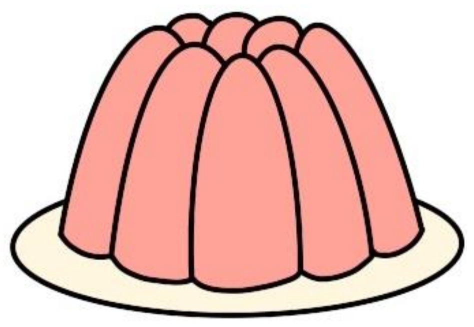


Squish to Strength: Gelatin's Mechanical Properties

Alexandra Lee

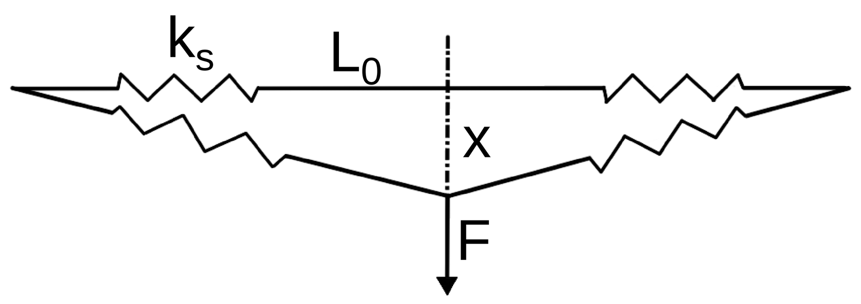
2.671 Measurement and Instrumentation

Abstract

Understanding how various gelatin ratios affect the puncture strength, cohesiveness, and elastic stiffness forms a basis for further research and innovation using gelatin. Puncture tests were performed on nine different gelatin percentages between 3-25% by mass weight to find the force and displacement over time with the Texture Analyzer. The puncture strength and cohesiveness for each concentration revealed an exponential relationship, and the pre-puncture behavior was modeled as a coupled spring system, with the elastic stiffness parameters k_s and L_0. Using our fits, we can predict the gelatin percentage needed for a specified threshold puncture strength, cohesiveness, or elastic stiffness for applications in food industries, bioengineering, packaging research, and more.

