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Trophic Diversity in Duckweed: Mixotrophy, More Than the Sum of its Extremes

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Duckweeds (Lemnaceae) are ideal model plants and valuable biotech resources with diverse trophic strategies, including mixotrophy. This study investigates the mechanisms and value of mixotrophy in *Spirodela polyrhiza* 7498. It demonstrates that mixotrophy endows duckweed with significant phenotypic and metabolic flexibility. Under mixotrophic conditions, duckweed enhances intracellular CO₂ supply through respiration, alleviating photosynthetic limitations and reducing oxidative damage. Crucially, mixotrophy achieves synergistic growth, with biomass yield significantly exceeding the sum of photoautotrophic and heterotrophic growth alone. Experiments confirmed that multiple carbon sources support this growth, with the mixotrophic growth rate reaching 6.22 and 4.98 times that of photoautotrophic and heterotrophic modes, respectively. Besides superior biomass, mixotrophy also promotes protein synthesis and effective nutrient removal from water. Notably, heterotrophic cultivation favors starch accumulation (2.06 times higher than mixotrophy), suggesting a combined strategy for starch-rich biomass production. This work reveals the synergistic advantages of duckweed mixotrophy, providing a theoretical basis for optimizing biomass production, high-value product synthesis, and organic wastewater remediation.

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