Conversion of Glycerol to 3-Hydroxypropanoic Acid by Genetically Engineered Bacillus subtilis

3-Hydroxypropanoic acid (3-HP) is an important biomass-derivable platform chemical that can be converted into a number of industrially relevant compounds. There have been several attempts to produce 3-HP from renewable sources in cell factories, focusing mainly on Escherichia coli, Klebsiella pneumoniae, and Saccharomyces cerevisiae. Despite the significant progress made in this field, commercially exploitable large-scale production of 3-HP in microbial strains has still not been achieved. In this study, we investigated the potential of Bacillus subtilis as a microbial platform for bioconversion of glycerol into 3-HP. Our recombinant B. subtilis strains overexpress the two-step heterologous pathway containing glycerol dehydratase and aldehyde dehydrogenase from K. pneumoniae. Genetic engineering, driven by in silico optimization, and optimization of cultivation conditions resulted in a 3-HP titer of 10 g/L, in a standard batch cultivation. Our findings provide the first report of successful introduction of the biosynthetic pathway for conversion of glycerol into 3-HP in B. subtilis. With this relatively high titer in batch, and the robustness of B. subtilis in high density fermentation conditions, we expect that our production strains may constitute a solid basis for commercial production of 3-HP.

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