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The plasticity of cyanobacterial metabolism supports direct CO_2 conversion to ethylene

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The cyanobacterial tricarboxylic acid (TCA) cycle serves in biosynthesis and energy generation. However, it has until recently been generally considered to be incomplete with limited flux, and few attempts were made to draw carbon from the cycle for biotechnological purposes. We demonstrated that ethylene can be sustainably and efficiently produced from the TCA cycle of the recombinant cyanobacterium *Synechocystis* 6803 expressing the *Pseudomonas* ethylene-forming enzyme (Efe). A new strain with a modified ribosome-binding site in front of efe gene diverts 10% of fixed carbon to ethylene and shows increased photosynthetic activities. The highest specific ethylene production rate reached 718±19 μL/L/h/OD_{730}. Experimental and computational analyses based on kinetic 13C-isotope tracer and LC-MS revealed that the TCA metabolism is activated by the ethylene forming reaction, resulting in a predominantly cyclic architecture. The outcome significantly enhanced flux through the remodelled TCA cycle (37% of total fixed carbon) in comparison to a complete, but bifurcated and low-flux (13% of total fixed carbon) TCA cycle in wild type. Global carbon flux is redirected toward the engineered ethylene pathway. The remarkable metabolic network plasticity of this cyanobacterium is manifested via the enhancement of photosynthetic activity and redistribution of carbon flux, enabling efficient ethylene production from the TCA cycle.

Technological advancements in bio-hydrogen production and bagasse gasification process in the sugarcane industry with regard to Brazilian conditions

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Global warming is caused mainly by the excessive use of fossil fuels (coal, oil, diesel, gasoline, etc.) that emit millions of tons of pollutants into the environment. Besides, the fact that these fossil fuels are nonrenewable resources promotes the research in cleaner energy sources. In this chapter are presented two different technologies that could be introduced in the sugarcane industry to generate electricity and other kinds of clean fuel (producer gas and hydrogen); the case of hydrogen production by ethanol steam reforming and biomass gasification, which appear like promising technologies for energy generation in the sugarcane industry. Currently, most hydrogen is obtained from natural gas through a process known as reforming. Other technologic alternatives that may improve the supply of energy to the sugarcane industry is the use of biomass gasifiers in association with cogeneration system utilizing combined cycles to produce simultaneously electricity and heat, a technology known as Biomass Integrated Gasification/Gas Turbine Combined Cycle (BIG/GTCC). Cogeneration has been accepted by different industries and has gained great application in the sugarcane industry, where the thermic and electric demands are favorable to use this type of energy system. The main fuel used in the process is sugarcane bagasse which is a by-product of sugar and ethanol production processes; the obtained energy is used in the form of mechanical power, electric power, and saturated steam in the processes. The surplus electricity can be sold. Technical, economical, and ecological analyses were performed for introduction of hydrogen production and BIG/GTCC in the sugarcane industry, using bagasse as fuel, in order to identify the better scenarios for electricity and heat generation. The introduction of these technologies will promote innovations in the sugarcane industry. The main results will increase electricity production with an economic and ecologic sustainable approach.