Accelerated Bio-Chemical Depolymerization of Plastics From Surgical Face Masks: A Proactive Solution to the Impending Environmental Pandemic

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The number of masks in the USA is about 7.4 billion, which leads to 84 million kilograms of waste. This waste seeps into the environment and takes over 400 years to degrade. There are a few reported chemical, enzymatic, and microbe-based methods known to depolymerize plastics, hence the purpose of this project is to evaluate the main and interactive effects of these processes. In addition, a handheld NIR Spectrometer was developed and was used to monitor the depolymerization reactions. Near-InfraRed (NIR) spectroscopy demonstrates a unique fingerprint for polypropylene, and the change in spectral behavior and intensity was used as an indicator of depolymerization. Furthermore, I took microscopic digital pictures with 10x and 40x objective lenses to monitor morphological changes. Initially, the effect of the chemical (ZnO), enzymes, and microbes was tested at the pilot level (5ml). Furthermore, the processes were scaled up in a 1.5 L bioreactor. I then studied synergy between the processes using a 3 variable at 2 level factorial design. I kept 5 fixed variables and 3 were studied for synergy statistically in 8 experiments (n=2) using a DoE. The data was then analyzed using Yates's algorithm. The results indicated that there was a significant interactive effect and synergy between the chemical and microbial treatment for both day 9 and day 25. In the future, I want to try anaerobic microbial degradation of polymers and I would like to make the NIR Spectrometer handier by replacing the laptop with a small computer called the Raspberry Pi.

Awards Won:

Second Award of $2,000