PCL and PLGA particles containing vitamins A and D for bone regeneration

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Purpose/Objectives

Vitamin D plays a pivotal role in calcium homeostasis and bone metabolism, whereas vitamin A deficiency can result in delayed bone growth and reduced bone mineral density. This study's objective was to produce, characterize and test poly(caprolactone) (PCL) and poly(lactide-co-glycolide) (PLGA) particles containing cholecalciferol and retinyl acetate in order to assist bone regeneration.

Methodology

The particles were prepared by solvent displacement, whereby water and surfactant were dripped into an oil phase of polymers (PCL or PLGA) dissolved in acetone, containing or not vitamins A and D. The product was subjected to a characterization in terms of their size and zeta potential and the viability was evaluated via MTT assay, following a one-day exposure to particles holding 0.77UI/ml vitamin A and 0.15UI/ml vitamin D.

Results

All of the particles exhibited a negative zeta potential, detailed in Figure 1. It was found micrometric size for the formulations by Z-Average, however the peak 1, the first and most important, was nanometric using Zetasizer equipment (Figure 1A). By optical microscopy/ImageJ, PCL formulations can be characterized as micrometrical, with size above the detection limit of the Zetasizer of 10 µm (Figure 2C, 2D).

A

	ZP (mV)		Pk 1 size (nm)		Z-Ave size (nm)	
Formulation	Mean	SD	Mean	SD	Mean	SD
PLGA	-61	1	205	34	1704	108
PLGA/Vit	-58	1	220	50	1161	340
PCL	-36	2	150	66	2627	469
PCL/vit	-43	2	74	82	3571	1161

B

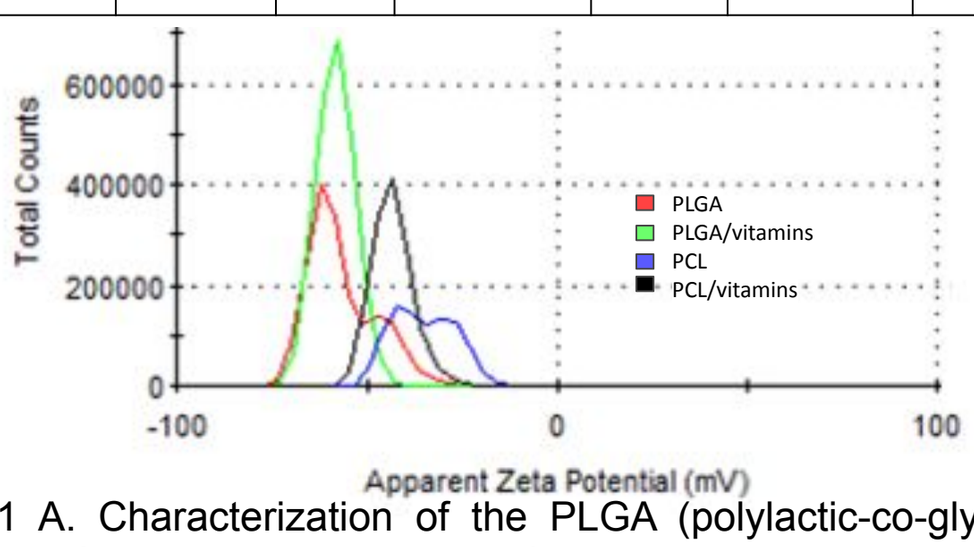

Figure 1 A. Characterization of the PLGA (polylactic-co-glycolic acid) and PCL (poly-ε-caprolactone) formulations, with and without incorporated vitamins. A) Table containing the data on zeta potential (ZP), size of the first peak (Pk 1) and average size (Z-Ave). B) Distribution graph of the zeta potential of the different formulations).

