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Editorial

Microalgae Production in the Context of the Transition for a Low-Carbon Economy

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Editorial

In recent years, there has been a significant increase in the number of publications and patents related to new equipment and the improvement of the processes used to obtain biomass of microalgae and target products with higher added value.

However, in most of the studies, the final remarks and conclusions were obtained in the laboratory and do not include results from a pilot project with natural factors - biotic and abiotic - such as rainfall, winds, intense sunlight or biological contaminants such as rotifers, protozoa, fungi and viruses reported as one of the biggest problems to be faced and overcome in open cultivation systems.

As a consequence, the results that are constantly being published in the international literature do not discuss in detail the factors of great importance for the success of crops that can be effectively expanded in their scale of production. The achievement of stability in the cultures performed outside the laboratory during annual periods is fundamental for the correct presentation of productivity obtained as an index to be accounted for in the operational costs of any future enterprise that uses microalgae biomass as its raw material.

The cost of producing microalgae become even more critical when one sees the success of a future commercial initiative to obtain third generation biofuels, such as biodiesel and Jet fuel, which are being mentioned and encouraged by large companies in the sector of transportation - Federal Express, Boeing - as well as by majors of the energy sector - Total, Exxon Mobil.

The composition of fuels prices obtained from large-scale plants such as sugar cane, maize or soya is strongly dependent on the price of the raw material used (by about 80%). Hence, the importance of using advanced agriculture to guarantee increased productivity without loss of quality of the product obtained with highly selected seeds, crop management that includes pest control, efficient harvesting and appropriate storage for biomass conservation.

Usually the set of processes for obtaining the microalgae biomass can be considered as upstream and the set of biorefine processes that encompass cell disruption, extraction of target compounds and their conversion to the final product can be referred to as the downstream. Both need to be worked simultaneously to obtain microalgae with characteristics favorable to their processing through economically

Figure 1: Pilot plant in the first phase running at Extremes under natural conditions throughout 2015 (courtesy from Rio Grande do Norte Federal University).

favorable routes. In the context of a transition to a low-carbon, economy it would be possible to produce fuels from microalgae provided there is a scale-up with economics. Although the analogy with the agricultural processes mentioned is useful the production of microalgae still requires biotechnology specially developed for each cultivated species and for each group of target molecules.

A number of scientific approaches highlighted below can be applied to the upstream and the downstream in order to substantially contribute to the advances in the economics of microalgae production and the chemical compounds synthesized by them.

Relevant topics related to upstream

- Promote continuous selection of native strains
- Decrease the mixing energy involved in growing
- Obtain cheap culture media for cultivation
- Recycle nutrients used for algae growth
- Induce biosynthesis of target compounds
- Decrease the energy for harvesting
- Improve CO_2 distribution in open ponds.

Relevant topics related to downstream

- Reduce the amount of energy spent in cell disruption
- Improve selective extraction of target compounds
- Stablish high conversion efficiency of target compounds in the final product

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An integrated approach to a demonstration scale plant - a minimum cultivation area of 10 hectares - that takes into account the issues mentioned above represents a real step forward in obtaining fuels with high potential for CO_2 capture that can actually collaborate for transition from the current economic form of fuel production towards a low-carbon economy.

Practical aspects involving these considerations have been developed and applied in a pilot plant designed and built through a partnership between Petrobras and the Federal University of Rio Grande do Norte in the municipality of Extremoz (NE region of Brazil).

The results obtained are promising. Six open ponds with a unit area of 20 m^2 were used in the cultivation experiments during the period between 2012 and 2015 that underwent a recent scale-up for two open ponds with a unit area of 100 m^2 (Figure 1).

Intensive CO_2 capture was reached with 70% conversion in microalgae biomass and a low energy cost harvesting system was developed that utilizes flocculation and sedimentation with high efficiency (95%).

High mean annual yields were obtained between 25 and 30 g/m^2/day (ash free dry weight) with 20% of lipids that were converted to biodiesel. These data confirm that this region has native microalgae (Monoraphidium sp. Chlamydomonas sp. and Desmodesmus sp.) with excellent potential for the production of advanced biofuels.

As previously mentioned, there are challenges in the field of micro-algal biotechnology that require solutions dependent on the performance of multidisciplinary teams, but which can be solved in the near future.

Among the options available to increase, the economics of cultivation is the genetic manipulation of microalgae that could create strains with singular characteristics. Greater lipid productivity was recently announced by Exxon Mobil in partnership with Synthetic Genomics. According to the advertisement, this strain would contain 40% of lipids suitable for fuels production, representing another breakthrough directed towards the transition to a low-carbon economy.

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