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ECOLOGICAL AND ECONOMIC EFFICIENCY OF HARVESTING MEDICINAL PLANT RAW MATERIALS

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Abstract: The consequences of intensive anthropogenic activities include disturbances in the ecological-cenotic balance of phytosystems and a decrease in biodiversity. As a result, natural resources of valuable plant species become depleted and irreversibly diminished. For the effective utilization of medicinal plants, it is necessary to research their resources in specific territories, study the ecological peculiarities and population characteristics of industrial species to ensure their sustainable exploitation and conservation. Effective protection of medicinal plants should be comprehensive and encompass various interconnected measures. Rational harvesting practices, taking into account industrial cultivation of key species, are a crucial element in preserving natural resources and ensuring sustainable utilization of medicinal plants. Preserving biodiversity requires a broader approach to assessing taxa, considering not only their biological and ecological characteristics, adaptability, and tolerance to external factors but also evaluating their strategies for resisting anthropogenic influences and their capacity for regeneration. Research on the flora of the Kyiv region is highly relevant due to the significant number of medicinal plants growing in this area. To ensure the sustainable development of the region, it is necessary to investigate the ecological-economic efficiency of harvesting plant medicinal raw materials. The aim of our study was to explore the ecological-economic peculiarities of cultivating medicinal plant raw materials in the Bucha district of the Kyiv region, based on the ESC "Myrotske" and to account for such resources. During this research, a detailed analysis of the distribution of medicinal plant raw materials in the territory of the ESC "Myrotske" in the Bucha district of the Kyiv region was conducted. Their economic evaluation was performed to determine the profitability of harvesting medicinal plant raw materials in specific areas.

Keywords: medicinal raw material, resources, economic evaluation, profitability.

1. INTRODUCTION

To ensure the sustainable utilization of phytodiversity, it is necessary to conduct scientific research on the distribution and status of plant resources within the country or a specific region. These studies help establish an objective picture of the availability of natural phyto-raw material reserves, which is important for planning their rational utilization. To ensure the sustainability of plant natural resource utilization, comprehensive protection and rational harvesting practices must be implemented, taking into account the principles of sustainable development. This approach allows for the preservation of plant biodiversity and ensures the sustainable utilization of natural resources, which is crucial for maintaining ecological balance and promoting human health.

Considering the significance of this issue, the aim was to evaluate the ecological-economic efficiency of harvesting medicinal raw materials in the ESC "Myrotske" territory, located in the Bucha district of the Kyiv region.

The research object is the resources of medicinal plant raw materials in this region.

2. THEORETICAL BACKGROUND

The growth in demand for plant-based raw materials exceeds the rates of their processing and harvesting. This creates the necessity for the efficient utilization of wild medicinal plant resources. Resolving this issue is only possible through comprehensive research on resource exploration and economic assessment, aimed at establishing the profitability of harvesting medicinal plant materials in specific regions (Bilenko, V. G., 2010).

One of the methods for the rational use of plant resources is the normative method of resource knowledge works. The normative method should be combined with the implementation of an indicator for the normative evaluation of the quality of medicinal raw material stocks. Using the quality evaluation indicator for existing or restored medicinal raw material stocks allows the development of effective measures for the protection and rational use of medicinal plant resources by harvesting organizations and enterprises (Minarchenko, V. M., 2008).

3. RESEARCH OBJECTIVE, METHODOLOGY AND DATA

By the nature of vegetation, soils, and climate, the territory of Ukraine is divided into separate botanico-geographical zones - Polissia (forest zone), Forest-Steppe, Steppe, Ukrainian Carpathians, and Crimean Mountains. Each of these zones significantly differs in the character of its vegetation cover Didukh, Ya. P., & Sheliag-Sosonko, Yu. R., 2008).

The vegetation of the Forest-Steppe is represented by forest and steppe species. Phytogeographic analysis of the flora shows that it is mainly composed of species belonging to nemoral and meadow-steppe geo-elements (Perevozchenko, I. I., & Andriienko, T. L., 2003).

