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Fabrication and Physiochemical Properties of Alginate and Natural Aloe Vera Biofilm for Wound Healing Applications

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Abstract

This study fabricates and characterizes hydrogel films using sodium alginate and natural aloe vera for wound healing. Different ratios of alginate/aloe vera mixtures are investigated. The films are analyzed using SEM, FTIR, contact angle measurements, and AFM. The results show distinct microstructural features, additional active compounds, hydrophilic nature, and varying surface roughness. These findings highlight the potential of the hydrogel films for wound healing applications.

1. Introduction

Wound healing is a complex process that poses challenges in terms of cost and management. Developing adequate, applicable, and affordable wound dressings is crucial. Bio-composites, which consist of multiple components, including bio-based materials, have gained interest in wound healing applications. Alginate, known for its high absorption capacity, is commonly used in wound dressings. However, mechanical properties can limit the effectiveness of bio-composites. In this study, we aim to create an antibacterial alginate-based wound dressing using natural aloe vera biofilm. Aloe vera offers moisture protection, accelerates healing, and provides antibacterial properties. Bacterial infections can impede wound healing, making antibacterial wound dressings highly beneficial. By combining alginate and aloe vera, we seek to enhance the wound healing process and address the need for effective wound management.

2. Materials and Methods

2.1 Materials

Sodium alginate powder ($C6H7NaO6$) with a molecular weight of 216.12 g/mol was obtained from a reliable supplier. Natural aloe vera gel was extracted from fresh aloe vera leaves using a standardized method. High-quality distilled water was used throughout the experiment.

