Development and Optimization of Hydrogels, Oleogels, and Bigels as Topical Drug Delivery Systems for Periodontitis

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Abstract

Periodontal disease is a chronic inflammatory disease of gum and tissues that surround and support the teeth. One approach of treating periodontitis is loading the nonsteroidal anti-inflammatory drugs (NSAIDs) in topical drug delivery systems to ease swelling and inflammation symptoms. The objective of this study was to investigate the mechanical properties (rheological, bioadhesive, and cooling-heating cycle) and *in vitro* drug release for topical gel formulations of the NSAID Ibuprofen (hydrogel, oleogel, and bigels (Ibuprofen-loaded oleogel and Ibuprofen-loaded hydrogel)). Ibuprofen hydrogel was prepared using the gelling agent Carbopol® 971P. Whereas, Ibuprofen oleogel was prepared using the organogelator Compritol® 888. Bigels were prepared by combining Ibuprofen hydrogel and Ibuprofen oleogel. Each gel formulation was characterized in terms of its viscoelastic properties (elastic modulus G′ and viscous modulus G″), heating-cooling cycle, and bioadhesion properties using a controlled stress rheometer. The *in*

vitro drug release was investigated using Franz diffusion cells. The four gels exhibited elastic behavior, where G' dominated G" at all frequencies. Ibuprofen oleogel exhibited the highest viscoelastic properties, indicating the formation of strong gel. However, Ibuprofen hydrogel exhibited lower viscoelastic properties than those of bigels, indicating the formation of a weaker gel. A negative interaction was found between mucin dispersion, and Carbopol® hydrogel and Carbopol®/Compritol®. Whereas, a positive interaction was found between mucin dispersion and Compritol® oleogel. The heating-cooling cycle showed no crossover point (i.e G'=G"), in agreement with the elastic behavior of gels. The release of Ibuprofen from the four gels showed a controlled release pattern over 6 h. An enhancement in drug release was found in Ibuprofen bigels and oleogels. Our results provide valuable insights into the mechanical properties and *in vitro* diffusion studies for the four gels by which different gel formulations can modulate drug release from topical gels.