Fractionation of proteins in surimi wastewater using membrane filtration

Raweewan Tacharatanamanee*, Kitti Cherdrungsi*, Wirote Youravong**

Membrane Science and Technology research center, Department industrial biotechnology, Department of food technology** Faculty of Agro-industry, Prince of Songkla University, Hat-Yai, Songkhla 90112, Thailand, Tel. 66-74-286363; Fax. 66-74-212889*

Abstract

Wastewater from surimi production consists of proteins and other valuable components. Proteins, caused the difficulty in wastewater treatment can be recovered by ultrafiltration and microfiltration and then can be partially purified by bulk crystallization. The results from SDS-PAGE study showed that the range of molecular weight of the soluble proteins was about 10-100 kDa. Ultrafiltration surimi wastewater using membrane with MWCO 100 and 300 kDa could not fractionate these proteins since most the proteins were retained in the retentate. Therefore these membrane can be used for protein concentration. Fractionation of protein from this waste was also studied by using microfiltration with the membrane at the pore size of 0.22 μm, 0.45 μm and 1 μm. The results from SDS-page showed that the protein profile in the retentate and permeate did not difference, indicating that these membranes also could not use for fractionation these types of proteins. These may be due to the narrow range of the molecular weight of these proteins.

Keywords : surimi wastewater/protein recovery/ fractionation/ ultrafiltration/ microfiltration

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1. Introduction

Surimi is a Japanese term of wash and dewatered fish mince widely used as a raw ingredient in manufacturing artificial crab meats, or kamaboko (Lee, 1984; Huang and Morrissey, 1998). Washing is one of the most important step in the production of surimi, extensive washing is utilized to remove water soluble substances, mainly sarcoplasmic proteins. As a result of washing, large volumes of wastewater containing high concentrations of organic materials are generated in the downstream dewatering operation. The direct discharge of the wastewater from surimi industry may generate negative impacts on the environment (Huang and Morrissey, 1998). Surimi wastewater were discharged about 29±3.5 L from the processing line in producing 1 kg of surimi (Lin et al., 1995). Most of sarcoplasmic proteins were lost during washing and 77% of the protein was recovered in the washed fraction (Adu et al., 1983). Solid waste from surimi processing is usually converted to animal feed or fishmeal. However, liquid waste is generally discarded back into the plant's waste stream.

Correspondence : ywirote@ratree.psu.ac.th

Ultrafiltration is the primary commercial method and has a great potential for the treatment (e.g., the concentration, fractionation and purification of soluble and insoluble materials) of seafood products (Afonso and Borquez, 2001). When small quantities of proteins need to be fractionated, techniques such as chromatography, affinity separation and electrophoresis can be used quite effectively. However, in a large number of cases, much greater quantities of proteins need to be fractionated. The membrane filtration process is a fractionation technique with potentials used for large-scale applications (Ghosh and Cui, 2000).

The aim of this work is to study the possibility of using of ultrafiltration and microfiltration to fractionate protein discharged from surimi wastewater.

2. Materials and methods

2.1. Sample collection and preparation

Four types of surimi liquid waste discharged from surimi processing were the first washing waste (W1), the second washing waste (W2), the third washing waste (W3) and dewatering waste (W4) and screw press waste (W4). The temperature of the waste was controlled at 4 ^{o}C. The sample were prefilted to remove suspended solid before being used.

2.2. Determine the molecular weight of protein

SDS-PAGE (non β-mercaptoethanol) were use to determine molecular weight of surimi was water protein.

2.3. Filtration process

Only W1 and W4 surimi wash water were used for filtration study. For crossflow untrafiltration, membrane used were 100 and 300 kDa. The experimental condition, pressure and temperature were 2.5 bar and 5 ^{o}C respectively .

For microfiltration, experiments have been performed with dead-end membrane, having diameter of 47 mm with pore size of 0.22 μm, 0.45 μm and 1 μm. The pressure and tempereature used were 2 bar and 10 ^{o}C .

3. Result and discussion

3.1. Composition of bigeye snapper surimi wastewater

Table 1
The physical and chemical properties of surimi wastewater in processing line.

