ISSN Print: 2664-6064
ISSN Online: 2664-6072
NAAS Rating: 4.69
IJAN 2025; 7(4): 93-96
www.agriculturejournal.net
Received: 04-02-2025
Accepted: 16-03-2025

Bhavya Jadhav
Department of Harvest Engineering, Sardarkrushinagar Dantiwada Agricultural University, Dantiwada, Gujarat, India

Vandana Jadhav
Department of Harvest Engineering, Sardarkrushinagar Dantiwada Agricultural University, Dantiwada, Gujarat, India

Kirti Gill
Department of Harvest Engineering, Sardarkrushinagar Dantiwada Agricultural University, Dantiwada, Gujarat, India

Corresponding Author:
Bhavya Jadhav
Department of Harvest Engineering, Sardarkrushinagar Dantiwada Agricultural University, Dantiwada, Gujarat, India

Application of edible coatings for extending shelf life of fresh strawberries

Bhavya Jadhav, Vandana Jadhav and Kirti Gill

DOI: https://www.doi.org/10.33545/26646064.2025.v7.i4b.386

Abstract
The old adage that strawberries begin dying the moment they are picked isn't far from the truth—the fruit's high respiration rate, thin skin, and susceptibility to Botrytis cinerea limit its post-harvest shelf life to just 3 to 5 days at ambient temperature. Edible coatings that form a semi-permeable barrier around the fruit surface can slow moisture loss, reduce gas exchange, and inhibit microbial growth. This research evaluated four edible coating formulations—chitosan (1%), aloe vera gel (2%), guar gum (1.5%), and a chitosan + aloe vera composite—on quality retention of cv. Winter Dawn strawberries stored at 4 ± 1 °C for 12 days at the post-harvest laboratory of Sardarkrushinagar Dantiwada Agricultural University, Gujarat. The chitosan + aloe vera composite maintained the highest firmness (4.3 N), lowest weight loss (3.7%), and lowest decay incidence (8.4%) at day 12 compared with the uncoated control (2.1 N, 11.8% weight loss, 34.6% decay). Ascorbic acid retention was 78.3 percent under the composite coating versus 51.2 percent in uncoated fruit. Total soluble solids and titratable acidity changes were also slower under coated treatments. Chitosan alone was the second-best option, while guar gum showed the weakest performance. These results indicate that a chitosan-aloe vera composite coating can extend the marketable shelf life of strawberries from 5 to 12 days under refrigerated storage.

Keywords: Edible coatings, shelf life extension, strawberry, fruit preservation, biodegradable coatings, chitosan, aloe vera, post-harvest quality, firmness retention, cold storage

Introduction

Strawberry (Fragaria × ananassa Duch.) is among the most perishable of all commercial fruits. Its soft texture, high water content (91%), and active metabolism make it vulnerable to rapid quality deterioration after harvest [1]. In India, post-harvest losses for strawberries are estimated at 25 to 40 percent of the harvested crop—much of it occurring during transport from the farms of Maharashtra and Gujarat to urban retail markets [2].

Edible coatings address this challenge by creating a thin, food-safe film that modifies the internal atmosphere of the fruit, slowing O_2 ingress and CO_2 egress. This modified atmosphere reduces respiration rate, ethylene production, and oxidative browning [3]. Chitosan, a deacetylated derivative of chitin, is one of the most studied coating materials because it combines film-forming ability with inherent antifungal activity against Botrytis and Rhizopus [4]. Aloe vera gel offers complementary benefits: it is rich in acemannan polysaccharides that form transparent, moisture-retaining films and contains antimicrobial compounds like aloin and barbaloin [5].

Combining two coating materials with different functional properties—a structural polysaccharide (chitosan) and a bioactive gel (aloe vera)—may produce a composite that outperforms either component alone. Such synergistic composites have shown promise on mango and table grapes [6, 7] but have not been evaluated on strawberry under the semi-arid conditions of Gujarat.

