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Production of protein nanofibers using alternative solvents for the design of innovative functional materials

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PURPOSE OF THE ABSTRACT

The production of chemicals, materials, fuels and energy is nowadays progressively moving in the direction of renewable resources, and there is a growing interest on the use of polysaccharides, such as cellulose, pullulan and chitosan for the development of new sustainable materials with distinct functionalities and applications. Proteins are also gaining increasing attention as singular components for multi-functional biomaterials. The assembly of proteins into long and insoluble ordered fibrillar structures (protein nanofibers) is a very recent and promising strategy for the development of nanosized reinforcing elements for bionanocomposites, with applications ranging from medicine to soft matter and nanotechnology [1,2].
In this work, hen egg white lysozyme (HEWL) was fibrillated with alternative solvents as ionic liquids (ILs) and deep eutectic solvents (DES), which reveal to accelerate the fibrillation process and to reduce the time of conventional methods from 15 h down to 2 h [3-5]. Furthermore, the potential of the obtained protein nanofibers as reinforcing elements was evaluated by preparing pullulan-based nanocomposite films containing lysozyme nanofibers with different aspect-ratios, resulting in highly homogenous and transparent films with improved mechanical performance, particularly for the nanofibers with higher aspect-ratios. Furthermore, the incorporation of lysozyme nanofibers in the pullulan films imparted them also with bioactive functionalities, namely antioxidant capacity and antibacterial activity against Staphylococcus aureus [6]. Lysozyme nanofibers were also blended with nanocellulose fibers to produce a sustainable sorbent film to be used in the removal of mercury (II) from natural waters, where the presence of lysozyme nanofibers demonstrated to increase expressively the mercury (II) removal with efficiencies higher than 80%, using realistic concentrations of mercury (II) under the limit established in the European Union regulations (50 ug L-1).
In sum, the use of ionic liquids and deep eutectic solvents can accelerate the formation of long and thin lysozyme nanofibers that can be explored as nanosized reinforcing elements for the development of new materials with applications ranging from food packaging to water purification systems and nanotechnology.

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FIGURES

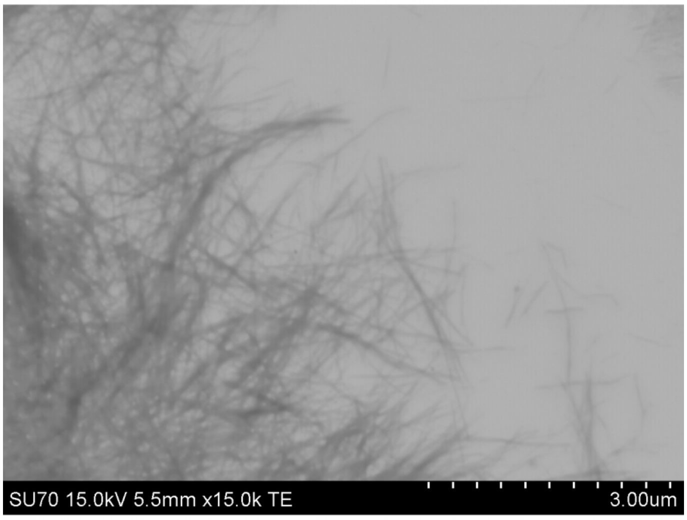

FIGURE 1

Figure 1

STEM image of lysozyme nanofibers produced by deep eutectic solvents.

FIGURE 2

KEYWORDS

Protein nanofibers | Ionic Liquids | Deep Eutectic Solvents | Innovative Materials

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