Power-Up With Produce: Repurposing Produce Loss to Develop Eco-Friendly Dye-Sensitized Solar Cells

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Produce loss is a globally significant issue that presents both environmental and financial implications. Dye-sensitized solar cells (DSSCs) are a third-generation class of solar technology that uses a photosensitive dye to absorb sunlight. This dye is generally made from synthetic materials that can be toxic to both humans during manufacturing and the environment upon disposal. Utilizing produce loss as an organic dye in DSSCs allows for a circular solution to otherwise-wasted produce and an eco-friendly, cost-effective alternative to traditional photovoltaic cells. In this study, produce possessing rich amounts of rutin, pelargonidin, cyanidin, betanin, and citric acid such as granny smith apples, strawberries, cherries, beetroots, and lemons were used to create individual, photosensitive dyes. These dyes were implemented into prototype DSSCs and tested for absorption properties, voltage and current outputs under multiple light conditions, and degradation patterns over 14 days. The cherry dye showed signs of rapid degradation despite initial high voltage and current output, underscoring stability challenges. Results of the singular dye experiments led to the development of a combined apple and strawberry dye, selected due to their complementary light absorption and electron transfer properties. Results with the co-sensitized dye demonstrated a 52% improvement in power conversion efficiency (PCE) compared to the average efficiency of singular dyes. Additionally, a detailed analysis of the current density-voltage (J-V) curve revealed an increase in maximum power output. This research suggests improved DSSC performance with the use of complementary dye properties, further promoting DSSCs as a viable way to repurpose produce loss.

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