RESEARCH PAPER

Edible Coating for Extending Shelf Life of Fruits: A Sustainable Approach

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ABSTRACT

This study presents the preparation of a natural edible coating for extending the shelf life of fruits using biodegradable and eco-friendly materials. Fresh fruits such as banana, apple, and tomato were selected and washed thoroughly with distilled water to remove surface impurities. The coating solution was prepared using Aloe Vera gel, starch, chitosan, glycerol, honey, and lemon extract. Aloe Vera gel was extracted from fresh leaves, filtered, and mixed with distilled water. Starch was dissolved separately under controlled heating conditions to obtain a uniform solution. Chitosan was added as an antimicrobial agent, and glycerol was incorporated as a plasticizer to improve flexibility of the coating. The prepared components were mixed and stirred continuously to obtain a homogeneous solution. The fruits were coated using the dipping method, where they were immersed in the coating solution for a few minutes, removed, and allowed to dry at room temperature. The coated and uncoated samples were stored under ambient and refrigerated conditions for further analysis. Various parameters such as weight loss, firmness, pH variation, microbial growth, and visual appearance were evaluated at regular intervals to determine the effectiveness of the coating. The results showed that the coated fruits exhibited significantly reduced moisture loss, delayed ripening, and lower microbial contamination compared to uncoated fruits. The edible coating acted as a semi-permeable barrier, controlling gas exchange and reducing respiration rate. The presence of natural antimicrobial compounds in chitosan and Aloe Vera enhanced preservation efficiency. The shelf life of coated fruits was extended up to 10–15 days, whereas uncoated fruits showed deterioration within 5–7 days. These findings indicate that edible coating is a simple, cost-effective, and sustainable technique for fruit preservation. This method can be effectively applied in small-scale and large-scale food industries to reduce post-harvest losses and improve food quality.

Keywords: Edible coating, Aloe Vera, Chitosan, Shelf life extension, Fruit preservation, Biodegradable coating, Post-harvest technology

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1. INTRODUCTION

One of the major challenges faced by the food industry is the rapid spoilage of fruits after harvest. Fruits are highly perishable in nature due to their high moisture content and metabolic activities such as respiration and transpiration. These processes lead to quality deterioration, weight loss, microbial growth, and reduced shelf life. Post-harvest losses of fruits have increased significantly in recent years due to improper storage, transportation, and lack of preservation techniques. According to recent studies, a considerable percentage of fruits are lost before reaching consumers, especially in developing countries where advanced storage facilities are limited. Fruits are widely consumed due to their nutritional value, including vitamins, minerals, antioxidants, and dietary fiber. However, once harvested, fruits continue to undergo physiological and biochemical changes that accelerate ripening and senescence. Factors such as temperature, humidity, microbial contamination, and mechanical damage further contribute to the deterioration of fruit quality. Microorganisms such as bacteria and fungi play a major role in spoilage, leading to decay and making the fruits unsuitable for consumption. Therefore, effective preservation methods are essential to maintain quality and extend shelf life.

Traditional preservation techniques such as refrigeration, chemical preservatives, and modified atmosphere storage have been widely used. However, these methods have several limitations. Refrigeration requires continuous energy supply and is not always

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feasible in rural areas. Chemical preservatives may pose health risks and are increasingly avoided by consumers due to safety concerns. Moreover, these methods may not effectively control moisture loss and microbial growth simultaneously. Hence, there is a growing need for safe, cost-effective, and environmentally friendly alternatives for fruit preservation. In recent years, edible coating technology has gained significant attention as an innovative approach for extending the shelf life of fruits. Edible coatings are thin layers of edible materials applied on the surface of fruits to act as a protective barrier. These coatings help in reducing moisture loss, controlling gas exchange, delaying ripening, and minimizing microbial contamination. Unlike synthetic packaging materials, edible coatings are biodegradable, non-toxic, and safe for consumption, making them suitable for sustainable food preservation.

Various natural polymers and bio-based materials are used in the preparation of edible coatings. Polysaccharides such as starch, chitosan, and alginate are widely used due to their excellent film-forming ability and biodegradability. Starch provides structural strength and forms a uniform coating layer, while chitosan exhibits strong antimicrobial properties that help in reducing microbial growth. Alginate enhances the stability and barrier properties of the coating, improving its effectiveness in preserving fruits. In addition, natural plant extracts such as Aloe Vera gel are incorporated due to their bioactive compounds, which include phenols, flavonoids, and enzymes that contribute to antimicrobial and antioxidant activities. Aloe Vera is a widely available natural material known for its medicinal and preservative properties. It acts as a natural coating agent that reduces respiration rate and delays ripening. The incorporation of glycerol as a plasticizer improves the flexibility and mechanical properties of the coating, preventing cracks and enhancing adhesion to the fruit surface.