Based on the ecological suitability of medicinal plants in Kyiv region, the main types of vegetation can be distinguished: forest, meadow, steppe, synanthropic, marshy, riparian, ruderal, nemoral, and others.

The most widespread in the territory of Kyiv region are 364 species of wild medicinal plants, of which 87 are pharmacopoeial, while others are used in folk medicine (Didukh, Ya. P., & Sheliag-Sosonko, Yu. R., 2008).

The species of pharmacopoeial medicinal plants that are distributed in the region belong to 34 families and 67 genera. In total, more than 114 species of medicinal plant raw materials are identified in the region, of which 87 are pharmacopoeial, with raw materials meeting regulatory requirements. Among the prioritized medicinal plant species for harvesting, 36 are considered promising, while 30 are categorized as rare and endangered. Medicinal plants of the main spontaneous vegetation are grouped within various types of plant communities based on their biological characteristics (Minarchenko, V. M., 2008).

During the study of the flora in the investigated area, the route method of floristic research was applied, which involved the establishment of a profile line of investigation and the compilation of a list of plant species along this line (Bilenko, V. G., 2010). For herbaceous plants, sample plots measuring 1m² (1x1) were established, where the morphological characteristics and ecological properties of the plants were thoroughly studied (Zaverukha, B. V., & Minarchenko, V. M., 2000).

In the study of forest communities, routes were laid less frequently - at intervals of 100, 200, or sometimes 500 meters, depending on the volume of plant species diversity in the area. In meadow phytocoenoses, routes were laid much denser - every 25-30 meters (Zaverukha, B. V., & Minarchenko, V. M., 2000). The establishment of sample plots is one of the means of the stationary method of geobotanical research. The size of the sample plots was chosen depending on the type of vegetation. In forest phytocoenoses, the area of sample plots was 16 square meters. In the case of studying herbaceous plants along the profile line, a sample plot measuring 1 by 1 meter was

established. On these sample plots, the morphological characteristics of plants, their ecological properties, and other important parameters were thoroughly studied.

Multiple sample plots were established, and they were selected using a randomized method, which ensured the random selection and independence of one plot from another.

To determine species projection cover of plants along the designated routes, bisection was used. For this purpose, square plots were selected on each route that were partially or fully occupied by plants, and their sum was calculated. Next, the projection cover score was determined using an asymmetrical scale: Less than 1% - 0 1–5% - 1 6–15% - 2 16–25% - 3 26–49% - 4 50% and more – 5 (Minarchenko, V. M., 2010).

When determining the operational reserve of medicinal plant raw material, the need to leave a portion of commercial specimens of raw materials for the restoration of stands was taken into account. Therefore, for some types of plant raw materials, the operational reserve consisted of 40% of the size of the biological reserve of the raw material collected from above-ground parts of medicinal plants (herbs, leaves, inflorescences), excluding fruits, seeds, and bark, and 10% of the size of the biological reserve of the raw material collected from underground parts (roots, rhizomes, bulbs, tubers, bulbocorms) and bark.

The annual volume of harvesting medicinal raw materials was determined as a fraction of the division of the size of the operational reserve of raw materials on all harvesting plots by the turnover of harvesting. The turnover of harvesting medicinal plant raw material is usually one year of harvesting (Dobrochaieva, D. M., & Zaverukha, B. V., 2006). The economic mechanism of harvesting plant-based medicinal raw materials includes several indicators that characterize qualitatively new aspects of harvesting activities. The following indicators are included in this group.

Maximum Allowable Harvesting (MAH) - indicates the amount of allowable harvesting, taking into account nature conservation measures that do not deplete the reserves of medicinal plant resources. MAH is determined as the ratio of the exploitable stock to the number of years required for the restoration of medicinal plant populations (Zuzuk, B. M., & Zuzuk, L. B., 2009).

MAH = Exploitable stock / Number of years for the restoration

Exploitable stock = 40% of the biological stock

Biological stock = (PM* NSA* PC) / A

PM - plant mass, kg

NSA - number of specimens per unit area, units

PC - projected cover, %

A – area.

