Designing a Smarter Smart Hydrogel: Optimization of Poly(vinyl alcohol)-Sodium Borate Hydrogels by Physical Crosslinking with Sodium Alginate for pH-Responsive Controlled Drug Delivery

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Poly(vinyl alcohol)-sodium borate hydrogels are promising candidates for controlled drug delivery because they are pH-responsive and biocompatible. However, they have weak single network structures that contribute to the rapid, not controlled, release of drugs. The purpose of this study was to investigate whether crosslinking PVA-borate hydrogels with varying concentrations of sodium alginate can optimize them for controlled drug release under acidic and alkaline conditions. It was hypothesized that PVA-borate hydrogels with 25 wt% sodium alginate would release the lowest concentration of loaded dye over time in acidic and alkaline solutions. PVA-borate hydrogels loaded with dye were physically crosslinked with 5, 10, 15, 20, or 25 wt% sodium alginate. The hydrogels were immersed in a 3.0 pH solution for 4 hours and a 7.4 pH solution for 8 hours. The absorbance of released dye was measured at different time intervals using a spectrophotometer. Data were analyzed using factorial ANOVA. Consistent with the hypotheses, hydrogels with 25 wt% sodium alginate released the least concentration of dye in both solutions over time. Increasing the sodium alginate concentration had a significant effect on final released dye concentrations in both solutions ($p<0.05$). Hydrogels with 20 wt% and 25 wt% sodium alginate exhibited slower and more sustained drug release profiles compared to the other hydrogels in both solutions. This study showed that PVA-borate hydrogels with 20 wt% or 25 wt% sodium alginate are suitable for the controlled oral delivery of drugs to the lower gastrointestinal tract and controlled direct delivery of anti-cancer drugs to tumor sites.

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