DETERMINATION OF NUMERICAL INDICATORS OF COLLECTION FOR PREVENTION AND TREATMENT OF DISEASES OF THE MUSCULOSKOLE SYSTEM

Tetiana Oproshanska, Olha Khvorost, Kateryna Screbtsova

National University of Pharmacy of Ukraine

Introduction. Diseases of musculoskeletal system are some of the most common in the world which are leading to partial or complete limitation of the patient's mobility. Treatment of such diseases requires comprehensive and long-term therapy. As a rule, comprehensive therapy includes drug treatment with a combination of phytotherapy, physiotherapy procedures, balanced nutrition and physical exercises. One of the main symptoms of diseases of musculoskeletal system is severe pain which occurs as a result of the inflammatory process in the joints (typical for most diseases). Nonsteroidal anti-inflammatory drugs, glucocorticosteroids, analgesics and muscle relaxants are used in therapy to reduce pain [1]. But these drugs have strong side effects with prolonged use. In this aspect, an alternative to synthetic drugs are phytopreparations which have anti-inflammatory, analgesic, antimicrobial, antioxidant, diuretic effects and normalize metabolism. Such a wide range of pharmacological activity is due to the chemical composition of the plant raw materials and technological approaches to their extraction. The main groups of compounds that exhibit these types of activity are polyphenols [2], in particular phenolcarboxylic acids [3], flavonoids [4], tannins [5], organic acids [6]. Information about the mineral composition of plant raw materials is of great importance [7-9]. In the technology of obtaining phytopreparations special attention is paid to the "green extraction" of this group of compounds [10] or the use of new approaches in the extraction process [11-15].

Taking into account the above mentioned and based on the results of our previous studies of plant raw materials [16-17], we developed the composition of the original collection "Opornofit" for the prevention and treatment of diseases of the musculoskeletal system with anti-inflammatory and membrane-stabilizing effects [18]. It is advisable to establish a number of numerical indicators for collection which that are relevant for the development of a draft quality control methods.

The aim of the work is to determine the following numerical indicators of some series of collection "Opornofit": loss on drying, total ash, quantitative content of total polyphenols, total hydroxycinnamic acids, total organic acids, and mineral composition.

Material & methods. To establish the lower and upper limits of numerical indicators and elements, the study was conducted on 3 series of collections. Plant raw materials were harvested in the summer and autumn of 2022: series 1 – in the Kharkiv region (49.982102, 36.747785; 49.975837, 36.056104; 49.910261, 36.61700; 49.970594, 36.756180), series 2 and 3 in the Vinnytsia region (48.219646, 28.668950; 48.195299, 28.716275; 48.224273, 28.822007; 48.260678, 28.557031; 48.237693, 28.512395; 48.241409, 28.476518; 48.500382, 28.435648).

Loss on drying and total ash were determined according to monographs 2.2.32 "Loss on drying" [19] and 2.4.16 "Total ash" [20]. The quantitative content of total polyphenols and total hydroxycinnamic acids was determined spectrophotometrically (Optizen POP spectrophotometer (Korea)) according to the methods given in monographs of the State Pharmacopoeia of Ukraine (SPhU) 2.0 "Tree grass[N]" and "Nettle leaves" in terms of pyrogallol and chlorogenic acid respectively [21]. The content of total organic acids was determined titrimetrically according to the method given in monograph of the SPhU 2.0 "Rosehip fruits" in terms of malic acid [22].

Elemental analysis was carried out using the atomic emission spectrographic method with photographic registration on the DFS-8 device. Graduation graphs in the range of measured concentrations of elements were built using standard samples of solutions of metal salts (ICOMP-23-27). The samples were evaporated from the graphite electrode craters in an alternating current arc discharge with a power of 16A at an exposure of 60s. IVS-28 was used as a source of excitation of the spectra. Spectra were recorded on photographic film using a DFS-8 spectrograph with a three-lens slit illumination system and a diffraction grating of 600 sp/mm.

