Bioactive Hybrid Microspheres for Bone Defect Filler

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Purpose of Study

Microsphere has been regarded as an important carrier for delivering proteins, peptides and genes, in the regeneration and repair of defective tissues. It is suggested that biodegradable polymers with bioactive inorganic species, i.e., hybrids may construct a new group of scaffolds appropriate for bone tissue engineering [1, 2]. In this research, we fabricated the gelatin-siloxane hybrid microsphere, and addressed its potential use in the bone regeneration field.

Materials and Methods

As a precursor for the microspheres, a gelatin solution containing appropriate amounts of siloxane and $CaCl_2$ was prepared. Type B gelatin was dissolved at 10 w/v % in distilled water at 40 ℃. 3-(glycidoxypropyl) trimethoxysilane and $CaCl_2$ were added to the solution at appropriate amounts. The microspheres were produced using the solvent extraction method via water-in-oil emulsion. The hybrid solution was added to oil bath containing emulsifier dropwise at various speeds which was maintained at 40 ℃ to form a micro-emulsion. After stirring, the oil bath was moved to water bath and induced gelation. Acetone was added to extract water and solidify the spheres, and followed by washing and filtering. The mineralization ability of the microspheres was examined in vitro. The structure and morphology of the hybrids were examined with XRD, FR-IR and SEM.

Results and Discussion

Under controlled emulsion conditions, microspheres were successfully obtained (Fig. 1). The average size of the microspheres was found to be ~7 μm at 650 rpm. Some particulates derived from $CaCl_2$ were also observed on the surface of the microspheres. Controlling the stirring speed and composition also modified the size of the microspheres: as the concentration of the material increased and the stirring speed decreased, the size of the microspheres increased. The obtained microspheres showed an excellent bioactivity, as observed in an in-vitro mineralization test using 1.5 SBF. After 3 days incubation, the surface of the microspheres was completely covered with calcium phosphate precipitates. Moreover, the incorporation of Ca within the hybrid also affected the degree of mineralization. When the Ca was not added within the composition, there was no indication of CaP precipitation within the test conditions. A study on the composition effect on the bioactivity of the hybrid microspheres is currently underway.

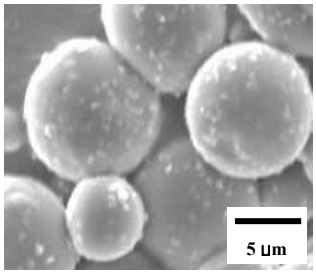

Fig. 1. Gelatin-Siloxane hybrid microsphere

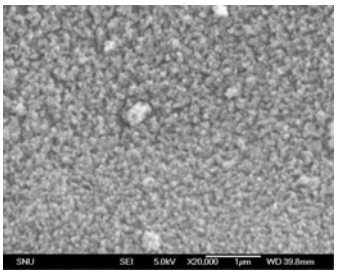

Fig. 2. Gelatin-Siloxane microsphere mineralized in 1.5SBF

Conclusions

The gelatin-siloxane hybrid microspheres were developed for the first time in this study. We observed the hybrid microsphere retained excellent in vitro bioactivity. Our developed bioactive microspheres are expected to be extensively useful in the bone regeneration field. Still further studies on the assessment of the cellular compatibility are warranted.

References

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