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INVESTIGATION OF FATTY ACIDS IN *CAMELINA MICROCARPA* ANDRZ

Actuality. *The available literature lacks information on the fatty acid content in the aerial parts of Camelina microcarpa grown in Ukraine.*

The aim of the study is to analyze the fatty acid composition of the herb and seeds of Camelina microcarpa Andrz.

Material and methods. *Raw material was cultivated and harvested in Zaporizhzhia region (Ukraine) in 2018. Seeds for cultivation were provided by the National Center for Plant Genetic Resources of Ukraine. Fatty acid composition was analyzed using a gas chromatograph (Agilent 7890B GC System) with a mass spectrometric detector (Agilent 5977B GC/MSD) and a DB-5ms column.*

Research results. *A total of 11 fatty acids were identified: 4 in the herb and 11 in the seeds. The total fatty acid content was 3,58% in the herb and 44,24% in the seeds. Saturated fatty acids predominated in the herb, while unsaturated fatty acids dominated in the seeds. The proportion of unsaturated fatty acids in the herb was 35,98%, with α-linolenic acid (27,34%) being the most abundant. In the seeds, unsaturated fatty acids (87,47%) significantly exceeded saturated acids, with α-linolenic acid (39,09%) as the dominant component. Linoleic, α-linolenic, palmitic, and arachidic acids were common in both the herb and seeds.*

Conclusion. *Camelina microcarpa Andrz. seeds are a promising plant-based source of polyunsaturated fatty acids for pharmaceutical applications.*

Key words: *Camelina microcarpa Andrz., herb, seeds, fatty acids, GC-MS.*

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ДОСЛІДЖЕННЯ ЖИРНИХ КИСЛОТ У *CAMELINA MICROCARPA* ANDRZ

Актуальність. *У доступних джерелах літератури відсутня інформація щодо вмісту жирних кислот у надземній частині Camelina microcarpa, вирощеного в Україні.*
Мета дослідження *– провести аналіз жирнокислотного складу трави та насіння Camelina microcarpa Andrz.*
Матеріал і методи. *Сировину культивували та збирали в Запорізькій області (Україна) у 2018 році. Насіння для культивування було надане Національним центром генетичних ресурсів рослин України. Жирнокислотний склад аналізували методом газової хроматографії (Agilent 7890B GC System) з мас-спектрометричним детектором (Agilent 5977B GC/MSD) та колонкою DB-5ms.*
Результати дослідження. *Виявлено загалом 11 жирних кислот: 4 у траві й 11 у насінні. Загальний вміст жирних кислот становив 3,58% у траві та 44,24% у насінні. У траві переважали насичені жирні кислоти, тоді як у насінні домінували ненасичені. Частка ненасичених жирних кислот у траві становила 35,98%, із яких α-ліноленова кислота (27,34%) була найбільш поширеною. У насінні вміст ненасичених жирних кислот (87,47%) значно перевищував насичені, до того ж α-ліноленова кислота (39,09%) була основним компонентом. Лінолева, α-ліноленова, пальмітинова й арахідонова кислоти були спільними для трави та насіння.*
Висновок. *Насіння Camelina microcarpa Andrz. є перспективним рослинним джерелом поліненасичених жирних кислот для фармацевтичного застосування.*
Ключові слова: *Camelina microcarpa Andrz., трава, насіння, жирні кислоти, ГХ-МС.*

Actuality. Polyunsaturated fatty acids (PUFAs) are obtained from various sources and can be incorporated into the daily diet to maintain health. They provide protection against several diseases, such as osteoarthritis, cancer, and autoimmune disorders. Particular attention is given to the PUFAs omega-3 (ω-3) and omega-6 (ω-6) fatty acids, which are found in both terrestrial and marine environments. Among PUFAs, ω-3 and ω-6 fatty acids are considered essential because they cannot be synthesized by the human body and must be obtained through diet. ω-3 and ω-6 PUFAs are derived from essential fatty acids, i.e., α-linolenic acid (ALA) and linoleic acid (LA), respectively. The body's requirement for ω-3 fatty acids can be met by consuming plant seeds (Shilman, 2016; Kapoor, 2021).

Therefore, the search for new plant sources of polyunsaturated fatty acids is a pressing task in modern pharmaceutical science to develop effective domestic drugs and dietary supplements.

