Introduction of pesticide-degrading bacteria to rapid sand filters as a tool to remediate pesticide-polluted drinking water

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Groundwater is used for drinking worldwide, but the resource is threatened by pollution by pesticides and other organic micropollutants. Sand filtration of anaerobic groundwater is often used at waterworks to remove iron, manganese, methane, ammonium, and organic matter from the groundwater. The aim of our research was to characterize microbial communities of waterworks sand filters and to remediate pesticide-polluted drinking water at waterworks by introducing specific pesticide-degrading bacteria to the sand filters. Correlations were found between the iron, manganese, methane, and ammonium concentrations of the groundwater and the prokaryotic community structures of the filters. Introduction to sand filters of the bacterium *Aminobacter* sp. MSH1, with the ability to degrade the pesticide residue 2,6-dichlorobenzamide (BAM), resulted in significant BAM degradation to concentrations below the EU legal threshold level (0.1 µg/L) for drinking water, without affecting other sand filter processes such as ammonium and iron oxidation. However, efficient degradation for longer periods was difficult to maintain due to loss of MSH1-bacteria, especially during backwashing, an operational procedure used at waterworks to prevent clogging of the filters. By limiting backwash procedures degradation was prolonged, but bacteria (and hence degradation activity) were still lost over time. Protozoa were observed to grow in the filters to a density that also contributed significantly to the general loss of bacteria from the filters. To increase the survival of *Aminobacter* sp. MSH1 we now combine reverse osmosis membrane filtration and bioaugmented sand filters. The membrane filtration provides pure water of drinking water quality, but also residual water with up to 10 times higher concentrations of not only BAM, but also inorganic nutrients and organic carbon. The residual water is then treated in the bioaugmented sand filter. This combined technology has resulted in complete removal of BAM for more than 40 days at laboratory-scale and is now to be tested at pilot-scale for remediation of actual BAM-polluted drinking water. Our research has shown that the groundwater geochemistry shapes the microbial community structure of waterworks sand filters and furthermore, that pesticide-polluted drinking water may be remediated by addition of specific degrader bacteria to waterworks sand filters.