CHAPTER I

INTRODUCTION

1.1 Background

Electrospinning has been recognized as a simple and versatile process to fabricate various polymeric and inorganic fibers by electrostatic force (Doshi J., *et.al.*, 1995; Travis J., *et.al.*, 2008). The applications of electrospun biomaterial fibers have been explored for vascular graft, wound dressing, tissue engineering scaffolds and drug delivery systems. These applications benefit from the high surface area of the fibers and high porosity (Jin H., *et.al.*, 2003). Among biomaterials used for medical applications, gelatin is one of attractive biopolymers since it is inexpensive, biocompatibility and biodegradability.

Gelatin is a natural biopolymer derived from collagen found in animal tissues such as skin, muscle, and bone. Type A and B gelatin microparticles were reported to use in the controlled release of bone morphogenetic protein-2 (BMP-2) by Patel Z. *et.al.* (2008). They found that type B gelatin microparticles were able to sustain the release of BMP-2 due to the attractive interaction, which depended on the opposite electrostatic charge of gelatin and BMP-2. In contrast, type A gelatin which showed positive charge, produced the repulsion force and caused the rapid release of BMP-2. The fabrication of gelatin into ultra-fine fibers by electrospinning has been recently reported (Songchotikunpan P., *et.al.*, 2008; Jeeratawatchai H., 2008). Previous work of our group by Jeeratawatchai (2008) showed that both type A and type B gelatin solution in formic acid can be spun into fiber. The presence of bead was found in both type of gelatin at low concentration (2.5%-30%w/v). The uniform fiber was produced when concentration reach up to 40%w/v. The obtained gelatin fiber mats were crosslinked via various methods including chemical and physical crosslinking. Among various chemical crosslinking techniques, solution spraying before direct soaking in 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide hydrochloride (EDC)

solution slightly reduced the weight loss of fiber mat while maintained the crosslinking percentage of each gelatin fiber mat compared to the case of direct soaking without spraying. However, the crosslinked electrospun fiber mats showed rapid degradation rate *in vitro*, which were not suitable for controlled release applications. Alternative material that is of interest for controlled release applications is the blended fiber mat of silk fibroin and gelatin. The presence of silk fibroin is expected to prolong the degradation rate of gelatin, possibly resulting in an appropriated controlled release of protein compound such as nerve growth factor, used to repair compression nerve injured.

Silk fiber has been used as biological sature for decades. Recently silk fibroin from silkworm is reconsidered as a potentially useful biomaterial for a range of applications in clinical repairs and scaffolds for tissue engineering due to its non-toxicity to cell, good mechanical properties and slow degradation rate (Ari T., *et.al.*, 2004; Kim U., *et.al.*, 2004; Horan R., *et.al.*, 2005). Silk fibroin uniform fiber mats were prepared by electrospinning from all aqueous solution (Chen C., *et.al.*, 2006) or acid solution (Ayutsede J., *et.al.*, 2005; Meechaisue C., *et.al.*, 2007). Silk fibroin film has been studied for controlled release applications. Hofmann S *et.al.*, (2006) investigated the effect of crystallinity of silk fibroin film after methanol treatment on release behavior of polysaccharide (dextran) and protein (horseradish peroxidase (HRP)). They found that, the increase in crystallinity resulted in the sustained release of dextran with molecular weight ranging from 4-40 kDa and HRP with no initial burst whereas for less crystallinity films sustained release was confined to the 40 kDa dextran.

Therefore, the aim of this study is to develop the electrospun fiber of blended Thai silk fibroin and gelatin. The morphology, physical and biological properties of the blended fiber mats will be investigated. The controlled release behavior of model compounds from the blended Thai silk fibroin/gelatin fiber mats will be focused.

1.2 Objectives

1.2.1 To develop Thai silk fibroin/gelatin electrospun fiber mats for controlled release of model compounds.

1.2.2 To study chemical, physical, and biological properties of Thai silk fibroin/gelatin electrospun fiber mats.

1.3 Scopes of Research

1.3.1 Prepare silk fibroin solution from cocoons of "Nangnoi srisaket1" silkworm.

1.3.2 Prepare 20%w/v of Thai silk fibroin/gelatin solution in formic acid.

1.3.3 Prepare Thai silk fibroin/gelatin fiber mat via electrospinning method. Parameters to be investigated is Thai silk fibroin/gelatin blending ratios : 80/20, 70/30, 60/40, 50/50, 40/60, 30/70, 20/80, 10/90 wt%

1.3.4 Characterize the following properties

- Properties of blended solution
    - Viscosity
    - Conductivity
- Properties of blended electrospun fiber mats
    - Morphology by scanning electron microscope (SEM)
    - Tensile test (wet condition)
    - Biodegradability in collagenase and phosphate buffer saline

1.3.5 Investigate the controlled release of methylene, azo-casein and nerve growth factor as model compounds

1.4 Expected Benefits

Thai silk fibroin/gelatin electrospun fiber mats will be developed for controlled release applications.