Spectral lines at a wavelength from 240 to 347 nm in samples were photometered in comparison with state samples of a mixture of mineral elements, using a MF-4 microphotometer. The relative standard deviation (for five parallel measurements) did not exceed 30% when determining the numerical values of element concentrations.

The results were processed by the method of mathematical statistics in accordance with the requirements of SPhU 2.0, with using the program Statistica 8 (StatSoft inc., USA) and a package of statistical functions of the Microsoft Excel program. The probability of differences in concentration values was assessed by Student's t-test ($p > 95\%$) [23].

Results & discussion. The results of determining of loss on drying, total ash, quantitative content of total organic acids, total hydroxycinnamic acids and total polyphenols in 3 series of collection are shown in Fig. 1.

The loss on drying is not more than 12.5 % and the total ash is not more than 7.0 %. The quantitative content of total organic acids in terms of malic acid was not less than 2.2±0.11 %, the total hydroxycinnamic acids in terms of chlorogenic acid was not less than 1.5±0.05 %, the total polyphenols in terms of pyrogallol was not less than 4.4±0.17 %.

The mineral composition of the 3 series of collection is shown in the diagrams in Fig. 2.

The elemental composition of the 3 series of collection was the same and represented by at least 19 mineral compounds. In the 3 collection series, the following pattern of macroelements content is observed: K>Ca>Mg. The content of K is in 3 times higher than Ca.

DOI: 10.5281/zenodo.14275503

The content of Mg for the 3 series of collection was in 2 times lower than Ca. The content of Si dominated among microelements.

Depending on the collection series, the quantitative content of macroelements K, Ca and Mg and the microelement P fluctuates by 1.3 times. The content of the microelement Si is less variable in the 3 series of collection and fluctuates by 1.1 times. The fluctuation of the content of Fe is 1.4 times, Al – 1.5 times, Mn – 1.8 times and Cu – 1.3 times. The content of the macroelement Na and the microelement Zn is comparable.

The quantitative content of elements such as Pb, Mo, Ni, Co <0.03 and Cd, As, Hg <0.01. The content of heavy metals is within permissible limits.

Conclusions. For the first time, a number of numerical indicators of the series of the original collection "Opornofit" were determined with the establishment, respectively, of the lower (content of total organic acids, total hydroxycinnamic acids and total polyphenols) and upper (loss on drying and total ash) limits of values. The mineral composition of 3 series of collection was also established. These data will be used in the development of the relevant sections of the project of methods for quality control of the collection "Opornofit".

