CHAPTER I

INTRODUCTION

1.1 Statement of Problem

Human hair consists of approximately 65 to 95% proteins. The remaining constituents are water, lipids, pigment, and trace elements.[1] Hair in general can be damaged by chemical reactions taking place during waving, straightening, bleaching/dyeing as well as sunlight exposure. Treating with hair conditioner is commonly known as an effective way to revitalize and improve the quality of damaged hair. In general, cationic ingredients in a hair conditioner are highly attracted to hair because of hair's low isoelectric point, which are approximately 3.67 in cosmetically unaltered hair. At any pH above the isoelectric point, the surface of hair bears a net negative charge. Therefore, positively-charged molecules are attracted to it. Over the past few decades, polymers have become increasingly important components of hair conditioners. Cationic polymers, such as quaternary ammonium polymers, are used in hair conditioners. Polyquaternium-7 (copolymer of acrylamide and diallyldimethylammonium chloride) and polyquaternium-10 (quaternized hydroxyethylcellulose) are two most important polymers used in hair conditioners.[1] Hair products containing polymers help prevent mechanical damage, and maintain the strength and integrity of hair by reducing the force required to comb through the hair.

Chitosan is a polysaccharide obtained by partial deacetylation of chitin, a natural substance found abundantly in the exoskeletons of insects, the shells of crustaceans, and fungal cell walls. Chitosan has a number of unique characteristics such as biocompatibility and low toxicity, which attract scientific and industrial interest in cosmetic fields. Due to its limited solubility (only soluble in acidic aqueous at pH< 6.5), a number of chemical routes to improve its solubility have been introduced. Among them, changing the free amino groups in the chitosan chains to positively-charged quaternary ammonium groups is recognized as an effective way to enhance chitosan solubility in water. *N,N,N*-trimethylammonium chitosan chloride (TMC)[2] and *N*-[(2-

hydroxyl-3-trimethylammonium)propyl]chitosan chloride (HTACC)[3] are reportedly two positively charged derivatives that are water soluble and have been applied in biomaterials and textile.[3]

To the best of our knowledge, there are few studies discussing in detail the resulting effect of mixing chitosan or positive-charged chitosan derivatives in hair conditioners on the physical appearance and mechanical properties of human hair that was damaged by chemicals and UV. The purpose of this present study was therefore to evaluate the use of chitosan and its two positively charged derivatives, TMC and HTACC, in "leave-on" hair conditioners. Physical changes in terms of microscopic appearance, tensile strength of coated hair, as well as its chemical integrity were determined. Cytotoxicities in terms of IC_{50} or 50% inhibitory concentrations of each of the three polymers on human keratinocyte cell line (HaCaT) were also determined. Although a number of studies and patents have reported the use of chitosan in some hair-care products, this work aimed to provide a complete result of using chitosan and the two cationic derivatives as a cationic ingredient in the conditioner. The outcome of this study can definitely leads to commercial application of chitosan and its positively charged derivatives in hair-care industry.

1.2 Objectives

The objective was to evaluate the use of chitosan, TMC, and HTACC as additives in "leave-on" conditioners.

1.3 Scope of Investigation

The stepwise investigation was carried out as follows:

1. Literature survey for related research work.
2. Synthesis and characterization of two positively charged derivatives of chitosan having different degrees of quaternization.
3. *In vitro* cytotoxicity (IC_{50}) test of chitosan and its derivatives on human keratinocyte cells line or HaCaT cells line.

4. Preparation of "leave-on" conditioners containing chitosan or each of the two chitosan derivatives.
5. Preparation of cosmetically-treated and UV damaged hairs.
6. Preparation and characterization of conditioner-coated hair samples in terms of physical and mechanical properties.
7. Discussion of the results and summary.