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STUDY OF THE CARBON ACIDS IN THE COMPOSITION OF *LYCIUM DEPRESSUM* FRUIT

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Abstract. At present, the extraction of biologically active substances from natural sources and the study of their composition are of great importance for the pharmaceutical, medical, and food industries. Carbohydrates, flavonoids, alkaloids, and organic acids found in plants are distinguished by their ability to regulate metabolism, as well as by their antioxidant and anti-inflammatory properties. The study of carboxylic acids creates opportunities for the development of new medicines, while the use of local raw plant materials contributes to increasing economic efficiency and reducing dependence on imports. Therefore, the analysis of sources in this field is of significant importance for future scientific and practical research.

Keywords: Lycium, biological activity, chemical composition, fatty acids, carbon acids

Annotatsiya Hozirgi kunda tabiiy manbalardan biologik faol moddalarni ajratib olish va ularning tarkibini o‘rganish farmatsevtika, tibbiyot hamda oziq-ovqat sanoati uchun muhim hisoblanadi. O‘simliklarda uchraydigan uglevod, flavonoid, alkaloid va organik kislotalar metabolizmni tartibga solish, antioksidant hamda yallig‘lanishga qarshi ta’siri bilan ajralib turadi. Karbon kislotalarni o‘rganish yangi dori vositalarini yaratish, mahalliy xomashyodan foydalanish esa iqtisodiy samaradorlikni oshirish va importga qaramlikni kamaytirishga xizmat qiladi. Shu bois ushbu yo‘nalishdagi manbalarni tahlil qilish kelgusidagi ilmiy-amaliy tadqiqotlar uchun muhim ahamiyatga ega.

Kalit so’zlar: Lycium, biologik faollik, kimyoviy tarkib. Polisaxaridlar, karbon kislotalar

Аннотация. В настоящее время выделение биологически активных веществ из природных источников и изучение их состава имеет важное значение для фармацевтики, медицины и пищевой промышленности. Углеводы, флавоноиды, алкалоиды и органические кислоты, содержащиеся в растениях, отличаются способностью регулировать обмен веществ, проявлять антиоксидантные и противовоспалительные свойства. Изучение карбоновых кислот открывает возможности для создания новых лекарственных средств, а использование местного растительного сырья способствует повышению

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экономической эффективности и снижению зависимости от импорта. Поэтому анализ источников по данной теме имеет важное значение для будущих научных и практических исследований.

Ключевые слова: Lycium, биологическая активность, химический состав, полисахариды, карбоновые кислоты.

Introduction

At present, the extraction of biologically active compounds from medicinal plants and their application in various fields is considered one of the urgent issues in pharmaceuticals, medicine, and the food industry. One such plant is *Lycium depressum* (goji), which belongs to the Solanaceae family. This plant is found in Central Asia, including Uzbekistan, and has long been widely used in traditional medicine. The fruits of *Lycium depressum* contain carbohydrates, proteins, fatty acids, flavonoids, alkaloids, carotenoids, and organic acids. These components are significant due to their role in regulating metabolic processes in the body, as well as their antioxidant, immunomodulatory, anti-inflammatory, and adaptogenic properties. In particular, the presence of fatty acids and flavonoids plays an important role in preventing cardiovascular diseases and slowing down the aging process.

The biological activity of goji berries provides a basis for studying them as a promising raw material in modern pharmacology for the development of new medicines, the preparation of dietary supplements, and the enrichment of food products. In addition, the use of local plant resources contributes to import substitution, increases economic efficiency, and ensures environmental safety. Therefore, studying the chemical composition of *Lycium depressum* fruits, especially the isolation of fatty acids and other biologically active compounds and the investigation of their properties, is among the pressing scientific tasks.

