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Use of organic waste from the brewery industry for high-density cultivation of the docosahexaenoic acid-rich microalga, *Aurantiochytrium* sp. KRS101

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HIGHLIGHTS

- ▶ Spent yeast was used to cultivate DHA-rich microalga, *Aurantiochytrium* sp. KRS101.
- ▶ A significant biomass was obtained using only spent yeast as a sole substrate.
- ▶ To make complete use of nutrients, KRS101 was cultivated in a stepwise manner.
- ▶ Use of spent yeast can substantially reduce the production cost of microalga DHA.

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ABSTRACT

In the present study, spent yeast from a brewery was used as the growth substrate for the docosahexaenoic acid (DHA)-rich microalga, *Aurantiochytrium* sp. KRS101. A significant biomass yield (6.69 g/l/d) was obtained using only spent yeast as the growth substrate, with simple stirring as pretreatment. Maximization of nutrient utilization through the use of stepwise cultivation increased the yield to 31.8 g/l of biomass. DHA constituted 38.2% (w/w) of the total fatty acids, and the highest DHA productivity was observed when the C/N ratio was 20:1 (w/w). Spent yeast thus served as a good growth substrate for the production of DHA. Economic assessment revealed that stepwise cultivation using spent yeast as either the sole growth substrate or as a nutrient source could substantially reduce the production cost of microalgal DHA.

1. Introduction

Polyunsaturated fatty acids (PUFAs), particularly eicosapentaenoic acid (EPA; 20:5, *n*-3) and docosahexaenoic acid (DHA, 22:6, *n*-3), which are collectively termed omega-3 fatty acids, are essential human nutrients (Brennan and Owende, 2010; Ganuza et al., 2008; Wu et al., 2005). DHA is one of the most abundant fatty acids in the central nervous system of mammals, the membrane lipids of the brain, and the visual elements of the retina (Innis, 2008). At present, PUFAs are principally sourced from marine fish; they may be admixed with toxins, and tend to be sub-optimal in terms of odor, taste, and oxidative stability. Thus, PUFA-producing (more generally called "oleaginous") microbes have attracted attention. The production of PUFAs by such microorganisms (e.g., microalgae) has many benefits, including rapid microbial growth under laboratory conditions, higher PUFA yields, and increased stability of the fatty acids (Kim et al., 2012). In addition, these PUFAs are less toxic than typical fish oil (Hong et al., 2011; Sijtsma and de Swaaf, 2004). As heterotrophic cultivation yields more biomass and lipids than photoautotrophic cultivation (Miao and Wu, 2006), heterotrophic strains of the genus *Thraustochytrium* or *Crypthecodinium* have been intensively studied in terms of DHA production (Chi et al., 2009; de Swaaf et al., 2003a,b; Ganuza et al., 2008; Hong et al., 2011, 2012; Mendes et al., 2009; Nakahara et al., 1996; Ratledge et al., 2001; Singh et al., 1996; Song et al., 2007; Zhou et al., 2007). Although rapid growth to high cell densities is possible, this mode of cultivation has the major disadvantage of requiring organic substrates, such as glucose, organic acids, yeast extracts, and/or corn steep liquor. When glucose is used as a carbon source, it accounts for over 60% of the total cost of lipid production (Fei et al., 2011; Li et al., 2007).

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