BIOTRANS
LA ROCHELLE 2023

N°674 / PC
TOPIC(s) : (Chemo)enzymatic strategies

Impact of different light sources on CvFAP photodecarboxylation

AUTHORS

Gabriela BREDA / UFRJ, AV ATHOS DA SILVEIRA RAMOS, 149, RIO DE JANEIRO
Alexandre FRANÇA / UFRJ, AV ATHOS DA SILVEIRA RAMOS, 149, RIO DE JANEIRO
Luiza BENINCA / SENAI, R. FERNANDO DE SOUZA BARROS, 120, RIO DE JANEIRO
Raquel LEÃO / UFRJ, AV ATHOS DA SILVEIRA RAMOS, 149, RIO DE JANEIRO
Kleber OLIVEIRA / UFSCAR, ROD. WASHINGTON LUIZ, S/N, SÃO CARLOS
Rodrigo ALMEIDA / UFRJ, AV ATHOS DA SILVEIRA RAMOS, 149, RIO DE JANEIRO
Frank HOLLMAN / TUDELFT, MEKELWEG 5, DELFT
Corresponding author : Rodrigo SOUZA / rodrigosouza@iq.ufrj.br

PURPOSE OF THE ABSTRACT

Chlorella variabilis fatty acid photodecarboxylase (CvFAP) catalyzes the elimination of CO2 from fatty acids (Cn) producing the corresponding hydrocarbon (Cn-1) from photoexcitation of the FAD prosthetic group [1]. The production of alkanes by biological route is of great biotechnological interest in the high-performance biofuel sector. However, despite the large number of publications in recent years, photodecarboxylation using CvFAP needs optimizations to increase yields and alternatives to reduce costs associated with this process. Therefore, the present project aims to intensify the photodecarboxylation reactions of palmitic acid using batch reactions with different light sources such as high-power LEDs and sunlight [2]. First, batch reactions with enzymatic extract containing CvFAP and 13 mM of palmitic acid as substrate were performed using illumination of blue LED lamps of different powers (50, 100, 200 and 300 W), which demonstrated that reductions in reaction time are possible by increasing the power of the light source (84% conversion using 300 W against 48% conversion using 100 W in 20 minutes reactions). A white LED lamp (300 W) connected to a solar panel was also used, which presented a slightly slower kinetic profile compared to the blue lamp of the same power (73% conversion using white LED against 94% conversion with blue LED in 30 minutes reactions). This alternative light source is beneficial as the energy consumption is lower and a solar panel is used. The further investigation studied the reaction application in flow reactors, as the scale-up remains a challenge for photodecarboxylation reactions using batch-type process. Reagents were added to a light-protected flask and pumped through a tubular reactor (FEP tubing) with the illumination of high-power LED (300 W white or blue LED). The product was collected in the end of the tubing and different residence times (flow rates) were tested. Full conversion (>99%) were obtained with 15 minutes of residence time for the blue LED and 60 minutes for the white LED. The results showed that continuous-flow approach is a potential alternative for scaling-up photodecarboxylation processes. Finally, batch reactions were also carried out using sunlight, which presented a higher yield when compared to the results with LED lamps reported in this work and in the literature so far, although using a lower light intensity (13.11 µmol.s-1.m-2 photon flux density for sunlight on a sunny day against 317.77 µmol.s-1.m-2 for 300 W blue LED lamp). After 12 minutes reaction using the sunlight, a full conversion (>99%) was obtained on a sunny day. A reduction in the efficiency of our process was also observed on cloudy day with >99% conversion after 60 minutes, which can be attributed to the lower sunlight intensity (4.21 µmol.s-1.m-2). The results of the present work correspond to the first reports of photodecarboxylation using CvFAP with white LED lamp and sunlight as alternative light sources, demonstrating its feasibility. The contributions of different wavelength ranges of the electromagnetic spectrum of sunlight, such as the <400 nm range together with the blue range (≈ 430-490 nm), could justify the higher yields using sunlight when compared to the blue LED lamps, that presents a shorter spectrum (439 nm).

FIGURES

FIGURE 1

FIGURE 2

KEYWORDS
photobiocatalysis | CvFAP | green chemistry | sunlight

BIBLIOGRAPHY

[1] sorigue, d., et al., plant physiol. 2016, 171, 2393-405.
[2] beninca, l., et al., molecular catalysis. 2022, 528, 112469.