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Temperature Dependence and Seasonal Variation of Denitrifying Microbial Consortia from a Woodchip Bioreactor in Denmark

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Abstract : Artificial wetlands such as woodchip bioreactors are efficient tools to remove nitrate from agricultural wastewater with a minimized environmental impact. However, the temperature dependence of the microbiological nitrate removal prevents the woodchip bioreactors from being an efficient system when the water temperature drops below 8℃. To quantify and describe the temperature effects on nitrate removal efficiency, we studied nitrate-reducing enrichments from a woodchip bioreactor in Denmark based on samples collected in Spring and Fall. Growth was quantified as optical density, and nitrate and nitrous oxide concentrations were measured in time-course experiments to compare the growth of the microbial population and the nitrate conversion efficiencies at different temperatures. Ammonia was measured to indicate the importance of dissimilatory nitrate reduction to ammonia (DNRA) in nitrate conversion for the given denitrifying community. The temperature responses observed followed the increasing trend proposed by the Arrhenius equation, indicating higher nitrate removal efficiencies at higher temperatures. However, the growth and the nitrous oxide production observed at low temperature provided evidence of the psychrotolerance of the microbial community under study. The assays conducted showed higher nitrate removal from the microbial community extracted from the woodchip bioreactor at the cold season compared to the ones extracted during the warmer season. This indicated the ability of the bacterial populations in the bioreactor to evolve and adapt to different seasonal temperatures.

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