IRSTI 31.23
Chemistry
Article

Comparative phytochemical profiling of the underground parts of *Cichorium intybus* L.

Ulpan Amzeyeva[1,2], Aiya Tolepbergen[1,2], Suhaer Huanbieke[2], Thiruventhan Karunakaran[3], Aizhamal Baiseitova[1,2], Janar Jenis[2*]

[1]Research Institute for Natural Products & Technology, Almaty, Kazakhstan; ulpan-92.kz@mail.ru, nis.sovetbek@gmail.com, aizhabaiseitova@gmail.com
[2]The Research Center for Medicinal Plants, Al-Farabi Kazakh National University, Almaty, Kazakhstan; janarjenis@kaznu.kz, 1549372750@qq.com
[3]Centre for Drug Research, Universiti Sains Malaysia, 11800 USM, Pulau Pinang, Malaysia; thiruventhan@usm.my
*Correspondence: janarjenis@kaznu.kz

Abstract: The roots of medicinal plants are rich in vital phytochemicals, serving as an important source of bioactive compounds for pharmaceutical and food industries. *Cichorium intybus* L. (chicory), a perennial plant of the *Asteraceae* family, is well known for its nutritional and medicinal properties. This study conducted a comparative investigation on the phytochemical composition of the underground parts (roots) of *C.intybus* L. cultivated in Kazakhstan and imported from China. Quantitative analysis showed that the cultivated roots contained 4.5±0.1% moisture, 2.69±0.11% ash, and 82.25±3.5% extractive substances (90% ethanol), while the imported samples contained 7.0±0.3%, 7.52±0.3%, and 85.78±3.3%, respectively. The cultivated roots also exhibited higher levels of polysaccharides (0.838±0.04%), tannins (2.18±0.1%), coumarins (2.407±0.13%), and saponins (1.326±0.07%) compared to the imported samples (0.444±0.025%, 1.75±0.08%, 0.095±0.01%, and 0.573±0.06%, respectively). GC-MS chemical profiling analysis further revealed the presence of major phytosterols, including stigmasterol and campesterol. The comparative findings indicate compositional variations influenced by geographical and cultivation factors, underscoring the potential of *C.intybus* L. roots as valuable sources of phytochemicals for nutraceutical and pharmaceutical applications.

Keywords: *Cichorium intybus* L.; phytochemistry; macroelements; microelements; GC-MS.

Citation: Amzeyeva, U., Tolepbergen, A., Huanbieke, S., Karunakaran, T., Baiseitova, A., Jenis, J. (2026). Comparative phytochemical profiling of the underground parts of *Cichorium intybus* L. Bulletin of the L.N. Gumilyov ENU. Chemistry. Geography Series, 154(1), 10-25. https://doi.org/10.32523/3107-278X-2026-154-1-10-25

Academic Editor:
E.E. Kopishev

Received: 21.05.2025
Revised: 09.02.2026
Accepted: 28.02.2026
Published: 31.03.2026

1. Introduction

Herbal remedies in both traditional and modern society have a long history as a combination purifier that has been approved by the Food and Drug Administration (Butler, 2004; Marcy et al., 2005; Koehn et al., 2006; Jones et al., 2006). *Cichorium intybus* L. is a known plant with many food costs and various biological activities. In recent years, the consumption of food products with animal origin has sharply increased, that along with

reduction in the consumption of plant foods rich in fiber, vitamins and trace elements has caused a series of health problems (Paniangvait et al., 1995; Lentini et al., 2007). Many researchers conducted over the past decade has identified that fresh leafy vegetables, are very important in the diet because of the vitamins (A, B, C, E, P), minerals (K, Ca, Mg, Fe, Zn) and biologically natural compounds (phenolic compounds, flavonoids, alkaloids) (Kimura et al., 2003; Kmiecik et al., 2001; Su et al., 2002).

Chicory is a medicinally important plant which belongs to the *Asteraceae* family. *C. intybus* L., commonly known as chicory, is a perennial herbal plant most often bearing bright blue flowers that has been grown since ancient times. Traditionally, *C. intybus* L. is used as food and medicinal crop in temperate parts of Europe and Asia and finds its application in food and pharmaceutical industries (Scholz et al., 2006; Blumenthal, 1998). Chicory is found to be effective in the treatment of jaundice, asthma, gout, rheumatic complaints (Poletti et al., 1989) as well as against cardiac ailments (Vilkhu et al., 2008). Besides the medicinal application of this plant, there are several other uses of *C. intybus* L., including the industrial extraction of inulin, as a coffee substitute, or as animal food. Moreover, the leaves of the plant can be consumed raw or cooked (Cadalen et al., 2010; Street et al., 2013). Its leaves and roots are consumed as fresh or cooked vegetables and coffee substitute, respectively. All parts of the plant including roots, stems, leaves, and flowers get dry and are used as powder form in a variety of herbal medicines.

Chicory has rich nutritional composition and is potentially a rich source of bioactive secondary metabolites for human food fortification: inulin, sesquiterpene lactones (lactucin, lactucopicrin, 8-deoxy lactucin, guaianolid glycosides, including chicoroisides B and C, sonchuside C), caffeic acid derivatives (chiroric acid, chlorogenic acid, isochlorogenic acid, dicaffeoyl tartaric acid), fats, proteins, hydroxycoumarins, flavonoids, alkaloids, steroids, unsaturated sterols, terpenoids, oils, volatile compounds, vitamins (α-tocopherol, γ-tocopherol), β-carotene, zeaxanthin, polyphenols and minerals (Abbas et al., 2015; Ferrazzano et al., 2011; Sampaio et al., 2009; Yoo at al., 2011). Among these chemical constituents, Inulin is the main component of its root that has many food and medicinal uses. Biological activity of inulin - improves bowel function, stimulates the growth of beneficial bacteria such as bifidobacteria, and improves microflora. Inulin also helps regulate blood sugar levels, helps reduce cholesterol levels, and improves metabolism (Visuthranuku et al., 2024; Qin et al., 2023).

In addition to its important nutritive profile, previous studies illustrated chicory has many types of pharmacological activities: hepatoprotective, anti-inflammatory, antioxidant, anthelmintic, anti-malarial, sedative, immunological, antiallergic, cardiovascular, hypolipidemic, antidiabetic, tumor-inhibitory, gastro-protective, antimicrobial, antibacterial and many others (Miller et al., 2011; Schumacher et al., 2011; Ghamarian et al., 2012; Krylova et al., 2015; Shaikh et al., 2012, Keshavarzi et al., 2024; Saeed et al., 2017, Aisa et al., 2020; Nwafor et al., 2017; Saadati et al., 2024).

Chicory is especially attractive as a cash crop since it can reach more than 62 t ha^{-1} under favorable conditions. Inulin content can reach on average 15% of root fresh weight and a yield of 8 t ha^{-1} of inulin is achievable (Papetti et al., 2013). The USA imports more than 2.3 million kilograms of chicons and 1.9 million kilograms of roasted chicory roots for coffee according to 2002 US Department of Commerce tariff and trade data (Schmidt et al., 2007). Numerous studies have focused on different cultivation aspects of chicory. Chicory is considered one of the most important sources of inulin since it has a high root yield potential and also a high root sugar content (Rani et al., 2004).

