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Authors

Hugo F. Rocha
Rita Gouveia
Goreti Pereira
Vânia Calisto

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A bi-parametric paper-based sensor for Al(III) and Fe(III) monitoring in well waters

Juliana I. S. Aguiar[1], António O. S. S. Rangel[1], Raquel B. R. Mesquita[1,*]

[1]*Universidade Católica Portuguesa, CBQF – Centro de Biotecnologia e Química Fina – Laboratório Associado, Escola Superior de Biotecnologia, Rua Diogo Botelho 1327, 4169-005, Porto, Portugal*
**rmesquita@ucp.pt*

The monitoring of water quality in rural and semi-urban areas is often hindered by the lack of portable, low-cost analytical tools capable of detecting metal contaminants such as aluminium and iron. This work describes the development of a novel bi-parametric microfluidic paper-based analytical device (μPAD) for the simultaneous detection of Al(III) and Fe(III). The detection was based upon the reaction with Chrome Azurol S (CAS), employing a dual-zone sensing strategy to attain the bi-parametric determination. One of the reaction zones enables the measurement of both metal ions (Al^{3+} + Fe^{3+}), and, in the other reaction zone, ascorbic acid is incorporated to mask Fe(III) through reduction to Fe(II), enabling the individual quantification of Al(III). In the end, the concentration of Fe(III) is determined as the difference between the two sets of values.

Accuracy was assessed by analysing certified water samples and well water samples (results compared with atomic spectroscopy techniques). The results proved comparable (relative errors < 10%), thus validating the developed device. Stability studies were made and confirmed a shelf-life of up to one month when stored in the freezer vacuum-sealed. Overall, the μPAD developed represents a robust, sustainable tool for on-site water quality assessment.

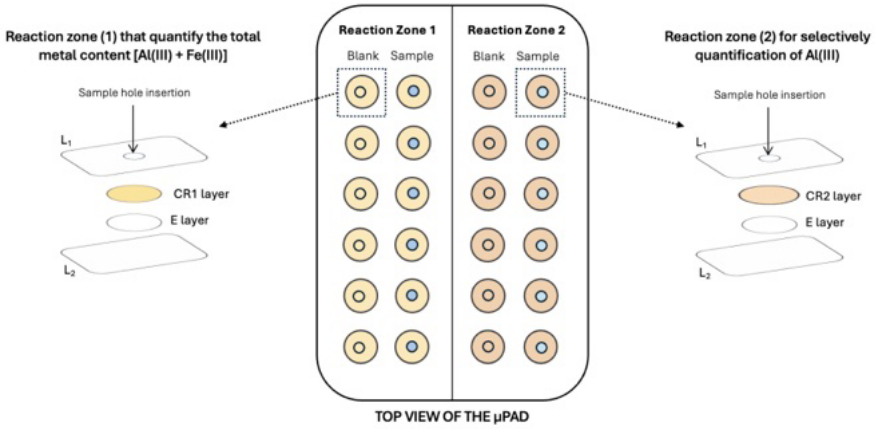

Figure 1: Schematic representation of the bi-parametric μPAD. Reaction zone 1 quantifies the total metal content [Al(III)+Fe(III)] using a colour regent (CR1) containing CAS and acetate buffer. Reaction zone 2 enables the selective quantification of Al(III) by incorporating 15 g/L of ascorbic acid in the reagent layer (CR2) to mask Fe(III) interference.

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