Determining Suitable Leaf Species for Perfusion of Leaf-Derived Vascular Scaffolds (LeaVS)

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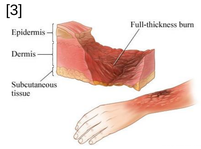
Clinical Significance of Burns

Skin maintains homeostasis and protects internal organs

- Burn injuries: 500,000 Americans treated annually [1]
- Pressure and venous ulcers: 3 million Americans treated annually [2]
- Full-thickness wounds requires extensive treatments and can result in scarring as well as permanent loss of function

[3]



[4]

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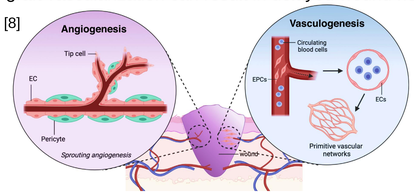
Current treatment methods are limited by **a lack of donor tissue** (autologous skin grafts), or **graft take** (dermal substitutes).

Importance of Revascularization

Vascular integration is critical for graft take and rapid wound healing

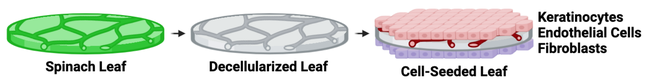
- Oxygen and nutrient diffusion from blood vessels is limited to 200μm [6]
- Revascularization occurs via angiogenesis and/or vasculogenesis
- Lack of graft vascularization can result in delayed wound healing [7]

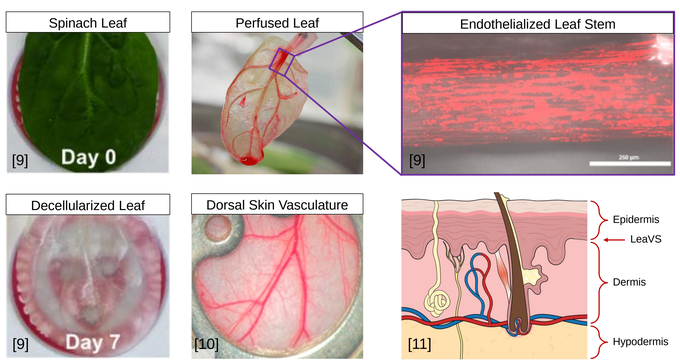
[8]



There is a need for a bioengineered skin graft that promotes **rapid vascularization**.

Scaffold Design and Rationale



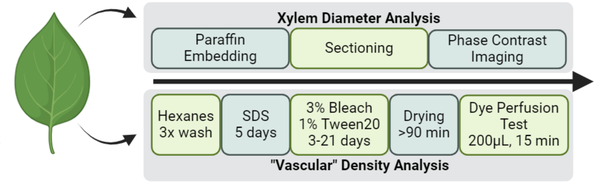


The goal of this study is to evaluate several different leaf types for their **decellularization ability**, their **perfusable vascular network morphology**, as well as their **xylem diameters**.

Materials and Methods

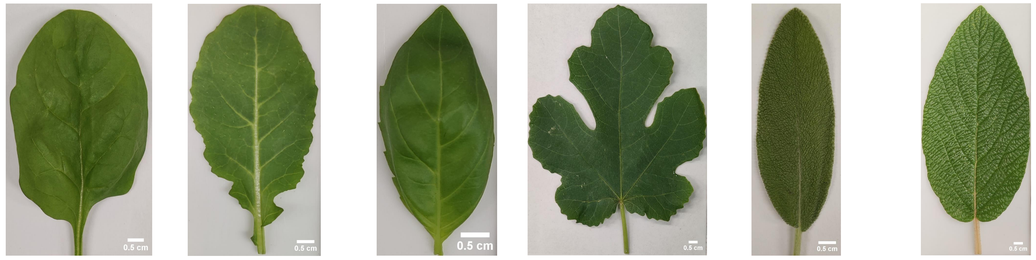
Leaves were selected for analysis based on specific criteria:

- Dicot venation pattern “vasculature”
- The presence of a petiole
- Durability to withstand decellularization process