Sample	pH	protein (mg/ml)	Total solid (mg/L) (mg/L)	COD* (mg/L)	BOD*
W1	6.87 ± 0.05^{ab}	1.57 ± 0.19^{c}	4.20 ± 0.35^{c}	7400 ± 390.51^{b}	5750 ± 589.49^{b}
W2	7.12 ± 0.04^{c}	1.03 ± 0.16^{b}	3.20 ± 0.43^{b}	6100 ± 476.97^{ab}	3650 ± 776.21^{a}

W3	6.90 ± 0.04[b]	0.11 ± 0.03[a]	1.14 ± 0.11[a]	5200 ± 396.86[a]	3100 ± 854.40[a]
W4	6.81 ± 0.01[a]	5.53 ± 0.26[d]	6.42 ± 0.24[d]	9600 ± 1389.24[c]	7600 ± 672.68[c]

W1 is first wash water and W4 is dewatering.
* : were measured before filtrated by Whatman No.4
a-d : Different letters in the same column indicate significant difference ($p<0.05$)

3.2. Flux and protein transmission during ultrafiltration

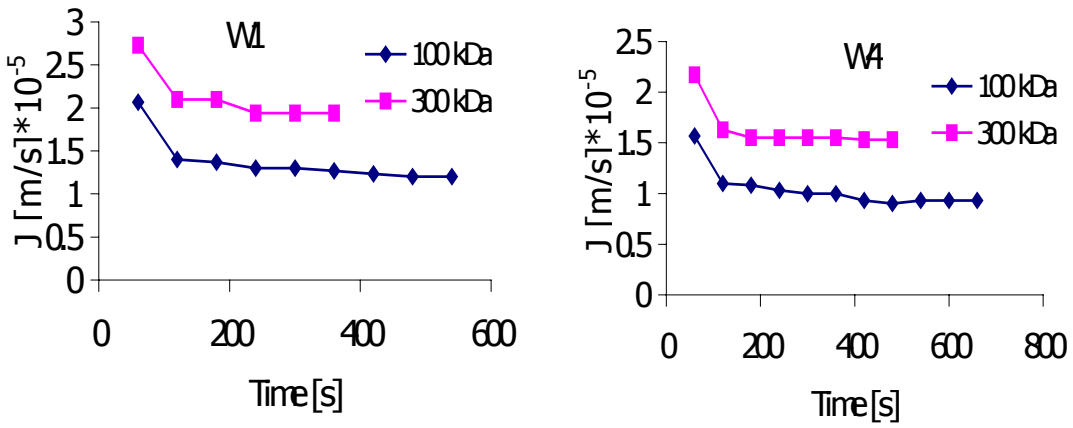


Fig.1 Permeate flux during ultrafiltration through 100 kDa and 300 kDa membrane at 5 °C, Pressure 2.5 bars .

Table 2
Protein transmission during ultrafiltration and microfiltration.

Sample	protein (mg/ml)	
	Retentatate	Permeateate
W1 / UF100	13.47 ± 1.60[e]	ND
W1 / UF300	12.63 ± 1.15[e]	ND
W1 / MF0.22	7.46 ± 1.55[d]	0.26 ± 0.05[ab]
W1 / MF0.45	5.74 ± 0.77[c]	1.34 ± 0.05[ab]
W1 / MF1	4.81 ± 0.18[c]	1.86 ± 0.05[ab]
W4 / UF100	26.66 ± 0.81[f]	ND

W4 / UF300	26.38 ± 0.95^{f}	ND
W4 / MF0.22	8.09 ± 0.60^{d}	0.16 ± 0.05^{ab}
W4 / MF0.45	7.64 ± 0.40^{d}	1.27 ± 0.05^{ab}
W4 / MF1	7.26 ± 0.31^{d}	5.51 ± 0.05^{ab}

W1 is first wash water and W4 is dewatering.
300 and 100 : pore size membrane (kDa) of ultrafiltration.
1, 0.45 and 0.22 : pore size membrane (μm) of microfiltration.
ND : not detected
a-f : Different letters in the same column indicate significant difference ($p<0.05$)