Optimizing extraction processes is crucial across industries and requires a combination of experimental techniques and tools. Ultrasonic-assisted extraction optimized by response surface methodology (RSM) has been used to obtain chicory extracts containing aesculetin, caftaric acid, caffeoylmalic acid, scopoletin, and chicoric acid, which demonstrated protective effects in liver cells, highlighting their potential as functional food ingredients (Baiseitova et al., 2025).

Relevance of the research topic**.** Despite its recognized potential, chicory′s pharmacological and chemical properties have not been extensively explored in Kazakhstan. While the plant is widely used in Europe and other regions, its applications and therapeutic potential remain underutilized in

Kazakhstan. There is a lack of comprehensive research regarding the chemical composition of Kazakhstan's native chicory varieties, and there is little understanding of how these varieties might differ from those used in other countries in terms of medicinal properties.

With increasing healthcare challenges in Kazakhstan, including the prevalence of lifestyle-related diseases, finding alternative and natural therapeutic agents from locally available plants is crucial. Chicory′s documented health benefits could offer new treatment options.

The theoretical significance of studying chicory lies in its potential for a deeper understanding of plant-derived bioactive compounds and their chemical interactions in the human body. Studying the chemical composition of chicory may contribute to the development of a more precise pharmacological profile of this plant, as well as the discovery of new bioactive molecules with potential medical applications.

The practical significance of chicory research lies in its potential for use in the pharmaceutical industry, where chicory can be used to develop natural therapeutic products.

The aim of this study is to comparatively evaluate the phytochemical composition of *Cichorium intybus* L. roots cultivated in Kazakhstan and imported from China, in order to assess variations in bioactive compounds and highlight their potential as valuable sources for nutraceutical and pharmaceutical applications.

2. Materials and methods

2.1. Plant material

Cultivated *Cichorium intybus* L. roots were identified by qualified scientists from the Research Institute for Natural Products & Technology LLP, Almaty, Kazakhstan and their botanical authenticity was confirmed in accordance with standard pharmacognostic procedures. Chicory roots were purchased from Jiangsu Yabang Chinese Medicine Co., Ltd., Jiangsu, China, as standardized, ready-to-use raw material, verified by the company′s specialists. The underground parts were individually chopped into small pieces, air-dried, and kept at room temperature (Figure 1).

a **b** **c**

Figure 1. The aerial part of cultivated *C. intybus* L.(a) root of the cultivated (b) and root of chicory was imported from China (c)

2.2. The quantitative and qualitative analysis

The quantitative and qualitative analysis of the main bioactive compounds in the underground parts of *Cichorium intybus* L. was carried out according to the methods described in the monograph (Scholz et al., 2006) and in Chemistry of Natural Compounds for Scientific and Laboratory Works (Jenis Janar, 2021). The extractive content of the roots of C. intybus L. was determined using a 90% ethanol solution, following the procedures outlined in the State Pharmacopoeia (State Pharmacopoeia, 2014). All data are expressed as the mean ±standard deviation of three replicates.

2.3. Mineral composition analysis

The mineral composition of the plant samples was determined using a Shimadzu AA-6200 Atomic Absorption Spectrophotometer (AAS) (Shimadzu Corporation, Japan). The instrument operates at a voltage of 220–230 V, a frequency of 50/60 Hz, and a power of 300 VA, allowing precise quantitative analysis of essential metals and trace elements in plant tissues. 3 g of raw material was placed in a pre-calcined and accurately weighed porcelain crucible. Then the crucible was gently heated, first letting the substance burn at the lowest possible temperature, and the flame was gradually increased. Calcination was performed at 500°C to obtain a constant mass. At the end of the calcination, the crucible was cooled in a desiccator and then the resulting ash was burned again at 600°C until a uniform gray color was obtained. The ash of plant was dissolved in 10.0 mL of 40% nitric acid by heating. After that, the resulting solution was heated to obtain wet salts. Subsequently, it was dissolved in 15.0 mL of 1 N nitric acid and transferred to a 25.0 mL volumetric flask for analysis.

2.4. Extraction and partition of the crude extract by polarity

Extraction was conducted with maceration method due to the high mass of the plant materials. This method involves repeatedly extracting the crushed plant material with small portions of solvent at room temperature. Aerial and underground parts of *C. intybus* L. were extracted with 90% ethanol in a 1:8 (wt%) ratio at room temperature for 7 days, with three extractions. The extract was then concentrated under vacuum at 45-50°C using a rotary evaporator. The crude extract was first fractionated with petroleum ether (PE). The remaining extract was subsequently fractionated with dichloromethane (DCM). The DCM-insoluble portion was further fractionated with ethyl acetate (EA), and the EA-insoluble fraction was then extracted with butanol (BuOH). The final aqueous residue was also collected.

Both cultivated and purchased *Cichorium intybus* L. were subjected to extraction and sequential fractionation. A total of 8.0 kg of cultivated plants and 5.0 kg of purchased plants were each extracted three times with 90% ethanol, yielding 1,400 g and 875 g of crude ethanol extract, respectively.

The crude extracts were sequentially fractionated using solvents of increasing polarity. Initially, the extracts were partitioned with petroleum ether (PE). The remaining extracts were subsequently fractionated with dichloromethane (DCM), producing 5.8 g and 3.6 g DCM fractions from cultivated and purchased plants, respectively.

2.5. *Gas Chromatography-Mass Spectrometry (GC-MS) determination*

The crude ethanol extract was mixed with water and dissolved at room temperature. The solution was then transferred to a separation funnel, where petroleum ether was added in a 1:1 ratio three times. After shaking the mixture mechanically and allowing it to settle for a period, the petroleum ether layer was separated from the aqueous phase and dried using an EYELA N-1300 rotary evaporator at 35ºC to yield the desired concentrate. The same procedure was repeated with dichloromethane.

Our gas chromatograph 7890A (Agilent, USA) is equipped with two split/splitless inlets, mass spectrometric Agilent 5975C TAD and electron-capture detectors. Such configuration allows flexible solution of many different analytical and research tasks. The sample volume was 0.5 μL, injection temperature was 280°C, with no split. Separation was performed using a DB-WaxEtr capillary chromatographic column, 30 m in length, 0.25 mm internal diameter, and 0.25 μm film thickness, with a constant carrier gas (helium) flow rate of 1 mL/min. The chromatography temperature was programmed from 40°C at a heating rate of 5°C/min to 260°C (hold 5 min). Detection was carried out in SCAN mode with m/z 34–750. Agilent MSD ChemStation software (version 1701EA) was used to control the gas chromatography system, record, and process the obtained results and data. Data processing included determination of retention times, peak areas, and analysis of the spectral information obtained from the mass spectrometric detector. The Wiley 7th edition and NIST′02 libraries (containing over 550,000 spectra) were used to interpret the obtained mass spectra.

2.6. *Statistical analysis*

All experiments were performed in triplicate, and the obtained data are presented as the mean ± standard deviation (SD). Statistical analysis was conducted to assess data variability and experimental reproducibility. Descriptive statistics were used to summarize the results. When applicable, differences between groups were evaluated using appropriate statistical methods, and a value of $p < 0.05$ was considered statistically significant.

3. Results

A quantitative and qualitative analysis of bioactive constituents, moisture content, total ash, and extractives was performed on *Cichorium intybus* L. The results are presented in Table 1.

The comparative analysis of root samples from cultivated *C. intybus* L. (CI-C) and those purchased from China (CI-I) reveals significant differences in their chemical composition. These variations could have implications for their nutritional, medicinal, and industrial applications.

