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Molecular Weight Degradation of Hyaluronic Acid

Methacrylated hyaluronan (HA-MA) hydrogels are novel biomaterials with promising applications as cell scaffolds for tissue regeneration. The performance of cell scaffolds is in part dependent on their mechanical properties, which in turn are linked to the molecular weight of their constituent polymers. Polymer cleavage occurs during the modification of HA by methacrylation, making the predicting of final molecular weights difficult. An approximation of molecular weight degradation due to methacrylation was conducted under the Barrett Scholarship. By testing the molecular weight of simple hyaluronan (HA) over time throughout a range of simulated reaction conditions, the parameters responsible for degradation are identified and the degradation rates quantified. This data is the first step in the creation of a model to accurately predict final HA-MA molecular weights. Solutions were prepared of 1.5 MDa HA in deionized water, varying the parameters of pH and concentration. A Peltier plate controlled the parameter of temperature. Viscosity measurements were taken over an hour at a constant strain rate for each sample. Mark-Houwink constants were determined by logarithmically plotting intrinsic viscosity against known starting molecular weights and calculating the slope and y-intercept of the line. Molecular weight degradation over time was determined by relating temporal viscosity to molecular weight via the Mark-Houwink equation. The validity of these methods was tested against controlled degradation of HA with a different starting molecular weight. It was found that each parameter investigated had a distinct effect on the rate of degradation. By quantifying these effects, this study opens the possibility of monitoring and controlling the reaction conditions of methacrylation to yield products with particularly desirable molecular weights. When molecular weight can finally be controlled, more rigorous investigation can be undertaken into the quantitative effects of degree of modification and concentration on the mechanical properties of HA-MA hydrogels.