

**DEVELOPMENT OF SILK FIBROIN-BASED BIOMATERIALS FOR
TISSUE ENGINEERING APPLICATIONS**



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ABSTRACT

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The present dissertation was proposed two possible approaches to develop silk fibroin-based biomaterials in the context of tissue engineering, i.e. (i) enhancement of the biological and physical functions of silk fibroin by blending/incorporating chitin derivatives, and (ii) the use of silk fibroin as a carrier matrix to delivery the bioactive agents. In case of (i), biodegradation of silk fibroin was greatly improved by blending with carboxymethyl chitin (CM-chitin). The biodegradability of the blends increased with increasing the CM-chitin contents. The incorporating chitin whiskers into the silk fibroin matrix not only promoted the dimensional stability but also enhanced in its mechanical properties. For (ii), the study was conducted both *in vitro* and *in vivo* using dyes and basic fibroblast growth factor (bFGF) as low- and high-molecular weight model drugs, respectively. The results indicate that the silk fibroin proteins were amphiphilic-charged materials depending on the existing pH. The strong interaction was observed, when the charge of model drugs and silk fibroin were opposite. The *in vivo* study demonstrated that the use of silk fibroin scaffolds as the carrier matrix enabled to control *in vivo* release of bFGF in the sustainable fashion.

บทคัดย่อ

ปัญญา วงศ์พานิช: การพัฒนาวัสดุที่มีไหมเป็นองค์ประกอบหลักสำหรับการประยุกต์ใช้ในวิศวกรรมเนื้อเยื่อ (Development of Silk Fibroin-based Biomaterials for Tissue Engineering Applications) อ. ที่ปรึกษา: รศ. ดร. รัตนา รุจิรวนิช และ ศ. ดร. ยาซูฮิโกะ ทาบาตะ 165 หน้า

วิทยานิพนธ์นี้เสนอสองแนวทางในการพัฒนาวัสดุไหมไฟโบรอินสำหรับวิศวกรรมเนื้อเยื่อ ได้แก่ (๑) ปรับปรุงคุณสมบัติทางชีววิทยาและทางกายภาพโดยผสมกับอนุพันธ์ของไคติน และ (๒) ใช้วัสดุไหมไฟโบรอินเพื่อเป็นวัสดุนำส่งสารประกอบที่ไวต่อสิ่งมีชีวิต สำหรับในกรณี (๑) การย่อยสลายของไหมไฟโบรอินมีคุณสมบัติที่ดีขึ้นเมื่อผสมกับคาร์บอกซีเมทิลไคติน และการย่อยสลายสูงขึ้นเมื่อเพิ่มองค์ประกอบของคาร์บอกซีเมทิลไคตินในของผสม การเติมไคตินวิสเกอร์ไม่เพียงแต่จะช่วยให้การคงรูปของวัสดุไหมไฟโบรอินมันยังช่วยให้คุณสมบัติเชิงกลของวัสดุดีขึ้นอีกด้วย . ในกรณีที่ (๒) การศึกษาการนำส่งยาได้ทดลองทั้งในหลอดทดลองและในสัตว์ทดลอง สารประกอบเพื่อเป็นตัวแทนยาสำหรับการศึกษาศักยภาพการนำเอาไหมไฟโบรอินมาใช้เป็นวัสดุนำส่งยาคือสีย้อมผ้าและเบสิกไฟโบรบลาสโตรคแพกเตอร์ ผลปรากฏว่า ไหมไฟโบรอินเป็นวัสดุที่มีสองประจุคือบวกหรือลบขึ้นอยู่กับค่าความเป็นกรด-ด่าง อันตรกิริยาระหว่างไหมและยานั้นสูงเมื่อประจุของยาตรงกันข้ามกับประจุของไหม และการศึกษาในสัตว์ทดลองพบว่าไหมไฟโบรอินสามารถควบคุมการปลดปล่อยเบสิกไฟโบรบลาสโตรคแพกเตอร์ โดยสามารถยืดระยะเวลาการปลดปล่อยในบริเวณที่ปลูกฝังได้ราวสองสัปดาห์

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TABLE OF CONTENTS

	PAGE
Title Page	i
Abstract (in English)	iii
Abstract (in Thai)	iv
Acknowledgements	v
Table of Contents	vi
List of Tables	ix
List of Figures	x
 CHAPTER	
I INTRODUCTION	1
II LITERATURE REVIEW	4
III EXPERIMENTAL	15
IV MISCIBILITY AND BIODEGRADABILITY OF SILK FIBROIN/CARBOXYMETHYL CHITIN BLEND FILMS	30
4.1 Abstract	30
4.2 Introduction	30
4.3 Experimental	32
4.4 Results and Discussion	35
4.5 Conclusions	45
4.6 Acknowledgements	45
4.7 References	46

