Fabrication and Optimization of Lipase-Immobilized Nanofiber Membrane Bioreactors

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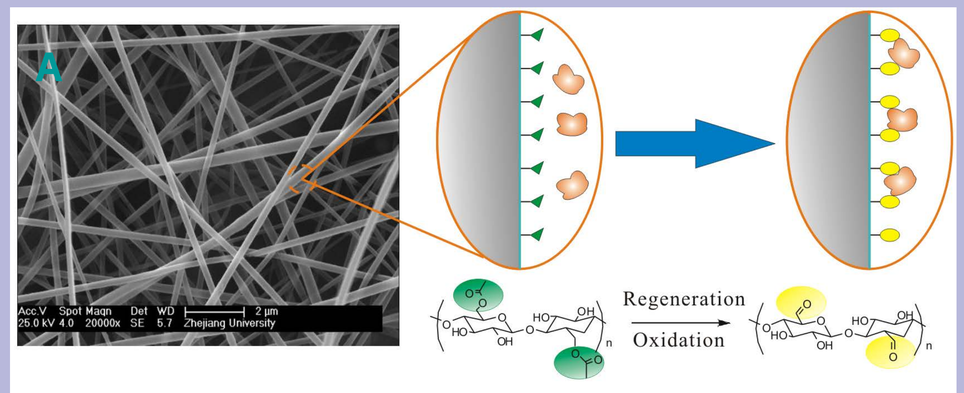
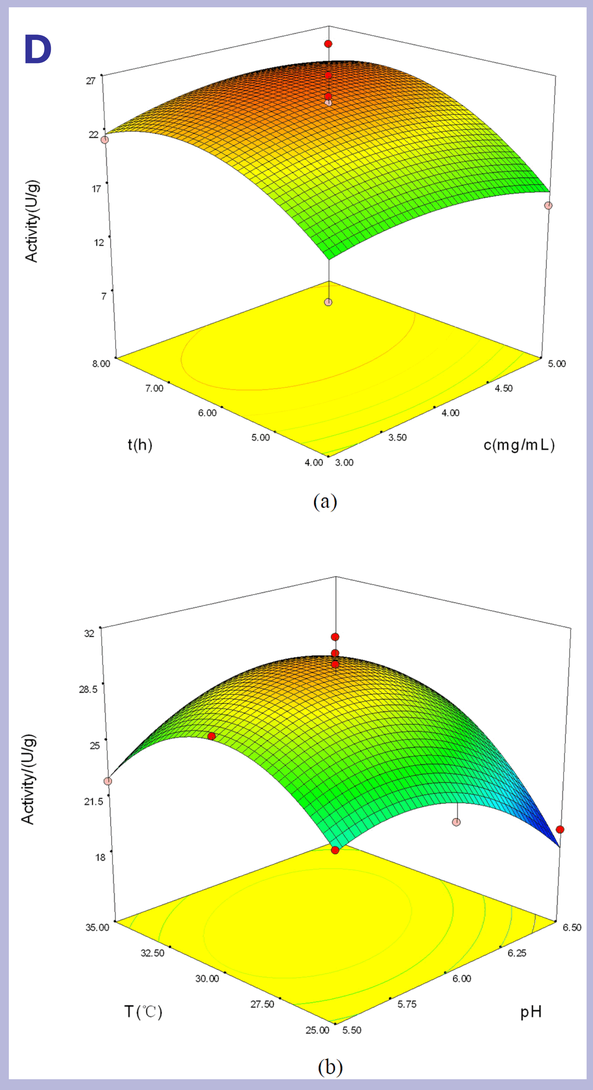
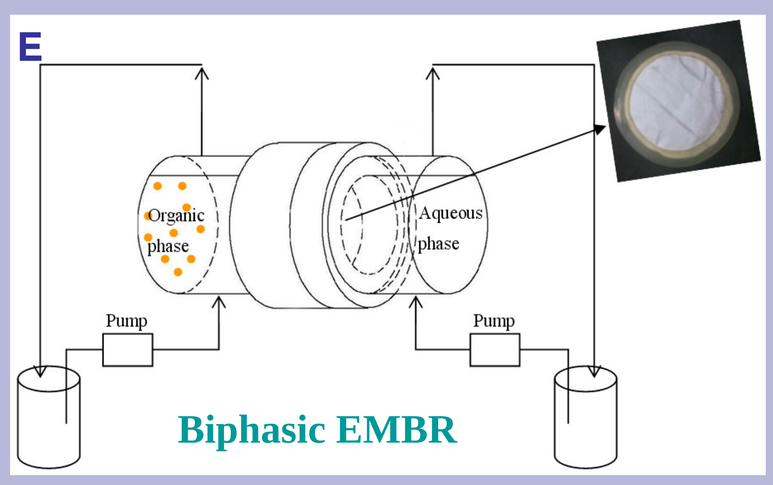
Enzyme-immobilized membrane bioreactors (EMBRs) combine biocatalysis with separation, and thus have generated interest among applied researchers[1,2]. Despite the advantages of EMBRs, some issues associated with the structure and operation parameters still remain to be addressed in order to achieve scale-up of such systems[3]. We reported the fabrication of a biphasic lipase-immobilized nanofiber membrane bioreactor with its structural optimization for higher catalytic performance.

