Self-Assembled Soft Sensing Monolayers for Fungal Metabolites Detection (SAMycoSENS)

Fungi are organisms that, throughout their life cycle, produce various chemical compounds. Some of these are secondary metabolites, such as mycotoxins and alkaloids. Mycotoxins, such as zearalenone, T-2 toxin, and HT-2 toxin, are highly toxic substances that often contaminate food products (e.g., grains, nuts, and spices). In turn, alkaloids produced by fungi, such as psilocybin, may have psychoactive properties. This means that consumption of certain mushrooms can induce hallucinations, states of euphoria, but also serious side effects, including anxiety and coordination problems. There are many pathways through which humans can be exposed to these compounds. The first and most common is the consumption of food contaminated with fungal metabolites – especially grains, grain-based products, spices, or nuts. The second route of exposure is occupational contact – people working in food production and processing (e.g., in mills, bakeries, or processing plants) can inhale dust containing mycotoxins. The third is contaminated water – due to runoff from agricultural fields with contaminated crops, mycotoxins can enter surface and groundwater. The fourth and increasingly important factor influencing the risk of exposure to fungal metabolites is climate change. Rising temperatures and increased air humidity create ideal conditions for the growth of fungi, making the problem of food contamination more widespread, even in regions previously considered less threatened. Finally, metabolites (e.g., psilocybin) may be consumed consciously, yet frequently illegally. All this means that mycotoxins and alkaloids pose a threat to the health of both humans and animals. Their detection using standard laboratory methods, although very accurate, is expensive and requires specialized equipment, limiting analysis to laboratory settings. As a result, there is a need for new and more accessible tools to detect these harmful substances.

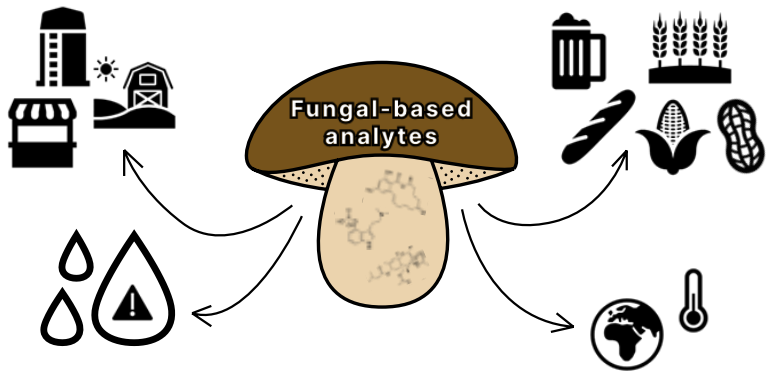

Fig. 1. Scheme showing possible pathways of exposure to fungal metabolites.

This project aims to develop innovative electrochemical sensors that will enable rapid and effective detection of mycotoxins and psilocybin. The innovative approach of this project is based on the use of so-called electrified liquid-liquid interfaces – boundaries between two immiscible liquids (water || oil) that will generate electric signal in the presence of studied molecules. These interfaces will be modified using monolayers of lipids linked to biological "sensors" – aptamers that recognize mycotoxins and an enzyme that will be used to detect psilocybin. Thanks to the fact that these layers self-assemble at the liquid-liquid interface, the entire system is expected to be resistant to damage and easy to reproduce. The developed electroanalytical system will enable the detection and determination of concentrations of selected fungal metabolites in food samples suspected of contamination, and in the future, it may also find application in environmental monitoring or in activities related to the control of psychoactive substances.