Results

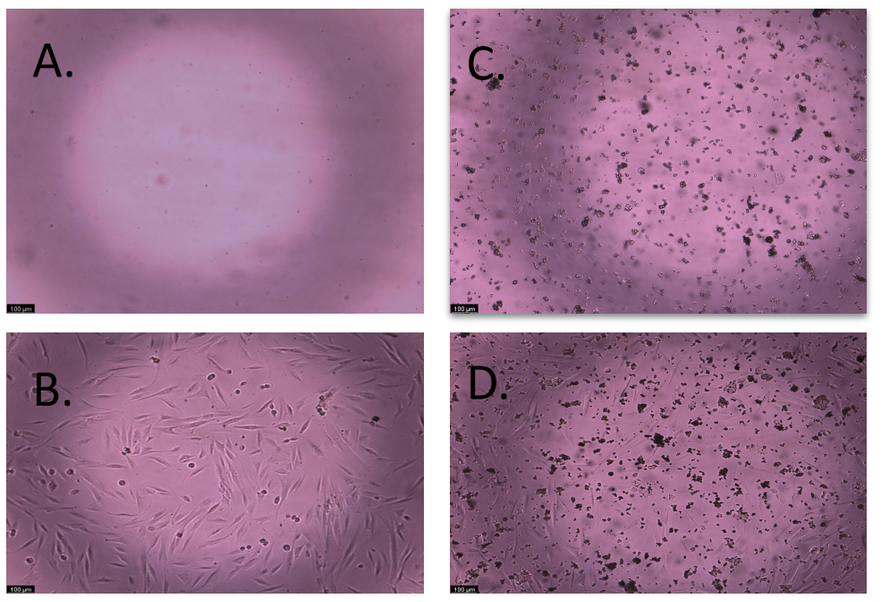

Figure 2. Optical microscopy of: A) PLGA/vitamins particles, B) PLGA/vitamins treatment on the stem cells, C) PCL/vitamins particles, D) PCL/vitamin treatment on the stem cells.

The particles containing vitamins did not significantly affect stem cell viability (p=0.560), as indicated by the absorbance values for stem cells incubated with PLGA, PLGA/vitamins, PCL and PCL/vitamins formulations (Figure 3). In spite of that, the particles presented no cytotoxicity.

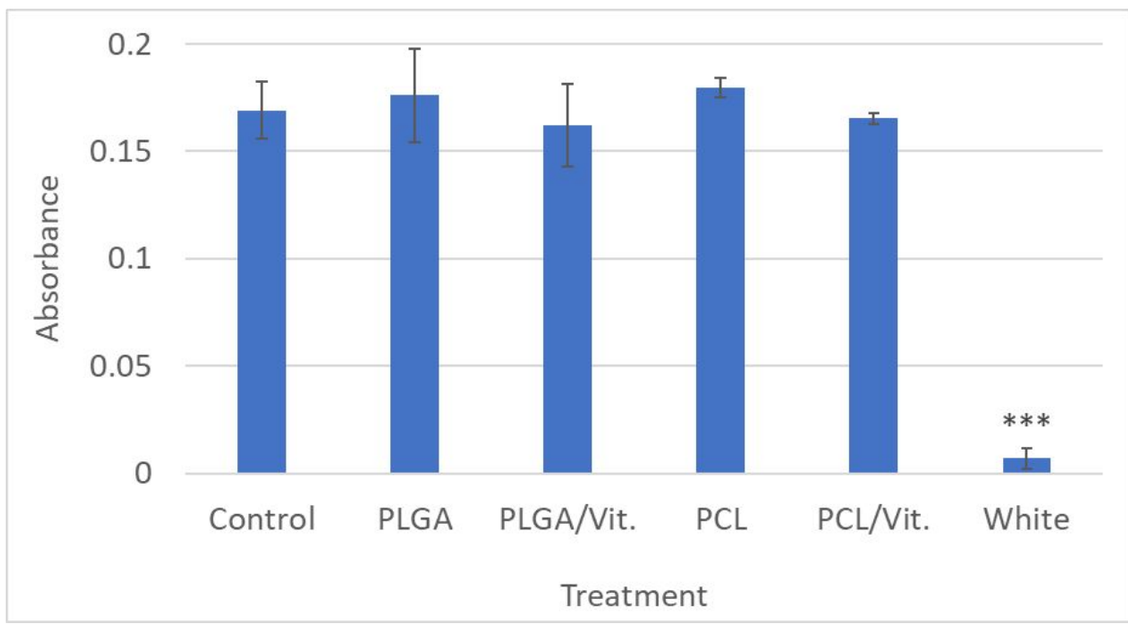

Figure 3. MTT results for viability comparing control (wells without particles), PLGA, PLGA/vitamin, PCL, PCL/vitamin and white (wells without cells) after a one-day exposure to treatment. Data expressed as mean ± standard deviation, with ***p=0.000.

Conclusion/Significance

The reached dimensions point to a nano- and micrometric particulate, a high negative surface zeta potential and low dispersion, results that indicate effectiveness on the used methodology for particle synthesis. Both the PCL and PLGA particles associated with vitamins have proven not to be cytotoxic, which can guide its applicability on bone regeneration strategies, incorporating the particles in bioink.

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