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BIOCHEMICAL STUDY OF PLANT RAW MATERIAL OF *SILPHIUM* L. SPP. IN M.M. GRYSHKO NATIONAL BOTANICAL GARDEN OF THE NAS OF UKRAINE

Objective *— to evaluate the biochemical composition of plant raw material of species of the Silphium L. genus in M.M. Gryshko National Botanical Garden of the NAS of Ukraine.*

Material and methods. *In this study investigated following species of Silphium genus and one cultivar: S. lacinatum L., S. integrifolium Milchx., S. perfoliatum L., S. perfoliatum L. cv. Kanadchanka, S. scaberrinum Ell., S. trifoliatum L. The content of dry matter and crude fiber were determined according to A.I. Yermakov et al. (1972), the total content of sugars, ascorbic acid and potassium concentration — according to V.P. Krishchenko (1983), the content of carotene — according to B.P. Pleshkov (1985), the content of ash — according to Z.M. Hrycaenko et al. (2003), the content of calcium, phosphorus and protein — according to H.M. Pochinok (1976). Obtained data processed in Data Analysis (Excel 2016).*

Results. *In the period of flowering content of dry matter in raw of species of Silphium L. genus was 21.14—29.02 %, total content of sugars — 3.54—12.17 %, crude fiber — 29.46—48.24 %, ascorbic acid — 77.12—296.35 mg%, carotene — 0.23—1.54 mg%, protein — 14.18—26.08 %, lipids — 2.34—4.26 %. Content of ash was 3.25—7.82 %, potassium — 0.78—2.18 %, calcium — 1.66—3.07 %, phosphorus — 0.13—0.35 %. The coefficient of correlation between all investigated parameters is determined.*

Conclusions. *Obtained data identified that in M.M. Gryshko National Botanical Garden of the NAS of Ukraine investigated species and cultivar of Silphium genus are rich sources of nutrients. The high content of dry matter and crude fiber, potassium, calcium detected for S. scaberrinum, the content of sugars, ascorbic acid, lipids for S. lacinatum, carotene for S. trifoliatum, protein for S. integrifolium, ash and phosphorus for S. perfoliatum. Taking into account obtained data about biochemical composition, plant raw material of these crops can be competitively capable among other forage crops.*

Key words: Silphium, plant raw material, biochemical composition.

Species of *Silphium* L. belong to Asteraceae Bercht. & J. Presl family and native to North America [18]. Among commonly known species of this genus is *Silphium perfoliatum* L., which also known as cup plant. They imported to the Europe region in the 18th century because of decorative features [24]. Also, *S. perfoliatum* is an alternative crop with high yields of biomass and have ecological advantages comparing with traditional cultures such as maize [31]. Investigated plants characterized by high productivity of biomass and can use an alternative energy crop as reported studies conducted in Ukraine, Moldova, Lithuania, Austria, Romania, Germany [7; 12—14; 20; 35; 38; 39—41]. Due to high productivity, the content of carbohydrates of plants of *S. perfoliatum* can compete as an energetic source with *Zea mais* on biogas production [34; 40]. As reviewed Gansberger et al. (2015), many experiments were conducted regarding the cultivation of cup plant in the former USSR, Japan, France, Switzerland, Romania, the Czech Republic, the USA, Germany, Hungary, Chile, China, Austria, etc. [14]. The yield of these plants depending on conditions of grows [37]. Interesting results obtained by Assefa et al. (2015) concerning biological features of seeds of cup plant that important for evaluating of genetic diversity of Asteraceae [5].

Study of biochemical composition reported that these plants source of phenolic acids, flavonoids, terpenes, saponins [8; 11; 23; 28]. In roots identified carbohydrate inulin [25]. Kowalski (2007)

reported that triterpene aglycones of saponins isolated from raw of *Silphium* species were oleanolic acid and ursolic acid [24]. According to Han et al. (2000a), *Silphium perfoliatum* had similar digestion parameters to *Medicago sativa* L. [15].

Plants from the Asteraceae family exhibited various biological activities such as antioxidant, antimicrobial, vasoprotective, antitumor, antiulcerogenic, hepatoprotective, antifungal, antiparasitic, neuroprotective, etc. [6]. Plant raw of *S. integrifolium, S. perfoliatum* and *S. trifoliatum* such as roots, leaves and essential oil demonstrated different biological activity of alcohol extracts [25; 26]. For example, rhizomes extracts had a high antimicrobial activity [24]. Jamiołkowska and Kowalski (2012) reported that ethanol extracts of *S. perfoliatum* from the leaves exhibited antifungal activity particularly concerning *Alternaria alternata* and *Colletotrichum coccodes* [19].

