

CHAPTER IV

CONCLUSION

In this work, chitosan-nanoparticles with UV absorption property were prepared. Phthaloylchitosan was first prepared by phthaloylation of chitosan to improve solubility property of the polymer. Grafting of mPEG-COOH (and 4-methoxycinnamic acid) onto phthaloylchitosan was done by using 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide, hydrochloride (EDCI) coupling agent and 1-hydroxy benzotriazole (HOBt) catalyst. Grafting of mPEG-COOH on chitosan gave mPEG-phthaloylchitosan with degree of substitution of 7% (Figure 4.1 A), Grafting of mPEG-COOH and 4-methoxycinnamic acid onto phthaloylchitosan gave mPEG-4-methoxycinnamoyl-phthaloylchitosan with degree of substitution of 0.313 and 5.7% for mPEG-COOH and 4-methoxycinnamic acid (Figure 4.1B). We could obtain nanoparticles directly from simple introducing hydrophobic/hydrophilic groups on chitosan chain under self-assembly mechanism by solvent displacement method. The chitosan-nanoparticles obtained from grafting only mPEG-COOH ($M_n = 5,100$ Dalton) show the average sizes in the range of 40-150 nm diameter as declared by TEM and SEM. However, the size of the obtained particles varied with concentration of the chitosan solution used during the self-assembly nanoparticles formation process. The result of the zeta potential indicates a marked negative charge of the mPEG-phthaloylchitosan particles (-30.3 mV). Average particle size distribution of the particles is 255 nm. Patch test (PT) and photopatch test (PTT) were selected as irritation tests for mPEG-phthaloylchitosan nanoparticles with UV absorption property. The results of patch test (PT) and photopatch test (PTT) of mPEG-phthaloylchitosan nanoparticles on forty volunteers indicated that the compound cannot trigger irritation on human skin.

Encapsulation of EHMC, ascorbyl palmitate and astaxanthin into mPEG-phthaloylchitosan nanoparticles could be successfully achieved with > 97% encapsulation efficiency (Table 4.1).

Table 4.1

Cosmetic actives	EHMC	Astaxanthin	Ascorbyl palmitate
% Encapsulation efficiency	97.65	100	100
% Weight of the active in the particle d (% w/w)	45	38.6	93.56

The result through $^1\text{H-NMR}$ indicated that the loaded EHMC into the particles was more photostable than the free EHMC after exposed UV light. Moreover, EHMC-loaded-particles that subjected to the investigation on the release of the loaded EHMC from the nanoparticles were indicated that the controlled release of the EHMC from the nanoparticles.

In this work, another type of chitosan-nanoparticles was prepared by grafting both mPEG-COOH ($M_n = 5,100$ Dalton) and 4-methoxycinnamic acid onto the phthaloylchitosan. The obtained particles show the average sizes in the range of 100-450 nm as declared by TEM and SEM. The result of the zeta potential indicated a marked negative charge of the mPEG-4-methoxycinnamoyl-phthaloylchitosan particles (-31.53 mV). Average particle size distribution of the particles is 295 nm.

Encapsulation of ascorbyl palmitate and astaxanthin into mPEG-4-methoxycinnamoyl-phthaloylchitosan nanoparticles could be successfully achieved with 100% encapsulation efficiency (EE) (Table 4.2).

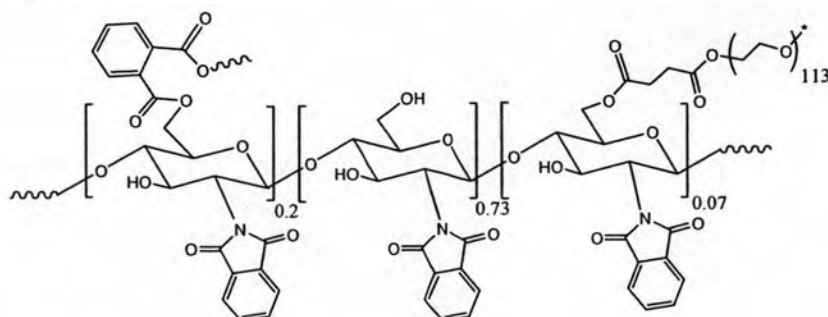
Table 4.2

Cosmetic actives	Astaxanthin	Ascorbyl palmitate
% Encapsulation efficiency	100	100
%Weight of the active in the particle e (% w/w)	22.13	68.88

Formulation study showed that mPEG 5000 and PEG 400 were the good stabilizer for particles **e**. Anti-microbial studied, mPEG-phthaloylchitosans and mPEG-4-methoxycinnamoyl-phthaloylchitosan nanoparticles can inhibit the growth of both *Staphylococcus aureus* ATCC 25923 and *Escherichia coli* ATCC 25922 bacteria.

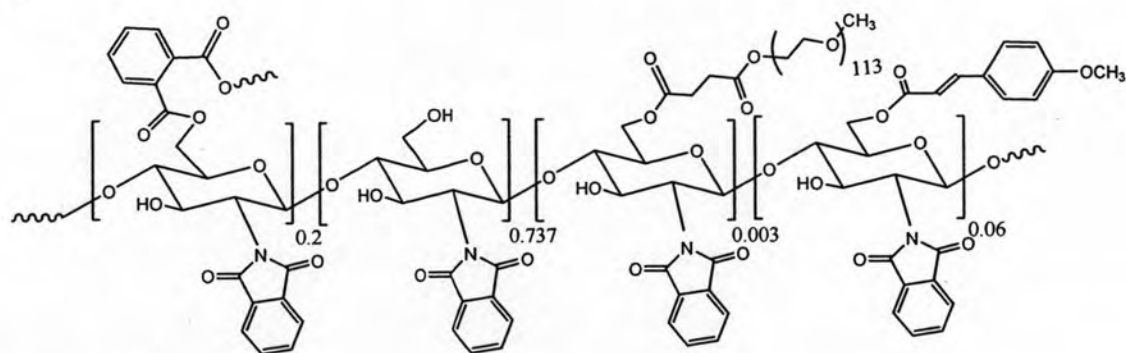
This work has successfully created stable chitosan nanoparticles. Application as cosmetic carrier was demonstrated. In the future, the work should, therefore, be extended to the systematic studies of nanoparticles application as a material for cosmetic delivery system. For example, the study of nanoparticles penetration across the stratum corneum and the release of the encapsulated cosmetic actives should be illustrated. Another part to be concerned is on formulation of cosmetic products using these nanoparticles.

A)



M.W. 428,402

B)



M.W. 218,748

Figure 4.1 A) mPEG-phthaloylchitosan B) mPEG-4-methoxycinnamoyl phthaloylchitosan