Aerobic granular sludge, a feasible technology for the treatment and recirculation of trout aquaculture water streams

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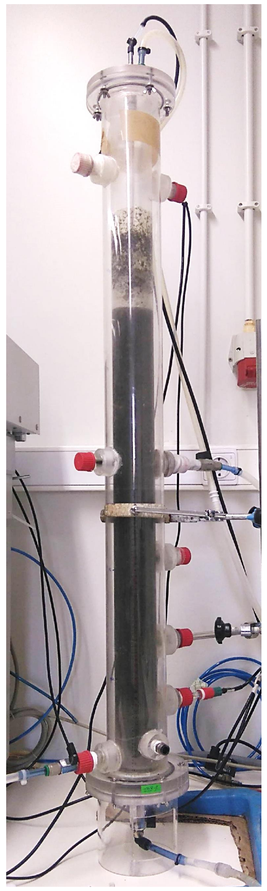
Introduction

Aquaculture is one of the fastest growing food production sectors. However, land-based aquaculture faces water scarcity and space restrictions which hamper its development. Aquaculture recirculation systems (RAS) help tackle these problems, although in most systems the recycling of water increases nutrient and organic matter concentrations, which often translates to fish mortality.

This work aimed to evaluate the feasibility of an aerobic granular sludge (AGS) system as an alternative for the treatment of aquaculture streams, characterized by low nutrient and carbon concentrations. The efficiency for nutrients removal aiming at water recirculation was assessed as well as the AGS microbiome composition dynamics over operation.

Methods

Aerobic granular sludge – Sequencing batch reactor



AGS Bioreactor in SBR mode

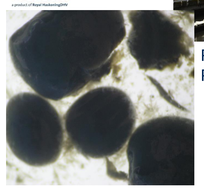
Feeding medium:

Synthetic medium mimicking a trout farm aquaculture recycling water.

Grupo Tres Mares – Galicia, Spain

Inoculum:

Frielas Nereda WWTP – Lisbon, Portugal



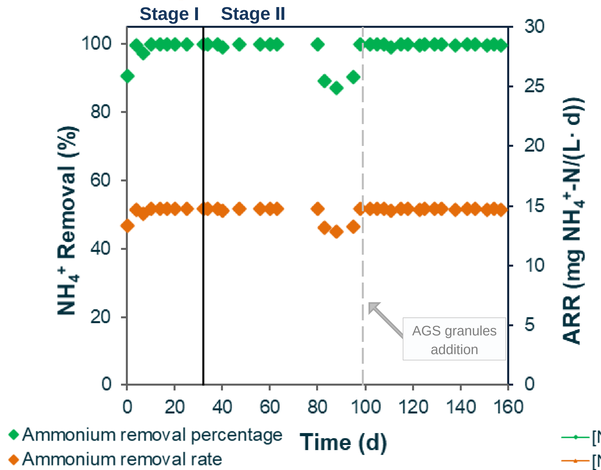
Mature granules from a full-scale Nereda® system.

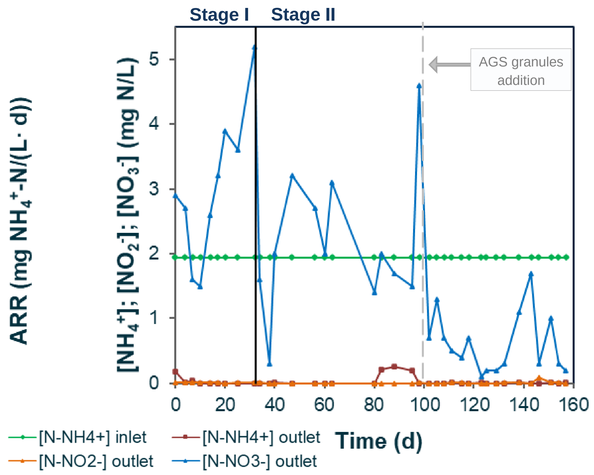
Operation:

Stage of operation	I	II
SBR mode (cycles/d)	8	16
Ammonium loading rate (mg NH_4^+-N/(L·d))	15.5	31.0
Influent ammonium fed/cycle [NH_4^+-N] (mg/L)	1.94	1.94

Results & Discussion

Reactor's performance

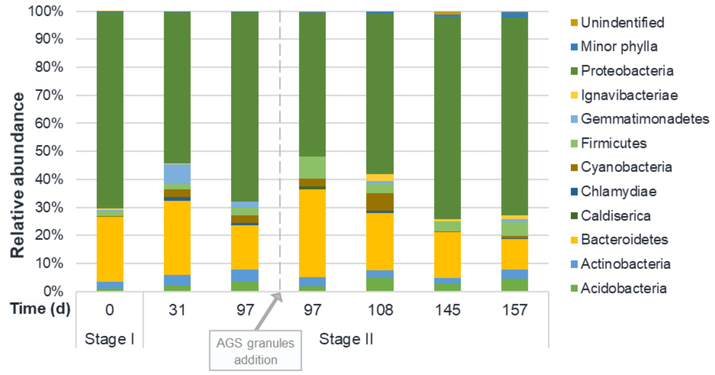




High chemical quality effluent
- **100% ammonium removal**
- Complete nitrification, no nitrite accumulation

Treatment of high flows
- 15 mg NH4+-N/(L·d) ARR

Microbiome analysis



Core microbiome

- **denitrifying** bacteria
- **ammonium oxidizing** bacteria
- phosphorus accumulating bacteria
- **EPS producing** bacteria

- **Proteobacteria** and **Bacteroidetes** were the most predominant phyla throughout operation
- Addition of new AGS on day-97 slightly altered the community composition
- Bacterial composition changed over Stage II, with shorter SBR cycles, though not affecting ammonium removal
- The core microbiome included bacteria responsible for crucial functions in the system

Conclusions

The AGS system was able to produce high quality effluents, with ammonium and nitrite contents below the toxic levels for rainbow trout (2.3 mg NH_4^+-N/L), and thus suitable for recirculation in aquaculture.

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