The study on the elemental composition of the feverfew herb (Tanacetum parthenium (L.) Schultz bip.)

Macro- and microelements affect the vital functions of plants; they are an integral part of the medicinal plant raw material and play a significant role in the pharmacological activity of herbal medicines. Expediency of determination of the heavy metals content is stipulated by the requirements to the raw material. Within the standardization of the feverfew raw material batches the comparative study of the elemental composition of the herb depending on the regions of the raw material collection has been conducted.

Aim. To analyze the degree of accumulation of macro- and microelements of the feverfew herb collected in 7 regions of Ukraine.

Materials and methods. The study object was batches of the feverfew herb collected in 7 regions of Ukraine. The qualitative composition and quantitative content of the elements were determined using the atomic emission spectroscopy method at the Laboratory of Analytical Chemistry of Functional Materials and Environmental Objects of the STC “Institute for Single Crystals”, National Academy of Sciences of Ukraine (Kharkiv) using a CAS-120 device, manufacturing group "Electron" by atomization in air-acetylene flame.

Results and discussion. As a result of the study conducted 18 elements were identified in all batches of the raw material. The prevailing content of potassium was identified in the samples from the Kharkiv, Zhytomyr and Poltava regions. The calcium content prevailed in the samples from the Kharkiv, Zhytomyr and Cherkasy regions. The greatest content of silicon and magnesium was identified in the samples from the Kharkiv and Zhytomyr regions. Nickel, molybdenum and lead were in the least quantity among the microelements in the feverfew herb. The content of cobalt, cadmium, arsenic and mercury was within the maximum permissible limits.

Conclusions. For the first time the study of the mineral composition of samples of the feverfew herb from different regions of Ukraine was carried out using the atomic emission spectroscopy. The studies conducted indicate that the content of potassium, calcium, silicon and magnesium prevails in all samples of the raw material.

Key words: feverfew (Tanacetum parthenium); mineral composition; atomic emission spectrophotometry; macro- and microelements
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Исследование элементного состава травы пижмы девичьей (Tanacetum parthenium (L.) Schultz bip.)

Макро- и микроэлементы влияют на жизненные функции растений, являются составляющей лекарственного растительного сырья и играют значительную роль в фармакологической активности растительных лекарственных средств. Целесообразность определения содержания тяжелых металлов обусловлена требованиями к качеству сырья. В рамках стандартизации серий сырья пижмы девичьей – Tanacetum parthenium (L.) Schultz bip. было проведено сравнительное изучение элементного состава травы в зависимости от региона заготовки.

Цель. Проанализировать степень накопления макро- и микроэлементов в 7 сериях травы пижмы девичьей, заготовленной в разных областях Украины.

Материалы и методы. Объектом исследования были серии травы пижмы девичьей, заготовленной в 7 областях Украины. Накопление макро- и микроэлементов определяли методом атомно-адсорбционной спектроскопии с атомизацией в воздушно-ацетиленовом пламени при приборе КАС-120 на базе НТК «Институт моно- кристаллов» НАН Украины.

Результаты и их обсуждение. В результате проведенного исследования во всех сериях ПРС обнаружено и определено содержание 18 элементов. Преобладающими элементами калия определено в образцах из Харьковской, Житомирской и Полтавской областей. Содержание кальция преобладало в образцах из Харьковской, Житомирской и Черкасской областей. Наименьшее содержание кремния и кальция наблюдалось в образцах из Харьковской и Житомирской областей. Среди микроэлементов в траве пижмы девичьей в наименьшем количестве были никель, молибден и свинец. Содержание кобальта, кадмия, мышьяка и мышьяка находилось в пределах гранничи допустимых концентраций.

Выводы. Впервые методом атомно-адсорбционной спектрофотометрии изучено накопление макро- и микроэлементов в образцах травы пижмы девичьей, заготовленной в разных областях Украины. Проведенные исследования свидетельствуют о значительном содержании калия, кальция, кремния и меди в траве пижмы девичьей.

Ключевые слова: пижма девичья (Tanacetum parthenium); минеральный состав; атомно-эмиссионная спектроскопия; макро- и микроэлементы

The human organism is a coherent system that functions harmoniously due to the optimal composition of many compounds. It is known that 31 compounds are essential for a person, including 8 amino acids, 12 vitamins and 11 mineral elements [1, 2].

Plants are the main source of minerals since they absorb elements from the soil and through the transpiration stream of water provide the tissues and organs of the plant organism with them. Mineral compounds getting into the human organism act as regulators of over 50,000 biochemical processes and normalize metabolism [3, 4].

Excess or deficiency of elements causes significant pathological changes in the human organism.

The study of the elemental composition of the raw material of promising medicinal plants is of current interest since it is known that macro- and microelements that are part of plant organs affect the biological activity of herbal medicinal products on its basis [5, 6, 7].

