# $W_1/O/W_2$ Multi-emulsion Capsules Containing Ascorbic Acid-2-Glucoside Prepared Using PCL-based Amphiphilic Di- and Tri-block Copolymers

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## Introduction

Biodegradable and amphiphilic di-block and tri-block copolymers, prepared with monomethoxy poly ethylene glycol (MPEG) and ε-caprolactone (ε-CL), were used for the application of $W_1/O/W_2$ multi-emulsion capsules. The effects of topology and the ratio of hydrophilic moiety of PCL-based polymers on the encapsulation efficiency of the $W_1/O/W_2$ multi-emulsion capsules containing Ascorbic Acid-2-Glucoside (AA-2-G) was investigated. The ratio of PEG and PCL was 1:0.5, 1:0.75, 1:1, and 1:1.25. PEG-PCL block copolymers were added to the first step of the preparation of $W_1/O$ emulsions.

## Experimental

### Preparation of PEG-PCL di- and tri-block copolymers

8.06g of ε-caprolactone was purified at 120℃. Water was eliminated from PEG and it was dissolved in 80ml of toluene and then stannous octoate was added to the PEG solution. Reaction was conducted at 120℃ for 24h. After reaction, the product was isolated in 30ml of ethyl ether and then PEG-PCL di-block copolymer was obtained. For PEG-PCL tri-block copolymer, HMDI was added in PEG-PCL and reaction was conducted at 60℃ for 7h. The reaction mixture was precipitated in ethyl ether and the residual solvent was removed under vacuum

### Preparation of $W_1/O/W_2$ multi-emulsions using the PEG-PCL di- and tri-block copolymers

Water-in-oil-in-water ($W_1/O/W_2$) multi-emulsions were prepared by a stepwise emulsification method. First, $W_1/O$ emulsion was prepared in a selected surfactant system and the most suitable condition that had been determined by a trial-and-error experiment. $W_1/O/W_2$ multi-emulsion was prepared with the previous $W_1/O$ emulsion as same method. Several kinds of copolymers were tested as shown in Table 1.

**Table 1. Di- and tri-block copolymers used for the encapsulation of $W_1/O/W_2$ multi-emulsions containing AA-2-G**

| PEG-PCL | PEG-PCL | PEG:PCL | | M.W. |
|---|---|---|---|---|
| P1 | | 1:0.5 | MPEG | 2000 |
| 3000 | 2k-1k | | PCL(114) | 1000 |
| P2 | | 1:0.75 | MPEG | 2000 |
| 3500 | 2k-1.5k | | PCL(114) | 1500 |
| P3 | | 1:1 | MPEG | 2000 |
| 4000 | 2k-2k | | PCL(114) | 2000 |
| P4 | | 1:1.25 | MPEG | 2000 |
| 4500 | 2k-2k | | PCL(114) | 2500 |
| | PEG-PCL-PEG | PEG:PCL | | M.W. |
| P1' | | 1:0.5 | MPEG | 2000 |
| 6000 | 2k-2k-2k | | PCL(114) | 4000 |
| P2' | | 1:0.75 | MPEG | 2000 |
| 7000 | 2k-3k-2k | | PCL(114) | 5000 |
| P3' | | 1:1 | MPEG | 2000 |
| 8000 | 2k-4k-2k | | PCL(114) | 6000 |
| P4' | | 1:1.25 | MPEG | 2000 |
| 9000 | 2k-5k-2k | | PCL(114) | 7000 |

### Characterizations

Dispersion stability and morphology of the $W_1/O/W_2$ multi-emulsions were extensively investigated. The time-evolution particle size of the emulsion droplet was observed with dynamic light scattering method. Morphology of the emulsion droplet was observed with confocal microscopy (w/ FITC) and the stability of the emulsion was observed with Turbiscan. Release behavior of the emulsion was observed with HPLC and the degradable behavior of PEG-PCL block copolymers was observed with GPC.

## Results and discussion

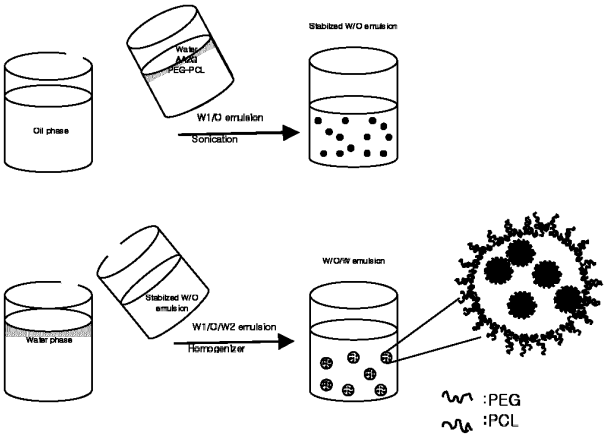


**Figure 1.** Schematics of the $W_1/O/W_2$ multi-emulsion capsules prepared by using PEG-PCL block copolymers.

For the preparation of $W_1/O/W_2$ multi-emulsion, the $W_1/O$ emulsions containing PEG-PCL di- and tri-block copolymers were dispersed in the aqueous solution, as shown in Figure 1. Figure 2 shows a representative Turbiscan profile of $W_1/O/W_2$ multi-emulsion without PEG-PCL.

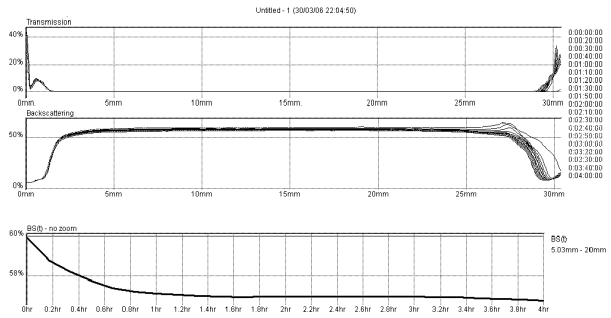


**Figure 2.** Turbiscan profile of $W_1/O/W_2$ multi-emulsion without PEG-PCL.

## Conclusions

Purpose of this study was the preparation of stable and well dispersed $W_1/O/W_2$ multi-emulsion containing bioactive material AA-2-G in inner water phase. Especially, the effect of the PEG-PCL block copolymers in W/O/W multi-emulsion was observed according to the various ratio of PEG-PCL block copolymer synthesized in laboratory. Biodegradability of PEG-PCL block copolymer observed by GPC was dependent upon the ratio of PEG and PCL. Also, release behavior of AA-2-G from encapsulated particle was measured by HPLC.
These results indicate that the PEG-PCL block copolymers are applicable materials in field such as food, cosmetic and drug delivery system.

## References

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