ABE FERMENTATION FROM MICROALGAE-DERIVED CARBOHYDRATES AFTER LIPID EXTRACTION

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Although lignocellulosic biomass is an abundant substrate, major challenges in their pretreatment and digestion remain a serious limitation for large scale second generation biofuel production. First generation feedstocks which are primarily starchy substrates like corn have much more favourable economics as they are simple to mash. However, concerns related to the use of water and land for the production of biofuel crops have generated a need for alternative biomass sources for renewable biofuel production from a non-food crop. One biomass which satisfies all of these concerns is microalgae. Many strains are capable of growing in waste water, can accumulate carbon intracellularly as starch, are not eaten as food in any significant amount, and also have the added bonus of fixing CO_2 during photosynthetic growth. However, production of microalgae biomass has its own particular challenges such as the high cost of dewatering and drying microalgal biomass.

In order to demonstrate a possible biofuel production strategy using microalgal biomass, *Chlorella vulgaris* was cultivated at the pilot scale (100 L) and harvested using centrifugation. Lipids were extracted for biodiesel production using either a water compatible ionic liquid based process or using traditional (non water compatible) solvent based process. The residual biomass containing proteins and carbohydrates was recovered from both processes and designated either ionic liquid extracted algae (ILEA) or hexane extracted algae (HEA). To convert these micro-algal carbohydrates into solvents (ABE), HEA and ILEA was either acid hydrolysed into glucose before fermentation or directly fermented as it is. The highest butanol titers (8.05 g/L) was obtained with the fermentation of acid hydrolysates of HEA, which however required detoxification to support solvent production while ILEA did not. Interestingly, both ILEA and HEA can be fermented directly without any additional steps and resulted in a butanol titer of 4.99 and 6.63 g/L, respectively, which significantly simplified the LEA to butanol process. Further study has shown that butanol titers close to the toxicity limits are possible with higher substrate loadings, however a a fed-batch approach is required in order to mitigate increased culture viscosity issues during direct fermentations. These results indicate that lipid extracted microalgae are a readily consumed substrate for biofuel production.

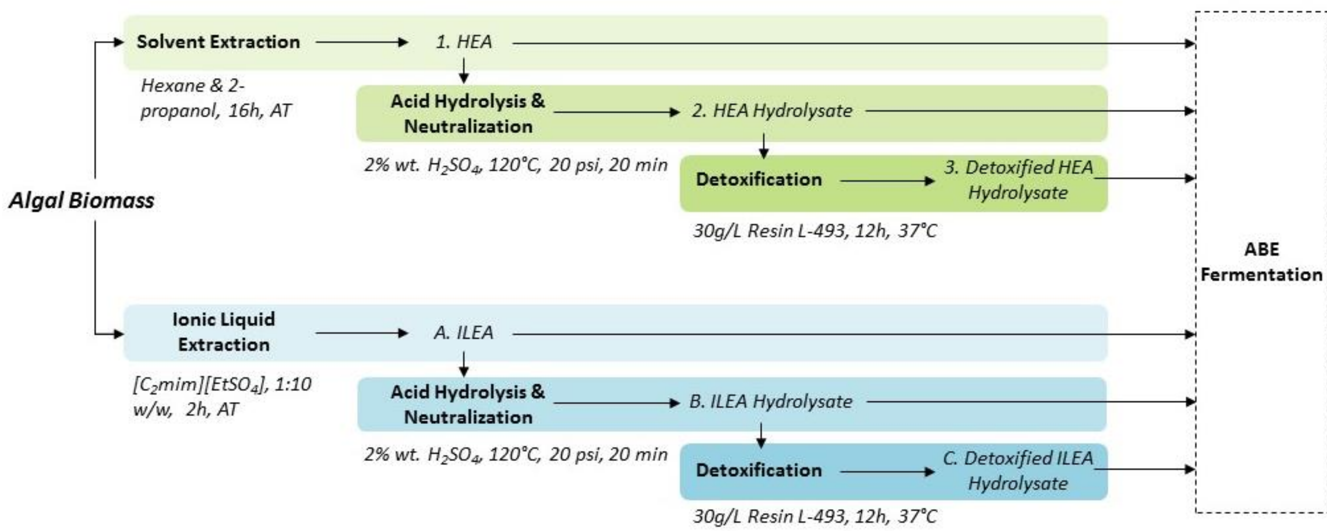

Fig. 1. Schematic diagram of the experimental design used in this study (K Gao, V Orr, L Rehmann 2016. Bioresource Technology 206, 77-85).