Cyclo.Plas 2: A Dual Focus Development as Alternative Materials to Plastic by Upcycling Fish Scale Waste Components

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The COVID-19 pandemic has exacerbated plastic pollution with the rise in PPE and single-use plastic consumption amplifying our plastic dependence and adding more plastic to our oversaturated oceans. Using biomimicry of the fish scale composition, calcium salts and collagen, my goal is a dual-focus materials development addressing the lack of plastic degradability and waste accumulation. Focus 1 applied the biomineralization concept to valorize 3D-printed PLA waste with fish scale-inspired minerals/hydroxyapatite to form a composite. Focus 2 utilized the sclerotization concept to enhance the physicochemical properties of intact collagenous matrix of fish scale waste, to form a thin, plastic-like material. Each focus had three parts: synthesis/formation, physical testing, and degradation/environmental testing. As composites, flexural strength exceeded that of 3D-printed PLA waste, and had higher degradation rates in hydrolysis, home composting, and acidic environments. Hydroxyapatite reinforces the structure and improves degradation, supported by SEM observations. As thin films, tensile strengths were comparable to LDPE, with 86% transparency and high shrinkage performance in 140-150°C, where LDPE melts. Samples biodegraded in soil after 8 weeks with no phytotoxicity and 3-7% higher plant growth. Trials showed improved thermal stability and water resistancy, yet could degrade with low total dissolved solids. The results supported the hypothesis that synthesis with fish scale waste components is key to the strength and degradability of Cyclo.Plas_2. The cost-effective prototypes are targeting single-use items and viable as non-medical PPE. Cylo.Plas_2 serves as a preventative solution and practical disposal solution through home composting to promote a circular economy.

Awards Won:

Second Award of $2,000

NC State College of Engineering: Alternates