

ABSTRACT

The liverworts (Marchantiophyta) are a group of spore-bearing plants, numbered 7,500 to 9,000 species. They probably first appeared on land, around 472 million years ago, and are therefore the ancestors of all terrestrial plants as we know them today. Liverworts are plants that are characterised by an extraordinary variety of chemical compounds. Secondary metabolites of a plant are the an important defence system against attacks by pathogenic plant bacteria and environmental influences. The synthesis and accumulation of phytochemicals depend on environmental conditions. For most plants, external factors such as environmental light, temperature and water can significantly influence some plant growth and development processes and even their ability to synthesize secondary metabolites. This changes the overall phytochemical profiles that play a strategic role in the production of bioactive substances. Secondary metabolites of plants may be gradually generated in response to environmental factors. The secondary metabolism of plants can be viewed as the behaviour of plants toward external stimuli.

In the present study, the aim is to characterise the liverworts of the *Calypogeia azurea* species in terms of the factors mentioned above.

In the theoretical part of the work, the available literature on liverworts was reviewed. The liverworts of the *Calypogeia azurea* species, which were the subject of the study, were discussed in detail. In addition, the secondary metabolites produced by liverwort cells were characterised. Based on the available literature, the influence of environmental stress on volatile organic compounds has also been described. Since extraction is an important step in the analysis of compounds present in botanical material, its strengths and weaknesses are discussed.

In the experimental part of this study, a phytochemical analysis of liverworts of the species *Calypogeia azurea* was performed. Because browning of the leaves was observed during the investigation, it was checked whether storage of the sample in various conditions (refrigerator, freezer) affects the content of volatile organic compounds.

Based on the fact that liverworts are plants particularly sensitive to environmental stress (temperature, humidity, sunlight, etc.), it was tested whether the season influences the composition of secondary metabolites present in the oily bodies of liverwort *Calypogeia azurea*. For this purpose, samples were collected in spring, summer and autumn. As extraction should ensure the isolation of all components present in *Calypogeia azurea* without the

formation of artefacts, the selection of the correct extraction technique was a key step in the investigation. This paper compares the four most popular methods of extraction of volatile organic compounds (VOCs): hydrodistillation (HD), solid-liquid extraction (SLE), microwave-assisted extraction (MAE), and solid-phase microextraction (SPME). In order to determine the VOC, the obtained extracts were analysed by gas chromatography coupled with mass spectrometry (GC-MS).

Since metals are also one of the most common abiotic stress factors that influence plant growth, the last objective of the study was to determine the correlation of metal content in *Calypogeia azurea* and on the substrate in which plants grow in the natural environment.