Green synthesis of silver nanoparticles incorporated in alginate hydrogels using olive leaf extract as the reducing agent and crosslinker

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Silver nanoparticles (AgNPs) have been successfully utilized in biomedicine due to their antibacterial and antimicrobial activity (Tzani et al., 2017). Green synthesis of nanoparticles using biological resources such as plants, bacteria, algae, and fungi has gained great interest from researchers. The phytochemical-mediated synthetic approach is a clean, effective, non-toxic, and nature-friendly viable approach for silver nanoparticles synthesis, to combat the problems associated with physical and chemical routes (Alshehri and Malik, 2020).

Natural Deep Eutectic Solvents (NADES) are mixtures of two or more natural occurring components, a hydrogen bond acceptor and a hydrogen bond donor, with a low-temperature eutectic point. Due to their high biodegradability potential, NADES are used in research for the development of greener processes and have a wide variety of applications(Tzani et al., 2021). In the present work, NADES were used as extraction solvents, in order to obtain an extract with high antioxidant (thus reducing) activity and as crosslinkers for the formation of hydrogels.

Olive leaves biowaste were extracted using a NADES consisting of glucose and lactic acid. The "as-obtained" extract efficiently acted as the reducing agent for the formation of silver nanoparticles in alginate hydrogels in the presence of visible light. This approach does not require the addition of a crosslinking agent because this role is played by the NADES.

The photo-induced phytomediated *in situ* synthesis of AgNPs within a hydrogel is a highly promising, economical and environmentally friendly method for the preparation of multifunctional materials.

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