Synthetic sugar for sustainable power!

Khaled Moustafa
Institut Mondor de la Recherche Biomédicale, Créteil, France

Email : khaled.moustafa@gmail.com

Natural photosynthesis allows biological systems to remarkably combine carbon dioxide and water molecules under sunlight to produce energy in the form of stored sugars. The stored sugar is then used by plants and animals to exert vital biological functions. If scientists can find the right protocol and materials to mimic this natural system to produce fermentable sugars, it could be the McCoy sustainable energy source for the future. The objective here is not to recall the photosynthesis mechanism, but to provide a future brief vision for a conceptual application of photosynthesis to produce bioethanol from organic synthetized sugar rather than from plants, which should be saved for human and animal feeding.

Energy is a major future challenge with important consequences on the economic stability, food security, water supply and global ecosystem. Sustainable energy is on the top interests of scientific and political programs in many countries, where economic development and industrial activities are main contributors of the emission of greenhouse gases. High accumulation of these gases are predictable to affect agricultural production and sharpen climate change. To alleviate these effects, scientists and stakeholders need to addresses all hypotheses relating to develop sustainable energy systems that minimize the levels of carbon dioxide (CO_2) on the biosphere. One potential approach to do so is to recycle CO_2 permanently and/or to convert it to an energy source rather than a damage causer.

Owing to industry and population growth, the reserves of oil and other fossil energy will become, at best, rare and costly for extraction and commercialization. Alternative energy resources include nuclear and solar-based platforms. Nuclear is a highly risk adventure at local and global level, especially under unpreventable cataclysms and uncontrollable climate

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change. The other safer approach is sunlight and its applications. An ideal energy system, however, should offer the possibility to produce sustainable power while reducing CO_2 emissions. An enhanced artificial photosynthesis protocol that uses CO_2, water and sunlight to produce fermentable organic matter (sugar), in the same way that plants do for their own natural photosynthesis, would be an ultimate solution for both energy production and CO_2 reduction. Figure 1 illustrates a simplified scheme of an energy system inspired from photosynthesis process, starting by capturing sunlight and CO_2 molecules to synthesis sugars. The synthetized sugar is then conducted to a fermentation chamber to generate bioethanol by fermenting microorganisms. Such an approach would not only offer the advantage to save valuable lands and crops, currently used for bioenergy setting, but also to reduce CO_2 and make industrial activities as desirable activities rather than culprit operations, because the emitted CO_2 will be recycled to feed the artificial system and produce bioethanol. In other term, the more CO_2 emitted by industrial activities, the more sugar synthesized, and the more bioethanol produced. To enable maximum fixation and level reduction of CO_2, such a system is expected to be implemented near industrial factories that intensively emit CO_2.

The composition, size, chemical and physical properties of appropriate devices and materials need to be scrutinized and custom-made for the specific projected task. This will entail efforts at the interface of multidisciplinary fields including chemistry, physics, engineering and plant biology. Moreover, in an ideal conception, a good sustainable energy platform should combine artificial photosynthesis with photovoltaic devices to take advantages from both settings in all circumstances.

Unlike the natural photosynthesis, whose rate is relatively low and depends on plant species and ambient conditions, the artificial system should enable better control and management of the bioenergy yield, once a powerful protocol is established. In fact, natural photosynthesis yield is not necessarily low, but just adapted to the needs of the photosynthetic organisms.

Artificial photosynthesis, on the other hand, is needed to offer more flexibility to control the production yield and satisfy great energy demands. Yet, one of the foremost challenges of sunlight-based technology is what to do when there is little or no sun? To address this intermittent nature of sunlight, an efficient photosynthesis system should mimic plants in their perfect absorption and tackling the light spectrum for their own photosynthesis. From hot and wet, to cold and rainy environments, plants efficiently capture light and develop intense vegetation with important organic matter produced (e.g. equatorial and boreal forests). Similarly, an artificial photosynthesis should be optimized to operate in all circumstances of light shifts and intensity differences. To achieve such an objective, future multidisciplinary advancements and strengthened efforts will be necessary to build an effective artificial photosynthesis, scalable for industrial energy production.

There is no doubt that earth's climate will inevitably change over the next decades due to anthropogenic activities. The effects of fossil energy uses combined to unsustainable agricultural and industrial practices will continue to cause damages. To avoid this, it is of high importance to reduce the global emission of greenhouse gases as soon as possible. In light of the depletion of fossil fuels, investment is an urgent way to develop safer and sustainable energy source to avert worst-case scenario. The establishment of new sustainable energies will require biologists, chemist and physicists to narrowly collaborate and examine a wide range of approaches. Artificial photosynthesis to produce synthetic sugar for fermentation and bioethanol production would be a promising method to focus on. The apparent benefit from such an approach is to reduce CO_2 levels and provide a clean renewable energy.

