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DETERMINATION OF COMPOSITION OF FATTY ACIDS IN *SAPONARIA OFFICINALIS* L.

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Treatment using medicinal plants with a long history of use is of interest to our society. These plants include *Saponaria officinalis* L., as well commonly known as common soapwort belongs to the family Caryophyllaceae. The herb and roots of this plant used as a blood purifier, an expectorant in bronchitis, diaphoretic and diuretic, for skin diseases, to increase bile flow. The plant contains various secondary metabolites, but there is no information on the fatty acids composition of *Saponaria officinalis* L. herb and roots.

The aim. The aim of the present study was to determine the qualitative composition and quantitative content of fatty acids by gas chromatography/mass spectrometry method (GC/MS) in *Saponaria officinalis* L. herb and roots.

Materials and methods. The determination of fatty acids composition of *Saponaria officinalis* L. herb and roots were carried out by gas chromatograph Agilent 6890N (Agilent Technologies, USA).

Results. The research of *Saponaria officinalis* L. herb showed a mixture of unsaturated (1.9 mg/g) and saturated (1.27 mg/g) fatty acids. The main components of this raw material were linolenic (1.15 mg/g), linoleic (0.75 mg/g) and heneicosylic (0.38 mg/g) acids. The main components of this raw material were palmitic (0.38 mg/g), linoleic (0.16 mg/g) and linolenic (0.09 mg/g) acids.

Conclusions. As a result of *Saponaria officinalis* L. study, the presence of fatty acids is established in herb and roots. Using the GC/MS method determined the qualitative composition and quantitative content of fatty acids in study raw material. Twelve fatty acids were determined in the herb of *Saponaria officinalis* L. The dominant fatty acids in the studied raw material were linolenic and linoleic acids, their content was 1.15 mg/g and 0.75 mg/g, respectively. Nine fatty acids were determined in the *Saponaria officinalis* L. roots. The palmitic acid prevailed among fatty acids, its content was 0.38 mg/g. Our findings suggest that *Saponaria officinalis* L. is a promising plant because of the important role of fatty acids in different biological processes

Keywords: *Saponaria officinalis* L., herb, roots, fatty acids, linolenic acid, linoleic acid, GC/MS

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1. Introduction

Today, methods of treatment using medicinal plants with a long history of use and small side effects are of interest to our society. The standard plants for diseases' treatment are the families of *Lamiaceae*, *Caryophyllaceae*, *Asteraceae*, *Boraginaceae*, *Fabaceae*, *Poaceae*, *Apiaceae* and *Rosaceae* [1].

Saponaria officinalis L. (*Caryophyllaceae*), usually named common soapwort, is native to Asia and Europe and is cultivated everywhere in the world [2]. The *Saponaria officinalis* is detergent properties have been known since long-standing times, and its basic traditional use has been as soap. As an herbal medicine, it has been used as an expectorant in bronchitis and as well as rheumatic disorders [3]. In the food industry, common soapwort has been used for the manufacturing of traditional halva and another sweet [4].

The various parts of *Saponaria officinalis* has been used in traditional medicine, roots as blood purifier, diaphoretic and diuretic; sap for hepatic eruptions, to increase bile flow; leaves and roots for skin diseases [5, 6].

Literature data revealed that the *Saponaria officinalis* contains a high level of saponins. The saponin frac-

tion of common soapwort has shown an anti-inflammatory activity in vitro against carrageenan induced rat-paw edema and inhibited prostaglandin synthetase [7, 8]. Purified saponins fraction of *Saponaria officinalis* have indicated hypocholesterolemic effects in vitro, which is consider to be due to the ability of saponin to form an insoluble complex with cholesterol [9, 10].

In supplement to saponins, common soapwort also contains tannins, quillaic acid, flavonoids, organosulphur compounds, different phenolic compounds and essential oils [3, 11]. Nabinejad has studied the minimum inhibitory concentration of *Saponaria* extracts for in vitro growth inhibition of an against avian pathogenic *Escherichia coli* using tube dilution technique. The present study has revealed that saponin extract from common soapwort has useful antibacterial effects [12].

It is known about reported antifungal activities of common soapwort's saponin fraction against *Gaeumannomyces graminis* var. *tritici* and *Fusarium culmorum*, which are pathogens of cereals [13].