The combination of these materials results in a multifunctional coating system that improves the overall quality and shelf life of fruits. The effectiveness of edible coatings depends on several factors such as coating composition, thickness, storage conditions, and type of fruit. The coating acts as a semi-permeable barrier, regulating the exchange of gases like oxygen and carbon dioxide, thereby slowing down metabolic activities. It also reduces water loss, maintains firmness, and preserves the visual appearance of fruits. Furthermore, the antimicrobial properties of chitosan and Aloe Vera help in controlling microbial growth, ensuring food safety. Therefore, the development of edible coatings using natural and biodegradable materials provides a promising solution to reduce post-harvest losses and improve fruit preservation. This study focuses on the preparation and application of an edible coating using Aloe Vera gel, Starch, chitosan, alginate, glycerol, and distilled water. The objective is to evaluate the effectiveness of the coating in extending shelf life and maintaining the quality of fruits under different storage conditions.

2. MATERIALS AND METHODS

2.1. Collection of Raw Material

The raw materials required for the preparation of edible coating include fresh Aloe Vera leaves, starch, chitosan, alginate, glycerol, and distilled water. Aloe Vera leaves were collected from local sources. Starch, chitosan, alginate, and glycerol were procured from chemical stores in Karur, Tamil Nadu. Distilled water was used throughout the experiment to maintain purity and avoid contamination.

2.2. Preparation of Aloe Vera Extract:

Fresh Aloe Vera leaves were washed thoroughly using distilled water to remove dust and surface impurities. The outer green layer of the leaves was carefully removed, and the inner gel was collected. The extracted gel was blended with a small quantity of distilled water to obtain a uniform mixture. The mixture was then heated at a controlled temperature for a few minutes to extract active components. After heating, the solution was cooled and filtered using filter paper to obtain a clear Aloe Vera extract.

2.3. Preparation of Edible Coating Solution:

The edible coating solution was prepared using starch, chitosan, alginate, glycerol, Aloe Vera extract, and distilled water. Initially, starch was dissolved in distilled water and heated under continuous stirring until a clear and viscous solution was obtained. Chitosan was dissolved separately in a mild acidic medium and added to the starch solution. Alginate was then incorporated to improve the structural stability and barrier properties of the coating. Glycerol was added as a plasticizer to enhance flexibility and prevent cracking of the coating film. Finally, the prepared Aloe Vera extract was added to the mixture. The entire solution was stirred continuously at a controlled speed to ensure uniform mixing and to obtain a homogeneous coating solution.

2.4. Application of Edible Coating on Fruits:

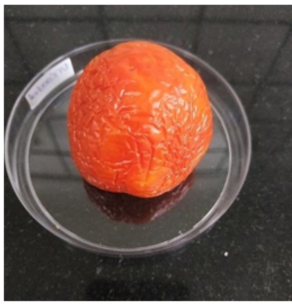
Fresh fruits such as banana, apple, or tomato were selected and washed thoroughly using distilled water to remove impurities. The fruits were then dried at room temperature. The prepared edible coating solution was applied to the fruits using the dipping method. In this process, the fruits were immersed in the coating solution for a few minutes to ensure uniform coating on the surface. After dipping, the fruits were removed and allowed to dry under ambient conditions. The coating formed a thin protective layer over the fruit surface. Both coated and uncoated fruits were stored under controlled conditions for further analysis and comparison.

2.5. Storage and Evaluation:

The coated and uncoated fruits were stored at room temperature and under refrigerated conditions. The performance of the edible coating was evaluated at regular intervals based on parameters such as weight loss, firmness, pH, microbial growth, and visual appearance.

Observations were recorded to determine the effectiveness of the coating in extending the shelf life and maintaining the quality of fruits.

3. RESULTS AND DISCUSSIONS



3.1 Weight Loss Measurement

Weight loss was calculated by measuring the initial and final weights of the fruits.