Material and methods

Plant material

Plants of following species of *Silphium* genus were used in this study: *S. lacinatum* L., *S. integrifolium* Milchx., *S. perfoliatum* L., *S. perfoliatum* L. cv. Kanadchanka, *S. scaberrinum* Ell., *S. trifoliatum* L. Plant raw material of investigated plants collected in the stage of flowering from both collections of forage and energetic plants of Cultural Flora Department of M.M. Gryshko National Botanical Garden of the NAS of Ukraine.

Biochemical analyses

All biochemical analyses were conducted using the above-ground part of plants at the period of full ripening of seeds. The above-ground part of plants shredded and used for next procedures. The determination of absolutely dry matter was done by drying to constant weight at 100—105 °C. The content of crude fiber identified using acid and alkaline washing. The procedure of the determination of total lipids was performed using Soxhlet extractor with petroleum ether. These procedures conducted according to A.I. Yermakov et al. [43]. The total content of sugars was investigated by Bertrand method in water extracts. The concentration of ascorbic acid (AA) of the acid extracts was determined by a 2.6-dichlorophenol-indophenol method based on the reduction properties of AA. The content of potassium determined on flame photometer (CL 378, ELICO, India) analyzing acid extracts of samples. Different solutions of KCl used as a standard. Before measurement conducted procedure of crude aching in the concentrated sulfuric acid (fixed mass of sample in 3 ml of acid) [43]. These analyses carried out according to V.P. Krishchenko [29]. The concentration of total carotene determined according to B.P. Pleshkov. The procedure carried out in petrol extracts by a spectrophotometric method using 2800 UV/VIS Spectrophotometer, Unico. Mixtures were left in a shaker for 2 hours and their absorbance was measured at the wavelength of 440 nm [32]. The level of total ash was determined using the method of combustion in muffle-oven (SNOL 7.2-1100, Termolab) at 300—800 °C until the samples turned into white ash to constant weight according to Z.M. Hrycajenko et al. [17]. The concentration of calcium was determined by the titration method of acid extracts with Trilon B. Phosphorus content in plants was identified in acid extracts using molybdenum solution. The content of protein determined by chloramine method. These analyses were done according to H.N. Pochinok [33].

Experimental data were evaluated by using Excel 2010. Mean values of three replicates and standard deviation are given in Fig. 1—4. Correlation analysis performed using Pearson's criterion.

Results and discussions

Study of different aspects of plants of genus *Silphium* in M.M. Gryshko National Botanical Garden has been conducted since 1970th first of all as forage [41]. These plants characterized by high productivity of green biomass, high content of dry matter and complex of nutrients. The height of plants can achieve up to 200 cm [1]. In other reports indicated that high yields possible twice in the stage of budding and flowering using a different combination of fertilizers [4]. Nowadays in the collection of forage plants of NBG six species (and cultivars) have cultivated and besides forage direction of use, it investigated as energetic crops [22; 35].

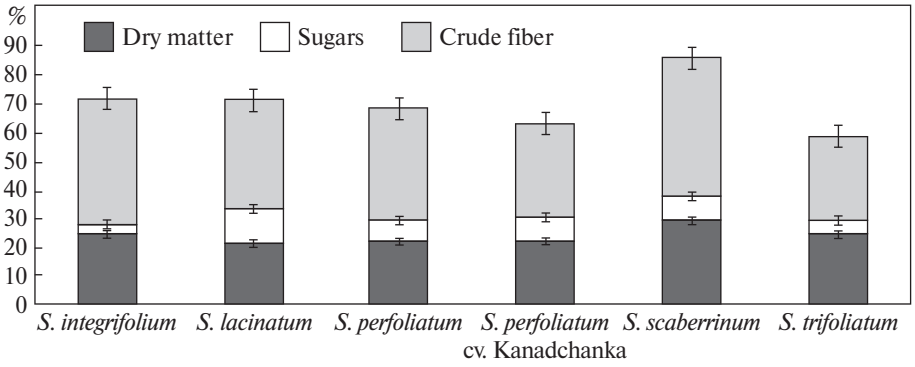

Fig. 1. The total content of dry matter, sugars and crude fiber in raw of *Silphium* L. species

