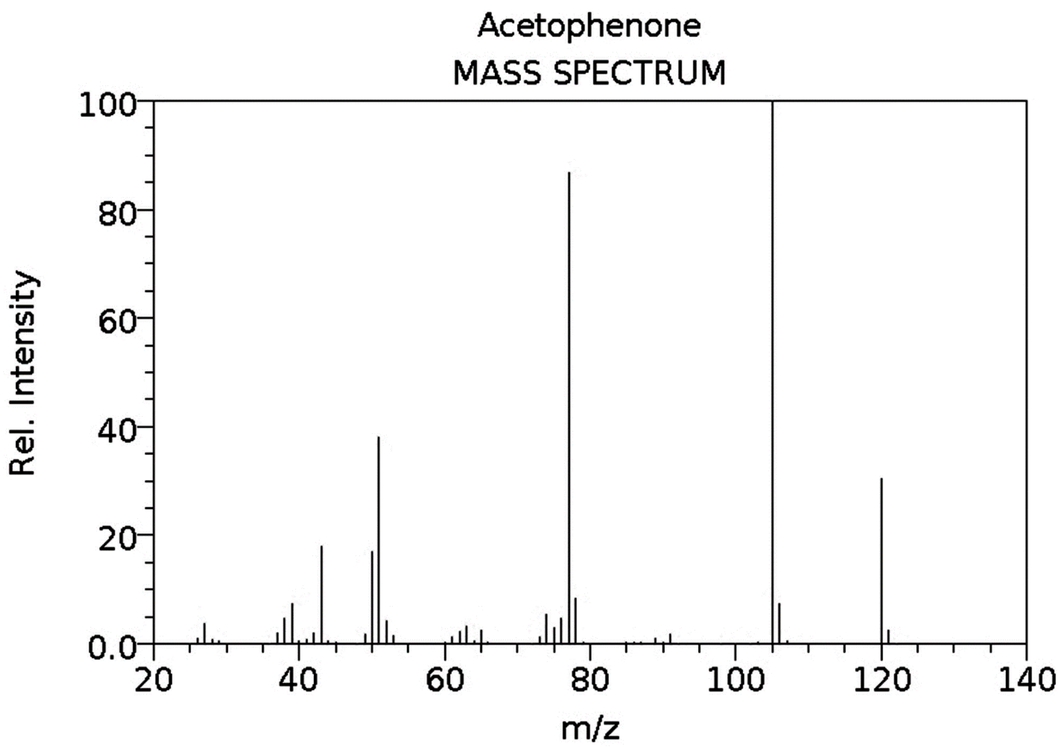

Figure 5: Mass spectrum of Acetophenone

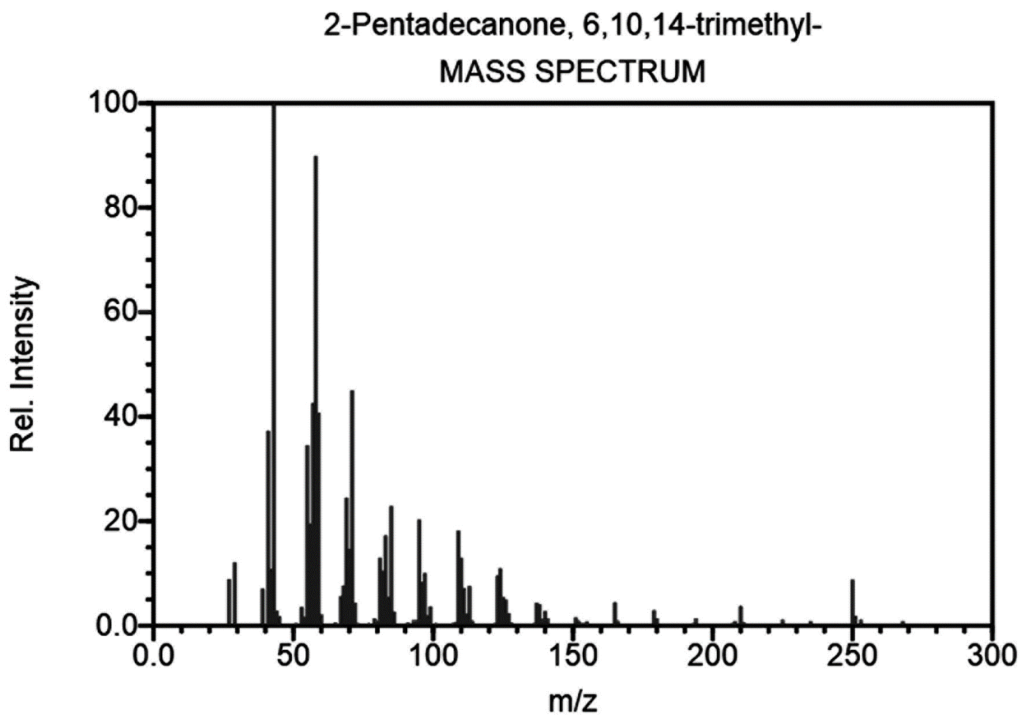

Figure 6: Mass spectrum of 2-Pentadecanone, 6,10,14-trimethyl

Identification of chemical compositions in water-distilled oils obtained from flowers and leaves of Astragalus schahrudensis, collected from Sabzevar, province Khorasan (Iran), by Akhlaghi et al. showed seventeen compounds from flower oil of the plant including germacrene D (47.6 %) and germacrene B (17.8 %) as well as fourteen components including α-pinene (33.8 %), bornyl acetate (14.2 %), limonene (12.2 %) and α-fenchyl acetate (10.0 %) from leaf oil. The flower oil of Astragalus schahrudensis consisted mainly of sesquiterpenes, while in leaf oil monoterpenes predominated over sesquiterpenes. Also, in Rezaee et al.'s report from the genus Astragalus the hydrodistilled oil from the aerial parts of Astragalus microcephalus Willd were found. The major constituents were hexadecanoic acid (31.9 %), heneicosane (9.1 %), α-cadinene (7.7 %), tridecanol (6.2 %) and benzyl benzoate (6.2 %)(21,22).

Conclusion

Recently, the usage of the essential oils and various extracts of plants have attracted interest as sources of natural products in aromatherapy and herbal medications. Further studies are necessary to investigate the properties of the essential oil of including antibacterial and antioxidant effects to their potential use as alternative remedies for the treatment of infectious and oxidative diseases as well as the preservation of foods from the toxic effects of bacteria and oxidants. The characterization of Astragalus Maximus has been carried out to identify its components' properties and GC method coupled with MS has been employed to characterize their chemical compositions. This approach is practical and efficient to identify essential oils obtained from different species or varieties for determining components of the essential oil. Overall, essential oil of aerial parts of Astragalus Maximus contains different Non-terpenoid compounds. In summary, the presence of relatively higher amounts of Myristcin, Benzaldehyde, 3-methyl, Tridecanol, Acetophenone, 2-Pentadecanone, 6,10,14-trimethyl and Phytol (2.3%) in the essential oil of the aerial parts Astragalus Maximus was reported for the first time in the present investigation.

Conflict of interest statement

We declare that we have no conflict of interest.

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