Table 1. Quantitative and qualitative analysis of the main biologically active components of the root parts of *C. intybus* L. (%)

Plant	Moisture	Ash	Extractive substances (EtOH)	Carboxylic acids	Flavonoids	Polysaccharides	Tannins	Vitamin C	Coumarins	Saponins
The root of the CI-C	4.5± 0.1	2.69± 0.11	82.25 ±3.5	0.035± 0.004	0.019± 0.002	0.838 ±0.04	2.18± 0.1	0.0062± 0.0007	2.407 ±0.13	1.326 ±0.07
The root of the CI-I	7.0± 0.3	7.52± 0.3	85.78 ±3.3	0.037± 0.004	0.001 ± 0.0001	0.444± 0.025	1.75± 0.08	0.0089 ± 0.001	0.095 ±0.01	0.573± 0.06

The analysis of trace elements in the roots of both cultivated and purchased *C. intybus* L. revealed notable differences in their concentration levels, indicating distinct environmental influences and physiological processes that affect the mineral uptake in these two forms of the plant. The results are presented in Table 2.

Table 2. Composition of macro-micro elements in the plant of the underground parts of *C. intybus* L. (mg/g)

Elements	The root of the CI-C	The root of the CI-I
Zn	0.5967±0.12	0.0152±0.0020
Ni	-	0.0035±0.0005
Mn	0.8902±0.17	0.0188±0.0025
Fe	5.1241±0.75	0.1527±0.0180
Pb	-	0.0020±0.0003
Cd	0.0017±0.05	0.0005±0.00007
Cu	0.2606±0.07	0.0051±0.0006
Ca	22.7368±1.50	4.5276±0.15
Mg	36.9904±2.70	1.2576±0.07
K	493.4968±8.20	462.0688±9.40
Na	91.9865±3.60	73.3265±3.80

The constituents of dichloromethane extracts from the underground part of *Cichorium intybus* L. were analyzed by GC-MS, which allows for detailed analysis of their chemical composition. This technique provides accurate identification and quantification of complex organic compounds, including active pharmacological substances, toxins, and metabolites. GC-MS also facilitates the identification of new biologically active components, monitoring the quality of herbal preparations, and assessing their safety, which is essential for the development of effective and safe drugs.

GC-MS chromatogram of dichloromethane extract from the underground part of chicory grown by ourselves (CI-C-DCM). Active substances with retention time, molecular formula, molecular weight and concentration (%) are presented in Table 3 and Figure 2. As a result, 51 compounds were identified and their concentrations were determined. The compounds detected are primarily fatty acids, sterols, and phenolic compounds, many of which are known for their biological activity. Among them, the main components are 9-Hexadecanoic acid, 4-((1E)-3-Hydroxy-1-propenyl)-2-methoxyphenol, oleic acid, benzenemethanol, 2,5-dimethoxy-, acetate, campesterol, stigmasterol.

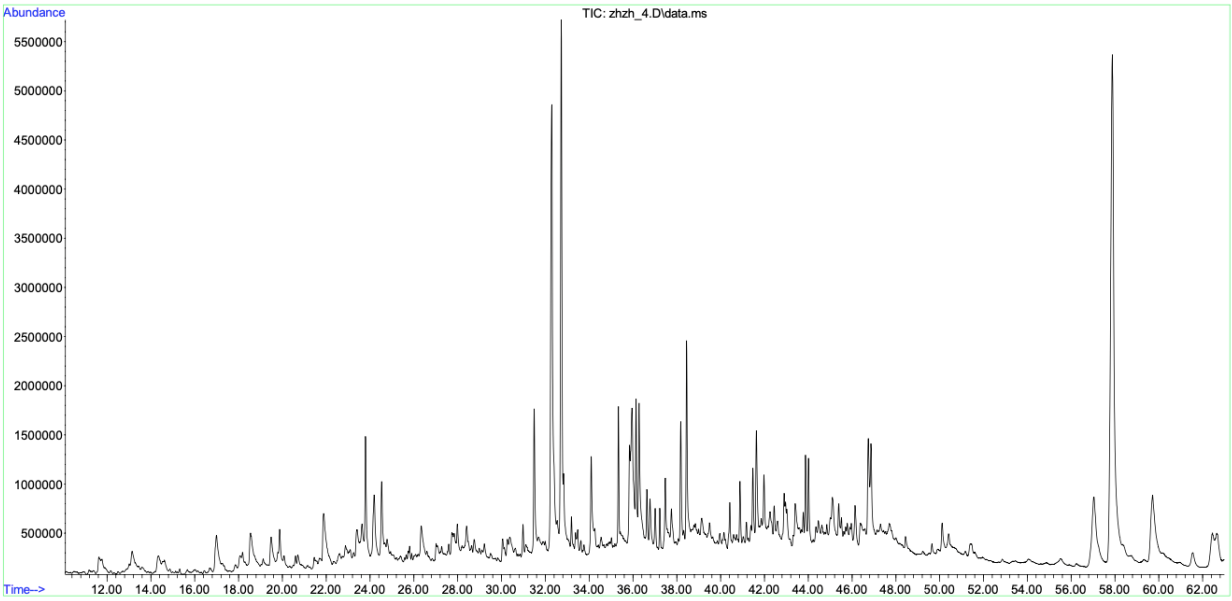
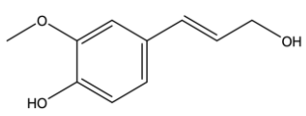
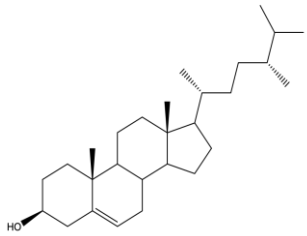
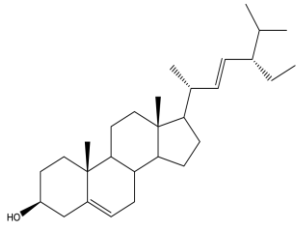


Figure 2. Chromatogram of CI-C-DCM underground part

Table 3. Major chemical constituents of CICDCM underground part

№	t_R (min)	Compounds	Molecular Formula	MW	Structure	Identification probability, %	Relative content, %
1	32.30	Hexadecanoic acid	$C_{16}H_{32}O_2$	256		85	10.57± 0.6
2	32.73	4-((1E)-3-Hydroxy-1-propenyl)-2-methoxyphenol	$C_{10}H_{12}O_3$	180		90	8.56± 0.4

3	35.96	Oleic acid	$C_{18}H_{34}O_2$	282		84	3.84± 0.02
4	57.05	Campesterol	$C_{28}H_{48}O$	400		67	3.61± 0.02
5	57.88	Stigmasterol	$C_{29}H_{48}O$	412		94	19.41±1

GC-MS chromatogram of the dichloromethane extract from underground part of the purchased chicory (CI-I-DCM). The active substances with their retention time, molecular formula, molecular weight and concentration (%) are presented in Table 4 and Figure 3.

