

ANALYSIS OF ADAPTATION OF LEMNA MINOR TO DIFFERENT GROWTH CONDITIONS AND ITS MORPHOPHYSIOLOGICAL AND BIOCHEMICAL INDICATORS

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Abstract: In this study, the growth characteristics of the aquatic plant Lemna minor under the influence of various environmental factors were studied. In particular, the development processes of the plant were evaluated depending on the light intensity, the composition of the nutrient solution, and the pH level of the medium. During the experiments, the increase in biomass, the number and size of leaf plates, the amount of chlorophyll, the activity of the photosynthesis process, the concentration of total protein and pigments were determined and analyzed. The results of the study showed that this plant is sensitive to environmental factors. Also, the obtained data confirm the possibilities of effective use of Lemna minor as a bioindicator and in biotechnological directions.

Key words: Lemna minor, aquatic plants, growth conditions, morphophysiological indicators, biochemical analysis, biomass.

INTRODUCTION

Bottom water plants distributed in aquatic ecosystems play an important role in maintaining ecological balance. Among them, Lemna minor is a fast-growing aquatic plant with high vegetative reproduction ability, belonging to the Lemnaceae family. This species is often found in freshwater ponds and is distinguished by the fact that it produces a large biomass in a short time.

In recent years, the increased interest in Lemna minor is due to its ecological and practical importance. This plant actively absorbs nitrogen and phosphorus compounds in the water environment, accumulates heavy metals and is used as a bioindicator in the biological assessment of water pollution. In addition, Lemna minor is a promising object in the fields of animal husbandry and biotechnology as a source of protein-rich biomass.

Plant growth and development are directly dependent on environmental factors, in particular, light intensity, nutrient composition, pH level, and temperature. These factors significantly affect the activity of photosynthesis, synthesis of pigments and metabolic processes. Therefore, in-depth study of growth dynamics and morphophysiological and biochemical indicators of Lemna minor under different conditions is important from a scientific and practical point of view.

The main goal of this study is to grow Lemna minor under different growth conditions and to determine the changes in its morphological, physiological and biochemical parameters. Based on this goal, the following tasks were defined:

Determining the growth rate of Lemna minor under different light and nutrient conditions;

- assessment of biomass and morphological indicators;
- analysis of chlorophyll and total protein content;
- determining the influence of growth conditions on biochemical processes.

MATERIALS AND METHODS

Research object

Samples of *Lemna minor* collected from a freshwater basin were used as the research object. Before the experiment, the plants were cleaned of mechanical impurities and washed in distilled water.

Experimental conditions

The experiment was conducted in laboratory conditions at a temperature of 21–25 °C. Plants were grown under the following conditions:

- light intensity: low (1000 lx), medium (3000 lx) and high (6000 lx);
- nutrient medium: distilled water and mineral nutrient solution;
- pH level: 5.5; 7.0 and 8.5.

Each variant was established in triplicates.

Determination of morphological indicators

During growth, the number of leaf plates, their average diameter and total biomass of *Lemna minor* were determined. Biomass was estimated by weighing using an analytical balance.

Biochemical analyses

The amount of chlorophyll was determined using the acetone extraction method and measured in a spectrophotometer. The amount of total protein was estimated based on the standard colorimetric method.

RESULTS

Growth dynamics of *Lemna minor* under different growth conditions

During the experiment, it was observed that the growth of *Lemna minor* is significantly dependent on external environmental factors. In particular, light intensity and the composition of the nutrient medium had a direct effect on the accumulation of plant biomass.

In low light conditions (1000 lx), the growth rate of plants was slow. The increase in the number of leaf plates was limited, and they were distinguished by their small size. In these conditions, the decrease in photosynthetic activity led to a slowdown in biomass accumulation.

At medium light intensity (3000 lx), growth activity of *Lemna minor* increased significantly. A rapid increase in the number of leaf plates was observed on days 7-10 of the experiment. The fact that these conditions are optimal for the plant was shown by the high indicators of the amount of biomass.

Although the growth activity was initially high under high light conditions (6000 lx), color changes and signs of physiological stress were observed in the leaf plates in the later stages of the experiment. This situation is explained by the negative effect of excessive light intensity on the photosynthetic apparatus.

