Lipid Biosynthesis and Production in Bacteria

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Bacteria synthesize beside polyhydroxyalkanoates other hydrophobic compounds like triacylglycerols and wax esters as storage compounds and deposit them as insoluble inclusions in the cytoplasm. The key enzyme for synthesis of the latter lipids was identified for the first time as a wax ester synthase/diacylglycerol acyltransferase in the Gram-negative bacterium *Acinetobacter baylyi* [1]. Meanwhile, homologues of this promiscous acyltransferases were detected in any lipid accumulating bacterium like in *Rhodococcus opacus*, *Mycobacterium tuberculosis*, *Alcanivorax borkumensis* and others. These acyltransferases are capable of synthesizing a wide range of different acyloxoesters and also acylthioesters with a widely varying carbon-chain-length of the constituents. Several acyltransferases have been characterized in detail at the biochemical and molecular level. The acyltransferase of *A. baylyi* and of other bacteria were heterologously expressed in a functional active form in *Escherichia coli* and *Saccharomyces cereviaiae*. Acyltransferases were also used to engineer bacteria for the production of tailor-made lipids and of fatty acid ethyl esters (FAEEs) which were referred to as 'Microdiesel' [2]. This lecture will illustrate the potential of these acyltransferase for the production of fine chemicals and oleochemicals on the one side and of bulk chemicals like lipids for fuel production and FAEEs on the other side [3]. This includes high cell density fermentations of bacteria to produce abundant amounts of lipids.

[1] Kalscheuer, R. & A. Steinbüchel (2003) A novel bifunctional wax ester synthase/acyl-CoA:diacylglycerol acyltransferase mediates wax ester and triacylglycerol biosynthesis in *Acinetobacter calcoaceticus* ADP1. J. Biol. Chem. 278:8075-8082.

[2] Kalscheuer, R., T. Stölting & A. Steinbüchel (2006) Microdiesel: *Escherichia coli* engineered for fuel production. Microbiology (SGM) 152:2529-2536.

[3] Stöveken, T. & A. Steinbüchel (2008). Bacterial acyltransferases as an alternative for lipase-catalyzed acylation for the production of oleochemicals and fuels. Angew. Chem. Int. Ed. 47:3688-3694.