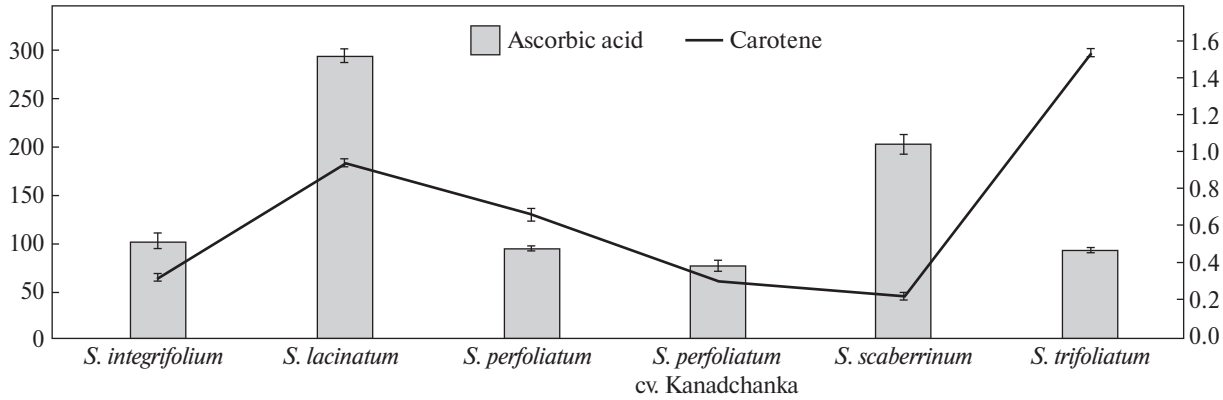

Fig. 2. The content of ascorbic acid and carotene in raw of *Silphium* L. species, mg%

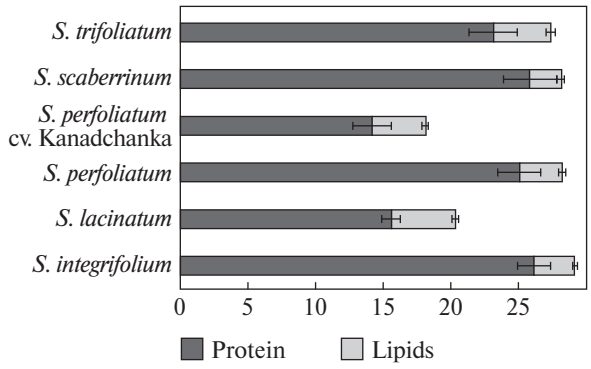

Fig. 3. The content of protein and lipids in raw of *Silphium* L. species, %

One of the most important parameters of introduced plants is the biochemical composition of plant raw, particularly concerning forage quality. This parameter identified as the capacity of forage plants to provide the complex of nutrients to livestock: the amount of proteins, digestible carbohydrates, ash, lignin, cellulose, crude fiber, carotene, etc. [3]. Forage plants use in the animal feed industry and searching of new species still the actual direction of biological science [21; 36].

We determined the content of dry matter, the total content of sugars and content of crude fiber (Fig. 1). The content of dry matter of plants of *Silphium* genus was in the range from 21.14 to 29.02 %. As described in Han et al. (2000b), *S. perfoliatum* had low dry matter content at harvest that takes into account at ensiling [16]. The total content of sugars was from 3.54 to 12.17 %, and crude fiber from 29.46 to 48.24 %. Results of a study of polysaccharide complex investigated in previous work and showed that detected 71 % of polysaccharides and carbohydrate moiety consists of glucuronoxylan [9].

