Further Studies on the Application of Novel Rapidly Degrading Bioplastics Derived From Upcycled Waste Products To Replace Polystyrene and Polypropylene in Single-Use Hard Plastics Like Cutlery

Zuravel, Kaitlyn (School: Terry Sanford High School)
Zuravel, Lauren (School: Terry Sanford High School)

With no biodegradable alternative to plastic cutlery on the market today, we were determined to find a valid, eco-friendly solution with rapid, non-toxic biodegradation in multiple environments and functional use in various applications. Last year's research developed rapidly degrading bioplastics to replace Polystyrene and Polypropylene for disposable items in wet or dry conditions. However, the prototypes were not fully tested due to Covid. This project provides the required tests to confirm non-toxic degradation and heat tolerance. Prototypes were made primarily from generic, beef, or pork gelatin and fortified with agar and enzymatic crosslinking using RM Transglutaminase. Degradation of the prototypes was analyzed by intensity changes in the significant IR peak at the broad range of 3000- 3700cm-1 using FTIR, demonstrating OH stretching of hydrogen-bonded networks. Data establishes that water degradation occurs through water absorption and thermal degradation occurs through water evaporation, with the Generic+Agar+Enzyme (GAE) prototype being most resistant to both. SEM images confirmed the FTIR findings, establishing the GAE prototype as less porous. Finally, TGA confirmed the FTIR findings and determined a burning/melting point at ~250°C for all prototypes. This research establishes that our eco-friendly and cost-effective bioplastic prototypes have (1) a non-toxic degradation process, (2) a stable shelf-life and functional use at temperatures below ~250°C, and (3) explains why the GAE prototype has superior functional strength, even when exposed to liquids during use. Our project is significant as there is no biodegradable alternative to plastic cutlery on the market. Conversely, our prototypes rapidly degrade in landfill, freshwater, and saltwater environments.

Awards Won:

National Security Agency Research Directorate : First Place Award "Material Science"