QuackWrap: Utilizing the Optimized Starch Content Within Lemna minor to Synthesize Biodegradable Plastics

Li, Felix (School: College Park High School)
Desai, Anshul (School: College Park High School)

Over years of increasing environmental awareness and ongoing pollution challenges of single-use plastics, contemporary bioplastics, despite their promise, still present significant ecological concerns, practical limitations for everyday living, and inefficiencies in feedstock cultivation. Addressing these challenges, our research identified Lemna minor, commonly known as duckweed, as a promising feedstock due to its rapid growth rate, efficient nutrient conversion, and high starch content—a critical bioplastic component. To minimize the cost of current bioplastic production, starch was optimized within Lemna minor through low-energy, low-cost treatments. It was identified that plant hormones—auxins (indole-3-acetic) and cytokinins (zeatin)—that focused on the strategic timing of cytokinin application in the presence of auxins and other nutrients over 10 days, would yield the highest starch dry-weight content within Lemna minor. Through a controlled freshwater environment, results varied with the timing of cytokinin introduction, with the greatest starch dry-weight content of 60.7% when cytokinin was added on day 4. Furthermore, when subjected to a simulated saltwater environment, each treatment demonstrated an average of a 19.8% reduction in starch content compared to their freshwater counterparts. Utilizing the optimized starch content, a low-cost procedure was developed to transform the duckweed starches into a bioplastic that lost ~20% of its mass over a 2-month period in nature, comparable to current bioplastics. This use of Lemna minor not only overcomes ecological, economic, and cultivation inefficiencies but also promises a sustainable alternative to traditional single-use plastics, paving the way for an eco-friendly future in material production and beyond.