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BIOLOGICAL PRODUCTIVITY AND RAW MATERIAL QUALITY INDICATORS OF MEDICINAL PLANTS UNDER THE CONDITIONS OF ANDIJAN REGION

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ABSTRACT

This article presents a biological analysis of productivity and raw material quality indicators of selected medicinal plants under the conditions of Andijan region. During the research, plant height, number of lateral branches, leaf area, aboveground biomass, dry raw material yield and selected quality indicators were studied. According to the results, the highest dry raw material yield was recorded in peppermint at 2.84 t/ha, followed by lemon balm at 2.36 t/ha, lavender at 1.92 t/ha and pot marigold at 1.48 t/ha. In terms of essential oil content, peppermint and lavender showed high values. The obtained results indicate that the studied medicinal plants are promising in terms of biological adaptability, capacity for vegetative mass accumulation and raw material quality under the conditions of Andijan region

KEYWORDS: *Medicinal Plants, Biological Productivity, Raw Material Quality, Andijan Region, Biomass, Essential Oil, Flavonoids, Vegetative Organs, Lemon Balm, Lavender*

INTRODUCTION

In recent years, the growing demand for medicinal plants has made their scientifically grounded study, adaptation to local soil and climatic conditions, and the production of high-quality medicinal raw material one of the most important research areas. Medicinal plants contain essential oils, flavonoids, phenolic compounds, organic acids, alkaloids, glycosides, saponins and other biologically active substances, which are widely used in pharmacy, traditional medicine, cosmetology and the food industry [1].

The biological productivity of medicinal plants is determined by the degree of formation of their vegetative and generative organs, photosynthetic surface area, biomass accumulation capacity, development of the root system and adaptability to external environmental factors. Raw material quality is directly associated with the amount of biologically active substances in the plant, dry matter accumulation, essential oil content, and the development level of leaf and flower organs [2].

Andijan region is located in the eastern part of the Fergana Valley and has specific agroclimatic conditions. The rapid rise in temperature during spring, hot and relatively dry weather in summer, and the wide distribution of irrigated light sierozem soils significantly affect the growth, development and raw material quality of medicinal plants. Therefore, studying the biological productivity of different medicinal plants in this region is important from both scientific and practical perspectives [3].

Lemon balm, lavender, peppermint and pot marigold are distinguished by their medicinal properties, richness in biologically active substances and importance as medicinal raw material. The leaves and young shoots of lemon balm are a source of biologically active compounds with sedative and antispasmodic properties. Lavender flowers and aerial parts are rich in essential oils and are used in aromatherapy and the pharmaceutical industry. Menthol and other essential oil components in peppermint increase its medicinal value. Pot marigold flowers are important as a source of flavonoids and carotenoids [4].

The research problem is that, although general phytochemical and pharmacological data are available for some species of medicinal plants, the biological productivity, vegetative mass formation capacity and raw material quality indicators of these plants under the conditions of Andijan region have not been sufficiently studied in a comparative manner. In particular, comparing the growth indicators and raw material yield of different medicinal plants under the same ecological conditions makes it possible to determine their cultivation prospects in local conditions.

The purpose of this study was to determine the biological productivity and raw material quality indicators of selected medicinal plants under the conditions of Andijan region and to biologically assess their prospects as medicinal raw material.

The research objectives were as follows: to determine the morphological indicators of medicinal plants; to evaluate aboveground biomass and dry raw material yield; to analyse selected biologically active substance indicators that determine raw material quality; to compare the results obtained for different plant species and to develop scientific conclusions.

The scientific novelty of the study lies in the fact that the biological productivity and raw material quality of four medicinal plant species were comparatively evaluated under the same ecological conditions in Andijan region. The results provide a scientific basis for developing practical recommendations on cultivating medicinal plants under local conditions, determining raw material harvesting periods and obtaining high-quality medicinal products.

MAIN PART

Morphological, biometric and phytochemical indicators are of great importance in studying the biological productivity of medicinal plants. Plant height, number of lateral branches, leaf area, aboveground biomass and dry raw material yield are the main parameters that describe the level of biological development of plants [5]. Raw material quality is assessed by the content of essential oil, flavonoids, total phenolic compounds and dry matter in the plant [6].

Four medicinal plant species cultivated under the conditions of Andijan region were selected as the object of the study: lemon balm (Melissa officinalis L.), lavender (Lavandulaangustifolia Mill.), peppermint (Menthapiperita L.) and pot marigold (Calendula officinalis L.).

Observations were carried out under open-field conditions. The plants were grown on irrigated light sierozem soils. For each species, 30 healthy and uniformly developed plants were selected. Biometric measurements were conducted during the active growth phase of the vegetation period and at the raw material harvesting stage.

