Laboratoire d biosciences
Ecole Polytechnique CNRS INSERM IP Paris

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A photoenzyme that produces biofuels: Discovery and mechanism of Fatty acid photodecarboxylase

Microalgae are considered a promising platform for the production of lipid-based biofuels. While oil accumulation pathways are intensively researched, the possible existence of a microalgal pathways converting fatty acids into alka(e)nes has received little attention.

Here, we provide evidence that such a pathway occurs in several microalgal species from the green and the red lineages, we also demonstrate that microalgae have the ability to convert C16 and C18 fatty acids into alka(e)nes by a new, light-dependent pathway (1).

Interested in this enzyme and curious to understand how light could regulate the activity, we purified the enzyme using liquid chromatography and by proteomic analysis, we identified in the microalgae Chlorella variabilis NC64A a photoenzyme that acts in lipid metabolism. This enzyme belongs to an algae-specific clade of the glucose-methanol-choline oxidoreductase family and catalyzes the decarboxylation of free fatty acids to n-alkanes or -alkenes in response to blue light (2).

This photoenzyme named FAP for Fatty Acid Photodecarboxylase (FAP) is of potential importance in green chemistry applications as alkanes are the main petroleum compounds and alkenes are synthons for organic chemistry. Yet its mechanism is far from fully understood. By combining static, time-resolved and cryotrapping spectroscopy and crystallography, we finally provide a comprehensive understanding of the strikingly complex catalytic cycle of FAP. We anticipate these insights will guide future engineering of this unique photoenzyme tailored to specific applications in green chemistry. (3)

References :

(1) D. Sorigué, *et al.* **Microalgae Synthesize Hydrocarbons from Long-Chain Fatty Acids via a Light-Dependent Pathway.** *Plant Physiol.* 171, 2393ï 2405 (2016).

(2) D. Sorigué, *et al.* **An algal photoenzyme converts fatty acids to hydrocarbons**. *Science*. **357**, 903ï 907 (2017).

(3) D. Sorigué, *et al.* **Mechanism and dynamics of fatty acid photodecarboxylase**. *Science*. under review (2021)