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## BIOTRANSFORMATION OF WASTE TYRE RUBBER MIXED WITH MICROALGAE BIOMASS: MONITORING GASEOUS EMISSIONS AND ENVIRONMENTAL IMPACT

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### **Introduction**

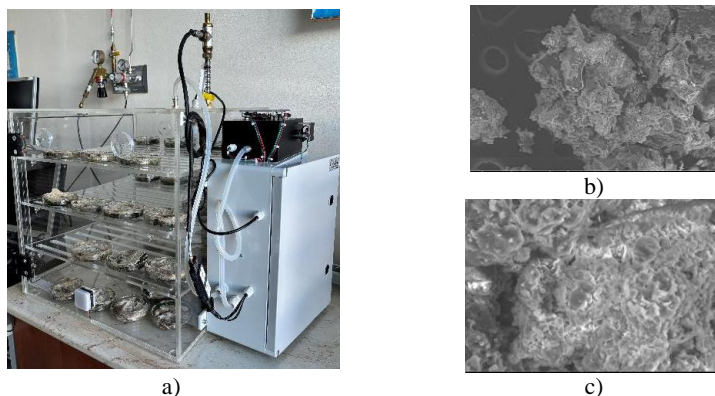
Combining WTR with biomass, such as microalgae from wastewater treatment, to create a biodegradable mixture that fungi could potentially break down offers a dual-purpose solution—addressing both rubber waste and biomass byproducts. The concept proposed for tackling the waste tyre rubber (WTR) issue aligns with sustainable waste management practices.

WTR contains a variety of complex polymers, primarily natural and synthetic rubber, along with carbon black, oils, and chemical additives that make it highly resistant to degradation. Traditional WTR is difficult to degrade because of its cross-linked structure and the presence of sulfur (from vulcanization). This creates a challenge for most microorganisms, including fungi. Microalgae biomass is rich in proteins, lipids, and carbohydrates, which could act as nutrients for fungi and other microorganisms, potentially stimulating the growth of specific strains capable of degrading WTR. The study aimed to show that the biomass can serve as a co-metabolite or conditioning agent to create an environment where fungi can adapt to target the rubber components of WTR. Fungi can be adapted to WTR by initially growing on more easily degradable biomass, like microalgae, before gradually introducing WTR into their environment. Certain fungal species like *Aspergillus niger*, *Pleurotus ostreatus*, and *Penicillium spp.* have shown promise in degrading rubber by producing extracellular enzymes such as peroxidases and cutinases that can break down rubber polymers. To aid biodegradation, it may be beneficial to pre-treat WTR (e.g., through mechanical grinding or pyrolysis) to reduce particle size and increase surface area, making it more accessible to fungi and enzymes.

### **Materials and methods**

The experimental study is related to the interaction between biomass, waste tire rubber, fungal development, and the possible degradation of WTR, making the WTR

more malleable or recyclable. All tests were performed in closed bioreactors with gas-monitoring capabilities (Figure 1).



**Figure 1.** a) Image of the bioreactor with gas sensors that monitors the gases resulted from the degradation/devulcanization of WTR/microalgae/fungi mixture, and morphology of WTR after treatment with algal biomass – scanning electronic microscopy (SEM) images: (b) – magnification 300x, c) magnification 1600x

There was an intentional reduction in the algal biomass content in different test sequences (different mass ratios of algal biomass to waste tyre rubber were tested, 1:1, 1:3, 1:4, and 1:5). This reduction of biomass content had the specific purpose to determine a limit value for biomass that could potentially lead to the degradation of the rubber. In summary, combining waste tyre rubber with microalgae biomass for fungal biodegradation is a creative and promising approach. If developed further, it could contribute significantly to the circular economy by addressing two waste streams simultaneously. Further research, especially on the adaptation of fungi and the hydrolysis process, would be critical in advancing this idea into a practical solution.

### ***Results and conclusions***

The study has a lot of potential, especially in tackling the problem of waste tyre rubber, which poses significant environmental challenges. By introducing a biological method involving microalgae, fungi, and atmospheric monitoring, it is intended to pave the way for innovative solutions in waste management and sustainability. The study conducted to valuable insights into bioremediation processes and even offer a pathway to recovering useful gases for energy applications.

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