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Editorial Open Access

Relationship between Interfacial Hydrophobicity and Hydroxylation Activity of Fungal Cells Located on an Organic–Aqueous Interface

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Editorial

A Liquid–liquid interface bioreactor (L–L IBR), which consists of a hydrophobic organic solvent (an upper phase), a layer of fungal cell-ballooned polyacrylonitrile microsphere (diameter, 20-40 μm; density, 0.03-0.20; a middle phase), and a liquid medium (a lower phase), is a unique and effective cultivation system for the microbial transformation with fungi [1]. The system has some interesting and practically important characteristics, i.e., alleviation of toxicity of poisonous substrate and/or product solubilized in the organic phase, excellent productivity of valuable hydrophobic chemicals, efficient supply of oxygen from the organic phase to fungal cells, control and management of pH and nutrients in the liquid medium, depression of catabolize repression caused by easily metabolizable carbon sources [2], and easy recovery of product without troublesome solvent extraction. The system has been applied to various microbial reactions, such as hydrolysis of an acetate ester [1,3], asymmetric reduction of an aromatic dike tone [4], and regio- and stereo selective epoxidation of -caryophyllene to (–)-β-caryophyllene oxide so far [5]. In all cases, it has been observed that substrate concentration, product accumulation, and region- and stereo selectivity's of reaction reached very high level compared with two traditional cultivation systems, submerged and organic–aqueous two-liquid-phase systems.

On the other hand, the authors have also succeeded in the highly region and stereo selective sub terminal hydroxylation of n-decane to (–)-4-decanol by a newly isolated fungus, Monilliera sp. NAP 00702 [6], although it has been recognized that the selective sub terminal hydroxylation of n-alkanes is very difficult in both chemical and enzymatic procedures for a long time. In this case, n-decane plays as roles of both a substrate and a reaction solvent. The region and enantio selectivity's of the reaction reached 99% and almost 100%, respectively [6], and the accumulation of (–)-4-decanol reached 12.5 g/L in an n-decane layer by using its UV-mutant in the optimum cultivation condition (not reported). Interestingly, excess reactions of the oxidation of 4-decanol to 4-decanone and the Baeyer-Villiger oxidation of produced 4-decanone were effectively repressed in the L-L IBR because the organic phase (n-decane) played as a reservoir of the products [6].

Recently, more interesting trials for the enhancement of (–)-4-decanol accumulation by the modification of electrostatic and hydrophobic properties of the organic–aqueous interface have been reported. The former trial, although the addition of cation-exchange and chelating resin micro particles into the polyacrynolitrile ballooned microsphere layer located on the organic–aqueous interface led to the strong inhibition of both fungal growth and hydroxylation activity, the mixing of anion-exchange resin micro particles having moderate total capacity (≤1.00 meq/g) significantly increased hyphal growth and hydroxylation activity [7]. The promoting effect of anion-exchange resin micro particles was also observed for the fermentative production of a fungicidal secondary metabolite, 6-pentyl-α-pyrone, by an NTG-mutant prepared from an isolated fungus, Trichoderma atroviride AG 2755-5NM398 [8].

On the other hand, it has been observed that the hydrophobic property of the fungus–microsphere mat also enhances hydroxylation activity of n-decane with Monilliera sp. NAP 00702 [9]. In this case, the higher the hydrophobicity of hydrophobic resin micro particles mixed in the microsphere layer, the larger the 4-decanol was produced with 0.747 of the coefficient of determination (R2). The accumulation of (–)-4-decanol produced was significantly enhanced to 132% by addition of hydrophobic polytetrafluoroethylene (PTFE; contact angle, 117°). Thus, it is concluded that the modification of physicochemical properties of a fungus–MS mat enables the enhancement of potential of fungal cells located on an organic–aqueous interface.

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