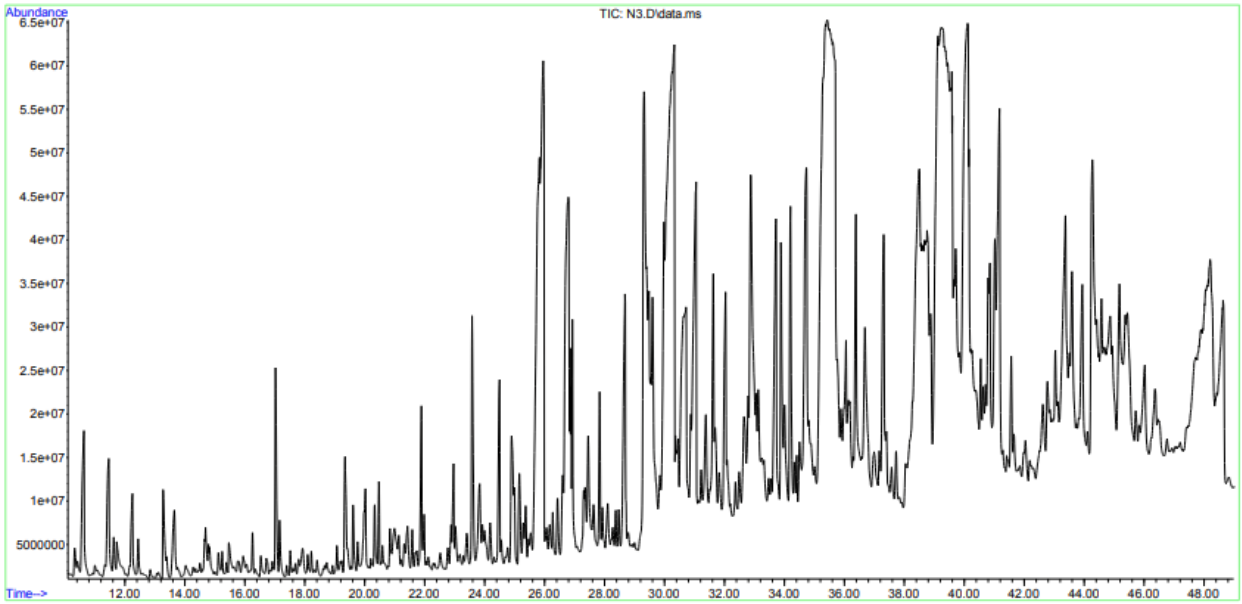
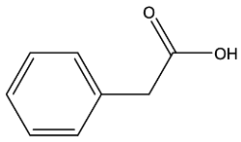
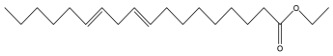
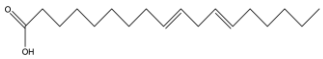
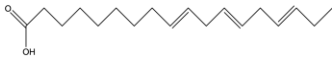
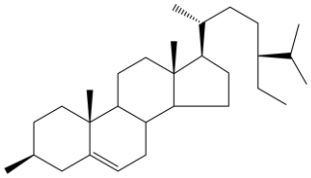


Figure 3. Chromatogram of CI-I-DCM underground part

Table 4. Major chemical constituents of CI-I-DCM underground part

№	t_R (min)	Compounds	Molecular Formula	MW	Structure	Identification probability, %	Relative content, %
1	25.93	Hexadecanoic acid, ethyl ester	$C_{18}H_{36}O_2$	284		87	4.57±0.05
2	29.33	Benzeneacetic acid	$C_8H_8O_2$	136		82	3.91±0.02
3	30.27	9,12-Octadecadienoic acid, ethyl ester	$C_{20}H_{36}O_2$	308		89	6.47±0.3
4	35.42	Hexadecanoic acid	$C_{16}H_{32}O_2$	256		90	10.34±0.4
5	39.25	9,12-Octadecadienoic acid (Z,Z)-	$C_{18}H_{32}O_2$	280		88	12.01±0.5
6	40.09	9,12,15-Octadecatrienoic acid, (Z,Z,Z)-	$C_{18}H_{30}O_2$	278		89	5.48±0.2
7	48.20	γ-Sitosterol	$C_{29}H_{50}O$	414		83	5.63±0.2

A total of 65 compounds were identified, with their concentrations quantified, revealing a complex mixture of fatty acids, esters, and sterols, all of which contribute to the overall bioactivity of the extract. Among these, several key compounds, such as 9,12-octadecadienoic acid (Z,Z)-, hexadecanoic acid, 9,12-octadecadienoic acid ethyl ester, γ-sitosterol, and hexadecanoic acid ethyl ester, were found in significant concentrations, indicating their potential role in the therapeutic effects of the extract.

4. Discussion

The moisture content of the CI-C was found to be 4.5±0.1%, whereas the CI-I had a higher moisture content of 7.0 ± 0.3%. This higher moisture content in the roots from China may indicate differences in the environmental or growth conditions, which may affect the plant's bioactive compound concentration. The higher moisture in wild-grown roots might also influence the storage and processing of these plants for use in various applications.

Root purchased exhibits a significantly higher ash content (7.52±0.3%) compared to the cultivated root (2.69±0.11%). Extractive substances (90% ethanol) were present at 82.25% in the

cultivated roots and 85.78% in the purchased roots. These extractives typically contain soluble bioactive compounds, suggesting that both root samples have a high potential for the extraction of biologically active substances.

Flavonoids are recognized for their antioxidant properties, and there are notable differences in their concentrations between the two varieties of *C. intybus.* The CI-C contains a much higher flavonoid level 0.019±0.002% compared to the second root 0.001±0.0001%. This difference could be attributed to the controlled growing conditions of the cultivated plants, which may enhance the production of these bioactive compounds, potentially through improved farming practices. Flavonoids play a crucial role in human health due to their ability to scavenge free radicals, reduce oxidative stress, and modulate inflammatory pathways. They have been linked to protective effects against cardiovascular diseases, metabolic disorders, and certain types of cancer, while also supporting immune function and overall cellular health (Shahparan et al., 2024;Keshavarzi et al., 2024).

Polysaccharides, essential for immune support and metabolic health, are found in both root varieties, with the CI-C showing a higher concentration (0.838±0.04%) compared to the wild variety (0.444±0.025%). Higher polysaccharide levels in cultivated roots suggest potential advantages for therapeutic applications where immunomodulatory or anti-inflammatory properties are desired.

Tannin content was found to be 2.18±0.1% in CI-C and 1.75±0.08% in the CI-I, demonstrating a slight difference between the two samples. Tannins are known for their astringent properties and potential health benefits, such as antimicrobial activity.

The content of vitamin C, carboxylic acids, coumarins and saponins in both types of roots is insignificant, with a preference towards cultivated plants for coumarins and saponins.

The elemental composition of *C. intybus* L. roots showed significant differences between cultivated and purchased roots. The zinc content in the cultivated roots was significantly higher (0.5967 mg/g) compared to the roots purchased (0.01524±0.0020 mg/g). Zinc is an essential micronutrient involved in many physiological processes, including enzyme function and protein synthesis. The lower concentration in the Chinese roots may indicate differences in the soil's availability of zinc or the specific agricultural practices employed.

A notable difference was observed in the iron content, with the CI-C containing 5.1241±0.75 mg/g, while the CI-I contained only 0.15273±0.0025 mg/g. Iron is vital for chlorophyll synthesis and overall plant health. This discrepancy could be influenced by soil iron availability or the specific cultivation practices in the respective regions.

The CI-C had a much higher calcium content (22.7368±1.5 mg/g) compared to the CI-I (4.52765±0.15 mg/g). Calcium plays a crucial role in cell wall structure and plant rigidity. The higher calcium content in the cultivated roots could indicate a more calcium-rich soil or different agronomic practices that favor calcium uptake. Calcium is not only essential for plant growth but is also a vital nutrient for human health. More than 99 % of calcium in the human body is stored in bones and teeth, where it contributes to bone strength and mineralization. Adequate dietary calcium intake is crucial for achieving peak bone mass in early adulthood, maintaining bone density throughout life, and reducing the risk of osteoporosis and fractures in older age (Zhu et al., 2012).

