Supercritical CO_2 fractionation applied to an aqueous suspension of *Chlorella vulgaris* microalgae

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Abstract

Until now, the supercritical CO_2 extraction of neutral lipids or high added value compounds from microalgae has been carried out in the majority of cases from dry biomass by using semi-continuous or batch processes. However, the cost of the energy intensive drying operation required to reach suitable water contents (less than 23wt% [1]) may be prohibitive for an industrial application. The use of the supercritical CO_2 fractionation process may be an interesting alternative to avoid such drying step. Indeed, supercritical CO_2 fractionation is a continuous unit operation used for separating compounds from a liquid feed, and based on their different solubilities in supercritical CO_2, and for which the liquid feed and the supercritical solvent are not miscible. The contact between the liquid charge and the solvent generally occurs in a countercurrent packed column. Supercritical CO_2 fractionation applied to wet microalgae (microalgal suspensions) cumulates the advantages of avoiding the drying, of allowing a continuous separation, and finally of offering an environmentally friendly separation performed under smooth temperature and pressure.

In this study, the supercritical CO_2 fractionation of an aqueous suspension of *Chlorella vulgaris* microalgae [2] has been investigated. The main objective of the present work was to obtain extracts rich in neutral lipids which can be tri-, di- or monoglycerides as well as free fatty acids, resulting from the supercritical fractionation of wet microalgae. In that aim, a series of CO_2 fractionation experiments were conducted to determine the influence of pressure, temperature and solvent-over-feed mass ratio on the neutral lipid recovery. For all experiments, the CO_2 mass flow rate was set at 12 $kg \cdot h^{-1}$ and the major part of CO_2 was recycled. Pressure was varied from 10 to 30 MPa and temperature ranged from 35 to 60 °C. The CO_2-over-feed mass ratio was varied from 8.2 up to 132 by decreasing the feed flow rate from 1.463 down to 0.091 $kg \cdot h^{-1}$. The extract and raffinate flow rates were determined by weighting and their compositions, in terms of lipidic classes and profiles, were obtained by gas chromatography.

Keywords: fractionation, supercritical CO_2, suspension, *Chlorella Vulgaris*, neutral lipids.

[1] A. Mouahid, C. Crampon, A. Toudji, E. Badens, Effects of high water content and drying pre-treatment on supercritical CO_2 extraction from Dunaliella salina microalgae: experiments and modelling, The Journal of Supercritical Fluids, 116, 271-280, 2016.

[2] European Patent (EP16305982), Continuous process for fractionating a suspension, 2016.