The effect of temperature on the rheological behaviour of chitin/gelatin hydrogels for 3D printing

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In this work, chitin/gelatin hydrogels were prepared for 3D printing. The incorporation of chitin into gelatin-based ink is a novel approach to improve cellular adhesion and protect cells from bacterial colonization. First, rheological analysis was carried out to determine the temperature range for 3D printing. As can be observed in Figure 1a, viscosity values decreased when shear rate increased, indicating that hydrogels showed shear thinning behaviour, a favourable performance for 3D printing. Regarding G' and G" moduli (Figure 2b), these values did not change a lot at different frequencies. Hydrogels showed higher storage modulus (G´) than loss modulus (G´´) and, thus, tan $\delta < 1$. Therefore, it can be said that hydrogels had solid-like behaviour[1]. The two moduli joined at high frequency values.

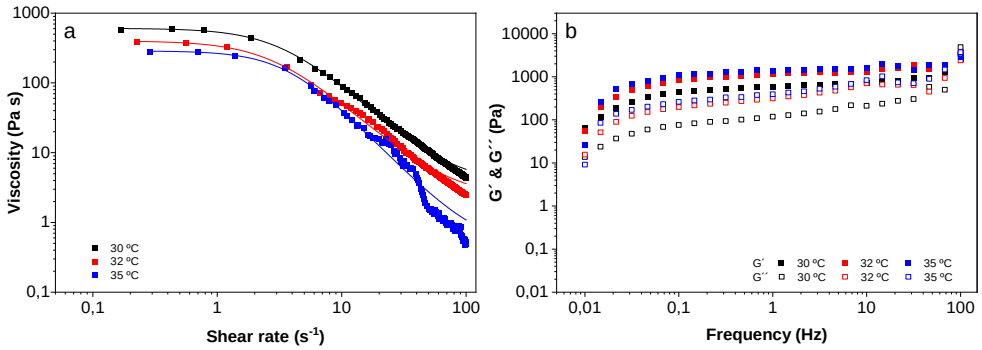

Figure 1: (a) Shear sweep and (b) frequency sweep tests for chitin/gelatin hydrogels at 30, 32 and 35 ºC.

Additionally, the effect of temperature on viscosity was also assessed. Viscosity values were reduced from 30 to 35 ºC. This effect is favorable for 3D printing, because low viscosities are required to facilitate material extrusion through the nozzle (high shear values)[2]. However, in addition to rheological properties, other factors must be considered in order to select the most appropriate temperature for 3D printing. In this work, since chitin sedimentation on the tip can cause nozzle clogging, 32 ºC was selected to ensure a homogenous chitin dispersion in the extruded hydrogel.

[1] S. Tian, et al., *Bioprinting.* **23**, e00156 (2021).
[2] S. C. Lee, et al., *Chem. Rev.* **120**, 10834 (2020).