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Evaluating the Potential of a Fast Growing Indian Marine Cyanobacterium by Reconstructing and Analysis of a Genome Scale Metabolic Model

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Abstract : Cyanobacteria is a promising microbe that can capture and convert atmospheric CO_2 and light into valuable industrial bio-products like biofuels, biodegradable plastics, etc. Among their most attractive traits are faster autotrophic growth, whole year cultivation using non-arable land, high photosynthetic activity, much greater biomass and productivity and easy for genetic manipulations. Cyanobacteria store carbon in the form of glycogen which can be hydrolyzed to release glucose and fermented to form bioethanol or other valuable products. Marine cyanobacterial species are especially attractive for countries with scarcity of freshwater. We recently identified a marine native cyanobacterium Synechococcus sp. BDU 130192 which has good growth rate and high level of polyglucans accumulation compared to Synechococcus PCC 7002. In this study, firstly we sequenced the whole genome and the sequences were annotated using the RAST server. Genome scale metabolic model (GSMM) was reconstructed through COBRA toolbox. GSMM is a computational representation of the metabolic reactions and metabolites of the target strain. GSMMs construction through the application of Flux Balance Analysis (FBA), which uses external nutrient uptake rates and estimate steady state intracellular and extracellular reaction fluxes, including maximization of cell growth. The model, which we have named isyn942, includes 942 reactions and 913 metabolites having 831 metabolic, 78 transport and 33 exchange reactions. The phylogenetic tree obtained by BLAST search revealed that the strain was a close relative of Synechococcus PCC 7002. The flux balance analysis (FBA) was applied on the model iSyn942 to predict the theoretical yields (mol product produced/mol CO_2 consumed) for native and non-native products like acetone, butanol, etc. under phototrophic condition by applying metabolic engineering strategies. The reported strain can be a viable strain for biotechnological applications, and the model will be helpful to researchers interested in understanding the metabolism as well as to design metabolic engineering strategies for enhanced production of various bioproducts.

Keywords : cyanobacteria, flux balance analysis, genome scale metabolic model, metabolic engineering
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