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GC-MS Analysis of Components of Datong Artemisia Argyi Oil Extracted by Ultrasound-assisted Solvent

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Abstract

Wild Artemisia argyi is abundant in Datong, Shanxi Province, China. After pretreatment, Artemisia argyi oil was extracted using n-hexane as the solvent under the assistance of ultrasound, and its components were identified by gas chromatography-mass spectrometry (GC-MS). The results showed that the yield of Artemisia argyi oil in Datong was 2.66%, and 23 compounds were identified by GC-MS. The main components included 9,12,15-Octadecatrienoic acid, (Z,Z,Z)- (14.32%), n-Hexadecanoic acid (11.94%), 9,12-Octadecadienoic acid (Z,Z)- (10.15%), 1,5-heptadien-4-ol, 3,3,6-trimethyl- (7.89%), Heptacosane (6.12%), Eucalyptol (5.13%), gamma-sitosterol (4.97%), Pentacosane (4.36%), and Bicyclo [3.1.0] hexan-2-ol, 2-methyl-5-(1-methylethyl)-, (1.alpha.,2.alpha.,5.alpha.)- (3.15%). In this study, the method of extracting Artemisia argyi oil was found to be simple and yielded high amounts of oil. The chemical composition of Datong Artemisia argyi oil was analyzed, providing a viable approach for the development and utilization of Artemisia argyi.

Keywords

Artemisia argyi; Essential oils; Ultrasonic-assisted; N-Hexane; GC-MS.

1. INTRODUCTION

Artemisia argyi, a perennial herb with semi-bush-like characteristics, is known for its strong aroma and is incredibly pervasive throughout China, except in the most arid and frigid regions where it is seldom found. This plant is also an important medicinal species, renowned for its volatile oil[1]. Artemisia argyi is commonly known as mugwort has a long history of its use in significant natural herbal medicine in different parts of the world， which can be traced back to 2000 years ago, with a high appraisal in many famous ancient books.Artemisia argyi has a long history of use in traditional Chinese medicine, particularly for its medicinal properties. According to the “Compendium of Materia Medica”, written by Li Shizhen during the Ming Dynasty in the 16th century, Artemisia argyi was used for various medical purposes, including dispelling cold, stopping bleeding, and reducing inflammation. References to Artemisia argyi can be found in many ancient Chinese medical texts and poetry, indicating its widespread application in ancient Chinese society. Artemisia argyi has a strong aromatic odour, which is why the essential oil is considered to be one of the main active ingredients of Artemisia argyi. Kumar S investigated the essential oils from the foliage (leaves and inflorescences) of 176 populations across 66 species of the Artemisia genus, revealing significant chemical diversity in the volatile oil composition both between and within species[2]. The major volatile compounds (present at levels exceeding 20%) were identified and ranked according to their frequency of occurrence, including camphor, 1,8-cineole, borneol, α- and β-thujone, Artemisia ketone, β-pinene, and other monoterpene compounds, as well as davanone and caryophyllene, which are

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sesquiterpenes. Additionally, certain volatile organic compounds (VOCs) were found in concentrations over 50% in the essential oils of specific Artemisia argyi populations, which can serve as chemical markers for these species.

In the contemporary world, ultrasound technology has become extensively utilized across various sectors, including medicine, industry, and defense[3,4,5]. Ultrasonic extraction techniques, commonly referred to as acoustic crushing, utilize the intense vibrations generated by ultrasonic waves. In this study, the technique was characterized by high acceleration, strong cavitation and vigorous agitation, which effectively destroyed the plant cell wall. Therefore, it speeds up the process of release of liposoluble compound compounds into organic solvents, resulting in improved extraction efficiency. By reviewing the existing literature, we found that there is a paucity of research data on the oil of DaTong Artemisia argyi. In this study, the chemical composition of Datong Artemisia argyi oil, extracted using an ultrasound-assisted solvent method, was analyzed, adding new significance to future applications in the field of research on the aromatic properties of this medicinal plant.

2. MATERIALS AND METHODS

2.1. Raw material and reagents

The Artemisia argyi was collected in May 2023 in the suburbs of Datong City and the species was identified by Prof.Zhang Jin of Shanxi Datong University. The Artemisia argyi were shade-dried for 14 days and pulverized for preparation.

2.2. Preparation of the ultrasonic extraction

50 g of Artemisia argyi powder and 300 ml of n-hexane were filled in a stoppered conical flask and sealed. Ultrasonic extraction was performed at 50°C with a power of 600 watts for 90 min. The stoppered conical flask was then placed on a shaker for 1 hour at 40°C and 120 rpm. The above experiments were repeated once. An appropriate amount of Na_2SO_4 was added to absorb water and filtered to remove residue to obtain filtrate. The n-hexane in the filtrate was recovered using a rotary evaporator to obtain yellow-green Artemisia oil.

2.3. Gas chromatography–mass spectrometry (GC–MS) analysis

The compound identification was performed on Agilent Technologies 7890B-7000C. The analysis was carried out on a HP-5MS capillary column (30 m × 0.25 mm × 0.25 μm) with helium as the gas carrier (1.0 mL/min). The oven temperature was kept at 50°C and hold for 2 min, then gradually increased to 300°C at 10°C/min and finally held for 5 min, respectively. The mass spectra were recorded at 70 eV (EI) and were scanned in the range 50–450 m/z. Injector and ion source temperatures were kept at 250 and 230°C. The constituents were identified by comparing the mass spectra of detected compound with the in-build NIST14.L Mass Spectral library.

