ORIGINAL RESEARCH

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THE MECHANICAL PERFORMANCE OF ADAMGEL: A COMPARATIVE STUDY OF TENSILE, COMPRESSIVE, AND DURABILITY PROPERTIES

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Introduction: Tissue-mimicking materials play an integral role in clinical education through providing a controlled, risk-free environment for skill development. While commercially available phantoms enhance trainee proficiency and patient safety, their high cost and limited accessibility hinder widespread adoption. Consequently, clinical training often relies on supervised practice, constrained by logistical challenges and patient safety concerns. To address these limitations, ADAMgel was developed as a low-cost, non-toxic, and recyclable biomaterial designed to replicate human tissue properties [1]. Its successful integration into procedural training models highlights its potential as an effective simulation medium. ADAMgel offers several advantages, including versatility, affordability (<£2/kg), self-healing properties, bacterial resistance, and compatibility with diathermy and harmonic scalpels. Additionally, it closely mimics human tissue under ultrasound imaging, making it particularly valuable for sonography-based training. However, a lack of comprehensive mechanics data has restricted broader implementation in medical training. This study systematically evaluates the mechanical properties of six ADAMgel formulations to refine their suitability for simulation applications.

Methods: Six formulations were prepared with varying concentrations of psyllium husk, glycol, antifoam, water, and gellan gum to assess their impact on mechanical performance. Each underwent standardised tests, including Ultimate Tensile Strength, Young's modulus in both tensile and compression modes, and durability evaluations. All tests were conducted in triplicate to ensure statistical reliability on the 15/01/24, with data incorporated into mathematical models for analysis.

Results: A controlled preparation protocol ensured consistency, facilitating reproducible comparisons. Mechanical properties varied significantly across formulations. V5 exhibited the highest ultimate tensile strength (1308.12 Pa) and compressive resistance (6540.60 Pa), indicating superior load-bearing capacity. In contrast, V1 demonstrated the lowest tensile resilience (687.5 Pa), reinforcing the inverse correlation between increased water content and structural integrity. Young's modulus in tension revealed that V4 was the most rigid (4216.03 Pa), while V1 and Standard formulations displayed greater elasticity. Durability testing indicated no material degradation following cyclic loading, supporting ADAMgel's durability for repeated use. Gum-based formulations (V5, V4) demonstrated enhanced mechanical stability, whereas lower-viscosity variants (V1, V3) showed greater deformability, making them suitable for applications requiring flexibility. The incorporation of gellan gum (V5) significantly improved tensile properties, highlighting its potential for load-bearing applications in surgical training.

Discussion: These findings underscore ADAMgel's adaptability and provide empirical data for optimising formulations to better mimic specific tissue types. Future research should focus on refining ADAMgel's composition to bridge the gap between synthetic and biological tissue properties, further enhancing its efficacy in procedural training models.

Ethics Statement: As the submitting author, I can confirm that all relevant ethical standards of research and dissemination have been met. Additionally, I can confirm that the necessary ethical approval has been obtained, where applicable.

REFERENCES

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