Weight Loss% = (Initial weight - Final weight) / Initial weight * 100

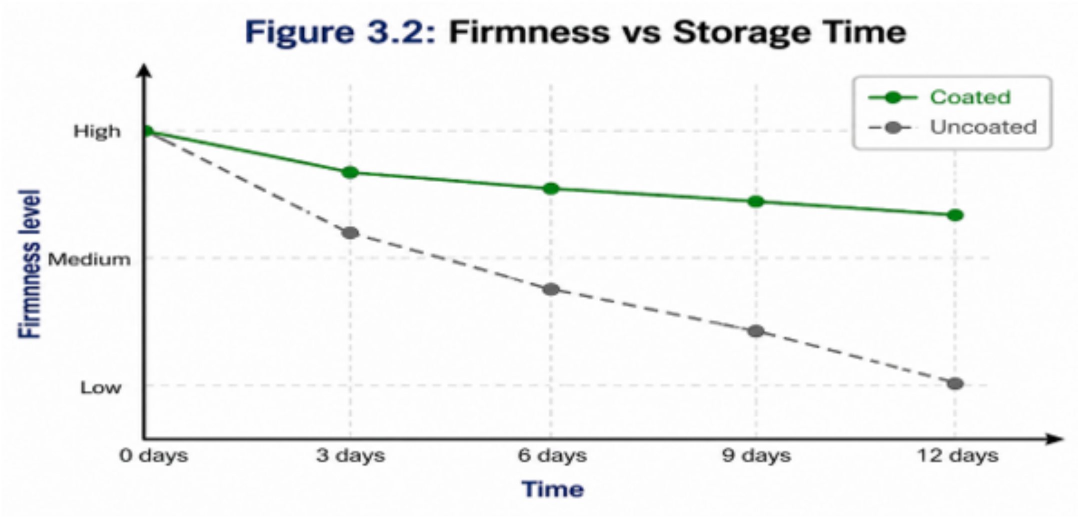
Table 1 : *Weight Loss Observation*

Day	Initial Weight (g)	Final Weight (g)	Weight Loss (%) – Coated	Weight Loss (%) – Uncoated
0	150	150	0	0
2	150	147	2.0	4.0

4	150	144	4.0	8.0
6	150	141	6.0	12.0
8	150	138	8.0	16.0
10	150	135	10.0	20.0

3.2 Texture and Firmness Analysis

Firmness was evaluated manually by applying gentle pressure to the fruits. Coated fruits remained firm for a longer time.



3.3 Microbial Analysis

Microbial growth was observed visually or using basic lab methods. Coated fruits showed reduced microbial growth.

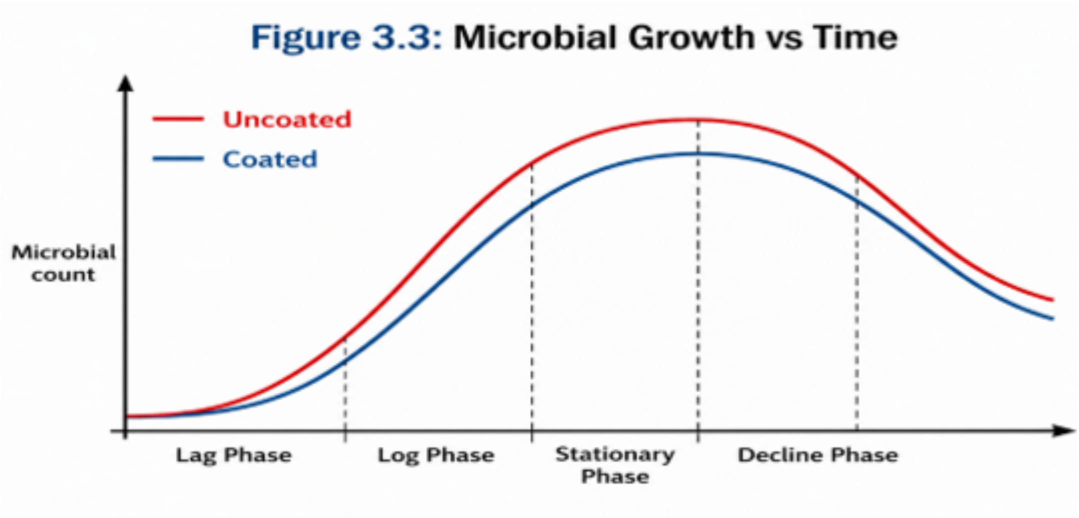


Table 2: *Microbial Growth Analysis*

StorageTime (Days)	Microbial Count (CFU/g) – Coated	Microbial Count (CFU/g) – Uncoated
0	1.0×10^3	1.0×10^3

