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Review

The contamination and control of biological pollutants in mass cultivation of microalgae

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HIGHLIGHTS

- Biological contamination in mass cultivation of microalgae is inevitable.
- Transmission routes of biological pollutants are analyzed.
- Different biological pollutants species have different contamination mechanisms.
- Recent attempts to overcome the contamination are under active study.

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ABSTRACT

The potential of microalgae as a biomass feedstock for biofuels, bioproducts and as a technological solution for CO_2 fixation is subject to intense academic and industrial researches. However, current microalgal mass culture technologies have failed to produce bulk volume of microalgal biomass at low cost, because the contaminations of biological pollutants become a big constraint in mass cultivation and impede the industrial process. Here the transmission routes, contamination mechanisms of biological pollutants both in open ponds and photobioreactors are described and recent attempts to overcome the barrier are reviewed. What worth noting, unlike conventional microbial fermentation which uses a pure monoculture, the cultivation of microalgae is a complicated symbiotic system of microalgae–bacterial–zooplankton where the target microalgae dominate, cross infection or contamination by biological pollutants is inevitable and it will require much further research. Further investigation and development of control methods are necessary, particularly microalgal strain selection.

1. Introduction

Microalgae are unicellular photosynthetic organisms with relatively simple requirements for growth, are sunlight-driven factories which can convert water and carbon dioxide (CO_2) into potential nutrients such as proteins, amino acids, lipids, polysaccharides, carotenoids and other biologically-active molecules (Asha et al., 2011; Mulbry et al., 2008). Microalgae can be promising biomass feedstock owing to their fast growth, high reproduction and low greenhouse gas emission. Priorly, microalgae have potentially many broad applications in biotechnology (Walter et al., 2005), including biofuel (Chisti, 2007), pharmaceuticals (Lorenz and Cysewski, 2003), aquaculture (Mulbry et al., 2005).

Bulk volume of microalgal biomass at low cost through large-scale cultivations should be satisfied to realize these industrial potentials of microalgae. Presently, most methods of producing microalgal biomass for productions of biofuels and bioproducts are mainly based on suspension culture. And raceway ponds (Chisti, 2007) and photobioreactors (Mata et al., 2010) are the most common style of cultivations in large scales. However, sustained open pond production has been successful only for a limited number of cultures like Spirulina and Dunaliella with extreme conditions such as very high salinity or high pH (Asha et al., 2011).

Sufficient supply of nutrients, efficient gas transfer and exchange, and delivery of photosynthetically-active radiation (PAR) (Logan and Roanld, 2011) are all major challenges during productions of microalgae, which have been the subject in academic and industrial studies. Besides these, it was also found by U.S.DOE in 2010, microalgal monocultures grown for biofuel and other bioproducts were susceptible to biological pollutants. Infection or Contamination by biological pollutants could cause sudden and massive death of microalgal cells, but little attention was paid to this.

This review gives an introduction of the transmission routes and contamination mechanisms of biological pollutants, follow which, possible typical measures for controlling biological pollutants are summarized and suggested.

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