Biodegradable Sponges from Hydrocolloids as Sustained Release Drug Carrier Systems

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9 Summary of the study

Sponges based on hydrophilic water-swellable hydrocolloids which generally exhibit high biocompatibility show promise as highly efficient sustained release drug carrier systems for various routes of administration. In this study the sponges of chitosan, collagen and gelatin have been evaluated for their potential uses as prolonged release drug carriers.

Triamcinolone acetonide, a lipophilic glucocorticosteroid, was used as a model drug for the release experiments. The hydrocolloid sponges were loaded with the drug by physical mixture with the polymer solutions during process of foam formation. No band in IR spectra indicating drug-crosslinking agent or drug-polymer interaction was observed by FT-IR spectroscopy. From the SEM photos of all sponges it can be suggested that the microcrystalline drug associated with the sponge matrices in two ways ; it becomes embedded firmly to the surface and entrapped in the inner matrices.

Chitosan has no foam-forming property. Chitosan sponge-like sheets prepared by freeze-drying chitosan solutions containing dispersed drug exhibited excellent retarded drug release but poor mechanical properties. Drug release from both partially N-acetylated chitosan and crosslinked chitosan matrices was pH-dependent and was a function of the square root of time. The release of drug can be controlled by drug content, degree of deacetylation and crosslinking.

Gelatin is a good foaming agent. Gelatin sponges were produced by freeze-drying gelatin foams. Generation of gelatin foams and crosslinking were optimized. Concentration, amount and pH of gelatin solutions, temperature, speed and duration of whipping affected properties and stability of gelatin foams drastically. Water uptake and mechanical properties of gelatin sponges were affected by gelatin type and degree of crosslinking. Drug liberation from gelatin sponges was pH-dependent and controlled by the gelatin type, the extent of crosslinking and drug loading. The release of drug from the sponges was relatively fast due to the solubility of the gelatin matrices.

9. Summary of the study

Gelatin was incorporated as a foam builder in the production of chitosan-gelatin sponges to overcome the drawbacks of chitosan in mechanical properties and the disadvantage of gelatin in retardation of drug release. Gelatin type B was suitable for chitosan to form stable chitosan-gelatin foams whereas when using gelatin type A instable chitosan-gelatin foams were obtained. The chitosan-gelatin sponges were elastic and had a high water uptake capacity. The drug release from crosslinked chitosan-gelatin sponges was pH-independent and followed Higuchi's mechanism. Retardation of incorporated drug was effective over 36 h and can be controlled by varying chitosan-gelatin ratio, viscosity grade of chitosan, degree of crosslinking, drug loading and plasticizers. Polyion complexation between chitosan and gelatin was considered as an important role in prolongation of drug release from chitosan-gelatin sponges.

The collagen foams were prepared by using a simple hand-mixer. The collagen sponges were obtained after freeze-drying the foams. High capacity of the sponges on water uptake was observed. The sustained release of the drug from collagen and chitosan-collagen sponges was successful. The achieved retardation of drug release was a combined effect of both crosslinking and polyelectrolyte complexation between chitosan and collagen. The drug liberation was pH-dependent and followed Higuchi's mechanism. The extent of drug release can be controlled by degree of crosslinking, type of crosslinking agents, chitosan-collagen ratio, drug loading and pH of dissolution media.

Finally, the release characteristic of the drug from the hydrocolloid sponges was found to be highly dependent on the nature of the hydrocolloids used as foam builders. In general, crosslinking of the hydrocolloids reduced the release rate of the drug from the sponges by means of a decreased water solubility of the hydrocolloids. Drug release appeared to be a Fickian process.