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Using Aloe Vera Gel (*Aloe barbadensis* Mill) as a Preservative to Increase the Stability of Vegetable Storage

Mohammed Abdulrazzaq Alsoufi*
Department of Goods Evaluation and Services Performance, Market Research and Consumer Protection Center, University of Baghdad, Iraq

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Abstract

The aloe vera (ALV) gel coating solution contains tannins, alkaloids, flavonoids, coumarins, terpenes, saponins, and glycosides. The inhibition growth rates of *Escherichia coli*, *Salmonella typhimurium*, *Staphylococcus aureus*, and *Bacillus subtilis* were 63, 58, 65, and 57%, respectively, at a rate of 60.75% for a 5% ALV gel coating solution. It was 66, 63, 70, and 64%, respectively, at a rate of 65.75% for 10% ALV gel coating solution. It was 73, 68, 70, and 66%, respectively, at a rate of 69.25% for 20% ALV gel coating. The weight loss of coated eggplants with sterile distilled water, 5, 10, and 20% ALV gel coating solution was 0.791, 0.714, 0.578, and 0.384%, respectively, during storage for 10 days at 4°C, while it was 15.416, 13.638, 12.462, and 9.326%, respectively, during storage for 21 days at 25°C. The soluble solids content of coated eggplants with sterile distilled water, 5, 10, and 20% ALV gel coating solution was 5.9, 5.7, 5.6, and 5.4%, respectively, while it was 6.6, 6.1, 5.8, and 5.5%, respectively, whilst it was 6.9, 6.4, 6.0, and 5.6%, respectively, during storage for 10, 20, and 30 days at 4°C.

Keywords: Aloe vera gel, *Aloe barbadensis* Mill, antimicrobial, eggplant coating extend shelf life, soluble solids content, vegetables weight loss.

استعمال هلام الصبار (*Aloe barbadensis* Mill) كمادة حافظة لزيادة ثباتية خزن الخضراوات

محمد عبد الرزاق الصوفي
قسم تقويم السلع واداء الخدمات، مركز بحوث السوق وحماية المستهلك، جامعة بغداد

الخلاصة

احتوى محلول التغطية هلام الصبار على كل من tannins وalkaloids وflavonoids وcoumarins وterpenes وsaponins وglycosides، وكانت نسبة التثبيط لنمو بكتريا *Escherichia coli* و*Salmonella typhimurium* و*Staphylococcus aureus* و*Bacillus subtilis* بواقع 63 و58 و65 و57% على التوالي وبمعدل 60.75% لمحلول التغطية المحضر من هلام الصبار بتركيز 5%، بينما كانت نسبة التثبيط بواقع 66 و63 و70 و64% على التوالي وبمعدل 65.75% لمحلول التغطية المحضر من هلام الصبار بتركيز 10%، في حين كانت نسبة التثبيط بواقع 73 و68 و70 و66% على التوالي وبمعدل 69.25% لمحلول التغطية المحضر من هلام الصبار بتركيز 20%، وكانت نسبة فقدان الوزن في الباذنجان المغطى باستعمال الماء المقطر المعقم ومحلول التغطية المحضر من هلام الصبار بتركيز 5 و10 و20% بواقع 0.791

*Email: alsoufim@mracpc.uobaghdad.edu.iq

و0.714 و0.578 و0.384% على التوالي خلال الخزن لمدة 10 ايام بدرجة حرارة 4م، بينما كانت بواقع 15.416 و13.638 و12.462 و9.326% على التوالي خلال الخزن لمدة 21 يوم بدرجة حرارة 25م، ولوحظ ان محتوى المواد الصلبة الذائبة في الباذنجان المغطى باستعمال الماء المقطر المعقم ومحلول التغطية المحضر من هلام الصبار بتركيز 5 و10 و20% بلغ 5.9 و5.7 و5.6 و5.4% على التوالي، بينما كان 6.6 و6.1 و5.8 و5.5% على التوالي، في حين بلغ 6.9 و6.4 و6.0 و5.6% خلال الخزن لمدة 10 و20 و30 يوم على التوالي بدرجة حرارة 4م.

1. Introduction

Recently, consumers around the world have demanded safe, fresh foods for continued daily consumption. Fruits and vegetables are considered a healthy type of food that consumers want to obtain with a high level of freshness and quality [1]. Moreover, the term "green consumerism" makes the current consumer more inclined to find and prefer foods that have more natural additives, avoid artificial additives, have guaranteed safety, have high nutritional value, have an extended shelf life, and avoid foodborne outbreaks due to the consumption of contaminated foods [2]. These demands have driven food producers to find appropriate technologies to overcome storage challenges after harvesting, handling, and marketing to enhance food safety and quality assurance through the use of biodegradable coating materials in packaging [3]. Therefore, food producers turned to natural polymers instead of artificial polymers despite their low cost, except that they have become hazardous for environmental and public health, resulting in their neglect in use in food industries [4].

