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Comparison of Chemical and UV Photo-Grafting Modification on Polyamide Microfiltration Membrane for the Preparation of Membrane Chromatography

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Membrane chromatography has been used widely as an alternative to the conventional packed bed chromatography for protein separation. Membrane chromatography used an adsorptive membrane that carried specific chromatography functionality. In the current study, a membrane chromatography was prepared by modification of commercial polyamide microfiltration membrane with acrylic acid monomer. Two modification methods were compared which are UV photo grafting and chemical grafting *via* redox reaction. Modification parameters studied were initiator concentration (1-50 mM), monomer concentration (0.2-5 M) and reaction time (5-60 min). The highest lysozyme binding capacity achieved was 0.175 mg of lysozyme/cm^2 membrane for the membrane prepared *via* UV photo grafting using 10 mM of photo-initiator, 0.1 M of acrylic acid and 15 min of reaction time.

Keywords: Protein separation, Membrane chromatography, UV grafting, Chemical grafting, Polyamide membrane.

INTRODUCTION

Increasing growth in biotechnology industries such as pharmaceutical and food industries requires reliable and efficient methods to purify the commercial-scale quantities of proteins [1]. Various type of separation can be used to capture the desirable protein of interest. The most common technique is by using packed bed chromatography. However, conventional packed bed chromatography shows several short comings such as high pressure drop, limited diffusional of solute to the binding site and low flow rate capability [2-4]. Membrane chromatography is used as an alternative to the packed bed chromatography for protein separation. Membrane chromatography uses an adsorptive membrane that carried specific chromatography functionality. The production of chromatographic membranes involve a chemical modification of the microfiltration membrane with specific type of functional groups to produce different types of chromatography interactions inside the membrane [5].

Various types of functional group could be introduced to the membrane according to their application and functionality. UV grafting is one of the common methods used for modification of ultrafiltration (UF) membrane for fouling control. UV grafting is simple, useful and versatile in improving the surface properties of the polymers [6]. The membrane was exposed to the UV light at certain wavelength and intensity in specified time of radiation. The monomer is grown continuously on the radical groups generated during the UV grafting process. Commercial polyethersulfone (PES)UF membrane was grafted by Taniguchi and Belfort [7] at 300 nm wavelength with various types of monomer such as N-2-vinyl pyrolidinone (NVP), 2-hydroxyethyl methacrylate (HEMA), acrylic acid (AA), 2-acrylamidoglycolic acid (AAG), 3-sulfopropyl methacrylate (SPMA) and 2-acrylamido-2-methyl-1-propanesulfonic acid (AMPS) in order to produce membrane that has low protein fouling. Abuhabib *et al.* [8] combined two monomers which are acrylic acid and ethylenediamine dihydrochloride during grafting to improve the fouling resistance of PES nanofiltration membrane for brackish water desalination. Mansourpanah and Momeni [9] studied the effect of UV-irradiation time and acrylic acid concentration on the performance and morphology of modified polyamide thin film composite (TFC) membranes.

Another approach for monomer grafting is through chemical grafting *via* redox reaction. The concept is quite similar to UV photo-grafting which produced free radical on the membrane surface for monomer attachment, but it is assists by redox initiator pair. Different redox initial pairs were used during grafting such as potassium persulfate ($K_2S_2O_8$)-potassium thiosulfate ($K_2S_2O_3$) [10], $K_2S_2O_8$–sodium sulfite (Na_2SO_3) [11], $K_2S_2O_8$–$Na_2S_2O_5$ [12] and potassium methabisulfite ($K_2S_2O_5$)–$Na_2S_2O_8$ [13].

Much of the membrane modification in the previous works, mainly aim for producing fouling resistant membrane