The CI-C had higher concentrations of, manganese (0.8902±0.17 mg/g), magnesium (36.9904±2.7 mg/g), copper (0.2606±0.07 mg/g), potassium (493.4968±8.2 mg/g), and sodium (91.9865 mg/g), suggesting soil differences and varying agricultural practices. In contrast, the CI-I contained lower levels of these elements, with notably lower zinc (0.01524±0.0020 mg/g), manganese (0.01882±0.0025 mg/g), and iron (0.15273±0.0180 mg/g). The presence of nickel (0.00352±0.0005 mg/g), lead (0.00203±0.0003 mg/g), and cadmium (0.00048±0.00007 mg/g) in the Chinese roots, along with their absence or lower concentrations in the cultivated roots, may indicate environmental contamination or differences in soil quality. Minerals interact together to maintain physiological cellular and tissue activities, and their dysregulation can impair organ function. Manganese is essential for enzymatic reactions and antioxidant defense, supporting plant growth, metabolism, and human bone and connective tissue health. Copper is essential for key enzymatic activities, including

energy production, iron metabolism, and the formation of connective tissue through cuproenzymes such as cytochrome c oxidase and lysyl oxidase (Obeng et al., 2024). Magnesium acts as a cofactor in over 300 enzymatic processes, supporting energy metabolism, muscle function, and nerve signaling (Al Alawi et al., 2018). Potassium, as the primary intracellular cation, maintains membrane potential and supports nerve impulse transmission, muscle contraction, and cardiovascular function (Zacchia et al., 2016).

The GC-MS data provides compelling evidence for the presence of several bioactive compounds in *Cichorium intybus*'s dichloromethane extract, including fatty acids, phenolic derivatives, and sterols, which contribute to its antioxidant, anti-inflammatory, and cholesterol-lowering properties. The high concentration of stigmasterol suggests that this plant could serve as a valuable source of bioactive sterols with potential therapeutic benefits.

The major components identified such as 9,12-octadecadienoic acid (Z,Z)-, hexadecanoic acid, and γ-sitosterol are known for their anti-inflammatory, antioxidant, and cholesterol-lowering effects, which are crucial for managing various chronic diseases. The synergistic effects of these compounds suggest that *C. intybus* could be a promising candidate for therapeutic applications, particularly in the prevention and management of cardiovascular diseases, metabolic disorders, and inflammatory conditions.

Identified compounds have been found to possess a wide range of biological activities. Their various activities are also mentioned in Table 5.

Table 5. Reported activities of the identified bioactive compounds from dichloromethane part *C. intybus* L.

№	Compound	Activity	References
1	Hexadecanoic acid	Anticancer activity and antioxidant activity	Kumar et al., 2025
2	4-((1E)-3-Hydroxy-1-propenyl)-2-methoxyphenol	Antioxidant, anti microbial and anti inflammatory	Hasanain et al., 2016
3	Oleic Acid	Pro- and anti-tumorigenic activities, antifungal and antitumoral activities	Alabi et al., 2018; Boer et al., 2023
4	Campesterol	Antibacterial, antimalarial, antifertility, anti-inflammatory, blood coagulation, wound healing, and anticancer properties	Uttu et al., 2022
5	Stigmasterol	Anticancer, anti-inflammatory, anti-arthritis, and anti-allergy	Goswami et al., 2023
6	Hexadecanoic acid, ethyl ester	Antioxidant, antifungal, aypocholesterolemic nematicide, aesticide, antiandrogenic flavour, hemolytic, 5-Alpha reductase inhibitor, antiseptic, antimicrobial, hair conditioning agent, solvent	Ajayi et al., 2011
7	Benzeneacetic acid	Antimicrobial, anti-inflammatory and analgesic, antioxidant, endocrine	Salaheldin et al., 2016
8	9,12-Octadecadienoic acid, ethyl ester	Hypocholesterolemic, Nematicide Antiarthritic, Hepatoprotective Anti androgenic, Hypocholesterolemic Nematicide, 5-Alpha reductase inhibitor, Antihistaminic, Anticoronary Insectifuge, Antieczemic and Antiacne	Jananie et al., 2011

9	9,12-Octadecadienoic acid (Z,Z)-	Hypocholesterolemic, Nematicide, Antiarthritic, Hepatoprotective, Anti androgenic, Hypocholesterolemic, Nematicide, 5-Alpha reductase inhibitor Antihistaminic, Anticoronary, Insectifuge, Antieczemic , Antiacne	Nishanthini et al., 2014
10	9,12,15-Octadecatrienoic acid, (Z,Z,Z)-	Hypocholesterolemic, Nematicide, Antiarthritic, Hepatoprotective, Antiandrogenic, Hypocholesterolemic, Nematicide, 5-Alpha reductase inhibitor Antihistaminic, Anticoronary, Insectifuge, Antieczemic, Antiacne	Nishanthini et al., 2014
11	γ-Sitosterol	Antidiabetic activity, anti-inflammatory, antioxidant	Balamurugan et al., 2011

The GC-MS analysis of *Cichorium intybus* dichloromethane extract reveals a diverse array of bioactive compounds with significant therapeutic potential. Key components such as hexadecanoic acid exhibit anticancer and antioxidant properties, contributing to the combat of oxidative stress and cancer cell proliferation. The methoxyphenol derivative 4-((1E)-3-Hydroxy-1-propenyl)-2-methoxyphenol shows strong antioxidant, antimicrobial, and anti-inflammatory effects, suggesting its role in supporting immune function and managing inflammation. Oleic acid, with both pro- and anti-tumorigenic properties, further supports the extract′s potential in cancer therapy.

Sterols like campesterol and stigmasterol offer a broad range of activities, including anti-inflammatory, anticancer, and antibacterial effects, making them vital for managing chronic diseases. Additionally, hexadecanoic acid ethyl ester presents versatile biological effects, including antioxidant, antifungal, and antiandrogenic properties. The extract′s high content of fatty acids and esters, such as 9,12-octadecadienoic acid (Z,Z)-, also indicates potential benefits for lipid metabolism, cholesterol reduction, and anti-inflammatory effects. Finally, γ-sitosterol enhances the extract's potential in managing metabolic disorders, with notable antidiabetic and antioxidant activities.

In future by isolating and identifying, these compounds can be considered to treat the human disorders.

5. Conclusion

This study represents the first scientific investigation of *Cichorium intybus* L. cultivated in Kazakhstan. While *C. intybus* has been studied elsewhere, its cultivation and chemical characterization in the local environmental and agricultural conditions of Kazakhstan have not been previously reported. The comparative analysis of cultivated and purchased roots highlights significant differences in chemical composition, bioactive compound content, and mineral profiles, reflecting the influence of controlled cultivation versus environmental variability. Comparative analysis of cultivated and imported *Cichorium intybus* L. roots revealed clear differences in chemical composition. Cultivated roots contained higher levels of bioactive compounds, such as flavonoids, polysaccharides, tannins, fatty acids, sterols, and phenolic compounds, while imported roots had higher moisture and ash content. GC-MS analysis confirmed the presence of key bioactive substances with antioxidant, anti-inflammatory, and cholesterol-lowering properties, with cultivated roots generally showing higher concentrations. These results highlight the impact of controlled cultivation on enhancing the production of beneficial compounds. The diverse bioactive profile of *C. intybus* underscores its potential as a valuable resource for therapeutic applications and functional foods, supporting its significance in both the pharmaceutical and food industries.

