Talk

Impact of expression of the carbon flow regulation on sucrose production in Synechocystis sp. PCC 6803

Domínguez-Lobo, María Teresa*; Muro-Pastor,M.Isabel; Florencio Bellido, Francisco J.

(1) Instituto de Bioquímica Vegetal y Fotosíntesis (IBVF), CSIC-Universidad de Sevilla, 41092 Sevilla,Calle Américo Vespucio, 49, Spain

Tutor académico: González Fontes de Albornoz, Agustín

Keywords: sucrose; glycogen; Synechocystis;carbon metabolism

ABSTRACT

In response to the increasing demand for sustainable production solutions [1], cyanobacteria have emerged as a promising alternative. Synechocystis sp. PCC 6803 is a model organism commonly used to study carbon metabolic fluxes. This moderately halotolerant cyanobacterium accumulates sucrose and glucosylglycerol as compatible solutes under salt stress. Adaptation of carbon flux during nitrogen deficiency promotes the accumulation of glycogen as a carbon pool not combinable with nitrogen [2]. In this context, the potential biotechnological interest of modulating carbon flux to redirect it towards sucrose production was explored [3]. Strains overexpressing regulatory proteins involved in carbon flux and carrying a plasmid inducibly expressing sucrose-phosphate synthase (SPS) and the heterologous permease CscB were phenotypically characterized. Under salt stress, the expression of these regulators led to a 40% increase in sucrose production compared to non-induced levels, reaching a maximum productivity of 48.16 mg L^{-1} h^{-1}. Under these conditions, a partial redistribution of fixed carbon toward sucrose production occurred, at the expense of glycogen accumulation and biomass generation. Additionally, an improvement in the photosynthetic activity of these strains was observed due to the presence of this carbon sink. The effect of eliminating glucosylglycerol synthesis on sucrose production was also analyzed. Under high salinity conditions (400 mM NaCl), this mutation contributed to an additional 10% increase in sucrose production, reaching a maximum of 2.72 g/L. These results suggest that modulation of carbon flux can significantly increase sucrose production, making it a valuable exogenous source of carbon or in co-cultures with heterotrophic organisms producing compounds of interest.

REFERENCES

[1]Melis, A., Hidalgo Martinez, D. A., & Betterle, N. (2023). Perspectives of cyanobacterial cell factories. Photosynthesis Research. https://doi.org/10.1007/s11120-023-01056-4

[2] Ortega-Martínez, P., Roldán, M., Díaz-Troya, S., & Florencio, F. J. (2023). Stress response requires an efficient connection between glycogen and central carbon metabolism by phosphoglucomutases in cyanobacteria. Journal of Experimental Botany, 74(5), 1532-1550. https://doi.org/10.1093/jxb/erac474

[3] Santos-Merino, M., Yun, L., & Ducat, D. C. (2023). Cyanobacteria as cell factories for the photosynthetic production of sucrose. Frontiers in Microbiology, 14, 1126032. https://doi.org/10.3389/fmicb.2023.1126032