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SYNTHESIS AND CHARACTERIZATION OF POLYANILINE-CHITOSAN COMPOSITE AND ITS APPLICATION AS ELECTROCHEMICAL SENSOR FOR PERFLUOROOCTANOIC ACID

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ABSTRACT

The overwhelming utilisation of perfluorooctanoic acid (PFOA) for household and industrial applications has posed a severe risk to human health and environmental pollution. PFOA is an anthropogenic contaminant under the Per- or polyfluoroalkyl substances (PFASs) family and is classified as a Persistent Organic Pollutant (POP) due to its long half-life degradation in the environment and toxic properties. In view of this, conducting polymers (CPs) and natural biopolymer have been often used in the development of electrochemical sensors. In this study, the pure Chitosan was extracted from crab shells using three simple steps which is deproteinization, demineralization and deacetylation. For polyaniline (PANI) and polyaniline-Chitosan (PANI-Chitosan) composite were synthesized using in-situ chemical oxidative polymerization technique by using ammonium persulfate as initiator. Therefore, PANI-Chitosan composite were synthesized with three different weight ratios of Chitosan such as PANI-Chitosan 1:0.5, PANI-Chitosan 1:1, and PANI-Chitosan 1:2. The physicochemical properties of Chitosan, PANI, and PANI-Chitosan composites were characterised using Attenuated Total Reflection-Fourier Transformed Infrared (ATR-FTIR) spectroscopy, Ultraviolet-Visible (UV-vis) spectrophotometry, Scanning Electron Microscopy (SEM) with Energy Dispersive X-Ray (EDX) spectroscopy, X-Ray Diffractometer (XRD), Thermal Gravimetric Analysis (TGA), and conductivity analysis. The development of an electrochemical sensor for the detection of PFOA in this study involved modifying a screen-printed carbon electrodes (SPCEs) with a Chitosan, PANI and PANI-Chitosan composites using the drop-casting methods. The samples that were successfully synthesised and characterized its properties was further used in electrochemical behaviour study. The resulting PANI-Chitosan composite was characterised using cyclic voltammetry (CV) and compared to the unmodified SPCE in term of their electroactive surface area (EASA). The results showed that the PANI-Chitosan 1:1 exhibited much better performance compared to the unmodified SPCE with significantly higher EASA of 0.221 cm^2. Based on this result, The PANI-Chitosan 1:1 modified SPCE was selected for further optimization studies via differential pulse voltammetric (DPV) where PANI-Chitosan 1:1 showed a linear correlation coefficient with high sensitivity of 8×10^{-7} to PFOA detection, with a linear range of 5-150 ppb and a limit of detection (LOD) of 1.08 ppb. The sensor's analytical performance was evaluated by measuring the current response to the reproducibility, long-term stability and presence of other interferents, and the sensor demonstrated good reproducibility with 1.25% RSD value. Additionally, PANI-Chitosan 1:1 recorded an outstanding stability for 12 days for detection of PFOA with 0.28% RSD and demonstrated good selectivity in the presence of other interferences. Overall, the developed sensor exhibited great sensitivity, excellent reproducibility, and good stability for the detection of PFOA.

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