Hong Kong Student Science Project Competition 2023

Template of Extended Abstract (Invention)
(Word Limit: 1,600 words, Pages: 3 pages only)

Team Number: SABC171

Project Title: Fungi Filters

Project Type: Invention

***To our best knowledge, there are no similar works in the market*;**

I. Background

Our project looks towards utilizing the nitrate absorbance abilities of fungi mycelium to filter water on a smaller household scale and targets water waste from cooking water. Recent research towards the usage of biological technologies to advance environmental protection and bioremediation has been advocated. Within their research, scientists have recommended the use of fungi as a biological measure to remove pollutants. Fungi are saprotrophic eukaryotic organisms that grow on organic matter and intake nutrients through extracellular digestion and absorption. They bear incredible absorbance qualities and are known to be efficient hard metal (copper, zinc, iron) and nitrogen absorbers, making them efficient mediums for breaking down fertilizers and pesticides. These chemicals bioaccumulate within the fungal intracellular components. This natural process produces no toxic by-products and is a potent method to filter out organic and inorganic matter in wastewater. Furthermore, fungi are notorious for being adaptable organisms and can grow in various environmental conditions, making them felicitous candidates for bioremediation purposes. Through developing methods of small-scale mycofiltration systems, we can significantly reduce the amount of water waste in Hong Kong and even extend our inventions to those in need around the world. It is effective, low cost and sustainable.

II. Objectives

This project aims to address the global water crisis issue and develop an sustainable alternative to filter water kitchen waste water for agricultural use. By utilizing the mycelium roots of fungi, we developed a prototype to filter water in an organic, sustainable and cost-efficient method.

III. Methodology

We started the project by purchasing the fungi roots. We kept the mycelium in a moist environment to ensure its growth and absorbing qualities. We then extracted the mushroom fruits from these fungal roots. Past researches have found that live and dead mushrooms, as well as the spent mushroom substrates, are potent materials for bioremediation. We tried to mimic that, so we collected the mushrooms, dried them and ground them up into powder to increase their surface area to volume ratio and absorbance abilities. We then conducted experiments by filtering different types of water through the mycelium cells of the powdered mushrooms.

Furthermore, we tested the nitrate content, phosphate content, colour and protein content before and after different liquids were filtered through the mushrooms. This was done to assess the impacts of the mycofiltration method on different areas of bioremediation in regard to cleansing agricultural water runoffs. We kept the starting mass of the mushrooms constant at 13g and added 20 ml of liquids in each test, which we repeated 3 times. We performed control tests with distilled water to ensure that there were no impurities within the system and that it was a fair test.

We processed the data using mean average, standard deviations and triangulation methods and found out that the utilization of the fungal mycelium caused a general decrease in the protein, nitrate, phosphate and color content of the liquids. We constructed different graphs and tables showing this in our project report.

IV. Design of Invention

The design of our prototype is centred around the absorbance capabilities of the saprotrophic mycelium. We maximized the surface area to volume ratio and absorbent abilities of the mushrooms by grinding them into powder. The powdered mushrooms are contained above the filter paper in a funnel, which is held up by a rack above a beaker for the water collection. This prevents the powder from filtering through the apparatus.

This design is simplistic and uses appliances that can be acquired around the house. It is also flexible and allows for further development, such as making the water filtration layer larger and increasing the layers through which the water filters through.