6. Supplementary Materials: no supplementary material.

7. Author Contributions

Conceptualization – U.A., J.J.; methodology - J.J., A.B.; software – U.A., A.T.; validation – Th.K., A.B.; formal analysis – A.T., S.H.; investigation - J.J.; resources - J.J., A.B.; data curation – A.T., S.H.; writing-original draft preparation – U.A.; writing-review and editing – U.A., Th.K.; visualization - J.J.; supervision - J.J., A.B.; project administration – A.B.; funding acquisition - J.J., A.B. All authors have read and agreed to the published version of the manuscript.

8. Author Information

Amzeyeva, Ulpan – senior researcher, Research institute for natural products & technology, Research center for medical plants, Al Farabi Kazakh National University, Al-Farabi ave., 71/17, Almaty, Kazakhstan, 050040; ulpan-92.kz@mail.ru, https://orcid.org/0009-0001-7193-4404

Tolepbergen, Aiya – master, Research institute for natural products & technology, Al-Farabi Kazakh National University, Al-Farabi ave., 71/17, Almaty, Kazakhstan, 050040; nis.sovetbek@gmail.com, https://orcid.org/0009-0001-6052-299X

Huanbieke, Suhaer – master student, Research institute for natural products & technology, Al-Farabi Kazakh National University, Al-Farabi ave., 71/17, Almaty, Kazakhstan, 050040; 1549372750@qq.com, https://orcid.org/0009-0007-5388-8946

Karunakaran, Thiruventhan – Dr. centre for drug research, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia; thiruventhan@usm.my, https://orcid.org/0000-0003-4470-2656

Baiseitova, Aizhamal – PhD, Research institute for natural products & technology, Al Farabi Kazakh National University, Al-Farabi ave., 71/17, Almaty, Kazakhstan, 050040; aizhabaiseitova@gmail.com, https://orcid.org/0000-0002-1549-8978

Jenis, Janar - PhD, Professor, Research center for medicinal plants, Al Farabi Kazakh National University, Al-Farabi ave., 71/17, Almaty, Kazakhstan, 050040; janarjenis@kaznu.kz, https://orcid.org/0000-0002-7148-7253

9. Funding: this research is funded by the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP32727157).

10. Acknowledgements: the authors would like to express their sincere gratitude to the Research Institute for Natural Products & Technology, Almaty, Kazakhstan for the conduction of research and expert support, which became the basis for the creation of this article.

11. Conflicts of Interest: the authors declare no conflicts of interest.

12. References

1. Abbas, Z. K., Saggu, S., Sakeran, M. I., Zidan, N., Rehman, H., & Ansari, A. (2015). Phytochemical, antioxidant and mineral composition of hydroalcoholic extract of chicory (*Cichorium intybus* L.) leaves. *Saudi. J. Biol. Sci*., 22(3), 322–6. https://doi.org/10.1016/j.sjbs.2014.11.015
2. Aisa, H. A., Xin, X., & Tang, D. (2020). Chemical Constituents and Their Pharmacological Activities of Plants From Cichorium Genus. *Chinese Herbal Medicines*, 12, 3, 224–236. https://doi.org/10.1016/j.chmed.2020.05.001
3. Uttu, A. J., Sallau, M. S., Ibrahim, H., & Iyun, O. R. A. (2022). Isolation, characterization, and docking studies of campesterol and β-sitosterol from *Strychnos innocua* (Delile) root bark. *J Taibah Univ Med Sci.*, 18(3), 566–578. https://doi.org/10.1016/j.jtumed.2022.12.003
4. Ajayi, G. O., Olagunju, J. A., Ademuyiwa, O., & Martins, O. C. (2011). GC-MS analysis and phytochemical screening of ethanolic root of *Plumbago zeylanica* (Linn.). *J. Med. Plants Res*., 5(9), 1756-1761

5. Alabi, K. A., Lajide, L., & Owolabi, B. J. (2018). Biological activities of oleic acid and its primary amide: experimental and computational studies. *J. Chem Soc. Nigeria*, 43, 2, 9-18.
6. Al Alawi, A. M., Majoni, S. W., & Falhammar, H. (2018). Magnesium and Human Health: Perspectives and Research Directions. *International Journal of Endocrinology*, 9041694. https://doi.org/10.1155/2018/9041694
7. Baiseitova, A., Amzeyeva, U., Tolepbergen, A., Ulfanova, Y., Shybyray, Ye., Dai, L., Shang, X., Bari Shah, A., Kim, J. Y. & Jenis, J. (2025). Response surface methodology optimization on ultrasonic-assisted extraction of chicory (*Cichorium intybus* L) and their UPLC-ESI-QTOF-MS analysis, antioxidant and hepatoprotective activity. *Journal eFood* , 6(4). https://doi.org/10.1002/efd2.70081
8. Balamurugan, R., Duraipandiyan, V., & Ignacimuthu, S. (2011). Antidiabetic activity of γ-sitosterol isolated from *Lippia nodiflora* L. in streptozotocin induced diabetic rats. *European Journal of Pharmacology*, 667, 1–3, 410–418. https://doi.org/10.1016/j.ejphar.2011.05.025
9. Blumenthal, M. (1998). The complete German Commission E monographs. American Botanical Council, Austin. TX, 109.
10. Deng, B., Kong, W., Suo, H., Shen, X., Newton, M. A., Burkett, W. C., Zhao, Z., John, C., Sun, W., Zhang, X., Fan, Y., Hao, T., Zhou, Ch., & Bae-Jump, V. L. (2023). Oleic Acid Exhibits Anti-Proliferative and Anti-Invasive Activities via the PTEN/AKT/mTOR Pathway in Endometrial Cancer. *Cancers*, 15(22), 5407. https://doi.org/10.3390/cancers15225407
11. Butler, M. S. (2004). The role of natural product chemistry in drug discovery. *J. Nat. Prod.*, 67, 2141–2153. https://doi.org/10.1021/np040106y
12. Cadalen, T., Morchen, M., Blassiau, C., Clabaut, A., Scheer, I., Hilbert, J., Hendriks, T., & Quillet, M. C. (2010). Development of SSR markers and construction of a consensus genetic map for chicory (*Cichorium intybus* L.). *Mol. Breed*., 25, 699–722. https://doi.org/10.1007/s11032-009-9369-5
13. Ferrazzano, G. F., Amato, I., Ingenito, A., Zarrelli, A., Pinto, G., & Pollio, A. (2011). Plant polyphenols and their anti-cariogenic properties: A review. *Molecules*, 16, 1486–1507. https://doi.org/10.3390/molecules16021486
14. Ghamarian, A., Abdollahi, M., Su, X., Amiri, A., Ahadi, A., & Nowrouzi, A. (2012). Effect of chicory seed extract on glucose tolerance test (GTT) and metabolic profile in early and late stage diabetic rats. DARU *Journal of Pharmaceutical Sciences*, 20, 56–65. https://doi.org/10.1186/2008-2231-20-56
15. Ghosh, S. K., Pandey, K., Ghosh, M., & Sur, P. K. (2025). Mycochemistry, antioxidant, anticancer activity, and molecular docking of compounds of F12 of ethyl acetate extract of *Astraeus asiaticus* with BcL2 and Caspase 3. *Scientific Reports*, 15. https://doi.org/10.1038/s41598-025-87775-1
16. Shareef, H. Kh., Muhammed, H. J., Hussein, H. M., & Hameed, I. H. (2016). Antibacterial effect of ginger (*Zingiber officinale*) roscoe and bioactive chemical analysis using gas chromatography mass spectrum. *Oriental Journal of Chemistry*, 32, 2, 817–837. http://dx.doi.org/10.13005/ojc/320207
17. Jananie, R., Prya, V., & Vijayalakshmi, K. (2011). Determination of bioactive components of *Cynodon dactylon* by GC-MS analysis. *New York Sci J.*, 4, 16–20.
18. Jenis, Janar (2021). Chemistry of Natural Compounds for Scientific and Laboratory Works. Almaty, Kazakh University.
19. Jones, W. P., Chin, Y. W., & Kinghorn, A. D. (2006). The role of pharmacognosy in modern medicine and pharmacy. *Curr. Drug. Targets*, 7, 247–264. https://doi.org/10.2174/138945006776054915
20. Keshavarzi, A., Akrami, R., & Zarshenas, M. (2024). Evaluation of the effect of *Cichorium intybus* L. on the liver enzymes in burn patients: a randomized double-blind clinical trial. *International Journal of Clinical Practice*, 2024, 1016247. https://doi.org/10.1155/2024/1016247