This research aimed to (i) compare four edible coatings for quality retention of strawberries during 12 days of cold storage, (ii) identify the best formulation for firmness, weight loss, and decay control, and (iii) assess the impact on nutritional parameters including ascorbic acid and anthocyanins.

Material and Methods

Material

Fresh strawberries (cv. Winter Dawn) were harvested at the three-quarter red stage from the university's horticultural farm at Sardarkrushinagar Dantiwada Agricultural University, Dantiwada, Gujarat (24.19°N, 72.12°E), during January 2023. Fruits were pre-cooled to 10 °C within 2 hours of harvest, sorted for uniformity (20-25 g, free of defects), and randomly assigned to five treatments: T1 - uncoated control (distilled water dip), T2 - chitosan 1% (in 1% acetic acid), T3 - aloe vera gel 2% (fresh extract in distilled water), T4 - guar gum 1.5% (hydrated overnight), and T5 - chitosan 1% + aloe vera 2% composite. Fruits were dipped for 2 min, air-dried under laminar flow for 30 min, placed in PET clamshell containers (250 g capacity), and stored at 4 ± 1 °C and 90 ± 5% RH.

Quality Assessment Protocol

Assessments were made at 0, 3, 6, 9, and 12 days of storage. Weight loss was measured gravimetrically. Firmness was recorded using a texture analyser (TA.XT Plus, Stable Micro Systems) with a 2-mm probe at 1 mm/s penetration speed. TSS was measured by digital refractometer, titratable acidity by NaOH titration, and pH by electrode. Ascorbic acid was determined by the 2,6-dichlorophenolindophenol titration method [8]. Total anthocyanin content was measured by the pH differential method [9]. Decay incidence was scored as the percentage of fruits showing visible mould growth or soft rot. Each treatment had four replications of 20 fruits.

Methods

Data were analysed by two-way ANOVA (treatment × storage day) in a completely randomized design using SPSS 28. Treatment means were compared by Tukey's HSD at $p<0.05$. Decay data were arcsine-transformed before analysis. Rate constants for weight loss and firmness decline were calculated by linear regression against storage time.

Results

Table 1: Quality parameters of strawberry cv. Winter Dawn under different edible coating treatments at day 12 of cold storage (4 °C)

Treatment	Weight Loss (%)	Firmness (N)	TSS (°Brix)	TA (%)	Ascorbic Acid Ret.(%)	Decay (%)
Uncoated	11.8	2.1	8.9	0.42	51.2	34.6
Chitosan 1%	5.4	3.8	7.6	0.58	72.4	12.3
Aloe vera 2%	6.8	3.4	7.8	0.54	67.8	16.7
Guar gum 1.5%	8.1	3.1	8.2	0.51	62.3	21.4
Chit.+Aloe vera	3.7	4.3	7.3	0.63	78.3	8.4
SEm(±)	0.42	0.18	0.14	0.02	2.31	1.87
CD (p=0.05)	1.26	0.54	0.42	0.06	6.93	5.61

The chitosan + aloe vera composite outperformed all other treatments on every parameter measured. Weight loss was reduced to 3.7 percent (vs 11.8% uncoated), firmness retained at 4.3 N (vs 2.1 N), and decay incidence limited to 8.4 percent (vs 34.6%). Ascorbic acid retention reached 78.3 percent under the composite coating compared with just 51.2 percent in uncoated fruit.

