Quantification of phytoplankton cell properties from mixed cultures and natural samples by FT-IR spectroscopy using flow cytometry

Zhixin Liu, Heiko Wagner, Christian Wilhelm

University of Leipzig, Faculty of Biosciences, Pharmacy and Psychology, Institute of Biology, Department of Plant Physiology, Johannisallee 21-23 04103 Leipzig, Germany

Fourier Transform Infrared (FTIR) spectroscopy provides quantitative information of cellular composition of the biomass produced by photosynthesis. The chemical nature of these photosynthetic products can be identified on the basis of their characteristic molecular vibration bands of macromolecular pools (e. g. proteins, lipids, and carbohydrates). Therefore, FTIR spectroscopy analysis can be applied to quantify the distribution of fixed carbon in the phytoplankton cells (cellular molecule composition), but also the elemental ratios, e.g. the C:N ratio, which is an indicator for the growth potential of the different phytoplankton taxa. All these cell properties were calculated using regression models, which have been validated by standard substances or chemical reference data.

The aim of this study was the use of these FTIR-techniques for monitoring changes of cellular properties of poly-algal lab culture and natural phytoplankton communities under modified light and/or nutrient conditions and in natural ecological environments, respectively. In the study, we used flow cytometry (FACS) to sort different algal species from a mixed algal lab culture and from fresh water samples taken from a eutrophic lake (Lake Auensee, Leipzig, Germany). We show that FTIR spectroscopy can be used to quantify the photosynthesis end products per cell as carbohydrate:protein:lipid ratio and the cellular C:N ratio of a selected taxonomic phytoplankton group within a mixed phytoplankton population. This opens the possibility of monitoring cells with respect to their biochemical features within a wide range of research applications.