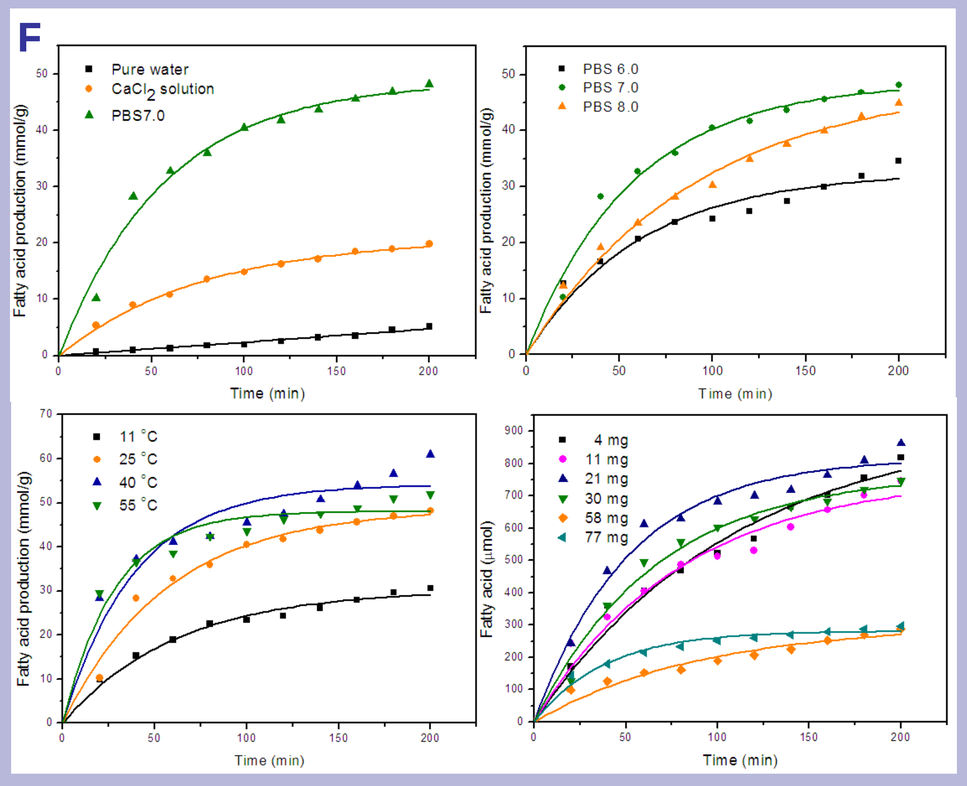


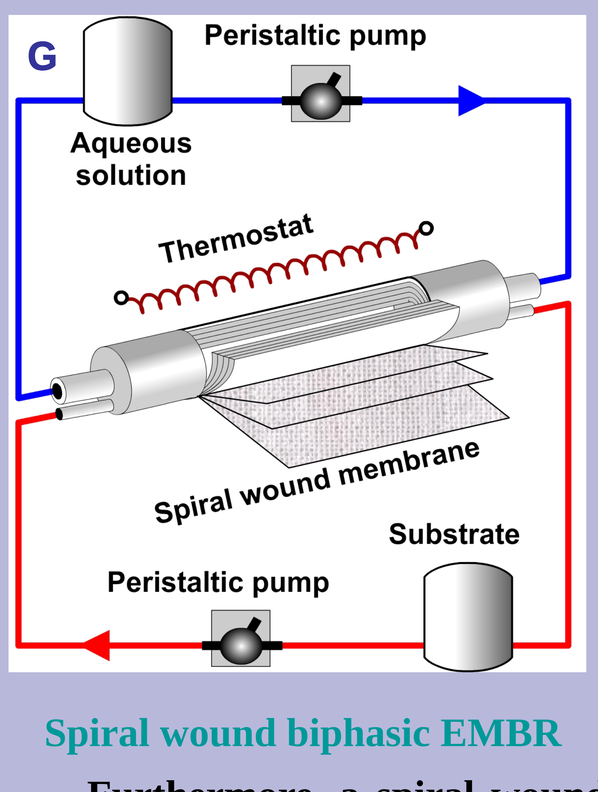
A cellulose nanofiber membrane was prepared by electrospinning (Figure A), and followed by alkaline hydrolysis (Figure B) and oxidation (Figure C) for covalent binding with lipase from *Candida rugosa*. We used response surface methodology to model the immobilization conditions (Figure D). Pentaethylenehexamine was introduced to give more freedom to the immobilized lipase, realizing a 76.26% increment of the activity retention.





A biphasic EMBR was assembled (Figure E). Two immiscible fluids, the organic phase (for dissolving substrates) and the aqueous phase (for extracting products) were separated by the lipase-immobilized membrane that functioned as a reaction interface.





The effect of operating variables on the performance of this biphasic EMBR was investigated with the hydrolysis of olive oil as a reaction model (Figure F). According to this research, when the transfer resistance for the products was not significant, the membrane usage had little impact on the hydrolysis conversion. Thus, it can be inferred that the efficiency of this biphasic EMBR can be improved by increasing the contacting area of the membrane with the substrate.

Conclusion:

- **Response surface methodology was adopted to optimize the modification conditions of the electrospun cellulose nanofiber membrane for lipase immobilization;**
- **A biphasic EMBR was assembled for the hydrolysis of olive oil, and by studying the operational parameters we managed an effective structural optimization to improve the bioreactor efficiency.**

Spiral wound biphasic EMBR

Furthermore, a spiral wound biphasic EMBR was fabricated to increase the amount of membrane actually in use (Figure G), achieving a 100% hydrolysis conversion of olive oil within 9 organic phase circulations.

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References:

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[3] S.G. Wan, X. Jiang, P.C. Chen , A.G. Yu, X.J. Huang, Int. J. Mol. Sci. 13 (2012) 14136–14148。