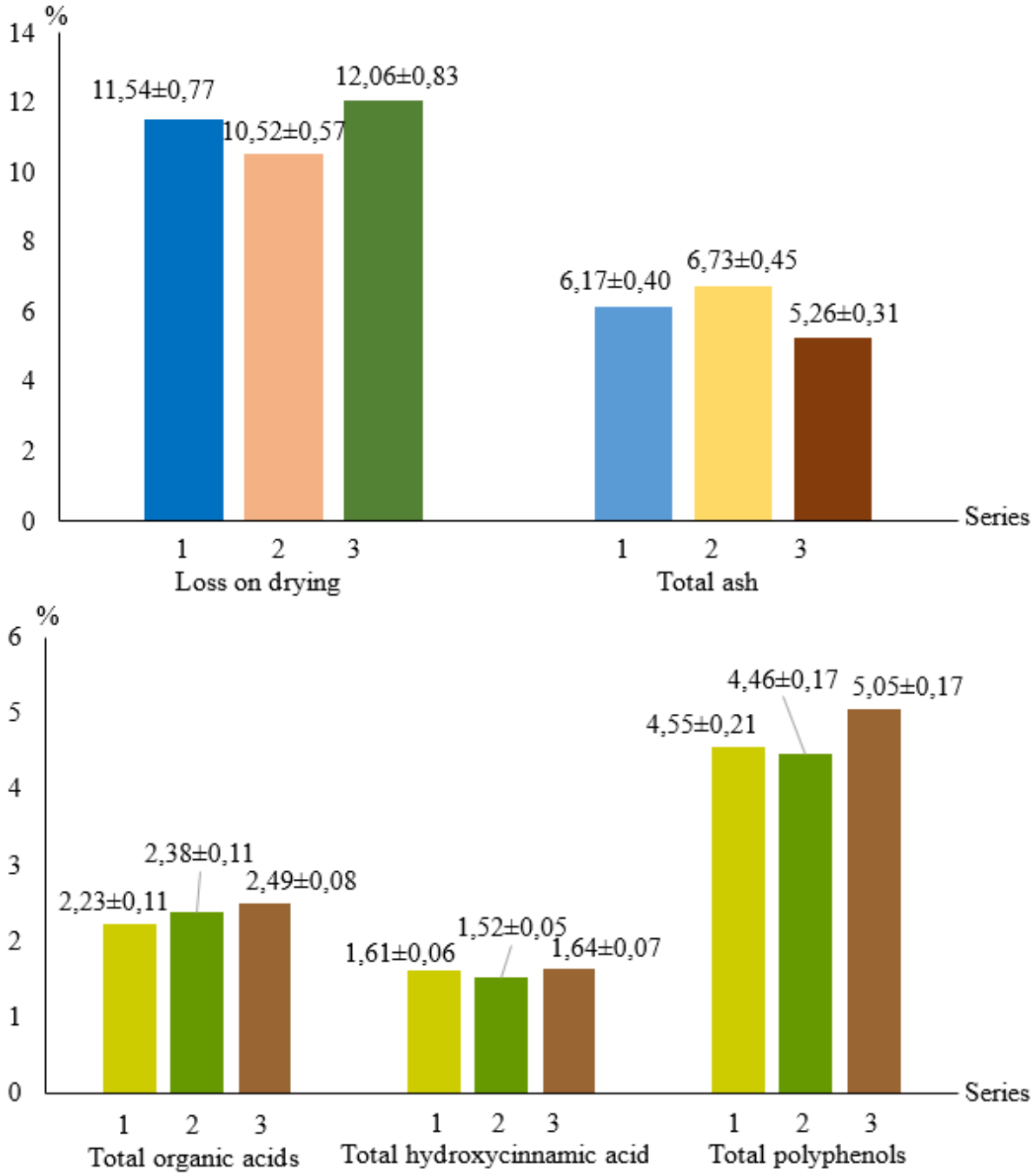

Fig. 1 Numerical indicators of the collection: loss on drying, total ash, quantitative content of total organic acids, total hydroxycinnamic acids and total polyphenols

