BIOTRANS
LA ROCHELLE 2023

N°518 / OC
TOPIC(s) : Biocatalytic cascade reactions / (Chemo)enzymatic strategies

Peroxygenase-Promoted Enzymatic Cascades for the Valorisation of Fatty Acids

AUTHORS

Yinqi WU / DELFT UNIVERSITY OF TECHNOLOGY, VAN DER MAASWEG 9, DELFT
Caroline PAUL / DELFT UNIVERSITY OF TECHNOLOGY, VAN DER MAASWEG 9, DELFT
Thomas HILBERATH / DELFT UNIVERSITY OF TECHNOLOGY, VAN DER MAASWEG 9, DELFT
Ewald JONGKIND / DELFT UNIVERSITY OF TECHNOLOGY, VAN DER MAASWEG 9, DELFT
Wuyuan ZHANG / TIANJIN INSTITUTE OF INDUSTRIAL BIOTECHNOLOGY, CHINESE ACADEMY OF SCIENCES, 32 WEST 7TH AVENUE, TIANJIN
Miguel ALCALDE / INSTITUTE OF CATALYSIS AND PETROCHEMISTRY, MARIE CURIE 2, MADRID
Corresponding author : Frank HOLLMANN / F.Hollmann@tudelft.nl

PURPOSE OF THE ABSTRACT

Fatty acids as renewable feedstock are used for the synthesis of a range of products such as polymer building blocks, paints, coatings, surfactants and lubricants.[1] Biocatalytic transformations of fatty acids generally relies on pre-existing functional groups, such as the carboxylate group or C=C-double bonds, enabling (trans)esterification, amidation, reduction reactions, epoxidation and hydration. Addition of new functionalities into the hydrocarbon part opens up new possibilities for fatty acid valorization (Scheme 1).

Recently, cytochrome P450 monooxygenases exhibiting alpha-, beta-, delta- or omega-selectivity for the hydroxylation of non-activated C-H-bonds in fatty acids have been reported;[2] interestingly fungal peroxygenases also display activity. While peroxygenase-catalysed hydroxylations benefit from the intrinsically much simpler reaction mechanism compared to P450 enzymes, their practical usefulness is hampered by their generally low selectivity towards fatty acids.[3] In our recent protein engineering study on the prototype evolved peroxygenase from Agrocybe aegerita (AaeUPO-PaDa-I) for selective fatty acid hydroxylations, a new mutant (AaeUPO-Fett) was reported for high regioselectivity (almost exclusively located at omega-1).[4]

In this contribution, we extended the synthetic potential of non-functionalised fatty acids as starting materials for value-added products and building blocks using AaeUPO-Fett as a promising catalysts to add functionality to the alkyl chain. The primary products (i.e. hydroxyl fatty acids (esters)) are interesting building blocks for lactone and polyester synthesis. If oxidised to the corresponding ketoacids, further synthetic possibilities arise as demonstrated by the Baeyer-Villiger oxidation and the reductive amination reactions in multi-enzyme cascades, thereby paving the way for new fatty acid valorization pathways.

FIGURES

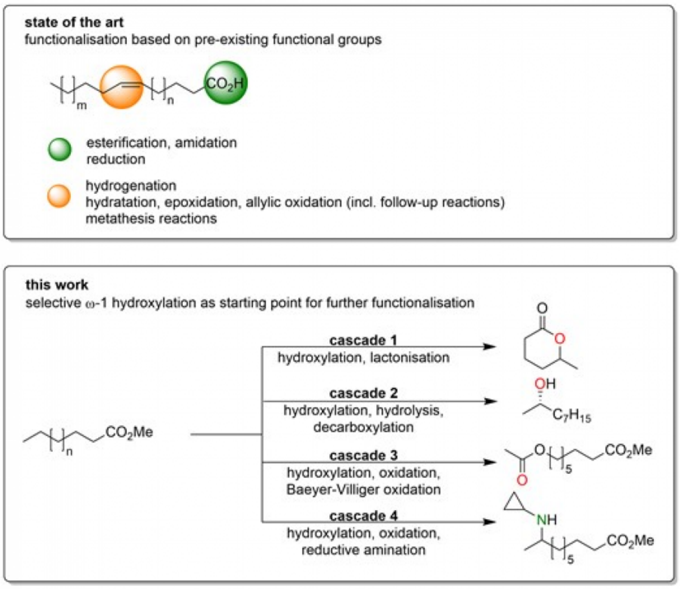

FIGURE 1

Scheme 1.

Established fatty acid valorisation approaches utilise existing functionalities such as the carboxylate group or pre-existing C=C-double bonds. In this contribution, we add functionality via selective, peroxygenase-catalysed hydroxylation enabling further

FIGURE 2

KEYWORDS

fatty acid valorisation | peroxygenase | selective oxyfunctionalisation | multi-enzyme cascades

---

BIBLIOGRAPHY

[1] a) C. Aouf, E. Durand, J. Lecomte, M.-C. Figueroa-Espinoza, E. Dubreucq, H. Fulcrand, P. Villeneuve, Green Chem. 2014, 16, 1740-1754; b) U. Biermann, U. T. Bornscheuer, I. Feussner, M. A. Meier, J. O. Metzger, Angew. Chem. Int. Ed. 2021, 60, 20144-20165.
[2] L. Hammerer, C. K. Winkler, W. Kroutil, Catal. Lett. 2018, 148, 787-812.
[3] a) A. Olmedo, C. Aranda, J. C. Del Rio, J. Kiebist, K. Scheibner, A. T. Martinez, A. Gutierrez, Angew. Chem. 2016, 128, 12436-12439; b) C. Aranda, J. Carro, A. Gonzalez-Benjumea, E. D. Babot, A. Olmedo, D. Linde, A. T. Martinez, A. J. B. A. Gutierrez, Biotechnol. Adv. 2021, 51, 107703.
[4] P. Gomez de Santos, A. Gonzalez-Benjumea, A. Fernandez Garcia, Y. Wu, A. But, P. Molina-Espeja, D. M. Mate, D. Gonzalez-Parez, W. Zhang, J. Kiebist, Angew. Chem. Int. Ed. 2023, 62, e2022173.