Our study focuses on *Camelina microcarpa* Andrz., an annual winter dicotyledonous plant of the Brassicaceae family, known as an oilseed plant (fig. 1). It is frequently found as a weed in fields and disturbed areas across most of Ukraine. *Camelina microcarpa* Andrz is also distributed in North Africa (Algeria, Libya, Morocco, Tunisia), Asia (Mongolia, China, the Middle East), and Europe. It has been naturalized in Japan, North America (Canada, the USA), and Argentina. It inhabits farms, fields, meadows, prairies, roadsides, forest edges, and open woodlands (Shevchenko, 2017).

Fig. 1. *Camelina microcarpa* Andrz.

The aim of the study was to analyze the qualitative composition and quantitative content of fatty acids in *Camelina microcarpa* Andrz.

Materials and methods. The raw material was cultivated and harvested in the Zaporizhzhia region (Ukraine) during the summer of 2018. *Camelina microcarpa* herb was collected at the beginning of the flowering stage, while *Camelina microcarpa* seeds were harvested when 60–70% of the fruits had ripened to prevent excessive seed shedding. Seed samples for cultivation were provided by the National Center for Plant Genetic Resources of Ukraine (The Plant Production Institute named after V.Y. Yuriev, NAAS of Ukraine, Kharkiv).

The sample of plant raw material was grinded into a powder by laboratory mill, then about 0,5 g (accurately mass) was selected and placed into the glass vial and 3,3 ml of reacting mixture (methanol: toluene: sulfusic acid (44:20:2 v/v)) and 1,7 ml of internal standard solution (decanoic acid in hexane solution) were added. The sample was maintained at 80 °C for 2 hours, cooled and centrifuged for 10 minutes at 5 000 rpm. 0,5 ml of the upper hexane phase was taken containing methyl esters of fatty acids.

The method is based on the production of methyl esters of fatty acids, followed by analysis by gas chromatography and mass spectrometry. Chromatographic separation was performed on gas chromate-mass-spectrometric system (GC/MS method) (Agilent Technologies 7890B/5977B, Agilent Technologies, USA), the column is capillary DB-5ms (30 m × 0,25 mm × 0,25 mkm, Agilent Technologies, USA). The evaporation temperature 250 °C, the interface temperature 250 °C. The separation was carried out in the programming mode of temperature – the initial temperature 50 °C was maintained for 4 minutes, later raised with a gradient of 4 °C / min to 320 °C. Detection was performed in SCAN mode in the range (30–700 m/z). The gas flow rate of the carrier through a column of achieved as 1,0 ml / min. Methyl esters of fatty acids were identified using NIST14 mass-spectra library. Quantification of fatty acids methyl esters was determined by the internal standard addition to the sample analyzed. Decanoic acid solution was used as the internal standard (Odyntsova, 2022; Lisova, 2022).

Research results and their discussion. Herb and seeds of *Camelina microcarpa* Andrz. been analyzed for fatty acids' qualitative composition and quantitative content by GC/MS method. Comparative results of identification and quantification of fatty acids are represented in table. GS/MC chromatograms of fatty acids of the investigated plant raw materials are shown on fig. 2–3.

Thus, 4 fatty acids (of which 2 saturated and 2 unsaturated) were identified in *Camelina microcarpa* Andrz. herb and the content of the summ of fatty acids is 3,58%. The content of saturated fatty acids is 64,02%, and unsaturated – 35,98%. It is determined that the highest content among unsaturated fatty acids is occupied by α-linolenic acid.

11 fatty acids (4 saturated and 7 unsaturated) have been detected of seed of *Camelina microcarpa* Andrz. The total content of fatty acids in the raw material is 44,24%. The content of saturated fatty acids relative to the total amount of fatty acids in *Camelina microcarpa* Andrz. seeds is 12,53%, and unsaturated – 87,47% Linolenic, paullinic and linoleic acids have the highest content among unsaturated fatty acids.

Linoleic, α-linolenic, paullinic, palmitic and arachidic acids are common fatty acids for herb and seeds of *Camelina microcarpa* Andrz.

The data we obtained coincide with the results of similar studies by Francis (2009) on the fatty acid composition of *Camelina microcarpa* Andrz. seeds, which found that the prevailing fatty acids were linolenic, linoleic, and eicosenoic acids. The oleic acid content in our seed samples is negligible, accounting for only 0,74% compared to the 14% reported by Francis & Warwick.

