# A rapid and scalable integrated membrane separation process for purification of polysaccharides from *Enteromorpha prolifera*

Wenyao Shao [a], Huan Zhang[a,b], Ran Duan [a], Quanling Xie[b,c,]*, Zhuan Hong[b,c], Zongyuan Xiao [a,]*

[a] *Department of Chemical and Biochemical Engineering, College of Chemistry and Chemical Engineering, Xiamen University, Xiamen361005,China*

[b] *Engineering Research Center of Marine Biological Resource Comprehensive Utilization, SOA, The Third Institute of Oceanography of the State Oceanic Administration, Xiamen 361005, China*

[c] *Fujian Collaborative Innovation Center for Exploitation and Utilization of Marine Biological Resources, Xiamen, 361005, China*

*Correspondence to: Q. Xie (qlxie@tio.org.cn) and Z. Xiao (xiaozy@xmu.edu.cn).*

Abstract: An integrated membrane separation process combining the tubular ceramic microfiltration (MF) membrane and the flat-sheet ultrafiltration (UF) membrane was developed to purify polysaccharides from *Enteromorpha prolifera*. The effects of membrane pore size, molecular weight cut-off (MWCO), transmembrane pressure (TMP) and adding-water multiples on membrane performance were in-depth studied. The results indicated that the optimal membrane pore size and TMP of the tubular ceramic MF process were found to be 1.2 μm and 0.225 MPa, and the optimal MWCO and TMP of the flat-sheet UF process were found to be 100 kDa and 0.3 MPa. The yields of polysaccharides were increased and optimized while the adding-water multiples was 1 during the diafiltration procedure. Furthermore, the water fluxes could be completely recovered using the specialized membrane cleaning methods, which ensured the reuse of membrane elements and satisfied the demands of industrial production. After purification by this integrated membrane separation process, the content of polysaccharides reached to 96.3%. The purified polysaccharides exhibited the superior moisture absorption and moisture retention properties compared to glycerol, polyethylene glycol (PEG) and luffa water.

Keywords: membrane separation; *Enteromorpha* polysaccharides; microfiltration; ultrafiltration

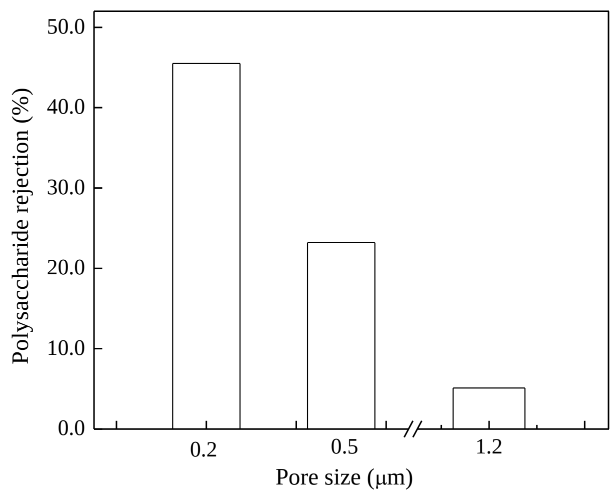


Fig. S1 Effects of MF pore sizes on the polysaccharides rejections (T= 55±1 ℃, TMP=0.225 MPa, the full recirculation mode)

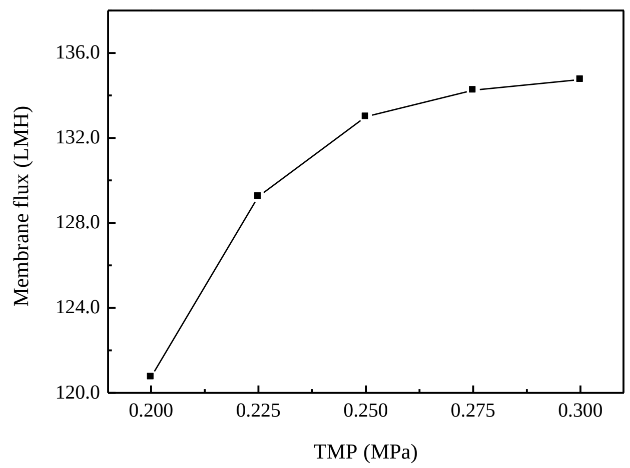


Fig. S2 Effects of TMP on the membrane fluxes (1.2 μm, T= 55±1 ℃, the full recirculation mode)

