A Spoonful of Sugar Helps the Nitrate Go Down: Denitrification in Wetland Soil

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Wastewater treatment plant effluent causes nitrate pollution. Nitrate can be removed by anaerobic wetland soil through denitrification, but the soil's ability to denitrify saturates at high nitrate concentrations. I hypothesized that this is due to the lack of easily digestible carbon substrate. In particular, I hypothesized that if denitrification at high nitrate concentration is limited by the availability of easily digestible carbon, adding glucose to wetland soil should increase denitrification especially at high nitrate concentration. In Study 1, 7 different nitrate concentrations were added to wetland soil. Denitrification was measured through the rate of nitrous oxide production. Fitting a Michaelis Menten curve to the data by transforming the data and then using linear regression, the results showed that increasing nitrate concentration increased denitrification. Study 2 tested the effect of glucose at two nitrate concentrations: zero and high (matching treatment plant effluent) in four experiment conditions (five replicates each): control with no additions, glucose addition , nitrate addition (to effluent nitrate level) , and added nitrate and glucose. As hypothesized, adding glucose increased denitrification only in the high nitrate condition. Study 3 studied real wastewater treatment plant effluent in three conditions: effluent only, effluent plus wetland soil , and effluent plus soil plus glucose. A oneway ANOVA found the effluent had a low level of background denitrification rate, which was approximately doubled by adding wetland soil. Adding glucose to soil further increased denitrification. Therefore, municipalities can reduce nitrate pollution from wastewater treatment plants by introducing wetland soil, possibly on small scales with added glucose.

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