BOOK OF ABSTRACTS

February 2021
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COST Action GREENERING
CA 18224
Green Chemical Engineering Network
towards upscaling sustainable processes

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ABOUT

Green Chemical Engineering Network towards upscaling sustainable processes (CA18224) – GREENERING, is project (Action) funded by COST (European Cooperation in Science and Technology).

The objective of GREENERING COST action is to promote and boost the industrial application of green chemistry and sustainable technologies, developing the tools for the scale-up and implementation of emerging processes into industry.

ACTION DETAILS

- MoU - 041/19
- CSO Approval date - 04/06/2019
- Start of Action - 14/10/2019
- End of Action - 13/10/2023

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DESIGNING A BIOCATALYTIC PROCESS INVOLVING DEEP EUTECTIC SOLVENTS: LIPASE-CATALYSED SYNTHESIS OF (*R*)-1-PHENYLETHANOL AS A CASE STUDY

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The synergistic use of deep eutectic solvents (DES) and biocatalyst fits logically to the efficient and sustainable production of various commercially interesting products. Namely, biocatalysis ensures catalyzing otherwise difficult transformations in high regio-, chemo- and enantioselective manner at mild and economic conditions, whereby DES can serve as strong green support for modulating/directing reaction route for obtaining the desired product. As the number of structural combinations encompassed by DES is tremendous, it is possible to design an optimal DES for each specific enzymatic reaction system. This important feature of DES allows to (i) enhance enzyme stereoselectivity, activity and stability, as well as reaction rate through enhanced substrate solubility; (ii) enhance reaction yield (iii) enhance/modify biocatalyst stereo preference; (iv) contribute to overall greenness of the process (including recycle and reuse). The use of DES for enzyme-catalysed reaction could be considered as “back to the roots”. Namely, when the compounds that constitute the DES are primary metabolites, namely, amino acids, organic acids, sugars or choline derivatives, they can provide cytoplasm-like natural environment for enzymes, meaning that enzymes can transform unnatural substrates in natural environment.

When designing efficient biocatalytic process involving DES, independently of reaction type and enzyme used, the following steps should be included: (i) preparation and characterization of DES (ii) screening of DES for optimal enzyme performance (iii) optimization of the biocatalytic process, and (iv) downstream process design with possible scale-up.

In this work green lipase-catalysed process for obtaining commercially interesting secondary alcohol (R)-1-phenylethanol of high optical purity in DES as medium was development. Several cholinium chloride-based DES were prepared and screened for optimal enzyme performance (enzyme activity, stability and enantioselectivity), followed by optimization of biocatalytic process (substrate and enyzme loading, water content in DES, reaction temperature). Recovery of the products/DES and DES recycling was successfully performed. After laboratory scale, production of (R)-1-phenylethanol was also effectively performed on a preparative scale (half liter batch reactor). The results of this study confirmed the great potential of DES in biocatalytic medium in terms of improved lipase stability and process sustainability.

Keywords: Biocatalysis, Green chemistry, Natural deep eutectic solvents

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SUPERCRITICAL CO_2 IMPREGNATION - SELECTION OF SUITABLE POLYMERIC CARRIER FOR HEMP SEED OIL

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Supercritical CO_2 impregnation (SCI) process allows incorporation of bioactive components into solid carriers in an environmentally friendly manner. In recent years, SCI was highlighted as a promising method for preparation of added value materials that can protect bioactive components from environment (sun light, air, moisture etc.), stabilise them, and increase their shelf life. SCI process is also suitable for preparation of material with controlled release of bioactive component. Taking into account the above-mentioned, SCI process was employed in this study for incorporation of hemp seed oil (HSO) into biocompatible polymers (starch xerogel, starch aerogel, α-cyclodextrin, β-cyclodextrin, and γ-cyclodextrin). Given that efficiency of SCI depends on process conditions and affinity of bioactive component towards $scCO_2$ and polymer, it is necessary to optimise process for every individual system. Proposed SCI process was performed at pressure of 30 MPa and temperature of 40 °C during 5 h and 18 h. FTIR analysis confirmed that $scCO_2$ did not have effect on polymer composition nor it remained in polymer after process. Additionally, FTIR and UV-Vis analysis showed that HSO is present in all tested polymers after SCI process. It was shown that impregnation of HSO is highly dependent on selection of polymeric carrier (its chemical composition and morphology) and operating time employed, resulting in loadings from 0.5% to 40%. Chemical analysis showed that HSO is rich in unsaturated fatty acids especially linoleic acid (54-60%) and α-linolenic acid (17-20%). These essential fatty acids have well-established health benefits including protection against cardiovascular, neurodegenerative and inflammatory diseases. Proposed SCI process gave guidelines for development of added-value materials that are solvent free and can be used as phytopharmaceuticals.

Keywords: Supercritical CO_2 impregnation, Hemp seed oil, Starch, Cyclodextrin

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