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Rational design and development of bioselective affinity materials for pharmaceutical applications

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Statement of the Problem: The removal of pharmaceutical compounds from water sources has an immense impact on public health, since the contamination arising from their presence in drinking water leads to gain tolerance in human body and can significantly decrease the effective treatment later on. The use of rationally designed affinity materials in separation columns and membrane filters may help to solve this problem; therefore, pharmaceuticals specific molecularly imprinted polymers nanoparticles (MIPNPs) were synthesized and applied onto the polyvinylidene fluoride (PVDF) membranes previously subjected to the plasma treatment.

Methodology & Theoretical Orientation: Computationally designed diclofenac-, metoprolol- and vancomycin-MIPs were applied onto the membranes and scanning electron microscopy was employed to visualize MIPNPs on the membrane. After functionalization of the membranes with target-specific MIPs the molecularly imprinted membranes (MIMs) affinity against their targets was evaluated using solid phase extraction (SPE) technique coupled with high performance liquid chromatography (HPLC). MIMs were used as filters to load the target solutions and evaluate the amount of pharmaceuticals in filtrate. Furthermore, a comparative study was performed by comparing the efficiency of MIMs functionalized either by adsorption or covalent immobilization.

Findings: The capacity analysis of MIPNPs by SPE–HPLC revealed 100%, 96.3%, and 50.1% uptake of loaded solution of metoprolol, diclofenac and vancomycin, respectively. MIMs showed 99.6% uptake with a capacity of 60.39 ng cm2 for metoprolol; 94.7% uptake with a capacity of 45.09 ng cm2 for diclofenac; and 42.6% uptake with a capacity of 16.9 ng cm2 for vancomycin. HPLC detection limits of targets were found as 3.7, 7.5 and 15 ng mL−1 for diclofenac, metoprolol and vancomycin, respectively. A small scale pilot test was also conducted which indicates the promising future applications of the developed MIMs for high volume of filtrates especially in the case of the plasma-treated PVDF membranes prepared by covalent immobilization of the MIPs.

Conclusion & Significance: MIPNPs were successfully incorporated into SPE columns and PVDF membrane. Nanostructured polymeric membrane is capable of capturing targets from water which demonstrates a new approach for water purification of pharmaceuticals.

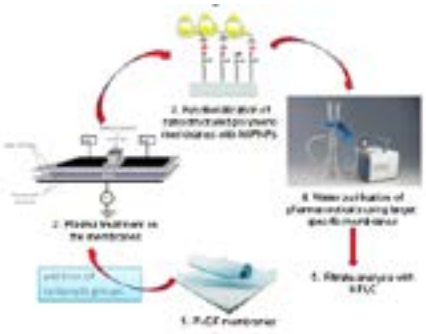

Figure 1: Development of bio-selective nanostructured polymeric membranes using affinity materials for water purification of pharmaceuticals.

Biography

Zeynep Altintas has her expertise in the fields of biosensors, biomimetic materials and diagnostics. She is the Head of Biosensors and Receptor Development Group in Technical University of Berlin. She has worked at the Cranfield University as a Faculty Member as well as in other institutes as Visiting Professor and Researcher. She pioneered nanoMIPs-based SPR sensors for the detection and removal of pharmaceuticals, toxins and viruses using a novel solid phase synthesis method. Her research on virus imprinting area creates new pathways for virus sensing and removal by providing strong alternatives to natural antibodies. Her works have received several awards from international organizations in recent years. She is serving as an Expert Reviewer for EU and Wisconsin Groundwater Coordinating Council (USA) founded projects in addition to acting as the reviewer for several important journals in her areas of expertise.

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