WT Green Microalgae Under Changing Light: Patterns of Physiology and Hydrogen Production

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Due to population growth and technological advancement, global energy demand is on the rise. Yet 86% of the world's energy is from burning fossil fuels, with only 8% from sustainable methods. Fossil fuels have major drawbacks: environmental pollution, limited supply and geopolitical pressure. This demands a clean, sustainable alternative like hydrogen (H2). H2 is an ideal fuel; it has higher energy density than oil and burns cleanly, emitting only water vapor. Our solution uses microalgae to produce green H2 affordably, potentially transforming the energy sector. Microalgae are a diverse family of single-celled aquatic plants. When light hits them, an electric current is generated to activate cellular mechanisms. During light exposure, algae risk cellular damage from this current. To mediate this, they use the hydrogenase enzyme to combine electrons with protons, producing H2 gas that is expelled. The aim of our project was to investigate how varying lighting conditions affect H2 and oxygen production rates in four wild algae strains, mapping gas production kinetics in their physiology. To achieve this, we used real-time dissolved gas measurement methods by MIMS and FireSting systems. We found one strain demonstrated extraordinary H2 production compared to lab standards. Conversely, another strain likely uses a different energy mediation method, producing no H2 upon light exposure. Two other samples identified as the same species exhibited major physiological differences, highlighting natural variations within wild populations. Understanding these environmental adaptations and mapping H2 capabilities across many algae strains opens the door to practical, industrial-scale biological H2 generation.

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