The following indicators were studied during the research: plant height, number of lateral branches, leaf area, aboveground biomass, dry raw material yield, essential oil content, total flavonoids and dry matter content. Plant height was measured using a measuring tape, the number of lateral branches was determined by direct counting, and biomass was

determined using scales. Dry raw material yield was calculated based on the mass obtained after drying freshly harvested raw material.

The obtained results were summarized using arithmetic mean values. During the analysis, the biological productivity, raw material quality and adaptability of medicinal plants to local conditions were compared.

The table below presents the main indicators of biological productivity and raw material quality of the medicinal plants studied under the conditions of Andijan region.

Table 1: Biological Productivity and Raw Material Quality Indicators of Medicinal Plants

No.	Medicinal Plant Species	Plant Height, Cm	Number Of Lateral Branches, PCS/Plant	Leaf Area, cm²/Plant	Above Ground Biomass, g/plant	Dry Raw Material Yield, t/ha	Total Flavonoids, mg/g
1	Lemon balm (Melissa officinalis L.)	64.2	38.6	2840	186.5	2.36	24.8
2	Lavender (Lavandulaangustifolia Mill.)	58.4	34.2	1980	142.7	1.92	18.6
3	Peppermint (Menthapiperita L.)	72.6	42.8	3260	214.3	2.84	21.4
4	Pot marigold (Calendula officinalis L.)	46.8	21.5	1740	128.6	1.48	29.2

According to the table, the highest plant height was observed in peppermint, where it reached 72.6 cm. This indicator was 64.2 cm in lemon balm, 58.4 cm in lavender and 46.8 cm in pot marigold. These results indicate that peppermint actively forms stem and leaf mass under the conditions of Andijan region.

Peppermint also showed the highest result for the number of lateral branches, with 42.8 branches per plant. The number of lateral branches was 38.6 per plant in lemon balm, 34.2 in lavender and 21.5 in pot marigold. A greater number of lateral branches expands the photosynthetic surface on which leaves and young shoots are formed.

In terms of leaf area, peppermint ranked first with 3260 cm² per plant. Leaf area was 2840 cm² per plant in lemon balm, 1980 cm² per plant in lavender and 1740 cm² per plant in pot marigold. A larger leaf area contributes to more intensive photosynthesis and greater accumulation of organic matter.

Aboveground biomass was 214.3 g per plant in peppermint, 186.5 g per plant in lemon balm, 142.7 g per plant in lavender and 128.6 g per plant in pot marigold. Dry raw material yield followed the same sequence: 2.84 t/ha in peppermint, 2.36 t/ha in lemon balm, 1.92 t/ha in lavender and 1.48 t/ha in pot marigold.

A different pattern was observed for total flavonoid content. The highest value was recorded in pot marigold, at 29.2 mg/g. Total flavonoids were 24.8 mg/g in lemon balm, 21.4 mg/g in peppermint and 18.6 mg/g in lavender. This indicates that biological productivity and raw material quality do not always change in the same direction. In other words, some plants may have high biomass, whereas other species may contain a higher concentration of biologically active substances.

The diagram below shows the essential oil content determined in the dry raw material of the studied medicinal plants.

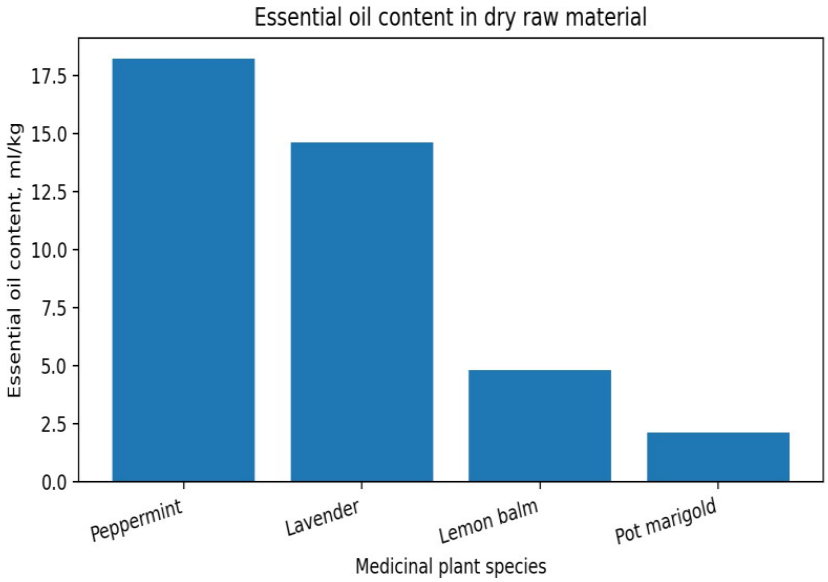

Figure 1: Essential Oil Content in the Dry Raw Material of Medicinal Plants, ml/kg.

