Treatment of Post-Hyrdothermal liquefaction wastewater for lettuce hydroponic systems

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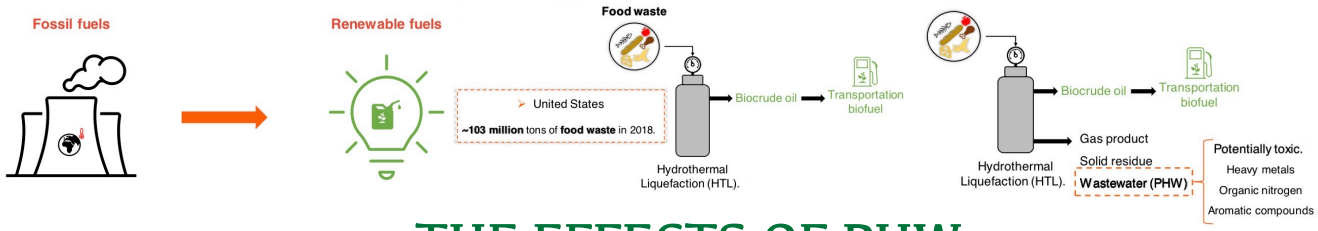
THE CHALLENGE:

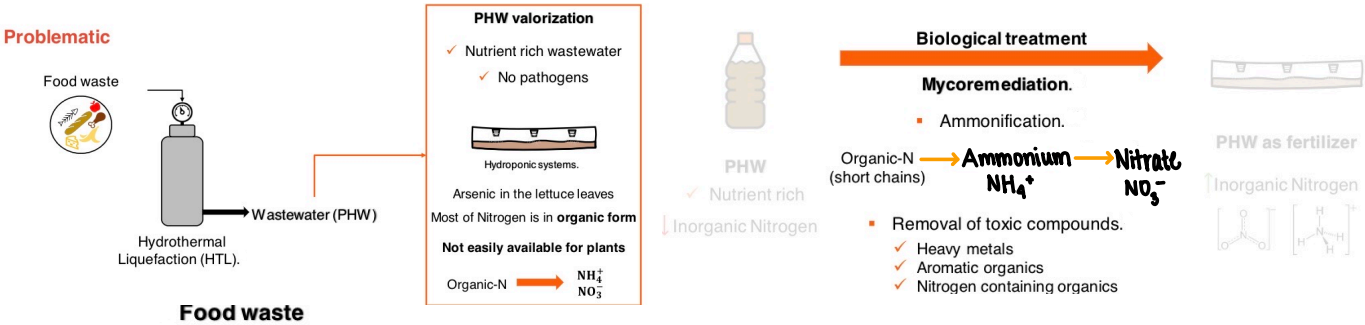
Post hydrothermal liquefaction wastewater, also known as PHW, is a byproduct of the process of transforming wet biomass into biocrude oil. This process is being utilized worldwide in order to create transportation biofuel without the need of fossil fuels.

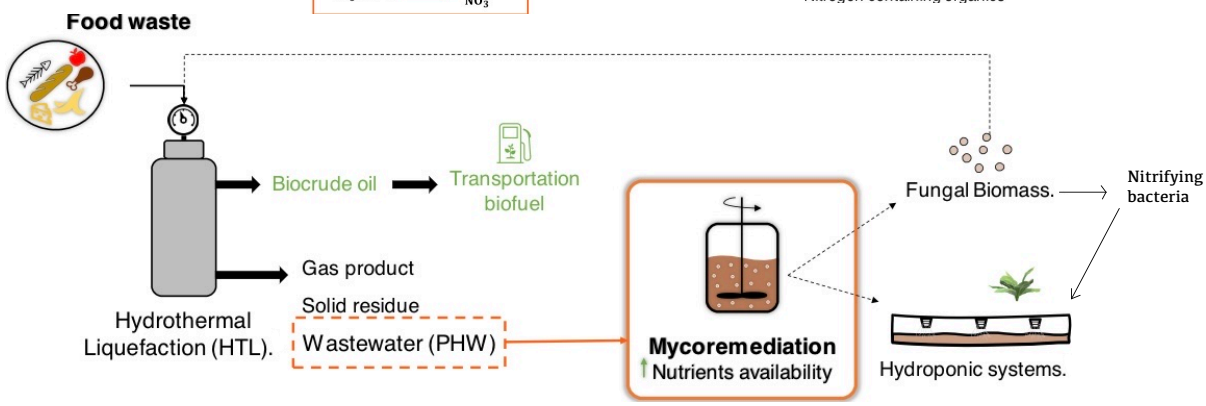


THE EFFECTS OF PHW:

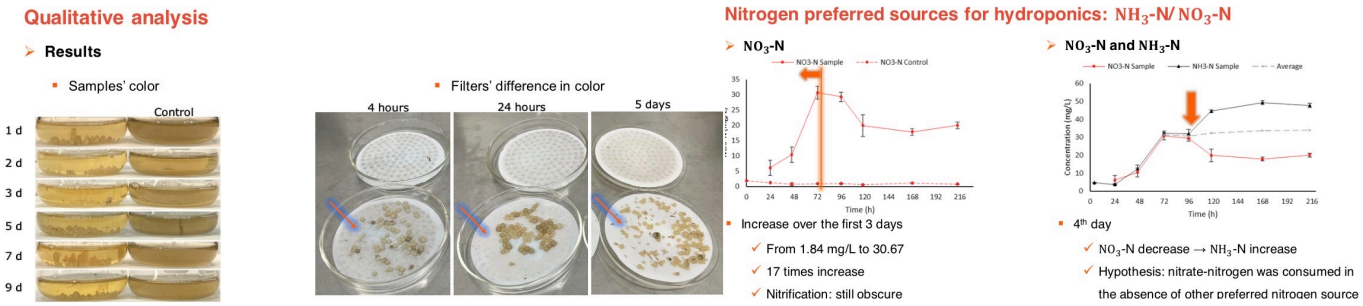
MY SOLUTION:

Treat the post hydrothermal liquefaction waste water which is rich in organic nitrogen, but also contains heavy metals such as arsenic. This water will be treated utilizing biomass and bacteria in order to eradicate the toxic components as well as converting the organic nitrogen into inorganic nitrogen, more specifically ammonium and nitrate. This water will then be recycled as a fertilizer in hydroponic systems for lettuce.

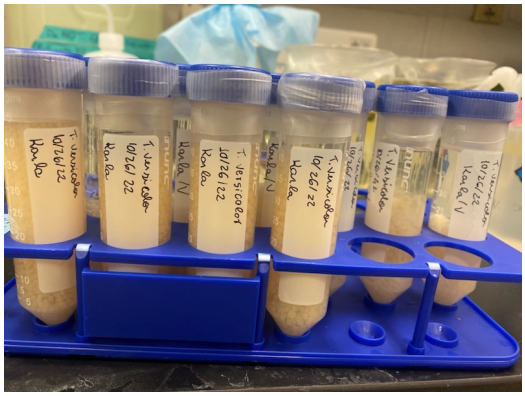


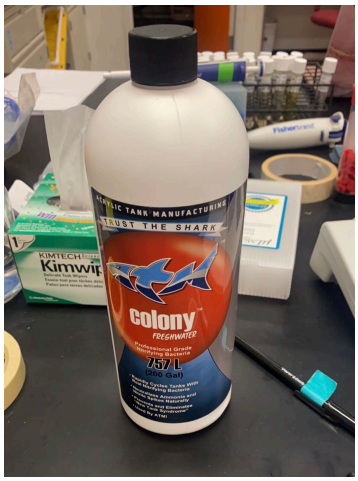


CURRENT RESEARCH:



I assisted a master's student here at the University of Illinois at Urbana Champaign in researching the functionality of the fungi, Trametes versicolor, in 5% PHW. The thesis that this fungi can release enzymes in order to convert organic nitrogen into inorganic nitrogen as well as deplete the toxicity from the PHW was defended and approved.





I have received support from Dr. Paul Davidson to implement my own research this semester in which I combine various methodologies from published papers. The difference in this proposed action is that I intertwine different strategies to treat PHW to produce the most optimal fertilizer. This proposal will improve aquatic life and society in the aspect of well-being and economy.

6 CLEAN WATER AND SANITATION

Treating PHW will improve water quality by reducing pollution, eliminating dumping, and minimizing release of hazardous chemicals and materials such as heavy metals. This way water related ecosystems will remain protected and recycling will be increased substantially.

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Utilizing PHW in hydroponic systems will reduce waste generation through recycling and reuse. Diminishing the toxic environment of the PHW will also reduce chemical waste, minimizing the adverse impacts on aquatic and human health.

7 AFFORDABLE AND CLEAN ENERGY

The formation of PHW comes from a process that supports the creation of renewable fuels. Biofuels will be an efficient source of renewable energy and compensate for the consumption increase in renewable energies. Recycling the byproduct will facilitate access to cleaner energy.

13 CLIMATE ACTION

Utilizing fungi as the main source of treatment will provide an alternative dependency on fossil fuels that lead to serious environmental problems, including the decimation of forests. It is also known that fossil fuels are the main factor in worsening global warming.