2.2 Methods

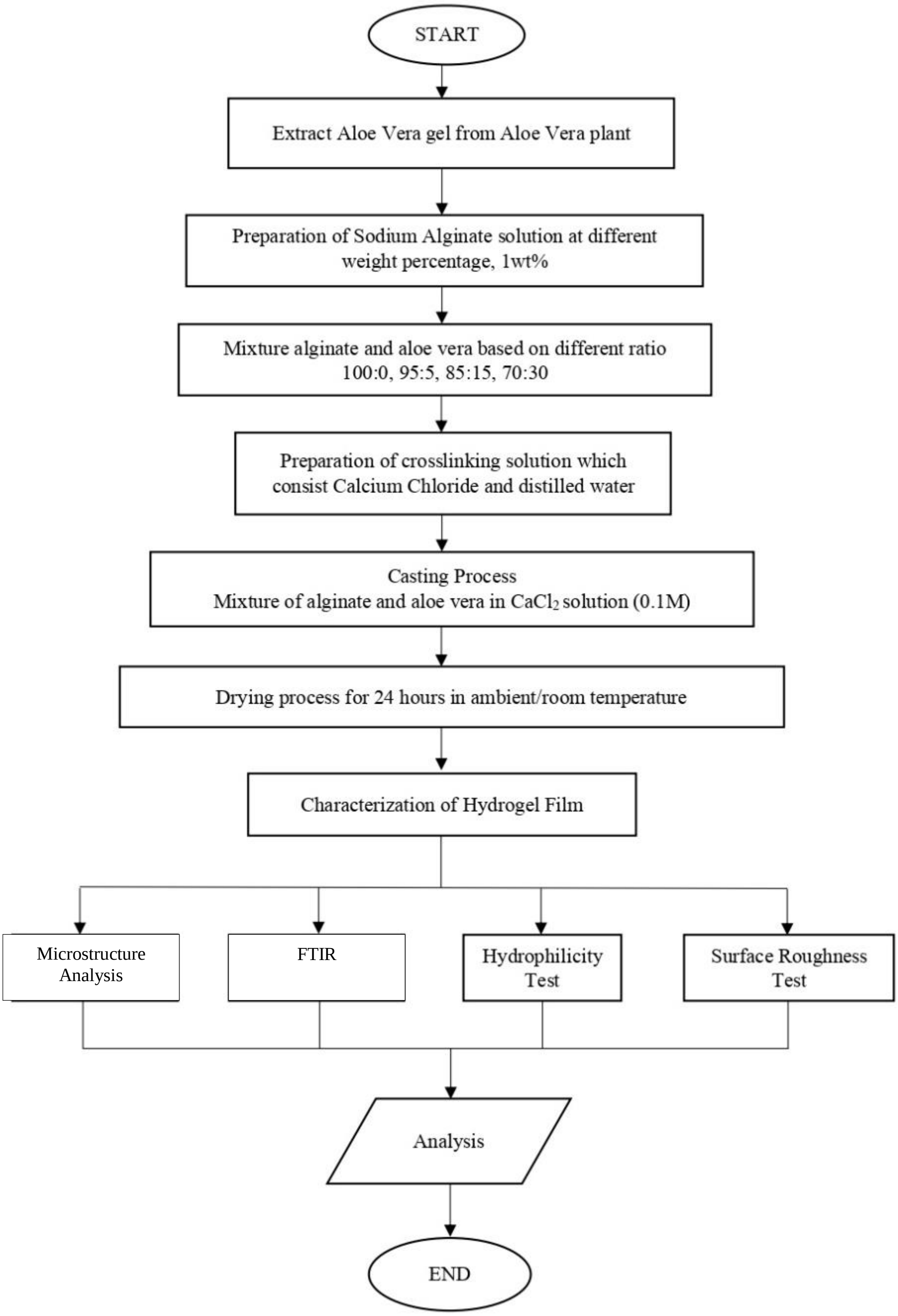
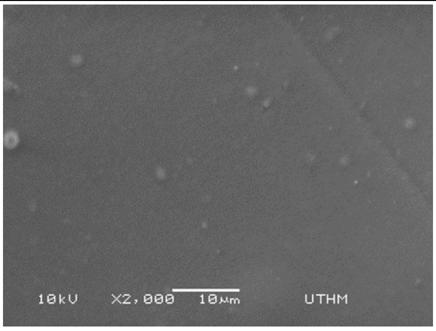
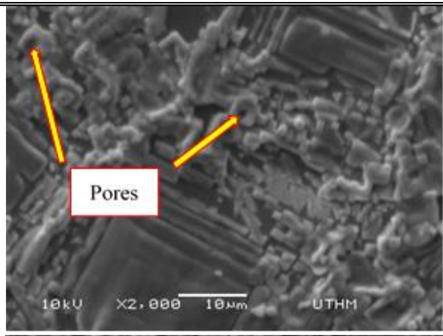
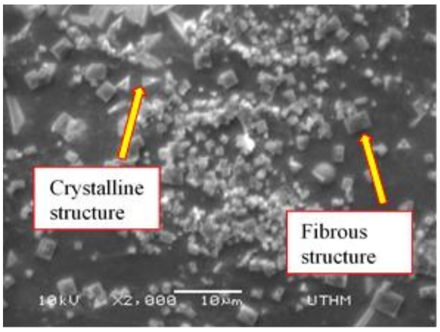
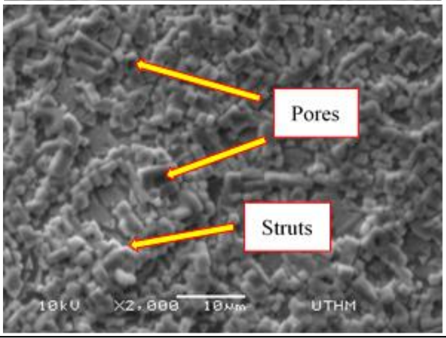


Fig. 1 *Methodology Flowchart*

3. Results and Discussion

3.1 Results

Table 1 *Microstructure result of hydrogel film*

Sample Ratio	Microstructure Image	Sample Ratio	Microstructure Image
100:0		85:15	
95:5		70:30	