CHAPTER		PAGE
V	PREPARATION AND CHARACTERIZATION OF CHITIN WHISKER-REINFORCED SILK FIBROIN NANOCOMPOSITE SPONGES	59
	5.1 Abstract	59
	5.2 Introduction	59
	5.3 Experimental	61
	5.4 Results and Discussion	66
	5.5 Conclusions	74
	5.6 Acknowledgements	74
	5.7 References	75
VI	INFLUENCE OF CHARGE CHARACTERISTIC OF SILK FIBROIN ON SORPTION AND RELEASE OF CHARGED DYES	91
	6.1 Abstract	91
	6.2 Introduction	91
	6.3 Experimental	93
	6.4 Results and Discussion	97
	6.5 Conclusions	105
	6.6 Acknowledgements	106
	6.7 References	106

CHAPTER	PAGE
VII IN VITRO AND IN VIVO RELEASE OF BASIC FIBROBLAST GROWTH FACTOR USING SILK FIBROIN SCAFFOLD AS DELIVERY CARRIER	119
7.1 Abstract	119
7.2 Introduction	119
7.3 Experimental	122
7.4 Results and Discussion	126
7.5 Conclusions	136
7.6 Acknowledgements	136
7.7 References.	137
VIII CONCLUSIONS AND RECOMMENDATIONS	153
REFERENCES	155
CURRICULUM VITAE	163

LIST OF TABLES

TABLE		PAGE
CHAPTER IV		
4.1	Spectral shifts of the amide I, amide II, and amide III of silk fibroin/CM-chitin blend films at various blend ratios.	48
4.2	Percent weight of films after enzymatic degradation for 6 days at 37°C (changing media daily).	49
CHAPTER V		
5.1	Bulk densities and specific moduli of the methanol-treated chitin whisker/silk fibroin sponges at a various C/S ratios.	82
CHAPTER VI		
6.1	Comparison of the values of partition coefficients between methanol-treated and water-annealed silk fibroin films of each dye.	111
6.2	Isoelectric points of the fibroin proteins determined from various methodologies.	112
6.3	Diffusion constants of Chromotrope 2R and Crystal violet at various pH values of the release media obtained by calculation of the initial slope of each curve in Figure 6.5C & D in comparison to their partition coefficients at the same pH.	113
CHAPTER VII		
7.1	Isoelectric points of the fibroin proteins determined from various methodologies.	146

LIST OF FIGURES

FIGURE		PAGE
CHAPTER II		
2.1	Principle of cell therapy. In cell therapy, cells from the patient are cultivated and injected into the damaged tissue or organ. In the therapy of burns and ulcers, the cultivated cells are laid, pipetted or sprayed (Minuth, Strehl, & Schumacher, 2005).	7
2.2	Principle of artificial tissue creation. The creation of a cartilage construct with cultivated cells and an artificial ECM (scaffold) for therapy of joint damage is shown (Minuth, Strehl, & Schumacher, 2005).	8
CHAPTER IV		
4.1	FTIR spectra of silk fibroin, CM-chitin, and the blend films at various silk fibroin/CM-chitin blend ratios (a to g) before methanol treatment (A) and after methanol treatment (B).	50
4.2	SEM micrographs of the fractured cross-sections of the methanol-treated silk fibroin/CM-chitin blend films at various blend ratios; 10/0 (A), 8/2 (B), 6/4 (C), 5/5 (D), 4/6 (E), 2/8 (F), and 0/10 (G).	51
4.3	SEM micrographs of the surfaces of the methanol-treated silk fibroin/CM-chitin blend films at various blend ratios; 10/0 (A), 8/2 (B), 6/4 (C), 5/5 (D), 4/6 (E), 2/8 (F), and 0/10 (G).	52

FIGURE		PAGE
CHAPTER IV		
4.4	SEM micrographs of the surfaces of the silk fibroin/CM-chitin blend films at 10/0 (before methanol treatment (A), after methanol treatment (B), and after extraction of methanol-treated films in water (C)), 8/2 (before methanol treatment (D), after methanol treatment (E), and after extraction of methanol-treated films in water (F)), and 6/4 (before methanol treatment (G), after methanol treatment H, and after extraction of methanol-treated films in water (I)) blend ratios.	53
4.5	DSC thermograms of the silk fibroin/CM-chitin blend films at various blend ratios from pure silk fibroin film (a) to pure CM-chitin films (g) before methanol treatment (A) and after methanol treatment (B).	54
4.6	XRD patterns of the silk fibroin/CM-chitin blend films at various blend ratios from pure silk fibroin film (a) to pure CM-chitin films (g) before-methanol treatment (A) and after -methanol treatment (B).	55
4.7	Formation of micellar structure of silk fibroin via self assembly (A). Interaction between silk fibroin micelle and CM-chitin chains (B).	56

