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EMPOWERING RURAL COMMUNITIES: A NOVEL PAPER-BASED SENSOR FOR MONITORING ALUMINIUM IN WATER USED FOR DOMESTIC CONSUMPTION

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ABSTRACT

Ensuring the safety of domestic water sources is critical for public health, particularly in rural areas where well water is commonly used for household consumption. Aluminium, a naturally occurring element, can leach into groundwater, and long-term exposure to high aluminium concentrations has been linked to neurodegenerative disorders such as Alzheimer's and Parkinson's diseases. So, the aim was to develop a microfluidic paper-based analytical device (μPAD) for the accurate quantification of aluminium levels in well water, providing an affordable, portable, and user-friendly tool for well owners to monitor their water source quality.

The μPAD was designed to attain aluminium determination using the colourimetric reaction with chrome azurol S (CAS). The device comprises two layers of paper, where the first layer is impregnated with a solution with three reagents: CAS, ascorbic acid, and acetate buffer solution. The CAS reagent reacts with aluminium(III) to produce a distinct colour product; ascorbic acid is used to eliminate interference from iron(III), and the acetate buffer solution ensures the appropriate reaction pH. The second layer of filter paper is empty to ensure a vertical flow approach as well as being a sample/standard reservoir. Several physical and chemical parameters of the device were optimised to attain the highest sensitivity for aluminium determination. Among the performed studies were the number of layers in the μPAD, the type and porosity of filter paper used, sample and reagent volumes, and reagents concentrations. The aluminium determination with the developed μPAD was validated using certified water samples and comparing the results obtained for several well-water with both the μPAD and AAS (atomic absorption spectrophotometry). After demonstrating its accuracy and robustness, the developed μPAD complies with the World Health Organization guidelines (having below 0.20 mg/L of aluminium in drinking water), enabling aluminium determination in the range of 0.10 to 1.00 mg/L. This μPAD provides a practical solution for regular monitoring of water quality, empowering well owners to take proactive steps in managing their water resources and ensuring their family's health and safety.

Keywords: Microfluidic paper-based analytical device (μPAD); Aluminium quantification; Well water quality; Real-time analysis; Environmental monitoring.

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