



त्वरित प्रतिदीप्ति-आधारित एल्ब्यूमिन विश्लेषक

गुर्दे के कार्य-विकार से संबंधित एल्ब्यूमिन्यूरिया की शीघ्र पहचान हेतु

Rapid Fluorescence-Based Albumin Analyser

For Early Detection of Albuminuria Associated with Kidney Dysfunction

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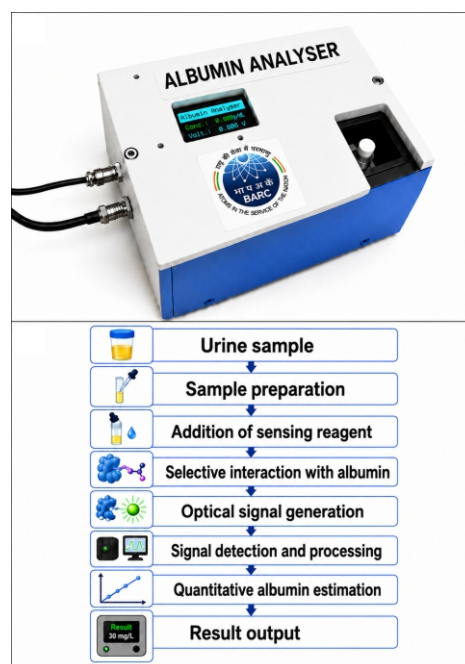
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Albumin in urine is an important biomarker of renal dysfunction, with increased urinary albumin excretion often appearing before an overt decline in kidney function. In particular, moderately increased albuminuria, traditionally referred to as microalbuminuria, is associated with early renal damage and is also an indicator of increased cardiovascular risk. Sensitive and quantitative determination of urinary albumin therefore has considerable value for early screening and disease monitoring. Conventional approaches for urinary albumin estimation include semi-quantitative dipsticks and quantitative immunochemical techniques such as immunoturbidimetry and immunonephelometry. Although established laboratory methods provide good analytical performance, their dependence on specialised instrumentation, reagents and trained personnel can limit their suitability for rapid and decentralised screening. Dipstick-based methods, on the other hand, are convenient but have limited sensitivity and provide primarily semi-quantitative information.

To address these limitations, an indigenously developed fluorescence-based Albumin Analyser has been designed for rapid and selective quantification of albumin in urine. The sensing strategy employs a water-soluble aggregation-induced emission (AIE) probe which is only weakly fluorescent when molecularly dispersed. In the presence of albumin, the probe molecules aggregate on the protein surface, restricting their intramolecular motion and producing a pronounced fluorescence “turn-on” response. The Albumin Analyser translates this molecular response into a simple quantitative readout. An LED excites the sample contained in a quartz cuvette. The resulting fluorescence is selected using a band-pass filter and detected by a photomultiplier tube (PMT). The optical signal is converted into an electrical voltage whose magnitude is related to the concentration of albumin present in the sample.

A simple background-correction step accounts for variations in the urine matrix, enabling reliable estimation of albumin concentration. The developed system provides a limit of detection of 21 ± 0.3 nM, a linear detection range of 0–0.6 μ M, and a typical response time of 1–2 min. The technology has undergone extensive photophysical and analytical characterisation, and comparison with standard clinical assays and a commercially available microalbumin

kit demonstrated the potential of the platform for reliable urinary albumin analysis. Built using commercially available components and requiring relatively low reagent consumption, the Albumin Analyser represents a promising compact platform for rapid urinary albumin screening and point-of-care renal health assessment, particularly where access to conventional laboratory infrastructure may be limited.



Fluorescence-based Albumin Analyser and schematic workflow.

About the authors



Dr. Prabhat K. Singh is Scientific Officer (G) at the Radiation and Photochemistry Division, BARC, Mumbai. His research focuses on ultrafast spectroscopy, supramolecular chemistry, and self-assembled materials for optical bio- and chemosensing. He has authored about 150 peer-reviewed publications and received several national and international scientific honours.



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