ICAM2009
11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25

Composite PLLA-PCL Fibrous Scaffolds For Improved Mechanical Strength and Better Biological Performance

S. Soliman(1), F. Pagliari(2), A. Rinaldi(1), P. Di Nardo(2), S. Licoccia(1), E. Traversa(1)*

(1) Department of Chemical Science and Technology, University of Rome Tor Vergata, Via della Ricerca Scientifica 1, 00133 Rome, Italy, e-mail: traversa@uniroma2.it
(2) Department of Internal Medicine, University of Rome Tor Vergata, Via della Ricerca Scientifica 1, 00133 Rome, Italy.
* Corresponding author.

Abstract – While Poly-L-lactic acid (PLLA) is a good base material for tissue engineering scaffolds due to its biocompatibility and ability to interact actively with cells, it has weak mechanical properties. The purpose of this study was to improve the mechanical properties of PLLA without sacrificing biological performance. We used Poly(ε-caprolactone) (PCL) as a stiffening compound. Composites made of PLLA/PCL surpassed the performance of the pure PCL and PLLA in terms of cells adhesion and proliferation

To fabricate engineered tissues, a specific cell population should be combined with a scaffold made of properly processed polymer materials. The scaffold mechanical properties are crucial for tissue engineering applications since they fundamentally influence the biological functionality of the engineered tissue [1]. Aliphatic polyesters, such as Poly-L-lactic acid (PLLA) and Poly(ε-caprolactone) (PCL), are currently widely studied biodegradable polymers. Although PLLA is biocompatible and able to actively interact with cells, its mechanical properties are too weak for electrospinning processing. The purpose of this study is to fine-tune the mechanical properties of PLLA, increasing its toughness without sacrificing biological performance, by the addition of PCL to fabricate composite scaffolds. PCL is also a bioabsorbable polymer and is more ductile than PLLA, having a lower glass transition temperature. Using PCL as reinforcement agent is expected to improve the mechanical properties of PLLA scaffolds.

In this work, we used two methods for this aim: (i) blending PLLA with PCL, and (ii) forming an electrospun combined mesh of PLLA and PCL fibers using a modified setup. Scanning electron microscopy (SEM) was used to characterize the morphology/geometry of the fibers and tensile tests were performed to investigate their mechanical properties. The biological validation of the produced scaffolds was performed in vitro using cardiac stem cells (CSCs) from adult mammalian heart. Cell viability and morphology were tested using an MTT assay and immunofluorescence on the scaffolds seeded with stem cells after 24, 48, and 72 h.

Mechanical testing showed that PCL improved the stiffness of PLLA. The biological validation showed that cells adhered preferentially on PLLA rather than on PCL, but the PCL and PLLA mixture surpassed the performance of pure PCL and PLLA in terms of adhesion and proliferation (Fig.1). The PLLA-PCL composite scaffolds retained the mechanical properties of PCL and the biological characteristics of PLLA, showing promise for applications in regenerative medicine.

Table 1: Characterization of the scaffolds.

Scaffold type	Fiber diameter ω, mean ± RMS (μm)	Average Young's modulus (MPa)
PLLA	2.1 ± 0.56	0.2
PCL	2.4 ± 0.43	2.5
Blend	2.3 ± 0.21	1.6
Mixtures	PLLA (2.3 ± 0.34) PCL (1.85 ± 0.61)	1.1

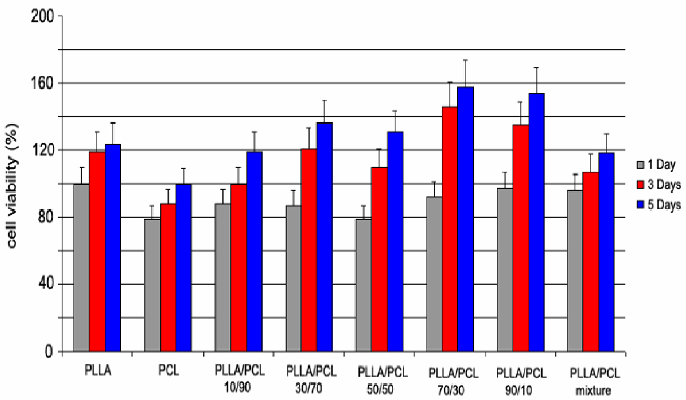

Figure 1: MTT assay after 1, 3, and 5 days in culture.

References

[1] G. Forte, F. Carotenuto, F. Pagliari, S. Pagliari, P. Cossa, R. Fiaccavento, A. Ahluwalia, G. Vozzi, B. Vinci, A. Serafino, A. Rinaldi, E. Traversa, L. Carosella. M. Minieri, P. Di Nardo. Stem Cells 26 (2008) 2093-2103.