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Synthesis and Characterization of Hydroxyethyl Cellulose/Chitosan Incorporated with Cellulose Nanocrystal Biopolymers Network

Farah Hanani Zulkifli[1,2,a*], Sulaiman Khan[1,2,b], Siti Maznah Kabeb[1,2,c], Nurul Huda Mohamed Shah[1,2,d]

[1]Faculty of Industrial Sciences and Technology, Universiti Malaysia Pahang, Lebuh Persiaran Tun Khalil Yaakob, 26300, Kuantan, Pahang, Malaysia.

[2]Center for Advanced Intelligent Materials, Universiti Malaysia Pahang, Lebuh Persiaran Tun Khalil Yaakob, 26300, Kuantan, Pahang, Malaysia.

[a,*]farahhanani@umpsa.edu.my, [b]khansulaiman5y7@gmail.com , [c]smaz@umpsa.edu.my, [d]hudashah@gmail.com

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Abstract. Biopolymeric scaffold remains one of promising candidates in various applications, such as biomedicine, pharmaceuticals, smart packaging, and cosmetics, following its advantage of non-toxicity, safety, and sustainability in bioresources. In this study, hydroxyethyl cellulose (HEC)/ chitosan (CS) incorporated with cellulose nanocrystals (CNC) was fabricated by lyophilization technique, obtaining fine porous scaffolds structure. HEC (5 wt.%) and CS (0.1 wt.%) were prepared and blended at 50:50 ratios following the addition of CNC as nanofiller material at 1, 2 and 3 wt.%. All scaffolds were characterized by their physical, chemical, thermal, and mechanical properties via SEM, ATR-FTIR, DSC and UTM. The SEM results show HEC/CS/CNC with pore diameter ranging from 25 μm to 28 μm. The ATR-FTIR spectra indicates a broad peak of O-H stretching at 3382 cm^{-1} to 3397 cm^{-1}, and C=O stretching of amide group in the range of1645cm^{-1} to 1653 cm^{-1}. Mechanical testing of the samples showed increasing tensile strength with increased concentration of CNC, indicating the improved toughness of the samples. The DSC result indicates a slight decrease in glass transition and melting temperature. Overall, the HEC/CS/CNC was successfully fabricated into biopolymeric scaffolds and could be a potential substrate for biomedical application.

Introduction

Biomaterial is a class of material that relates to any natural or synthetic polymers that is further designed to mimic or replace the biological function in human body. During the past few decades, natural polymer has been intensively studied, considering its non-toxicity, environmentally friendly, and nature abundant in resources. Developing material based on natural polymer, for example, chitin, chitosan, collagen, cellulose, and alginate can be low cost or economical with excellent interface with living cells [1-3].

Synthetic polymers, derived from multiple bonds or more functional groups, such as nylon, polyethylene and epoxy had been immensely studied, precedent a promising biomaterials product at desirable stability, strength, and tunable properties [4-5]. However, synthetic polymer encountered lack of immunogenicity, thus exhibit low-to-moderate cells adhesion and tissue reconstruction. Therefore, multifaceted intermolecular forces between natural with synthetic materials are advantageous; facilitate the construction of new blend polymers, with comparable performance; that significance to be optimized according to its niche functionality and applicability.

Cellulose, the most abundant bioresources in nature, can be easily processed into other derivative's such as hydroxyethyl cellulose (HEC), carboxymethyl cellulose (CMC), and cellulose nanocrystals (CNC) [6-7]. HEC, a non-ionic water-soluble polymer containing β -glucose linkage has been widely used in coating, cosmetics and pharmaceutical field. HEC was also used as thickening agent, binder and dispersing agent which help in enhancing the thickness of the material and lubricant. Besides, HEC also exhibits properties such as good biocompatibility, non–toxic and