Table

The fatty acids profile of *Camelina microcarpa* Andrz. (GC/MS)

Names of Compounds	Compounds' content in plant raw materials, mg/g		Compounds' content in plant raw materials, %	
	Herb	Seeds	Herb	Seeds
Saturated fatty acids				
Eicosanoic acid, methyl ester (Arachidic acid)	1,42	14,98	3,96	3,39
Docosanoic acid, methyl ester (Behenic acid)	–	3,42	–	0,77
Hexadecanoic acid, methyl ester (Palmitic acid)	21,47	34,89	60,06	7,89
Tetracosanoic acid, methyl ester (Lignoceric acid)	–	2,11	–	0,48
Unsaturated fatty acids				
cis-13-Eicosenoic acid, methyl ester (Paullinic acid)	–	87,00	–	19,76
cis-11,14-Eicosadienoic acid, methyl ester	–	8,95	–	2,02
9,12-Octadecadienoic acid, methyl ester (Linoleic acid)	3,08	82,93	8,64	18,74
9,12,15-Octadecatrienoic acid, methyl ester (α- Linolenic acid)	9,78	172,94	27,34	39,09
13-Docosenoic acid, methyl ester (Erucic acid)	–	25,64	–	5,80
9-Octadecenoic acid, methyl ester (Oleic acid)	–	3,26		0,74
cis-15-Tetracosenoic acid, methyl ester (Nervonic acid)	–	6,26		1,42

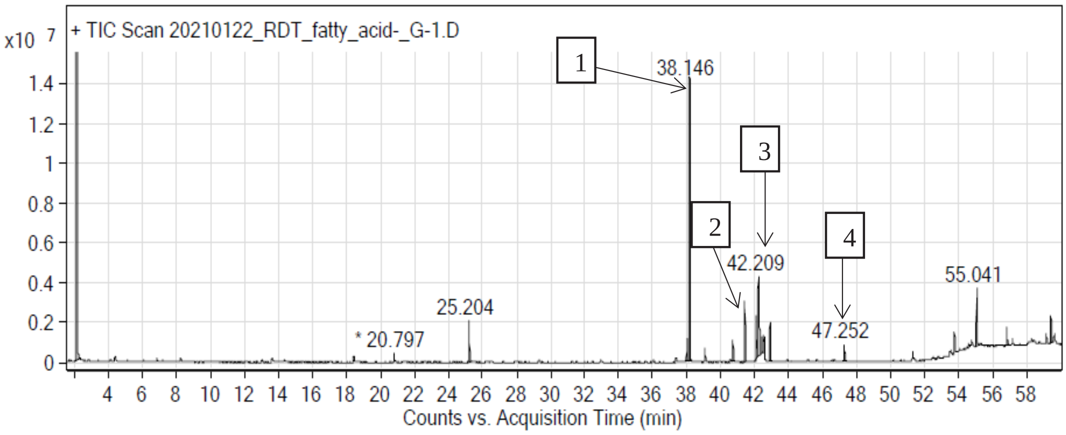

Fig. 2. GS/MS chromatogram of fatty acids from herb of *Camelina microcarpa* Andrz. (1 – palmitic acid, 2 – linoleic acid, 3 – linolenic acid, 4 – arachidic acid

