Microalgae attachment to aerobic granular sludge for the treatment of freshwater aquaculture effluents

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Introduction

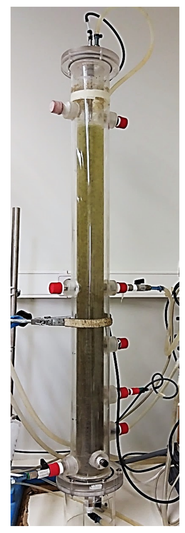
- Aerobic granular sludge (AGS) technology has proven an effective solution for wastewater treatment, mainly due to its compact microbial structure, with high biomass retention and excellent settling properties;
- Microalgae-bacteria consortia can increase the efficiency of wastewater treatment, with microalgae potentiating nutrient removal while generating O_2 that can be used by bacteria in their biological processes;
- This work aimed to evaluate the capacity of establishing microalgae-bacteria granular sludge for the treatment of aquaculture wastewater to recirculating quality, while evaluating the dynamics of the microbial community in the granules.

Methods

A photo sequencing batch reactor (SBR) was inoculated with AGS from a full-scale plant and with a suspended microalgae consortium composed by strains isolated from a freshwater aquaculture facility. A synthetic medium mimicking the aquaculture facility's wastewater was used to feed the reactor.

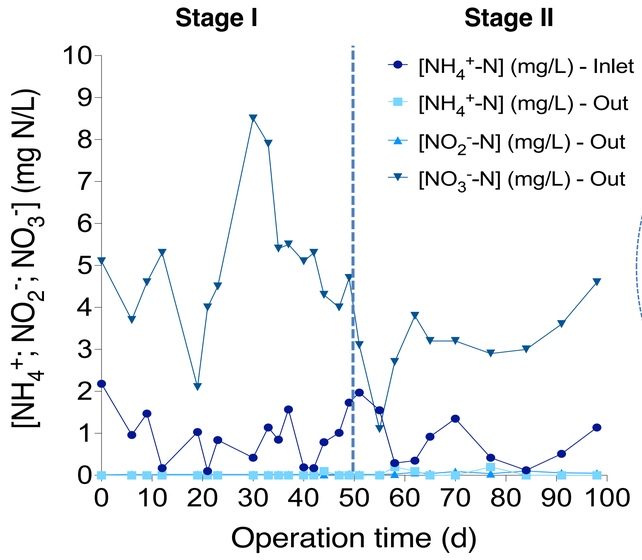
Stage	Duration of operation (d)	SBR mode (cycles/d)	Ammonium loading rate mg/(L.d)
I	0-50	6	11.6
II	51-98	16	31.0

Nitrogen removal was followed along reactor operation, microalgae attachment to bacterial granules was evaluated, and the bacterial granules community was assessed.



Results & Discussion

Nitrogen removal performance

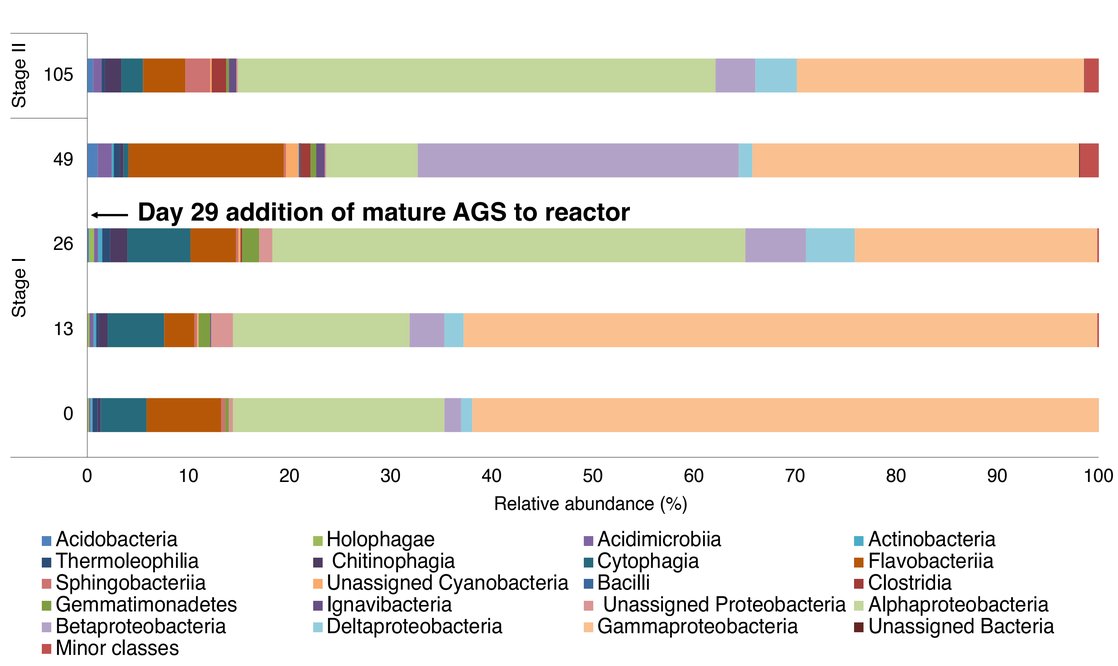


[NH4+] < 0.4 mg/L
[NO_2^-] < 0.2 mg/L

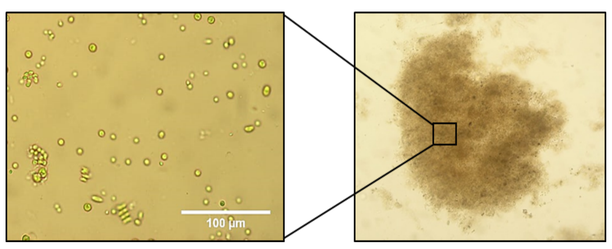
Optimum concentration to rear salmonids

Ammonium was completely removed and converted to nitrate, without nitrite accumulation.

Bacterial granules community



Microalgae attachment to AGS



Microalgae present in crushed granules after bioaugmentation indicating **the self-immobilization capacity** of microalgae into bacterial granules.

- **Gradual adaptation of the population** to reactor operational conditions;
- Along reactor operation, **the diversity within the bacterial community decreased**;
- A core microbiome was present mainly composed by genera of the **Gammaproteobacteria** and **Alphaproteobacteria** classes;
- On day-29 addition of mature **AGS was performed changing** the bacterial community composition; nevertheless on day-105 the population returned to a similar previous composition (day-26).

Conclusions

- Microalgae-bacterial granules were able to treat water streams mimicking freshwater aquaculture wastewater, producing effluents with N content below the toxic levels for fish, suitable for water recycling purposes;
- The attachment of microalgae to bacterial granules was successfully achieved under the reactor operational conditions;
- Bacterial granules community was diverse and dynamic along reactor operation, with a core microbiome composed of bacterial groups related to the reactor's nitrogen removal performance (i.e. ammonia-oxidizing bacteria).

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