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Lipid profiles of yeast cells under different growth conditions

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Introduction and objectives

The most common biofuel in Europe is biodiesel and the global biodiesel market is estimated to reach 37 billion gallons by 2016 with an average annual growth of above 40 % [1].

Traditional 1st generation (1G) biodiesel production (transesterification of triacylglycerols from plant oils) has various drawbacks and limitations [2] such as: 1) season and climate-dependent cultivation of the plant oil feedstock (rapeseed, soybean); 2) the agricultural land competition for food, resulting in reduction of cultivated area for feed and consequently increasing food prices; and 3) international pressure to reduce the use of terrestrial plants in biofuels production.

The objective of this investigation was therefore to study the effect of growth conditions on the lipid profile (long chain fatty acid (LCFA) composition) of a range of yeast strains.

Yeast usually produces palmitic (C16:0), stearic (C18:0), oleic (C18:1) and linoleic (C18:2) acids [3].

Materials and methods

Yeast strain isolates (YSIs) from a biodiesel plant (Emmelev A/S, Denmark) showed promising high contents of lipids in a screening assay [4]. YSIs were pre-grown on YEPG agar and transferred to a liquid medium for cell culture growth. Effect of different factors: pH (4, 6 and 8), C:N-ratio (55:1, 110:1 and 220:1), carbon source type (glycerol (GLY) and glucose (GLU)) and concentration (25, 50, 100 and 200 g/L) on the lipid profile were studied.

Dry biomass was determined (constant weight at 105°C) and lipid contents were determined using a modified version of the Folch method [5].

C16:0, C18:0, C18:1 and C18:2 LCFA composition of the extracted lipids were determined after transesterification (MeOH HCl, 100°C for 1 hour, extraction with hexane) applying GC-MS using C_{17}-methylester as the internal standard.

Fig. 1: Growth conditions vs. lipid production

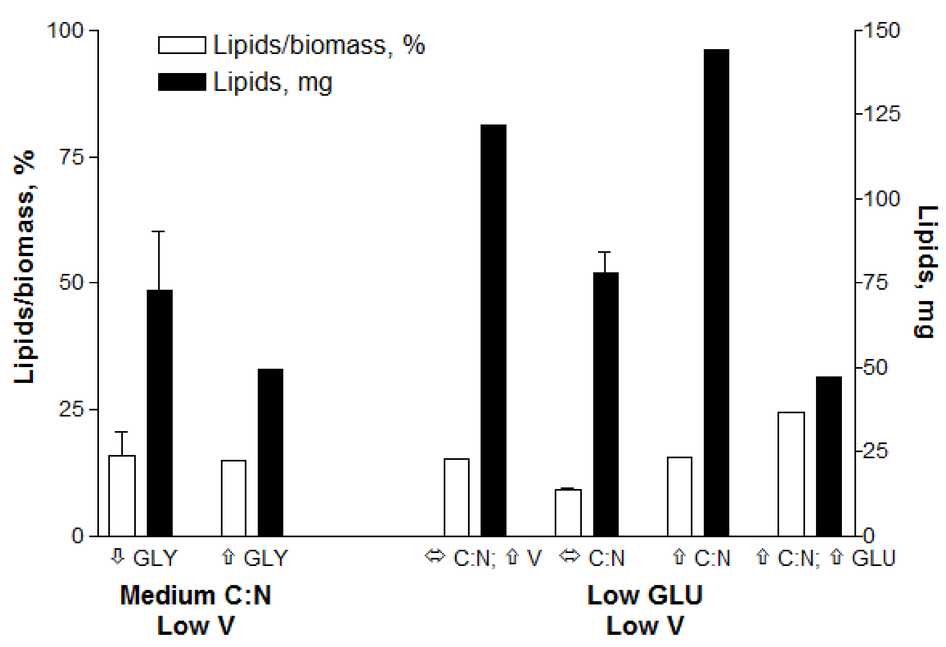
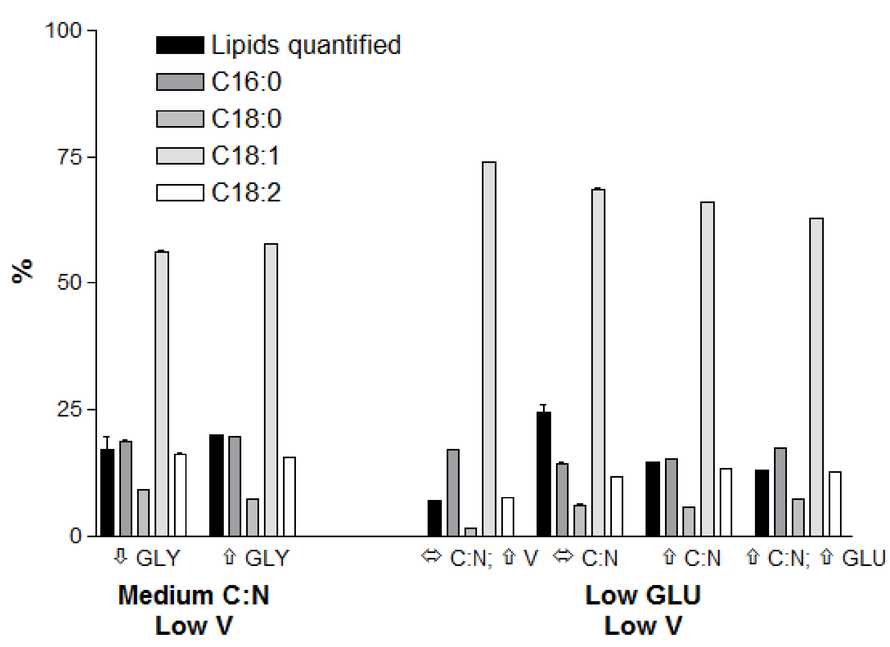


Fig. 2: Growth conditions vs. LCFA composition



Results and discussions

Depending on the growth conditions, Fig. 1 shows that the YSI produces 9-20% lipid based on dry weight. The produced lipid quantity, was not correlated with the biomass production, indicating that different growth conditions influences the lipid production.

GLY concentration did not affect the lipid production. When grown on GLU, increasing the C:N ratio also increased the lipid production. Increasing the GLU concentration as well, also increased the lipid content, but not the actual quantity of lipid produced.

Fig. 2 shows that the GLY concentration does not affect the LCFA composition. Grown on GLU and a low culture volume, a medium C:N ratio gives a larger part of the lipids belonging to the studied LCFAs, whereas increasing the culture volume gives a smaller part of the lipids belonging to the studied LCFAs. Also C16:0 and C18:1 are more predominant and C18:0 and C18:2 are less predominant.

However, generally a minor fraction (7-26%) of the lipids is assigned to the four studied LCFAs.

Conclusions

GLY and GLU as carbon sources seem to be equally good substrates for total lipid production.

On the other hand, increased C:N ratio and GLU concentration affected the lipid production.

The studied YSI seems to be unusual, in the sense that it produces a range of other LCFA than the studied C16:0, C18:0, C18:1 and C18:2, as only 7-26% of the produced lipid were assigned to the four LCFAs.

The culture volume seems to have an effect on the LCFA composition, favouring C16:0 and C18:1.

References

[1] Li et al. (2008); [2] Kalscheuer et al. (2006); [3] Kamel et al. (2004); [4] Poli (2011), unpublished results; [5] Folch et. (1957).

Acknowledgement

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