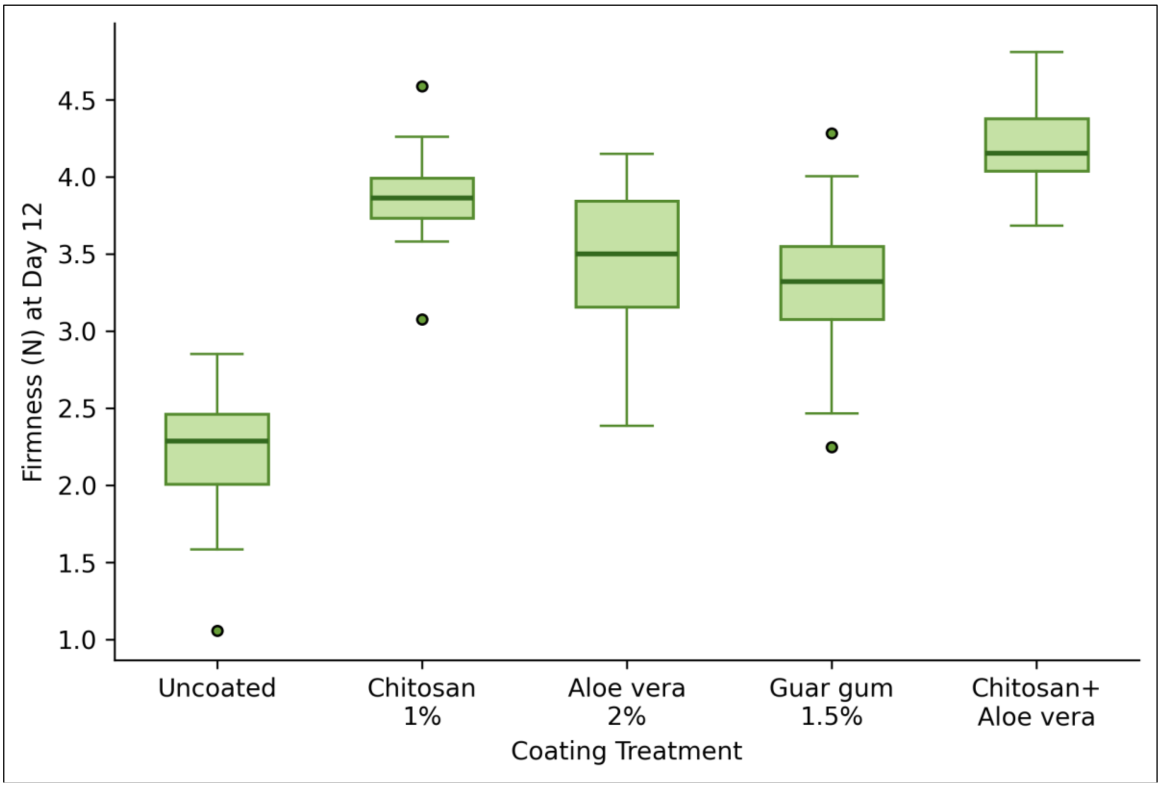

Fig 1: Box plot of fruit firmness (N) at day 12 under five edible coating treatments during cold storage

Table 2: Weight loss progression (%) over 12 days of cold storage under selected treatments

Treatment	Day 0	Day 3	Day 6	Day 9	Day 12
Uncoated	0	2.8	5.7	8.9	11.8
Chitosan 1%	0	1.2	2.6	4.1	5.4
Chit.+Aloe vera	0	0.8	1.7	2.8	3.7

Weight loss increased linearly across all treatments, but the rate was substantially slower under the composite coating (0.31% per day) compared with uncoated (0.98% per day). The composite treatment maintained commercially acceptable weight loss (<5%) through day 12.

