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The Effect of Processing Temperature on Mechanical Properties of Novel Silk Fibroin and Chitosan Blend Scaffolds for Musculoskeletal Regeneration

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A major goal in tissue engineering is to fully restore functional musculoskeletal tissue by stimulating and guiding the body's capacity to regenerate using specially engineered and tissue responsive biomaterials. For example, fabricate bone to restore defects in the maxillofacial skeleton secondary to tumor resection or the effects of radiation and chemotherapy. One challenge in tissue engineering is the lack of biomaterials that are tissue conductive and lead to functional tissues. The role of biomaterials is to provide an extracellular matrix-like surface for the cells to infiltrate into and form three dimensional tissues. The extracellular matrix consists of collagen, which provides a supporting network, strength, and cell adhesion properties, and glycoaminoglycans, which provide water storage, compressive properties, and growth factor reservoirs. We have developed a library of biomaterials consisting of two natural polymers, silk fibroin and chitosan (SFCS), that can mimic these extracellular matrix properties, provide unique structural and mechanical properties, and promote a matrix for guided blood vessel assembly and cell infiltration. In a study by Gobin et al [1], SFCS blend scaffolds demonstrated an *in vivo* regeneration of three-dimensional tissue bridging layers of muscle and fascia, integrated seamlessly with adjacent native tissue interface, and provided mechanical properties similar to adjacent tissue by four weeks. In addition, preliminary findings indicate that SFCS blend scaffolds support bone regeneration in an *in vivo* sheep model (data not shown).

In this study, we assessed the mechanical strength of nine different SFCS blend scaffolds consisting of 25:75, 50:50, and 75:25 SF:CS, that were processed at the temperatures of -20°C (N=5),-80°C (N=4) [2], and -190°C (N=5). Stress vs. strain curves were obtained on the EnduraTech ELF 3200 mechanical tester using a 1000g load cell. Elastic moduli and ultimate tensile strength data were determined for all samples and statistically analyzed using one-way ANOVA (**Fig. 1**). The ultimate tensile strengths were similar for 50:50 and 75:25 blend scaffolds prepared by the three freezing temperatures. SFCS blend of 25:75 ratio prepared at -190°C was twice as strong as compared to the 25:75 blend scaffolds prepared at -20°C and -80°C ($p < 0.05$). The elastic moduli of the 25:75 and 75:25 blend scaffolds prepared at -20°C were significantly higher than those prepared at -80°C ($p < 0.01$ and $p < 0.05$, respectively).

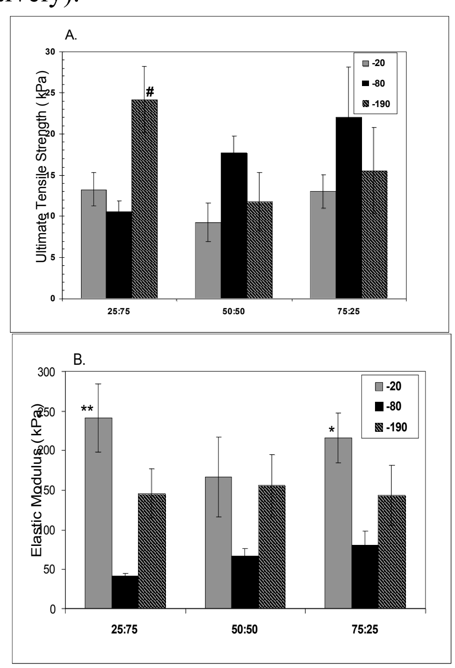

Figure 1 : A comparison of the (**A**) Ultimate Tensile Strengths and (**B**) Elastic Moduli of three

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silk fibroin to chitosan blend scaffolds prepared at the three processing temperatures. # Indicates $p < 0.05$ as compared to -20°C and -80°C. ** Indicates $p < 0.01$ and * indicates $p < 0.05$ as compared to -80°C.

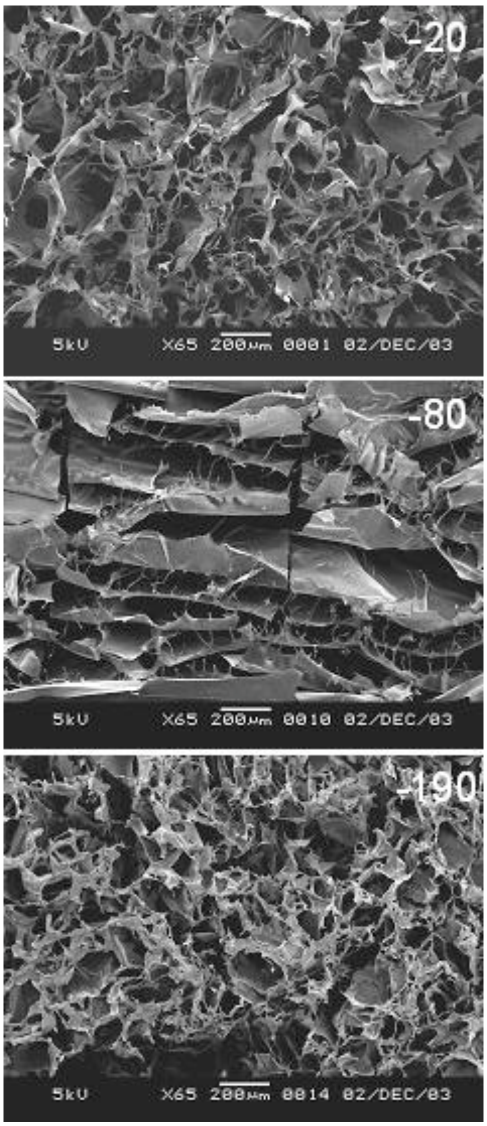

Figure 2 : SEM images of 50:50 SFCS blend scaffolds at three different processing temperatures.

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References

1. Gobin, A.S., Butler, C.E., Mathur, A.B. (2006) *Tissue Engineering* **12**, in press.

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