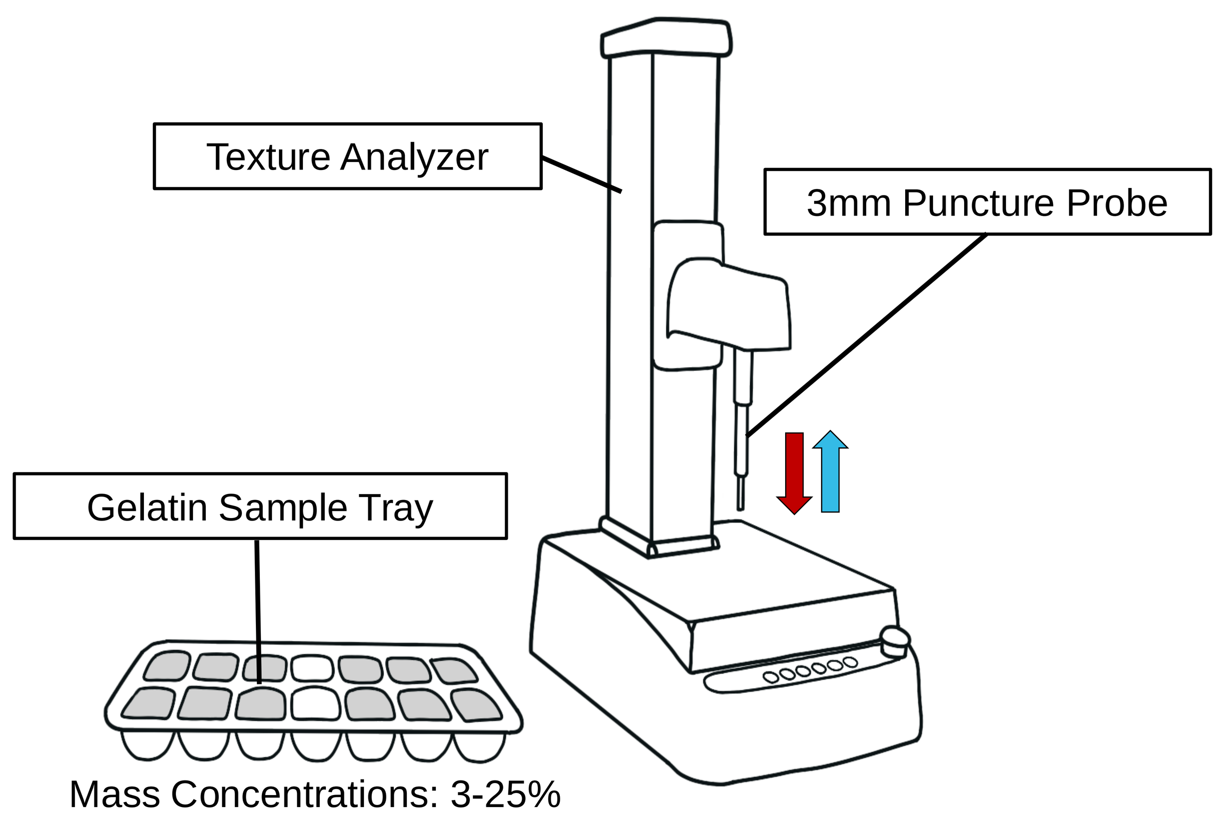
Experimental Design

Elastic Gelatin Model

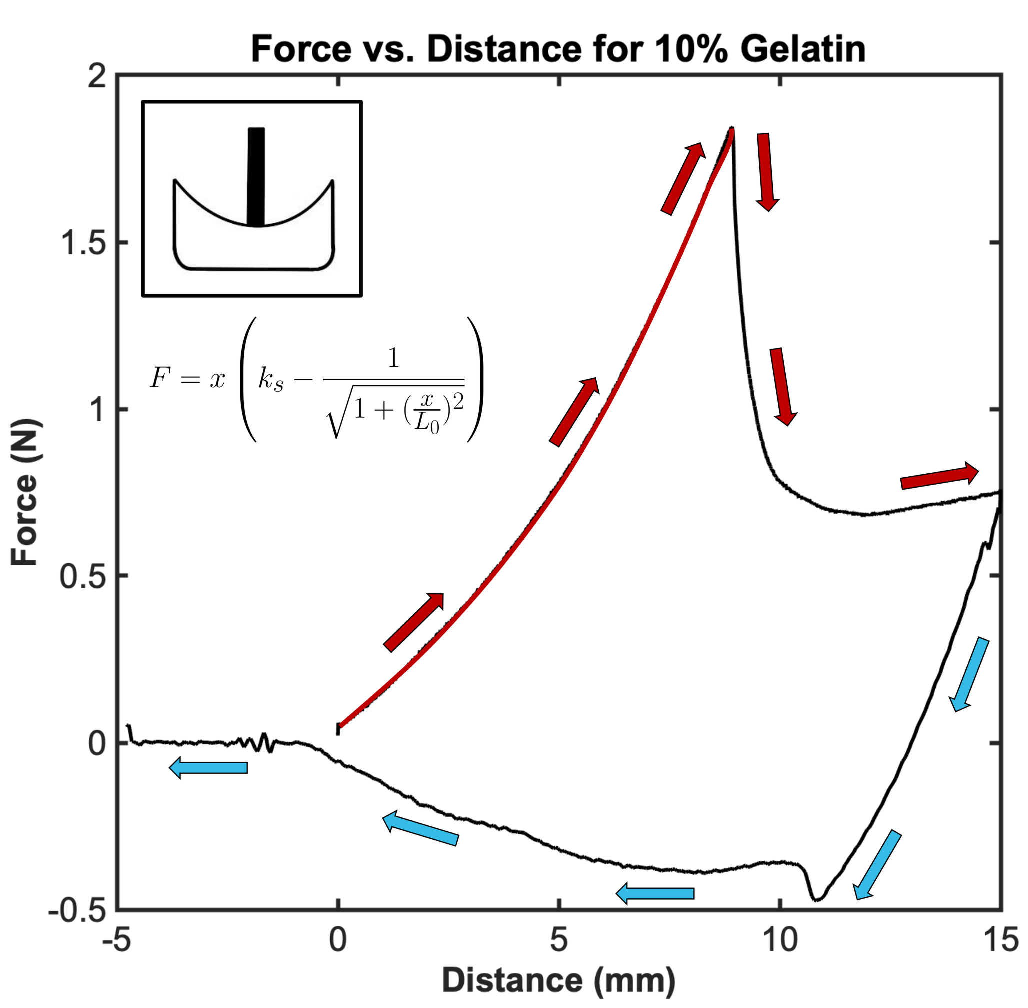


k_s = effective spring constant
