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ABSTRACT

Evaluation of different combinations of biomaterials for bone regeneration

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Introduction

Although many works can be found in the literature where the use of PLA/β-TCP composite scaffolds is investigated for bone regeneration [1], no references have been found about the simultaneous addition of $CaCO_3$ and β-TCP to 3D printed PLA-based scaffolds.

Materials and methods

Materials

Pellets of PLAL130 were kindly supplied by Corbion Purac. Commercial grade calcium carbonate 0179-500G with a particle size of 30 µm was purchased from VWR, while β-tricalcium phosphate (β-TCP) was kindly provided by the 3B's Research Group of Universidade do Minho with a mean particle size of 45 µm.

Manufacturing of the samples

The following blends were performed under compression moulding (wt:wt): PLA:$CaCO_3$ 95:5, PLA:β-TCP 95:5, PLA:$CaCO_3$:β-TCP 90:2.5:2.5.

Water Contact Angle Measurement (WCA)

The WCA was determined at room temperature using an optical contact angle measuring device by measuring the static contact angle of 2 µL distilled water droplets onto the surface of the samples. The test was carried out both on dry and pre-wetted samples.

Mechanical Characterization

The 3 points bending test was carried out using a MTS universal testing machine in displacement control mode at a crosshead speed of 1 mm/min.

Results

Water Contact Angle Measurement (WCA)

From the WCA values for samples in pre-wetted state it can be concluded that the addition of $CaCO_3$ and β-TCP effectively reduce the hydrophobicity of the PLA matrix, as very highly statistically significant difference ($p<0.001$) between the groups of samples containing additives and the group of PLA samples were obtained.

Table 1. Water contact angle values of pre-wetted samples.

Material	WCA in pre-wetted state (°)
PLA	88.85 ± 2.24
PLA:$CaCO_3$ 95:5	84.34 ± 4.17 [1]
PLA:β-TCP 95:5	83.56 ± 3.59 [1]
PLA:$CaCO_3$:β-TCP 95:2.5:2.5	84.05 ± 3.46 [1]

[1]***$p<0.001$ compared to the group of pure PLA samples.

Mechanical Characterization

The value of the flexural modulus and the maximum flexural stress remains unchanged between the groups ($p>0.05$), with the first property ranging from 3.1 to 3.3 GPa, and being the second one between 19-23 MPa for the four groups of samples evaluated.

Conclusions

The decrease of the hydrophobicity of the composite samples could lead to enhanced cell attachment [2]. In this way, it would be possible to adjust the characteristics of the scaffold for bone regeneration to achieve greater cell adhesion ability while maintaining the mechanical properties of the base material.

References

1. Lou, T. et al (2014). Fabrication of PLLA/β-TCP nanocomposite scaffolds with hierarchical porosity for bone tissue engineering. International Journal of Biological Macromolecules, 69, 464-470.

2. Perez, R. A., & Mestres, G. (2016). Role of pore size and morphology in musculo-skeletal tissue regeneration. Materials Science and Engineering C, 61, 922-939.