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Direct xylan conversion into glycolipid biosurfactants, mannosylerythritol lipids, by *Pseudozyma antarctica* PYCC 5048^T

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ABSTRACT

Mannosylerythritol lipids (MEL) are glycolipid biosurfactants, produced by *Pseudozyma* spp., with increasing commercial interest. While MEL can be produced from D-glucose and D-xylose, the direct conversion of the respective lignocellulosic polysaccharides, cellulose and xylan, was not reported yet. The ability of *Pseudozyma antarctica* PYCC 5048^T and *Pseudozyma aphidis* PYCC 5535^T to use cellulose (Avicel®) and xylan (beechwood) as carbon and energy source has been assessed along with their capacity of producing cellulolytic and hemicellulolytic enzymes, toward a consolidated bioprocess (CBP) for MEL production. The yeasts assessed were neither able to grow in medium containing Avicel® nor produce cellulolytic enzymes under the conditions tested. On contrary, both yeasts were able to efficiently grow in xylan, but MEL production was only detected in *P. antarctica* PYCC 5048^T cultures. MEL titers reached 1.3 g/l after 10 days in batch cultures with 40 g/l xylan, and 2.0 g/l in fed-batch cultures with xylan feeding (additional 40 g/l) at day 4. High levels of xylanase activities were detected in xylan cultures, reaching 47–62 U/ml (31–32 U/mg) at 50 °C, and still exhibiting more than 10 U/ml under physiological temperature (28 °C). Total β-xylosidase activities, displayed mainly as wall-bounded and extracellular activity, accounted for 0.154 and 0.176 U/ml in *P. antarctica* PYCC 5048^T and *P. aphidis* PYCC 5535^T cultures, respectively. The present results demonstrate the potential of *Pseudozyma* spp. for using directly a fraction of lignocellulosic biomass, xylan, and combining in the same bioprocess the production of xylanolytic enzymes with MEL production.

1. Introduction

The industrial conversion of renewable feedstock into useful compounds, like fuels, fine chemicals and materials, is receiving increasing attention as a strategy to overcome environmental and economic concerns related to the use of non-renewable resources. The transition from an oil-based economy to a bio-economy will be mostly dependent on the use of lignocellulosic materials, which are the most abundant, ubiquitous and renewable carbon source on Earth [1,2]. Most of the research on the use of lignocellulose has been devoted to the production of second generation (2G) bioethanol [2–4]. Recently, the conversion of lignocellulosic materials into other added-value bio-based products has gained significant attention [1,5]. Several bulk and fine chemicals generated from oil refining are expected to be progressively replaced by bio-based products, including ethanol, lactic acid, succinic acid, 1,4-butanediol, sorbitol, isoprene, among others [6].

Biosurfactants are expected to reach more than USD 2 billion by 2020 [7], with industrial applications in the production of food, cosmetics, and pharmaceutics, as well as in removal of contamination by heavy metals, oils and other toxic organics [8]. The considerable interest in these bio-based products is related to their unique physical and chemical properties, biodegradability, mild production conditions and antimicrobial activity [9].

Mannosylerythritol lipids (MEL) are glycolipid biosurfactants produced by *Pseudozyma* spp., *Ustilago* spp. and related yeasts and filamentous fungi [8,10]. Soybean oil is the preferred substrate for MEL production with high yields and titers [8,9]. However, the industrial production of biosurfactants from vegetable oils may have sustainability constrains, due to the negative

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