Robust polysiloxane-ACA capsules for ethanol production from wood hydrolyzate by yeast

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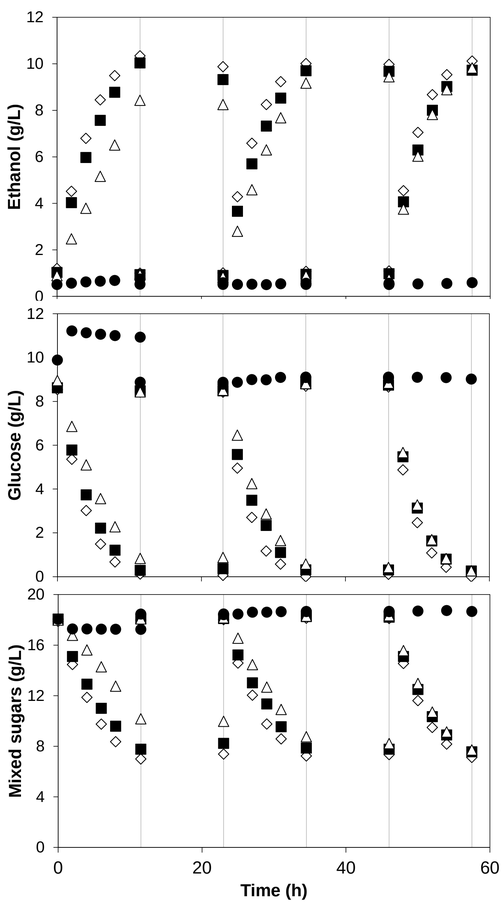
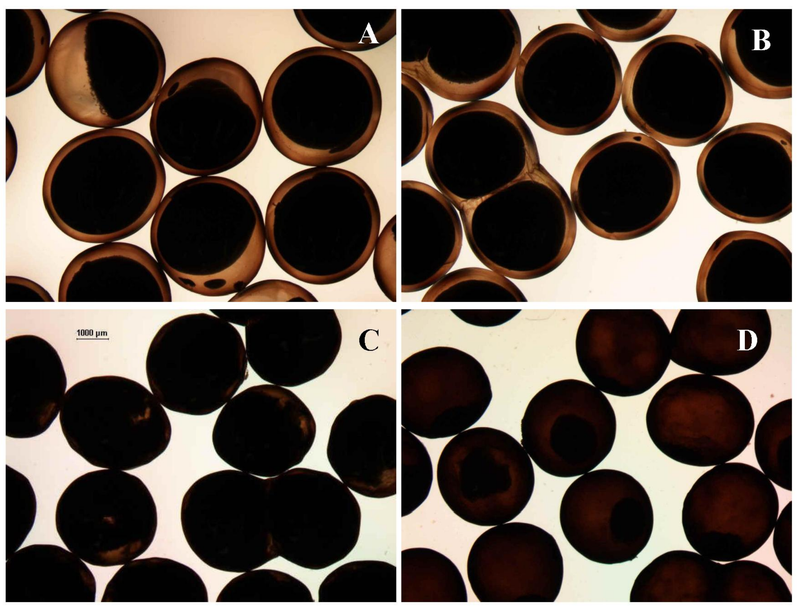
INTRODUCTION

Encapsulating the fermenting yeast can be a potential option to make the cells more inhibitor and stress tolerant when compared with suspended yeast. In the encapsulation process the yeast is enclosed in a capsule having a thin semi-permeable membrane surrounding the cells in the liquid core. However, in order to apply encapsulated yeast for industrial applications the capsules need to be mechanically stable for long periods without breaking during reactor operation. In order to produce more mechanically robust capsules a new encapsulation method was developed. In the study alginate chitosan alginate (ACA) capsules were treated with hydrolyzed 3-aminopropyltrietoxysilane (hAPTES) at different concentration to reinforce ACA capsules with polysiloxane (PS).

RESULTS

Fermentation efficiency

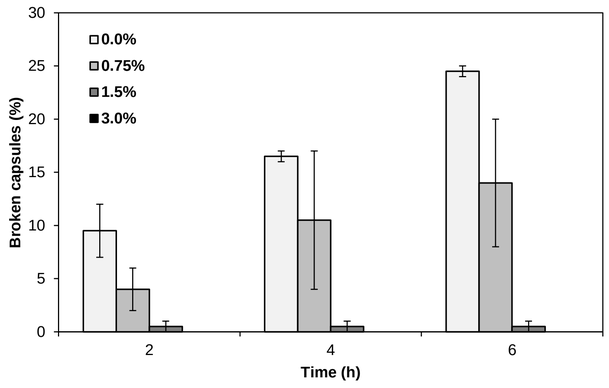




- Microscopic image of untreated ACA capsules 0.0% (A), and PS-ACA capsules prepared with 0.75% (B), 1.5% (C) and 3.0% (D) hAPTES after five consecutive anaerobic cultivations in spruce hydrolyzate medium. The scale bar in (C) is 1000 µm.

