

Polyunsaturated fatty acid production with *Mortierella alpina* by solid substrate fermentation

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(Received April 16, 1999; Accepted May 28, 1999)

Abstract. Polyunsaturated fatty acids (PUFA) were produced with *Mortierella alpina* by solid substrate fermentation. Rice bran was the most effective substrate for PUFA production, followed by peanut meal residue, wheat bran, and sweet potato residue. The optimal conditions for PUFA production were rice bran supplemented with 2.3 to 5% nitrogen at an initial moisture content of 65 to 68% and a pH range of 6 to 7. Each gram of substrate carbon yielded 122.2 mg of total PUFA, including 12.8 mg of eicosapentaenoic acid (EPA), 47.8 mg of linoleic acid (LA), 7.1 mg of α -linolenic acid (ALA), and 54.5 mg of arachidonic acid (ARA) for 8 to 12 days incubation. C/N ratios between 14.5 and 18.5 favored EPA and LA production, while C/N ratios between 19.8 and 21 enhanced ARA and total PUFA production. Total PUFA, EPA and ARA production increased 12, 84.4 and 46.1%, respectively, when the culture temperature was shifted from 20°C to 12°C on the fifth day. Supplement of soybean and linseed oils increased LA by 84.9 and 36%, ARA by 71 and 42.1%, and EPA by 130.6 and 92.1%, respectively.

Keywords: *Mortierella alpina*; Polyunsaturated fatty acid; Rice bran; Solid substrate fermentation.

Introduction

The *w*-3 and *w*-6 series of polyunsaturated fatty acids have shown tremendous potential for use in food additives and pharmaceuticals for heart and circulatory disorders and cancer as well as inflammatory diseases (Dyerberg, 1986; Reddy and Maruyama, 1986). The submerged culture of *Mortierella* is usually used for PUFA production with glucose or glycerol as a carbon source (Bajpai et al., 1991; Li and Ward, 1994). However, submerged culture needs a higher energy input and produces more wastewater (Canpel and Moo-Young, 1980; Yang, 1988). In addition, culture media and culture conditions affect the quality and the quantity of PUFA production (Granger et al., 1992; Li and Ward, 1994).

Agricultural wastes—such as rice bran, wheat bran, peanut meal residue, and sweet potato residue—are abundant in Taiwan. Both rice bran and wheat bran are good substrates for enzyme and oil production (Deschamps et al., 1985; Yang and Chiu, 1986; Yang and Wang, 1999). Being economically competitive, rice bran was used as the basal substrate in this report to produce PUFA with *Mortierella alpina* by solid substrate fermentation, and the optimal conditions for PUFA production were also investigated.

Materials and Methods

Microorganism

Mortierella alpina ATCC 32222 was purchased from American Type Culture Collection and used for the production of polyunsaturated fatty acids.

Solid Substrate

Rice bran, wheat bran, peanut meal residue, and sweet potato residue were purchased in a local market. The chemical composition of the test solid substrate is listed in Table 1.

Culture Media and Conditions

Mortierella was grown at 20°C in a membrane culture containing (mg l⁻¹): glucose, 10; yeast extract, 5 and agar, 20 at pH 6.5. Mycelia were harvested from membrane culture and blended with a micro-Waring blender for mycelial suspension.

Submerged and Solid State Fermentation

Submerged basal medium contained (mg l⁻¹) soluble starch, 20; Bacto yeast extract, 5; KNO₃, 10; KH₂PO₄, 1 and MgSO₄·7H₂O, 0.5 at pH 6.5. The broth was inoculated with 5% (v/v) mycelial suspension and shaken at 200 rev min⁻¹ and at 20°C for 2 to 10 days. Each ml of mycelial suspension contained 1.0-1.5 × 10⁶ mycelial fragments.

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