During the measurement of a single plant's mass, analytical scales were used, which provide accurate readings with an error margin of 0,1 grams. The number of specimens was calculated as the number of plant species within a frame with an area of 1 m², scaled up to 1 hectare. Projected cover represents the percentage ratio of the number of plant species to the unit area. In this case, the same frame with an area of 1 m² was used. The area under investigation was 1 hectare.

During the research, the following indicators were calculated: biological stock, exploitable stock, and maximum allowable harvesting. It should be noted that while calculating the maximum allowable harvesting, which is determined as the ratio of exploitable stock to the number of years required for the restoration of the medicinal plant population, the latter indicator was taken as 3 years. According to the methodology, this is the amount of time needed to replenish the reserves of medicinal plant materials in the specific natural-climatic zone to which the Bucha district of the Kyiv region belongs (Grodzinsky, D. M., Sheliag-Sosonko, Yu. R., & Cherevchenko, T. M., 2009).

4. RESULTS AND DISCUSSION

During the research, a general description of the distribution of resources of medicinal plant raw materials in the district was presented (Table 1).

From the table, it can be seen that the average projective cover of all ten plant species varied. The lowest values were observed for *Rumex confertus* Willd. and *Artemisia absinthium* L. plants (9,1% and 10,7%, respectively). Higher average projective cover was found in *Taraxacum officinale* L. and *Lamium album* L. plants – 57,4% to 61,1%. This indicator directly affects the magnitude of the planned yield, which ranged from 0,17 to 1,72 tons per hectare.

Tab. 1. Characteristics of medicinal plant resources

№	Species name	Average projective cover, %	Yield of raw material from 1% projective cover, kg	Planned yield, tons/ha
1	*Lamium album* L.	61,1	0,027	1,71
2	*Salvia pratensis* L.	27,0	0,018	0,49
3	*Prunella vulgaris* L.	23,5	0,011	0,26
4	*Taraxacum officinale L.*	57,4	0,030	1,72
5	*Chamomilla recutita (L.)* Reuschert.	12,2	0,014	0,17
6	*Artemisia absinthium* L.	10,7	0,024	0,26
7	*Chenopodium album* L.	41,2	0,034	1,41
8	*Urtica dioica* L.	21,1	0,021	0,44
9	*Capsella bursa pastoris* Medic	34,6	0,009	0,31
10	*Rumex confertus* Willd.	9,1	0,041	0,37

Biological reserves of raw materials, operational reserves of raw materials, and the volume of possible annual harvesting were determined for each of the species (Table 2). It should be noted that the operational reserve of medicinal plant raw materials constitutes 40% of the biological reserve, and the volume of possible annual harvesting represents the indicators that allow for annual collection of raw materials without harming the phytocoenosis and constitute 50% of the operational reserve.

Tab. 2. Volume of medicinal plant raw material harvesting

№	Species name	Biological reserve, kg	Operational reserve, kg	Volume of possible annual harvesting, kg
1	*Lamium album* L.	1844,2	737,7	368,9
2	*Salvia pratensis* L.	125,9	50,4	25,2
3	*Prunella vulgaris* L.	42,5	17,0	8,5
4	*Taraxacum officinale* L.	1714,5	685,8	342,9
5	*Chamomilla recutita* (L.) Reuschert.	206,2	82,5	41,3
6	*Artemisia absinthium* L.	382,3	152,9	76,5
7	*Chenopodium album* L.	1181,9	472,8	236,4
8	*Urtica dioica* L.	288,1	115,2	57,6
9	*Capsella bursa pastoris* Medic	263,1	105,2	52,6
10	*Rumex confertus* Willd.	131,7	52,6	26,3

From the table, we can conclude that the volume of harvesting medicinal plant raw material depends on the biological reserve indicator. Specifically, the latter determines the size of the operational reserve.

According to the data in Table 3, the following plant species showed higher maximum allowable harvests: *Lamium album* L. – 245,9 kg, *Taraxacum officinale* L. – 228,6 kg, and *Chenopodium album L.* – 157,6 kg. The higher values of these indicators were influenced by several factors. Firstly, these plant species had a higher density of specimens per unit area. Secondly, their projected cover in percentage terms was higher compared to other plant species. And thirdly, the average mass of a single plant was higher. The combination of these three factors resulted in higher values of the maximum allowable harvest.

