Culturing Aquaponic Microalgae in Aquaponic Wastewater: Circular Economy Philosophy

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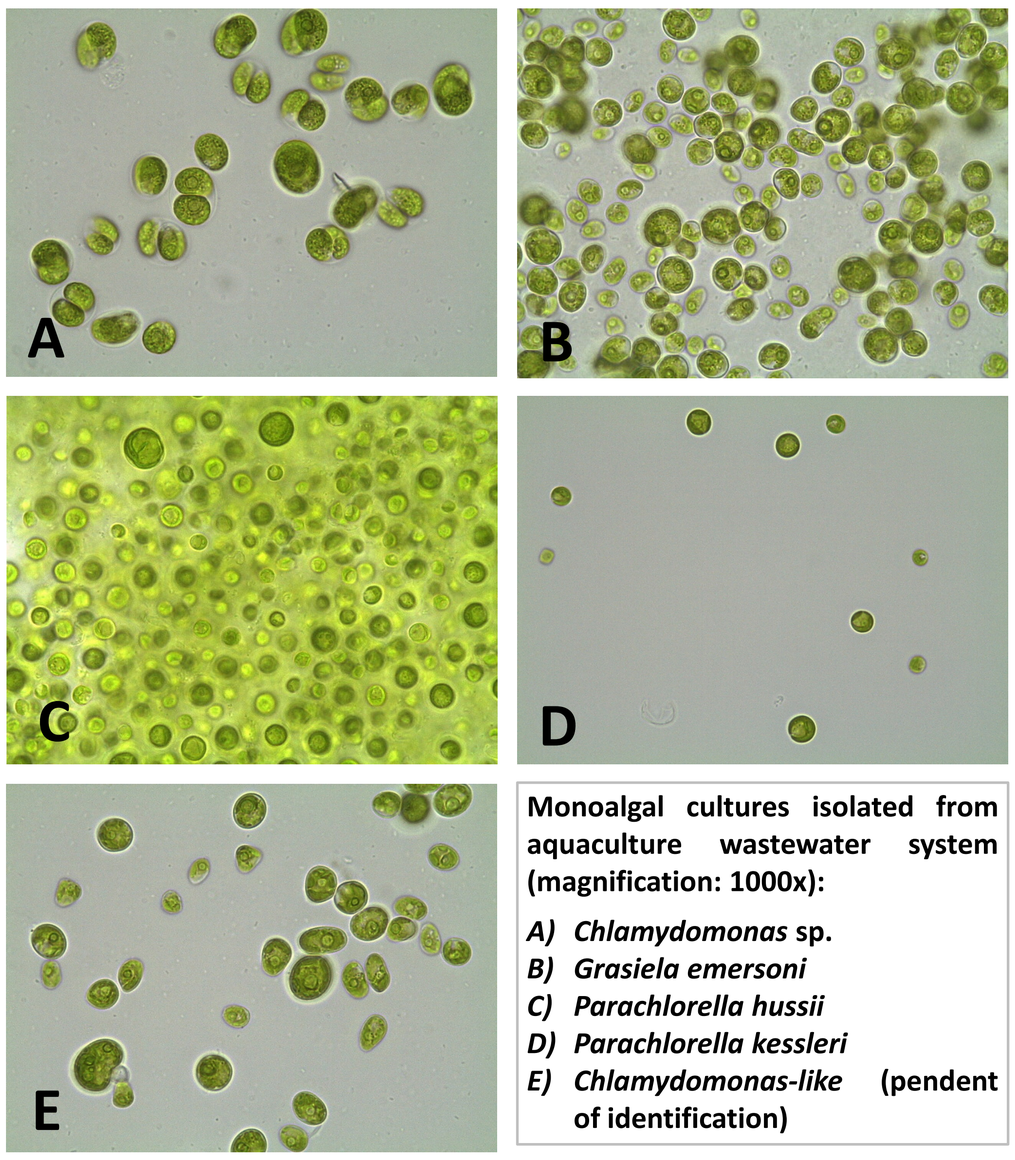
Aquaponics, also known as the integration of hydroponics with aquaculture, is gaining increased attention as a bio-integrated food production system. In aquaponics, water from an aquaculture system is fed to a hydroponic system where the by-products are broken down by nitrifying bacteria initially into nitrites and subsequently into nitrates that are utilized by the plants as nutrients. The water is then recirculated back to the aquaculture system. Nevertheless, in our system (Tilapia, *Oreochromis* sp. was the culturing fish, and lettuce, *Lactuca sativa* was the culturing vegetable), approximately 2% of this water still has to be replaced with fresh one every week. The aim of this work was to use this 2% wastewater to produce microalgae biomass and remediate the waterwaste.