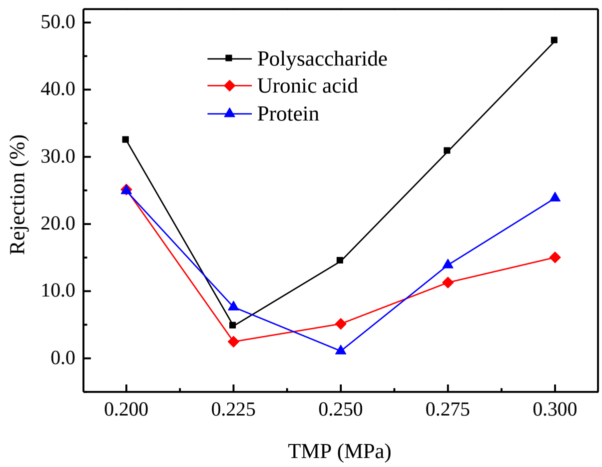


Fig. S3 Effects of TMP on the rejections of polysaccharides, uronic acids and proteins (1.2 μm, T= 55±1 ℃, the full recirculation mode)

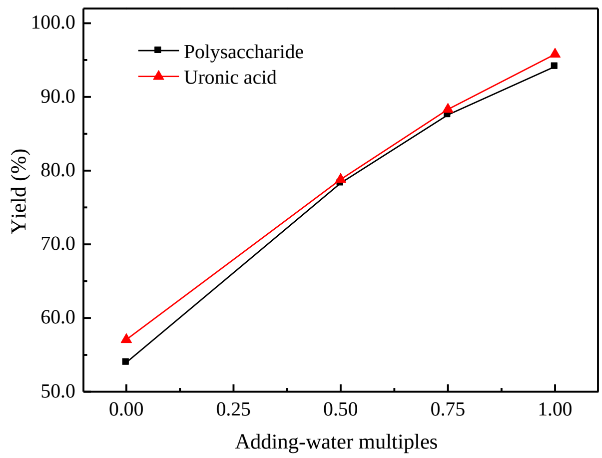


Fig. S4 Effects of adding-water multiples on the yields of polysaccharides and uronic acids (1.2 μm, TMP=0.225 MPa, T= 55±1 ℃)

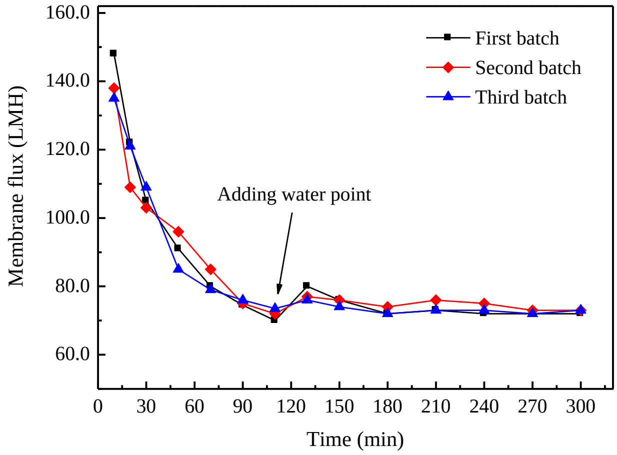


Fig. S5 Membrane flux vs. time (1.2 μm, T= 55±1℃, TMP=0.225 MPa)

