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Method development and validation of a rapid silica-based smart-phone assisted device in the detection of iron in water

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Abstract

A new method of rapidly detecting iron in water using a smartphone assisted device is introduced. Currently, point-of-need devices have largely explored patterned paper as a substrate. While paper is affordable and detection is rapid, its sensitivity is compromised by its fast-wicking nature hence the need for methods of retaining and immobilizing analytes. Silica generally has a higher absorptive power than paper therefore can better immobilize analytes for better detection. The improvement of sensitivity in such devices is important in the monitoring of heavy metals such as iron that can be dangerous to plant and animal life. Testing of such metals not only requires rapid methods of detection but those with low detection limits. The pairing of these devices with smartphones contributes to their rapidity. The aim of this paper is to present findings on the method development and validation of silica-based smart-phone assisted rapid detection of iron in water. Iron standards were prepared in various amounts (0-60 ng) and converted to iron (II). A silica plate was prepared by adding 1,10-phenanthroline that would turn bright orange on reacting with iron (II). A box structure was built around the silica plate to control light and the distance of the light source (smartphone). The standards and reference material were tested by depositing on the treated silica plate before capturing with the smartphone and analyzed using a software called ImageJ. Detection limit, linear range, accuracy and precision were determined. The results showed a limit of detection of 0.2 ng, a limit of quantification of 0.6 ng, a linear range of 0.6 ng to 30.0 ng and RSD of <5%. The results also showed that for silica not only are complex immobilizing reagents not necessary but they in fact, lead to worse precision, accuracy and sensitivity. From this study we conclude that silica-based substrates make a more sensitive detection method while requiring less reagents. The settings of the software were found to be unique to the substrate.

Keywords: Silica, rapid testing, iron detection, ImageJ, heavy metals, method validation