

**FROM RENEWABLE TO USABLE –
BIOTRANSFORMATION FROM CARVONE TO
CARVOLACTONE AND ITS COPOLYMERISATION WITH LACTIDE**

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The massive scale on which polymers are produced, used and disposed nowadays leads to a series of issues, such as the congregation of non-degradable plastic in the environment and the dependency on non-renewable feedstocks.^[1] The Mihovilovic group found a way to transform enzymatically a natural product, namely (+)-carvone, which is the main component of caraway oil (60%), into the highly valuable product carvolactone by *E. coli*. The enzymatic approach managed to handle this two-step synthesis as a one-pot reaction, without isolating the intermediates, which is usually required in the classical chemistry. The reactions were done by an enoate reductase (XenB) and a Baeyer–Villiger monooxygenase (CHMO_{Acineto}).

Carvolactone is an interesting building block which can serve as a monomer for polymer production through a ring opening polymerization. Their olefinic side chains can be easily functionalized and crosslinked.^{[3][2]} In addition, polymerized lactones such as poly-epsilon-caprolactone (PCL) and polylactide (PLA) are known for being biodegradable.^[4]

The biotransformation in *E. coli* was a *proof of concept* and could only lead to small amounts of carvolactone, which were not enough to start any polymerization trials due to the instability of the CHMO_{Acineto} in *E. coli*. Therefore, a new organism, namely *P. pastoris*, was chosen to optimize the biotransformation cascade to obtain enough carvolactone for polymerization trials.^[5]

Therefore, the two organisms, namely *E. coli* and *P. pastoris*, were used and compared for the bio-catalysed conversion of carvone into carvolactone. The yeast *P. pastoris* proved to be better suited for this biotransformation. Obtaining 1 g carvolactone with *P. pastoris*, polymerisation trials could be carried out. For the polymerization, the monomers carvolactone and lactide were polymerized in different ratios in order to obtain polymers with different amounts of double bonds and therefore different grafting and crosslinking characteristics. GPC and NMR analysis of the obtained polymers proved the successful polymerisation of the monomers.

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[3] T. Bayer, *et al.*, *ChemCatChem*, **2017**, 9, 2919-2923

[4] Hanan L. Messiha, *et al.*, *Biochem.*, **2018**, 57, 1997-2008

[5] M. Geier, *et al.*, *Chem. Commun.*, **2015**, 51, 1643-1646