On the other hand, lower maximum allowable harvests were observed in the following plant species: *Rumex confertus Willd.* – 17,6 kg, *Salvia pratensis L.* – 16,8 kg, *and Chamomilla recutita (L.) Reuschert*. – 27,5 kg. The plant species *Prunella vulgaris L.* showed the lowest maximum allowable harvest, specifically 5,7 kg. The reason for this was the lowest individual plant mass and the lowest density of specimens per unit area.

Tab. 3. Ecological efficiency of harvesting medicinal plant materials

Species name	**Maximum Allowable Harvesting, kg**	**Exploitable stock, kg**	**Biological stock, kg**	**Plant mass, kg**	**Number of specimens per unit area, units**	**Projected cover, %**	**Area, ha**
Lamium album L.	245,9	737,7	1844,2	0,009	2940	69,7	1
Salvia pratensis L.	16,8	50,4	125,9	0,007	610	29,5	1
Prunella vulgaris L.	5,7	17,0	42,5	0,006	460	15,4	1
Taraxacum officinale L.	228,6	685,8	1714,5	0,007	3440	71,2	1
Chamomilla recutita (L.) Reuschert.	27,5	82,5	206,2	0,003	1210	56,8	1
Artemisia absinthium L.	50,9	152,9	382,3	0,013	850	34,6	1
Chenopodium album L.	157,6	472,8	1181,9	0,014	1910	44,2	1
Urtica dioica L.	38,4	115,2	288,1	0,011	870	30,1	1
Capsella bursa pastoris Medic	35,1	105,2	263,1	0,004	1640	40,1	1
Rumex confertus Willd.	17,6	52,6	131,7	0,012	560	19,6	1

Having obtained the value of the admissible harvesting indicator (Table 3), and also knowing the average price of the commodity production, which ranged from 15 to 75 UAH/kg, we were able to calculate the production cost indicator at selling prices (the product of the two indicators).

According to B. M. Zuzuk (Zuzuk, B. M., & Zuzuk, L. B., 2009)., the expenses for collective team harvesting of wild medicinal plant materials amount to 60% of the value of the raw materials themselves. Thus, the production cost ranged from 9 to 45 UAH/kg. Having obtained all the aforementioned data, we calculated the value of net income (the difference between the production value and production expenses) (Figure 1). In this way, the highest economic effect was observed for the plant species *Lamium album* L. and *Taraxacum officinale* L.

