OceanBioplas: The Plasticity of Marine Exoskeleton-Inspired Materials and Their Degradability in the Environment (Soil and Seawater/Saltwater)

Prawira, Jacqueline (School: Mountain House High School)

Purpose: Shell waste contains useful compounds: chitin, calcium carbonate, and protein. Yet unlike plastics, they can naturally degrade in the environment. Inspired by the concept of marine exoskeleton composition, I developed alternative materials to combat the plastic problem. Procedure: Development took place in 4 stages: Preliminary, Experimental, Degradation testing in 5 different settings for 12 weeks and Enhancement. Using permutations, I formulated the ratios/combinations as mathematical inequalities that defined intervals where the formation was achieved. Results: The physical properties range from thin, flexible films to more rigid, composite-like structures. Chitosan (chitin derivative) and $CaCO_3$ have positive correlations to tensile strength while diminishing flexibility. Each gram of Chitosan increases tensile strength by 15%-154% depending on ratios/combinations, while each gram of $CaCO_3$ increases tensile strength by 5%-13%. The addition of protein improves tensile strength up to 5 times and stretchability on chitosan and $CaCO_3$ combination. Biodegradation in organic soil occurs faster than photodegradation in saltwater. Melanin in squid ink slightly accelerates the degradation process, with minimal effect on tensile strength and flexibility. Conclusions: Compounds derived from crustacean shell waste can be utilized to synthesize alternative materials to plastic. The ratios/combinations determine the qualities and applications. Some OceanBioplas meets ASTM D6400 for 60% degradation within 180 days in organic soil without high temperatures, has the potential to photodegrade in saltwater with longer time based on linear projection and has comparable tensile strength to regular plastic according to ASTM D638. Prototypes were successfully created.

Awards Won:

United States Environmental Protection Agency: Alternate trip winner

National Security Agency Research Directorate : Honorable Mention "Material Science"