According to the diagram, the highest essential oil content in dry raw material was observed in peppermint, reaching 18.2 ml/kg. This value can be explained by the well-developed essential oil glands in peppermint leaves and the accumulation of menthol and other volatile compounds [7].

In lavender, essential oil content was 14.6 ml/kg, which makes it possible to assess this plant as a high-quality source of aromatic raw material. In lavender, most essential oils accumulate in the corolla, calyx and young shoots. Therefore, the budding and mass flowering stages are important for harvesting lavender raw material [8].

Essential oil content in lemon balm was 4.8 ml/kg. Although this value is lower than in peppermint and lavender, the medicinal value of lemon balm is determined not only by its essential oil but also by the presence of flavonoids, phenolic acids and other biologically active substances [9].

In pot marigold, essential oil content was 2.1 ml/kg. The main medicinal importance of pot marigold is associated more with flavonoids, carotenoids and triterpene compounds than with essential oil. Therefore, in the table, pot marigold surpassed the other species in total flavonoid content, reaching 29.2 mg/g.

Lemon balm also showed high vegetative development indicators. A plant height of 64.2 cm, 38.6 lateral branches per plant, leaf area of 2840 cm² per plant and dry raw material yield of 2.36 t/ha confirm its importance as medicinal raw material. Since leaves and young shoots are the main medicinal organs of lemon balm, the leaf area of 2840 cm² per plant is an important biological indicator. This parameter shows that photosynthetic activity proceeded at a sufficient level in the plant.

The data obtained for lavender show that its biological productivity is lower than that of peppermint and lemon balm, but it is highly important in terms of raw material quality. In lavender, dry raw material yield was 1.92 t/ha, while essential oil content was 14.6 ml/kg. This indicates that the main value of lavender is manifested primarily as aromatic raw material. Therefore, in evaluating lavender, essential oil content should be considered one of the main criteria along with biomass.

In pot marigold, plant height was 46.8 cm, the number of lateral branches was 21.5 per plant, leaf area was 1740 cm² per plant and dry raw material yield was 1.48 t/ha. Although these indicators were lower than those of the other plants, total flavonoid content reached 29.2 mg/g, with the highest result recorded precisely in pot marigold. Thus, the biological productivity of pot marigold may be relatively lower, but some of its raw material quality indicators are high.

The analysis shows that it is not sufficient to evaluate medicinal plants only by yield indicators. In some plants, aboveground mass and dry raw material are higher, whereas in others the concentration of biologically active substances may be higher. For this reason, morphological, physiological and phytochemical indicators should be analysed together in the scientific assessment of medicinal plants.

From a biological point of view, leaf area and the number of lateral branches are among the main factors determining raw material yield. In plants with a large leaf area, photosynthesis proceeds actively, more organic matter is synthesized and aboveground biomass increases. In peppermint and lemon balm, high leaf area and a large number of lateral branches resulted in higher dry raw material yield.

All studied plants completed their growth and development phases successfully during the vegetation period under the conditions of Andijan region, which indicates their potential adaptability to local conditions. However, a differentiated agrobiological approach is required for each species. For peppermint and lemon balm, cultivation practices aimed at increasing leaf and shoot mass are important; for lavender, harvesting at the flowering stage is essential; and for pot marigold, the proper collection and drying of flower heads is particularly important.

CONCLUSION

Under the conditions of Andijan region, the studied medicinal plants showed different indicators of biological productivity and raw material quality. Peppermint demonstrated high values in vegetative mass, leaf area, dry raw material yield and essential oil content and was assessed as a promising plant for the production of medicinal and aromatic raw material.

Lemon balm also had high vegetative development indicators and was distinguished by a dry raw material yield of 2.36 t/ha and total flavonoid content of 24.8 mg/g. This shows its important role in the production of medicinal leaf and shoot raw material.

Although lavender had a medium level of dry raw material yield, its essential oil content of 14.6 ml/kg gives it special importance as aromatic and essential-oil raw material. Pot marigold, with a total flavonoid content of 29.2 mg/g, was evaluated as a medicinal plant with high quality indicators.

The results of the study show that, when cultivating medicinal plants under the conditions of Andijan region, it is necessary to take into account the biological characteristics of each species, the formation of vegetative organs, the timing of raw material collection and quality indicators. In future research, it is advisable to study in greater depth the sowing dates, irrigation rates, fertilization systems and seasonal changes in biologically active substances for these plants.

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