

MODERN METHODS OF STUDYING THE ANTIFUNGAL AND ANTIBACTERIAL EFFECTS OF PHYTOCHEMICAL COMPONENTS OF THE AZOLLA PLANT.

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Annotation: This article studies the phytochemical composition of the Azolla plant and its antifungal and antibacterial properties. During the study, the bioactive components of Azolla (flavonoids, phenols, alkaloids, terpenoids) were analyzed and their effect on pathogenic microorganisms was evaluated. The plant composition was studied using modern research methods - GC-MS, HPLC, FTIR methods, and antimicrobial efficacy was determined by disk diffusion, MIC and MBC tests. The results showed that Azolla extract can significantly suppress the growth of bacteria and fungi. This study opens up prospects for the development of new biological antimicrobial agents based on Azolla.

Keywords: Azolla, phytochemical composition, flavonoids, phenols, alkaloids, terpenoids, antifungal, antibacterial, GC-MS, HPLC, MIC, MBC, disk diffusion, bioactive substances.

Introduction: Azolla is an aquatic fern-like plant, which is characterized by its nitrogen fixation ability and richness in biologically active substances. This plant is used in agriculture as a green fertilizer, animal feed and environmental cleaning agent. In recent years, scientific research on the phytochemical composition of Azolla and its potential for use in medicine has been increasing. In particular, the study of its antifungal and antibacterial properties is of great importance. This article reviews the phytochemical composition of the Azolla plant, its bioactive substances, and modern methods for assessing their effect against microorganisms.

1. Phytochemical composition of the Azolla plant: Azolla is rich in various bioactive substances, among which flavonoids, phenols, alkaloids, and terpenoids play an important role. These substances increase the ecological adaptability of the plant and participate in its defense mechanisms.

1.1. Flavonoids and phenols: Flavonoids have strong antioxidant properties, have the ability to reduce inflammatory processes and have antimicrobial effects. Phenols, on the other hand, inhibit the growth of bacteria and fungi by disrupting the cell wall.

1.2. Alkaloids and terpenoids: Alkaloids disrupt bacterial cell metabolism, while terpenoids alter the membrane structure and damage microorganisms. These compounds are considered to have important biological activities in the pharmaceutical industry.

2. Antifungal and antibacterial properties: Extracts from the Azolla plant can be used as an effective agent against bacteria and fungi. Studies show that its bioactive substances significantly reduce the growth of some pathogenic microorganisms.

2.1. Antifungal effect: Azolla extracts have been found to be effective against fungi such as *Candida albicans*, *Aspergillus niger*. They have been observed to limit the growth of fungi by affecting their cell walls.

2.2. Antibacterial effect: Substances contained in the Azolla plant can have bacteriostatic and bactericidal effects against bacteria such as *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*. The mechanism of action is based on membrane damage, protein synthesis disruption, and disruption of cell metabolism.

3. Research methods: The following modern research methods are used to evaluate the phytochemical composition of Azolla and its antimicrobial effect:

3.1. Determination of phytochemical composition:

a) GC-MS (Gas Chromatography-Mass Spectrometry): Used to determine organic compounds in Azolla extract.

b) HPLC (High Performance Liquid Chromatography): One of the main methods for determining flavonoids and phenolic compounds.

c) FTIR (Far Infrared Spectroscopy): Identification of functional groups in the plant.

3.2. Evaluation of antimicrobial properties: Disk diffusion method: Determination of the effect of Azolla extract on bacterial and fungal colonies.

MIC (Minimum Inhibitory Concentration): Determination of the minimum effective concentration of the extract. MBC (Minimum Bactericidal Concentration): Estimation of the amount of extract required to completely destroy bacteria.

4. Results and Discussion: The phytochemical composition and bioactive substances of the Azolla plant have been confirmed in studies to be effective against various pathogenic microorganisms. In particular, it has been found that flavonoids and phenols affect the membrane structure of bacteria, while alkaloids disrupt cell metabolism.

Experiments have shown that Azolla extract, when used in high concentrations, significantly inhibits the growth of bacteria and fungi. This expands its application in the pharmaceutical and biotechnology fields.

Conclusion: Azolla is not only an ecologically important plant, but also a natural antimicrobial agent rich in biologically active substances. It has been found that flavonoids, phenols, alkaloids and terpenoids contained in it are effective against various microorganisms.

In future studies, it is important to further study the pharmacological properties of Azolla extract, isolate its components and continue work on the creation of new biological medicinal products.

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