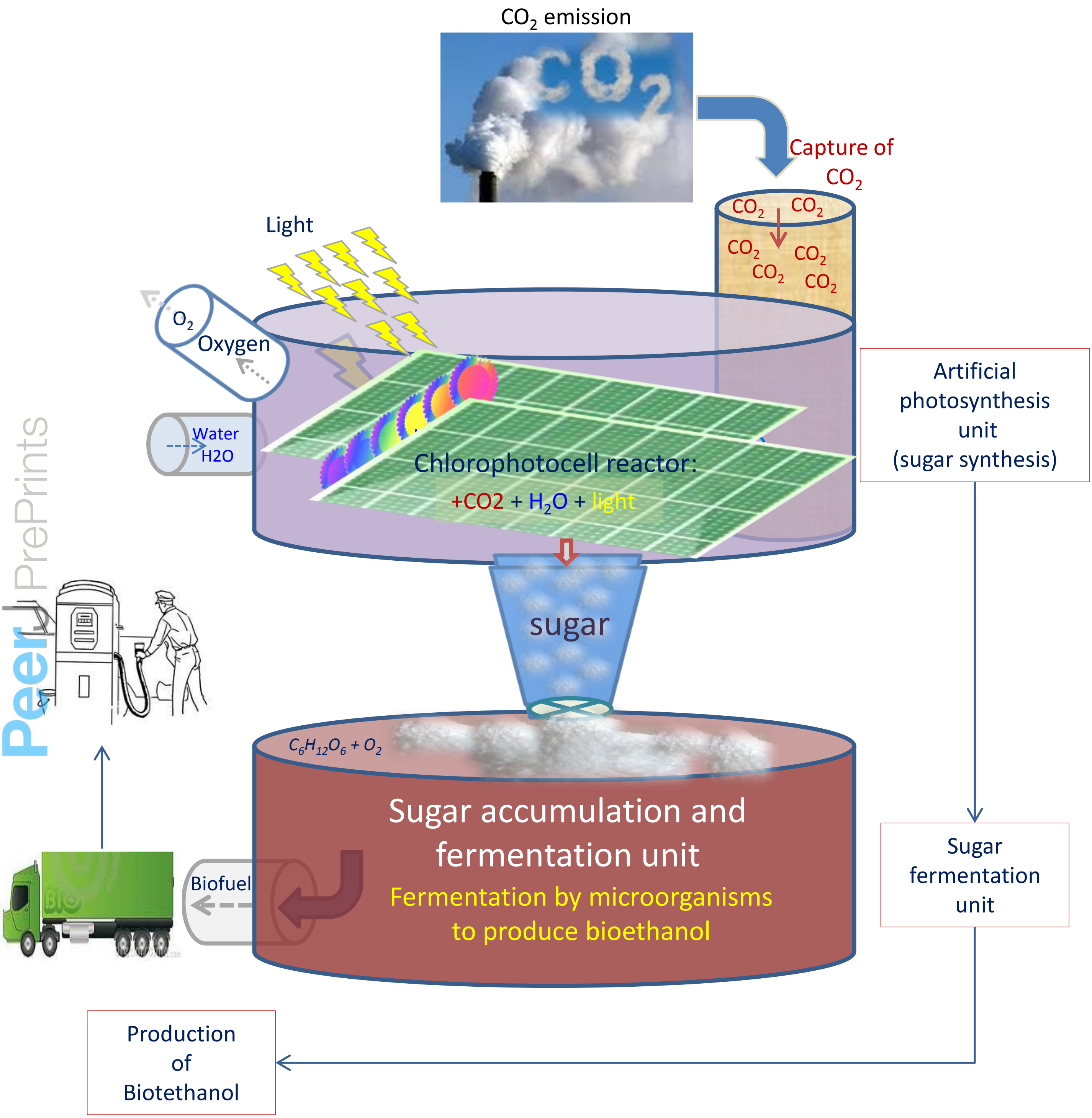

Figure 1. Conceptual scheme of an artificial photosynthesis approach for the production and fermentation of synthetic sugars to produce bioethanol.

Rather than to use valuable crops (e.g. maize, beet) for the production of biofuels, an artificial photosynthesis may present a good alternative to produce fermentable sugar from CO_2 and water in a kind of artificial plastids (i.e. Chlorophotocell). The conceptual system could be composed of two mains units: a large unit to capture sunlight and atmospheric CO_2 to synthesis sugar, and another unit to collect and ferment synthetized sugar by microorganisms (fermentation unit) to produce ethanol as a biofuel.

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