DOI: 10.5281/zenodo.14275503

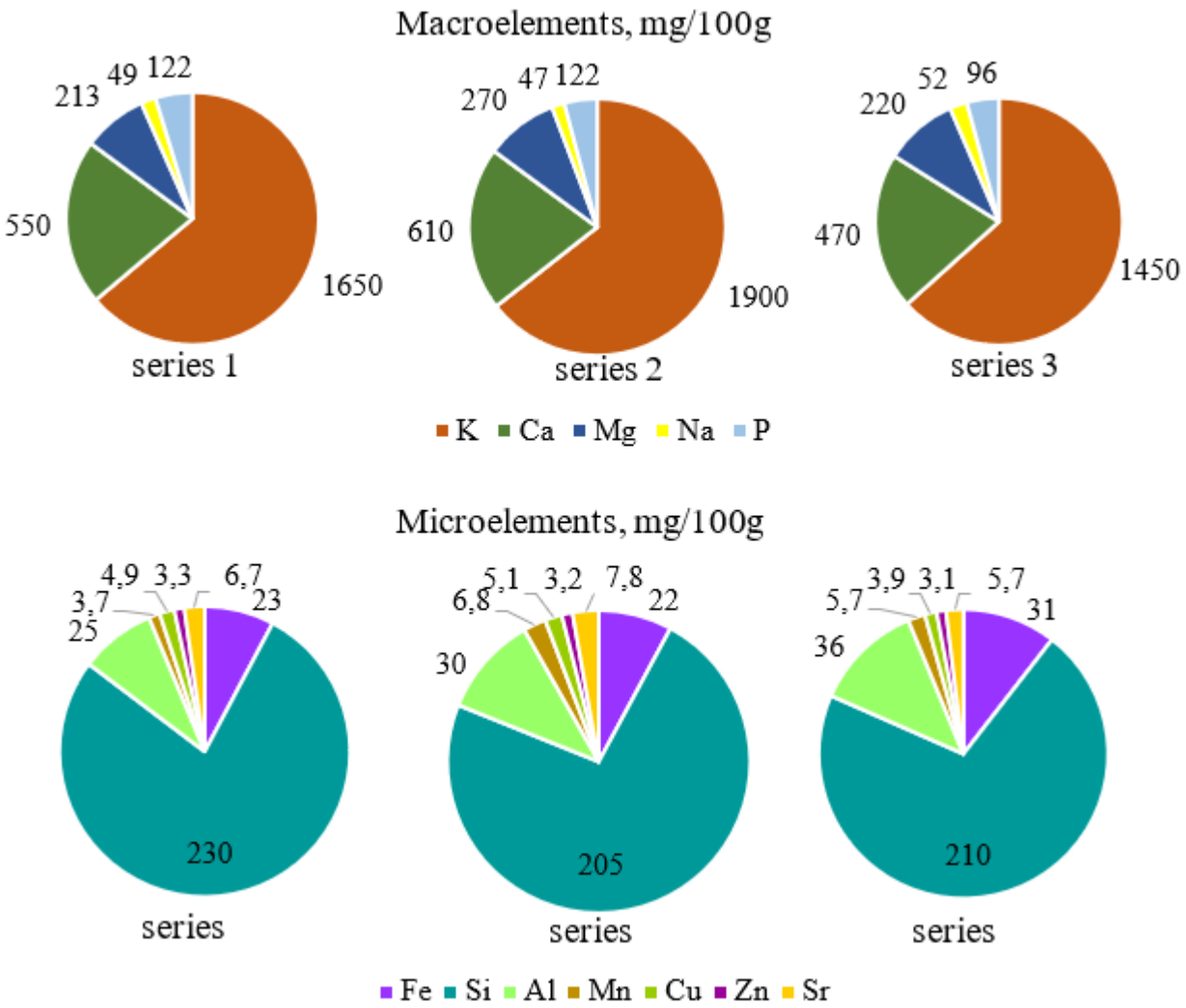

Fig. 2 Elemental composition of 3 series of collection

Determination of numerical indicators of collection for prevention and treatment of diseases of the musculoskole system

Tetiana Oproshanska, OlhaKhvorost, Kateryna Screbtsova

Diseases of musculoskeletal system are some of the most common in the world which are leading to partial or complete limitation of the patient's mobility. Treatment of such diseases requires comprehensive and long-term therapy which includes nonsteroidal anti-inflammatory drugs, glucocorticosteroids, analgesics and muscle relaxants are used in therapy to reduce pain. But these drugs have strong side effects with prolonged use. In this aspect, an alternative to synthetic drugs are phytopreparations which have anti-inflammatory, analgesic, antimicrobial, antioxidant, diuretic effects and normalize metabolism. Taking into account the above mentioned and based on the results of our previous studies of plant raw materials, we developed the composition of the original collection “Opornofit” for the prevention and treatment of diseases of the musculoskeletal system with anti-inflammatory and membrane-stabilizing effects. The aim of the work is to determine the following numerical indicators of some series of collection “Opornofit”: loss on drying, total ash, quantitative content of total polyphenols, total hydroxycinnamic acids, total organic acids, and mineral composition.