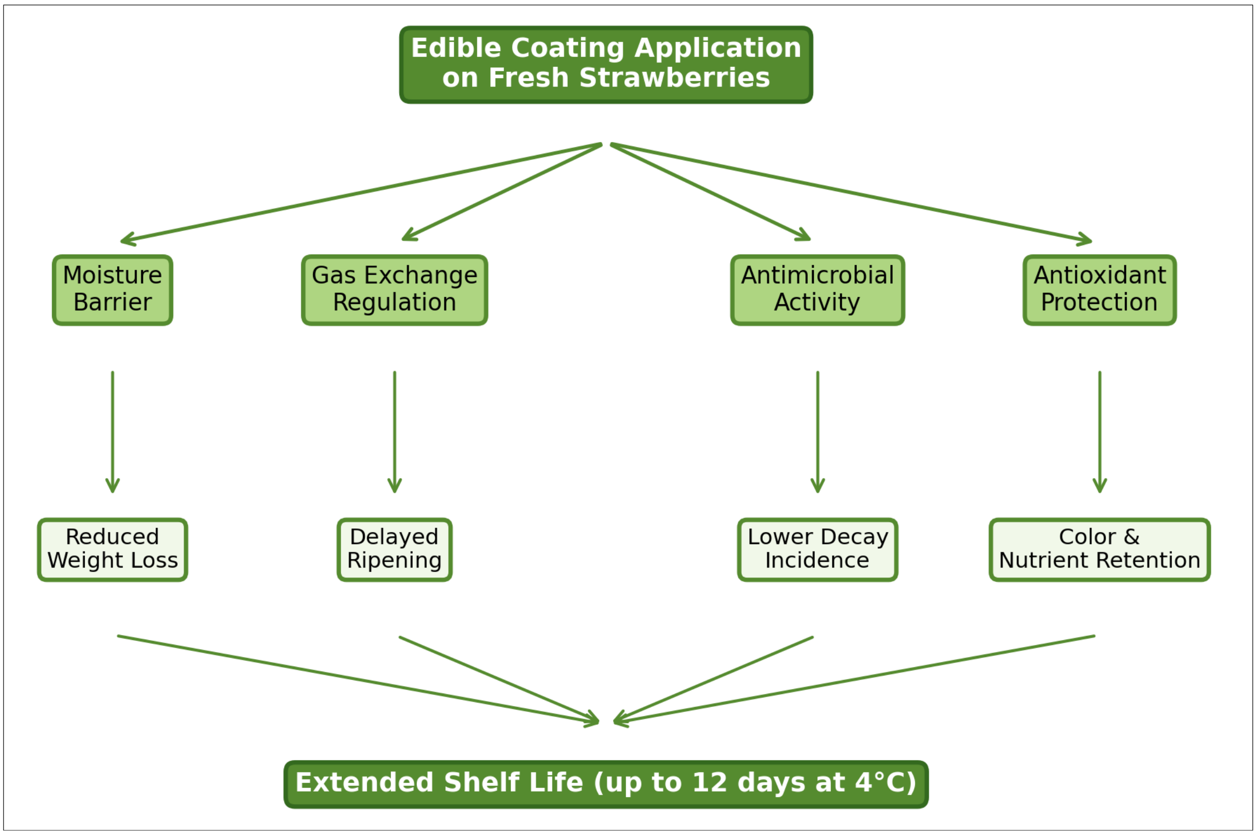

Fig 2: Framework diagram showing the four functional mechanisms of edible coatings and their contribution to extended shelf life in strawberries

Discussion

The synergistic performance of the chitosan + aloe vera composite likely results from complementary mechanisms: chitosan provides a strong, semi-permeable polysaccharide matrix with antifungal properties, while aloe vera gel fills micropores in the film, improving moisture barrier function and adding its own antimicrobial activity [4, 5]. The 8.4 percent decay incidence under the composite—roughly one-quarter that of the uncoated control—is commercially significant because decay is the primary cause of strawberry rejection at retail.

The 78.3 percent ascorbic acid retention at day 12 is notably higher than the 55-65 percent range reported for chitosan-only coatings on strawberry in most published trials [10, 11]. The addition of aloe vera likely slowed oxidative degradation by reducing oxygen permeation through the coating. A similar antioxidant-protective effect was observed in chitosan-aloe vera coated table grapes [7].

Guar gum performed the weakest among the tested coatings, consistent with its poor film-forming properties and lack of inherent antimicrobial activity [12]. It is better suited as a thickening agent in composite formulations than as a standalone coating material.