L_0 = unstretched spring length

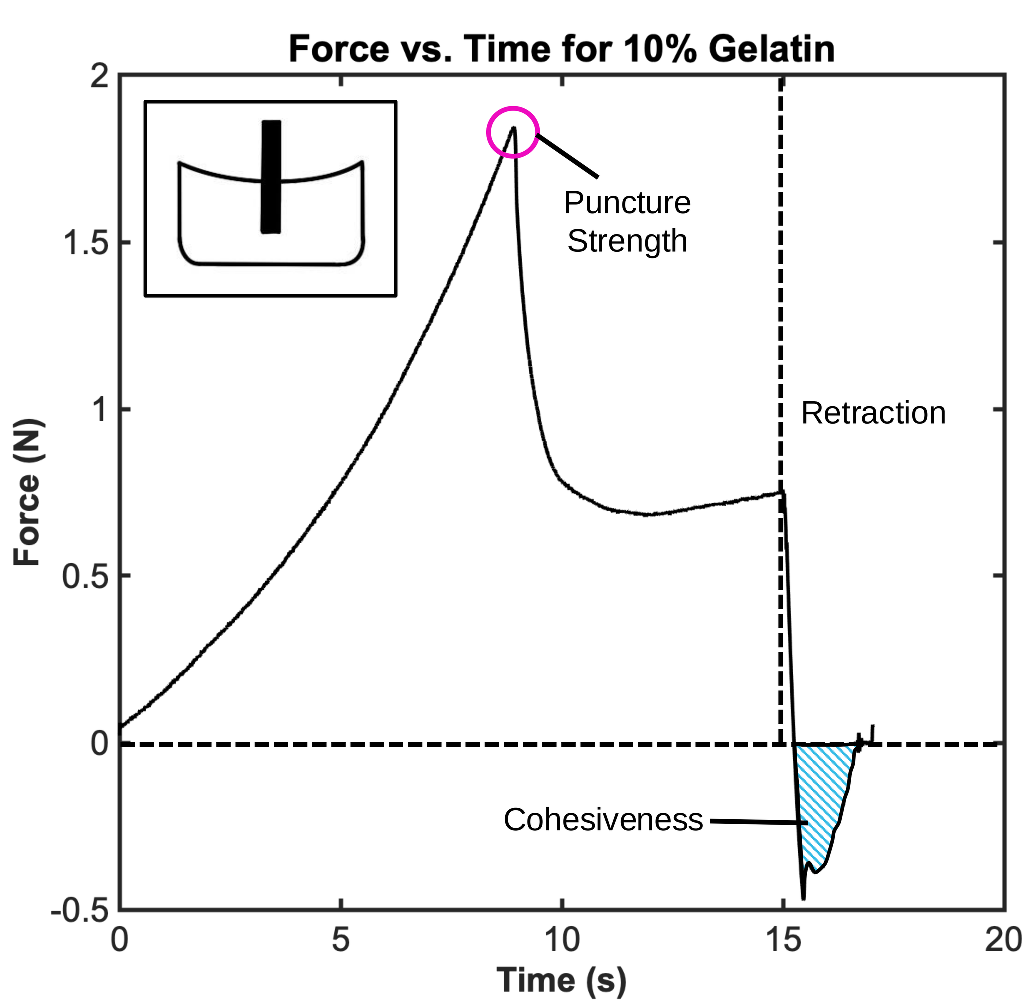
$$F = x\left(k_s - \frac{1}{\sqrt{1+(\frac{x}{L_0})^2}}\right) \quad [1]$$



