Plant-derived dehydrogenases as selective biocatalysts for the catalytic separation of terpenoid stereoisomers

Ivana Drienovská[a], Dajana Kolanović[a], Volker Sieber[b], Michael Hofer[b] and Robert Kourist[a]

[a]Institute of Molecular Biotechnology, Graz University of Technology, Petersgasse 14, 8010 Graz, Austria
[b]Fraunhofer Institute for Interfacial Engineering and Biotechnology Bio, Electro and Chemocatalysis BioCat, Straubing Branch, Schulgasse 11a, 94315 Straubing, Germany

Enzymes for selective terpene functionalization are of particular importance for industrial applications. Borneol and isoborneol are fragrant constituents of several essential oils and have frequent application in cosmetics and therapy. Racemic borneol can be easily obtained from racemic camphor, which in turn is readily available from industrial side-streams. A selective borneol dehydrogenase is highly desirable as it would allow the catalytic separation of the enantiomers of borneol and isoborneol. Yet, borneol dehydrogenases from plants and bacteria do not show any enantioselectivity towards camphor or borneol enantiomers. In the early 80s, Croteau described *Salvia* leaves to specifically oxidize just one borneol enantiomer, however no specific enzymes have been characterized since. We expected that one or several alcohol dehydrogenases encoded in the recently elucidated genome of *Salvia sp*. would therefore be stereoselective. This study reports on the recombinant expression in *E. coli* and characterization of two alcohol dehydrogenases from the *Salvia sp.* genome, SsBHD1 and SsBDH2, and their comparison to other known ADHs. With a k_{cat} of 0.037 min^{-1} and a K_M of 0.6 mM, SsBDH2 shows similar activity compared to related dehydrogenases from plants. Surprisingly, the resolution of racemic borneol forms preferentially (+)-camphor, while the oxidation of racemic isoborneol forms (-)-camphor.

The two dehydrogenases thus highly selective catalysts for the synthesis of the optically pure borneol and isoborneol as important bio-based chemicals.