Arabinoxylan Sponges for wound healing applications

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Statement of Purpose: Fabrication of an ideal wound dressing material is critical in managing healing post-injury. Wound dressing materials have been developed to help treat acute, moderately exudating wounds by creating a moist microenvironment conducive to tissue regeneration while preventing infection at the injury site. An ideal wound healing material must possess the following properties to help aid wound management. It must be an occluder and have good biocompatibility. It should have mechanical strength for insulation, wound protection and exudate removal from the injury site. Lastly, it must be absorptive, impermeable to bacteria and inexpensive. Many current wound dressing materials on the market possess the aforementioned properties but none have used arabinoxylan as a base material. Arabinoxylan has the ability to absorb and release exudate at the injury site. Carboyhydrate based polymers such as arabinoxylan have also shown an ability to modulate immune response which is critical during the inflammation stage of wound healing.[1] The goal of this study is to investigate if the material and biocompatible properties of arabinoxylan sponges compare favorably to a similar wound dressing material currently in the market.

Methods:

Synthesis. To make 60 mg/mL arabinoxylan sponges, 600 mg of arabinoxylan bran ferulate powder was added to 10 milliliters of de-ionized water and stirred into a homogenous solution.

Crosslinking. The arabinoxylan solutions were then crosslinked by addition of 60 and 100 µL of peroxidase and hydrogen peroxide respectively to form a gel within 2-3 hours.

Processing. The crosslinked hydrogels were frozen for several hours and lypholized overnight in the final fabrication step to form sponges.

Characterization. Scanning Electron Microscopy is used to confirm sponge morphology. Rheometry of dry and wet sponges at room and physiological temperatures was conducted using Discovery Hybrid Rheometer. The scaffold's storage modulus (G') at 0.1-100 Hz frequencies and given a 0.1% strain rate was quantified. Swelling ratio was measured in simulated wound fluid over a 7 day time course at room and physiological temperature to assess fluid absorption. Trypan blue assay will be used to assess in vitro fibroblast, keratinocyte and macrophage cell viability.

Control. 3M™ Tegaderm™ Alginate foam dressing is an industry standard used for comparison.

Results: The morphology of arabinoxylan sponges were analyzed using Scanning Electron Microscopy which showed a randomized, highly porous surface with pores of varying sizes. The control exhibited random microfiber morphology with many pores throughout the surface. This allows for high fluid absorption and swelling. Rheometry testing suggests arabinxoylan sponges in dry conditions have higher storage moduli than the control by one order of magnitude across the frequency range. However, in wet states, the storage moduli of the control are several orders of magnitude higher than the arabinoxylan sponges across the frequency range. Swelling ratio data indicates that arabinoxylan sponges have a greater absorptive capacity when compared to controls. Cell viability studies with trypan blue assay are ongoing.

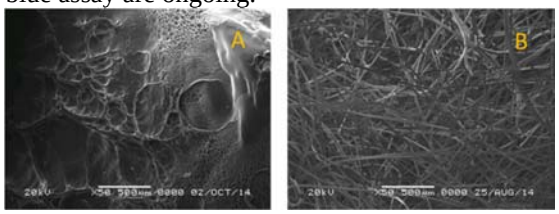

Figure 1. SEM Image of A) Arabinoxylan Sponges; B) 3M™ Tegaderm™ Alginate (control)

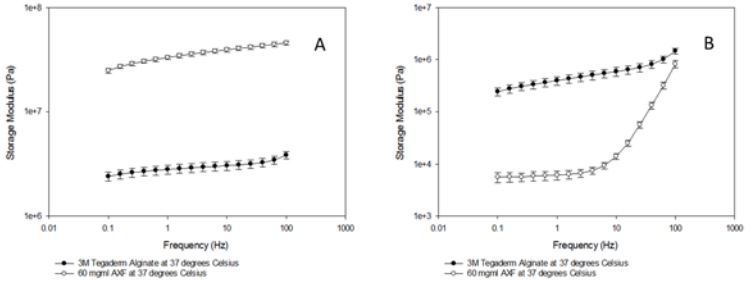

Figure 2. Rheological Measurement of A) Arabinoxylan Sponges and B) 3M™ Tegaderm™ Alginate (control)

Conclusions: Arabinoxylan sponges are simple to fabricate and exhibit a very porous surface which enables high absorptive capacity when immersed in fluid. However, its elasticity in wet states is much lower than industry controls due to its hydrophilic nature and weak bonds holding the polymer chains together. The next phase of this study is impregnating the sponges with silver while evaluating its cumulative release and anti-microbial profile.

References:

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[2] Lloyd L, Kennedy J, Methacanon P, Paterson M, Knill C. Carbohydrate polymers as wound management aids. Carbohydr Polym 1998;37(3):315-22.