Pre-puncture Properties



Post-puncture Properties



Acknowledgements

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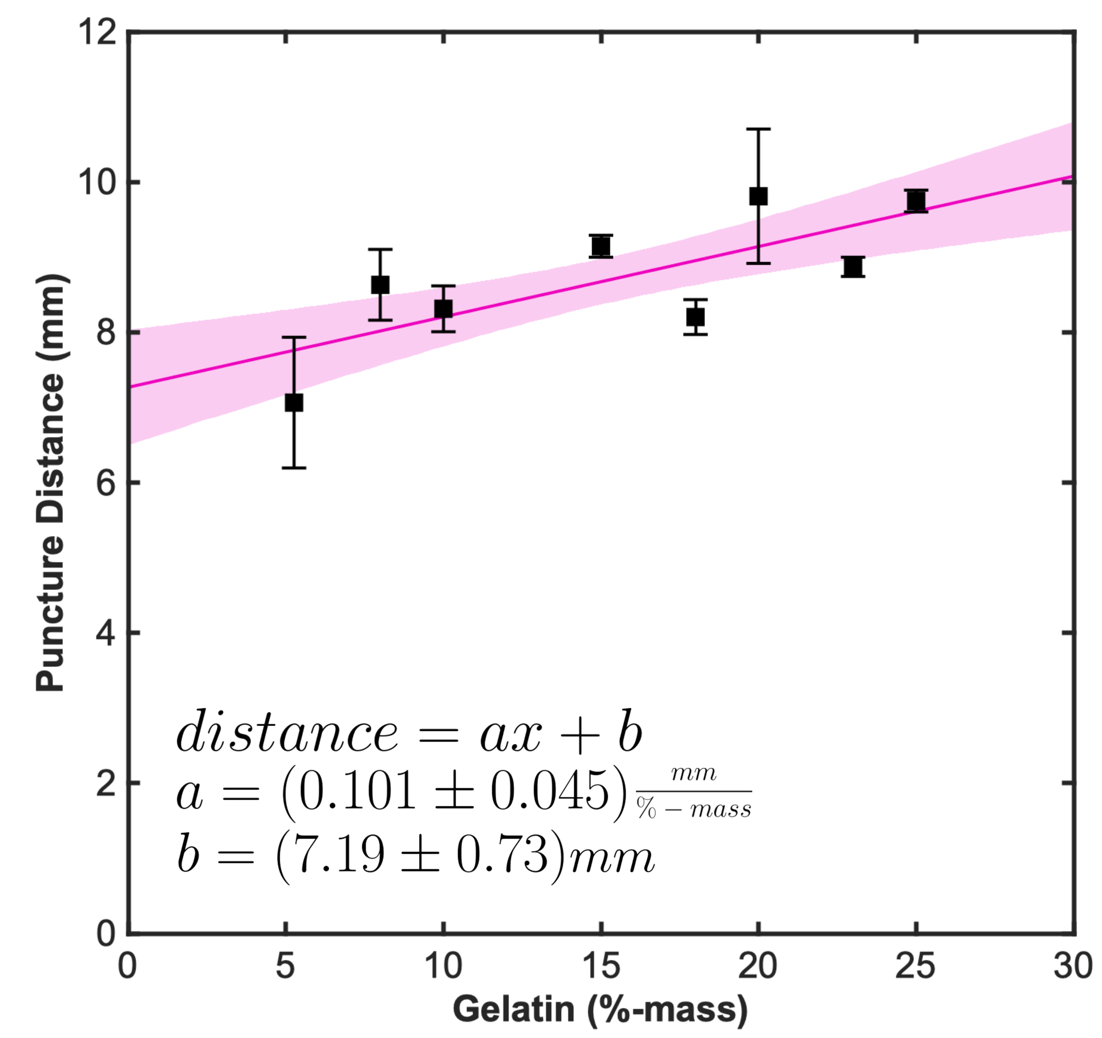
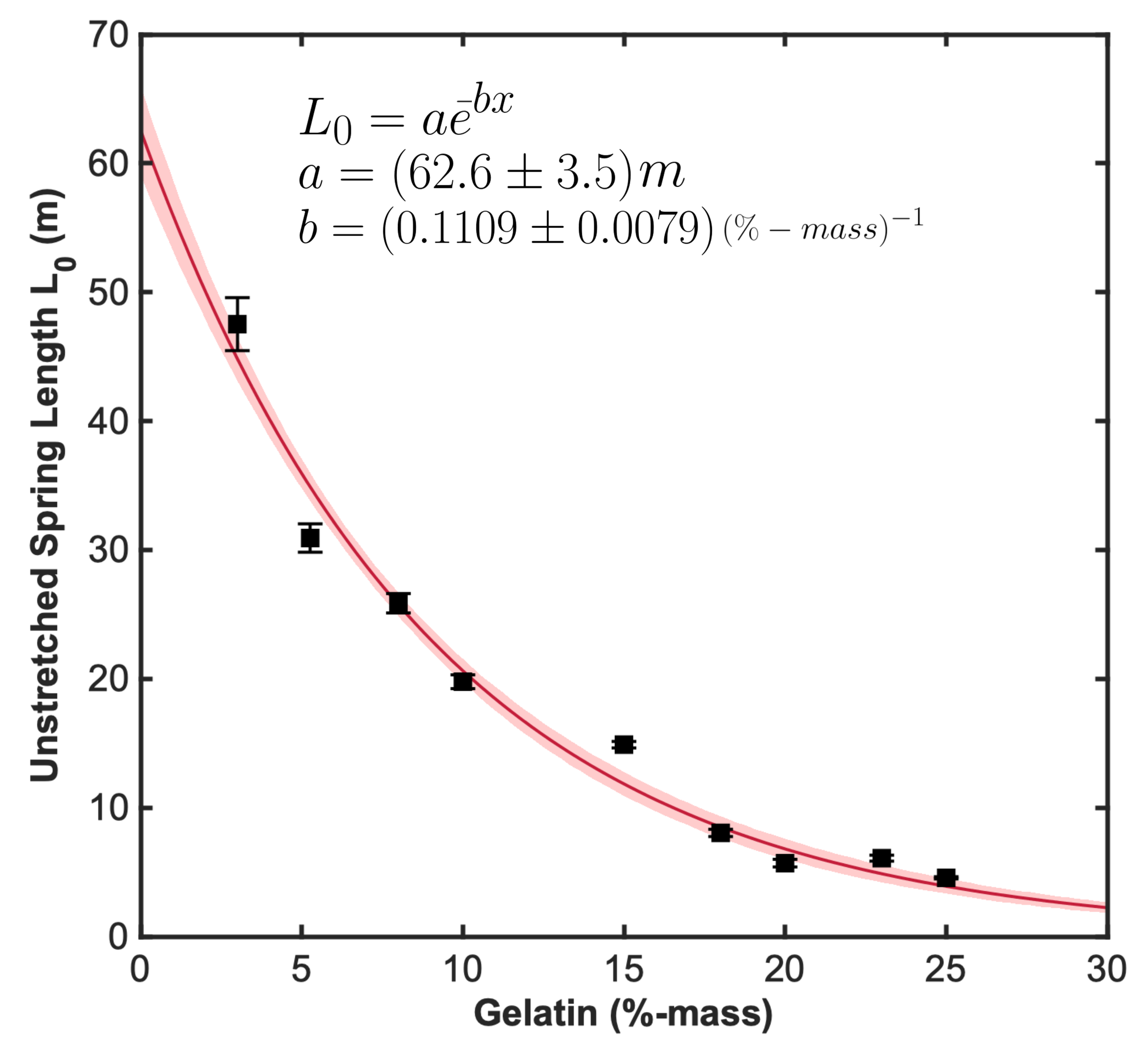
References

[1] Eager, D., et al., 2022, "Investigation into the Trampoline Dynamic Characteristics and Analysis of Double Bounce Vibrations," Sensors, 22(8), p. 2916.

