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Short Communication

Microbial oil produced from biodiesel by-products could enhance overall production

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HIGHLIGHTS

▶ Microbial lipids were produced from biodiesel derived glycerol and rapeseed meal.
▶ Rapeseed meal biomedium is better than yeast extract for lipid accumulation.
▶ Fatty acid profiles of the lipids are excellent for biodiesel production.

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ABSTRACT

Glycerol and rapeseed meal, two major by-products of biodiesel production, have been tested for possible use as low-cost raw materials for the production of microbial bio-oil using the oleaginous yeast *Rhodosporidium toruloides*. Using fed-batch fermentation with crude glycerol and a novel nitrogen rich nutrient source derived from rapeseed meal as feed, it was shown that 13 g/L lipids could be produced, compared with 9.4 g/L when crude glycerol was used with yeast extract. When 100 g/L pure glycerol was used, the final lipid concentration was 19.7 g/L with the novel biomedium compared to 16.2 g/L for yeast extract. The novel biomedium also resulted in higher lipid yields (0.19 g lipid/g glycerol consumed compared to 0.12 g/L) suggesting it provides a better carbon to nitrogen balance for accumulating lipids. FAMEs produced from the microbial lipids indicated a high degree of unsaturation confirming that the fatty acids produced from the novel biomedium have potential for biodiesel production.

1. Introduction

Global production and use of biodiesel has increased dramatically in recent years and the fuel represents a promising alternative for use in compression-ignition (diesel) engines. It is generally produced by transesterification of vegetable oils such rapeseed oil. In the case of rapeseed, following extraction of the oil, a protein rich solid by-product, rapeseed meal, is generated, which is usually sold as organic fertilizer or animal feed. Global rapeseed production was 47 million tons in 2010 (FAO, 2010), resulting in the production of more than 25 million tons of rapeseed meal. However, the utilization of rapeseed meal as an animal feed is limited because it contains some anti-nutritional constituents such as phytic acid, erucic acid and fibre and precursors of toxic compounds such as glucosinolates and phenol (Koutinas et al., 2007). As a consequence, the continued expansion of the biodiesel industry is likely to result in the production of greater quantities of rapeseed meal than the current demand can justify. Alternative uses for this by-product would therefore be desirable.

Another by-product of the biodiesel industry is crude glycerol, a mixture of the glycerol produced during the transesterification process along with residual methanol and salts of the reaction catalyst (sodium or potassium hydroxide). This can be purified but refining crude glycerol to high purities is expensive and energy-intensive and, again, the market is limited. The utilization of crude glycerol directly, without refining, could help to make biodiesel production more profitable and sustainable. There are many reports of the biological conversion of crude glycerol to value-added products such as animal feeds (Nitayavardhana and Khanal, 2011), 1,3-propanediol (Chatzifragkou et al., 2011), succinic acid (Vlysidis et al., 2011), single cell oil (Papanikolaou and Aggelis, 2009; Saenge et al., 2011) and citric acid (Papanikolaou and Aggelis, 2009; Rymowicz et al., 2010). However, these studies have generally relied on the use of yeast extract or peptone as the nitrogen source to accompany the glycerol carbon source. Such materials are too expensive for use in a large biorefinery. In a sustainable, integrated biorefinery, it would make sense to utilise the available nitrogen source (rapeseed meal) alongside the crude glycerol for such

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