Freezing influence in KGM hydrogels aiming application as biomaterials

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Introduction:

Konjac glucomannan (KGM) is a neutral polysaccharide extracted from the tuber of Amorphophallus konjac C. Koch with excellent biocompatibility and biodegradability. It produces a thermally stable hydrogel in the presence of an alkaline coagulant[1]. This hydrogel can be used as scaffold in tissue engineering.

The development of new materials in tissue engineering is an important topic in biomaterial research. These materials are generally porous because they need to support cells growth and they must have adequate mechanical properties to support the efforts that it will be submitted. Freezing is a method used to improve the size and quantity of pores in some materials[2]. In this context, this study evaluated the morphologic and mechanical properties differences between frozen KGM hydrogels and the KGM hydrogels kept at room conditions.

Materials and Methods:

The KGM (Konjac glucomannan powders, Konjac foods, China) solution 2 wt % was prepared with distilled water. Samples with about 40 g of solution were heated at 65 °C for 1 h. Then, 2 mL of 0.2 M calcium hydroxide was added and mixed quickly. Some samples were frozen in conventional freezer (- 6 °C) and the others were kept at room temperature for two days.

For scanning electron microscopy (SEM) the samples were immersed in liquid nitrogen and freeze-dried to analyze the structure of porous. Confined compression tests were performed in the hydrogels in cylindrical shape (diameter = 20 mm; height = 20 mm), on a TA.XT2 texture analyzer (Stable Microsystems SMD), with a 1 kg load cell and at room conditions. The probe of 12.7 mm in diameter was used and the samples were tested at 0.2 mm/s. The compression strength was evaluated when the probe penetrated 1 cm into the samples. Previously to the test, the frozen samples were kept at room temperature to completely thaw.

Results:

The porosity was evaluated by SEM. The images are shown in Figure 1.

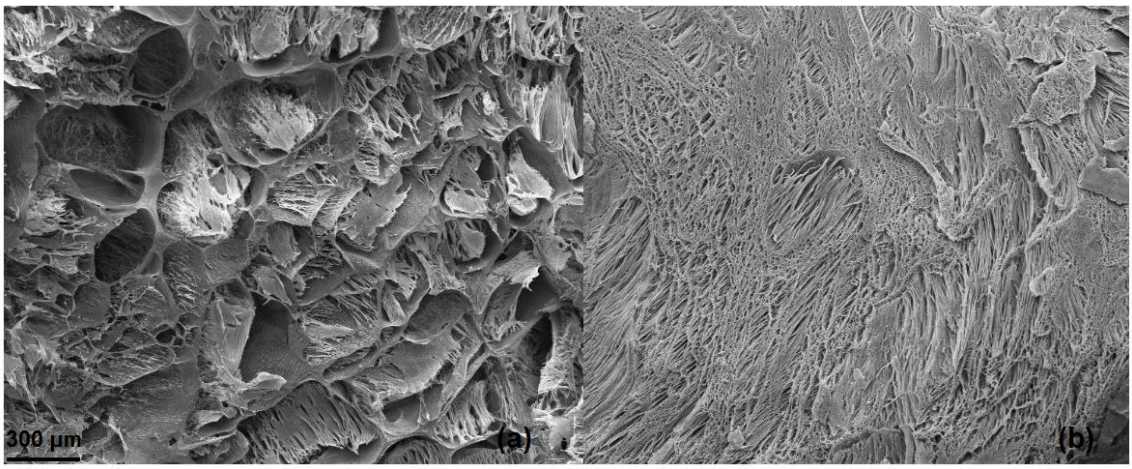

Figure 1 – SEM images (100 x) to (a) hydrogel frozen at – 6 °C and (b) hydrogel at room temperature.

The confined compression tests were used to available the strength of hydrogels with and without freezing (Figure 2).

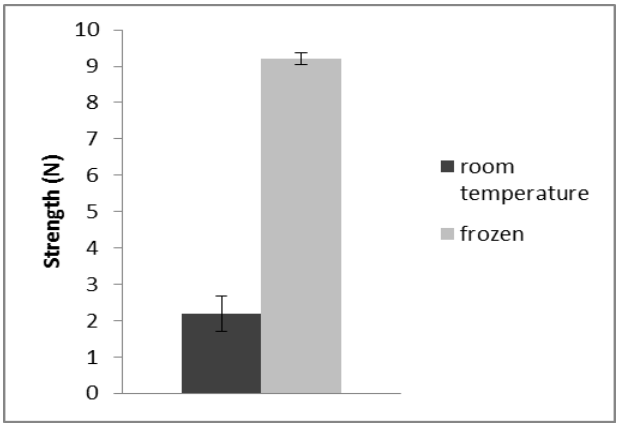

Figure 2 – Confined compression results to KGM hydrogel

Discussion:

The main aim of freezing the hydrogels is to increase the pores size and reinforce the mechanical properties. This occurs due to the formation of ice crystals that grow and confine the polymer chains, increasing the contact between them, and creating regions of high density of polymer, that are stable when thawed[3]. In Figure 1 (a), it is possible to observe that junction zones appear in the frozen hydrogel. Also, there are regions of polymer agglomeration and the porous size is bigger than the KGM hydrogel prepared at room temperature, Figure 1 (b).

The mechanical strength of the hydrogels is hardly increased by freezing, as shown in Figure 2. The hydrogels that were frozen are about 4 times more resistant than the hydrogels kept at room temperature.

The present study shows that freezing can be an interesting tool to prepare highly porous and more resistant KGM hydrogels.

References:

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