To establish the lower and upper limits of numerical indicators and elements, the study was conducted on 3 series of collections. Plant raw materials were harvested in the summer and autumn of 2022 in Kharkiv region and Vinnytsia region. Loss on drying, quantitative content of total polyphenols, total hydroxycinnamic acids and total organic acids were determined according to monographs of State Pharmacopoeia of Ukraine. Total ash was determined according to monographs of Europian Pharmacopoea 11th edition. Elemental analysis was carried out using the atomic emission spectrographic method with photographic registration on the DFS-8 device. The loss on drying is not more than 12.5 % and the total ash is not more than 7.0 %. The quantitative content of total organic acids in terms of malic acid was not less than 2.2±0.11 %, the total hydroxycinnamic acids in terms of chlorogenic acid was not less than 1.5±0.05 %, the total polyphenols in terms of pyrogallol was not less than 4.4±0.17 %. The elemental composition of the 3 series of collection was the same and represented by at least 19 mineral compounds. In the 3 collection series, the following pattern of macroelements content is observed: K>Ca>Mg. Depending on the collection series, the

DOI: 10.5281/zenodo.14275503

quantitative content of macroelements K, Ca and Mg and the microelement P fluctuates by 1.3 times. The content of the microelement Si is less variable in the 3 series of collection and fluctuates by 1.1 times. The fluctuation of the content of Fe is 1.4 times, Al – 1.5 times, Mn – 1.8 times and Cu – 1.3 times. The content of the macroelement Na and the microelement Zn is comparable. The quantitative content of elements such as Pb, Mo, Ni, Co <0.03 and Cd, As, Hg <0.01. The content of heavy metals is within permissible limits. **Conclusions.** For the first time, a number of numerical indicators of the series of the original collection "Opornofit" were determined with the establishment, respectively, of the lower (content of total organic acids, total hydroxycinnamic acids and total polyphenols) and upper (loss on drying and total ash) limits of values. The mineral composition of 3 series of collection was also established. These data will be used in the development of the relevant sections of the project of methods for quality control of the collection "Opornofit".

