CHAPTER V

CONCLUSION

In order to find a novel system for reactive agent encapsulation applied for cosmetic usage. Emulsion system was selected. However, emulsion is thermodynamically instable owing to unfavorable contact between oil and water. Emulsifier was required to reduce interfacial tension and stabilize the emulsion. In this research, a novel emulsifier to stabilize emulsion system, or in other word, a novel nano-micelle carrier to deliver reactive substances was investigated. PCTS was selected as natural based emulsifier owing to its amphiphilic and amphoteric properties. Therefore in this research was divided into 2 parts. Emulsifying capability of PCTS, and its physical mechanism were investigated and concluded in Part 1. Emulsion destabilization factors and mechanism were investigated and concluded in Part 2.

Part 1: Emulsifying capability was determined in terms of Hydrophilic-Lipophilic Balance (HLB), Critical Micelle Concentration (CMC), emulsion type evaluation, and emulsifying efficiency. PCTS solution presented HLB around 19 which was preferable for O/W emulsion and CMC around 0.13 %w/v. Emulsion type was determined by varying water to oil ratio and measuring emulsion index. It was found that the appropriate water to oil ratio was 8:2. Drop test was used to confirm the continuous phase and found that the continuous phase was water. This indicated that PCTS would rather suitable emulsified for O/W emulsion. Then, emulsifying stability was studied in terms of storage appearance alteration and droplet size alteration. The emulsion droplets possessed constant although storage emulsion at room temperature for 90 days when using PCTS0.1 as emulsifier in the range of concentrations of 0.25-3.0%w/v. The emulsion was unstable after storage when using PCTS0.1 as emulsifier in lower concentration than CMC (0.063%w/v) and much high concentration (4%w/v). In order to explain the mechanism of unstable emulsion in detail, physical mechanism of unstable emulsion was investigated by observing the unstable emulsion droplets though confocal laser scanning microscope, and by evaluating the reversibility of stable-unstable emulsion under simple pH variation. Ionic levels (degree of substitution of phosphate group) were also considered as a factor influenced to physical mechanism of unstable emulsions. It can be concluded that the physical mechanism of unstable emulsion was flocculation for the emulsion preparing by using PCTS with DS lower than 0.65. When using PCTS with DS over than or equal to 0.65, the emulsion did not represent an unstable mechanism.

Part 2: Systematic conditions such as pH, ionic strength and temperature, were set to investigate the effect of destabilization of emulsion. Physical mechanism using to explain destabilized phenomena was discussed in detail in this part. Emulsion was prepared using 1%w/v PCTS as emulsifier and diluted in various environmental pH, ionic strength, and temperature. The emulsion using PCTS with DS 0.04 (coding E85/0.1) exhibited positive surface charges, whilst that of using PCTS with DS 0.25 and 0.62 (coding E85/1 and E85/2) exhibited negative surface charges. Those emulsions showed isoelectric points (pI) which shifted to lower pH as increasing DS. E85/0.1 gradually increased its droplets size above pI, whereas E85/1 and E85/2 maintained constant in their size, except agglomerate below pI. With increasing electrolyte concentrations in the range of 0.1-4 mM or 0.1-1 mM, the droplet size for those E85/0.1, E85/1 and E85/2 maintained constant without considering the surface charges. With increasing electrolyte concentrations more than or equal 6 mM for E85/0.1 and 2 mM for E85/1, E85/2, may cause to compress the electric double layer in a consequence of agglomeration. The surface mean diameter of E85/0.1, E85/1, and E85/2 increased abruptly around 50°C due to the water dehydration around PCTS molecule inducing more hydrophobic surface. The individual droplets became closer with hydrophobic interaction, resulting in agglomeration.

Therefore, it should be concluded that PCTS should be a new attractive polymer for using as emulsifier, i.e. reactive agents encapsulators, especially for pharmaceutical and drug delivery system, including in personal care products.

Future Aspects

Part 1

1. The hydrophobic and hydrophilic balance can be adjusted simply by varying DD of chitosan, so this hypothesis can be confirmed by measuring HLB of PCTS synthesized from various DD chitin-chitosan copolymer.

2. In order to support the confocal micrograph result and confirm either flocculation or coalescence, the physical mechanism of emulsion using PCTS as emulsifier at concentration of 0.063%w/v should also be investigated.

Part 2

1. In order to verify steric repulsive when varying temperature. The hydrodynamic radius of gyration of emulsion would be further investigated.

2. HLB is also a simple method to determine hydrophilicity when varying temperature.