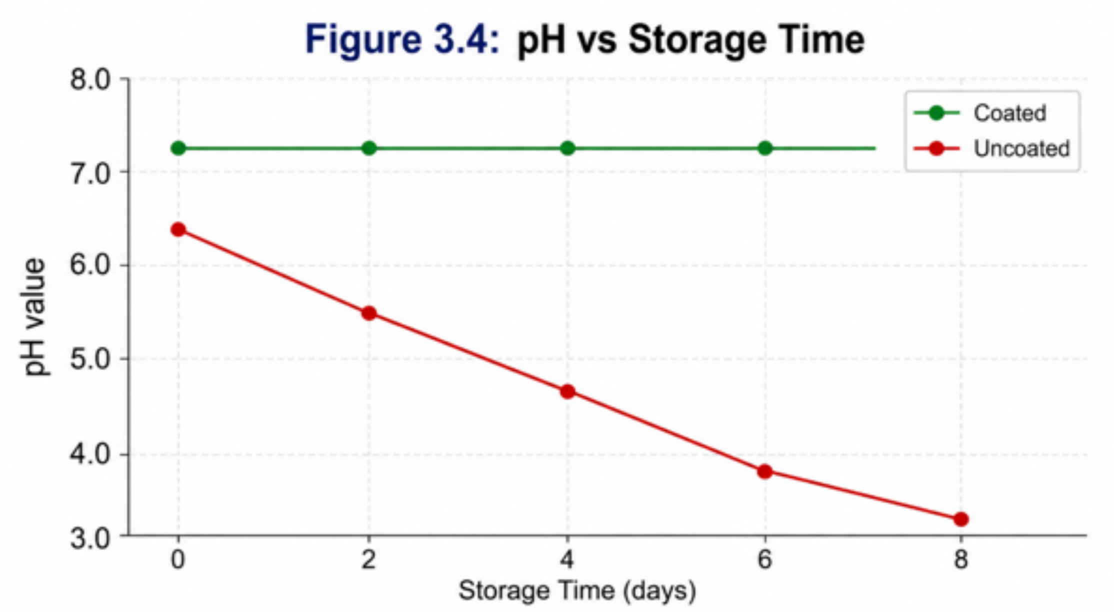
3	1.5×10^3	3.0×10^3
6	2.0×10^3	6.5×10^3
9	3.0×10^3	1.2×10^4
12	4.5×10^3	2.0×10^4

3.4 Quality Evaluation

Quality of fruits was evaluated based on different parameters.

3.5 pH and Acidity Measurement

pH values were measured during storage. Coated fruits showed slower change in acidity.



3.6 Color and Sensory Evaluation

Color and appearance were observed visually. Coated fruits retained freshness and color

compared to uncoated fruits.

3.7 Microbial Growth Analysis

Microbial growth is a major cause of fruit spoilage.

- Uncoated fruits showed **rapid increase in CFU count**.
- Coated fruits showed **Delayed Microbial Growth.**

3.8. Comparison of Coated vs. Uncoated Fruits

A comprehensive comparison highlights the advantages of edible coating.

Table 3: Expanded *Comparison Table*

Parameter	Coated Fruits	Uncoated Fruits
Moisture Loss	Minimal	High
Firmness	Retained	Lost quickly
Microbial Growth	Controlled	Rapid
Appearance	Attractive	Dull
Shelf Life	Extended (10–15 days approx)	Short (5–7 days approx)

4. CONCLUSION

In this study, a natural and biodegradable edible coating was successfully prepared using Aloe Vera gel, starch, chitosan, alginate, glycerol, and distilled water. The developed coating solution was effectively applied to fresh fruits using a simple dipping method, forming a thin protective layer on the surface. The results demonstrated that the edible coating significantly improved the storage stability and overall quality of the fruits compared to uncoated samples. The coated fruits showed reduced weight loss, delayed ripening, improved firmness, and lower microbial growth during the storage period. The coating acted as a semi-permeable barrier, controlling moisture loss and gas exchange, thereby slowing down respiration and senescence processes. The presence of chitosan and Aloe Vera contributed to antimicrobial activity, which helped in minimizing spoilage and extending shelf life. The study confirms that the combination of natural polymers and plant-based extracts can be effectively utilized to develop eco-friendly preservation techniques. The edible coating prepared in this work is cost-effective, non-toxic, and easy to apply, making it suitable for both small-scale and industrial applications. Overall, this approach provides a sustainable solution to reduce post-harvest losses and improve food quality. With further optimization and large-scale implementation, edible coatings can play a significant role in enhancing food preservation and reducing environmental impact.

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