3. RESULTS AND DISCUSSION

3.1. Artemisia argyi oil yield

The oil derived from Artemisia argyi through ultrasound-assisted solvent extraction displayed a yellow-green color and a pronounced odour. The experiment was repeated 3 times, yielding an average extraction efficiency of 2.66% for the Artemisia argyi oil.

3.2. Composition of Artemisia argyi Oil

The composition of Artemisia argyi oil is shown in Table 1. The GC-MS analysis resulted in the identification of 23 constituents, and the relative contents were calculated by the area

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normalization method. The results of the analyses showed that the solvent-extracted Artemisia argyi oil contained fatty acids, long-chain alkanes, monoterpenes and sesquiterpenes, ester organic compounds, phytosterols, and so on. The main components were 9,12,15-Octadecatrienoic acid, (Z,Z,Z)- (14.32%), n-Hexadecanoic acid (11.94%), 9,12-Octadecadienoic acid (Z,Z)- (10.15%), 1,5-Heptadien-4-ol, 3,3,6-trimethyl- (7.89%), Heptacosane (6.12%), Eucalyptol (5.13%), gama.-Sitosterol (4.97%), Pentacosane (4.36%), Bicyclononane, 2-methyl-5-(1-methylethyl)-, (1.alpha. ,2.alpha.,5.alpha.)- (3.15%). Other volatile oils include endo-Borneol (3.07%), Caryophyllene oxide (2.55%), and alpha.-Amyrin (2.48%).

Table 1. Chemical composition of Artemisia argyi oil

Peak no	RT (min)	Compound	Molecular formula	Peak area (%)
1	6.725	Eucalyptol	$C_{10}H_{18}O$	5.13%
2	7.356	Bicyclo[3.1.0]hexan-2-ol, 2-methyl-5-(1-methylethyl)-, (1.alpha.,2.alpha.,5.alpha.)-	$C_{10}H_{18}O$	3.15%
3	7.467	1,5-Heptadien-4-ol, 3,3,6-trimethyl-	$C_{10}H_{18}O$	7.89%
4	9.045	endo-Borneol	$C_{10}H_{18}O$	3.07%
5	14.585	Caryophyllene oxide	$C_{15}H_{24}O$	2.55%
6	17.21	Phytol, acetate	$C_{22}H_{42}O_2$	1.74%
7	18.515	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	11.94%
8	19.762	Z-8-Methyl-9-tetradecenoic acid	$C_{15}H_{28}O_2$	1.45%
9	19.972	Phytol	$C_{20}H_{40}O$	1.31%
10	20.014	Oxiraneundecanoic acid, 3-pentyl-, methyl ester, cis-	$C_{19}H_{36}O_3$	1.26%
11	20.141	9,12-Octadecadienoic acid (Z,Z)-	$C_{18}H_{32}O_2$	10.15%
12	20.199	9,12,15-Octadecatrienoic acid, (Z,Z,Z)-	$C_{18}H_{32}O_2$	14.32%
13	20.388	7-Methyl-Z-tetradecen-1-ol acetate	$C_{17}H_{32}O_2$	2.96%
14	21.119	2(1H)-Naphthalenone, octahydro-4a-phenyl-, trans-	$C_{16}H_{20}O$	2.16%
15	21.514	2-Isopropenyl-2,3-dihydrofuro[3,2-g]chromen-7-one	$C_{14}H_{12}O_3$	5.64%
16	24.787	cis-Vaccenic acid	$C_{18}H_{34}O_2$	1.78%
17	24.855	Oxiraneoctanoic acid, 3-octyl-, cis-	$C_{18}H_{34}O_3$	2.05%
18	25.334	Oleic Acid	$C_{18}H_{34}O_2$	1.51%
19	26.092	Pentacosane	$C_{25}H_{52}$	4.36%
20	27.65	Heptacosane	$C_{27}H_{56}$	6.12%
21	29.597	Stigmasterol	$C_{29}H_{48}O$	2.01%
22	30.376	gamma.-Sitosterol	$C_{29}H_{50}O$	4.97%
23	30.939	alpha.-Amyrin	$C_{30}H_{50}O$	2.48%

4. DISCUSSION

The yield of wild Artemisia argyi oil in Datong was 2.66%. A total of 23 compounds were identified by GC-MS. The highest content in artemisia oil was 9,12, 15-octadecatrienoic acid, (Z,Z,Z)-(14.32%), n-Hexadecanoic acid (11.94%), and N-hexadecanoic acid (11.94%). 9, 12-octadecadienoic acid (Z,Z)-(10.15%), all belong to the common plant fatty acids. Solvent extraction is a traditional method for extracting oil from plant using organic solvents such as hexane and ethanol. This method has the advantage of being able to extract non-volatile components that may not be efficiently extracted in hydrodistillation. Solvent extraction is suitable for those essential oils that contain a higher proportion of non-volatile components, such as certain fatty acids and other fat-soluble components[6]. This shows that with the

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assistance of ultrasound, the cell membrane of artemisia sinensis was destroyed, and the non-volatile oil was dissolved into n-hexane in large amounts, so the yield of artemisia sinensis oil extracted by solvent method was greatly improved. Compared with hydrodistillation, solvent extraction can extract artemisinin, which is an intermediate product in the artemisinin biosynthesis pathway. In summary, the ultrasound-assisted solvent extraction method is simple and has a high yield, and the chemical components of essential oils can be qualitatively and quantitatively analyzed by GC-MS. This study is very helpful for exploiting Datong wild Artemisia argyi.

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