The natural polymers have various features due to their biocompatibility, biodegradability, and compliance with chemical and biochemical modifications [5]. Most edible coating materials are polysaccharides that have the capacity to hydrate in water either by forming a gel or stabilizing emulsion systems [6], which are used in the packaging process to control changes in the fruit and vegetable after harvesting such as spoilage, weight loss, and shelf life [7]. ALV gel is one of the coating materials that protect the texture, color, and shelf life of fruits and vegetables during storage. This gel is natural, safe for human consumption, environment-friendly, edible, invisible, odorless, and does not affect the taste [8]. Moreover, it has biological effects and pharmaceutical and therapeutic properties [9, 10]. Therefore, this study aimed to use ALV gel (*Aloe barbadensis* Mill) to extend the shelf life of eggplant.

2. Materials and Methods

2.1 Aloe vera gel preparation

Leaves from the ALV were obtained from the local markets in Baghdad, washed with tap water to remove surface dirt, dipped in the sodium hypochlorite solution at 0.1% for 3 minutes, and kept at 25°C until completely dried. The gelatin was separated manually and clarified with a muslin cloth to remove the fiber. The pH of the raw gel was maintained below 3.5 with a 1% solution of citric acid (w/v) and pasteurized at 70°C for 45 min. After that, the gel was cooled to ambient temperature and kept in the refrigerator until used for coating [11].

2.2 Eggplant preparation

Fresh eggplant (*Solanum melongena*) was obtained from local markets in Baghdad, washed with tap water to remove surface dirt, and dipped in the sodium hypochlorite solution 0.1% for 3 minutes to reduce microbial contamination. Next, eggplants were rinsed with sterile deionized distilled water to remove traces of sodium hypochlorite solution and kept at 25°C until completely dried, then used in the experiment of coating [2].

2.3 Microorganism's strains

Fourth-generation bacterial isolates: *Escherichia coli*, *Salmonella typhimurium*, *Staphylococcus aureus,* and *Bacillus subtilis* were obtained from the Department of Biology, College of Science, University of Al-Mustansiriah, Iraq. All isolates were kept in nutrient agar slants at 4°C through the study period as stock cell cultures.

2.4 Detection of active compounds

Active compounds such as glycosides, alkaloids, terpenes, saponins, tannins, coumarins, and flavonoids were detected in ALV hot aqueous extract [12, 13].

2.5 Aloe vera gel coating solution

The coating solutions (5, 10, and 20%) were prepared by diluting them with sterile deionized distilled water in a ratio of v/v, then adding glycerol 1% (v/v) to the solution as a gelling agent to improve the viscosity and plasticity of the ALV gel coating solution. The coating for eggplant was conducted by dipping it in the coating solution (5, 10, and 20%) for 5 minutes, then drying at room temperature, and then storing it for 10 and 21 days at 4 and 25 °C, respectively [2].

2.6 Inhibition (%) of microorganism strains

The inhibition (%) of microorganism strains was calculated by transferring 1 mL (105 CFU/mL) of the microorganism to a Petri dish with nutrient agar, then distributing it by stirring and coating it with 1 mL of ALV gel solution (5, 10, and 20%), leaving it for 60 min in the laminar chamber under continuous sterile conditions till completely dry, then incubating it at 37°C for 24 h. Steril was used as a control. The growth of the microorganism strains was calculated at a rate of three replicates for each sample, and the inhibition (%) was determined from the following equation according to the method of Alsoufi & Aziz [14].

$$\text{Inhibition (\%)} = \frac{\text{No. of colonies for sample}}{\text{No. of colonies for control}} \times 100$$

2.7 Weight loss

Eggplant were washed, completely dried from water, and weighted, then coated with 5, 10, and 20% of ALV gel coating solution using a sterilized little brush. After the coating solution dried, the eggplant was weighted again and then stored at 4°C for 10 days and 25°C for 21 days. The percentage of weight loss (%) was calculated through the following equation as a method of Al-Soufi [15].

$$\text{Weight loss (\%)} = \frac{\text{Weight after storage period}}{\text{Initial weight}} \times 100$$

2.8 Estimation of soluble solids content

Soluble solids content was estimated by using KRUSS HR900 manual hand-held refractometer (0–90% Brix/0.2% Brix) in the extracted juice of flesh and peel eggplant [16].

3. Results and Discussion

3.1 Qualitative detection of active compounds

The results in Table 1 show the qualitative detection of the active compounds of the ALV gel coating solution, which included tannins, alkaloids, flavonoids, coumarins, terpenes, saponins, and glycosides.

Table 1: Qualitative detection of the active compounds in the aloe vera gel

Active compound	Indication
Tannins	+
Alkaloids	+
Flavonoids	+
Coumarins	+
Terpenes	+
Glycosides	+
Saponins	+

(+): Contain of active compound.
(-): Free of active compound.

Aloe vera has many pharmacological activities, including antibacterial, antifungal, antiviral, anti-inflammatory, and others. [17], this activity was attributed to the phytochemical substances found in the plant, such as tannins, alkaloids, flavonoids, and coumarins [18], alkaloids, phenolic acids/polyphenols [19], alkaloids, saponins, tannins, glycosides, and flavonoids [20], and alkaloids, terpenes, phenols, tannins, coumarins, and flavonoids [21].

