Biotransformation of cyclohexane to ε-caprolactone using *Arabidopsis thaliana* as a whole-cell biocatalyst

(*Graduate School of Science, Osaka Metropolitan University*) ○Yuya Machi, Jina Yoshida, Hideo Kojima, Satomi Takeda

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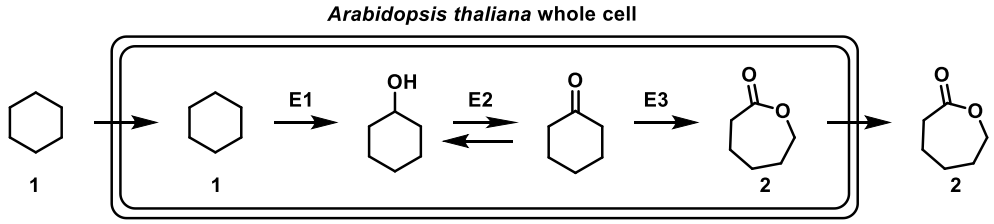
The synthesis of high-value-added substances often involves multi-step reactions, requiring isolation and purification of products at each step. Recently, cascade reactions consisting of multiple enzymes have attracted much attention. By using such enzymatic cascade reactions, multiple chemical transformations can be performed continuously without the need to isolate intermediate products. Furthermore, in the enzymatic cascade reactions using whole cells, the coenzyme regeneration system is provided as an intrinsic cellular metabolic pathway, and a one-pot reaction system can be constructed, enabling multi-step molecular transformations under simpler and less expensive conditions. Previously, we have reported on the use of *Arabidopsis thaliana* (*A. thaliana*) as a whole-cell biocatalyst to synthesize optically active alcohols by asymmetric reduction of ketones.[1] Since *A. thaliana* is known as a model plant, which is easy to cultivate and its entire genome has already been analyzed, it is easy to obtain mutant strains in which specific enzymes are disrupted or strongly expressed. In this study, we investigated the whole-cell enzymatic cascade reaction from cyclohexane (**1**) to ε-caprolactone (**2**) (Scheme 1).

A. thaliana seeds were sown on agar medium and incubated under light (40 μmol m^{-2} s^{-1}) at 22°C for 2 weeks. 100 mg of the plants was added to 5 mL of phosphate buffer solution (pH 7.0) containing substrate (0.5 mM) and the reaction mixture was incubated under light (40 μmol m^{-2} s^{-1}) or in the dark at 25°C for 24 h (Scheme 1). After the reaction, the plant was removed and the mixture was extracted with ether. The yields were determined by gas chromatography. We found that **2** was produced in 15% yield under light conditions and 11% yield under dark conditions from **1**.



Scheme 1

1) S. Takeda *et al*., *Plant Biotechnol*., **28**, 77–82 (2011).