Effluent treatment in an aquaponics-based closed aquaculture system with single-stage nitrification–denitrification using a down-flow hanging sponge reactor

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ABSTRACT: A laboratory-scale demonstration of the aquaculture effluent treatment was conducted in a system that combined a down-flow hanging sponge (DHS) reactor and a hydroponic cultivation bed (HCB). Cyprinus carpio was used as a model aquaculture fish and Cupsicum frutescens was used as a model hydroponic plant. The aquarium water was circulated through the HCB and DHS using a submerged pump. The experiment was divided into six phases in which the sodium acetate solution was supplied using different feeding patterns. The sodium acetate solution acted as a carbon source and not only eliminated nitrogen through denitrification but also increased the alkalinity through biological degradation of the acetate. Denitrification was observed to eliminate 7.7% of the total nitrogen at the inlet out of which 53.5% was converted by C. frutescens to form a fruit. The microbial community in the sludge that was retained in the DHS contained both nitrifying and denitrifying bacteria. Nitrososhaera was the dominant ammonia-oxidizing bacterium, whereas Nitrospira was the dominant nitrite-oxidizing bacterium. Further, Opitutus acted as the dominant denitrifying bacterium. No major bacterial pathogen was detected in the DHS–HCB system. The study confirmed that the DHS system provided single-stage nitrification–denitrification and that the overall DHS–HCB system provided a low-cost and high-performance aquaculture effluent treatment system that is capable of being used for safe food production.

Highlights

- Down-flow hanging sponge (DHS) reactor was applied as single-stage nitrification-denitrification reactor for aquaculture effluent treatment.
- DHS reactor was combined with a hydroponic cultivation bed (HCB) inoculating Cupsicum frutescens based on aquaponics system (DHS-HCB system).
- 53.5% of inlet total nitrogen was harvested as C. frutescens.
- The DHS-HCB system provided a low-cost and high-performance aquaculture effluent treatment system with safe food production.

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