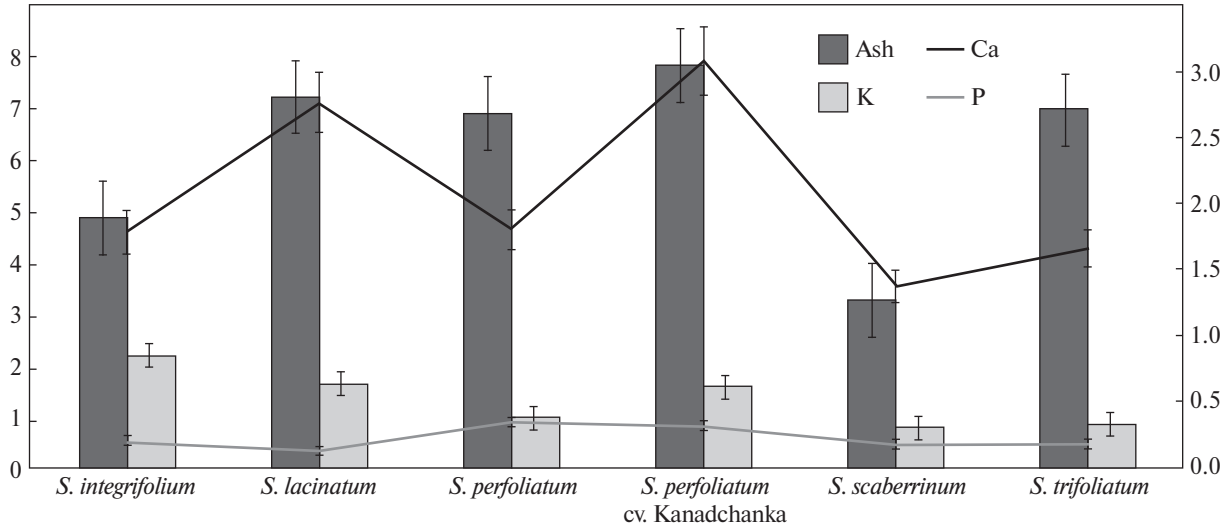

Fig. 4. The content of ash, potassium, calcium and phosphorus in raw of *Silphium* L. species, %

Accumulation of vitamins in raw of forage plants is a necessary parameter for evaluation of use. Ascorbic acid and carotene along with other components included in the forage production. The content of ascorbic acid in plant raw material of investigated plants at the flowering stage was from 77.12 to 296.35 mg% and carotene from 0.23 to 1.54 mg% (Fig. 2).

Study of protein content in the above-ground part of six investigated samples showed that this parameter was from 14.18 to 26.08 % and lipids from 2.34 to 4.73 % (Fig. 3). According to Dudkin et al. (1980), crude protein in raw of *Silphium perfoliatum* was 20 % that is similar to our results [10]. The content of protein among forage plants was 36 % (*Agropyron cristatum*), 34 % (*Lolium perenne*), and 32 % (*Medicago sativa, Trifolium repens*), etc. [30].

An important parameter in the study of forage plants is content of ash and mineral component that it includes. We found that content of ash in *Silphium* species was in the range from 3.25 to 7.82 %, potassium from 0.78 to 2.18 %, calcium from 1.37 to 3.07 %, and phosphorus from 0.13 to 0.35 % (Fig. 4).

According to Wever et al. (2019), the content of ash for different samples was 8.86—9.40 % [42]. Dudkin et al. (1980) found 2 % of ash substances in the plants of *Silphium perfoliatum* [10]. Data of Achakzai et al. (2018) reported that plants from *Asteraceae* possessed a significantly high concentration of K in the vegetative stage than in the reproductive period. In this case, the content of K in raw of some selected species was from 9.33 mg/g (*Achillea wilhelmsii* C. Koch) to 21.33 mg/g (*Seriphidium quettense* (Podleh) Ling, Bull). Also, in this study described that accumulation of phosphorus was higher in vegetative stage than in the reproductive growth stage [2]. The maximal value of this research was similar to our data.

We used correlation analysis to find out the relationship between all studied parameters of investigated plants. Obtained results showed very strong correlation between following substances: content of lipids and carotene (r = 0.80), lipids and ash (r = 0.81), proteins and crude fiber (r = 0.88). Strong correlation found between the accumulation of calcium and ash (r = 0.68), crude fiber and ascorbic acid (r = 0.68). Relationship between accumulation of potassium and calcium (r = 0.47), lipids and calcium (r = 0.49), ash and carotene (r = 0.52) demonstrated moderate correlation. The coefficient of correlation between of rest parameters was weak, very weak or negative.

Conclusions

Thus, it was identified that in conditions of M.M. Gryshko National Botanical Garden of the NAS of Ukraine investigated species and cultivar of *Silphium* genus are a valuable source of nutrients. Maximal content of dry matter and

cellulose, potassium, calcium identified for *S. scaberrinum*, the content of sugars, ascorbic acid, lipids for *S. lacinatum*, carotene for *S. trifoliatum*, protein for *S. integrifolium*, ash and phosphorus for *S. perfoliatum*. Results showed that very strong correlation exists between the content of lipids and carotene, lipids and ash, proteins and cellulose. Relationship between the accumulation of calcium and ash, cellulose and ascorbic acid determined as strong correlation. Based on obtained data, investigated plants of *Silphium* genus can compete with other forage plants as valuable plant raw material.