3.3. Flux and protein transmission during microfiltration

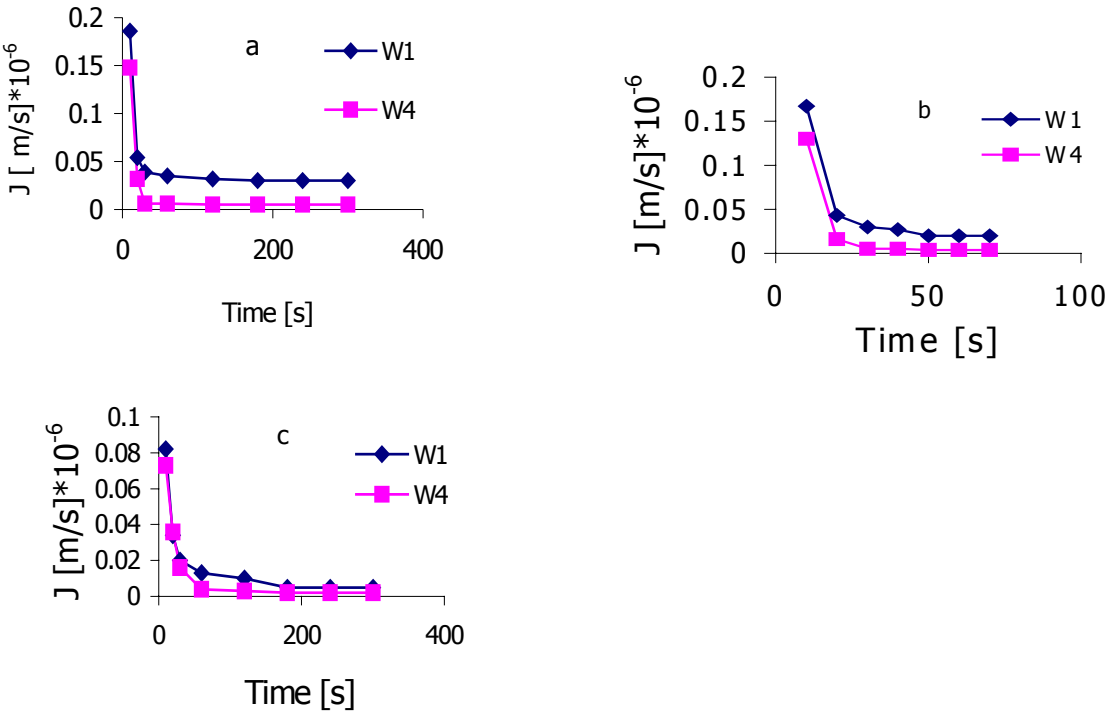


Fig.2 Permeate flux during microfiltration process of W1 and W4 at 10 °C, Pressure 2 bars. (a :1 μm, b:0.42 μm, c0.22 μm)

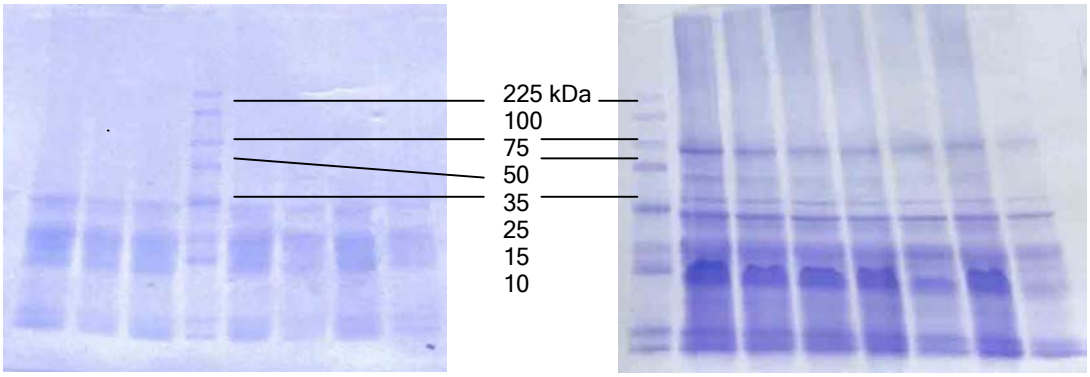
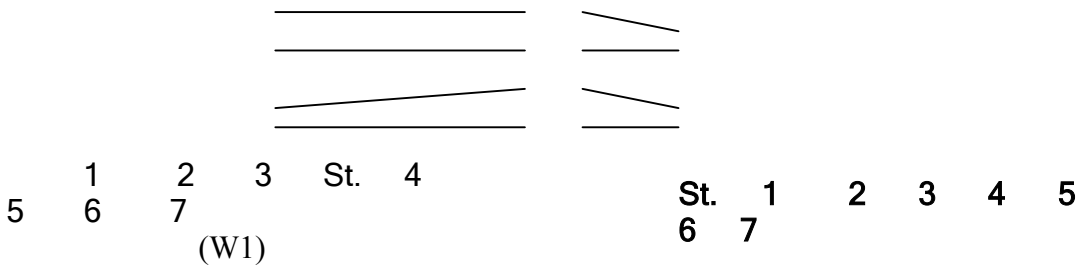


Fig.3 SDS-PAGE pattern of W1 and W4 through 1μm, 0.45 and 0.22 microfiltration membrane.

(W1) Lane 1: W1, 2: W1 /R1, 3: W1 /P1, St.: standard proteins , 4: W1 /R0.45, 5: W1 /P0.45 , 6: W1 /R0.22 , 7: W1 /P0.22

(W4) Lane St.: standard proteins., 1: W4 /R1, 2: W4 /P1, 3: W4 /R0.45, 4: W4 /P0.45 , 5: W4 /R0.22, 6: W4 /P0.22 , 7: W4



3. Conclusion

Surimi wastewater discharged from dewatering step had the highest protein content. Ultrafiltration can be used for protein concentration. Ultrafiltration and micorfiltration used in this study could not be employed for fractionation proteins containing in surimi wash water.

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