Journal of Applied Microbiology

Journal of Applied Microbiology ISSN 1364-5072

ORIGINAL ARTICLE

Jerusalem artichoke as low-cost fructose-rich feedstock for fossil fuels desulphurization by a fructophilic bacterium

T.P. Silva, S.M. Paixão, J.C. Roseiro and L. Alves

LNEG – National Laboratory of Energy and Geology, Bioenergy Unit, Lisbon, Portugal

Keywords
biodesulphurization, Doehlert distribution, fructophilic bacterium, *Gordonia alkanivorans*, Jerusalem artichoke, sulphate removal.

Correspondence
Susana M. Paixão and Luís Alves, LNEG – National Laboratory of Energy and Geology, Bioenergy Unit, Estrada do Paço do Lumiar, 22, 1649-038 Lisbon, Portugal.
E-mails: susana.alves@lneg.pt; luis.alves@lneg.pt

2014/1773: received 27 August 2014, revised 27 October 2014 and accepted 7 December 2014

doi:10.1111/jam.12721

Abstract

Aims: Through biodesulphurization (BDS) is possible to remove the sulphur present in fossil fuels to carry out the very strict legislation. However, this biological process is limited by the cost of the culture medium, and thus, it is important to explore cheaper alternative carbon sources, such as Jerusalem artichoke (JA). These carbon sources usually contain sulphates which interfere with the BDS process. The goal of this work was to remove the sulphates from Jerusalem artichoke juice (JAJ) through $BaCl_2$ precipitation viewing the optimization of dibenzothiophene (DBT) desulphurization by *Gordonia alkanivorans* strain 1B.
Methods and Results: Using a statistical design (Doehlert distribution), the effect of $BaCl_2$ concentration (0·125–0·625%) and pH (5–9) was studied on sulphate concentration in hydrolysed JAJ. A validated surface response derived from data indicated that zero sulphates can be achieved with 0·5–0·55% (w/v) $BaCl_2$ at pH 7; however, parallel BDS assays showed that the highest desulphurization was obtained with the juice treated with 0·5% (w/v) $BaCl_2$ at pH 8·73. Further assays demonstrated that enhanced DBT desulphurization was achieved using hydrolysed JAJ treated in these optimal conditions. A total conversion of 400 μmol l^{-1} DBT into 2-hydroxybiphenyl (2-HBP) in <90 h was observed, attaining a 2-HBP maximum production rate of 28·2 μmol l^{-1} h^{-1} and a specific production rate of 5·06 μmol^{-1} g^{-1}(DCW) h^{-1}.
Conclusions: These results highlight the efficacy of the treatment applied to JAJ in making this agromaterial a promising low-cost renewable feedstock for improved BDS by the fructophilic strain 1B.
Significance and Impact of the Study: This study is a fundamental step viewing BDS application at the industrial level as it accounts a cost-effective production of the biocatalysts, one of the main drawbacks for BDS scale-up.

Introduction

Fossil fuels still account for 87% of the primary commercial energy supply, most of which comes from oil (OPEC 2011). However, when used, these fuels cause the emission of nitrogen oxides, volatile organic compounds, sulphur as sulphur dioxide (SO_2) and the fine particulate matter made of metal sulphates. Gaseous sulphur compounds represent a major health hazard. At high levels, SO_2 gas can cause bronchial irritation and trigger asthma attacks in susceptible individuals. Also, long-term exposure to combustion-related fine particulate air pollution is an important risk factor for cardiopulmonary and lung cancer mortality (Mohebali *et al.* 2008). In addition, incomplete burning of liquid fossil fuels causes emissions of aromatic sulphur compounds to the air. The oxidation of sulphur compounds in the atmosphere may lead to the formation of sulphuric acid aerosol responsible for the acid rains and also contributes to the increase of the hole on ozone (Denis 2010).

Consequently, several countries around the world have been drastically reducing the legal limits of sulphur concentration on fuels, forcing companies to develop methods of removing the sulphur contained in the oil (Boniek