Feverfew (Tanacetum parthenium (L.) Schultz Bip.), a plant of the genus Tanacetum is widely used in folk medicine. This is a perennial herbaceous plant originating from Eurasia, Asia Minor and the Balkan Peninsula; it is widely cultivated in Ukraine and other European countries [8, 9]. The main indications for the use of the feverfew herb are inflammatory diseases of the connective tissue, gynecological diseases and migraine [10]. The biological activity of this plant is mainly due to sesquiterpene lactones, which are approximately 30, phenolic compounds, such as flavonoids, hydroxycinnamic acids, coumarins, organic acids [11, 12, 13, 14].

The aim of the work was to analyze the degree of accumulation of macro- and microelements of the feverfew herb in 7 batches collected in 7 regions of Ukraine.

Materials and methods

The study object was batches of the feverfew herb collected in Kharkiv (Rs 868), Zhytomyr (Rs 864), Cherkasy (Rs 865), Sumy (Rs 866), Dnipropetrovsk (Rs 867), Poltava (Rs 869), and Kiev (Rs 870) regions. The batches of the medicinal plant raw material were registered in the State Enterprise “Ukrainian Scientific Pharmacopoeial Center for Quality of Medicines”.

The qualitative composition and quantitative content of the elements were determined using the atomic emission spectroscopy method at the Laboratory of Analytical Chemistry of Functional Materials and Environmental Objects of the STC “Institute for Single Crystals”, National Academy of Sciences of Ukraine (Kharkiv) using a CAS-120 device, manufacturing group “Electron” by atomization in air-acetylene flame. Analytical parameters were the following: pressure – 0.4 kg/cm², flame temperature – 2250 °C. The plant material samples were pretreated with diluted sulfuric acid with further carbonization in a muffle furnace under the temperature of 500 °C and evaporation from graphite electrode craters in AC arc discharge at 16 A current and 60 sec exposure. Registration of the samples was carried out on a DFS-8 spectrograph, estimation of the line intensity in the spectra – by a MPH-1 microphotometer. The spectra were photographed in the wavelength range of 230-330 nm. The calibration plots were built using the standard samples of solutions of metal salts (ICOMP-23-27) [15, 16].
Results and discussion

The results of studying the qualitative composition and quantitative content of macro- and microelements in the batches of the feverfew herb are shown in Table.

As a result of the study conducted 18 elements were identified in all batches of the raw material, and their content was determined. Potassium, calcium, silicon and magnesium contained in the largest quantities there. The prevailing amount of potassium was determined in the samples from the Kharkiv, Zhytomyr and Poltava regions (3840 μg/100 g, 3000 μg/100 g, 2940 μg/100 g). Calcium predominated in the samples of the raw material from the Kharkiv, Zhytomyr and Cherkasy regions (1080 μg/100 g, 840 μg/100 g, 790 μg/100 g). The highest content of silicon and magnesium was observed in the samples from the Kharkiv and Zhytomyr regions, slightly smaller amount in the samples from the Dnipropetrovsk and Poltava regions. A rather high content of copper was determined in the sample from the Cherkasy region – 3.16 μg/100 g.

After analyzing the degree of accumulation of elements in the batches of the raw material it was determined that the elements in the samples from the Zhytomyr, Cherkasy and Dnipropetrovsk regions accumulated in the following order: K > Ca > Si > Mg > P > Na > Al > Fe > Mn > Zn > Cu > Ni > Mo > Pb. In the samples from the Sumy and Poltava regions the degree of accumulation of elements was the same and corresponded to the following order: K > Ca > Mg > P > Si > Na > Al > Mn > Fe > Zn > Cu.

The content of potassium, calcium, sodium, aluminum, and copper was also observed at the same level in all batches of the raw material. Therefore, one can assume that their content in the raw material is quite stable regardless of the place of growth of the species. The content of the other elements varied slightly in different batches.

Nickel, molybdenum and lead were in the least quantity among the microelements in the feverfew herb. The content of nickel ranged from 0.04 to 0.12 μg/100 g, the content of molybdenum – from 0.03 to 0.07 μg/100 g. A relatively high content of lead was observed in the samples of the raw material from the Poltava, Sumy and Cherkasy regions (from 0.06 to 0.08 μg/100 g). It may indicate that the area where these samples were collected is quite polluted. The content of such heavy metals as cobalt, cadmium, arsenic and mercury was within the maximum permissible limits, meeting the requirements for the raw material and food products [17].

CONCLUSIONS

For the first time the study of the mineral composition of samples of the feverfew herb from different regions of Ukraine was carried out using the atomic emission spectroscopy. The studies conducted have shown that all samples are characterized by the prevalent accumulation of potassium, calcium, silicon, magnesium from macroelements, aluminum and iron from microelements. The highest content of all elements is observed in the samples of the raw material from the Kharkiv, Zhytomyr and Poltava regions compared to other batches.

Conflict of Interests: authors have no conflict of interests to declare.
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