The algal organic matter: A novel carbon source to enhance the nitrogen removal in situ of aerobic denitrifiers

In recent years, nitrogen pollution, especially nitrate is an important problem faced by lots of reservoirs. Excessive nitrogen levels can cause water eutrophication, resulting in deterioration of water quality by increasing turbidity, affecting taste and odor, and increasing organic matter content due to algal blooms. The earliest and still most prevalent process for removing nitrogen is biological nitrification/denitrification. Among them, the aerobic denitrification has attracted much more attention due to that it is not limited by oxygen concentration and make nitrification and denitrification occur in one system then reduce the treatment cost. The studies investigate that carbon source is one of the most vital limited factors affecting aerobic denitrification. However, man-made organic matters acting as carbon source for oligotrophic aerobic denitrification have been studied extensively, while less attention has been paid to the actual organic matter derived from drinking water reservoir. Consequently, investigating the effect of natural organic matter (NOM) in reservoir on aerobic denitrification, especially the relationship between different molecular weight (MW) fractions as carbon source and denitrification performance is crucial, so that they can provide a novel carbon source to promote *in situ* nitrogen removal of aerobic denitrifiers in drinking water reservoir.

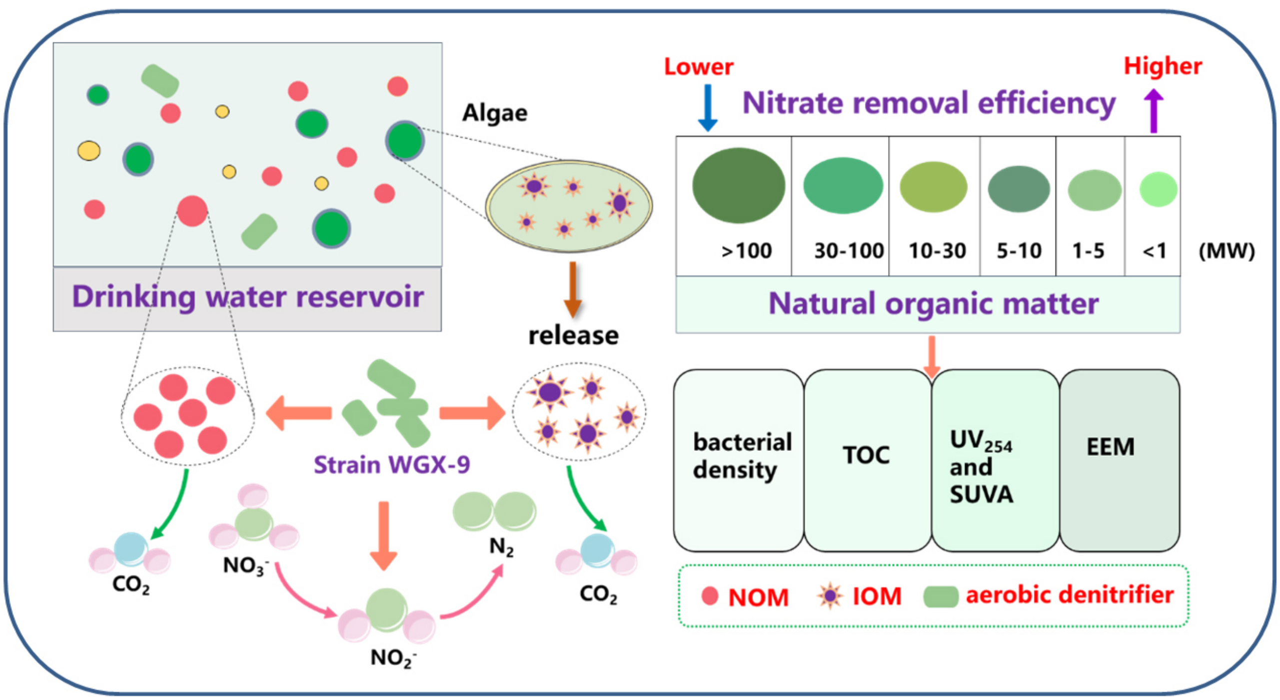

Fig. 1. Simplified scheme of the aerobic denitrifiers strain WGX-9 using natural organic matter of different molecular weight as the carbon source.

This work explored the effect of NOM including humic acid (HA) and fulvic acid (FA), intracellular organic matter (IOM) extracted from *Microcystis aeruginosa* (MA) and *Chlorella* sp. (CH), and their different MW fractions on the aerobic denitrification performance of bacterial strain WGX-9 by detecting nitrogen removal efficiency and testing changes in organic matter with HA, FA, MA-IOM and CH-IOM as the sole carbon source.

The strain WGX-9 was identified as *Acinetobacter johnsonii* and has excellent aerobic denitrification performance with sodium acetate as the carbon source, with a nitrate removal efficiency and a maximum nitrate removal rate of 86.56% and 0.203 mg/L/h, respectively. Next, we observed that lower nitrate removal efficiency by strain WGX-9 was observed using NOM and IOM as the sole carbon source when compared with that using sodium acetate, and the nitrate removal efficiency and rate with IOM as the sole carbon source was relatively higher than that with NOM as the sole carbon source, which may be because of the lower molecular weight and complex composition of IOM. Finally, it has been observed that the nitrate removal efficiency of strain WGX-9 was improved with the decreasing MW of organic matter. With the MW less than 1 kDa, the nitrate removal efficiency was increased to 36.67%, 37.88%, 60.90%, and 68.90% using HA, FA, MA-IOM, and CH-IOM as the carbon source, respectively, which may be due to that the lower MW represents better bacterial growth and carbon source utilization ability, and shows lower UV_{254} and SUVA to promote nitrate removal (Fig. 1).

Thus, we regarded this study is a relatively new and meaningful in the field of aerobic denitrification for micro-polluted drinking water reservoirs. However, the changes in the abundance of related enzymes (nitrate reductase, nitrite reductase, nitric oxidoreductase, and nitrous oxidoreductase) and protein expression in the denitrification process are still missing, and the cycling pathway of carbon and nitrogen is not very comprehensive with the NOM as the carbon source. Therefore, future studies should be focused on the molecular biological mechanism of aerobic denitrification bacteria with the NOM as the carbon source.

In summary, these results demonstrate that the strain WGX-9 can utilize lower MW natural organic matter, which lays the foundations for nitrogen removal in actual drinking water reservoirs. Based on the discovery of above results, this research might be useful for predicting the denitrification effect of aerobic denitrifying bacteria in drinking water reservoir and whether aerobic denitrifying bacteria can be applied.

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