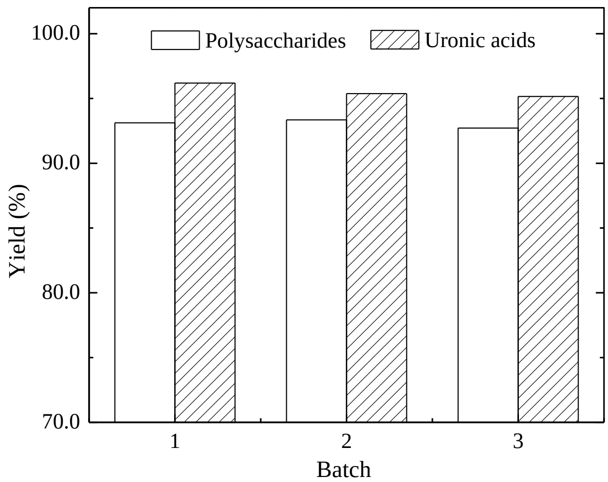


Fig. S6 Polysaccharides and uronic acids yields of three batches

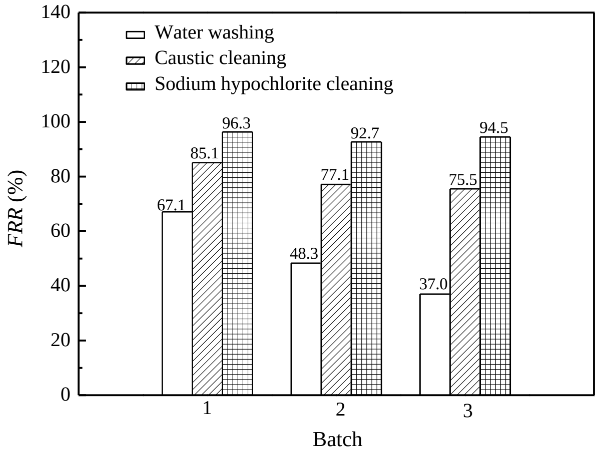


Fig. S7 *FRR* after water washing and chemical cleaning

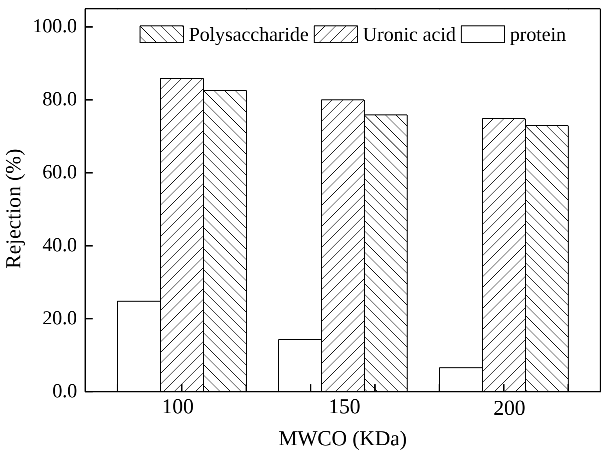


Fig. S8 Effects of UF MWCO on rejections of polysaccharides, uronic acids and proteins (TMP=0.3 MPa, T=40±1 ℃, the full recirculation mode)

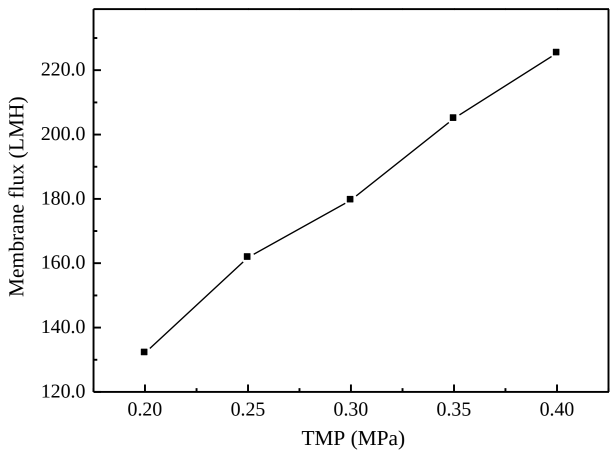


Fig. S9 Effects of TMP on membrane fluxes (UC100, T=40±1 ℃, the full recirculation mode)

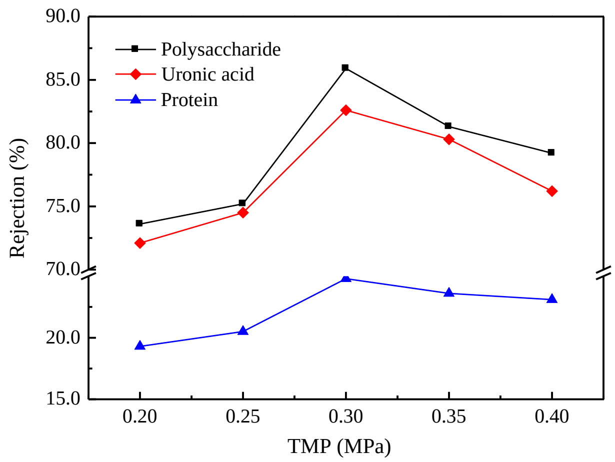


Fig. S10 Effects of TMP on the rejections of polysaccharides, uronic acids and proteins (UC100, T=40±1 ℃, the full recirculation mode)

