

Comparison of the Bioactive Volatile Components of Plants Known as Marshmallow Flower from the Malvaceae Family

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Abstract

Malvaceae family commonly seen in tropical and milder regions is perennial plants growing around the regions from Mediterranean to Southwest Asia. In the western Mediterranean basin (Malva, Lavatera Althaea) and the Middle East (Alcea), the genus are the main centers. In this study, volatile components of *Althaea hirsuta* L., *Alcea apterocarpa*, and *Lavatera punctata* All. plants were analyzed by GS-MS analysis. *Althaea hirsuta* L. contains 9 volatile components with 6 of them having bioactive properties. *Alcea apterocarpa* plant contains 26 volatile components with 20 of them having bioactive properties. *Lavatera punctata* All plant contains eleven volatile components with four of them having bioactive properties. All of these three types of marshmallow have only one volatile component which is 1-methyl-2-pyrrolidinone. This study revealed the chemical components of these plants having pharmacological, bioactive and drug properties.

Keywords: Bioactive, *Alcea apterocarpa*, *Althaea hirsuta* L., *Lavatera punctata*, Marshmallow

Introduction

The Malvaceae family consists of about 85 taxons and 1000-1500 species. It is commonly found in tropical and milder climates. The Malvaceae family is a perennial plant and grown in the regions from Mediterranean to Southwest Asia. In the western, Mediterranean basin (Malva, Lavatera Althaea) and Middle East (Alcea) are the main centers of the genus (Bates, 1968; García et al., 2009; Ammar et al., 2013). There are 9 taxons and 43 species in Turkey (Ozer et al., 1998).

Althaea and *Alcea* taxons are seen in the regions where the Mediterranean and Iran-Turan phytogeographies intersections. These taxons are distributed throughout Europe (except the northern side), North America, North Africa, the Caucasus and southern Russia, and from Anatolia to Afghanistan. *Alcea* and *Althaea* flowers contain plenty amount of mucilage. Therefore, they can be used in medicinal applications. (Uzunhisarcikli and Vural, 2009; Ozkan and Uzunhisarcikli, 2008; Uzunhisarcikli and Vural, 2012;). There are four *Althaea* species in Turkey, which are *A. Cannabina* L., *A. Armeniaca* Ten., *A. Officinalis* L. and *A. Hirsuta* L. The species of this genus are known as hollyhock in Turkey. *Althaea* species are single or perennial herbaceous plants. These species can be grown up to one to two meters. The leaves of these plants have three to seven lobes. Their calyxes are red, violet or white colors. It grows naturally on river and territory sides, especially in moist and sandy soils. All parts of the plant, especially in the roots, contain mucilage. It is commonly used as a tea in the traditional treatments of coughs, peptic ulcers, mouth mucosa, throat and stomach inflammation (Cullen and Davis, 1972; Heinrich et al. 2004; Özkan and Uzunhisarcikli, 2008; Uzunhisarcikli and Vural, 2012). Due to their high mucilage content, plants have been widely used to cure internal and external inflammations, sore throat, minor wounds and chapped skin (Grieve, 1984; Özkan and Uzunhisarcikli, 2008). Flowers and leaves of *Althaea* species in Anatolia are used against colds and coughs. Tea prepared in Niğde from the flowers of *A. Hirsuta* and quince leaves cures sore throat and bronchitis. In addition, the flowers of this plant are also used to heal for wounds and sprains

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(Baytop, 1999; Şimşek ve ark., 2004; Sezik ve ark., 2001; Sezik ve ark., 1997; Özkan ve Uzunhisarcıklı, 2008). *Althaea hirsuta* L. is an annual herbaceous plant with a size of 4-70 cm. The roots of this plant are spherical shaped with 1-5 mm in diameter. The plant is completely woolly. Their leaves contain 3-5 lobes. This plant is grown in the regions of Turkey, Europe, northern Africa and south-west Asia (Uzunhisarcıklı and Vural, 2012).

