Monitoring of baker's yeast fermentations

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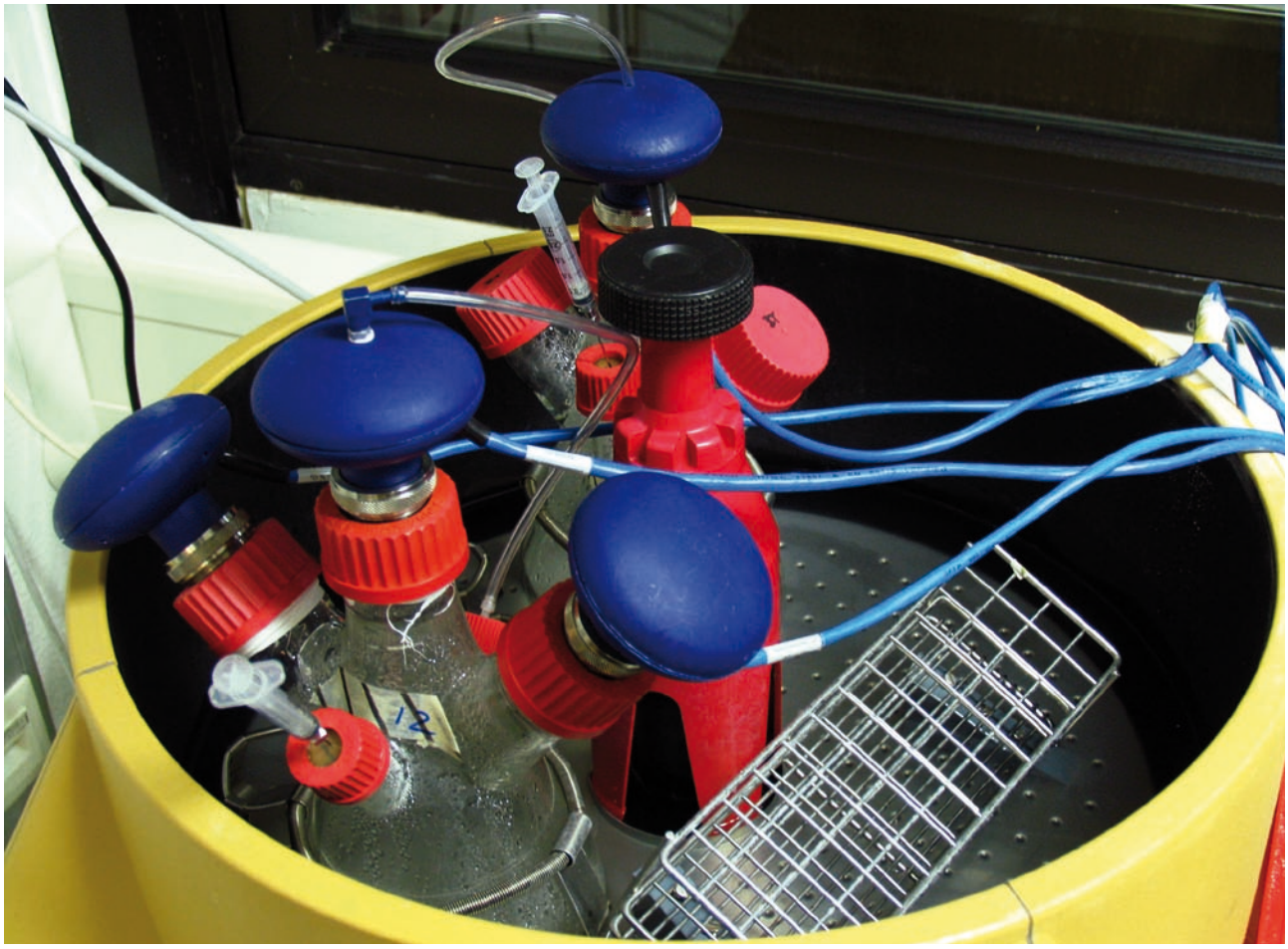
The open question we addressed with the new setup from BlueSens (CO_2 and ethanol sensor) originated from our previous finding (Blank and Sauer, 2004) that under aerobe and glucose excess conditions ethanol production and the rate of TCA cycle operation were dependent on the glucose uptake rate. As ethanol generally cannot be quantified in shake flasks, the finding relied only on indirect observations from 13C-tracer metabolic flux analyses. Here we aimed to directly quantify the TCA cycle flux by closing the carbon balance using the BluesSens sensors for quantification of the volatile fermentation products ethanol and CO_2.

As can be seen in figure 1, the new setup delivered fermentation data of very high quality (lines represent a simultaneous fit of the experimental data using an exponential growth model). As contribution to the scientific discussion, a strong negative correlation between glucose uptake rate and the rate of TCA cycle operation could be communicated (Heyland et al., 2009). The BlueSens setup was invaluable for the here presented quantitative physiology project with baker's yeast. Since then, numerous co-workers used the setup and experienced a tremendous increase in data amount and more importantly in quality.



