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ELEMENTAL COMPOSITION OF CAMELINA SATIVA (L.) CRANTZ

***The aim of the work is** to establish the qualitative composition and quantitative content of mineral elements in the herb of Camelina sativa (L.) Crantz.*

***Materials and methods.** Camelina sativa (L.) Crantz herb («Slavutych» species) was selected as the object of the study. Samples of seeds for cultivation were provided by the National Center for Plant Genetic Resources of Ukraine. To determine the qualitative composition and quantitative content of macro- and microelements, an atomic emission spectrograph method with photographic registration on the DFS-8 device was used.*

***Results and discussion.** The obtained experimental data of the macro- and micronutrient composition of Camelina sativa (L.) Crantz herb indicate the presence of at least 19 elements in the raw material, of which 6 are macroelements, 8 are microelements and 5 are ultra-microelements. Macroelements such as K, Ca, and Mg are accumulated in the largest quantities; microelements such as Al, Fe, Zn, and Mn are accumulated in the largest quantities. The content of inorganic elements of toxicological significance does not exceed in raw materials the maximum allowable concentrations set by the standards. K, P, and Ca have the highest coefficient of biological accumulation. Of particular interest are Zn and Mg, which may have a variety of pharmacological effects in the treatment of metabolic syndrome and diabetes. Zn is known to play an important role in the activity of the pancreas, insulin synthesis and its binding to hepatocytes, as well as in lipoprotein synthesis. Mg restores insulin sensitivity, thereby preventing the formation of insulin resistance.*

***Conclusions.** The elemental composition of Camelina sativa herb was first studied with atomic emission spectrometry. The obtained data enable to predict certain types of pharmacological activity of extracts and substances obtained from Camelina sativa herb and will be used in the development of quality control methods for raw materials.*

***Key words:** Camelina sativa (L.) Crantz, herb, elemental composition, atomic-emission spectrography.*

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ЕЛЕМЕНТНИЙ СКЛАД ТРАВИ РИЖІЮ ПОСІВНОГО (*CAMELINA SATIVA* (L.) CRANTZ)

***Мета роботи.** Встановлення якісного складу та кількісного вмісту мінеральних елементів в траві рижію посівного.*

***Матеріали та методи.** Об'єктом дослідження було обрано траву рижію посівного сорту «Славутич». Зразки насіння для вирощування були надані Національним центром генетичних ресурсів рослин України. Для визначення якісного складу та*

кількісного вмісту макро- та мікроелементів використовували метод атомно-емісійної спектрографії з фотографічною реєстрацією на приладі ДФС-8.

Результати та їх обговорення. *Отримані експериментальні дані щодо макро- та мікроелементного складу трави рижію посівного свідчать про наявність в сировині не менше 19 елементів, із яких 6 відноситься до макроелементів, 8 мікроелементів 5 ультрамікроелементи. У найбільших кількостях акумулювались такі макроелементи як калій, кальцій, магній; мікроелементи – алюміній, ферум, цинк, манган. Вміст неорганічних елементів у сировині, які мають токсикологічне значення не перевищують гранично допустимі концентрації, що встановлені стандартами. Найвищі показники коефіцієнту біологічного накопичення були для калію, фосфору та кальцію. Певний інтерес представляють цинк та магній, які можуть проявляти різноманітні фармакологічні ефекти при лікуванні метаболічного синдрому та цукрового діабету.Відомо, що цинк відіграє важливу роль у діяльності підшлункової залози, синтезі інсуліну та процесах його зв'язування з гепатоцитами, синтезі ліпопротеїнів. Магній відновлює чутливість до інсуліну, перешкоджаючи тим самим формуванню інсулінорезитентності.*

Висновки. *Методом атомно-емісійної спектрометрії вперше досліджено елементний склад трави рижію посівного. Отримані дані дають змогу прогнозувати певні види фармакологічної активності екстрактів і субстанцій, одержаних з трави рижію посівного, та будуть використані при розробці методик контролю якості на сировину.*

Ключові слова: *рижій посівний, трава, елементний склад, атомно-емісійна спектрографія.*

Introduction. Microelements are the most important catalysts of metabolic processes. They also play an important role in the body's adaptation to the norm and pathology. Despite the fact that microelements do not have energetic value the way proteins, fats and carbohydrates do, many enzymatic processes are impossible without the participation of certain elements (Letivin, 2017). Most of the essential microelements are found in plant products. Therefore, taking into account the important biological role of mineral elements, the actual issue of modern pharmacy is to determine their content in plants in order to expand the raw material base and identify new opportunities for their further use.

In this relation, plants that have long been known in folk medicine and due to lack of information on chemical composition are not used in official medicine, are of particular interest.

The genus Camelina (L.) Crantz belongs to the family Brassicaceae and has 6 species in Ukraine and 19 species in the world (Dobrochaeva, 1987, Francis, 2009). C. sativa is the most common and most well-known species of this genus. Breeders contribute to increasing the diversity of C. sativa. To date, 8 varieties of C. sativa have been registered in Ukraine (State register, 2022). In present-day Ukraine, a valuable gene pool of Camelina has been created; it is located in the National Botanical Garden of M.M. Hryshko National Academy of Sciences of Ukraine (Rakhmetov, 2014, pp. 65-77).

