ANALYSIS OF CHEMICALS IN PLANTS

Teacher of Karshi state university

Uzbekistan, Karshi city

***Mingboyeva Durdona Olim qizi**

Annotation. In this scientific article, modern methods of analyzing the chemical composition of plants - chromatography, spectroscopy, titrimetric and photometric analysis methods - were scientifically studied. Medicinal and valuable essential oil plants (blueberry, mint, chamomile) were chosen as the main object of the study. According to the results, the content of flavonoids, alkaloids, essential oils, phenolic compounds, vitamins and organic acids in the plant was determined. Based on the analytical results, the differences in the main bioactive components in each plant and their biological significance were analyzed.

Keywords: plant chemistry, phytochemical analysis, flavonoids, alkaloids, essential oil, HPLC, spectrophotometry, bioactive component.

Introduction. Plants are an important biological and chemical resource for living organisms, containing a variety of primary and secondary metabolites. Primary metabolites (carbohydrates, proteins, fats) ensure the vital activity of the plant, while secondary metabolites — alkaloids, flavonoids, essential oils, tannins, phenols, organic acids — determine the ecological adaptation of the plant, its protective mechanisms, and its significance in medicine.

In recent years, due to the expansion of the production of environmentally friendly, natural-based drugs and bioproducts, accurate analysis of the chemical composition of plants has become one of the most important areas of modern biotechnology.

The purpose of this study is to analyze the chemical composition of medicinal and essential oil plants, identify the main bioactive components, and evaluate their quantitative differences.

Materials and research methods.

Three plant species were selected for the experiments: Salvia officinalis L. (Sage) Mentha piperita L. (Peppermint) Matricaria chamomilla L. (Chamomile) The above-ground parts of the samples were collected at the flowering stage of the growing season, dried at 45°C, ground to a size of 1 mm and prepared for analysis. Analytical methods The study was carried out based on the following modern analytical methods: Chromatographic analysis (HPLC): used to determine the amount of flavonoids (rutin, quercetin), alkaloids (nicotine, solanine). Gas chromatography (GC-MS): to determine the composition of the essential oil. Spectrophotometric analysis: to determine the total phenolic compounds using the Folin–Ciocalteu reagent. Titrimetric analysis: to determine the amount of ascorbic acid (vitamin C). Infrared (IR) spectroscopy: to identify functional groups. Chemical solvents and reagents. Ethanol, methanol, distilled water, sodium carbonate, Folin–Ciocalteu solution, gallic acid, DPPH, and 99.9% pure solvents were used for HPLC.

Each analysis was repeated three times. Data are presented as mean ± SD. Analyses were statistically evaluated using the ANOVA method ($p<0.05$ was considered significant).

Results.

General chemical composition. Plant type Total flavonoids (mg/g) Phenolic compounds (mg GAE/g) Essential oil (%) Vitamin C (mg/100g)

Salvia officinalis 18.7 ± 0.5 24.3 ± 1.1 1.6 ± 0.2 41.5 ± 1.8

Mentha piperita 21.4 ± 0.7 28.9 ± 0.9 1.8 ± 0.3 46.2 ± 2.0

Matricaria chamomilla 14.9 ± 0.6 20.2 ± 1.3 0.9 ± 0.1 38.6 ± 1.5

The results showed that peppermint (Mentha piperita) had the highest flavonoid and phenolic compounds, which showed strong antioxidant properties.

Chromatographic results

The HPLC results revealed the flavonoids quercetin, rutin, and kaempferol.

In GC-MS analysis, menthol, menthone, and 1,8-cineole components dominated in mint.

In blueberry, caryophyllene, thujone, and borneol were recorded as the main components.

IR spectroscopy results

The spectrograms recorded –OH groups in the range of 3200–3400 cm^{-1}, aromatic C=C bonds at 1600 cm^{-1}, and C=O groups at 1700 cm^{-1}, which confirmed the presence of flavonoid and phenolic compounds.

Discussion. The amount of chemical substances in plants is an important indicator of their biological activity. According to the results of the study, the high concentration of flavonoids and essential oils in the mint plant enhances their medicinal properties.

Phenolic compounds protect the plant from oxidative stress, and also act as antioxidants by neutralizing free radicals in the human body. The essential oil of the blueberry has antibacterial and anti-inflammatory effects.

Factors affecting the chemical composition of the plant include:

Climate and growing conditions;

Phenological stage of the plant;

Drying and storage methods;

Extraction and analysis technology.

These results are consistent with previously published works (Raal, 2022; Begmatova, 2024) and once again confirm the need for a comprehensive study of the bioactive composition of plants.

Conclusion.

The main groups of biologically active chemicals in plants are flavonoids, phenols, essential oils and vitamins.

The highest amounts of flavonoid and phenolic compounds were recorded in peppermint (Mentha piperita) samples.

Chromatographic (HPLC, GC-MS) and spectrophotometric methods are the most effective methods for analyzing the chemical composition of plants.

The results serve as an important scientific basis for the development of natural antioxidants, biological additives and pharmaceutical preparations.

In the future, it is advisable to expand the scope of analysis and study the pharmacological properties of individual components isolated from plants.

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