Alcea L. genus is a member of *Malvaceae* family consisting about 70 species that distributed around Mediterranean and Iran-Turan phytogeographies. There are 20 species in Turkey (Davis, 1967; Uzunhisarcıklı and Vural, 2012). There are 18 *Alcea* taxons in the Turkey flora (Ozturk et al., 2009; Green and Akalin, 2009). These species are commonly used for wound healing, bowel and stomach diseases, conjunctivitis, cough, fungal infection and wart treatment (Tuzlaci and Aymaz, 2001; Yeşil and Akalin, 2009; Ertaş et al., 2016).

Alcea is an annual, biennial or perennial plant. Leaves of *Alcea* species have 3-9 lobes. Their flowers are in the form of bunches (Öztürk et al., 2009; Uzunhisarcıklı and Vural, 2012). Sub-species of *Alcea* can be used in many medical applications such as antioxidant, antimicrobial, antiviral and hepatoprotective. *Alcea* has some alkaloids which have no toxic side effects on humans. *Alcea* sub-species (*acaulis*, *apterocarpa*, *pallida*, *hyrcana*, *kurdica*, *setosa*, *rosea*) contains polyphenols showing antioxidant activities. However, the antioxidant capacities of different parts of the plants are different from each other, but they generally have strong antioxidant capacities (Swamy et al., 2011; Azab, 2017).

Alcea apterocarpa is a perennial plant with a size of 30-200 cm. The roots of the plant are cylindrical shaped with 2.5-15 mm in diameter. Their leaves contain 3-5 lobes. Their petals are white, yellow or pink colors. Fruits are spherical shaped as mericarp (Öztürk et al., 2009; Uzunhisarcıklı and Vural, 2012). Plants are grown in the regions of Turkey, Iraq and Egypt (Uzunhisarcıklı and Vural, 2012). The roots and herbs of *Alcea apterocarpa* is used for healing wounds, anti-inflammatory, skin diseases, urinary system diseases, kidney stones, lung diseases, intestinal diseases, stomach diseases and cough. This plant is used in the treatment of diseases by decoction or infusion method (Ezer and Arısan, 2006; Altundağ and Ozturk, 2011; Azab, 2017). *Alcea apterocarpa* (Fenzl) Boiss. is also used to relief stomach pain, cough and bronchitis, menstrual regulator and abdominal pain (Ezer and Arısan, 2006).

Lavatera genus is seen around Mediterranean region (Uzunhisarcıklı and Vural, 2009). *Lavatera* L. is a single or perennial herbaceous plant (Özer et al., 1998). *Lavatera* L. (*Malvaceae*) plant has 21-23 genus in the forms of bushes and strata (Ray, 1995). *Lavatera punctata* All. is a member of *Malvaceae* family. It is known as hibiscus among the people. Leaves of *Lavatera punctata* All. are used to relieve stomach pain (Karcı, 2013).

Materials and Method

Sample preparation and chemicals

Althaea hirsuta L., *Alcea apterocarpa* and *Lavatera punctata* All. plants naturally grown on Amanus Mountain (Hatay/Belen) were collected/harvested and dried at room temperature. Methanol (Isolab, catalog# 947.043.2500) and ethyl acetate (Tekkim, catalog# TK.050140.02500) were purchased and used as received.

Extraction procedure

Extractions of the plants were performed according to the ultrasonic-assisted solvent extraction method (input power 180 W, 35 kHz frequency at 25 °C) as described in the literature (Jalali-Heravi ve ark. 2009; Göktürk ve Asil, 2018). Extractions of the plant samples were carried out as follows: 1 g of a plant was grounded into fine particles. Obtained powder was then put in a flask. The flask was charged with a mixture of (42–18 mL) methanol: ethylacetate (70:30) as the extraction solvent and sonicated. Sonication was performed for 15 min. After sonication, organic extract was filtered to remove solid residue. Obtained organic extract was stored at 4 °C in the fridge and the absence of light before GC–MS analysis. 1 µL of the extract was used for GC–MS analysis.