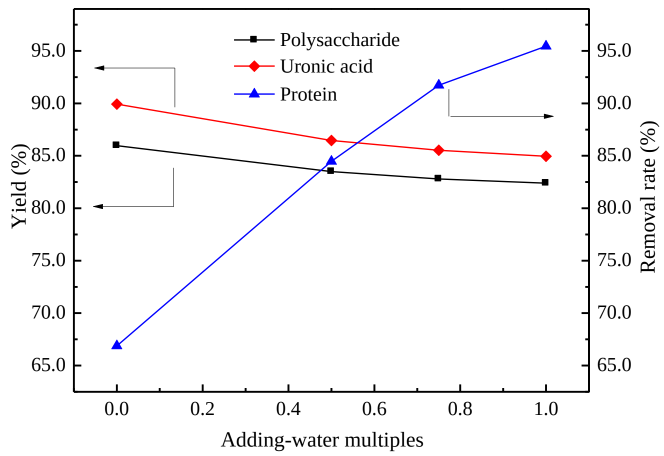


Fig. S11 Effects of adding-water multiples on the yields of polysaccharides and uronic acids and the removal rate of proteins (UC100, TMP=0.3 MPa, T=40±1 ℃)

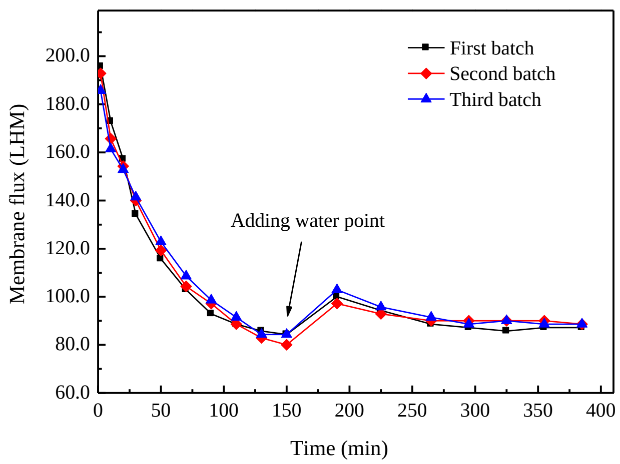


Fig. S12 Membrane fluxes vs. time of three batches (UC100, TMP=0.3 MPa, T=40±1 ℃)

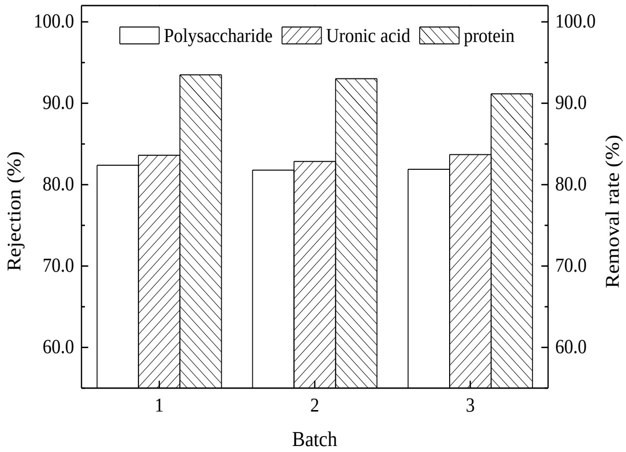


Fig. S13 Yields of polysaccharides and uronic acids and the removal rates of proteins