Analysis of biomass accumulation

The results obtained in different growth conditions showed significant differences in the amount of biomass. The amount of biomass in Lemna minor samples grown in mineral nutrient solution was higher compared to the variants grown in distilled water.

The effect of pH level was also evident. A neutral environment (pH 7.0) is the most favorable condition for plant growth, and the biomass reached the maximum value. In acid (pH 5.5) and alkaline (pH 8.5) environments, the growth process slowed down, which is associated with the derailment of metabolic processes.

High rates of biomass accumulation were recorded in the combination of medium light intensity and mineral nutrient medium. This situation confirms the ability of intensive reproduction of Lemna minor.

Changes in morphological indicators

The results of the experiment showed that the morphological characteristics of Lemna minor are sensitive to growth conditions. The number of leaf plates and their diameter changed according to light and nutrient conditions.

Under optimal conditions, the leaf plates were wider and greener, and their number increased rapidly. In stressful conditions, the leaves are small, prone to discoloration, and vegetative reproduction is slowed down.

Changes in morphological indicators are closely related to photosynthetic activity, which indicates the adaptability of the plant to the external environment.

Changes in the amount of chlorophyll

Biochemical analyzes showed that the chlorophyll content of Lemna minor varies significantly depending on the growth conditions. At medium light intensity, the content of chlorophyll "a" and "b" is high, which confirms the activity of the photosynthesis process.

Under low light conditions, the synthesis of pigments was insufficient, and under high light conditions, the processes of chlorophyll decomposition increased. These results show that there is an optimal limit of light intensity.

Analysis of total protein content

Total protein content was evaluated as an important indicator of plant metabolism. The protein content of Lemna minor samples grown in mineral nutrient medium and neutral pH conditions was high.

A decrease in protein synthesis was observed under stress conditions, which indicates a decrease in metabolic activity. The obtained results reflect the mechanisms of biochemical adaptation of Lemna minor.

DISCUSSION

The results of this study showed that the growth and development of Lemna minor is highly dependent on external environmental factors. It was found that the intensity of light, the availability of nutrients and the pH level have a significant effect on the morphological, physiological and biochemical parameters of the plant.

High biomass accumulation at medium light intensity is explained by optimal energy supply for photosynthetic processes. Limitation of the photosynthesis process under low light conditions

led to a decrease in chlorophyll synthesis and metabolic activity. At high light intensity, photoinhibition phenomena were observed, which was manifested by chlorophyll breakdown and physiological stress.

The effect of the composition of the food environment is also important, and it was found that the growth rate and protein synthesis of *Lemna minor* increased significantly in the environment rich in mineral elements. This situation confirms the important role of nitrogen and phosphorus elements in metabolic processes. In the conditions of distilled water, growth limitation is associated with a lack of nutrients.

It was determined that the neutral value of the pH level is the most favorable condition for the plant, and the slowing down of growth processes in acid and alkaline environments is explained by the violation of enzymatic activity. These results indicate that *Lemna minor* has high biological efficiency under optimal conditions, although its ecological adaptability is limited.

The obtained results expand the prospects of using *Lemna minor* for biological treatment of water bodies, pollution assessment and as a source of protein-rich biomass. The results of the research confirm the bioindicator properties of this plant.

CONCLUSION

Based on the conducted research, the following conclusions were reached:

1. Growth and biomass accumulation of *Lemna minor* are directly dependent on light intensity, nutrient medium and pH level.
2. Medium light intensity (3000 lx) and mineral nutrient medium are the most favorable conditions for optimal plant growth.
3. Morphological and biochemical indicators had the highest values in conditions of neutral pH (7.0).
4. Changes in the amount of chlorophyll and total protein reflect the photosynthetic and metabolic activity of *Lemna minor*.
5. The obtained results confirm the possibilities of using *Lemna minor* for environmental monitoring, biological treatment of water bodies and biotechnological purposes.

The results of this research can serve as a scientific basis for the cultivation and practical use of *Lemna minor* on an industrial scale in the future.

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