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The impact of dynamic clay system on the infectious viruses

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OBJECTIVES

Viruses in natural waters and wastewaters are frequently found attached onto sand, clays, suspended colloids etc. Moreover, clays minerals have been reported to affect the growth and metabolic activity of viruses. Clays are used in the drilling of oil and water wells, are turned into mud, which seals the walls of the boreholes, lubricates the drill head and removes drill cuttings. Also, clays are used to decolorize, filter, and purify animal, mineral, and vegetable oils and greases due to their high absorbing properties. Finally, clays are used to establish low permeability liners in landfills, sewage lagoons, water retention ponds, golf course ponds, and hazardous waste sites. Human adenoviruses (HAdVs) are waterborne viruses which have been used as viral indicators of fecal pollution. The objective of this study was to investigate the survival of HAdV in dynamic clay systems.

METHODS

The clays used as a model were crystalline aluminosilicates: kaolinite and bentonite. The survival of HAdVs onto these clays was characterized at two different controlled temperatures (4 and 25^{o} C) under static and dynamic batch conditions. Control tubes, in the absence of clay, were used to monitor virus inactivation due to factors other than adsorption to clays (e.g. inactivation or sorption onto the tubes walls). The batch equilibration method used consists of adding a virus stock solution into 2 ml centrifuge tube containing 0.02 gr of the clay at a concentration of 10 mg clay per ml. Controls containing only viruses and suspended clay particls were used to monitor virus inactivation, virus sorption to the centrifuge tube and PCR inhibition due to suspended clay particles. For both static and dynamic batch experiments, samples were collected every 24 hours for a period of seven days and centrifuged at 3000 xg for 5 minutes. To infer the presence of infectious HAdV particles, all samples were treated with Dnase and the extraction of viral nucleid acid was performed using a commercial viral RNA kit. All samples were analyzed by Real – Time PCR which was used to quantify viral particles in clays.

RESULTS

Exposure time intervals in the range of seven days (0.50-144 hours) resulted in a load reduction of 0.74 to 2.96 logs for kaolinite and a reduction of 0.89 to 2.92 for bentonite. Furthermore, virus survival was higher onto bentonite than kaolinite ($p<0.005$). The experimental results of this work indicate that viruses were systematically more persistent at 4^{o} C than at 25^{o} C onto both clays ($p<0.005$). The adsorption of HAdV onto both clays increase with increasing time and it is higher in dynamic experiments ($P<0.005$).

CONCLUSIONS

Dynamic clay systems improve the contact of viruses and possibly decrease their survival because the number of accessible sites for attachment is higher. The increased reduction of infectious viral numbers by their contact with clays systems could play an important role in the prevention of infectious viral waterborne diseases.

Keywords: Human Adenovirus; clays; Infection