21. Kimura, M., & Rodriguez-Amaya, D. B. (2003). Carotenoid composition of hydroponic leafy vegetables. *Journal of Agricultural and Food Chemistry*, 51, 2603–2607. https://doi.org/10.1021/jf020539b
22. Kmiecik, W., Lisiewska, Z., & Jaworska, G. (2001). Effect of storage conditions on the technological value of dill (*Anethum graveolens* L.). *Folia Horticulturea*, 13, 33–43.
23. Knight, T. L., Moss, R. A., Fraser, T. J., Rowarth, J. S., & Burton, R. N. (1996). Effect of pasture species on internal parasites of lambs. *Proc. N. Z. Grassl. Assoc.*, 58, 59–62. https://doi.org/10.33584/jnzg.1996.58.2217
24. Koehn, F. E., & Carter, G. T. (2005). The evolving role of natural products in drug discovery. *Nat. Rev. Drug Discov.*, 4, 206–220. https://doi.org/10.1038/nrd1657
25. Krylova, S. G., Vymyatnina, Z. K., Zueva, E. P., Amosova, E. N., Razina, T. G., & Litvinenko, I. (2015). Effects of *Cichorium Intybus* L. root extract on secretory activity of the stomach in health and ulcer disease. 159(5), 638–41. https://doi.org/10.1007/s10517-015-3035-1
26. Lentini, F., & Venza, F. (2007). Valorizzazione delle piante selvatiche di uso alimentare in Sicilia. Corissia. Agrigento (Italy). https://doi.org/10.1186/1746-4269-3-15
27. Balunas, M. J., & Kinghorn, A. D. (2005). Drug discovery from medicinal plants. *Life Sciences*, 78(5), 431–41. https://doi.org/10.1016/j.lfs.2005.09.012
28. Goswami, M., Priya, Jaswal, Sh., Gupta, Gh. D., & Verma, S. K. (2023). A comprehensive update on phytochemistry, analytical aspects, medicinal attributes, specifications and stability of stigmasterol. *Steroids*. 196, 109244. https://doi.org/10.1016/j.steroids.2023.109244
29. Miller, M. C., Duckett, S. K., & Andrae, J. G. (2011). The effect of forage species on performance and gastrointestinal nematode infection in lambs. *Small Ruminant Research*, 95, 2–3, 188–192. https://doi.org/10.1016/j.smallrumres.2010.09.006
30. Abdelkader, M. S. A., Rateb, M. E., Mohamed, G. A., & Jaspars, M. (2016). Harpulliasides A and B: Two new benzeneacetic acid derivatives from *Harpullia pendula*. *Phytochemistry Letters*, 15, 131–135. http://dx.doi.org/10.1016/j.phytol.2015.12.006
31. Nishanthini, A., Mohan, V. R., & Jeeva, S. (2014). Phytochemical, FT-IR, and GC-MS analysis of stem and leaf of *Tiliacora acuminata*. *IJPSR*, 5(9), 3977-3986. http://dx.doi.org/10.13040/IJPSR.0975-8232.5(9).3977-86
32. Nwafor, I. C., Shale, K., & Achilonu, M. C. (2017). Chemical Composition and Nutritive Benefits of Chicory (*Cichorium intybus*) as an Ideal Complementary and/or Alternative Livestock Feed Supplement. *Scientific World Journal*, 2017, 7343928. https://doi.org/10.1155/2017/7343928
33. Obeng, S. K., Kulhanek, M., Balik, J., Cerny, J., & Sedlar, O. (2024). Manganese: from soil to human health-a comprehensive overview of its biological and environmental significance. *Nutrients*, 16(20), 3455. https://doi.org/10.3390/nu16203455
34. Paniangvait, P., King, A. J., Jones, A. D., & German, B. G. (1995). Cholesterol oxides in foods of animal origin. J. Food. Sci. 60, 1159–74. https://doi.org/10.1111/j.1365-2621.1995.tb04548.x
35. Papetti A., Mascherpaa D., Carazzonea C. (2013). Identification of organic acids in *Cichorium intybus* inhibiting virulence-related properties of oral pathogenic bacteria. *Food Chemistry*, 138, 2–3, 1706–1712. https://doi.org/10.1016/j.foodchem.2012.10.148
36. Qin, Y., Wang, L., Yang, X., Xu, Y., Fan, G., Fan, Y., Ren, J., An, Q., & Li, X. (2023). Inulin: properties and health benefits. *Food Funct.*, 14, 2948-2968. https://doi.org/10.1039/D2FO01096H
37. Rani, P., & Khullar, N. (2004). Antimicrobial evaluation of some medicinal plants for their anti-enteric potential against multi-drug resistant Salmonella typhi. *Phytotherapy Research*, 18, 670–673. https://doi.org/10.1002/ptr.1522
38. Saadati, F., Chahardehi A. M., Jamshidi, N., & Ghasemi, D. (2024). Coumarin: a natural solution for alleviating inflammatory disorders. *Current Research in Pharmacology and Drug Discovery*, 7, 100202. https://doi.org/10.1016/j.crphar.2024.100202