REFERENCES

1. *Abramov, A.A.* (1992), Silfiya pronsennolistnaya v kormoproizvodstve [Cup plant in the fodder production]. Kyiv: Naukova dumka, 155 p.
2. *Achakzai, A.K.K., Masood, A., Tareen, B.R. and Rahman, U.M.* (2018), Nutrients compositions of common plant species of Asteraceae in Quetta at two growth stages. Journal of the Chemical Society of Pakistan, vol. 40, N 4, pp. 722—731.
3. *Amiri, F. and Shariff, M.R.A.* (2012), Comparison of nutritive values of grasses and legume species using forage quality index. Songklanakarin Journal of Science and Technology, vol. 34, N 5, pp. 577—586.
4. *Arkhipenko, F.N. and Larina, V.I.* (2011), Silfii pronzionnolistnyi (*Silphium perfoliatum* L.) v Lesostepi Ukrainy [Cup plant (*Silphium perfoliatum* L.) in the Ukrainian Forest-Steppe]. Introdukciya Roslyn [Plant Introduction], vol. 49, N 1, pp. 9—13. http://dx.doi.org/10.5281/zenodo.2545906
5. *Assefa, T., Wu, J. and Boe, A.* (2015), Genetic variation for achene traits in cup plant (*Silphium perfoliatum* L.). Open Journal of Genetics, vol. 5, pp. 71—82. http://dx.doi.org/10.4236/ojgen.2015.52006
6. *Bessada, S.M.F., Barreira, J.C.M. and Oliveira, M.B.P.P.* (2015), *Asteraceae* species with most prominent bioactivity and their potential applications: a review. Industrial Crops and Products, vol. 76, pp. 604—615. http://dx.doi.org/10.1016/j.indcrop.2015.07.073
7. *Blume, Ya.B., Grygoruk, I.P., Dmytruk, K.V., Dubrovin, V.O., Yemec, A.I., Kaletnyk, G.M., Melnychuk, M.D., Myronenko, V.G., Rakhmetov, D.B., Sabirnyi, A.A. and Tsygankov, S.P.* (2014), Systema vykorystannya bioresursiv u novitnih biotehnologiyah otrymannya alternatyvnyh palyv [System of use of bioresources in the nowadays biotechnologies of obtaining of alternative biofuels]. Kyiv: AhrarMediaGrup, 360 p. ISBN 978-617-646—207-1
8. *Davidyants, E.S., Kartasheva, I.A. and Neshin, I.V.* (1997), Efect triterpenovyh glikosidov *Silphium perfoliatum* L. na fitopatogennye griby [The effect of triterpene glycosides of *Silphium perfoliatum* L. on phytopathogenic fungi]. Rastitelnye Resursy, vol. 4, pp. 93—98.
9. *Dudkin, M.S., Cherno, N.K. and Shkantova, N.G.* (1979), Characteristics of the water-soluble polysaccharides of the leaves of *Silphium perfoliatum*. Chemistry of Natural Compounds, vol. 15, N 6, pp. 680—682.
10. *Dudkin, M.S., Shkantova, N.G. and Parfenteva, N.A.* (1980), Alkali-soluble polysaccharides of the stems of *Silphium perfoliatum*. Chemistry of Natural Compounds, vol. 16, N 1, pp. 26—27.
11. *El-Sayed, N.H., Wojcińska, M., Drost-Karbowska, K., Matławska, I., Williams, J. and Mabry, T.J.* (2002), Kaempferol triosides from *Silphium perfoliatum*. Phytochemistry, vol. 60, pp. 835—838.
12. *Franzaring, J., Holz, I., Kauf, Z. and Fangmeer, A.* (2015), Responses of the novel bioenergy plant species of *Sida hermafrodita* (L.) Rusby and *Silphium perfoliatum* L. to CO_2 fertilization at different temperatures and water supply. Biomass and Bioenergy, vol. 81, pp. 574—583. http://dx.doi.org/10.1016/j.biom.bioe.2015.07.031
13. *Franzaring, J., Schmid, I., Bauerle, L., Gensheimer, G. and Fangmeier, A.* (2014), Investigations on plant functional traits, epidermal structures and the ecophysiology of the novel bioenergy species *Sida hermafrodita* Rusby and *Silphium perfoliatum* L. Journal of Applied Botany and Food Quality, vol. 87, pp. 36—45. http://dx.doi.org/10.5073/JABFQ.2014.087.006
14. *Gansberger, M., Montgomery, L.F.R. and Liebhard, P.* (2015), Botanical characteristics, crop management and potential of *Silphium perfoliatum* L. as a renewable resource for biogas production: A review. Industrial Crops and Products, vol. 63, pp. 362—372. http://dx.doi.org/10.1016/j.indcrop.2014.09.047
15. *Han, K.J., Albrecht, K.A., Mertens, D.R. and Kim, D.A.* (2000a), Comparison of *in vitro* digestion kinetics of cup-plant and alfa-alfa. Asian-Australasian Journal of Animal Sciences, vol. 13, N 5, pp. 641—644. https://doi.org/10.5713/ajas.2000.641
16. *Han, K.J., Albrecht, K.A., Muck, R.E. and Kim, D.A.* (2000b), Moisture effect of fermentation characteristics of cup-plant silage. Asian-Australasian Journal of Animal Sciences, vol. 13, N 5, pp. 636—640. https://doi.org/10.5713/ajas.2000.636
17. *Hrycajenko, Z.M., Hrycajenko, V.P. and Karpenko, V.P.* (2003), Metody biologichnyh ta agrohimichnyh doslidzhen roslyn i gruntiv [Methods of biological and agrochemical investigations of plants and soils]. Kyiv: Nichlava, 320 p.
18. *Huxley, A., Griffiths, M. and Levy, M.* (1992), The new dictionary of gardening. London: Macmillan, 3000 p.
19. *Jamiołkowska, A. and Kowalski, R.* (2012), *In vitro* estimate of influence of *Silphium perfoliatum* L. leaves extract on some fungi colonizing the pepper plants. Acta Scientiarum Polonorum, vol. 11, N 3, pp. 43—55.

