CHAPTER I
INTRODUCTION

In the formation of silk filament, the cocoon shell is composed of two proteins named fibroin, held together by a gum-like protein called "sericin". Removal of the sericin from silk fibroin is accomplished by a process called "degumming". Most of the sericin must be removed during raw silk production at the reeling mill and the other stages of silk processing. At present, sericin is mostly discarded in silk processing wastewater. If this sericin protein is recovered and recycled, it could lead to significant economic and social benefits.

The amount of sericin ranges from 19 to 28 percent according to the type of cocoon, usually the sericin content of the cocoon shell is at the maximum level at the outside layer 1 becoming progressively lower at the middle layers 2 and 3 and the minimum at the inside layer 4.

Protein $H\text{-}(HN\text{-}CHR\text{-}CO\text{-})_n\text{-}OH$

Table 1.1 Amount of the key amino acids in sericin

Amino acid	R	per 100 grams of protein
Serine	CH_2OH	30.1 g
Aspartic acid	CH_2COOH	16.8 g
Glutamic acid	CH_2CH_2COOH	10.1 g
Threonine	$CH(OH)CH_3$	8.5 g

Sericin is a complex protein composed of three distinct components (I, II, III) of which sericin III is the interior layer directly adjacent to the fibroin core. The sericin I outer layer is the most soluble of the three constituents, while sericin III is difficult to dissolve (Becker *et al.*1995)

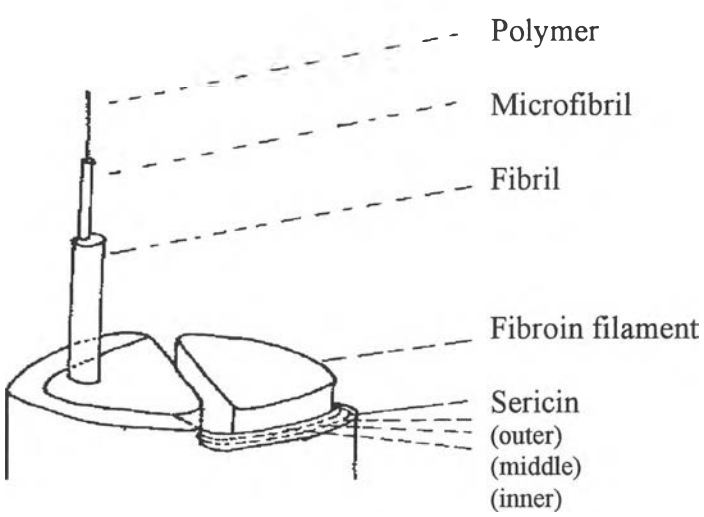


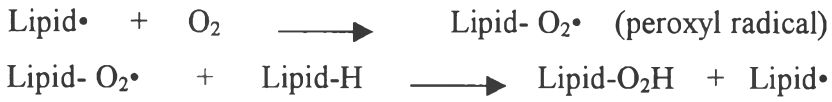
Figure 1.1 Three layers of sericin.

Sericin is a macromolecular protein. Its molecular weight ranges widely from about 10 to over 300 kDa. The sericin protein is made of 18 amino acids most of which have strongly polar side groups such as hydroxyl, carboxyl, and amino groups.

Sericin is a water-soluble protein. When sericin is dissolved in a polar solvent, hydrolyzed in acid or alkaline solutions, or degraded by a protease, the size of the resulting sericin molecules depends on factors such as temperature, pH, and the processing time. Lower-molecular weight sericin peptides or sericin hydrolysates are used in cosmetics including skincare and haircare products, health products, and medications. High-molecular weight sericin peptides are mostly used as medical biomaterials, degradable biomaterials, compound polymers, functional biomembranes, hydrogels, and functional fibers and fabrics.

A normal biological membrane consists of a phospholipid bilayer with proteins embedded in this molecular bilayer. The hydroxyl species (OH•) of the free radicals commonly attacks fatty acid chain and damage the membrane by removing a hydrogen atom from the carbon chain of the fatty acid. (See Scheme 1)

This lipid free radical C• generated in the hydrophobic interior of a membrane will then react with dissolved oxygen (O_2 is more soluble in lipid than water).



Scheme 1 Reaction of hydroxyl radical with lipid.