39. Saeed, M., Babazadeh, D., Arif, M., & Asif, M. (2017). Silymarin: a potent hepatoprotective agent in poultry industry. *World's Poultry Science Journal*, 73, 483–492. https://doi.org/10.1017/S0043933917000538
40. Sampaio, F. C., Pereira, M. do S., Dias, C. S., Costa, V. C., Conde, N. C., & Buzalaf, M. A. (2009). *In vitro* antimicrobial activity of *Caesalpinia ferrea Martius* fruits against oral pathogens. *Journal of Ethnopharmacology*, 124, 289–294. https://doi.org/10.1016/j.jep.2009.04.034
41. Schmidt, B., Ilic, N., Poulev, A., & Raskin, I. (2007). Toxicological evaluation of a chicory root extract. *Food Chem. Toxicol*., 45, 1131–1139. https://doi.org/10.1016/j.fct.2006.12.019
42. Scholz, E. (2006). Monographien: *Cichorium*, *Cichorium intybus* L., *Cichorii folia* et radix, *Cichorii radix*. In Hagers handbuch der drogen und arzneistoffe. Springer Medizin Verlag, Heidelberg.
43. Schumacher, E., Vigh, E., Molnar, V., Kenyeres, P., Feher, G., Kesmarky, G., Toth, K., & Garai, J. (2011). Thrombosis preventive potential of chicory coffee consumption: a clinical study. *Phytother Res.*, 25(5), 744–8. https://doi.org/10.1002/ptr.3481
44. Shaikh, T., Rub, R. A., & Sasikumar, S. (2012). Antimicrobial screening of *Cichorium intybus* seed extracts. Arabian Journal of Chemistry. https://doi.org/10.1016/j.arabjc.2012.04.012
45. Shahparan, I., Rashmia, N., & Nazmul, Q. (2024). Medicinal herbs and their metabolites with biological potential to protect and combat liver toxicity and its disorders: A review. *Heliyon*, 10(3), e25340. https://doi.org/10.1016/j.heliyon.2024.e25340
46. State Pharmacopoeia of the Republic of Kazakhstan. Third edition. MZ RK. (2014). Astana. ISBN 978-601-294-214-9.
47. Street, R. A., Sidana, J., & Prinsoloo, G. (2013). *Cichorium intybus*: Traditional uses, phytochemistry, pharmacology, and toxicology. *J. Evid. Based Complement. Altern. Med*., 579319. https://doi.org/10.1155/2013/579319
48. Su, Q., Rowley, K. G., Itsiopoulos, C., & O'Dea, K. (2002). Identification and quantitation of major carotenoids in select components of the Mediterranean diet. *European Journal of Clinical Nutrition*, 56, 1149–1154. https://doi.org/10.1038/sj.ejcn.1601472
49. Vilkhu, K., Mawson, R., Simons, L., & Bates, D. (2008). Applications and opportunities for ultrasound assisted extraction in the food industry: A review. *Innovative Food Science and Emerging Technology*, 9, 161–169. https://doi.org/10.1016/j.ifset.2007.04.014
50. Visuthranukul, C., Sriswasdi, S., Tepaamorndech, S., Chamni, S., Leelahavanichkul, A., Joyjinda, Y., Aksornkitti, V., & Chomtho, S. (2024). Enhancing gut microbiota and microbial function with inulin supplementation in children with obesity. *International Journal of Obesity*, 48, 1696–1704. https://doi.org/10.1038/s41366-024-01590-8
51. Yoo, S., Murata, R. M., & Duarte, S. (2011). Antimicrobial traits of tea- and cranberry derived polyphenols against *Streptococcus mutans*. *Caries Research*, 45, 327–335. https://doi.org/10.1159/000329181
52. Zacchia, M., Abategiovanni, M., Stratigis, S., & Capasso, G. (2016). Potassium: from physiology to clinical implications. *Kidney Diseases*, 2(2), 72–79. https://doi.org/10.1159/000446268
53. Zhu, K., & Prince, R. L. (2012). Calcium and bone**.** *Clinical Biochemistry*, 45(12), 936–942. https://doi.org/10.1016/j.clinbiochem.2012.05.006

Cichorium intybus L. жер асты бөлігінің салыстырмалы фитохимиялық бейіні

Ұлпан Әмзеева, Айя Төлепберген, Сұңқар Хуанбике, Тирувентан Карунакаран, Айжамал Байсеитова, Жанар Жеңіс

Аңдатпа. Дәрілік өсімдіктердің тамырлары фитохимиялық қосылыстарға бай болып, фармацевтикалық және тамақ өнеркәсібі үшін биологиялық белсенді заттардың маңызды көзі болып табылады. Cichorium intybus L. (цикорий), Asteraceae тұқымдасына жататын көпжылдық өсімдік, өзінің тағамдық және дәрілік қасиеттерімен жақсы танымал. Бұл зерттеуде Қазақстанда өсірілген және Қытайдан импортталған C.intybus L. тамырларының фитохимиялық құрамын салыстырмалы түрде зерттеу жүргізілді. Сандық талдау көрсеткендей, өсірілген тамырларда 4.5±0.1% ылғал, 2.69±0.11% күл және 82.25±3.5% экстрактивтік заттар (90% этанол) анықталды, ал импортталған үлгілерде тиісінше 7.0±0.3%, 7.52±0.3% және 85.78±3.3% болды. Өсірілген тамырларда полисахаридтер (0.838±0.04%), таниндер (2.18±0.1%), кумариндер (2.407±0.13%) және сапониндер (1.326±0.07%) деңгейі импортталған үлгілерге қарағанда жоғары болды (0.444±0.025%, 1.75±0.08%, 0.095±0.01% және 0.573±0.06%, сәйкесінше). ГХ-МС химиялық талдау негізгі фитостеролдардың, соның ішінде стигмастерол мен кампестеролдың бар екенін көрсетті. Салыстырмалы нәтижелер құрамдағы айырмашылықтардың географиялық және егу жағдайларына байланысты екенін көрсетіп, *C.intybus* L. тамырларының нутрицевтикалық және фармацевтикалық қолдану үшін құнды фитохимиялық қосылыстар көзі болып табылатын әлеуетін айқындайды.

Түйін сөздер: *Cichorium intybus* L.; фитохимия; макроэлементтер; микроэлементтер; биологиялық белсенділік; ГХ-МС.

Сравнительный фитохимический профиль подземных частей *Cichorium intybus* L.

Улпан Амзеева, Айя Толепберген, Сункар Хуанбике, Тирувентан Карунакаран, Айжамал Байсеитова, Жанар Женис

Аннотация. Корни лекарственных растений богаты важными фитохимическими соединениями и служат значимым источником биологически активных веществ для фармацевтической и пищевой промышленности. *Cichorium intybus* L. (цикорий) – многолетнее растение семейства *Asteraceae*, хорошо известно своими питательными и лекарственными свойствами. В данном исследовании проведено сравнительное изучение фитохимического состава подземных частей (корней) *C. intybus* L., выращенного в Казахстане и импортированного из Китая. Количественный анализ показал, что корни казахстанского происхождения содержали 4,5±0,1% влаги, 2,69±0,11% золы и 82,25±3,5% экстрактивных веществ (90% этанол), тогда как импортные образцы содержали, соответственно 7,0±0,3%, 7,52±0,3% и 85,78±3,3%. Корни, выращенные в Казахстане, также имели более высокое содержание полисахаридов (0,838±0,04%), танинов (2,18±0,1%), кумаринов (2,407±0,13%) и сапонинов (1,326±0,07%) по сравнению с импортными образцами (0,444±0,025%, 1,75±0,08%, 0,095±0,01% и 0,573±0,06%, соответственно). Химический анализ методом ГХ-МС дополнительно выявил присутствие основных фитостеролов, включая стигмастерол и кампестерол. Сравнительные результаты указывают на вариации в составе, обусловленные географическими и агротехническими факторами, что подчеркивает потенциал корней *C. intybus* L. как ценного источника фитохимических соединений для нутрицевтического и фармацевтического применения.

Ключевые слова: *Cichorium intybus* L.; фитохимия; макроэлементы; микроэлементы; биологическая активность; ГХ-МС.