The chemical composition of C. sativa has not been sufficiently studied. It is known that in folk medicine Camelina herb is used as a hypoglycemic, bactericidal, anti-inflammatory, and wound healing agent (Shevchenko, 2017).

The aim of the work is to establish the qualitative composition and quantitative content of mineral elements in C. sativa herb to determine the characteristics of elements accumulation and assess the compliance of raw materials with the SPU requirements.

Materials and methods of research. Camelina sativa (L.) Crantz herb ("Slavutych" species) was selected as the object of the study. Raw material was grown and harvested in the summer of 2018 in the territory of Tersyanka village of Zaporizhzhia region. Samples of seeds 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 elemental composition of the soil on which plant raw materials were grown, was also determined.

The elemental composition was studied on the base of State Scientific Establishment "STC «Institute for Single Crystals» of NAS of Ukraine (Kharkiv). The elements were identified and quantified were conducted using atomic emission spectrophotometry (Derzhavne pidpryiemstvo, 2015, Osmachko, 2017). Spectrograph DFS-8 with a measuring complex for photoelectric registration of emission spectra has been used.

The arc of alternating current was generated by generator «IVS -28». The following conditions of powders evaporation have been set: the amperage of arc alternating current – 16A, the frequency of igniting pulse – 100 bits per second, the analytical slit – 2 mm, the slit width – 0,012 mm, the exposure – 60 seconds. Spectra have been recorded on the photographic film using spectrograph DFS-8 with a diffraction grating of 600 lines/mm and a three-lens system of slit lighting. Lines of spectra have been determined at a wavelength from 270 nm to 347 nm in samples comparing with standard samples of the mineral elements mixture using microphotometer MF-4.

Research results and their discussion. In Camelina sativa (L.) Crantz herb, 19 elements have been identified and quantified: among them there are 6 macroelements (K, P, Mg, Ca, Si, Na), 8 microelements (Fe, Mn, Al, Zn, Mo, Cu, Pb, Sr) and 5 ultramicroelements (Co, Ni, As, Hg, Cd) (table 1).

Table 1

Element composition of Camelina sativa (L.) Crantz

Element	Element content, mg / 100g		Coefficient of biological accumulation
	Herb	Soil	
K	880	1700	0.52
P	90	300	0.30
Mg	175	1500	0.12
Ca	400	1600	0.25
Si	65	34000	0.0019
Na	22	1500	0.015
Fe	3.3	4000	0.000825
Zn	1.7	-	-
Al	9.7	7500	0.0013
Mn	1.3	50	0.026
Ni	0.04	7.0	0.0057
Cu	0.33	30	0.011
Sr	1,5	10	0.15
Mo	0.08	8.0	0.01
Ti	-	550	-
Cr	-	20	-
Pb	<0.03	1.0	<0.03

In Camelina sativa (L.) Crantz herb, the dominant macroelements are (mg/100g): K (880), Ca (400), and Mg (175), and the dominant microelements are Al (9.7), Fe (3.3), Zn (1.7), and Mn (1.3).

The descending series of chemical elements in Camelina sativa (L.) Crantz herb is K>Ca>Mg>P>Si>Na>Al>Fe>Zn> Sr>Mn>Cu>Mo>Ni>Pb=Co>Cd=Al=Hg.

The content of toxicologically significant inorganic elements in the raw material (Pb, Co, Cd, As, Hg) stays within acceptable limits of the level of heavy metals specified in State Pharmacopoeia of Ukraine (mg/100g): Pb<0.03, Co<0.03, Cd<0.01, As<0.01, Hg<0.01 (Derzhavne pidpryiemstvo, 2015).

According to the literature (Pohorielov, 2010) on the daily consumption of elements in the human diet, it can be concluded that C. sativa herb of can meet the human needs in Mg and Si.

An integral criterion for estimating the selective absorption of nutrients from the soil is the coefficient of biological accumulation (CBA). If the value is more than 1, it indicates a high level of accumulation of elements and vice versa.

The highest CBA values were observed for K, P and Ca. In C. sativa herb indicators were the following: K - 0.52, P - 0.30 and Ca - 0.25. The lowest CBA values were registered for Si, Fe and Al.

We did not find reliable data on the elemental content of C. sativa herb for comparison.

It was found that extracts from herb and seeds of C. sativa prevent the formation of insulin resistance in experimental model of metabolic syndrome (Tsykalo, 2020, pp. 137–142). Therefore, in our opinion, Zn and Mg are of some interest, which can have various pharmacological effects in the treatment of metabolic syndrome and diabetes. Zn is known to play an important role in the activity of the pancreas, insulin synthesis and its binding to hepatocytes, as well as for lipoprotein synthesis. Glucose tolerance is impaired due to the deficiency of this element (Chekman, 2013; Martynova, 2019; Suslyk, 2014). Mg restores insulin sensitivity by combining with the latter, activates this hormone and potentiates the transmembrane transition of glucose into muscle, hepatocytes and other energy-intensive, mitochondrial-saturated cells of the body, thereby preventing the formation of insulin resistance (Suslyk G.I., 2014, 19-24).

Conclusions

1. The elemental composition of C.sativa herb was first studied by atomic emission spectrometry. The content of 19 elements has been determined.

2. K, Ca and Mg are accumulated in the largest amount.

3. The obtained data enable to predict certain types of pharmacological activity of extracts and substances obtained from C. sativa herb and will be used in the development of quality control methods for raw material.

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