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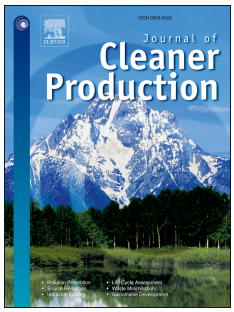

Technological aspects of the production of biodegradable polymers and other chemicals from renewable sources using lactic acid

R. Kozlovskiy, V. Shvets, A. Kuznetsov

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Technological aspects of the production of biodegradable polymers and other chemicals from renewable sources using lactic acid

R. Kozlovskiy*, V. Shvets, A. Kuznetsov
Departments of Petrochemistry and Biotechnology
D. Mendeleev University of Chemical Technology of Russia, Moscow
e–mail: shvetsvf@mail.ru, rakozlovskiy@mail.ru, ae-kuz@yandex.ru

Abstract

Lactic acid produced from renewable sources is used for the production of polylactic acid and lactic acid-based biodegradable polymers. However, large-scale production of biodegradable polymers and other large-tonnage lactic acid-based chemical products is limited by the difficulties of production-related waste and low productivity. To overcome these problems, we developed a method of ammonium lactate production from carbohydrates using a membrane bioreactor and semicontinuous cultivation with controlled parameters. During the 130 cycles, the average specific productivity of the biochemical reactor for ammonium lactate was 56 $g \cdot L^{-1} \cdot h^{-1}$, which was 10-fold higher than that obtained using traditional industrial processes. This method of using concentrated biomass in membrane reactors may also be applied in other similar processes of microbial transformation of organic substances. To significantly reduce the waste produced in the form of calcium sulfate, lactic acid derivatives were isolated from the butyl lactate intermediate without calcium sulfate formation. A method for the production of large-volume chemicals such as propylene glycol was also developed through hydrogenation of butyl lactate on a copper oxide–silica catalyst. This highly effective process gave 99% yield and 99% selectivity for propylene glycol formation. Our data on the development and improvement of the production processes of lactic acid and its derivatives pave the way for the development of competitive industrial processes for the production of biodegradable polymers and large-tonnage chemical products based on renewable raw materials.

Keywords:

Renewable sources, lactic acid, propylene glycol, membrane reactor, biodegradable polymers, green chemistry

1. Introduction

Lactic acid produced from renewable sources is used for the production of polylactic acid (PLA) and lactic acid-based polymers. PLA is a linear, aliphatic, thermoplastic, and readily biodegradable polymer (Iteavaara, 2002; Bowmer, 1998) used for medical applications, in packaging materials, and in mulching films (Rudeekit, 2008**).** The environmental performance of PLA-based polymers is better than that of petrochemical polymers in terms of global warming, dependency on fossil energy, and human toxicity (Papong et al, 2014). Lactic acid is also used for the production of green biodegradable solvents such as butyl lactate and other lactic acid esters (Farran et al., 2015) as well as for the production of nontoxic propylene glycol (http://journal.publications.chestnet.org/), which is widely used in pharmaceuticals, food processing, and industries. The growing demand for lactic acid for use in the production of biodegradable polymers and for green chemistry is not being satisfied because of the high cost of lactic acid and the large amount of waste generated during lactic acid production (1 ton of waste calcium sulfate produced per ton of lactic acid) (Corma et al., 2007; Wee et al., 2006). To solve these problems, we developed a cell recycling process for lactic acid production from glucose and changed the method of lactic acid isolation from the fermenter broth.