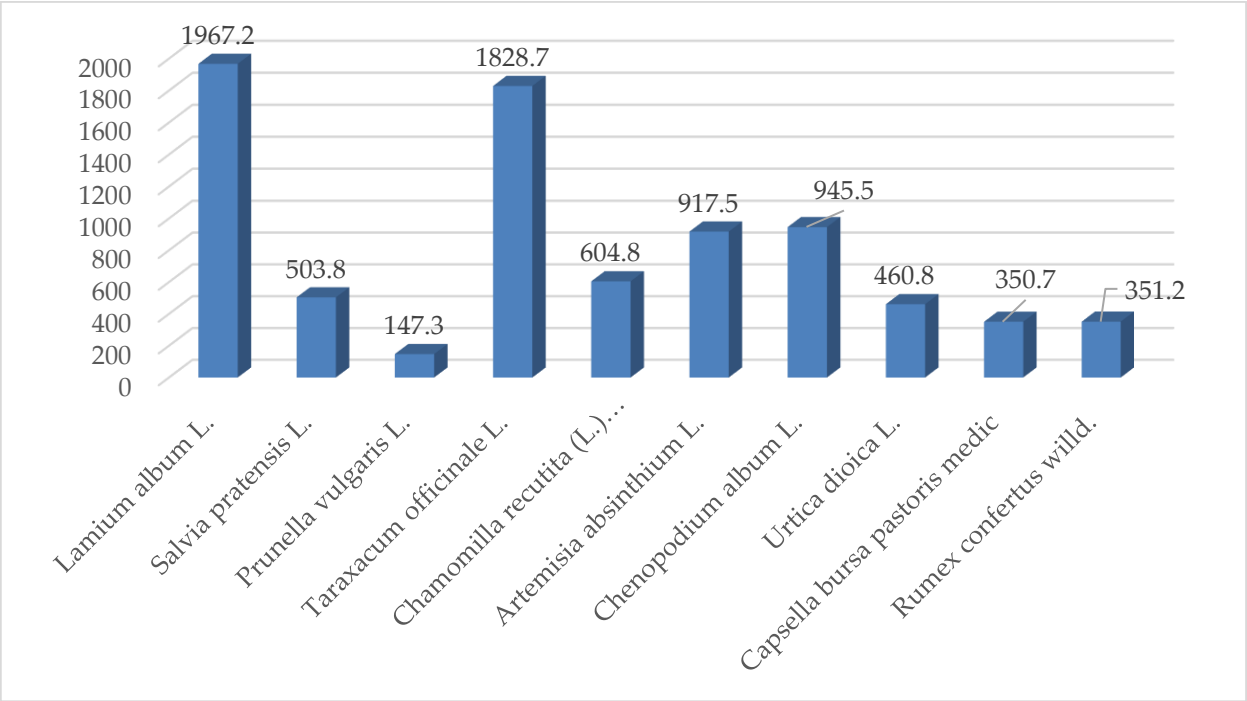

Fig. 1. Economic efficiency of harvesting medicinal plant materials

5. CONCLUSION

Based on the conducted research, the following conclusions can be drawn. The process of maximum allowable harvesting of ten wild medicinal plant species in the Bucha District of Kyiv region is ecologically viable and economically efficient. Considering the significant prevalence of certain representatives of medicinal plant materials, such as *Taraxacum officinale* L. and *Lamium album* L., in certain phytocenoses (forest-edge, ruderal), it is advisable to recommend their cultivation under these conditions.

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Андрійченко Сергій, Діденко Ігор, Амбер Артур, Василенко Ольга. Еколого-економічна ефективність заготівлі лікарської рослинної сировини. *Журнал Прикарпатського університету імені Василя Стефаника*, 10 (2023), 113-119.

Наслідками інтенсивної антропогенної діяльності стають порушення еколого-ценотичного балансу фітосистем та зменшення біорізноманіття. Внаслідок цього природні ресурси цінних видів рослин стають виснаженими і неможливі до відновлення. Для ефективного використання лікарських рослин необхідне дослідження їх ресурсів на конкретній території, вивчення екологічних особливостей і популяційних характеристик промислових видів з метою забезпечення їх безвиснажливої експлуатації та охорони. Ефективна охорона лікарських рослин повинна бути комплексною та включати багато взаємопов'язаних заходів. Раціональне ведення заготівель з урахуванням промислового вирощування сировини найважливіших видів є ключовим елементом в збереженні природних ресурсів та забезпеченні стійкої експлуатації лікарських рослин. Для збереження біорізноманітності необхідний ширший підхід до оцінки таксонів, не лише їх біологічні та екологічні характеристики, здатність до адаптації, амплітуду толерантності до зміни зовнішніх факторів, оцінку екологічних ніш, а й оцінка стратегії протидії впливу антропогенного чинника та можливості відновлення. Дослідження флори Київської області є надзвичайно актуальною проблемою з огляду на значну кількість лікарських рослин, які ростуть на цій території. Для забезпечення сталого розвитку регіону необхідно дослідити еколого-економічну ефективність заготівлі рослинної лікарської сировини. Метою нашого дослідження було вивчення еколого-економічних особливостей вирощування рослинної лікарської сировини в Бучанському районі Київської області на базі ННЦ «Мироцьке» та облік таких ресурсів. У ході даного дослідження було проведено детальний аналіз поширення рослинної лікарської сировини на території ННЦ «Мироцьке» Бучанського району Київської області. Була здійснена їх економічна оцінка з метою встановлення рентабельності заготівлі лікарської рослинної сировини на окремих масивах.

Ключові слова: лікарська сировина, ресурси, економічна оцінка, рентабельність.