



indox
industrial
oxidoreductases



OPTIMIZED OXIDOREDUCTASES FOR
MEDIUM AND LARGE SCALE INDUSTRIAL
BIOTRANSFORMATIONS.



The **indox** Project is a collaborative research initiative funded by the European Commission 7th Framework Programme (FP7) that gathers together the expertise of sixteen participants from seven EU countries plus one partner from an EU candidate country. Our main objective is to provide relevant industrial case stories to demonstrate the efficacy of optimized biocatalysts on targeted reactions, compared to chemical conversion processes.



Objectives

- 1 To identify oxidoreductases of interest for target biotransformations by genome, transcriptome and/or culture mining, and characterize them, together with already available enzymes, in order to establish relationships between the catalytic properties and the molecular structure characteristics.
- 2 To tailor the selected oxidoreductases to obtain *ad hoc* biocatalysts with optimized properties for oxidation, oxyfunctionalization, chiral synthesis and polymerization reactions, using protein engineering and computational tools.
- 3 To produce the oxidoreductases isolated in the previous genome (or transcriptome) screening using both laboratory and other expression hosts, yielding enzymes for laboratory engineering and bioprocess development.
- 4 To optimize enzymatic or chemo-enzymatic systems based on the new and/or engineered oxidoreductases by:
 - Enzyme immobilization;
 - In situ* generation of cofactors;
 - Development of preparations acting in "water-free" media; and
 - Multi-enzymatic and double-oxidation cascade reactions.
- 5 To develop oxidation/oxyfunctionalization bioprocesses of interest using the new and/or engineered oxidoreductases acting in optimized systems for:
 - Intermediates of agrochemicals/APIs;
 - Precursors for specialty polymers;



- Dye-stuff intermediates;
- Functionalized polymers for the pulp and paper; and
- Fragrances.

6 To provide relevant industrial case stories by up-scaling at least three of the previously developed bioprocesses for the production of agrochemicals, chiral compounds, dye stuffs and/or precursors for specialty polymers, based on the use of new and/or engineered oxidoreductase biocatalysts.

The biocatalysts

Researchers in INDOX are devoted to a specific group of biocatalysts, the oxidoreductases, a type of enzymes catalysing a wide range of oxidation and oxyfunctionalization reactions. The project aims to explore the industrial applicability of the most promising families of oxidoreductases in several target oxidative reactions of industrial interest.

Project work flow

Nowadays, the chemical industry (specialties excluded) is not yet embracing enzymatic oxidation reactions to a significant extent, primarily due to the lack of biocatalysts with the required selectivity, availability and compatibility with the rigorous process conditions.

The industrial partners participating in the project have identified a few oxidation and oxyfunctionalization target reactions that form the basis for the INDOX screening and optimization



of new biocatalysts to obtain industrially relevant compounds like:

- Intermediates for agrochemicals/active pharmaceutical ingredients (APIs)
- Polymer precursors and functionalized polymers
- Intermediates for dye-stuffs

It has been shown that fungi and other microorganisms provide the wider and more easily exploitable source for oxidative enzymes. Therefore, the biocatalyst screening and optimization is addressed by following these steps:

- Recovery of selective oxidoreductase biocatalysts from fungal genomes and other sources;
- Improvement of their oxidative activity and stability by protein engineering to fulfil the operational and catalytic conditions required by the chemical industry; and
- Optimization of reaction conditions and reactor configurations (including immobilization technologies and new enzymatic cascade reactions).

The INDOX approach is supported by a highly-specialized consortium of SMEs, large companies and research/academic institutions. Production of the new optimized biocatalysts and their introduction into the chemical market will take advantage from the participation of the world-leading company in the sector of industrial enzymes, together with several chemical companies willing to implement the new medium- and large-scale biotransformation processes.



Partners



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More information: www.indoxproject.eu