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Characterization of denitrifying granular sludge with and without the addition of external carbon source

Beni Lew [a,e,*], Peter Stief [b], Michael Beliavski [c], Aviad Ashkenazi [c], Olivera Svitlica [b], Abid Khan [d], Sheldon Tarre [c], Dirk de Beer [b], Michal Green [c]

[a] The Volcani Center, Institute of Agriculture Engineering, P.O. Box 6, Bet Dagan 50250, Israel
[b] Max Planck Institute for Marine Microbiology, Celsiusstr. 1, D-28359 Bremen, Germany
[c] Faculty of Civil and Environmental Engineering, Technion, Haifa 32000, Israel
[d] Department of Civil Engineering, IIT Roorkee, NH 58, Uttrakhand 247667, India
[e] Department of Civil Engineering, Ariel University Center of Judea and Samaria, Ariel 40700, Israel

HIGHLIGHTS

- The denitrification rate was five times lower without external electron donor.
- The nitrite removal rate was similar with or without external electron donor.
- Nitrate without external electron donor led to a slight drop in microprofiles pH.
- Nitrite without external electron donor led to an increase in microprofiles pH.
- Large increases in pH were observed when acetate was used with nitrate or nitrite.

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ABSTRACT

In this study granular sludge taken from a denitrifying upflow sludge reactor was characterized. Denitrification rates were determined in batch tests with and without external carbon source addition and pH microprofiles of the granules were studied. The microbial community structure was also determined. The results showed that denitrification without carbon source addition occurs; however, the process rate was lower than with external carbon source. This suggests that bacteria use dead biomass and extracellular material in the granular sludge as a carbon source when readily available substrate has been exhausted and nitrate is still present. Microprofiles showed a slight pH decrease for denitrification without external carbon source addition, and an increase in pH when using nitrite as the electron acceptor. Microprofiles using acetate as the carbon source for denitrification showed a significant increase in pH. Clone sequences obtained were close to the species *Vitellibacter* sp., *Denitromonas indolicum* str. and *Denitromonas aromaticaus* sp.

1. Introduction

Contamination of groundwater with nitrate is a common phenomenon as a result of fertilizer application and disposal of animal waste. High nitrate concentrations in drinking water, and their subsequent conversion to nitrite and/or N-nitrosamines in the body, may contribute to adverse health effects. Consequently, the European Union has set a maximum concentration of nitrate in drinking water of 50 mg/L and nitrite of 0.1 mg/L (EU, 1998). According to the water framework directive given by the European Union, sustained upward trends of groundwater contaminants caused by human activities must be reversed by 2015.

There are several options available to solve the problem of high nitrate concentrations in groundwater including improving farming practices, implementation of aquifer protection zones, or blending of affected sources with low-nitrate water supplies. However, these options are often not available within legislative constraints, and further problems may arise related to logistics and/or cost, thus, the chosen method of water treatment is often the only practical option left for dealing with contaminated aquifers. To remove excess nitrate from groundwater supplies, a range of methods can be used including phytoremediation, ion exchange, distillation and reverse osmosis; however, these methods can be impractical and/or too expensive (Soares, 2000; Van der Hoek et al., 1987).

* Corresponding author. Address: Agricultural Research Organization, P.O. Box 6, Bet Dagan 50250, Israel. Tel.: +972 39683453; fax: +972 34604704.
E-mail address: benilew@agri.gov.il (B. Lew).

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