Gas chromatography–mass spectrometry (GC–MS) analysis

GC–MS analyses were performed using a Hewlett-Packard 6890 gas chromatograph equipped with a HP-5MS fused silica column (5% phenyl methyl polysiloxane 30 m 0.25 mm i.d., film thickness 0.25 µm), interfaced with a Hewlett-Packard mass selective detector 6890. GC-MS analysis was performed according to the procedure described in the literature (Göktürk ve Asil, 2018). The oven was first heated at 60 °C for 2 min. The oven temperature was increased to 180 °C by 4 °C/min. The temperature was then increased to 210 °C by 2 °C/min and increased to 230 °C by 5 °C/min and waited for 1 min. Finally, the oven temperature was increased to 280 °C by 1 °C/min. Helium (99.9999%) was used as the carrier gas and at a flow rate of 1 mL / min. The injector temperature was kept at 200 °C. The separation rate was 1:5.

Results and Discussion

The extracts obtained from *Althaea hirsuta* L. were analyzed in GC-MS instrument. According to the GC chromatogram, 21 volatile components were found in the extract. Ten of them exist in higher fractions (%) given in Table 1. Five components were found to show pharmacological activities, five of them had bioactive properties and two of them were found to be used as drugs according to the literature. 1-methyl-2-pyrrolidinone and 1-hexadecanol compounds found in the extract show drug, bioactive and pharmacological properties. 1-tridecene and methyl palmitate show bioactive and pharmacological properties according to the literature. The most abundant components having higher existence ratios in the extract were methyl-9-octadecenoate (58.93%) and methyl-8-octadecenoate (25.35%) (Anonimus 2018c; Anonimus 2018d).

Table 1. Chemical components of *Althaea hirsuta* L.

No	RT	Compound name	Area (%)	CAS	Qual	Molecular formula	Molecular weight (g/mol)	Application areas
1	9.71	1-Methyl-2-pyrrolidinone	0.18	000872-50-4	91	C ₅ H ₉ NO	99.133	Drug info – Pharmacology - Bioactivities
2	20.84	1-Tridecene	0.15	002437-56-1	91	C ₁₃ H ₂₆	182.351	Pharmacology - Bioactivities
3	26.86	1-Hexadecanol	0.13	0036653-82-4	91	C ₁₆ H ₃₄ O	242.447	Drug info – Pharmacology - Bioactivities
4	32.33	Methyl oleate	0.09	000112-62-9	93	C ₁₉ H ₃₆ O ₂	296.495	Bioactivities
5	36.80	Methyl palmitate	0.91	000112-39-0	99	C ₁₇ H ₃₄ O ₂	270.457	Pharmacology - Bioactivities
6	47.39	Methyl-9-octadecenoate	58.93	001937-62-8	99	C ₁₉ H ₃₆ O ₂	296.495	Pharmacology
7	47.53	Methyl-8-octadecenoate	26.48	002345-29-1	99	C ₁₉ H ₃₆ O ₂	296.495	
8	47.69	Methyl elaidate	6.49	001937-62-8	99	C ₁₉ H ₃₆ O ₂	296.495	
9	48.94	Methyl stearate	5.96	000112-61-8	98	C ₁₉ H ₃₈ O ₂	298.511	

The extracts obtained from *Alcea apterocarpa* contained 69 volatile components according to the GC-MS chromatogram. 32 of them exist in higher ratios given in Table 2. According to the literature, 27 components found in the extract show bioactive properties. 1-methyl-2-pyrrolidinone (19.33%) shows drug, pharmacology and bioactive properties. The second most abundant component, 1-hexadecene (13.97%), can be used in the applications of pharmacology and bioactivity (Anonymous 2018c; Anonimus 2018d).

Ertaş et al. (2016) found twenty-nine components in the essential oil composition of *A. apterocarpa*. The major compounds in the extracts were found to be hexatriacontane (25.3 %) and tetracontane (15.4%). In the same study, petroleum ether extracts of *Alcea apterocarpa* were also analyzed by GC-MS. They found fifteen components from the petroleum ether extract of *Alcea apterocarpa*. The main fatty acid components of the petroleum ether extract were found to be oleic acid (25.6 %) and linoleic acid (24.8 %).

