Poly(butylene succinate) and poly(3-hydroxybutyrate-co-3-hydroxyvalerate) blend nanofibers for skin tissue engineering

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Statement of Purpose: Skin damages can cause serious health problems, as they do not heal quickly or completely. Biodegradable scaffolds have been prepared for promoting tissue regeneration as they disappear after the cells start producing their own extracellular matrix (ECM).[1] Nanofibrous scaffolds can provide contact guidance to cells and orient them apart from promoting cell adhesion, infiltration and spreading.[2] Poly(butylene succinate) PBSu and poly(3-hydroxybutyrate-co-3-hydroxyvalerate) PHBV are biocompatible and biodegradable polymers. The objective of this work is to fabricate a blend nanofibrous scaffold of these two polymers which can be used as a scaffold for skin tissue engineering.

Materials: PBSu-PHBV (1:1) blend nanofibers was fabricated through electrospinning by optimizing the operating and solution parameters. The surface morphology of the polymeric scaffold was examined by field emission scanning electron microscopy (FE-SEM, JSM 6701F, JEOL, Japan). Mouse fibroblasts (L929) and human keratinocytes (HaCaTs) cytoskeletal morphology, adhesion and cell proliferation on the PBSu-PHBV scaffold were investigated.

Results: Figure 1 shows the surface morphology of electrospun PBSu-PHBV nanofibers. The average fiber diameters were found to be 419±55 nm.

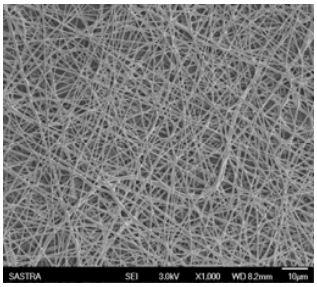

Figure 1.
Surface morphology of PBSu-PHBV nanofiber.

L929 and HaCaTs adhered and proliferated well on the blend nanofibrous scaffold (Figure 2). After 1, 3 and 7 days of culture there was a time dependent increase in cell proliferation. However, after 7 days of culture L929 proliferation was lesser than TCPS control.

Further, to assess the suitability of the scaffold for skin regeneration, the cytoskeletal protein actin and focal adhesion protein vinculin of the adhered L929 cells were immunostained to evaluate the cell-scaffold interactions (Figure 3). Cytoskeletal and viability staining of the L929 cells cultured on the scaffold showed extended morphology which suggest the positive cues provided by the nanofibrous scaffold to the growing cells.

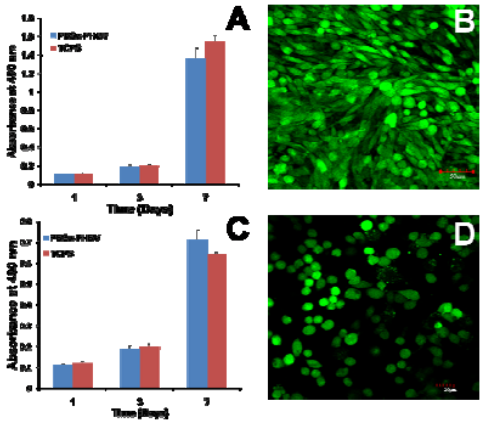

Figure 2. L929 fibroblasts [A] Proliferation; [B] viability; HaCaTs proliferation [C] ; and viability [D] on the PBSu-PHBV blend nanofibers

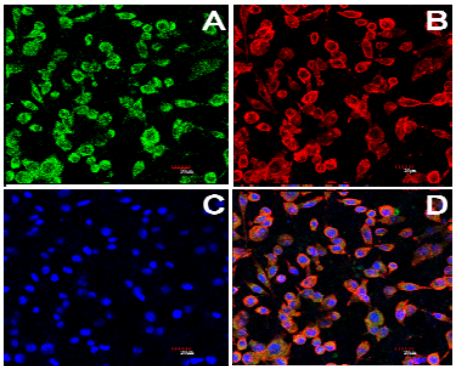

Figure 3. Focal contacts of L929 stained using anti-Vinculin monoclonal antibody and IgG FITC-conjugated secondary antibody [A]; F-actin was detected using rhodamine-phalloidin [B]; Nucleus stained with Hoechst [C]. [D] Overlaid image of [A], [B], and [C].

Conclusions: Defect-free PBSu-PHBV blend nanofibers were fabricated and the average nanofiber diameter was found to be 419±55 nm. This scaffold was found to support the adhesion and proliferation of skin epidermal cells (HaCaTs) and skin dermal cells (fibroblasts) Therefore, this novel blend nanofibrous scaffold can be used as a scaffold for skin damages.

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References:

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2. Sundaramurthi D et al. Biomed. Mater. 2012;7:1-12