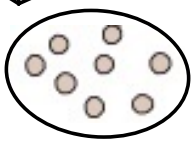
8 DECENT WORK AND ECONOMIC GROWTH

Treating PHW with this method will support the bio economy which will qualify stem job opportunities in rural America for positions like chemists and engineers and lead to economic development. This will also support a circular economy which keeps resources in use longer and minimizes waste. New market opportunities will also develop for agricultural commodities.

14 LIFE BELOW WATER

Terminating the addition of PHW into ponds, lakes, oceans, etc. will improve the sustainability for aquatic life by not allowing the addition of harmful chemicals into the water environment. Recycling this water will help prevent the deaths of aquatic life due to chemical pollution.

IMPLEMENTATION:

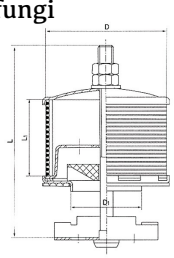


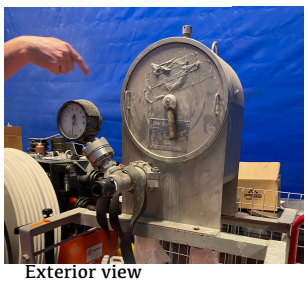
Inoculation of Trametes versicolor

The fermenter will contain 5% PHW and the main media will consist of potato dextrose agar. The conditions in the fermenter must be sterile and kept at 28° with an agitator set at 135 RPM.

A DSM stainless steel filter will be used to separate the PHW from the fungi

Interior view

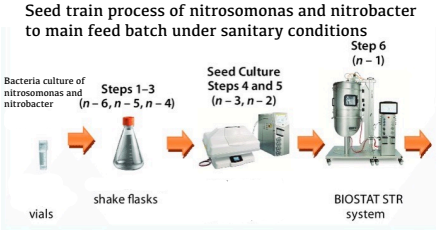




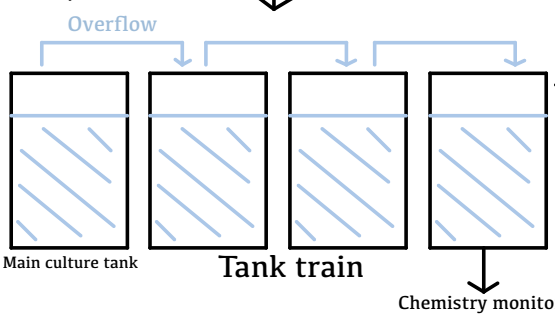
Exterior view

The fungi that is separated will be reinoculated into the fermenter .

Seed train process of nitrosomonas and nitrobacter to main feed batch under sanitary conditions



Since nitrifying bacteria are photo- sensitive this process must be kept under dark conditions.



Usable hydroponic water

This process would be implemented in a power plant and will consist of a continuous process. The resources required are finances, engineers, and technology. The main obstacle in the solution will be the need for financial funding, however, as many of the resources required in this process are recyclable, financial profits are probable.

I would like to thank Dr. Paul Davidson for showing tremendous mentorship as well as Vitória Lemé who I assisted over this past summer. I would also like to show my appreciation for both of my managers at the Integrated Bioprocessing Research Laboratory, Marissa and Phil, who were able to provide me with great guidance.

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REFERENCES:

Fang, H.- Y., Chou, M.-S., & Huang, C.-W. (2003, April 10). Nitrification of ammonia-nitrogen in refinery wastewater. Science Direct. Retrieved November 21, 2022, from https://doi.org/10.1016/0043-1354(93)90114-W
Focht, D. D., & Chang, A. C. (2008, April 15). Nitrification and Denitrification Processes Related to Waste Water Treatment. ScienceDirect. Retrieved November 21, 2022, from https://doi.org/10.1016/S0065-2164(08)70428-3
Jesse, S. D., & Davidson, P. C. (2019, April 24). Treatment of post-hydrothermal liquefaction wastewater (PHWW) for heavy metals, nutrients, and indicator pathogens. MDPI. Retrieved November 21, 2022, from https://www.mdpi.com/2073-4441/11/4/854
Jiang, Y., Ge, Z., & Liu, Z. (2017, December 22). Microbial electrolysis treatment of post- hydrothermal liquefaction wastewater with hydrogen generation. Science direct. Retrieved November 21, 2022, from https://doi.org/10.1016/j.apenergy.2017.12.065
Rezai, B., & AlllahKarami, E. (2021, October 1). Chapter 2 - Wastewater Treatment Processes - Techniques, Technologies, Challenges Faced, and Alternative Solutions. Sceince direct. Retrieved November 21, 2022, from https://doi.org/10.1016/B978-0-12-824463-0.00004-5