Table 2. Chemical components of *Alcea apterocarpa*

No	RT	Compound name	Area (%)	CAS	Qual	Molecular formula	Molecular weight (g/mol)	Application areas
1	6.14	(3E)-3,7-dimethyl-1,3,6-octatriene	5.63	003779-61-1	83	C ₁₀ H ₁₆	136.238	Pharmacology - Bioactivities

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2	7.69	Methyl vinyl ketone	0.50	000078-94-4	4	C ₄ H ₆ O	70.091	Pharmacology - Bioactivities
3	8.68	Chlorine dioxide	0.28	010049-04-4	2	ClO ₂	67.448	Drug info - Pharmacology - Bioactivities
4	8.90	2-fluoro-acetamide	1.07	000640-19-7	2	C ₂ H ₄ FNO; FCH ₂ CONH ₂	77.058	Pharmacology - Bioactivities
5	9.62	1-methyl-2-Pyrrolidinone	19.33	000872-50-4	91	C ₅ H ₉ NO	99.133	Drug info - Pharmacology - Bioactivities
6	9.88	2-Methyl-3,4,5,6-tetrahydropyrazine	2.09	344240-21-7	7	C ₅ H ₁₀ N ₂	98.149	
7	9.97	3-Methyl piperidine	0.61	000626-56-2	5	C ₆ H ₁₃ N	99.177	Bioactivities
8	10.01	2-Methyl piperidine	2.09	000109-05-7	4	C ₆ H ₁₃ N	99.177	Pharmacology - Bioactivities
9	11.13	N-methyl-N-(methylideneamino)pro p-2-en-1-amine	1.08	066075-09-0	9			
10	14.23	Octyl cyclopropane	7.67	001472-09-9	64	C ₁₁ H ₂₂	154.297	
11	20.83	1-Hexadecene	13.97	000629-73-2	91	C ₁₆ H ₃₂	224.432	Pharmacology - Bioactivities
12	24.17	(Z)-9-Octadecenamide	0.24	000301-02-0	4	C ₁₈ H ₃₅ NO	281.484	Pharmacology - Bioactivities
13	24.63	Butylated hydroxytoluene	1.29	000128-37-0	83	C ₁₅ H ₂₄ O or undefined	220.356	Drug info - Pharmacology - Bioactivities
14	24.71	3-(phenylmethyl)-1,2,4-thiadiazol-5-amine	0.63	017467-27-5	2	C ₉ H ₉ N ₃ S	191.252	Bioactivities
15	26.85	(E)-5-Octadecene	10.42	007206-21-5	90	C ₁₈ H ₃₆	252.486	
16	32.32	2-Tridecanol	4.84	001653-31-2	59	C ₁₃ H ₂₈ O	200.366	Bioactivities
17	46.50	Cyclohexanemethanol	6.93	000100-49-2	16	C ₇ H ₁₄ O	114.188	Bioactivities
18	48.66	2-methyl-1-Propanol	0.68	000078-83-1	3	C ₄ H ₁₀ O	74.123	Drug info - Pharmacology - Bioactivities
19	60.96	3-Pyrrolidinol	0.41	040499-83-0	4	C ₄ H ₉ NO	87.122	Bioactivities
20	71.77	1H-1,2,3-Triazole	0.23	000288-36-8	2	C ₂ H ₃ N ₃	69.067	Bioactivities
21	71.84	1H-1,2,4-Triazole	0.80	000288-88-0	2	C ₂ H ₃ N ₃	69.067	Pharmacology - Bioactivities
22	80.69	6-Nitro-8-methoxy-2H-chromene	1.07	062063-7-4	2			
23	80.90	2-(4-methylphenyl)-indolizine	1.59	007496-81-3	2	C ₁₅ H ₁₃ N	207.276	Bioactivities
24	81.10	1-methyl-4-[4,5-dihydroxyphenyl]-hexahydropyridine	0.90	094427-47-1	5	C ₁₂ H ₁₇ NO ₂	207.273	Bioactivities
25	82.09	3,8,11-Trioxatetracyclo[4.4.1.0(2,4).0(7,9)]undecane	1.14	050267-13-5	9			
26	83.80	2-chloro-4,6-bis(methylthio)-1,3,5-triazine	0.10	004407-40-3	4	C ₅ H ₆ ClN ₃ S ₂	207.694	Bioactivities

