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Photobiocatalytic decarboxylation of fatty acids in flow – optimization and application in a two-step reaction sequence

AUTHORS

Stefan SIMIC / UNIVERISTY OF GRAZ, HEINRICHSTRASSE 28/II, GRAZ
Isabella KROSCHEL / UNIVERISTY OF GRAZ, HEINRICHSTRASSE 28/II, GRAZ
Christoph WINKLER / UNIVERISTY OF GRAZ, HEINRICHSTRASSE 28/II, GRAZ
Wolfgang KROUTIL / UNIVERSITY OF GRAZ, HEINRICHSTRASSE 28/II, GRAZ

PURPOSE OF THE ABSTRACT

The combination of photo- and biocatalysis has provided unique solutions for biocatalysis by both direct and indirect supply of photoinduced electrons to redox enzymes.[1-5] Fatty-acid photodecarboxylase from Chlorella variabilis (CvFAP), an FAD-dependent photoenzyme, was first described in 2017 and has since shown promising results for the production of biofuels.[6-11] Currently, the most common form of biofuel is biodiesel, however, multiple properties of biodiesel limit its practical applicability.[12] As a viable alternative to biodiesel, drop-in biofuels consist of aliphatic compounds, thereby having higher caloric value and similar properties to those of fossil fuels. Despite this, the chemocatalytic production of drop-in biofuels demands harsh and energy-intensive conditions.[13] In this regard, biocatalytic methodology employing CvFAP for biofuel production would enable comparatively mild reaction conditions and circumvent side-product formation, although the photostability of CvFAP remains a key limiting factor for its future applications.[14] Despite the benefits of performing light-dependent reactions in continuous flow,[15] utilization of CvFAP in flow remained unprecedented until recently.[16-17]

Herein the CvFAP-catalyzed photodecarboxylation of palmitic acid in continuous flow under homogeneous and heterogeneous catalysis conditions is described. A custom-made flow setup employing fluorinated ethylene propylene tubes was used. Under homogeneous conditions up to 65% yield was achieved after 10 min residence time, amounting to a space-time yield of 5.7 g·L-1·h-1, representing the highest pentadecane productivity of any CvFAP-catalyzed process to date. Additionally, a two-step reaction sequence involving lipase-catalyzed hydrolysis of triolein and subsequent CvFAP-catalyzed decarboxylation of the resulting oleic acid, was performed in flow. This represents the first instance of a two-reaction sequence involving CvFAP in continuous flow.

FIGURES

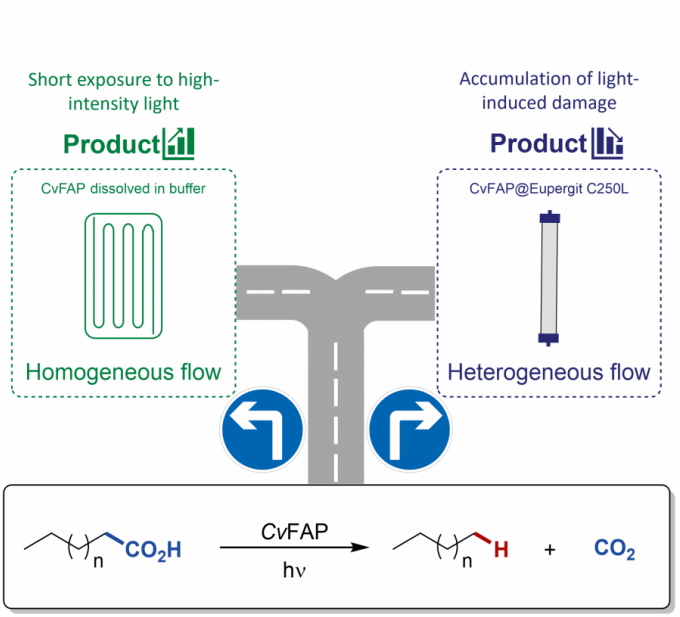

FIGURE 1
CvFAP-catalyzed photodecarboxylation of fatty acids in homogeneous and heterogeneous flow

FIGURE 2

KEYWORDS
Photobiocatalysis | Flow | Reaction sequence | Immobilization

BIBLIOGRAPHY