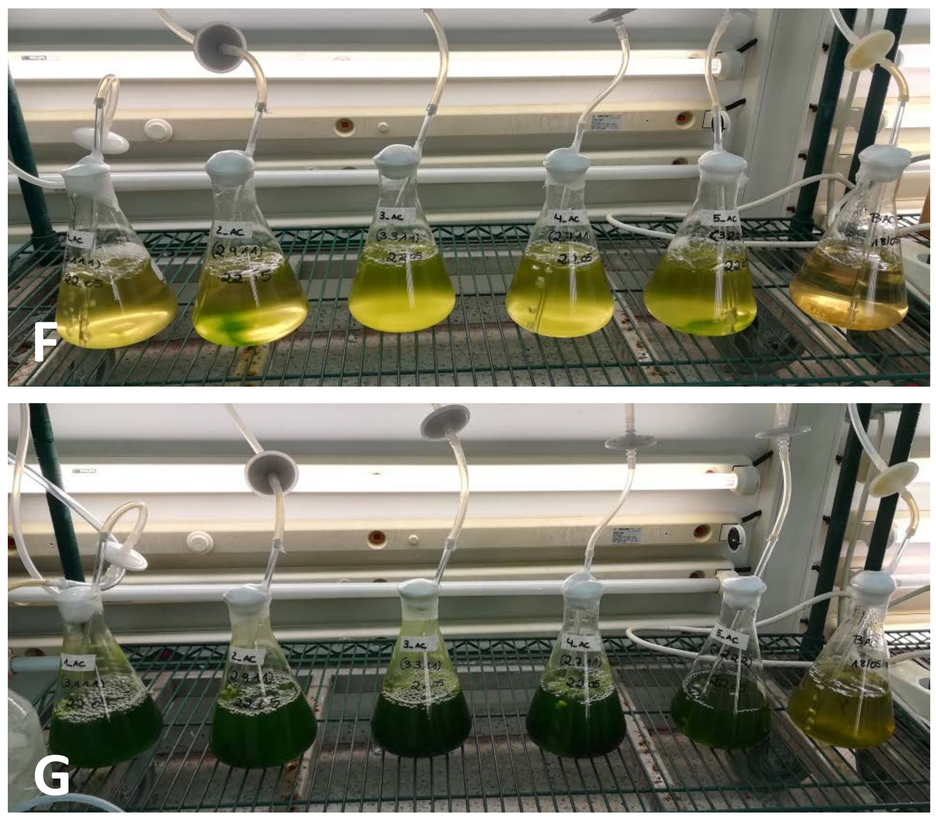
In this way, five microalgae species previously isolated from the same wastewater aquaponic system were used under laboratory conditions: *Chlamydomonas* sp., *Grasiela emersoni*, *Parachlorella hussii*, *Parachlorella kessleri* and a *Chlamydomonas-like* strain. Aside, forced blooms with just agitation or bubbling (Air + 1% CO_2) were also tested. The removal of nutrients from aquaponics wastewater and the microalgae biomass production was more effective with microalgae inoculum than with just promoting natural blooms, in the conditions of our experiment.

In conclusion, microalgae were able to remediate the aquaponics wastewater and the biomass obtained, at a higher scale production, might have different application such as fertilizers and fish feed.