However, there are no previously published data about the fatty acids chemical composition of common soapwort. As such the **aim of this study** was to deter-

mine the fatty acids content of *Saponaria officinalis* L. roots and herb. To the best of our knowledge this is the first report on the common soapwort fatty acids.

2. Planning (methodology) of research

An analysis of the scientific literature showed that the chemical composition of the *Saponaria officinalis* L. herb and roots has not been sufficiently studied, and no

information on its fatty acids composition has been found in available sources. Based on this, we set a goal to study the fatty acids composition of common soapwort by GC/MS, since this method is one of the most optimal for the analysis of these objects.

To reach this aim and obtain answers to all questions, the conception of the experiment was done (Fig. 1).

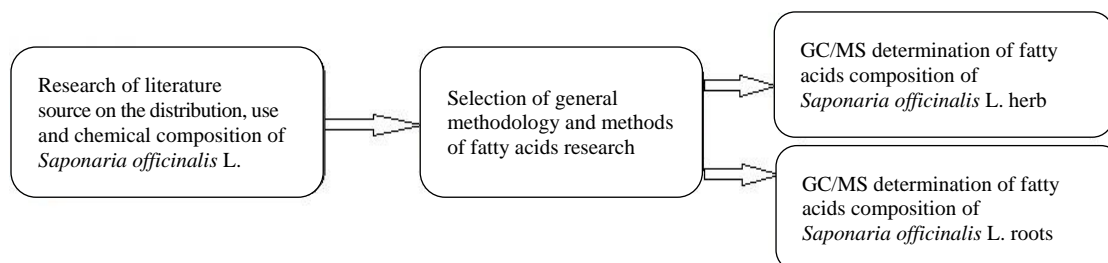


Fig. 1. Design of the experiment

3. Material and method

3.1. Plant materials

Herb and roots of *Saponaria officinalis* L. (common soapwort) were selected as the objects of the study and collected in Western Ukraine, Chernivtsi region (N 48°15'33.1" E 25°12'01.9"). The aboveground part was collected during a mass flowering period and roots were collected in autumn after the death of the aboveground parts in 2019. The raw material was authenticated by prof. Svitlana Marchyshyn (TNMU, Ternopil, Ukraine). The study plant material was dried using conventional method and stored in paper bags in a dry place [14].

3.2. Chemicals and standards

Solvents and chemicals used which includes methanol, heptane and toluene were purchased as HPLC analytical grade, and where necessary, solvents were redistilled before use. Fatty acids were identified by the reference standard mixture FAME (Supelco, Belle fonte, PA, USA). The internal standard nonadecanoic acid used for metabolite quantification was purchased from Sigma-Aldrich (St. Louis, MO).

3.3. Determination of fatty acids

GC/MS analysis of fatty acids was performed using gas chromatograph Agilent 6890N with mass detector 5973 inert (Agilent Technologies, USA) [15]. Samples were analyzed on a silica capillary column HP-5MS (apolar) length – 30 m, internal diameter – 0.25 mm, the diameter of sorbent grain 0.25 µm [16]. The interface and evaporator were operated at 250 and 380 °C respectively. The initially set up oven temperature at 60 °C for 4 min, then at the rate of 4 °C/min raised to 250 °C and kept at this point for 6 min and maintained at a final temperature for 7 min. Helium was used as the carrier gas at a constant flow rate of 1.0 ml/min. The sample with a volume of 1 µl was injected in a splitless mode using 7683 series Agilent Technologies injector. Detection was performed in scan mode in the range (38–400 m/z).

0.5 g (accurately mass) of the raw material was refluxed with a 3.3 ml mixture containing (methanol: toluene: sulfuric acid (44:20:2 v/v)) and 1.7 ml of internal standard solution (nonadecanoic acid in heptane solution). The sample was maintained in the ultrasonic water bath at 80 °C for 2 h. The resulting mixture was allowed to cool and centrifuged for 10 min at 5000 rpm. Then 0.5 ml of the upper heptane phase with containing methyl esters of fatty acids was selected [15].

The compositions of the product obtained were identified by comparison of their mass-spectrums with data obtained from National Institute Standard and Technology (NIST, 2008) database. The quantitative content of fatty acids was done using internal standard of nonadecanoic acid in heptane solution added to the sample.

