PREPARATION AND CHARACTERIZATION OF 1,4 BUTANEDIOL

by Choirul Amri

PREPARATION AND CHARACTERIZATION OF 1,4-BUTANEDIOL-ESTERIFIED ALGINATE MEMBRANES

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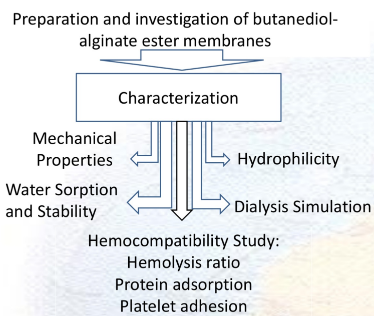
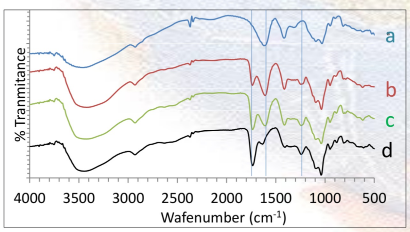
INTRODUCTION

Hemodialysis is an important clinical procedure for dialysis of blood. Cellulose and its derivatives, naturally based polymers, are often used as membrane in hemodialysis. One of natural polymers with structure similar to cellulose is alginate Unmodified alginate may have weak stability against water since it has mainly carboxylic groups. In this study, the carboxylic groups of alginate is modified by esterification using 1,4-butanediol. The resulting ester is expected to have balance performance between hydrophilicity and hydrophobicity. The membrane of butanediol-alginate ester may be used as a mass transfer channel that can transport toxic uremic compounds of urea and creatinine through hydrogen bond. The modification is also expected to reduce protein adsorption and platelet adhesion to the surface. The mechanical properties (tensile strength and elongation), water sorption and stability, hydrophilicity, hemocompatibility (hemolysis, protein adsorption, platelet adhesion), and dialysis performance to urea and creatinine clearance are tested. Cellulose acetate-based membrane is used as comparison.

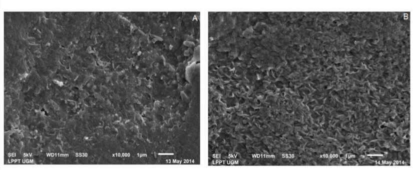
EXPERIMENTAL SECTION



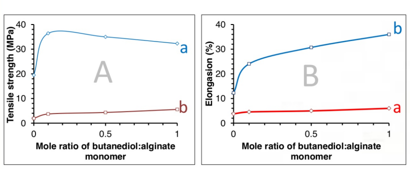
RESULTS



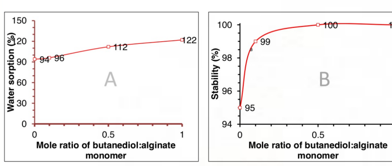
FTIR spectra of butanediol-alginate ester membranes result of preparation: without 1,4-butanediol (a), butanediol-alginate in mole ratio 0.1 (b), 0.5 (c), and 1.0 (d)



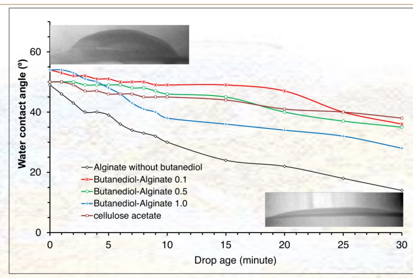
SEM micrograph of butanediol-alginate ester membrane in state of dry (A), and in state of wet after diffusion usage (B)



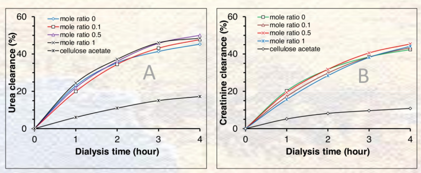
Mechanical properties of butanediol-alginate ester membranes: Tensile strength (A), Elongation (B), in state of dry (a), and wet (b)



Water sorption (A) and Stability (B) of butanediol-alginate ester membranes



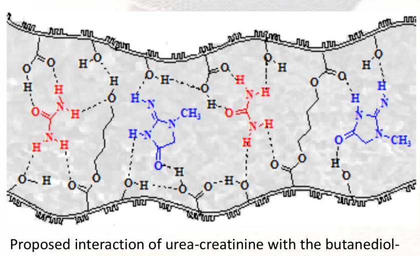
Water contact angle of butanediol-alginate ester membranes with reference of cellulose acetate membrane at various drop time



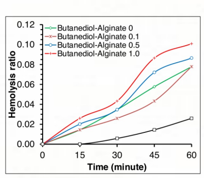
Performance of urea (A) and creatinine (B) clearance of butanediol-alginate ester membranes with the molar ratio of 0, 0.1, 0.5, and 1 in a dialysis simulation experiment for 1, 2, 3, and 4 hours

Performance of urea and creatinine flux butanediol-alginate ester membranes

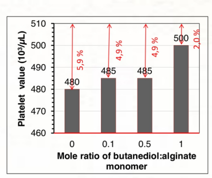
Mole ratio of butanediol-alginate	Flux (mg cm^{-2} h^{-1})	
	Urea	Creatinine
0	2.541	0.059
0.1	2.605	0.058
0.5	2.748	0.061
1	2.742	0.058
Cellulose acetate	0.954	0.015



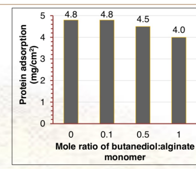
Proposed interaction of urea-creatinine with the butanediol-alginate ester membrane through hydrogen bond



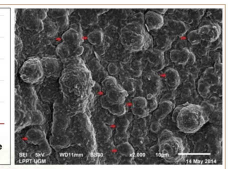
Hemolysis performance of butanediol-alginate ester membrane with reference of cellulose acetate membrane as function of time



Decrease in percentage of platelet in PRP after contacting with the butanediol-alginate ester membrane for 1 hour. The initial amount platelet in PRP 510000cells/µL



Plasma protein adsorption on butanediol-alginate ester membrane



SEM micrograph of adhesion platelet type on the membrane surface of butanediol-alginate ester

CONCLUSION

The membrane prepared from butanediol-alginate ester has mechanical strength, stability, protein adsorption, platelet adhesion, urea and creatinine diffusion, and hydrophobicity better than that of unmodified alginate. The butanediol to alginate molar ratio of 0.1 produces the highest tensile strength of 36.4 MPa. Increase in molar ratio causes elongation to increase. At molar ratio of 1.0, the membrane has 6% elongation when dry and 36.0% when wet. The stability of membrane can reach 100% at molar ratio of 0.5 and 1.0. Increase in molar ratio results in the increase of hemolysis ratio, and causes the adsorption of protein and platelet adhesion on the membrane surface to decrease. In the case of protein adsorption and platelet adhesion, the membrane with molar ratio of 1.0 has better hemocompatibility behavior. In the dialysis simulation done for 4 hours with the urea flux 2.742 mg cm^{-2} h^{-1} and creatinine flux 0.058 mg cm^{-2} h^{-1}, the membrane can reduce 48.5% and 44.2% of urea and creatinine concentration, respectively

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