ABSTRACT

Currently, effective methods to eliminate nitrate in wastewater with a low C/N ratio are urgently needed. Considering that sediment is the main nitrogen removal carrier in lakes and that woodchip is an excellent carbon source, this study was undertaken under an integrated system of these two substances to explore the process and efficiency of the denitrification involved.

Material and methods

Using methods of kinetics and molecular biology, denitrification processes involving a woodchip-sediment system were investigated in an up-flow bioreactor (UFBR). Performance indices, functional genes, and microbial community changes in this integrated system were explored through water quality monitoring, quantitative PCR, and high-throughput sequencing.

Results and discussion

When the hydraulic residence time reached above 3.82 days, the nitrate elimination efficiency could achieve an effective level of higher than 93.3% even under the different flow rates. It was also noted that the nitrate elimination rate in this integrated system fitted the Michaelis–Menten kinetics, a combination of zero-order equation ($R^2 > 0.98$) and first-order equation ($R^2 > 0.95$). A combination of zero-order kinetic equations of nitrate elimination and total organic carbon (TOC) release exhibited nitrate elimination efficiency under direct influence of TOC release rate on the C/N ratio. Microbiological analysis indicated co-existence of composting bacteria and denitrifiers as well as aerobic degradation and heterotrophic denitrification, with the former process providing effective carbon sources for the latter process.

Conclusions

This study provided a deep insight into the denitrification process of a woodchip-sediment integrated system, which might inspire a potential wastewater treatment method for reduced eutrophication in the aquatic environment.