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Application of $Fe(NO_3)_3$-based as nitrogen source and coagulant for cultivation and harvesting of *Chlorella sorokiniana*

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HIGHLIGHTS

- Ferric nitrate served both as coagulant and nitrogen source.
- 0.8 g/L ferric nitrate showed highest harvesting efficiency.
- The spent medium well supported *Chlorella sorokiniana* growth.
- Substantial amounts of nutrients could be saved.

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ABSTRACT

In this study, *Chlorella sorokiniana* was successfully cultivated in the recycled medium whose nitrogen was supplied directly from the coagulant, $Fe(NO_3)_3$. With a dosage of 0.80 g/L, harvesting efficiency of 95% could be achieved. What is more, this amount of nitrate in the coagulant was enough to fully support the growth of *C. sorokiniana* during the 8 day cultivation period, almost as much as the initial nitrogen content in the BG11 culture medium. Other nutrients had to be supplemented, however, with at least 50% amount as in the BG11 recipe. *C. sorokiniana* culture grown in recycled medium replenished with 50% of nutrients showed much higher Fatty acid methyl esters (FAME) productivity than the control, with 88.3 mg/L/day. The recycle of the medium is certainly a way of reducing the water footprint for the purpose of microalgae-derived biodiesel production; better still, it may serve to lower the nutrient footprint.

1. Introduction

Biodiesel is one of only a few renewable fuel options in a practical sense. This seemingly environmental-friendly fuel, however, is commercialized nearly exclusively from oil-rich terrestrial sources such as canola, soybean, palm, sunflower, and cottonseed, though also from waste vegetable oils (Pragya et al., 2013); and because main sources being edible, it causes ethical as well as economic constraints (Singh et al., 2014). Microalgae might be a good alternative oil-source with several advantages such as high lipid productivity, production of value-added chemicals, carbon dioxide capture, and wastewater treatment (Novoveska et al., 2016). This sustainable source, in spite of boundless possibilities, has a great deal of obstacles that need to be solved for the purpose of large-scale commercialization and in literally all sub-steps including cultivation, harvesting, extraction and conversion. Harvesting and extraction are energy-intensive due to the small, rigid, and complex nature of algal cells (Sostaric et al., 2012); conversion needs specialized catalysts, along with energy (Likozar et al., 2016). Of all the steps, cultivation is the most challenging and expensive: in view of current fuel price, carbon, nitrogen, phosphate, and other nutrients, and water are not cheap at all. In the autotrophic cultivation, the cost to provide inorganic carbon source (CO_2) can be reduced via utilization of flue gases from a power plant (Duarte et al., 2016). In fact, algal cultivation is considered as a green way of CCU (carbon dioxide capture and utilization) by itself. Nitrogen, on the other hand, does not have such a free supply source. According to Yang et al. (2011), the production of 1 kg of microalgae-derived biodiesel requires roughly 0.33 kg of nitrogen, along with 3726 kg of water and 0.71 kg of phosphate. It is this reason that a spent culture medium need be recycled: in so doing, water footprint can be reduced to 591 kg of water per 1 kg of biodiesel, and nutrient usage by 55%.

Another critical issue arises from the dilute nature of microalgae culture in the prevalent mode of suspension growth

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