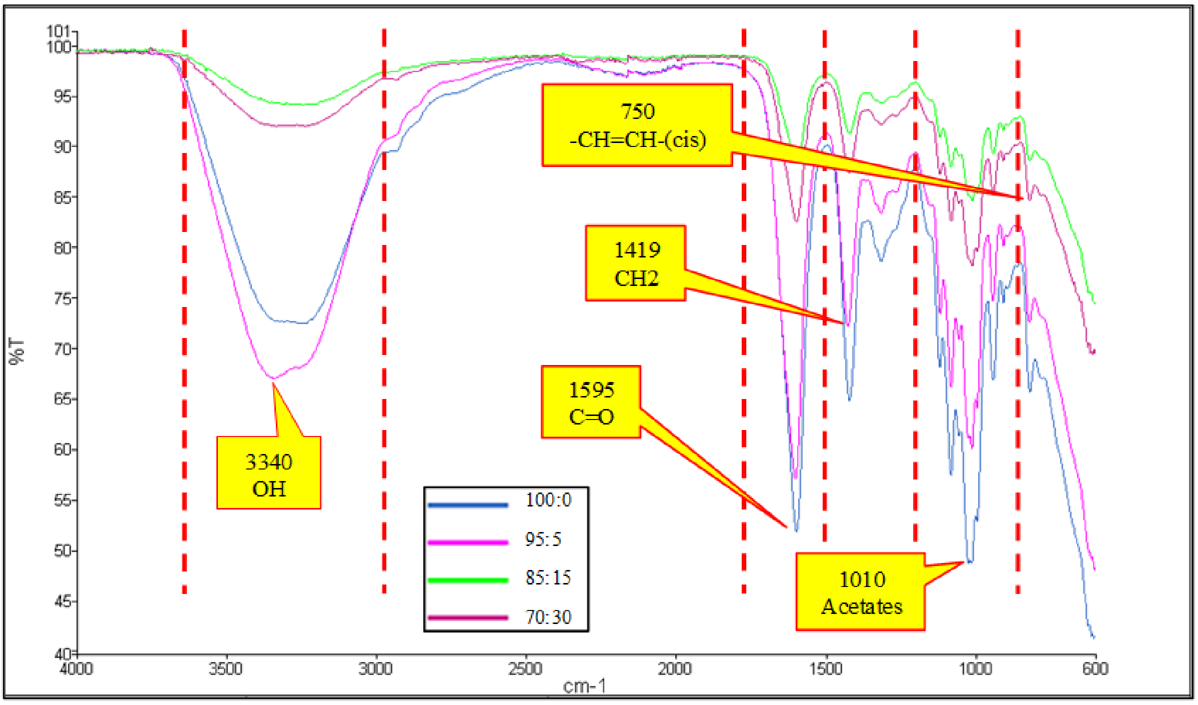


Fig. 2 *Graph analysis of active compound in hydrogel film*

Table 2 *Water droplet and angle of the hydrogel film*

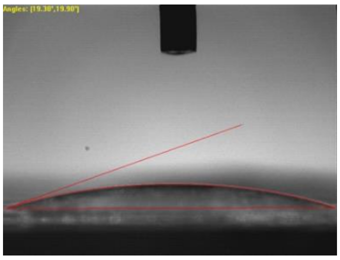
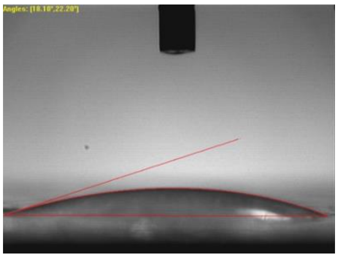
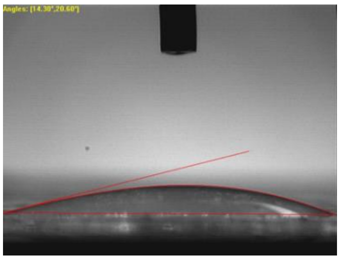
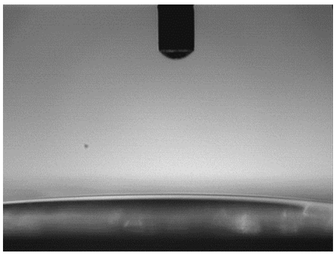
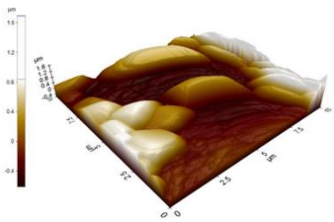
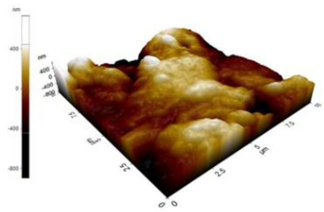
Sample Ratio	Static Contact Angle (°)	Surface Fluid Interaction
100:0	19.30	
95:5	18.10	
85:15	14.30	
70:30	Totally Dissolved	