FIGURE	PAGE	
CHAPTER IV		
4.8	Percent weight of films after enzymatic degradation (A) and percent equilibrium water content (B) of the methanol-treated silk fibroin and silk fibroin/CM-chitin blend films crosslinked with 0.0075% glutaraldehyde as a function of CM-chitin content (●, films in PBS solution without protease; ○, films in PBS solution with protease). N = 3, bars represent standard deviation. The films were submerged in media for 2 days at 37°C.	57
4.9	SEM micrographs of the methanol-treated films with and without crosslinking after enzymatic degradation for 6 days 37°C in protease solution; the methanol-treated silk fibroin film without crosslinking (A), the methanol-treated silk fibroin/CM-chitin blend films crosslinked with 0.0075% glutaraldehyde at 10/0 (B), 9/1 (C), and 7/3 (D) blend ratios .	58
CHAPTER V		
5.1	TEM micrographs of chitin whisker; Bar, 2 μm (A), and TEM micrographs of ultrathin section of chitin whisker/silk fibroin sponge at C/S ratios of 4/8; Bar, 200 nm (B).	83
5.2	Percent shrinkages of chitin whisker/silk fibroin sponges at various C/S ratio. *, $P < 0.05$; significant against the percent shrinkage of the neat silk fibroin sponges.	84
5.3	FTIR spectra of the as-prepared silk fibroin sponge (A), methanol-treated sponges at various C/S ratios (B to E), and chitin whisker film (F). Arrows indicate the absorption shoulder.	85

FIGURE	PAGE
CHAPTER V	
5.4 DSC thermograms of the methanol-treated silk fibroin sponge (A), the methanol-treated chitin whisker/silk fibroin sponges having different C/S ratios, 1/8 (B), 2/8 (C), 4/8 (D), and the freeze-dried chitin whisker (E).	86
5.5 Cross-sectional SEM micrographs of chitin whisker/silk fibroin sponges at C/S ratio of 0 (A), 1/8 (B), 2/8 (C) or 4/8 (D); and the corresponding methanol-treated sponges at C/S ratio of 0 (E), 1/8 (F), 2/8 (G) or 4/8 (H).	87
5.6 SEM micrographs of attached cells on methanol-treated silk fibroin sponges for (A) 6 and (B) 24 h of cultivation and SEM micrographs of attached cells on methanol-treated chitin whisker/silk fibroin sponges at C/S ratio of 4/8 for (C) 6 and (D) 24 h of cultivation.	89
5.7 Percent cell spreading of the L929 cells on methanol-treated neat silk fibroin sponges and methanol-treated chitin whisker/silk fibroin sponges having C/S ratio at 4:8, *, $P < 0.05$; significant against the percent cell spreading of methanol-treated neat silk fibroin sponges.	90
CHAPTER VI	
6.1 Chemical structures of (A) Phenol Red, (B) Chromotrope 2R, (C), Crystal violet and (D) Indoine blue.	114
6.2 ATR-FTIR spectra of a) as-cast, b) water-annealed and c) methanol-treated silk fibroin films.	115
6.3 Partition coefficients of (o) Chromotrope 2R and (●) Crystal violet by silk fibroin films at 30°C as a function of pH.	116

FIGURE		PAGE
CHAPTER VI		
6.4	Schematic illustration of the interactions between dyes and fibroin chains as a function of pH.	117
6.5	Release profiles of Chromotrope 2R (A & C) and Crystal violet (B & D) from dye-loaded silk fibroin films in different pH media.	118
CHAPTER VII		
7.1	Cross-sectional morphology of (A) the HFIP-derived and (B) the aqueous-derived silk fibroin scaffold. The average pore size of the HFIP-derived and aqueous-derived scaffolds was 479 ± 130 and 473 ± 146 μm , respectively.	147
7.2	<i>In vitro</i> degradation of HFIP-derived and aqueous-derived silk fibroin scaffolds. The concentration of protease XIV in the PBS was (A) 0.05 and (B) 0.5 $\text{mg}\cdot\text{ml}^{-1}$.	148
7.3	Release profile of bFGF from bFGF-impregnated HFIP-derived or aqueous-derived silk fibroin scaffolds submerged in PBS under strong shaking with periodic replacement with fresh PBS.	149
7.4	Release profile of the bFGF from bFGF-impregnated HFIP-derived or aqueous-derived silk fibroin scaffolds under the enzymatic degradation of the silk fibroin. After 24 h releasing in PBS, the release media was replaced by PBS containing protease XIV at (A) 0.05 or (B) 0.5 $\text{mg}\cdot\text{ml}^{-1}$.	150

FIGURE		PAGE
CHAPTER VII		
7.5	<i>In vivo</i> degradation of HFIP-derived or aqueous-derived silk fibroin scaffolds. Patterns of declining radioactivity in the backs of mice after subcutaneous implantation of the ^{125}I -labeled silk fibroin scaffolds. *, $P < 0.05$; significant against the group of aqueous-derived scaffolds.	151
7.6	<i>In vivo</i> release of the bFGF from bFGF-impregnated scaffolds. Patterns of declining radioactivity in the backs of mice after subcutaneous implantation of ^{125}I -labeled bFGF (●) impregnated in HFIP-derived or (○) aqueous-derived silk fibroin scaffolds, and the declining radioactivity of the ^{125}I -labeled bFGF (◆) by subcutaneous injection. *, $P < 0.05$; significant compared to every other groups.	152