

Photosynthetic Cell Factories

René H. Wijffels, Wageningen University, Food and Bioprocess Engineering Group. P.O. Box 8129, 6700 EV Wageningen, The Netherlands. Rene.Wijffels@wur.nl; www.marine.wur.nl

A major bottleneck for the application of microalgae is the low productivity obtained with the processes used presently. The fundamental reason for this is that in those processes algae are grown and after that (usually after application of stress) cells are harvested and products are purified. The growth of cells is a slow process, mainly because much energy (usually from solar illumination) is needed for the fixation of CO₂ in biomass (photosynthesis). By 'milking' products from biomass, grown biomass is reused and has not to be grown again.

In the past few years we worked on extractive fermentation of carotenoids from microalgae: 'milking of algae' (Hejazi *et al.* 2002a,b, 2003a,b, 2004a,b,c). Carotenoids like β -carotene and astaxanthin are grown in the presence of organic solvents. Compounds extracted from the algae are produced again by the microalgae and as such the lipophilic compounds are 'milked' from the microalgae. Presently we are studying the principle of milking of products from microalgae with the goal to enhance the rate of extraction further and to apply this principle for other products such as poly unsaturated fatty acids.

Hejazi M.A., de Lamarliere C., Rocha J.M.S., Vermuë M., Tramper J., Wijffels R.H. (2002a) Selective extraction of carotenoids from the microalga *Dunaliella salina* with retention of viability. *Biotechnol. Bioeng.* 79: 29–36

Hejazi M.A., Holwerda E., Tramper J., Wijffels R.H. (2002b) Process for continuous production and extraction of carotenoids from natural sources. EP 02076803.2

Hejazi M.A., Andrysiewicz E., Tramper J., Wijffels R.H. (2003a) Effect of mixing rate on β -carotene production and extraction by *Dunaliella salina* in two-phase bioreactors. *Biotechnol. Bioeng.* 84: 591-596

Hejazi M.A., Wijffels R.H. (2003b) Effect of light intensity on β -carotene production and extraction by *Dunaliella salina* in two-phase bioreactors. *Biomol. Eng.* 20: 171-175

Hejazi M.A., Holwerda E., Wijffels R.H. (2004a) Milking microalga *Dunaliella salina* for β -carotene production in two-phase bioreactors. *Biotechnol. Bioeng.* 85: 475-481

Hejazi M.A., Wijffels R.H. (2004b) Milking of microalgae. *Trends Biotechnol.* 24: 189-194

Hejazi M.A., Kleinegris D., Wijffels R.H. (2004c) Mechanism of extraction of β -carotene from microalga *Dunaliella salina* in two-phase bioreactors. *Biotechnol. Bioeng.* 88: 593-600