Effects of Biodegradable Triblock Copolymers on the Microencapsulation of Ascorbic Acid-2-Glucoside in W₁/O/W₂ Multi-Emulsions

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Summary: A skin-active functional material, AA2G (ascorbic acid-2-glucoside, W₁ phase), was encapsulated via a stepwise emulsification method using PEO-PLGA-PEO and PEO-PCL-PEO biodegradable triblock copolymers as wall materials. The emulsion stability of the W₁/O/W₂ multi-emulsions was observed using a ferroxyl test method and on-line turbidity analysis for a short period of time. The morphology of the multi-emulsions was observed using the laser confocal and optical microscopes. The use of copolymers in W₁ phase was found to be more effective. The copolymers decreased the size of the multi-emulsions and enhanced emulsion stability.

Keywords: ascorbic acid-2-glucoside; biodegradable; emulsion stability; microencapsulation; triblock copolymers

Introduction

Until recently, various research works concerning the effective and stable delivery of functional materials had been carried out in a number of potential fields. A variety of method to carry active materials have been reported such as, micelles,[1,2] nanocapsules,[3,4] lipid and polymeric vesicles.[5] In addition, the representative techniques, like spray drying, double emulsion method and solvent evaporation have been established for nanocapsules.[4,6,7] Among the techniques, water in oil in water (W₁/O/W₂) has been regarded as a multi-emulsion system that contains water-soluble species in the inner aqueous phase (W₁ phase). This system can protect a variety of vulnerable functional materials from the surroundings, such as heat, oxygen, light, and pH levels. In addition colloidal stability could be enhanced. The W₁/O/W₂ multi-emulsions, however, are thermodynamically unstable and they often show phase separation as time goes on. To overcome this instability, a lot of works have been accomplished in the application field such as food, cosmetics, and pharmaceutics.[8–13] In this study, ascorbic acid-2-glucoside (AA2G), which is relatively more stable than pure Vitamin C, was dissolved in a W₁ phase and encapsulated using biodegradable and amphiphilic triblock copolymers, i.e., poly(ethylene oxide)-poly(lactic acid-co-glycolic acid)-poly(ethylene oxide) (PEO-PLGA-PEO) and poly(ethylene oxide)-poly(ε-caprolactone)-poly(ethylene oxide) (PEO-PCL-PEO). Concerning biodegradable copolymers in the encapsulation process, there has been a vast amount of published research. Michaout et al. suggested that the stability of multiple emulsions can be enhanced by using amphiphilic polyelectrolyte in the outer aqueous phase in multiple emulsions.[14] Ozer et al. studied stability by increasing viscosity induced by...