This reaction results in the damaging of the membrane. The hydroxyl radical is a highly reactive species that can drastically attack all biological molecules including lipid, DNA and protein by initiating a free radical chain reaction; it has an in vivo lifetime of only a few nanoseconds. Environmental free radicals enter human body through skin, respiration and other means. The main source of hydroxyl radical in both clean and polluted air is the photolysis of ozone (wavelenght (λ) below 310 nm) to produce a singlet oxygen atom, which may react with a water molecule to yield OH•. In polluted air, photodissociation of nitrous acid is a significant source of OH•. The environmental hydroxyl radical concentration is about $1x10^5$ molecule/cm^3 (Eisele *et al* .1991).

Toxic radicals are not only in the air, but are also part of some microorganisms. Fungi and bacteria are important factors influencing indoor air quality. A wide range of fungal and bacterial species can be isolated from indoor air. Outdoor air is thought to be an important source of indoor fungi. The study found Penicillium to be the most frequently isolated fungus in indoor air; the dominant bacteria were Bacillus, Staphylococcus and Micrococcus. Several health effects have been associated with fungal and bacterial species in the indoor environment. These

health effects include rhinitis, upper respiratory symptoms, asthma and other effects such as allergic skin reaction.

Filter media can be treated with an antibacterial/antifungi coating. This coating will keep the filter from being a potential incubator of mold, mildew, fungi and bacteria. The chemical inhibits the growth of these microorganisms in the filter media, thereby, reducing this risk. However, it is not likely that this treatment actually kills viruses or bacteria, which are airborne and pass through the filter, only those that would potentially grow on the filter (McIlvaine *et al.*1998).

Different species of silk cocoon have different properties of sericin depending on its amino acid composition and amount of each amino acid. This work studies the different actions on antioxidant and antimicrobial of three different cocoon species, shown in Table 1.2.

Table 1.2 Characteristic of silk cocoon

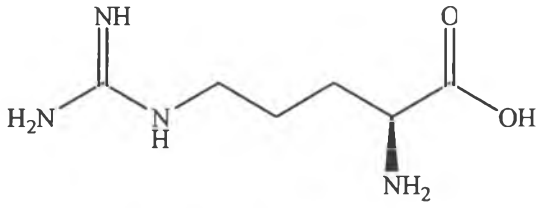
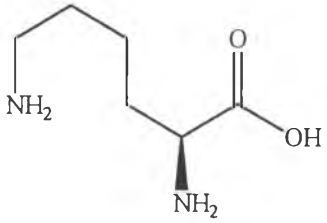
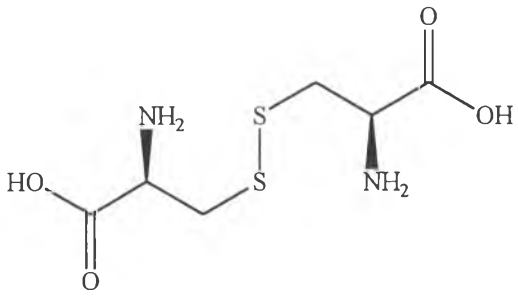
Name	Shape of cocoon	Cocoon Color	Country of Origin	Details
Nang Noi	Spindle	Yellow	Thai	Polyvoltine
Dok Bua	Oblong	Yellow	Thai + Japan	Polyvoltine x Bivoltine
Jul	Oblong	White	Japan	Bivoltine

There are three amino acids in sericin that have an interesting properties correlated with this study. Their properties and chemical structures are describes in Table 1.3 and Table 1.4, respectively.

Table 1.3 Properties of amino acid

Amino acid	Properties
Arginine	Improved immune responses to bacteria and viruses
Lysine	Effective against herpes by improving the balance of nutrients that reduce viral growth
Cystine	Functions as an antioxidant and is a powerful aid to the body in protecting against radiation and pollution

Table 1.4 The chemical structure and amount of amino acid in sericin

Name	Chemical Structure	Amount (mol %)
Arginine		3.58
Lysine		0.87
Cystine		0.20

As sericin has a high antioxidant and antibacterial activity, this means sericin can stop the oxidation reaction of hydroxyl radical and inhibit microorganisms growth leading to numerous diseases. The application of this study is to use sericin coated on fiber used as an air filter to reduce the amount of hydroxyl radical enter through the body and inhibit microorganisms growing on the air filter media.