CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The permeate flux and sodium chloride rejection of aqueous extract of *A. ebracteatus* Vahl. are found to be depend on both of flow velocity and transmembrane pressure (TMP). At low flow velocity, the TMP seems not to effectively increase permeate flux due to fouling effect. The optimal conditions are determined at the flow velocity of 0.875 l/min and TMP of 10 kg/cm^2 at which the rejection of sodium chloride is 0.31. The deviations between experiment and the selected mathematical models based on Steric-Hindrance Pore (SHP) model and Teorell-Meyer-Sievers (TMS) occur at low flow velocity. The mathematical model seems to be better agreement with high flow velocity because of less fouling effect at high shear rate.

The application of diafiltration process comprises 1.5 concentration step followed by 2 times of diafiltration allows 80% sodium chloride removal. In addition, the use of diafiltration enhances the permeate flux due to the reducing of membrane fouling by adding fresh water. The mathematical simulation for diafiltration process is found to be excellent to experiment results.

The aqueous extract of *A. ebracteatus* Vahl. after desalinization shows better cytotoxicity against both of KB and HeLa cell lines with IC_{50} values of 3200 and 3500 μg/ml, respectively to compare with the initial extract. This indicates that the removal of salts could be improved bioactivity due to the higher concentration of bioactive components in the product.

6.2 Recommendations

The other components than sodium chloride are found to pass through the membrane (with 36.6 % removal after diafiltration process). Thus it should be interesting to study feed properties of aqueous extract of *A. ebracteatus* Vahl.; also the rejections of active components should be evaluated.

In our experiment, the aqueous extract is used with the constant concentration. The concentration may be different from other systems, thus it should be interesting to study the effect of concentration on permeate flux and sodium chloride rejection, also the effect of temperature should be considered.

Nomenclature

NF nanofiltration

TMP transmembrane pressure (kg/cm^2)

A filtration area (m^2)

A_k membrane porosity

c concentration (mol m^{-3})

c_b concentration in bulk

c_m concentration at membrane surface

c_p concentration in permeate

d_h equivalent hydraulic diameter (m)

D diffusion coefficient ($m^2 s^{-1}$)

D_i diffusivity of ion i in free solution ($m^2 s^{-1}$)

D_s solute diffusivity for neutral molecule or generalized diffusivity for 1-1 type of electrolyte defined as $D_S = 2D_1D_2/(D_1 + D_s)$ ($m^2 s^{-1}$)

F Faraday constant (=96487) ($C mol^{-1}$)

J_s averaged solute flux over membrane surface (mol $m^{-2} s^{-1}$)

J_v averaged volume flux over membrane surface ($m^3 m^{-2} s^{-1}$)

H_D, H_F steric parameters related to wall correction factors under diffusion and convection conditions respectively

k mass transfer coefficient (ms^{-1})

$k_{D,i}$, $\overline{k}_{F,i}$ averaged distribution coefficients of ion i by the electrostatic effect under diffusion and convection condition respectively

L_w pure water permeate flux

N_{Re} Reynolds number ($=u.d_h/\upsilon$)

$N_{Re\text{-}y}$ new Reynolds number ($=u.d_h/\upsilon_w$)

N_{Sc} Schmidt number (=)

N_{Sh} Sherwood number ($=k.d_h.D$)

R gas constant or actual rejection.

R_{obs} observed rejection

r radial variable of capillary (m)

r dimensionless radial location defined as $\overline{r} = r/r_p$ (-)

r_p pore radius (m)

r_s	Stockes radius (m)
S_D	distribution coefficient of solute in diffusion condition
S_F	distribution coefficient of solute in convection condition
T	temperature
t	time recorded using to calculate permeate flux (s)
V	volume of permeate measured, using to calculate volume permeate flux (ml)
V_{fo}	initial feed volume using in diafiltration simulation (l)
V_w	volume of fresh water using in diafiltration simulation (l)
x	distance inside the membrane
X	charge density of membrane
z_i	electrochemical valence of i-th ion
α	transport number of cation in free solution defined as $\alpha=D_1/(D_1+D_2)$
ε_0	dielectric constant of vacuum (=8.8542x10^{-12} $C^2J^{-1}m^{-1}$)
ε	relative dielectric constant of water (=78.303)
η	ratio of solute radius to pore radius
υ	kinematic viscosity (m^2 s^{-1})
ϕx	effective charge density of membrane
v_i	specific volume
Δx	membrane thickness
$\Delta\pi$	osmotic pressure difference across the membrane (Pa)
ΔP	transmembrane pressure difference

<subscript>

D	diffusion
f	feed
F	convectrion
i	i-th ion (i=1 cation; i=2 anion)
m	membrane surface
p	permeate
salt	salt or sodium chloride
neu	neutre
w	water