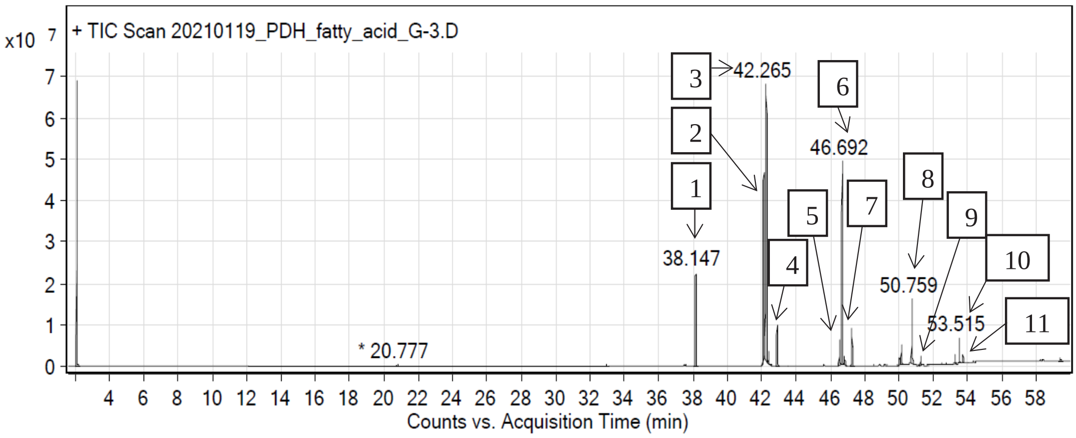

Fig. 3. GS/MS chromatogram of fatty acids from seeds of *Camelina microcarpa* Andrz. (1 – palmitic acid, 2 – linoleic acid, 3 – linolenic acid, 4 – eicisadienoic acid, 5 – paullinic acid, 6 – arachidic acid, 7 – erucic acid, 8 – behenic acid, 9 – tricosenoic acid, 10 – nervonic acid, 11 – lignoceric acid)

We did not identify stearic acid. The erucic acid content in our samples is nearly three times higher than that reported in the study by Francis et al (Francis, 2009).

We also compared the fatty acid composition of *Camelina microcarpa* with its closest relative, *Camelina sativa*, which is widely cultivated in Ukraine and worldwide (Lisova, 2022). Comparing the qualitative fatty acid composition in the seeds of the studied *Camelina* species, it can be concluded that both species have similar components in nearly equal amounts. The difference in quantitative content is insignificant. Additionally, *Camelina sativa* seeds contain 22-tricosenoic acid, while *Camelina microcarpa* seeds contain oleic acid. The erucic acid content in *Camelina sativa* seeds is lower at 4,89% (within the permissible limit of 5,00% for edible oils).

In the available literature sources, we were unable to find reliable data on the fatty acid content of *Camelina microcarpa* herb.

Unsaturated fatty acids are not only an important source of energy but also potent biological regulators, contributing to the prevention of numerous diseases and the maintenance of health at the cellular level. Unsaturated fatty acids exhibit several key biological activities, including anti-inflammatory, hypolipidemic, antioxidant, immunomodulatory effects, among others (DiNicolantonio, 2020; Mozaffarian, 2011).

We have also investigated the presence of phenolic compounds (Tsykalo 2020), carbohydrates (Tsykalo, 2021), and macro- and microelements (Tsykalo, 2018) in the raw material of Camelina microcarpa. Studies (Wang, 2024) indicate that chlorogenic acid, when combined with fatty acids of varying degrees of unsaturation, demonstrates enhanced antioxidant activity. Rutin, due to its hydrophilic nature, exhibits limited bioavailability. However, modification of rutin through esterification with unsaturated fatty acids significantly increases its lipophilicity and bioavailability. These lipophilic derivatives of rutin show improved antioxidant activity in lipid environments (Dehelean, 2022).

Water-soluble polysaccharides promote the growth of beneficial gut bacteria, such as bifidobacteria and lactobacilli, which in turn may improve overall intestinal health and influence fatty acid metabolism (Peng, 2024).

Microelements, including zinc, magnesium, calcium, iron, and copper, are essential for the normal metabolism and absorption of fatty acids. For instance, zinc serves as a cofactor for more than 300 enzymes, including those involved in the synthesis and metabolism of fatty acids (Gimenez, 2011).

These findings open up promising opportunities for the development of new functional food products and pharmaceutical formulations with enhanced biological properties.

Conclusions. 1. In this study we compared the fatty acid composition of herb and seeds of Camelina microcarpa Andrz. collected in Ukraine.

2. The total amount of fatty acids in Camelina microcarpa Andrz. herb is 3,57%, and in seeds – 44,24%.

3. The amount of unsaturated fatty acids (35,98%) in Camelina microcarpa Andrz. herb is almost a third of the total content dominated by α-linolenic acid (27,34%). At the same time, the amount of unsaturated fatty acids of Camelina microcarpa Andrz. seeds (87,47%) significantly exceeds the amount of saturated acids with the dominance of α-linolenic acid (39,09%).

4. The obtained results allow to recommend Camelina microcarpa Andrz. seeds as a plant source of polyunsaturated fatty acids in order to create effective domestic drugs based on it.

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