V. Application / Market Need

Clean water is not readily available in many places around the world, with over 2 billion people suffering from a lack of access towards clean water. Furthermore, conventional water purifying methods such as distillation water treatment facilities require large amounts of resources and time to design and build, which is simply not possible for developing nations. Current water and wastewater treatment utilities contributing to over 5% of global greenhouse gas emissions in 2022. Kitchen waste water greatly contributes to the exacerbation of water waste. On average, each person uses over 70 litres of water per week to cook dishes and hand wash utensils. This places a burden on the planet and on low income households. Kitchen wastewater contains high nitrate levels, protein, oils and unsaturated fatty acid contents, making them unsuitable to be discharged into the sewage system. Along with fertilizer run-off, the discharged nitrates may lead to pools or rivers. The nitrates propagate the proliferation of algae, which blocks the sunlight for underwater plants. This restricts their aerobic respiration, increasing anaerobic respiration and depleting the oxygen content of the water. This further promotes the proliferation of microorganisms and bacteria, further depleting the water of oxygen and causing all aquatic life to die. This cyclical phenomenon is commonly known as eutrophication and is a severe ecological problem around the world. Our product places forth a clean, effective and cost efficient method to low income households to filter household grey water to advance agricultural usage.

VI. Conclusion

From our results, it is clear that the mycelium filter is effective in lowering the range of the nitrate and phosphate levels. The biuret absorbance also decreased after filtration with the percentage change being -25.820%, indicating that there was a general uptake of proteins from the mycelium which lowered the levels of protein. Overall, the mean percentage change in the absorbancy of the colored waters is -2.080%. Such results prove that, though small, our prototype has had an impact on lowering the nitrate, phosphates and colored chemical contents in the liquids filtered through.

Unfortunately, due to financial and technological constraints, wer were unable to conduct more trials and produce accurate results. However, we believe tat the data we have gathered are effective in addressing the potential usage of fungal mycelium for advancing bioremediation purposes and ameliorating the issue of water insecurity around the globe. In particular, by lowering the nitrate and phosphate levels, our prototype proves its potency in being used to resolve issues regarding

agricultural and domestic water runoff, Further research and chemical re-engineering may help us collect more accurate data and ultimately develop a large scale mycofiltration system to resolve all global issues regarding water insecurity, poverty and environmental sustainability.

References:

Rose-Innes, O. (2017). *See: How much water do you use per day?* Health24. Retrieved March 1, 2023, from https://www.news24.com/health24/lifestyle/environmental-health/see-how-much-water-do-you-use-per-day-20170613#

Kulshreshtha, S., Mathur, N., & Bhatnagar, P. (2014, April 1). *Mushroom as a product and their role in mycoremediation*. AMB Express. Retrieved February 24, 2023, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4052754/

Mnkandla, S. M., & Otomo, P. V. (2021). Effectiveness of mycofiltration for removal of contaminants from water: a systematic review protocol. *Environmental Evidence*, *10*(1), NA. https://link.gale.com/apps/doc/A669964647/AONE?u=anon~3d90dd54&sid=googleScholar&xid=abe3ef2f

Bhatnagar, A. (2021). *Wastewater treatment and mycoremediation by - iopscience*. IOP Conference Series: Earth and Environmental Science. Retrieved February 27, 2023, from https://iopscience.iop.org/article/10.1088/1755-1315/775/1/012003

Removal of oil and grease from produced water using electrocoagulation ... (n.d.). Retrieved March 8, 2023, from https://ascelibrary.org/doi/abs/10.1061/%28ASCE%29HZ.2153-5515.0000463

Chislock , M. (2013). *Eutrophication: Causes, Consequences, and Controls in Aquatic Ecosystems*. Nature news. Retrieved February 13, 2023, from https://www.nature.com/scitable/knowledge/library/eutrophication-causes-consequences-and-controls-in-aquatic-102364466/

Ehmccoy. (2022, February 3). *Mycoremediation: How fungi can repair our land*. Office of Sustainability - Student Blog. Retrieved March 9, 2023, from https://usfblogs.usfca.edu/sustainability/2022/02/03/mycoremediation-how-fungi-can-repair-our-land/

Mohamadhasani, F., & Rahimi, M. (2022, November 19). *Growth response and mycoremediation of heavy metals by fungus pleurotus sp.*. Nature News. Retrieved December 3, 2022, from https://www.nature.com/articles/s41598-022-24349-5