The fatty acid components of the methanol/ethyl acetate extract of *Lavantera punctata* All. were determined by GC-MS analysis. A total of 15 components were found in the extract. The most abundantly found components in the extract are listed in Table 3, which are methyl-9-octadecenoate (38.90%), Methyl-8-octadecenoate (19.17%) and Methyl-9-octadecenoate (% 18.80). In Table 3, three components have bioactive properties, one component has been used as a drug and two components are found to have pharmacological properties according to the literature. 1-methyl-2-pyrrolidinone possesses pharmacological, drug and bioactive properties. Methyl hexadecanoate component has pharmacological and bioactive properties, nonylcyclopropane is found to have pharmacological properties and methyl-9-octadecenoate component is found to be only bioactive properties according to the literature (Anonimus 2018c; Anonimus 2018d).

Tablo 3. Chemical components of *Lavantera punctata* All.

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No	RT	Compound name	Area (%)	CAS	Qual	Molecular formula	Molecular weight (g/mol)	Application areas
1	9.73	1-methyl-2-pyrrolidinone	0.18	000872-50-4	91	C ₅ H ₉ NO	99.133	Drug info – Pharmacology - Bioactivities
2	14.25	Nonylcyclopropane	0.09	074663-85-7	83	C ₁₂ H ₂₄	168.324	Pharmacology
3	36.83	Methyl hexadecanoate	5.43	000112-39-0	99	C ₁₇ H ₃₄ O ₂	270.457	Pharmacology - Bioactivities
4	40.30	Methyl-(Z)-9-octadecenoate	0.11	000112-62-9	93	C ₁₉ H ₃₆ O ₂	296.495	Bioactivities
5	46.90	Methyl-8-octadecenoate	19.17	002345-29-1	99	C ₁₉ H ₃₆ O ₂	296.495	
6	47.40	Methyl-9-octadecenoate	62.70	001937-62-8	99	C ₁₉ H ₃₆ O ₂	296.495	
7	47.43	Methyl-11-octadecenoate	6.76	052380-33-3	99	C ₁₉ H ₃₆ O ₂	296.495	
8	47.71	Methyl-(Z)-11-octadecenoate	4.86	001937-63-9	99	C ₁₉ H ₃₆ O ₂	296.495	
9	48.87	Methyl-16-methyl-heptadecanoate	3.16	005129-61-3	98	C ₁₉ H ₃₈ O ₂	298.511	

The common volatile components of *Lavatera punctata* All., *Althaea hirsuta* L. and *Alcea apterocarpa* plant extracts are given in Table 4. As can be seen from Table 4, three plant extracts have only one common component which is 1-methyl-2-pyrrolidinone. Four volatile components are also found to be common in *Lavatera punctata* All. and *Althaea hirsuta* L. extracts.

Table 4. The common volatile components of *Lavatera punctata* All., *Althaea hirsuta* L. and *Alcea apterocarpa* extracts

No	Compound name	<i>Lavatera punctata</i> All. (%)	<i>Althaea hirsuta</i> L. (%)	<i>Alcea apterocarpa</i> (%)
1	1-Methyl-2-pyrrolidinone	0.18	0.18	19.33
2	Methyl hexadecanoate	5.43	0.91	
3	Methyl-(Z)-9-octadecenoate	0.11	0.09	
4	Methyl-8-octadecenoate	19.17	26.48	
5	Methyl-9-octadecenoate	62.7	65.42	

Conclusions

Lavatera punctata All., *Althaea hirsuta* L. and *Alcea apterocarpa* plants are traditionally used in the treatment of diseases such as cough, throat, gastroenteritis and skin diseases. However, there are a limited number of studies about whether these plants are medicinal and aromatic plants. In the literature, the volatile components of these plants have been determined to have pharmacological, bioactive and drug properties. Therefore, the volatile components of these plants can be potentially used in the pharmaceutical industry.

Conflicts of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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