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Oil production by *Mortierella isabellina* from whey treated with lactase

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HIGHLIGHTS

- De-proteinized whey can be utilized as a feed stock for production of microbial oil.
- DP-whey treated with lactase resulted in the highest microbial oil concentration.
- A higher biomass and oil were obtained with higher initial lactose concentrations.
- The best kinetic parameters were determined in DP-whey treated with lactase.
- The maximum γ-linolenic acid content of 5.48% was obtained at the highest lactose concentration in DP-whey without enzyme addition.

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ABSTRACT

Whey, a by-product of cheese manufacturing is rich in nutrients such as lactose, proteins, and mineral salts. The fungus *Mortierella isabellina* was used for production of oil containing γ-linoleic acid (GLA) during fermentation on deproteinized whey permeate (DP-WP) with and without lactase addition. The maximum oil concentration was 3.65 g/L in DP-whey (16.0% lactose) without enzyme treatment. Treatment of DP-WP with lactase resulted in an increase in oil content to 17.13 g/L. Palmitic (22.50–25.80%) and oleic acids (37.60–48.56%) were the major fatty acids along with GLA (2.18–5.48%), linoleic (16.21–22.43%) and stearic acid (3.20–10.08%). This study suggests that whey can be utilized as a feedstock for production of microbial oil.

1. Introduction

Microbial oil (single cell oil, SCO) is commercially produced as a source of specific lipids for dietary supplements (Fidler et al., 1999; Lewis et al., 2000; Kimura et al., 2004; Papanikolaou et al., 2004; Huang et al., 2009). Several microorganisms accumulate intracellular lipids at more than 50% of the dry cell weight (Ratledge, 1993; Kavadia et al., 2001; Kimura et al., 2004; Papanikolaou et al., 2007). Among these oleaginous microorganisms, certain fungi accumulate intracellular lipids, especially triacylglycerol (TG), depending on the culture conditions.

Oleaginous fungi from the genus *Mortierella* have been used for production of lipids rich in polyunsaturated fatty acids (PUFAs). The major PUFAs produced by fungi are γ-linolenic acid (GLA- C18:3 ω-6), dihomo-γ-linolenic acid (DHGLA- C20:3 ω-6), arachidonic acid (ARA- C20:4 ω-6), and docosahexaenoic acid (DHA- C22:3 ω-3). These PUFAs have medical and dietetic applications (Wibert et al., 1997; Kavadia et al., 2001; Huang et al., 2002; Kimura et al., 2004; Papanikolaou et al., 2004). Long chain polyunsaturated fatty acids (LCPUFA), also called vitamin F, are important nutrients (Boswell et al., 1996; Zhang and Ratledge, 2008). Although GLA production by filamentous *Mortierella* sp. has been reported (Hiruta et al. 1996a), evening primrose oil is currently the major commercial source of GLA (Ratledge 1993; Kavadia et al., 2001). In Japan, *Mortierella isabellina* is used as the SCO producer and GLA-containing SCO is used as food additives in beverages and candies and in the form of tablets as a functional food supplement.

Whey is a by-product of the cheese industry, which represents about 85–95% of the milk volume and contains nutrients, such as lactose, soluble proteins, lipids, minerals, vitamins, and organic acids. The disposal of cheese whey is a continuing and growing issue in the dairy industry. Cheese production, in particular, can cause significant environmental problems if it is not utilized or treated before disposal (Cristiani-Urbina et al., 2000; Athanasiadis et al., 2002; Paraskevopoulou et al., 2003). Due to the high carbohydrate content of whey, it has been utilized for production of value added products, especially by fermentation (Economou et al., 2011a; Vamvakaki et al., 2010).

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