

Determination of Potassium Ion Concentration using Paper-Based Devices and Electrochemical Methods

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Rapid quantification of ions in bodily fluids can be important for guiding an individual's nutrition to prevent illness. The level of micronutrients (magnesium, calcium, potassium) is also relevant for diagnostics, such as identifying a health condition. For example, potassium levels in blood below 3 mM can be indicative of abnormal heart rhythms. We are currently working on the detection of potassium on a paper-based device as a proof-of-concept of a novel electrochemical micronutrient sensing platform. Paper-based platforms are useful in bioanalysis for point-of-care measurements because of their simplicity, low cost, portability and disposability. These advantages make them a valid alternative to conventional ion-selective electrodes, which are fragile, subject to interference from biological samples, often expensive and require careful calibration and maintenance

Our platform is based on an unusual electrochemical method employing the measurement of the shift in potential of a redox reaction. For potassium quantification, we measured the redox reaction of an electrodeposited Prussian blue layer. The shift in potential is proportional to the concentration of the targeted ion (potassium). We explored the best conditions for electrodepositing Prussian blue using commercial screen-printed electrodes and successfully tested aqueous solutions containing potassium ions in the range of 0 to 1 M. The results in this range show a reliable and reproducible trend correlating the shift in potential and the concentration of potassium. We also verified that sodium ions at high concentration in blood have a negligible interference. The next steps of the project include the validation of the assay on paper-based electrodes, tests of human serum samples throughout the relevant health range (3.5-5 mM) and assessment of the reproducibility and specificity of the platform by considering other potentially interfering ions.