20. *Jucsor, N. and Sumalan, R.* (2018), Researches concerning the potential of biomass accumulation in cup plant (*Silphium perfoliatum* L.). Journal of Horticulture, Forestry and Biotechnology, vol. 22, N 2, pp. 34—39.
21. *Kambashi, B., Boudry, C., Picron, P. and Bindelle, J.* (2014), Forage plants as an alternative feed sources for sustainable pig production in the tropics: a review. Animal, vol. 8, N 8, pp. 1298—1311. http://dx.doi.org/10.1017/S1751731114000561
22. *Kataloh* roslyn viddilu novyh kultur [Catalogue of plants of new culture department] (2015), Kyiv: Fitosociocentr, 112 p.
23. *Kowalski, R.* (2005), Analysis of lipophilic fraction from leaves, inflorescences and rhizomes of *Silphium perfoliatum* L. Acta Societatis Botanicorum Poloniae, vol. 74, pp. 5—10.
24. *Kowalski, R.* (2007), Studies of selected plant raw materials as alternative sources of triterpenes of oleanolic and ursolic acid types. Journal of Agricultural and Food chemistry, vol. 55, pp. 656—662.
25. *Kowalski, R.* (2008), Antimicrobial activity of essential oils and extracts of rosinweed (*Silphium trifoliatum* and *Silphium integrifolium*) — plants used by the American Indians. Flavour and Fragrance Journal, vol. 23, pp. 426—433.
26. *Kowalski, R. and Kędzia, B.* (2007), Antibacterial activity of *Silphium perfoliatum* extracts. Pharmaceutical Biology, vol. 45, N 6, pp. 494—500. http://dx.doi.org/10.1080/13880200701389409
27. *Kowalski, R. and Wierciński, J.* (2004), Evaluation of some *Silphium* L. species as alternative inulin raw materials. Annales Universitatis Mariae Curie-Skłodowska, sec. E, vol. 59, pp. 189—195.
28. *Kowalski, R. and Wolski, T.* (2003), TLC and HLPC analysis of the phenolic acids in *Silphium perfoliatum* L. leaves, inflorescences and rhizomes. Journal of Planar Chromatography, vol. 16, pp. 230—236.
29. *Krischenko, V.P.* (1983), Metody ocenki kachestva rastitelnoy produkcii [Methods for evaluating of quality of plant production]. Moscow: Kolos, 192 p.
30. *Lee, M.A.* (2018), A global comparison of the nutritive values of forage plants grown in contrasting environments. Journal of Plant Research, vol. 131, pp. 641—654. http://dx.doi.org/10.1007/s10265-018-1024-y
31. *Noemi, J. and Sumalan, R.* (2018), Researches concerning the potential of biomass accumulation in cup plant (*Silphium perfoliatum* L.). Journal of Horticulture, Forestry and Biotechnology, vol. 22, N 2, pp. 34—39.
32. *Pleshkov, B.P.* (1985), Prakticum po biohimii rasteniy [Plant biochemistry workshop]. Moscow: Kolos, 256 p.
33. *Pochinok, H.M.* (1976), Metody biohimicheskoho analiza rastenii [Methods of biochemical analyse of plants]. Kyiv: Naukova dumka, 336 p.