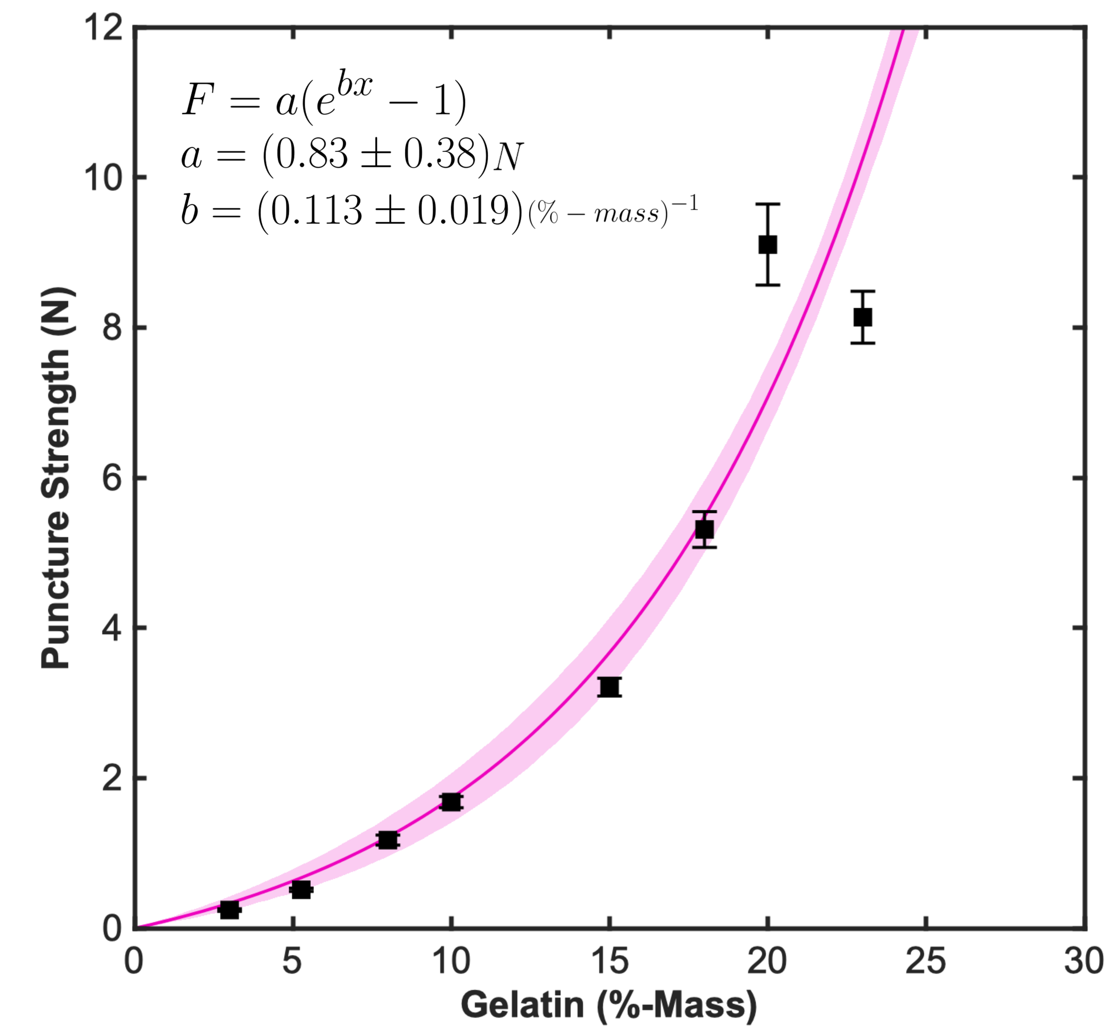
Results

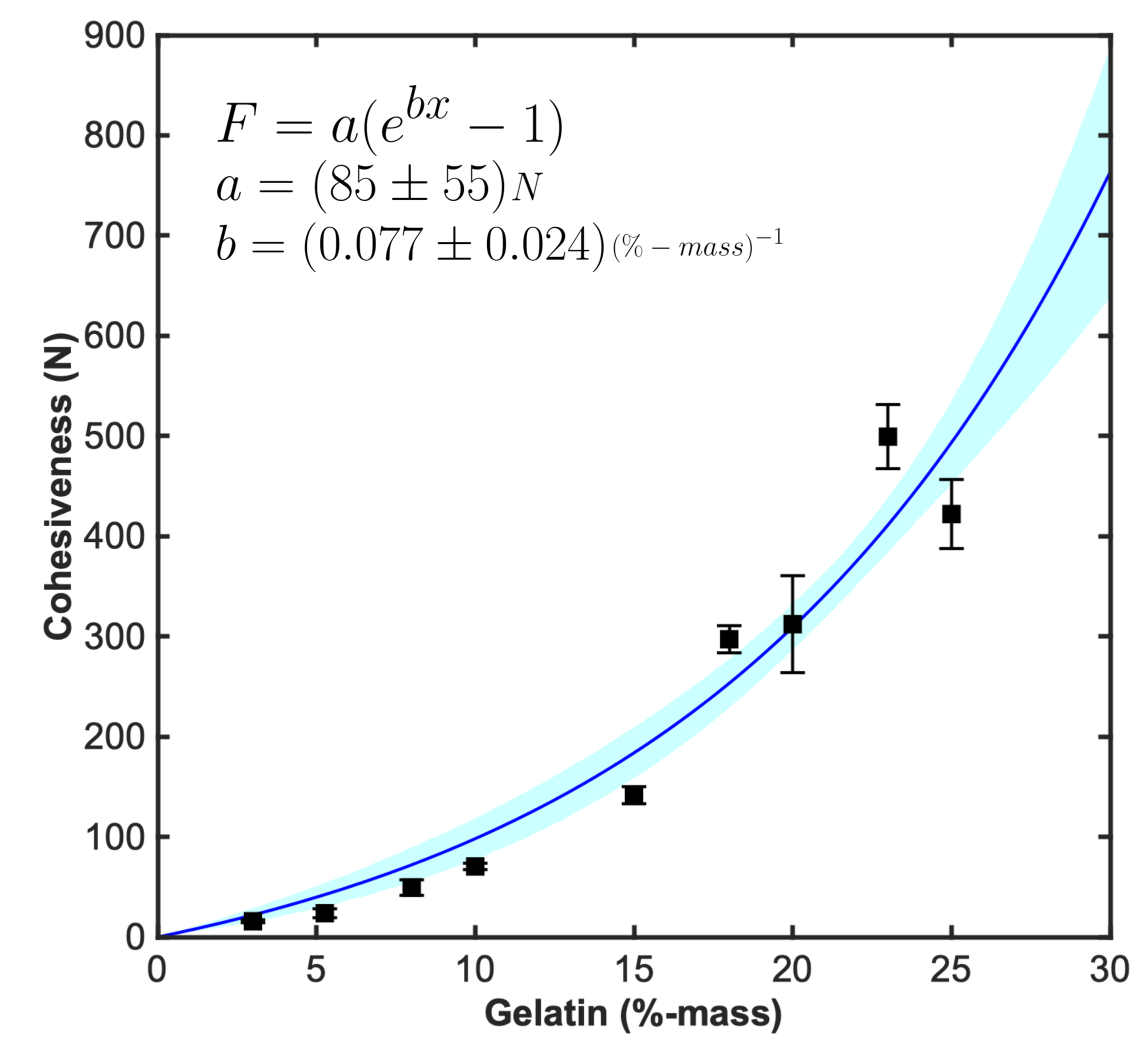
Pre-puncture Properties





Post-puncture Properties





Conclusions

- Puncture force and cohesiveness exponentially increases with gelatin mass concentration, better resisting puncture and being more cohesive
- Effective spring constant has a polynomial relationship and unstretched spring length fits a decreasing exponential function
- Higher gelatin concentrations and higher effective spring constants result in more "stiff" gelatin and is more resistant to compression
- Unstretched spring length decreases and k_s increases with higher gelatin concentration, indicating that the gelatin starts to behave more like a rigid body at high concentrations

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