Shake flasks equipped with CO2, O2 and ethanol sensor in a waterbath shaker

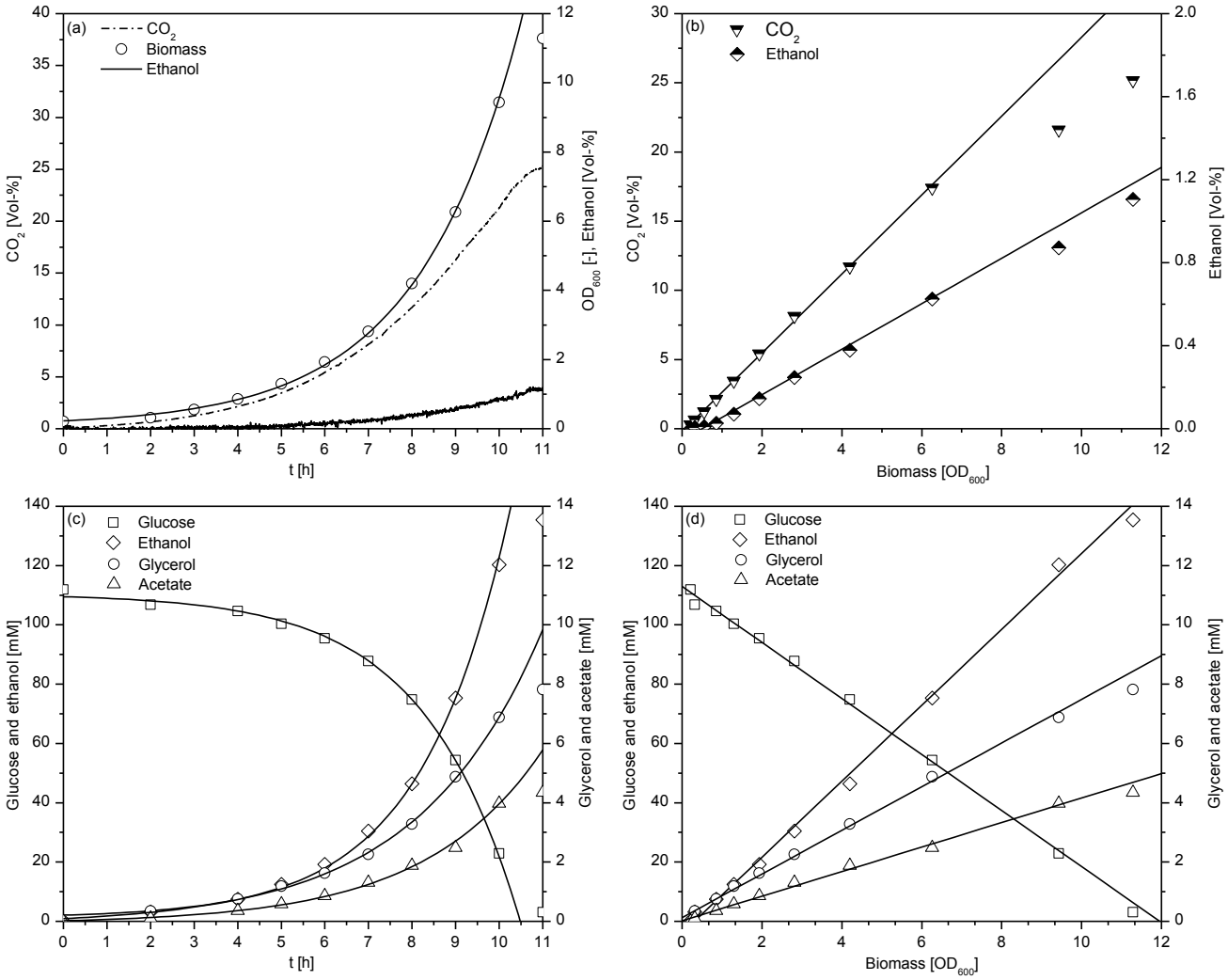


Figure 1. Fermentation course of S. cerevisiae during respiro-fermentative growth. (a) CO_2 and gaseous ethanol concentrations were monitored in the gas phase using infrared sensors. (b) Biomass plotted vs. CO_2 and gaseous ethanol concentrations. (c) Concentrations of glucose, ethanol, glycerol, and acetate were quantified by UV-RI-HPLC. (d) Biomass plotted vs. concentrations of glucose, ethanol, glycerol and acetate. Lines represent a best fit of all experimental data using an exponential growth model or by linear fit implemented in the Sigma Plot statistic module during exponential growth until 10 h. Linear fitting for gaseous CO_2 and Ethanol was only conducted until 9 h.

Literature

Blank, L. M. and U. Sauer, TCA cycle activity in Saccharomyces cerevisiae is a function of the environmentally determined specific growth and glucose uptake rate, Microbiol. 2004 150: 1085-1093

Heyland J., J. Fu, and L. M. Blank, Correlation between TCA cycle flux and glucose uptake rate during respiro-fermentative growth of Saccharomyces cerevisiae, Microbiology, 2009, 155: 3827-3837