Guanosine hydrogels for tissue regeneration: stability and mechanical properties

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It is well known that guanosine hydrogel (G-hydrogel) is a supramolecular and physical biomaterial, composed of guanine derivatives, such as guanosine (Gua) and guanosine 5'-monophosphate (GMP). These molecules self-assemble, first forming the planar tetrameric structures called G-quartets, and then the G-quadruplexes through pi-pi stacking interactions [1, 2]. The balance between the negatively charged GMP and the uncharged Gua gives rise to the formation of a hydrogel with a water concentration of up to 99% v/v, which appears transparent and stable at room temperature. The wide range of fields in which the G-hydrogel may find applications is remarkable. Indeed, we demonstrated its use as a molecular filter for pollutant remediation, as a drug delivery system, but also in tissue engineering. Regarding this point, the G-hydrogel can be used as a scaffold for cell growth. In this regard, modulating the chemical-physics properties is essential not only to avoid the dissolution of the hydrogel within the cell medium but also to ensure the formation of spheroids [3].

We report a systematic structural and rheological characterization of G-hydrogels prepared under different conditions. The chosen hydrogel composition has a molar ratio Gua/GMP 1:1 and 90% water. Moreover, samples were formulated by varying the concentration of additives that act as stabilisers of the 3D network, such as spermine, spermidine, $MgCl_2$ and glycerol. Samples were analyzed using rheology, dynamic light scattering (DLS), X-ray diffraction (XRD) and small-angle X-ray scattering (SAXS). Swelling behaviour and transition temperatures were also evaluated. The combined data provide insight into how different additives modulate gel viscosity, stiffness, internal structure, elasticity, and thermal response, contributing to the rational design of tunable guanosine-based soft materials for biotechnological applications, such as tissue engineering.

[1]Carducci F. et al., *Soft matter*, 2018

[2]Pepe A. et al., *Nanoscale*, 2023

[3]Pepe A. et al., J. *Phys. Chem. B*, 2025