A novel antibody-like material for breast cancer antigen CA15-3, used to track breast cancer by potentiometric transduction

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This work presents the development of a low cost sensor device for the diagnosis of breast cancer in point-of-care, made with new synthetic biomimetic materials inside plasticized poly(vinyl chloride), PVC, membranes, for subsequent potentiometric detection. This concept was applied to target a conventional biomarker in breast cancer: Breast Cancer Antigen (CA15-3).

The new biomimetic material was obtained by molecularly-imprinted technology. In this, a plastic antibody was obtained by polymerizing around the biomarker that acted as an obstacle to the growth of the polymeric matrix. The imprinted polymer was specifically synthetized by electropolymerization on an FTO conductive glass, by using cyclic voltammetry, including 40 cycles within -0.2 and 1.0 V. The reaction used for the polymerization included monomer (pyrrol, 5.0×10^{-3} mol/L) and protein (CA15-3, 100U/mL), all prepared in phosphate buffer saline (PBS), with a pH of 7.2 and 1% of ethylene glycol. The biomarker was removed from the imprinted sites by proteolytic action of proteinase K.

The biomimetic material was employed in the construction of potentiometric sensors and tested with regard to its affinity and selectivity for binding CA15-3, by checking the analytical performance of the obtained electrodes. For this purpose, the biomimetic material was dispersed in plasticized PVC membranes, including or not a lipophilic ionic additive, and applied on a solid conductive support of graphite. The analytical behaviour was evaluated in buffer and in synthetic serum, with regard to linear range, limit of detection, repeatability, and reproducibility.

This antibody-like material was tested in synthetic serum, and good results were obtained. The best devices were able to detect 5 times less CA15-3 than that required in clinical use. Selectivity assays were also performed, showing that the various serum components did not interfere with this biomarker.

Overall, the potentiometric-based methods showed several advantages compared to other methods reported in the literature. The analytical process was simple, providing fast responses for a reduced amount of analyte, with low cost and feasible miniaturization. It also allowed the detection of a wide range of concentrations, diminishing the required efforts in previous sample pre-treating stages.

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