Centrifugal spun fibers-based scaffolds for tissue regeneration

Biopharmaceutics and Formulation Development Laboratory

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EWMA — Society of Tissue Viability

INTRODUCTION

Background. Wound healing is the physiological process that restores tissue integrity (1). To enhance the biological response, four-dimensional (4D) scaffolds, which are 3D platforms that react to external stimuli, have been developed (2). In this scenario, electrical stimulation has a proven therapeutic role in medicine, especially in the treatment of pain and wounds since it can support tissues biological functions, enhancing cell proliferation (3).

Aim of the work. Given these premises, the **aim** of the present study was the design and the manufacturing of 4D scaffolds based on polycaprolactone (PCL) and collagen (COL) fibers, enriched with graphene oxide (GO), via centrifugal spinning, for wound healing. GO was added as it is a conductive material that promotes the passage of the electrical current, and, after skin electrical stimulation, it should enhance cell regeneration and adhesion together with antibacterial activity.

METHODS

PCL-COL (10:1 weight ratio) blends were prepared in acetic acid 96% v/v and subjected to centrifugal spinning. GO was added to PCL-COL blend at 4 different concentrations (0.5, 1, 2, 5 % w/w). The final formulations, which have been subjected to further studies, are reported in ***Table I.***

Table I: Quali/quantitative composition of blends based on PCL and COL, enriched with GO, dissolved in acetic acid 96°

Blends	PCL:COL	GO (%w/w)
PCL-COL-GO 0	10:1	0
PCL-COL-GO 0.5	10:1	0.5
PCL-COL-GO 1	10:1	1
PCL-COL-GO 2	10:1	2

The **morphological** and **dimensional analyse**s were carried out by scanning electron microscopy (Phenom Pure G6 Desktop SEM, Thermo Fisher Scientific, Alfatest, Italy). Moreover, **mechanical properties** were evaluated by means of a Texture Analyzer (TAXT Plus, Stable Micro Systems, UK). Force at break (MPa) and maximum elongation % at break point were assessed on both dry and hydrated samples. .

The **degradation of fibers** was investigated by keeping each sample in PBS at 37 °C in a water bath for 28 days. **Contact angle** (Contact Angle Meter DMe-211 Plus) was performed to assess wettability of the scaffolds: a droplet of water was captured every 100 ms for 30 times (total time of 3000 ms).

RESULTS

SEM CHARACTERIZATION

Fibers are characterized by smooth surface and regular dimensions of about 4 μm (***Figure 1***). The addition of the GO to the composition do not induce a statistically significant decrease of the fibers dimensions.

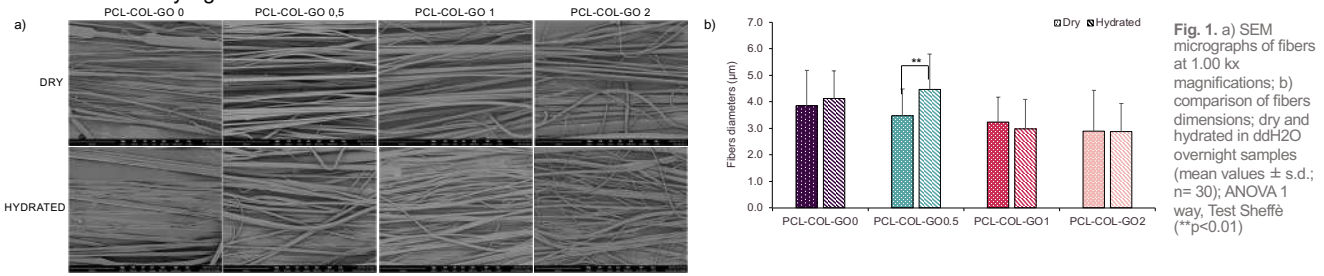

Fig. 1. a) SEM micrographs of fibers at 1.00 kx magnifications; b) comparison of fibers dimensions; dry and hydrated in ddH2O overnight samples (mean values ± s.d.; n= 30); ANOVA 1 way, Test Sheffè (**p<0.01)

WETTABILITY

All scaffolds are characterized by a contact angle lower than 90°, suggesting a hydrophilic surface that should support cell attachment (***Figure 3***).

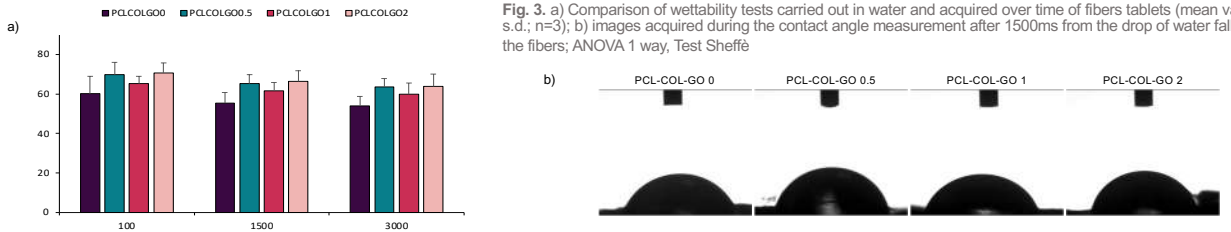

Fig. 3. a) Comparison of wettability tests carried out in water and acquired over time of fibers tablets (mean values ± s.d.; n=3); b) images acquired during the contact angle measurement after 1500ms from the drop of water falling on the fibers; ANOVA 1 way, Test Sheffè

MECHANICAL PROPERTIES

Figure 4 shows the values of force at break point (Fmax). The addition of GO to the formulation do not impact on the structure strength and stiffness: no statistically significant changes in the values of force at break point occurs. Similarly, the hydration process do not affect the scaffolds resistance.

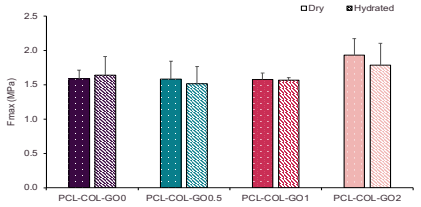

Fig. 4. Values of maximum force (MPa) at break point; dry and overnight water hydrated scaffolds (mean values ± s.d.; n= 3); ANOVA 1 way, Test Sheffè

DEGRADATION TEST

Weight loss % was measured overtime until 28 days (***Figure 5***). Scaffolds appear resistant to degradation as the weight is maintained and no statistically significant differences are recorded among the formulations or physical mixtures, except for PCL-COL and PCL-COL-GO 0.5 after 28 days.

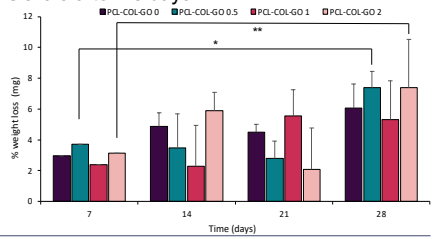

Fig. 5. % weight loss of scaffolds fibers 28 days (mean values, ±s.d.; n = 3); ANOVA 1 way, Test Sheffè (*p<0.05 **p<0.01)

CONCLUSIONS

PCL-COL fibers, loaded with GO, have been successfully developed via centrifugal spinning avoiding toxic solvents. The structure stiffness is maintained even after the addition of collagen and GO. Further investigations are on-going to prove scaffolds electrical conductivity and assess safety and efficacy on in-vitro and in-vivo models.

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References

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