Keywords: collection, numerical indicators, elemental composition

References

1. Compendium // https://compendium.com.ua/uk/atc/m/
2. Salas-Arias C., Irias-Mata, A., Sanchez-Calvo, L., et al. Isolation of polyphenols in strawberry leaves: preliminary experiments on *Fragaria* × *ananassa* cv. Festival. *Molecules*. 2024, 29, 2467. https://doi.org/10.3390/molecules29112467.
3. Kiriakoudi A., Kalfa E., Zimvrakaki et al. Recovery of ellagic acid from pomegranate peel by ultrasonic-assisted alkaline hydrolysis. *Molecules.* 2024, 29, 2424. https://doi.org/10.3390/molecules29112424.
4. Mechshanova A., Polyakov V., Radoykova T. The study of the natural substances obtained from the poplar buds and their use for protection against the action of ionizing radiation. *ScienceRise: Pharmaceutical Science*, 2023, 3 (43), 79–86. doi: http://doi.org/10.15587/2519-4852.2023.271837
5. Xu J., Wang X., Yu H. et al. Research on the qualitative characteristics of *Chebulae* Fructus and its impurities and the decomposition pathway of hydrolyzable tannins. *Molecules*. 2024, 29, 2399. https://doi.org/10.3390/molecules29102399.
6. Savych A., Marchyshyn S., Basaraba R., Kryskiw L. Determination of carboxylic acids content in the herbal mixtures by HPLC. *ScienceRise: Pharmaceutical Science*. 2023, 2 (30), 33–39. doi: http://doi.org/10.15587/2519-4852.2021.229132
7. Baloch S. Essential and Non-Essential Elements in Medicinal Plants: A Review. *Biomedical Journal of Scientific & Technical Research*. 2021, 33 (4), 26098-26100. DOI: 10.26717/BJSTR.2021.33.005446
8. Brima E. I. Levels of Essential Elements in Different Medicinal Plants Determined by Using Inductively Coupled Plasma Mass Spectrometry. *J. Anal. Methods Chem*. 2018, 20, 7264892. https://doi.org/10.1155/2018/7264892
9. Al-Fartusie F. S., Mohssan S. N. Essential Trace Elements and Their Vital Roles in Human Body. *Indian Journal of Advances in Chemical Science*. 2017, 5 (3), 127–136. DOI:10.22607/IJACS.2017.503003
10. Mechshanova A., Polyakov V., Radoykova T. The study of the natural substances obtained from the poplar buds and their use for protection against the action of ionizing radiation. *ScienceRise: Pharmaceutical Science*, 2023, 3 (43), 79–86. doi: http://doi.org/10.15587/2519-4852.2023.271837
11. Roselli V., Pugliese G., Leuci R. et al. Green methods for extracting bioactive compounds from food industry waste: sustainable practice from a circular economy perspective. *Molecules*. 2024, 29, 2682. https://doi.org/10.3390/molecules2
12. Lianza M., Antognoni F. Comparison and optimization of the Green method for the extraction of anthocyanins from Sangiovese grape pomace: a critical evaluation of the experimental design approach. *Molecules*. 2024, 29, 2679. https://doi.org/10.3390/molecules29112679
13. Lee S., Wang G., Zhao J. et al. Ultrasound-assisted extraction of phenolic compounds from Seltuc (*Lactuca sativa* var. *augustana*) leaves using natural deep eutectic solvents (NADES): process optimization and extraction mechanism study. *Molecules*. 2024, 29, 2385. https://doi.org/10.3390/molecules29102385.
14. Masala V., Jokic S., Aladich K. et al. Study of the extraction of phenolic compounds from saffron flowering by-products (*C. sativus*) using ultrasonic-assisted extraction, deep eutectic solvent extraction and subcritical aqueous extraction. *Molecules*. 2024, 29, 2600. https://doi.org/10.3390/molecules29112600.
15. Milosevic S., Zekovich Z., Pavlic B. Cherry pit valorization: polyphenol extraction using natural deep eutectic solvents (NADES). *Molecules*, 2024, 29, 2766. https://doi.org/10.3390/molecules29122766
16. Oproshanska, T., Khvorost, O., Batiuchenko, I., et al. Establishment of quality indicators of promising plant raw materials - underground organs of Rumex confertus Willd. L. ScienceRise: Pharmaceutical Science. 2022, № 3 (37), 40-47. https://doi.org/10.15587/2519-4852.2022.259583
17. Oproshanska, T., Khvorost, O., Skrebtsova, K., et al. Comparative pharmacognostic study of the roots of the most common species of plants of the genus Arctium. L. ScienceRise: Pharmaceutical Science. 2024, № 3 (49), 54-62. https://doi.org/10.15587/2519-4852.2024.307262
18. Oproshanska T.V., Shapoval O.M., Khvorost O.P., Koiro O.O. Development of the composition of a phytocomposition for the treatment of gout. Modern achievements of pharmaceutical science in the creation and standardization of medicines and dietary supplements containing components of natural origin: mat. VI International Scientific-Practical Internet Conference, April 12, 2024. Kharkiv. P. 140-141.
19. Derzhavna Farmakopeia Ukrainy. Dop. 5 (2021). [The State Pharmacopoeia of Ukraine. Supplement 1] Kharkiv: DP «Naukovo-ekspertnyi farmakopeinyi tsentr». (in Ukrainian).
20. European Pharmacopoeia 11th ed. Supplement 11.6. Available at: // https://pheur.edqm.eu/home
21. Derzhavna Farmakopeia Ukrainy. (2016). [The State Pharmacopoeia of Ukraine. Supplement 1] Kharkiv: DP

«Naukovo-ekspertnyi farmakopeinyi tsentr». (in Ukrainian).
22. Derzhavna Farmakopeia Ukrainy. V. 3. (2014). [The State Pharmacopoeia of Ukraine. Vol. 3]. Kharkiv: DP «Naukovo-ekspertnyi farmakopeinyi tsentr». (in Ukrainian).
23. Derzhavna Farmakopeia Ukrainy. V. 1. (2015). [The State Pharmacopoeia of Ukraine. Vol. 1]. Kharkiv: DP «Naukovo-ekspertnyi farmakopeinyi tsentr». (in Ukrainian).

DOI: 10.5281/zenodo.14275503