

Group	:	Organic Chemistry
Project	:	3D-printed smartphone-based biosensor employing paper microfluidics for on-site plant toxin detection
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Introduction

Providing the growing world population with safe and nutritious foods in a sustainable manner is one of the major challenges mankind faces today. The safety of our food, however, is under pressure by a range of drivers like climate change, growing world population, alternative supply chains, and dietary transformations. These drivers are expected to increase the presence of food contaminants, like plant toxins, which are already a major food safety concern. Two of the most frequently occurring classes of plant toxins, regulated by the European union, are tropane alkaloids (TAs) and pyrrolizidine alkaloids (PAs). Traditionally used techniques for the analysis of these contaminates, such as high-performance liquid chromatography – tandem mass spectrometry (HPLC-MS/MS) or enzyme-linked immunosorbent assays (ELISA) are time-consuming, laboratory-bound, and expensive. There is therefore an urgent demand to develop rapid on-site devices that enable non-expert end-users to screen food commodities for the presence of these plant toxins. These devices should provide non-experts the tools to perform simplified sample preparation, contaminant detection, and data-interpretation on-site.

In this project, miniaturized paper-based analytical device (µPAD) integrated with smartphone data-processing that can analyze food products for the presence of plant toxins will be developed. An indirect competitive lateral flow immunoassay (icLFIA) will be at the core of this µPAD. Many people have become accustomed with using LFIA's (e.g. pregnancy, SARS-CoV-19, and HIV tests). icLFIAs are based on the competition between free analyte in the sample and an immobilized antigen-conjugate for a limited number of primary mAb. As plant toxins are very toxic and regulation is strict, the limit of detection (LOD) of the µPAD is crucial. Examples of research projects are:

A. Increasing the available binding opportunity of the antibody with the test-line to make the LFIA more sensitive. Recent research has shown that the LOD of an LFIA can be improved by reducing capillary flowrate in or the test-zone area of the LFIA via chemical and mechanical modifications. An in depth overview and comparison of the performance and applicability of the current modifications to improve a LFIA however is lacking. Therefore, in this thesis project the student will examine multiple different strategies to improve the performance of a LFIA.

B. On-site applicable sample preparation protocols will enable plant toxin extraction, enrichment, and matrix clean-up, to aid with improving detection limits. However, such approaches require chemically modified surfaces to allow solid-phase or liquid-liquid extractions on paper. The objective of the thesis is the development of such fluidic systems, their characterization and implementation in the on-site screening assay.

Are you an enthusiastic and motivated student with an affinity for analytical chemistry? Are you an ambitious go-getter, not afraid to be challenged? Then we are looking for you!

Techniques to be used

Developing and running LFIA's, chemically modifying paper, 3D-printing to assist the mechanical modification of the LFIA, LC-MS to compare performance of LFIA with gold-standard

Requirements

-Full-time available
-MSc or BSc thesis student
-No background in immunochemistry required