The amount of fatty acids in mg/g was calculated according to the following equation:

$$X = \frac{S_x \times Minst \times 1000}{Sinst \times m},$$

where S_x – is a peak area of each fatty acid, $Minst$ – is a mass of the internal standard, $Sinst$ – is a peak area of the internal standard, m – is a mass of a plant material [17, 18].

3.4. Statistical analysis

Statistica v. 10.0 (StatSoft I nc.) program was used for descriptive statistical analysis. The reliability of the obtained results was evaluated according to the criterion of reliability of Student. The level of significance was set at * $p < 0.05$ for all statistical analyses.

4. Results

The fatty acids profiles of the herb and roots of *Saponaria officinalis* L. were evaluated using GC/MS method (Fig. 2, 3, Table 1). Twelve fatty acids were determined in the *Saponaria officinalis* L. herb, including myristic, margaric, stearic, nonadecanoic, arachidic, behenic, heneico-

sylic, tricosylic, lignoceric, cerotic, linoleic and linolenic acids. Of them, ten fatty acids were saturated (C14–C26) and two fatty acids were polyunsaturated (C18). Nine fatty acids were determined of the roots of *Saponaria officinalis* L., seven fatty acids namely pentadecylic, palmitic, stearic,

nonadecanoic, arachidic, behenic, lignoceric were saturated and two fatty acids like linoleic and linolenic were polyunsaturated.

The quantitative content of fatty acids of *Saponaria officinalis* L. herb and roots is presented in Table 1.

