Valorization of anthropogenic waste with microbial tools

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Nowadays, post-consumer textile wastes are a big problem that has not yet found a satisfactory solution. A small part is degraded and most of the used textiles of various origins are burned or landfilled mainly in poorer countries such as Chile and Kenya. Only 12% is recycled and less than 1% is used to re-manufacture clothes [1]. Textiles can contain natural fibers of plant (cellulose) or animal origin (fibroin) and different amount of synthetic fiber addition (such as polyester). This results in the fact that the organic part of the resulting waste (cellulose fraction) can be managed as feedstock for production of biofuels (e.g. biomethane, bioethanol), while the synthetic fibers created after degradation can be reused in accordance with the circular economy. Although recycling can be beneficial, unfortunately the limiting factor is the wide variety of fibers and dyes used, which means that such waste must be properly sorted and prepared (e.g. removal of dyes, shredding, etc.) before further processing. Current methods mostly involve the use of chemical hydrolysis [1] and the use of enzymatic catalysis is mainly limited to auxiliary processes (e.g., increasing the solubility of cellulose) [2] or requires prior separation of chemical and organic fibers [3]. Our research focuses on finding a suitable biocatalyst (fungi or bacteria) capable of decomposing cellulose fibers directly in the fabric sample, without first separating the organic part. The aim of the research is to degrade the cellulose and use the released sugars for cellular purposes if a whole-cell biocatalyst is used, or to enzymatically hydrolyze the biopolymer and increase the solubility of sugar part (post-culture extracellular enzyme cocktail). In both cases, the resulting synthetic fibers will be directed for reuse (Figure 1). Due to limited literature reports, process optimization requires both the determination of optimal conditions for the cultivation of microorganisms and cellulase production, as well as the fabric transformation process itself. Preliminary research allowed to establish favorable conditions for the production of cellulases by the fungus *Trichoderma viride* and bacteria *Ideonella sakainensis* and to confirm the method of detecting the progress of the reaction (scanning microscopy). Further research will focus on quantifying the level of activity of the produced enzymes, selection of the appropriate method of preparing textile waste samples and determining the impact of external factors (temperature, time) on the efficiency of hydrolysis of cellulose fibers in the tested samples.

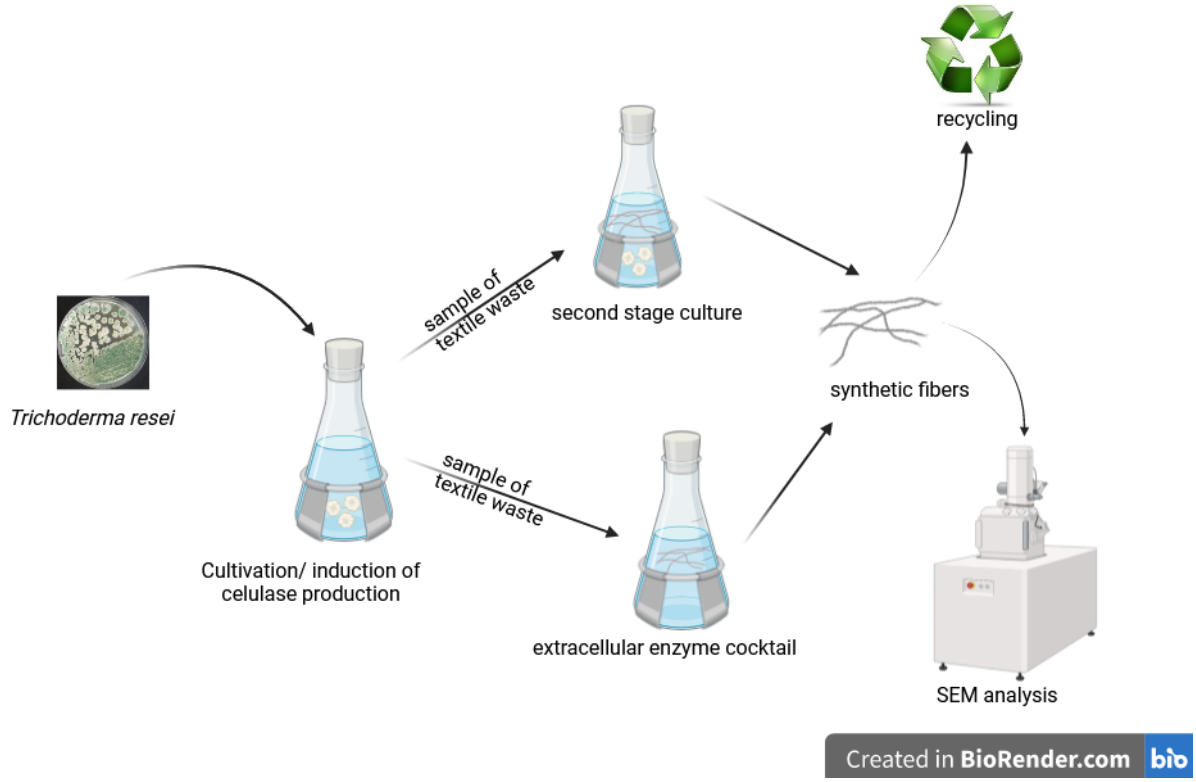

Figure 1. Simplified scheme for the valorisation of textile wastes.

References

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