34. *Rakhmetov, D.B.* (2011), Teoretychni ta prykladni aspekty introdukcii Roslyn v Ukrajini [Theoretical and practical aspects of plant introduction in Ukraine]. Kyiv: AhrarMediaGrup, 398 p. ISBN 978-966-2424-87-4
35. *Rakhmetov, D.B. and Stadnichuk, N.O.* (2014), Energetychnyi potentsial roslyn rodu *Silphium* L. *(*Asteraceae) introdukovanyh v NBS im. M.M. Gryshka NAN Ukrajiny [Energetical potential of the plants of *Silphium* L. genus *(*Asteraceae) that introduced in the M.M.Grysko National Botanical Garden of the NAS of Ukraine]. Biologichni resursy i novitni tehnologii vyrobnytstva biopalyv. Mat. nauk. konf. [Biological resources and new technologies of biofuel production]. Kyiv: Fitosotsiotsentr, pp. 97—102.
36. *Sahito, M.A., Ansari, T.I., Narejo, T.N. and Suheryani, I.* (2015), Comparative study of biochemical properties of non-conventional plant sources to prepare low cost fish feed. Pakistan Journal of Nutrition, vol. 14, N 7, pp. 431—435.
37. *Shalyuta, B.V. and Kostitskaya, E.V.* (2018), The yield of *Silphium perfoliatum* L. depending on the conditions of cultivations. Agricultural Engineering, vol. 22, N 2, pp. 91—97. http://dx.doi.org/10.1515/agriceng-2018-0019
38. *Šiaudinis, G., Skuodienė, R. and Repšienė, R.* (2017), The investigation of three potential energy crops: common mugwort, cup plant and Virginia mallow on Western Lithuania's albeluvisol. Applied Ecology and Environmental Research, vol. 15, N 3, pp. 611—620.
39. *Stadnichuk, N.O. and Rakhmetov, D.B.* (2012), Introdukciia roslyn vudiv rodu *Silphium* L. v Ukrayini [Introduction of plants of species of *Silphium* L. genus in Ukraine]. Problemy eksperymentalnoji botaniky ta biotehnologiji [Problems of experimental botany and biotechnology], vol. 1, pp. 48—60.
40. *Ţîţei, V.* (2017), The evaluation of biomass of the *Sida hermaphrodita* and *Silphium perfoliatum* for renewable energy in Moldova. Scientific Papers. Series A. Agronomy, vol. 60, pp. 534—540.
41. *Uteush, Yu.A. and Lobas, M.G.* (1996), Kormovi resursy flory Ukrajiny [Forage resources of Ukrainian flora]. Kyiv: Naukova dumka, 222 p. ISBN 5-12-004685-1
42. *Wever, C., Höller, M., Becker, L., Biertümpfel, A., Köhler, J., van Inghelandt, D., Westhoff, P., Pude, R. and Pestsova, E.* (2019), Towards high-biomass yielding bioenergy crop *Silphium perfoliatum* L.: phenotypic and genotypic evaluation of five cultivated populations. Biomass and Bioenergy, vol. 124, pp. 102—113. https: //doi.org/10.1016/j.biombioe.2019.03.016
43. *Yermakov, A.I., Arasimovich, V.V., Smirnova-Ikonnikova, M.I. and Yarosh, N.P.* (1972), Metody biohimicheskoho issledovaniya rasteniy [The methods of biochemical investigations of plants]. Leningrad: Kolos, 456 p.