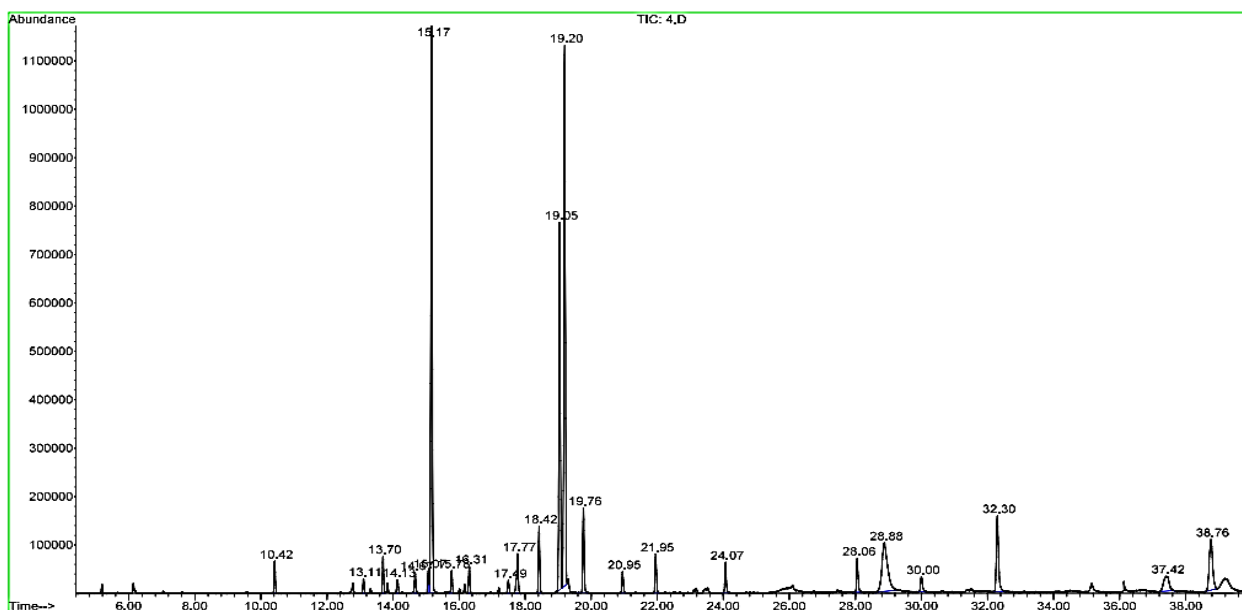


Fig. 2. GC/MS chromatogram of fatty acids in *Saponaria officinalis* L. herb

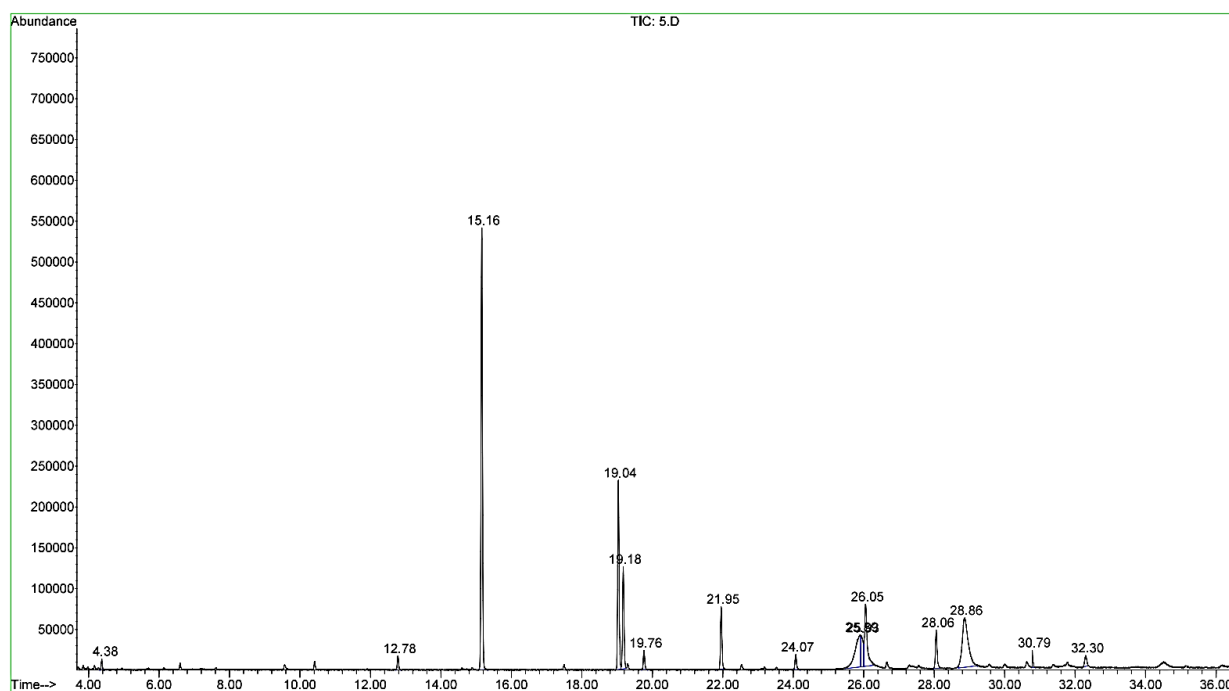


Fig. 3. GC/MS chromatogram of fatty acids in *Saponaria officinalis* L. roots

Table 1

The results of fatty acids determination in *Saponaria officinalis* L. herb and roots

No.	Retention time	Common name of fatty acid (IUPAC)	Chemical nomenclature	Quantitative content of methyl esters of fatty acids			
				herb		roots	
				mg/g	% of the total	mg/g	% of the total
Saturated acids							
1.	10.42	Myristic (tetradecanoic)	C 14:0	0.06±0.002	1.89	–	–
2.	12.78	Pentadecylic (pentadecanoic)	C 15:0	–	–	0.01±0.000	1.39
3.	15.16	Palmitic (hexadecanoic)	C 16:0	–	–	0.38±0.01	52.78
4.	17.49	Margaric (heptadecanoic)	C 17:0	0.03±0.001	0.95	–	–
5.	19.76	Stearic (octadecanoic)	C 18:0	0.16±0.004	5.05	0.02±0.000 6	2.78
6.	21.95	Nonadecanoic	C 19:0	internal standard			
7.	24.07	Arachidic (eicosanoic)	C 20:0	0.06±0.001	1.89	0.01±0.000 2	1.39
8.	28.06	Behenic (docosanoic)	C 22:0	0.07±0.001	2.21	0.04±0.001	5.55
9.	28.88	Heneicosylic (heneicosanoic)	C 21:0	0.38±0.01	11.99	–	–
10.	30.00	Tricosylic (tricosanoic)	C 23:0	0.04±0.001	1.26	–	–
11.	32.30	Lignoceric (tetracosanoic)	C 24:0	0.23±0.01	7.25	0.01±0.000 3	1.39
12.	38.76	Cerotic (hexacosanoic)	C 26:0	0.24±0.01	7.57	–	–
Polyunsaturated acids (ω-3 and ω-6)							
13.	19.05	Linoleic (octadecadienic, ω-6)	C 18:2	0.75±0.02	23.66	0.16±0.005	22.22
14.	19.20	α-Linolenic (octadecatrienic, ω-3)	C 18:3	1.15±0.03	36.28	0.09±0.003	12.5
The amount of saturated fatty acids				1.27	40.06	0.47	65.28
The amount of unsaturated fatty acids				1.9	59.94	0.25	34.72
Total				3.17	100	0.72	100