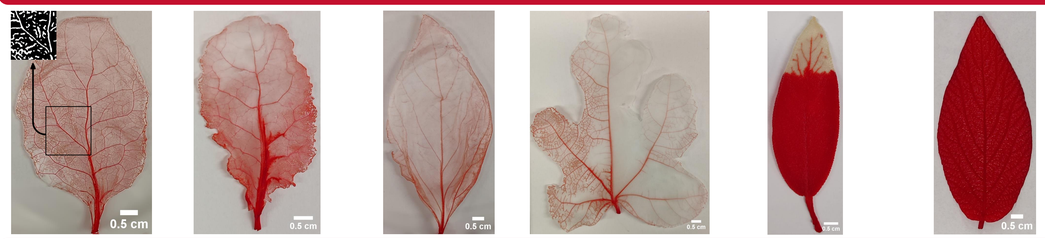


Leaf Species and Characteristics

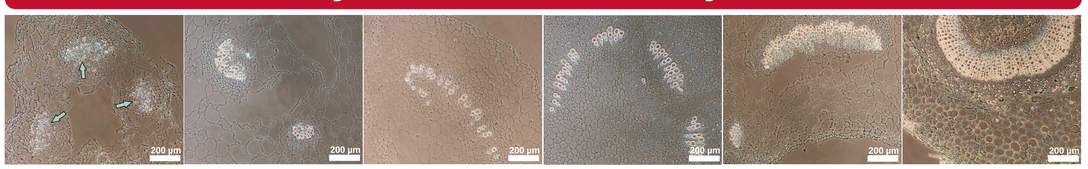
Spinach	Baby Kale	Basil	Chicago Hardy Fig	Sage	Leatherleaf Viburnum
Spinacia oleracea	*Brassica oleracea*	*Ocimum basilicum*	*Ficus carica*	*Salvia officinalis*	*Viburnum rhytidophyllum*



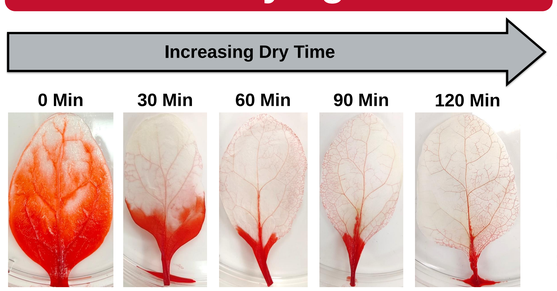
Dye Perfusion Test and “Vascular” Analysis



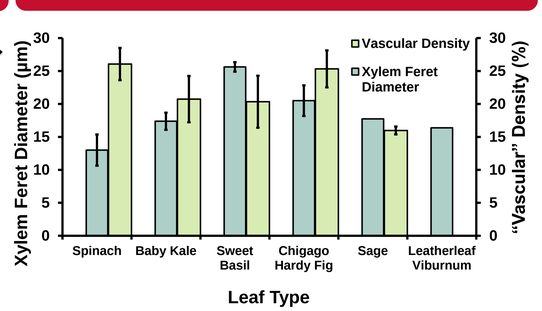
Xylem Diameter Analysis



Varied Drying Times



Results



Discussion and Conclusions

Fluid Perfusion in LeaVS

- Increased drying time improved spatial distribution of perfused fluids
- “Vascular” density of all leaves falls within range of human endothelial vascular density in 2D culture [12]
- The bulk perfusion pattern of leatherleaf viburnum and sage may have applications in drug delivery to implants

Potential Alternatives to Spinach LeaVS

- Basil and fig both have mean xylem Feret diameters greater than spinach and similar “vascular” densities
- Larger Feret xylem diameters may enhance endothelial cell perfusion through “vasculature”

Future Work

Evaluation of Particle Perfusion

Determining particle sizes that can perfuse throughout leaf vascular networks

Endothelialize the Leaves

Endothelial paracrine signaling to enhance skin regeneration

***In Vivo* Implantation**

Implantation in full-thickness wound model to evaluate functional recovery

Acknowledgements

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