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Removal of trace metals from contaminated street and wetland sediments with a biosurfactant (Saponin) and an artificial surfactant (SDS)

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Trace metals are the most common priority contaminants in urban runoff. Their influx within watersheds due to urban development affecting water and sediment contamination is an ongoing concern. Motor vehicle traffic is an important source of copper, lead, manganese and zinc. Contaminants transported within stormwater discharges are a major cause of impairment of receiving waters.

The objective of this study is to investigate the effectiveness of two surfactants: (1) plant-derived saponin, and (2) artificial/synthetic sodium dodecyl sulfate (SDS) to remove trace metals from contaminated sediments. Sediment samples from a street trap of a busy suprmarket parking lot (organic matter 75 g/kg) and constructed wetland (organic matter 200 g/kg) were collected in highly urbanized areas of Vancouver, Canada. The trace metals (Cu, Mn, Pb, Zn) were analyzed for their total concentrations. The sediment samples were subjected to batch desorption tests to determine the trace metal removal by these two surfactants. Surfactant concentrations were 200, 2,000, 5,000, 10,000 and 20,000 mg/L; reaction times of 0.5, 1, 2, 6, 12 and 24 h were tested. Exchangeable forms of trace metals were determined by extraction with 1 M $MgCl_2$ at pH 7 for the sediment samples before and after surfactant treatment (20,000 mg/L surfactants for 24 h) for their effectiveness in removing the bio-available trace metals. Remediated sediments of the highest surfactant concentration tested (20,000 mg/L) and reaction time (24 h) were subjected to three distilled water washings to remove the remaining surfactants from the sediments and ensure that no surfactant is introduced into the environment.

The metal removal capacities of saponin and SDS were enhanced as the surfactant concentration increased from 200 to 20000 mg/L. The surfactants assisted in the effective removal of the metals with 1 h of desorption, and the removal of metals increased slowly as the reaction time increased from 1 to 24 h. The maximum removal was 10-20% of the total trace metals. The removal of the metals by saponin was 5-10% higher than by SDS under the same washing conditions. Both surfactants are most effective in removing the exchangeable Zn (40-70%). Saponin removed 50% of the exchangeable Cu, whereas SDS is ineffective in desorbing exchangeable Cu. Saponin and SDS removed 50% exchangeable Mn from the wetland sediment, but only 10% from the parking lot street sediment. The surfactant sediment concentrations after three rinses with distilled water were reduced by 99%. The residual saponin and SDS were both below the toxicity limits (LC_{50}) for aquatic life.