TAILORED SCAFFOLDS AS MEDICAL DEVICES IN BIOMEDICAL ENGINEERING: A SYSTEMATIC AND QUANTITATIVE STUDY OF GELATIN GELS IN CELL CULTURE MEDIUM

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ABSTRACT

In the dynamic field of biomedical engineering, there is a continuously growing interest in medical devices based on gelatin gels, attributed to the remarkable properties of gelatin, including biocompatibility, biodegradability, versatility, and distinctive sol-gel transition characteristics. It is well-established that the mechanical and structural properties are pivotal in tissue engineering scaffold design; however, based on the current literature there is no systematic or quantitative understanding of these factors. At the same time, even if the importance of understanding gelatin behavior in realistic physiological conditions for optimal biomedical relevance is strongly emphasized, the interaction dynamics between gelatin and the prominent complex solvent in biological cell cultures, Dulbecco's Modified Eagle Medium (DMEM), remain largely under-investigated. In this interdisciplinary study, a quantitative investigation of the mechanical and structural changes of gelatin gels in cell culture medium is for the first time presented, through rheological and Differential Scanning Calorimetry (DSC) analyses as well as imaging techniques. Employing a rigorous approach, the mechanical behavior and structural properties of both type A and type B gelatin are examined under physiological conditions across a broad concentration spectrum, ranging from 0.5% to 42% w/v in DMEM, providing an understanding beyond the conventional parameters of water or phosphate buffer solution (PBS). Additionally, departing from practices that often involve cross-linking gelatin for enhanced stability, this study uniquely emphasizes the intrinsic properties of each gelatin type. Independently establishing the influence of gelatin type, concentration, and temperature, a large body of systematic experimental data is collected and fitted, leading for the first time to equations that describe the rheological properties and the stability of gelatin gels as well as their structural transitions, thus defining different concentration regimes. It is highlighted that both gelatin types have similar melting behavior and the vertical shift of gelatin's type B curve emerges as a predictive metric for information about gelatin type A, within reasonable accuracy frameworks. This comprehensive approach not only offers valuable insights into the structural behavior of gelatin gels but also provides a fundamental quantitative foundation that can enhance their *a priori* control, leading to the design of tailored and innovative medical devices for diverse biomedical applications.

KEYWORDS: Gelatin gel, DMEM, Tailored medical device, Rheology