Biocontrol and biostimulation potential of microbial consortia in soilless agriculture

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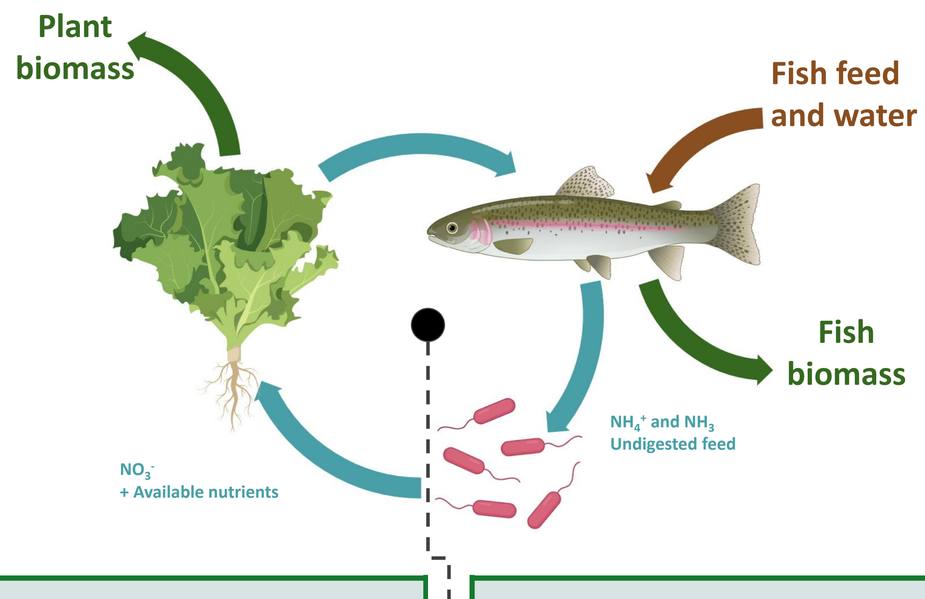
Context

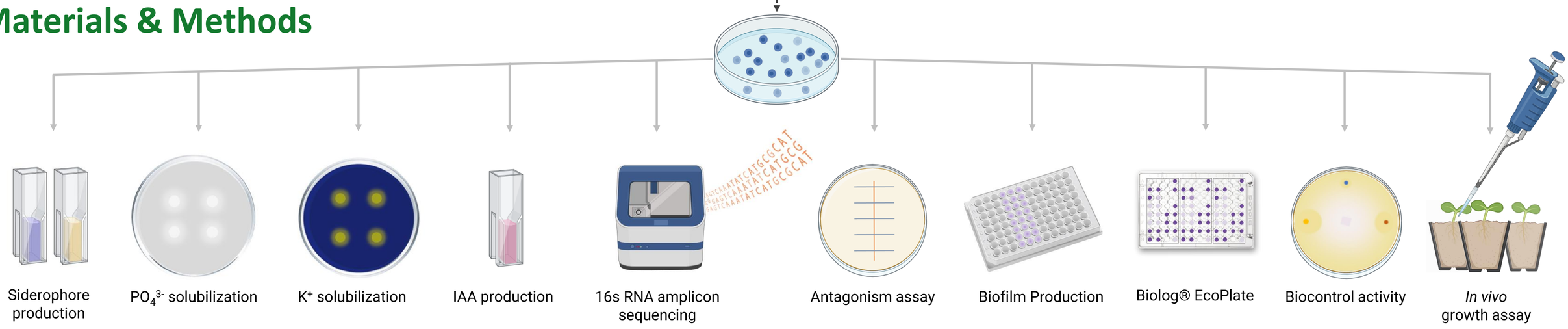
Aquaponics is a **soilless food production system** that sustainably yields plant and fish biomass in a closed loop[1]. It relies on the continuous flow of water and nutrients and the beneficial interactions between **fish, bacteria, and plants**. Although promising, this system presents drawbacks: (1) only a **limited amount of available mineralized nutrients** reach the plants, and (2) the risk of plant pathogen outbreaks remains a concern in soilless systems, underscoring the need for a dual solution that simultaneously enhances nutrient availability and mitigates disease risk.



Objective

Previous studies have highlighted the existence of a complex microbial network[3] and the presence of both plant growth-promoting (PGP) bacteria and biocontrol agents within aquaponic systems. Nutrient cycling and crop health, and therefore yield in aquaponics could be improved by harnessing such diversity by designing a PGP bacterial consortium made from native, complementary bacterial strains and based on their PGP and biocontrol traits.

Materials & Methods



Strains' PGP traits : *in vitro* evaluation

	Biochemical traits				Biofilm production		
Bacterial Strain	IAA prod.	Siderophore production	PO_4^{3-} solub.	K^+ solub.	M63 media	Filtered Trout water	Filtered Koi Carp water
A	++	++	+++	+++	+	+	+
H	+++	+++	/	/	/	/	/
T	+	+++	++	+	+	+	+
Shb30	+	+	++	/	/	/	/

Table 1 : Qualitative assessment of the 4 selected strains' biochemical traits and ability to form biofilms. Biofilm production was evaluated in different growth media; a minimal media (M63) and filtered water from two aquaponic facilities. No antagonism was detected between the strains.