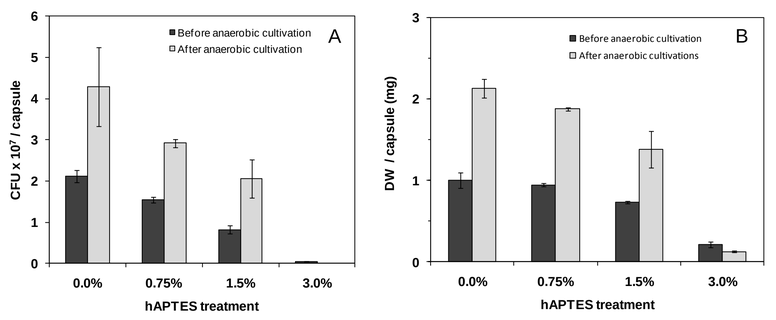
- The fermentation rate for the hAPTES-treated capsules was lower than for the ACA capsules in the first batches
- In the fifth repeated batch, the ethanol production was nearly the same as for untreated ACA capsules

Robustness test



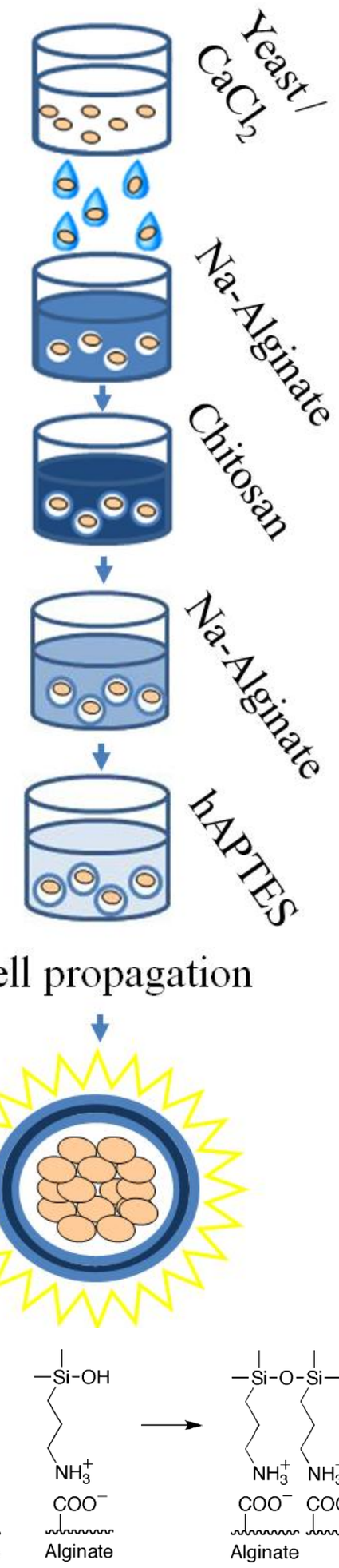
- ACA capsules had poor mechanical robustness, since 25% of the capsules ruptured within 6 h when subjected to intense agitation.
- PS-ACA capsules treated with a 1.5% hAPTES solution were more robust, and only 0-2% of these capsules broke in the shear test.

Viability and dry weight in capsules after 5 batch fermentations



- The cell content in the capsules decreased with increasing hAPTES concentration. This was clear both after the aerobic propagation culture and after the five repeated anaerobic hydrolyzate fermentations.
- In the 3% hATPES treatment, cell viability was very low, likely due to a negative effect of the hAPTES or the low permeability of these capsules.

ENCAPSULATION PROCEDURE



Hypotized chemical structure on capsule membrane (Kurayama et al.)

CONCLUSION

Capsules treated with 1.5% hAPTES were significantly stronger and showed similar ethanol production profile to untreated ACA capsules cultivated in spruce hydrolyzate. The produced PS-ACA capsules were easily prepared and demonstrated high stability, reusability, and good ethanol production which are crucial features in order to make the capsules applicable at large scale.

INDUSTRIAL BIOTECHNOLOGY

References:

Ylitervo, P., Franzén, C. J. and Taherzadeh, M. J. (2012), Mechanically robust polysiloxane–ACA capsules for prolonged ethanol production. J. Chem. Technol. Biotechnol.. doi: 10.1002/jctb.3944

Kurayama, F.; Suzuki, S.; Oyamada, T.; Furusawa, T.; Sato, M.; Suzuki, N., Facile method for preparing organic/inorganic hybrid capsules using amino-functional silane coupling agent in aqueous media. *Journal of Colloid and Interface Science* **2010,** 349, (1), 70-76.