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Passive sampler chitosan/activated carbon for norovirus analysis in water

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Abstract

Human noroviruses are the world's leading cause of acute gastroenteritis in humans. The goal of this study is to design a passive sampler capable of adsorbing sewage and drinking water viruses onto a porous material, then desorbing and quantifying them by genome analysis (RT-qPCR).

Chitosan (CS) and chitosan/mesoporous carbon[1] (CS/CX, X = 10, 50, 100) hydrogel films of controlled thickness (0.5-2 mm) were prepared by spreading acidic solutions of CS or CS/CX (2-3.5% mass. chitosan) and then gelling by soaking in a basic solution. The composition of the CS/CX composite films was varied in the range 20/80 to 50/50 (mass/mass).

While the specific surface area (N_2 , 77K) of mesoporous carbons ranges from 250 m².g⁻¹ to 1540 m².g⁻¹, that of freeze-dried composite films is lower (S_{BET} : 60 - 870 m².g⁻¹) but higher than that of freeze-dried films made from chitosan alone (S_{BET} ~ 7 m².g⁻¹). Scanning electron microscopy (FEG-SEM) of the films showed homogeneous dispersion of the carbon particles and the presence of micro- and macroporosity, confirming the pore size distribution determined by the BJH method (\varnothing_{pore} : ~10-80 nm). Isoelectric point pH values measured by zetametry are around 7 and 4 for the processed films and mesoporous carbons, respectively. Sorption of murine noroviruses ("MNV", a non-human pathogenic virus used as a model for human noroviruses, (\varnothing : ~ 35 nm) were studied in saline water (NaCl 0.1 mol.L⁻¹) and their desorption was studied by varying the physico-chemical parameters of the solution (pH, temperature, time, adsorbent mass, ionic strength, addition of surfactant). MNV adsorption kinetics in saline water (C_0 : 108 ug.mL⁻¹, 10 mg dry material) show that after 2 h contact time, chitosan hydrogel films adsorb ~ 75% of suspended MNVs, while CS/CX composite hydrogel films adsorb up to 98% of MNVs. Under optimal desorption conditions, up to 16% of adsorbed viruses could be recovered. The desorption method gains in performance as the amount of material used during adsorption decreases. The heterogeneity of the material suggests the presence of different adsorption sites, some of which interact strongly with the viruses. The proportion of these sites occupied is lower when the adsorbent/virus ratio is low, which facilitates virus desorption. The porous hydrogel films developed have suitable properties (porosity, surface charge) for the adsorption of MNVs in water. These materials will be tested in real water (water leaving a wastewater treatment plant) to evaluate their potential use as passive samplers.

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References

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