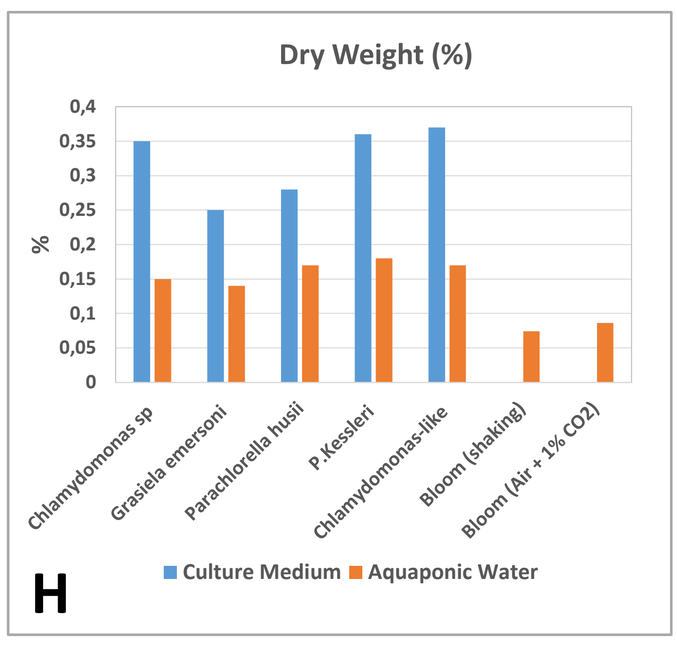


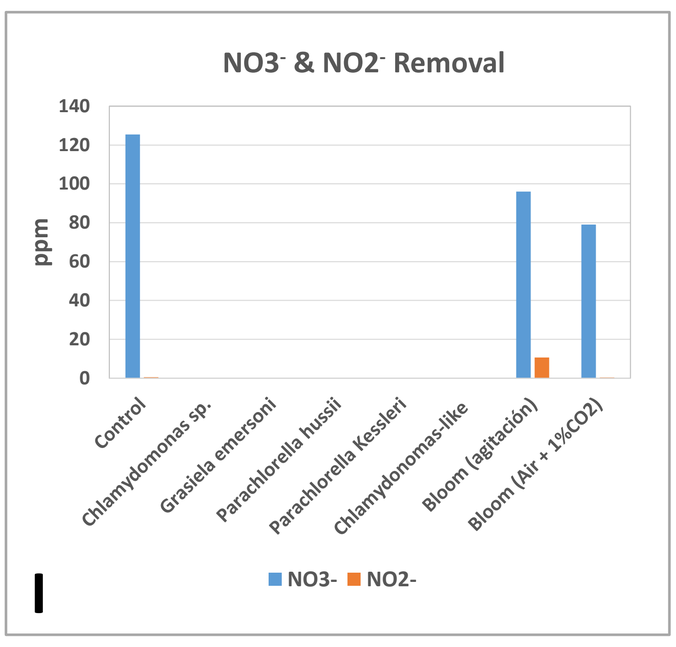
Monoalgal cultures isolated from aquaculture wastewater system (magnification: 1000x):

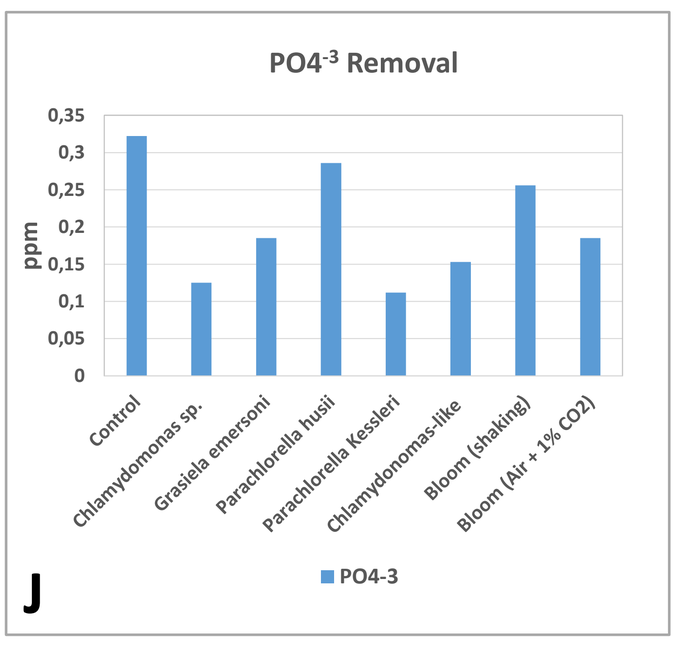
A) Chlamydomonas sp.
B) Grasiela emersoni
C) Parachlorella hussii
D) Parachlorella kessleri
E) Chlamydomonas-like (pendent of identification)



The five microalgae strains grown in aquaponic wastewater under lab conditions (23,5ºC, continuous light 90 µmol m^{-2} s^{-1}) at the beggining (F) and at the end (G) of the experiment (duration: 11 days) . In both photos, each erlenmeyer from left to right: *Chlamydomonas* sp., *Grasiela emersoni*, *Parachlorella hussi*, *Parachlorella kessleri*, *Chlamydomonas-like* strain and forced bloom (air + CO_2). Bloom with shaking is not shown. Microalgae grown in the blooms were mainly benthonic.







The biomass obtained from the different microalgae in the standard culture medium (Bold's Basal Medium) was superior to the one obtained in aquaponics wastewater (H). In all cases, the use of a microalgae inoculum to start the cultures (20 ml in 400 ml aquaponic wastewater) was more effective in biomass production (H), NO^{3-}, NO^{2-} (I) and $PO4^{-3}$ (J) removal than just forcing natural blooms, during the timimg of the experiment (11 days). The low amount of NO^{3-}, NO^{2-} present in the aquaponic wastewater (in comparison with the standard culture medium) might be the limitation for the microalgae growth. The microalgae observed in the forced blooms were similar (microscopic observations) to the ones isolated previously and used in this study (data not shown). Blooms were only forced in aquaponic wastewater, and the wastewater used to culture the other microalgae was previously filtered by 0,22µm.

ACKNOWLEDGEMENT

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