Biofuel recovery from microalgae biomass grown in dairy wastewater treated with activated sludge: The next step in sustainable production

Henrique Vieira de Mendonça a,⁎, Marcelo Henrique Oteniob, Leonilde Marchãoc, Alice Lomeua, Denise Salvador de Souzaa, Alberto Reisd

a Institute of Technology / Engineering Department, Federal Rural University of Rio de Janeiro, Campus Seropédica, 23897-000, Seropédica, Rio de Janeiro, RJ, Brazil
b Embrapa Dairy Cattle, Brazilian Agricultural Research Corporation, 36038-330 Juiz de Fora, MG, Brazil
c Chemistry Centre - Vila Real (CQVR) and Department of Chemistry, University of Trás-os-Montes e Alto Douro, 5000-801 Vila Real, Portugal
d National Laboratory of Energy and Geology, I.P. (LNEG), Bioenergy Unit, Campus Lumiar, 1649-038 Lisbon, Portugal

HIGHLIGHTS

• Microalgae were grown in synthetic dairy wastewater treated by activated sludge
• Bioremediation and CO2 fixation rates were promising
• For production of 24.99 × 10⁹ L year⁻¹, an area of 2 ha would be needed
• It is possible to produce ~306 g of biofuels from 1 kg of Scenedesmus obliquus
• It is possible to produce 276 g of biofuels from 1 kg of Chlorella vulgaris

ABSTRACT

Microalgae biofuel could be the next step in avoiding the excessive use of fossil fuels and reducing negative impacts on the environment. In the present study, two species of microalgae (Scenedesmus obliquus and Chlorella vulgaris) were used for biomass production, grown in dairy wastewater treated by activated sludge systems. The photobioreactors were operated in batch and in continuous mode. The dry biomass produced was in the range of 2.30 to 3.10 g L⁻¹. The highest volumetric yields for lipids and carbohydrates were 0.068 and 0.114 g L⁻¹ day⁻¹. Maximum CO2 biofixation (750 mg L⁻¹ day⁻¹) was obtained in continuous mode. The maximum values for lipids (21%) and carbohydrates (39%) were recorded in the batch process with species Scenedesmus obliquus. In all of the experiments, the Linolenic acid concentration (C18:3) was greater than 12%, achieving satisfactory oxidative stability and good quality. Projected biofuel production could vary between 4,863,708 kg and 9,246,456 kg year⁻¹ if all the dairy wastewater produced in Brazil were used for this purpose. Two hectares would be needed to produce 24.99 × 10⁹ L year⁻¹ of microalgae bioethanol, a far lower value than used in cultivating sugar cane. If all dairy wastewater generated annually in Brazil were used to produce microalgae biomass, it would be possible to obtain approximately 30,609 to 53,647 barrels of biodiesel per year. These data show that only by using dairy wastewater would biofuels be produced to replace 17% to 40% of the fossil fuels currently used in Brazil.

ARTICLE INFO

Article history:
Received 8 December 2021
Received in revised form 7 February 2022
Accepted 8 February 2022
Available online 15 February 2022

Editor: Huu Hao Ngo

Keywords:
Bioresources
Renewable energy
Fatty acids
Bioremediation
Biodiesel

1. Introduction

Dairy products are widely consumed in most developed countries, and their consumption in developing countries is increasing quickly (Rüös et al., 2016; Mendonça et al., 2017a, 2017b; Souza et al., 2021). Over the two last