Materials and Methods

Plant material. Fully ripened goji berries (*Lycium depressum*) were collected in September from the Surkhandarya region. The harvested fruits were dried in a thermostat at 40 °C for 48 hours. In phytochemistry, conventional methods are widely used for the separation and fractionation of compounds from complex mixtures. In this process, plant raw materials are extracted using organic solvents of varying polarity, and the compounds are separated into different fractions according to their polarity. In addition, purification was carried out using column chromatography (CC), paper chromatography (PC), and thin-layer chromatography (TLC) with different adsorbents, allowing the isolation of pure compounds. The composition of organic carboxylic acids was analyzed on an Agilent GC 5975S inert MSD/7890A mass spectrometer.

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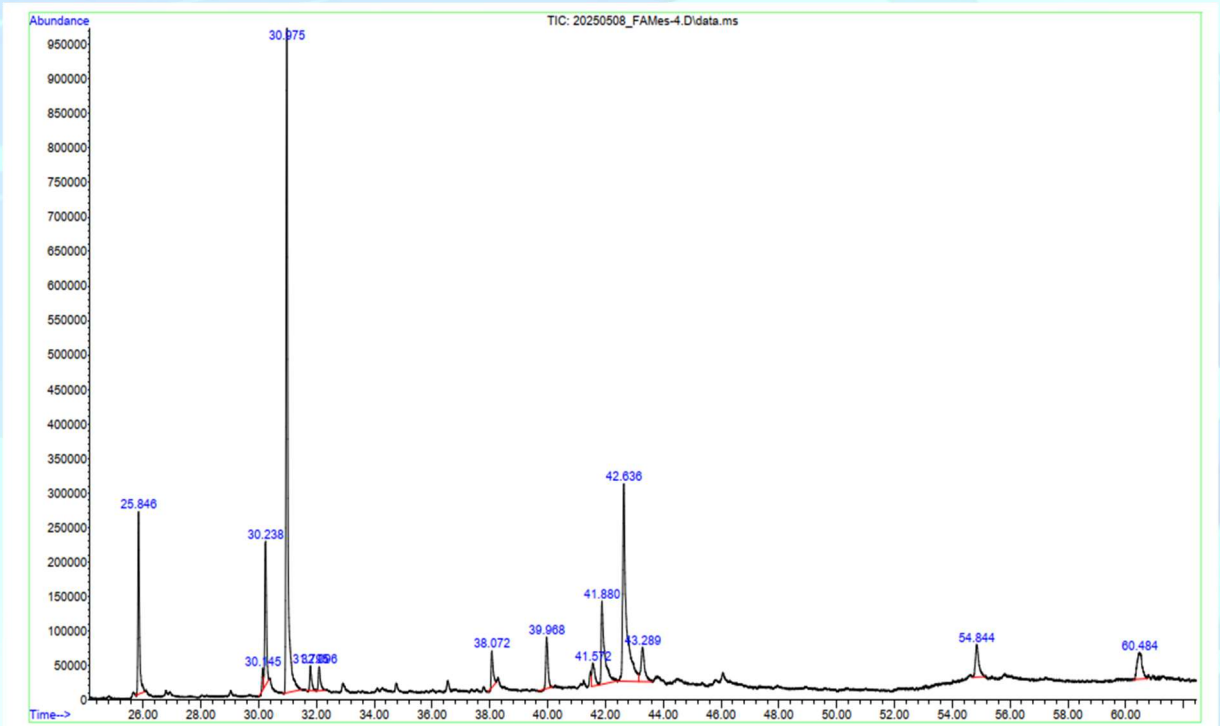
Experiments

As a result of the conducted studies, fatty acids were extracted from *Lycium depressum* (goji) fruits using hexane in a Soxhlet apparatus, and their composition was analyzed after methylation by GC–MS. For this purpose, 20 g of dried goji berries were first subjected to extraction with hexane for 48 hours. However, since the fruits were not ground, the yield was very low. Then, after cleaning and grinding, 20 g of berries were extracted with hexane in a Soxhlet apparatus for 48 hours. The obtained hexane fraction was concentrated using a rotary evaporator and then separated into aqueous and hexane fractions after decantation. When passed through a hexane–chloroform mixture (3.5:1.5), identical spots were observed in fractions 1 and 2, while fraction 3 showed a very low concentration. This indicated that fatty acids were efficiently extracted into the hexane fraction.
During the methylation process, 0.5 ml of 24 N H_2SO_4 and 2.5 ml of ethanol were added to the hexane fraction, and the mixture was refluxed in a water bath for 90 minutes. The composition of organic carboxylic acids in the obtained methylated sample was analyzed on an Agilent GC 5975S inert MSD/7890A mass spectrometer.

