Abstrak

Rekayasa jaringan dikhususkan untuk mengganti atau meregenerasi sel, jaringan atau organ pada tubuh manusia untuk dapat mengembalikan fungsi normalnya yang hilang karena sakit atau cedera. Kunci dari teknik jaringan adalah menyemai sel-sel sehat pada bahan yang biokompatibel dengan struktur tiga dimensi (3D). Kemajuan dalam bioprinting menawarkan platform manufaktur yang sangat baik untuk memproduksi *scaffold* hidrogel yang sarat dengan sel untuk penerapan teknik jaringan. Namun, arsitektur 3D yang kompleks membutuhkan bahan bioink spesifik, yang mana merupakan tempat sel dimasukkan selama dan setelah proses pencetakan. Banyak penelitian telah menetapkan dampak pada sifat fisikokimia hidrogel gelatin-metakrilloil dari parameter berbasis proses dan bahan. Namun, masih sedikitnya karya dalam literatur yang ada tentang hubungan perbandingan jenis prekursor metakrilat dan kemampuan mencetak bioink. Ini mendorong dilakukannya penelitian untuk menjelaskan efek prekursor metakrilil yang berbeda melalui sifat fisikokimia dan kemampuan cetak dari sistem bioink berbasis gelatin. Dalam analisis ini, gugus amino direaksikan dengan metakrilat anhidrat untuk gelatin, dan glikidil metakrilat direaksikan dengan gugus hidro dan karboksil dalam gelatin. Ditemukan bahwa rasio *swelling* dan degradasi meningkat dengan menurunnya konsentrasi gelatin-metakrilloil dan gelatin-glikidil metakrilil. Penggunaan berbagai prekursor metakrilloil yang berbeda dapat mengubah suhu pembentuk gel dan viskositas hidrolgel gelatin, sehingga dapat ditentukan dalam parameter pencetakan yang optimal.

Kata kunci: *tissue engineering, hydrogel, gelatin-methacryloyl, bioprinting*

亞洲大學

生物資訊與醫學工程學系

碩士論文

生物列印用光固化型明膠水膠製備與性質分析

Preparation and Characterization of Photo-Curable Gelatin Hydrogel for Bioprinting Application

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中 華 民 國 一零九 年 一 月

亞洲大學
生物資訊與醫學工程學系碩士班
碩士論文

中文題目:生物列印用光聚合型明膠水膠製備與定性

英文題目: Preparation and characterization of photo-curable gelatin hydrogel for bioprinting application

本論文業經審查及口試合格特此證明

指導教授

論文口試委員

中華民國 109 年 1 月

摘要

組織工程致力於替換或再生人類細胞、組織、或器官，以恢復由於疾病或傷害導致組織或器官所喪失的正常功能。組織工程學的關鍵技術是將健康細胞播種在具有三維結構的生物相容性材料上。其中，生物列印技術的進步也為製備組織工程應用中之乘載細胞水膠支架提供了一個很好的製造平台。然而，負責的三維結構需用使用可於列印過程或列印結束後植入細胞之特定生物墨水材料。為此，目前已有許多研究便專注探討不同參數控制對於光固化型甲基丙烯酸明膠物理與化學特性之影響。可惜的是，現有研究文獻中對於甲基丙烯酸酯前驅物對於光固化明膠可列印性影響之研究成果有限。這驅使我們試圖探討不同前驅物的使用對於所得生物墨水之物理、化學、與可列印性的影響。為此，本論文使用甲基丙烯酸酐與甲基丙烯酸環氧丙酯，分別接枝於明膠之一級氨官能基與羧基上，以製成不同類型之光固化型水膠明膠。研究結果顯示，隨著甲基丙烯酸明膠與甲基丙烯酸環氧丙酯濃度降低，其固化完成之膠體膨潤度與降解性也會隨之增加，且因不同前驅物接枝率不同，使得水膠之成膠溫度與黏度受到影響，導致最佳列印參數產生差異。

關鍵字: 組織工程, 水膠, 甲基丙烯酸明膠, 生物列印

Abstract

Tissue engineering is devoted to replacing or regenerating human cells, tissues or organs to restore the normal function lost due to illness or injury. Tissue engineering's key technique is to seed healthy cells on a biocompatible material with three-dimensional (3D) structures. The advance in bioprinting offers an excellent manufacturing platform for producing cell-laden hydrogel scaffolds for the application of tissue engineering. However, the complex 3D architecture requires a specific bioink material in which the cells are inserted during and after the printing process. Many studies have established the impact on the physicochemical properties of the gelatin-methacryloyl hydrogel of process-based and material-based parameters. There is no work in the existing literature on the relation of methacrylate precursors and bioink printability. This encouraged us to elucidate the effects of different methacryloyl precursors on the physicochemical properties and printability of the photocurable gelatin-based bioink system. In this analysis, amino groups were reacted with methacrylic anhydrate for gelatin, and glycidyl methacrylic reacted with hydroyl and carboxyl groups in gelatin. It was found that the swelling ratio and degradation increased with declining concentration of both gelatin-methacryloyl and gelatin-glycidyl methacryloyl. The use of different methacryloyl precursors can alter the gelling temperature and viscosity of the gelatin hydrolgel, resulting in the alternation in the optimal printing parameters.

Keywords: tissue engineering, hydrogel, gelatin-methacryloyl, bioprinting

Acknowledgements

First of all, my deepest gratitude for Ida Sang Hyang Widhi Wasa for the blessing and guide me in my tough condition during my master degree. Therefore, I always have the spirit to never give up during my master study in Taiwan.

I would like to express the deepest appreciation to my advisor Chia-Che Ho who always guide, encourage, support and advice me during the time as his student. I obtained knowledge and experience in science during our brainstorming and discussion about the manuscript. And also, I saw how his consistency in doing his passion in research made me realized how to be a scientist. Without his supervision and constant help, this thesis would not have been possible.

I would like to thank to Airlangga University, especially for my advisor Mr.Mochamad Zakki Fahmi who always support and advice me during my study and Asia University for giving me a scholarship and also financial support during my master degree. As a result, I can survive in Taiwan and I can reach a prestigious achievement in my life. I hope this achievement will let me able to help my parents, family and many people.

Furthermore, I would like to thank my parent, I Made Budiastawa Dwijaksara and Ni Kadek Redimasri, for their unconditional love, support and pray for me. I dedicated this M.Sc degree for them.