A new player in the biorefineries field: phasin PhaP enhances tolerance to solvents and boosts ethanol and 1,3-propanediol synthesis in Escherichia coli

The microbial production of biofuels and other added-value chemicals is often limited by the intrinsic toxicity of these compounds. Phasin PhaP from the soil bacterium Azotobacter sp. strain FA8 is a polyhydroxyalkanoate granule-associated protein that protects recombinant Escherichia coli against several kinds of stress. PhaP enhances growth and poly(3-hydroxybutyrate) synthesis in polymer-producing recombinant strains and reduces the formation of inclusion bodies during overproduction of heterologous proteins. In this work, the heterologous expression of this phasin in E. coli was used as a strategy to increase tolerance to several biotechnologically relevant chemicals. PhaP was observed to enhance bacterial fitness in the presence of biofuels, such as ethanol and butanol, and to other chemicals, such as 1,3-propanediol. The effect of PhaP was also studied in a groELS mutant strain, in which both GroELS and PhaP were observed to exert a beneficial effect that varied depending on the chemical tested. Lastly, the potential of PhaP and GroEL to enhance the accumulation of ethanol or 1,3-propanediol was analyzed in recombinant E. coli Strains that overexpressed either groEL or phaP had increased growth, reflected in a higher final biomass and product titer compared to the control strain. Taken together, these results add a novel application to the already multifaceted phasin protein group, suggesting that expression of these proteins or other chaperones can be used to improve biofuels and chemicals production.

Importance.

This work has both basic and applied aspects. Our results demonstrate that a phasin with chaperone-like properties can increase bacterial tolerance to several biochemicals, providing further evidence of the diverse properties of these proteins. Additionally, both the PhaP phasin and the well-known chaperone GroEL were used to increase the biosynthesis of the biotechnologically-relevant compounds ethanol and 1,3-propanediol in recombinant E. coli These findings open the road for the use of these proteins for the manipulation of bacterial strains to optimize the synthesis of diverse bioproducts from renewable carbon sources.