Note: – – not found

5. Discussion

The sum of unsaturated fatty acids in *Saponaria officinalis* L. herb was greater than saturated fatty acids. The unsaturated coefficient, which was defined as the correlate of the quantity of unsaturated acids to the quantity of saturated acids, was 1.5. In the roots of *Saponaria officinalis* L. was greater saturated fatty acids. Their content was 65.28 %.

Saturated fatty acids are a source of energy for the human body and participate in the construction of cell membranes, absorption of microelements and vitamins, and hormone synthesis [15, 19].

The contents of saturated acids namely heneicosylic, cerotic, lignoceric, stearic were the greatest in the herb of *Saponaria officinalis* L. and which was 0.38 µg/mg and 0.24 µg/mg, 0.23 µg/mg, 0.16 µg/mg, respectively. The quantitative content of the other saturated acids were much under. Also, the *Saponaria officinalis* L. herb not contained pentadecylic and palmitic acids.

Saponaria officinalis L. roots was contained palmitic acid as the main saturated acid, it is content in the study raw material was 0.38 mg/g (52.78 % from total content fatty acids). The quantitative content of the other saturated acids like pentadecylic, stearic, arachidic, behenic, and lignoceric acids were much lesser. Myristic, margaric, heneicosylic, tricosylic and cerotic acids were not found.

The unsaturated fatty acids of *Saponaria officinalis* L. were presented linoleic and linolenic acids, their content in the herb was 0.75 mg/g, 1.15 mg/g, and in the roots was 0.16 mg/g, 0.09 mg/g, respectively. Polyunsaturated fatty acids are not synthesized in the human body, but perform an essential role in the body's life

functions and are the point of departure for the synthesis of other fatty acids. Linoleic acid is a component of the omega-6 fatty acids and ensures normalization of metabolic processes, production of bile acids in the liver, affects the hormonal balance and production of prostaglandins [15, 20]. Linoleic acid turns into the human body to γ-linolenic acid [15]. Linolenic acid is a component of omega-3 fatty acids [21, 22]. This polyunsaturated fatty acid at the transformation to prostaglandin E1 increases immunity, blood cholesterol-reducing, and arterial pressure [23–25].

Study limitations. For the statistical significance of the study, it would be advisable to investigate wild samples of raw materials from various regions of Ukraine. The research needs additional study of fatty acids since some of the acids compounds were not identified during the study.

Prospects for further research. According to the received results of the studies, further screening of pharmacological studies, and development of parameters for standardization of *Saponaria officinalis* L. herb and roots are planned.

6. Conclusion

Using the GC/MS method we determined the qualitative composition and quantitative content of fatty acids in the herb and roots of *Saponaria officinalis* L. Twelve fatty acids were determined in the herb of *Saponaria officinalis* L. Unsaturated acids dominated, the content of which was 59.94 % from total content fatty acids. The dominant fatty acids in the studied raw material were linolenic and linoleic acids, their content was 1.15 mg/g (36.28 % from total

content acids) and 0.75 mg/g (23.66 % from total content acids), respectively. Among saturated acids the contents of heneicosylic (0.38 µg/mg), cerotic (0.24 µg/mg), lignoceric (0.23 µg/mg) and stearic (0.16 µg/mg) acids were the greatest. Nine fatty acids were determined in the *Saponaria officinalis* L. roots. Saturated fatty acids dominated, their content was 65.28 % from total content fatty acids.

The palmitic acid prevails among saturated fatty acids, its content was 0.38 mg/g (52.78 % from total content acids). Polyunsaturated fatty acids were lesser.

The quantitative content of linoleic and linolenic acids was 0.16 mg/g (22.22 % from total content acids) and 0.09 mg/g (12.5 % from total content acids), respectively. Our findings suggest that *Saponaria officinalis* L. is a promising plant because of important role fatty acids in a different of biological functions.

Conflict of interests

The authors declare that they have no conflicts of interest.

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