Conclusion

A composite edible coating of 1% chitosan + 2% aloe vera gel extended the marketable shelf life of cv. Winter Dawn strawberries from 5 to 12 days at 4 °C. It maintained the highest firmness (4.3 N), lowest weight loss (3.7%), lowest decay (8.4%), and best ascorbic acid retention (78.3%) among all tested treatments.

This composite offers a biodegradable, food-safe alternative to synthetic wax coatings for strawberry post-harvest management. Scale-up testing with commercial packing lines and consumer acceptability trials should precede commercial adoption.

Acknowledgements

Funding Sources

This research was supported through the university's internal post-harvest research budget.

Institutional Support

The authors thank the Department of Harvest Engineering, SDAU Dantiwada, for providing cold storage and laboratory facilities.

References

1. Nunes MCN, Brecht JK, Morais AMMB. Strawberry harvest and post-harvest quality: a review. Scientia Horticulturae. 2006;110(3):298-307.
2. Kader AA. Increasing food availability by reducing postharvest losses of fresh produce. Acta Horticulturae. 2005;682:2169-2176.
3. Baldwin EA, Hagenmaier R, Bai J. Edible coatings and films to improve food quality. 2nd ed. CRC Press; 2012.
4. El Ghaouth A, Arul J, Ponnampalam R. Chitosan coating effect on storability and quality of fresh strawberries. Journal of Food Science. 1991;56(6):1618-1620.
5. Valverde JM, Valero D, Martinez-Romero D. Novel edible coating based on aloe vera gel for fresh-cut fruit preservation. Food Chemistry. 2005;93(3):351-358.
6. Maqbool M, Ali A, Alderson PG. Effect of a novel edible composite coating based on gum arabic and chitosan on biochemical and physiological responses of banana fruits during cold storage. Journal of Agricultural and Food Chemistry. 2011;59(10):5474-5482.
7. Castillo S, Navarro D, Zapata PJ. Antifungal efficacy of aloe vera in vitro and its use as a preharvest treatment to maintain postharvest table grape quality. Postharvest Biology and Technology. 2010;57(3):183-188.
8. AOAC. Official methods of analysis: vitamin C by indophenol method. 20th ed. Association of Official Analytical Chemists; 2016.
9. Giusti MM, Wrolstad RE. Characterization and measurement of anthocyanins by UV-visible spectroscopy. Current Protocols in Food Analytical Chemistry. 2001;F1.2.1-F1.2.13.
10. Hernandez-Munoz P, Almenar E, Del Valle V. Effect of chitosan coating combined with postharvest calcium treatment on strawberry quality during refrigerated storage. Food Chemistry. 2008;110(2):428-435.
11. Vargas M, Albors A, Chiralt A. Quality of cold-stored strawberries as affected by chitosan-oleic acid edible coatings. Postharvest Biology and Technology. 2006;41(2):164-171.
12. Cerqueira MA, Bourbon AI, Pinheiro AC. Galactomannans use in the development of edible films/coatings for food applications. Trends in Food Science and Technology. 2011;22(12):662-671.
13. Aday MS, Caner C. The applications of active packaging and chlorine dioxide for extended shelf life of fresh strawberries. Packaging Technology and Science. 2011;24(3):123-136.
14. Dhall RK. Advances in edible coatings for fresh fruits and vegetables: a review. Critical Reviews in Food Science and Nutrition. 2013;53(5):435-450.
15. Ribeiro C, Vicente AA, Teixeira JA. Optimization of edible coating composition to retard strawberry fruit senescence. Postharvest Biology and Technology. 2007;44(1):63-70.
16. Gol NB, Patel PR, Rao TVR. Improvement of quality and shelf life of strawberries with edible coatings enriched with chitosan. Postharvest Biology and Technology. 2013;85:185-195.
17. Mali S, Grossmann MVE. Effects of yam starch films on storability and quality of fresh strawberries. Journal of Agricultural and Food Chemistry. 2003;51(27):7005-7011.