Characterization of hydrogels for their application in tissue regeneration

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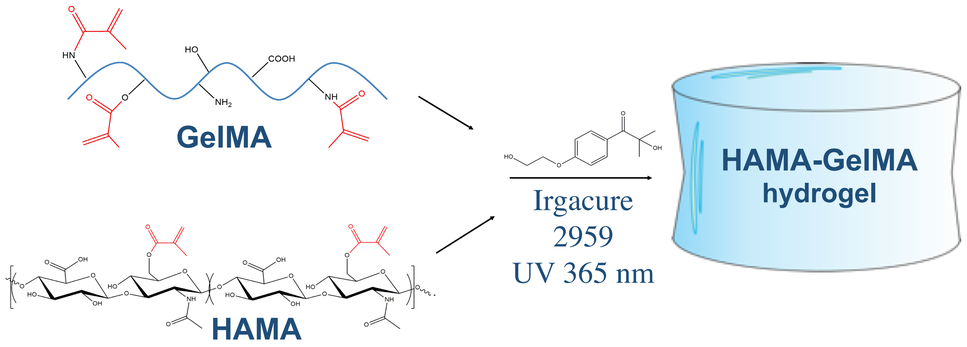
INTRODUCTION

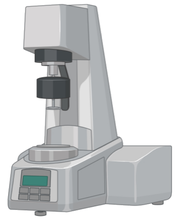
Neurodegenerative diseases as, for example, Parkinson´s (PD), Alzheimer´s (AD), and Huntington´s (HD), are responsible for around 9.4 million global death[1]. These disorders are the consequence of neurogenesis alterations that cause irreparable loss of brain nerve tissue. In this regard, hydrogels based on natural biopolymers have attractive properties, such as excellent biocompatibility, a low immune response[2], and a significant similarity to the extracellular matrix (ECM) of tissues, thus supporting cell proliferation and migration[3].

Therefore, the methacrylation of HA (HAMA) and Gel (GelMA) through carboxyl and hydroxyl groups can produce polymeric scaffolds with elastic modules similar to tissues. HAMA and GelMA hydrogels were cross-linked under UV light to determine rheological behavior. This was followed by in vitro experiments to confirm their suitability to adhere, host, and facilitate proliferation and differentiation of cells[4]. We could approve that these novel biopolymer hydrogels can potentially act as a replacement for damaged tissue caused by neurodegenerative diseases.

METHODOLOGY

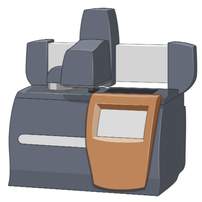


Rheology



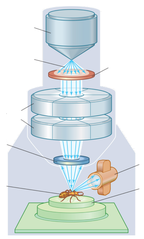
Frequency sweep:
Frequency: **0.1-100 Hz**
Temperature: **37ºC**
Strain: **1%**

TGA



Sample weight: **3-8 mg**
Temperature range: **40-800ºC**
Heating rate: **10 ºC/min**
Flow rate nitrogen: **60 mL/min**

SEM



Samples were prepared by cryo-fracturing freeze-dried. The samples were analyzed after iridium coating (~10 nm).

RESULTS

Figure 1 shows G' and G'' vs. the logarithm of the frequency for the HAMA-GelMA hydrogels. The dominant behavior for all hydrogels is elastic because of the entire frequency range, G' is remarkably greater than G''.

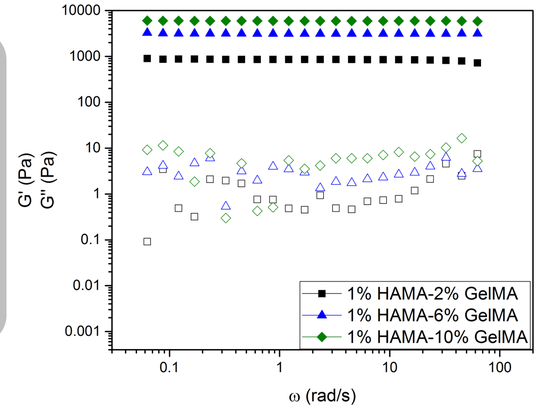


Figure 1.- Frequency dependence of storage modulus (G') and loss modulus (G'').

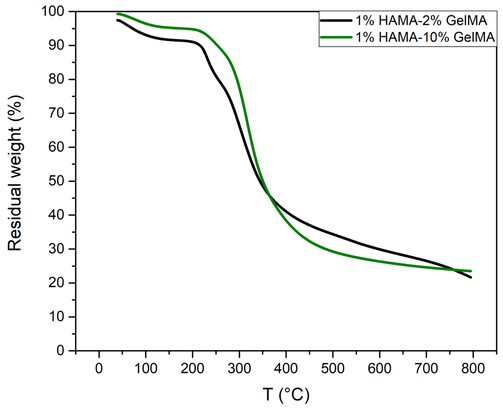


Figure 2.- TGA spectra of HAMA-GelMA hydrogels.

Figure 2 shows the weight loss curves for HAMA-GelMA hydrogels. The first step loss in the range 40-170ºC is attributed to the loss of moisture from the sample. However, the second step loss starting at 250 ° C is due to the decomposition of the polymeric network.

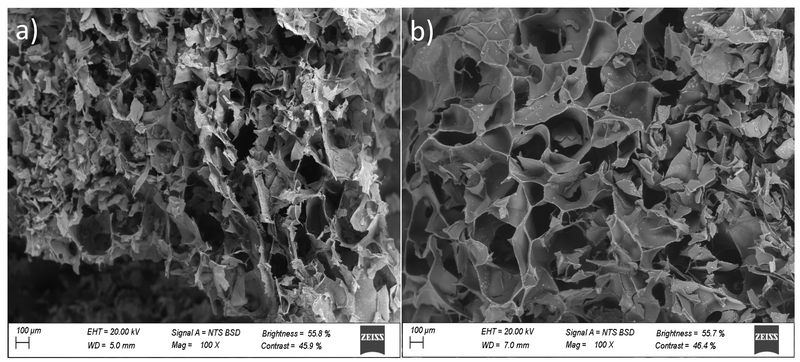


Figure 3.- Micrographs of a) 1% HAMA-2% GelMA and b) 1% HAMA-6% GelMA hydrogels.

Figure 3 shows the morphology of the GelMA-HAMA hydrogel mixtures with defined and homogeneous pores. An increment in the concentration of GelMA results in a better defined porous structure.

CONCLUSIONS

The mechanical properties of these hydrogels show a remarkable increase in the storage modulus as the GelMA concentration grows. Additionally, TGA results indicate a significant improvement in HAMA-GelMA hydrogel's thermal properties compared to hydrogels composed of each component separately. Finally, the micrographs show a homogeneous porous network.

These hydrogels are appropriated for the release of drugs as well as for tissue regeneration as these results indicate.

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