Photometric-based biosensor for PKU and control unit miniaturization for point-of-care diagnostics

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Phenylketonuria (PKU) is a metabolic disease resulting from a deficient enzyme (phenylalanine hydroxylase) and consequent build-up of dangerous levels of an amino acid, L-Phenylalanine (L-Phe), in the blood.[1] If left untreated, PKU can lead to neurodegenerative symptoms, which can be prevented by following a diet low in L-Phe.[2] Thus, early detection of PKU in newborns is essential. Screening and monitoring of the disease is currently centralized at the site of patient care, which generally requires specialized and costly equipment, as well as qualified personnel to perform the diagnostics.[3,4] In this work, we present an enzyme-based qualitative photometric strategy to accurately diagnose PKU. It consists of an assay performed in a 96 well microplate, previously functionalized to specifically detect L-Phe. Measurements are performed by a microplate reader, which allows the samples of up to 48 patients to be analyzed simultaneously within a matter of hours and at the site of patient care. The measurements are fast, versatile, low-cost and easy to carry out. The presented diagnostic system has been validated with anonymous real plasma samples provided by the hospital Sant Joan de Deu (HSJD), accurately discriminating healthy from diseased patients.

Moving forward, a more portable point-of-care (POC) device is also envisaged which aims to miniaturize the control unit for electrochemical detection or integrate a smartphone with the photometric sensor. With this goal in mind, we are developing a compact stand-alone benchtop photometric sensor with wifi and bluetooth connectivity, allowing real-time plotting on a mobile phone. In addition, a low-cost miniaturized potentiostat has been designed and assembled for a more wearable/portable electrochemical sensing platform with state-of-the-art performance.

References

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Figures

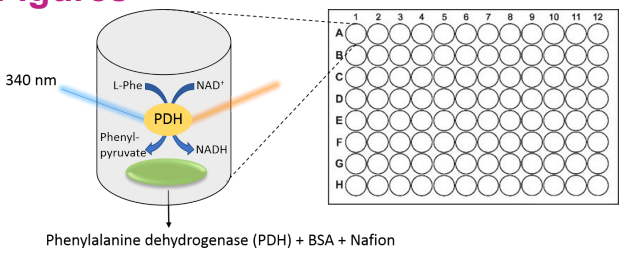

Figure 1. Schematic representation of the detection mechanism of the photometric platform for phenylalanine detection. The bottom of the microplate wells is modified with a mixture containing phenylalanine dehydrogenase (PDH), an enzyme that catalyzes the conversion of phenylalanine into phenylpyruvate in the presence of NAD^+ cofactor. The production of NADH (the reduced form of the cofactor) is monitored by measuring the absorbance at 340 nm.