Oxygen mass transfer into a biphasic medium used for aroma production in an airlift bioreactor

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Abstract

Gamma-decalactone is a peach-like aroma compound which can be biotechnologically produced through the biotransformation of ricinoleic acid. In this work, biotransformation was carried out by the aerobic yeast _Yarrowia lipolytica_, in an oil-in-water emulsion, with methyl ricinoleate (MR), a source of ricinoleic acid, as organic phase. The emulsion was stabilized by the non-ionic surfactant, Tween 80.

Previous studies have demonstrated the importance of oxygen in the overall process. Thus, an airlift bioreactor was used due to its well-known advantages concerning mass transfer, and energy saving due to non-mechanical agitation.

Before performing the biotransformation experiments, an exhaustive study of the oxygen mass transfer to the emulsion was executed, under different oil and surfactant concentrations and using different gas-flow rates.

The gas-liquid interfacial area (a) was determined by a photographic method and by the application of Eq. 1, which takes into account the number of bubbles (NB) and the ratio between the bubble surfaces (SB) and the total volume in the reactor (VT).

$a = NB(SB/VT)$ (Eq. 1)

The volumetric mass transfer coefficient (kLa) was obtained by Eq. 2, using oxygen concentration data along time and taking into account C* and C as the solubility and dissolved oxygen concentrations, respectively.

$dC/dt = kLa(C^*-C)$ (Eq. 2)

The liquid side mass transfer coefficient (kL) was calculated as the quotient between kLa and a.

Results demonstrate that the increase of the organic phase has a positive effect on kL but decreases the interfacial area, resulting in a negative effect on the global absorption process. The presence of surfactant in the emulsion increases the specific interfacial area but decreases kL. In all situations, the augment of gas-flow rate improves kLa.

Biotransformations were carried out using the optimal medium composition previously determined: 3% (v/v) MR and 0.3% (v/v) Tween 80, and aeration rates of 1, 5, 7.5 and 10 L/min. The highest gamma-decalactone concentration (971 mg/L) was achieved under an aeration of 1 L/min. Although higher aeration rates have a positive effect upon the oxygen mass transfer, the increase of this variable is not beneficial for the aroma production.