Biocontrol activity

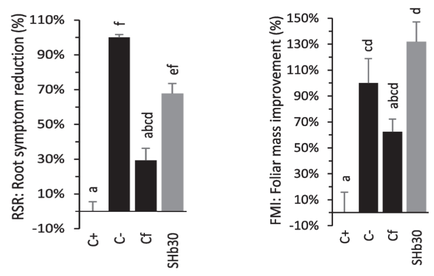


Figure 1 : Root symptom reduction and foliar mass improvement following treatment with Shb30. C+, C– and Cf are the positive, negative and synthetic fungicide controls. Adapted from [4].

- The efficacy of strain Shb30 exceeds the control capacity of the synthetic crop protection product against *Pythium aphanidermatum* on lettuce seedlings.
- More biocontrol assays to come!
- Screening against various pathogens.

Lettuce growth improvement

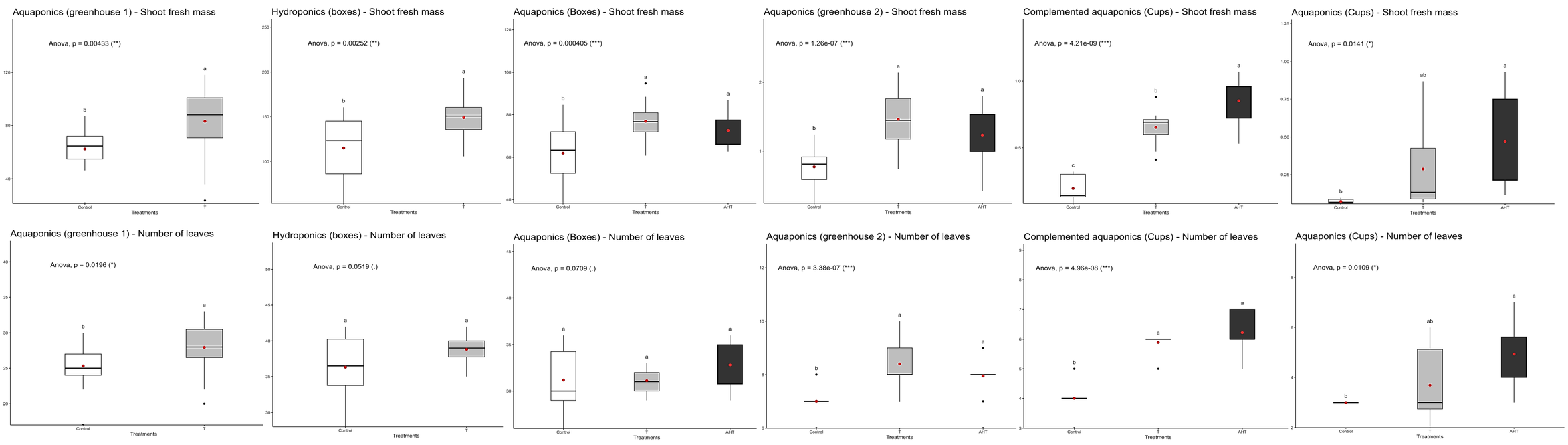


Figure 2 : Mean shoot fresh mass (top row) and mean number of leaves (bottom row) of lettuces under different treatments (Control, T strain alone, AHT consortium). From left to right, the graphs show results from: Aquaponics (Trouts) under greenhouse, Hydroponics under controlled conditions, Aquaponics (Koï Carps) under controlled conditions, Second Aquaponics (Trouts) under greenhouse trial, Complemented Aquaponics (Koï Carps) under controlled conditions and Aquaponics (Trouts) under controlled conditions. Controlled conditions
aquaponic conditions with trout in a growth room, and aquaponic conditions with trout in a greenhouse.

- **Treatments significantly improved various growth parameters** : biomass (root and shoot, fresh and dry), number of leaves, and longest leave length across different conditions.
- Consortium's **performance appeared to vary with experimental conditions**, i.e. aquaponic water origin (i.e. Trouts and Koï Carps) and growth conditions (greenhouse, grow room). A more comprehensive comparison should shed light on the consortium's robustness and reliability.

Conclusions & prospects

The encouraging results obtained in these studies highlight the microbial communities' potential of aquaponic systems as an untapped source of PGPB. Further analyses are needed to confirm the consortium's effectiveness (larger scale, complete growth cycle, etc.), its robustness across different soilless systems and to deepen our understanding of the consortium mode of action. Key elements that will be developed later on are : the biocontrol ability of the consortium's strains, to that end, control activity against different common pathogens in soilless systems will be screened. Another exciting aspect to be investigated is the treatment's effect on the root microbiota. Pathogens and treatments' effects on microbial community insights will allow for a better design of microbial based solutions.

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Lab's website

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