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БІОХІМІЧНЕ ДОСЛІДЖЕННЯ РОСЛИННОЇ СИРОВИНИ ВИДІВ РОДУ *SILPHIUM* L. У НАЦІОНАЛЬНОМУ БОТАНІЧНОМУ САДУ імені М.М. ГРИШКА НАН УКРАЇНИ

Мета — оцінити біохімічний склад рослинної сировини видів роду *Silphium* L. у Національному ботанічному саду імені М.М. Гришка НАН України.

Матеріал та методи. Досліджували види роду *Silphium* та один сорт : *S. lacinatum* L., *S. integrifolium* Milchx., *S. perfoliatum* L., *S. perfoliatum* L. cv. Kanadchanka, *S. scaberrinum* Ell., *S. trifoliatum* L. Вміст сухої речовини визначали за А.І. Єрмаковим та ін. (1972), загальний вміст цукрів, аскорбінової кислоти та концентрацію калію — за В.П. Крищенком (1983), вміст каротину — за Б.П. Плешковим (1985), вміст золи — за З.М. Грицаєнко та ін. (2003), вміст кальцію, фосфору та білка — за Х.М. Починком (1976). Отримані дані опрацьовано в пакеті Аналіз даних (Excel 2016).

Результати. В період цвітіння вміст сухої речовини в сировині видів роду *Silphium* становив 21,14—29,02 %, загальний вміст цукрів — 3,54—12,17 %, целюлози — 29,46—48,24 %, аскорбінової кислоти — 77,12—296,35 мг%, каротину — 0,23—1,54 мг%, білка — 14,18—26,08 %, ліпідів — 2,34—4,26 %, золи — 3,25—7,82 %, калію — 0,78—2,18 %, кальцію — 1,66—3,07 %, фосфору — 0,13—0,35 %. Визначено коефіцієнти кореляції між всіма досліджуваними параметрами.

Висновки. Отримані дані свідчать, що в Національному ботанічного саду імені М.М. Гришка НАН України досліджені види роду *Silphium* та сорт є цінним джерелом поживних речовин. Високий вміст сухої речовини та целюлози, калію, кальцію визначено для *S. scaberrinum*, високий загальний вміст цукрів, аскорбінової кислоти, ліпідів — для *S. lacinatum*, каротину — для *S. trifoliatum*, білка — для *S. integrifolium*, золи та фосфору — для *S. perfoliatum*. Рослинна сировина досліджених культур може конкурувати з іншими кормовими культурами.

Ключові слова: *Silphium*, рослинна сировина, біохімічний склад.

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БИОХИМИЧЕСКОЕ ИССЛЕДОВАНИЕ РАСТИТЕЛЬНОГО СЫРЬЯ ВИДОВ РОДА *SILPHIUM* L. В НАЦИОНАЛЬНОМ БОТАНИЧЕСКОМ САДУ имени Н.Н. ГРИШКО НАН УКРАИНЫ

Цель — оценить биохимический состав растительного сырья видов рода *Silphium* L. в Национальном ботаническом саду имени Н.Н. Гришко НАН Украины.

Материал и методы. Исследовали виды рода *Silphium* L. и один сорт: *S. lacinatum* L., *S. integrifolium* Milchx., *S. perfoliatum* L., *S. perfoliatum* L. c. Канадчанка, *S. scaberrinum* Ell., *S. trifoliatum* L. Содержание сухого вещества определяли по А.И. Ермакову и др. (1972), общее содержание сахаров, аскорбиновой кислоты и концентрацию калия — по В.П. Крищенко (1983), содержание каротина — по Б.П. Плешкову (1985), содержание золы — по З.М. Грицаенко и др. (2003), содержание кальция, фосфора и белка — по Х.Н. Починку (1976). Полученные данные обработаны в пакете Анализ данных (Excel 2016).

Результаты. В период цветения содержание сухого вещества в сырье видов рода *Silphium* составляло 21,14—29,02 %, общее содержание сахаров — 3,54—12,17 %, целлюлозы — 29,46—48,24 %, аскорбиновой кислоты — 77,12—296,35 мг%, каротина — 0,23—1,54 мг%, белка — 14,18—26,08 %, липидов — 2,34—4,26 %, золы — 3,25—7,82 %, калия — 0,78—2,18 %, кальция — 1,66—3,07 %, фосфора — 0,13—0,35 %. Определены коэффициенты корреляции между всеми исследованными параметрами.

Выводы. Полученные данные свидетельствуют, что в Национальном ботаническом саду имени Н.Н. Гришко НАН Украины исследованные виды рода *Silphium* и сорт являются ценным источником питательных веществ. Высокое содержание сухого вещества и целлюлозы, калия, кальция определено для *S. scaberrinum*, общее содержание сахаров, аскорбиновой кислоты, липидов — для *S. lacinatum*, каротина — для *S. trifoliatum*, белка — для *S. integrifolium*, золы и фосфора — для *S. perfoliatum*. Растительное сырье исследованных культур может конкурировать с другими кормовыми культурами.

Ключевые слова: *Silphium,* растительное сырье, биохимический состав.