Table 3 *AFM 3D image of the surface roughness*

Sample Ratio	AFM 3D image	Sample Ratio	AFM 3D image
100:0		85:15	

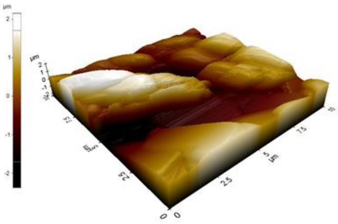
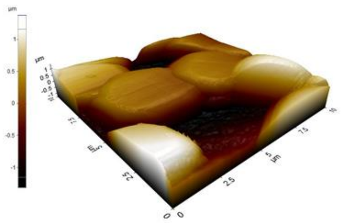
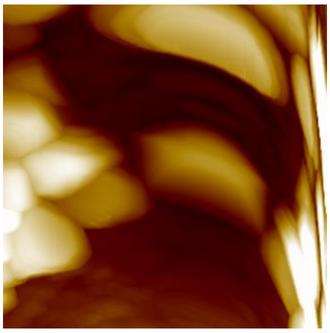
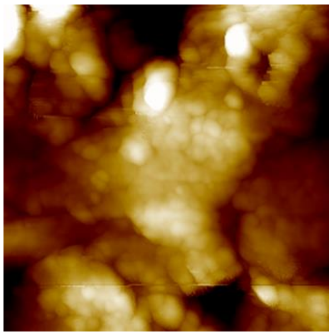
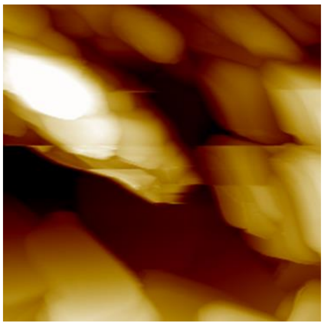
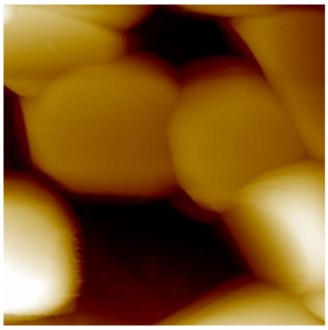
95:5		70:30	

Table 4 *Surface morphology via AFM*

Sample Ratio	AFM Surface Morphology	Sample Ratio	AFM Surface Morphology
100:0		85:15	
95:5		70:30	

3.2 Discussions

The results indicate that the preparation of hydrogel films using sodium alginate and natural aloe vera has shown promising characteristics for wound healing applications. The microstructure analysis revealed varying pore sizes depending on the aloe vera content in the films. The presence of additional active compounds in the hydrogel films, as shown by the FTIR results, suggests the potential for enhanced wound healing properties. The hydrogel films exhibited hydrophilic properties, as indicated by the contact angle measurements. Furthermore, the surface roughness values varied among the different ratios, with higher aloe vera content leading to increased roughness. These findings suggest that the hydrogel films have desirable features that can contribute to the wound healing process, such as improved breathability and adherence to the wound site. Further studies and optimizations are warranted to fully explore the potential benefits of these hydrogel films in wound healing applications.

4. Conclusions

In conclusion, the study successfully achieved its objectives in fabricating and characterizing sodium alginate and natural aloe vera hydrogel films. The SEM analysis revealed distinct microstructural features, while FTIR confirmed the presence of active compounds. The hydrophilic nature of the films was observed through contact angle measurements, and AFM analysis showed varying surface roughness. These findings demonstrate the potential of sodium alginate and natural aloe vera for wound healing applications. Further research can focus on optimizing film ratios and properties for specific biomedical uses, paving the way for advancements in wound care and tissue engineering.

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