CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

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Project Number

S1116

Project Title

Ocean.Bioplas: The Plasticity of Marine Exoskeleton-Inspired Materials and their Degradability in the Environment.

Abstract

Objectives

To develop alternative materials to plastics, inspired by the concept of marine exoskeleton composition and to test their tensile strength, flexibility, and degradability.

Methods

The Preliminary Stage varied ratios/combinations of shell waste compounds for the formation development of Chitosan (CH) and Chitosan+Calcium Carbonate (CHCC). Poor quality samples were eliminated. In the Experimental Process, trials were conducted on Chitosan (CH1-7) and Chitosan+CaCO3 (CHCC1-21) samples for tensile strength and flexibility testing. The Degradation testing added Squid Ink. Data was generated through observation in 5 different settings for 12 weeks. In the Final Development Stage, Partially Hydrolyzed Collagen was added to enhance tensile strength.

Results

Chitosan compounds are thin, transparent and flexible with plastic-like quality; while the inclusion of CaCO3 produces a thicker, porous and composite-like quality. Chitosan and CaCO3 have positive correlations to tensile strength while diminishing flexibility. Each gram of Chitosan increases tensile strength by 154% in CH and 15%-44% in CHCC, while each gram of CaCO3 increases tensile strength by 5%-13%. The presence of partially hydrolyzed collagen improves tensile strength up to 5x and stretchability in CHCC. Melanin in squid ink speeds up the degradation process slightly, with minimal effect to tensile strength and flexibility, by absorbing the UV light and turning the light energy into heat energy. Biodegradation in organic soil occurs faster than photodegradation in saltwater/seawater. Salinity contributes to buoyancy, while water circulation wears down the samples by jostling and friction. Ratios/combinations were formulated as mathematical inequalities.

Conclusions

Compounds derived from crustacean shell waste can be utilized to synthesize alternative materials to plastic. However, the properties of each material once extracted are similar but altered. Finding the ratios/ combinations is crucial to achieving certain qualities as each compound brings each own challenges and solutions. OceanBioplas meets ASTM D6400 for 60% degradation within 180 days in organic soil without high temperatures and has the potential to photodegrade in saltwater/seawater with longer time. OceanBioplas has comparable or better tensile strength than some regular plastics based on ASTM D638. Prototypes were successfully created.

Summary Statement

I formulated Ocean.Bioplas as an alternative material to plastics using the marine exoskeleton concept to combat the plastic problem, meet the biodegradation standard and has comparable tensile strength to some regular plastics.

Help Received

I developed and conducted the experiments myself. Mrs. Gillmore and Mr. Brown from SJCOE provided feedback and support. My parents provided materials and adult supervision as required.