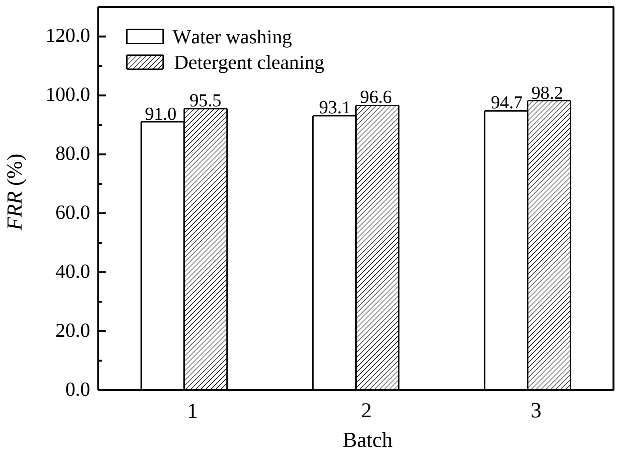


Fig. S14 *FRR* after water washing and chemical cleaning

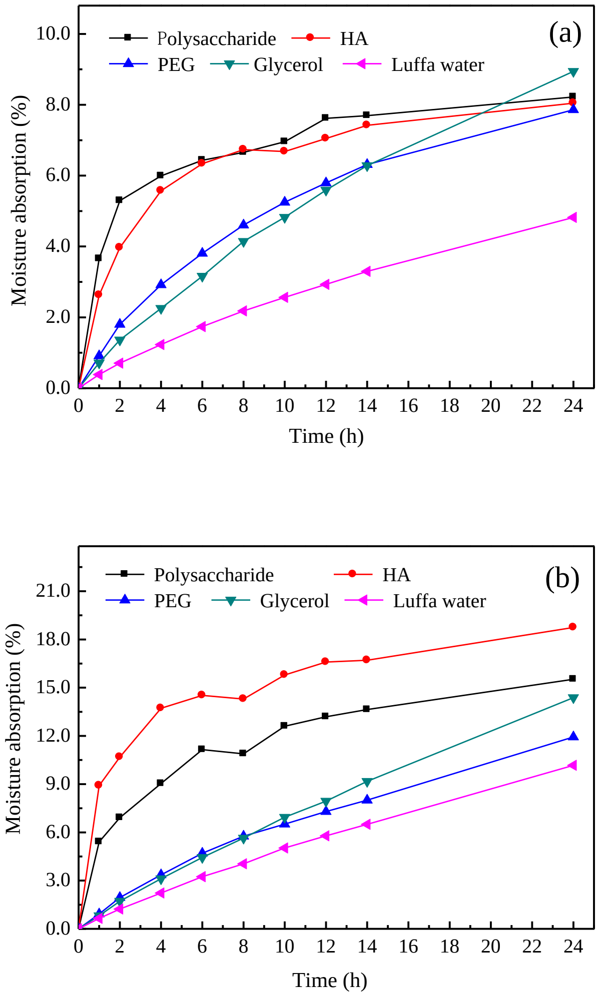


Fig. S15 Moisture absorption abilities at different relative humidity: (a) 43%, (b) 81%

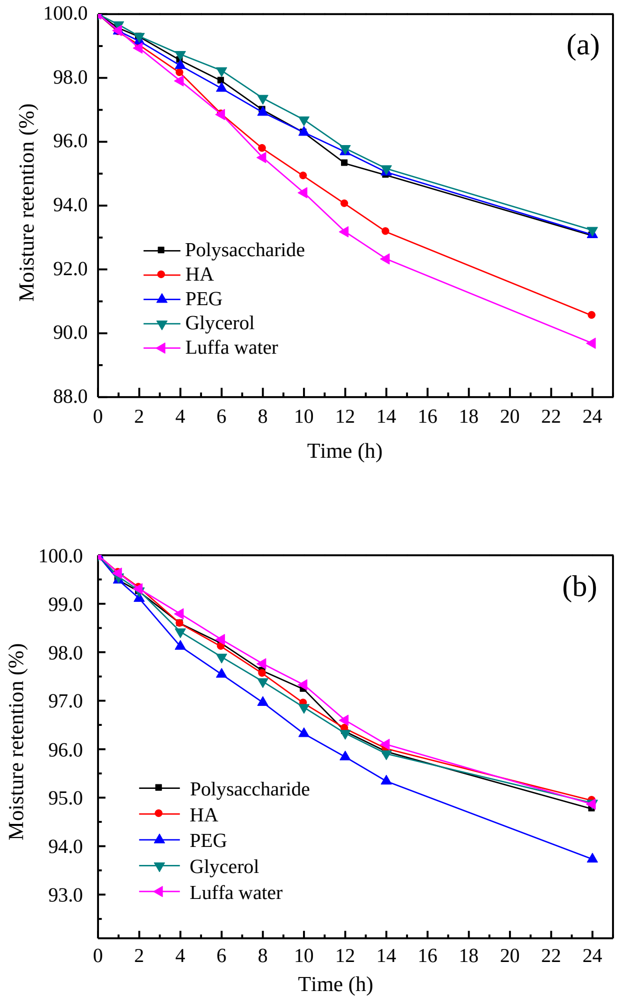


Fig. S16 Moisture retention abilities at different relative humidity: (a) 43%, (b) 81%

Table S1 Properties of flat sheet UF membranes

| Type | MWCO (kDa) | Material |
|---|---|---|
| UC 100 | 100 | Cellulose acetate (CA) |
| UP 150 | 150 | Polyethersulfone (PES) |
| UV 200 | 200 | Polyvinylfluoride (PVDF) |