Results and Discussion

The GC–MS analysis revealed that the extract contained peaks corresponding to the methyl esters of hexadecanoic acid (18:0), tridecanoic acid (13:0), pentadecanoic acid (15:0), heptadecanoic acid (17:0), tetradecanoic acid (14:0), octadecenoic acid (18:1(11)), octadecenoic acid (18:1(13t)), octadecenoic acid (18:1(13s)), 10,13-octadecadienoic acid, 11,14-octadecadienoic acid, and 9,12,15-octadecatrienoic acid.

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The highest proportions were represented by methyl linoleate (C18:2) — 34.29% and linoleic acid isomers (CLA) — 20.66%. Methyl palmitate (C16:0) and methyl oleate (C18:1) accounted for 8.48% and 6.82%, respectively. The lowest amount was observed for methyl stearate (C18:0), which constituted only 0.65%.

The retention index (RI) values of the methyl esters of carboxylic acids in *Lycium depressum* were calculated relative to the retention times (RT) of the corresponding hydrocarbons. When compared with reference database values, almost complete agreement was observed, confirming the reliability of the results. The RI values increased consistently with the chain length and degree of unsaturation of the fatty acids (Table 1).

Table 1.

Chemical composition of the fruit of *Lycium depressum*

	RT (min)	Peak area (%)	Main compound	Similarity (%)
1	25.845	8.48	Methyl palmitate (C16:0)	96
2	31.406	0.65	Methyl stearate (C18:0)	97
3	32.095	6.82	Isomers of methyl oleate (C18:1)	98
4	35.210	34.29	Isomers of methyl linoleate (C18:2)	99

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5	31.796	1.38	Bicyclo[3.1.1]heptane derivative	91
6	32.093	1.43	Bicyclo[10.1.0]tridecane and other minor compounds	78
7	38.076	2.82	1-Pentadecene / 1-Tetradecene	96
8	39.008	2.09	1-Tetradecene / Tetracosane / Cetene	95
9	39.752	1.82	Cyclotetradecane	92
10	40.685	3.32	9-Octadecenal (Z) + Cetene	93
11	42.152	6.66	Linoleate (Z,Z) isomers / CLA	99
12	42.853	1.90	Cyclododecane / Tetradecane	93
13	54.844	3.18	2-Tetradecene (E) isomer	87
14	60.448	3.83	1-Tridecene / Epoxides (low quality)	25

The total number of organic carboxylic acids (fatty acid derivatives) was five, with a combined percentage of > 70.9% (8.48 + 0.65 + 6.82 + 34.29 + 20.66). This suggests that the sample also contained essential oils and other non-acidic compounds (Table 2).

Table 2.

Methyl esters of carboxylic acids in *Lycium depressum* and their corresponding chromatographic parameters

#	RT (min)	Area (%)	Compound name	Quality (%)	Calculated RI	Reference RI
1	25.845	8.48	Methyl palmitate (C16:0)	96	1783	~1780–1785
2	30.146	0.65	Methyl stearate (C18:0)	95	1912	~1905–1915
3	30.237	6.82	Isomers of methyl oleate (C18:1)	99	1916	~1910–1920
4	30.974	34.29	Isomers of methyl linoleate (C18:2)	99	1953	~1950–1960

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5	42.637	20.66	Methyl linoleate isomers: 9,12-(Z,Z)-octadecadienoic acid and 9(E),11(E)-linoleic acid	99	2532	~2520–2550

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