

# 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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## 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.

## 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. *Nitrososphaera* 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.

## Keywords

Aquaculture effluent, Down-flow, hanging sponge reactor, Hydroponic cultivation, Single-stage nitrification–denitrification