3.2 Effect of Aloe vera gel coating solution on growth inhibition of some microorganisms

The growth inhibition of *E. coli*, *S. typhimurium*, *S. aureus*, and *B. subtilis* was 63, 58, 65, and 57%, respectively, at a rate of 60.75% for a 5% ALV gel coating solution. It was 66, 63, 70, and 64%, respectively, at a rate of 65.75% for 10% ALV gel coating solution. It was 73, 68, 70, and 66%, respectively, at a rate of 69.25% for a 20% aloe vera gel coating solution (Table 2).

Table 2: Effect of aloe vera gel coating solution on growth inhibition of somemicroorganisms

Microorganisms	Inhibition (%)		
	Aloe vera gel coating solution (%)		
	5	10	20
Escherichia coli	63	66	73
Salmonella typhimurium	58	63	68
Staphylococcus aureus	65	70	70
Bacillus subtilis	57	64	66
Average (%)	60.75	65.75	69.25

In the present study, all the ALV gel coating solution concentrations that were used showed antimicrobial activity against selective microorganisms, while the maximum antibacterial effect for all isolates was at ALV gel coating solution 20%. The inhibition activity of ALV extract has been evaluated against some bacteria such as *E. coli*, *Listeria monocytogenes*, *Shigella boydii*, *S. aureus*, *Pseudomonas aeruginosa*, *Streptococcus pyogenes*, *Streptococcus mutans*, *Bacillus sphaericus*, *Enterococcus faecalis*, *Klebsiella pneumoniae*, *Proteus mirabilis*, and others [19, 22, 23].

3.3 Weight loss and soluble solids content

The weight loss of coated eggplants with sterile distilled water, 5, 10, and 20% ALV gel coating solution was 0.791, 0.714, 0.578, and 0.384%, respectively, during storage for 10 days

at 4°C (Figure 1), while it was 15.416, 13.638, 12.462, and 9.326%, respectively, during storage for 21 days at 25°C (Figure 2).

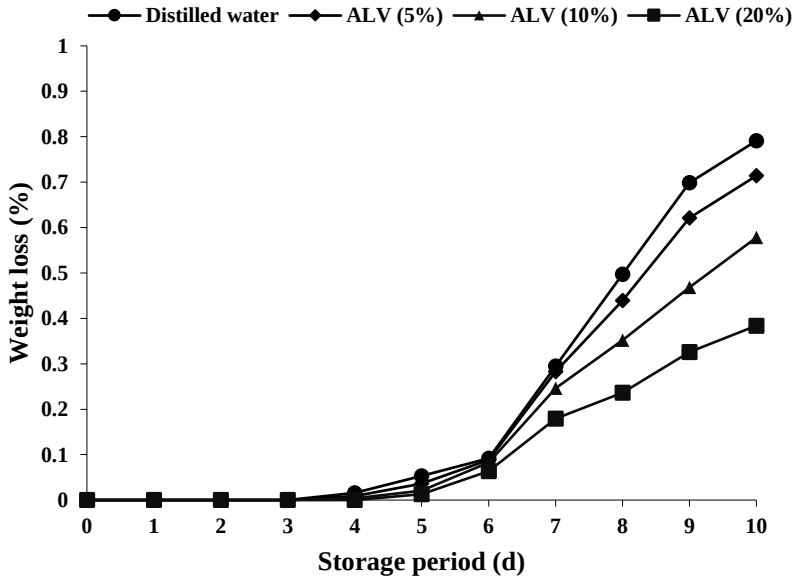

Figure 1: Weight loss of eggplant coated with an aloe vera gel coating solution during storage for 10 days at 4 °C

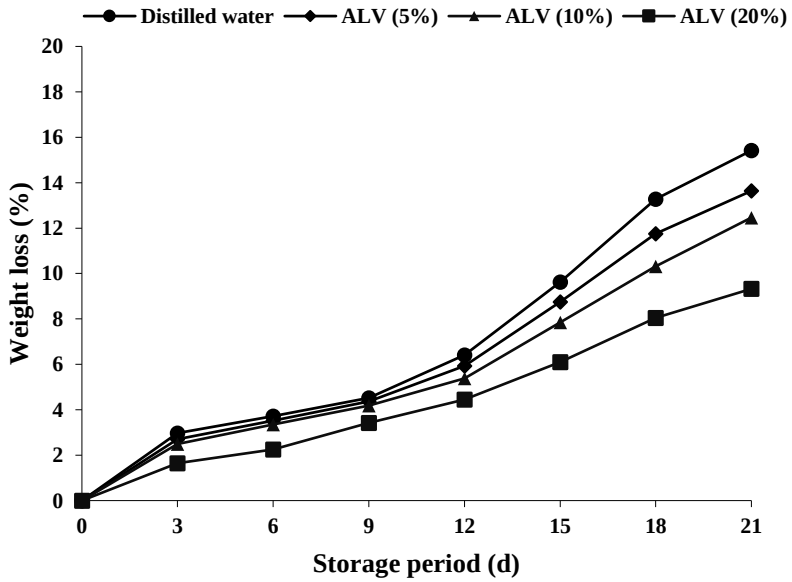

Figure 2: Weight loss of eggplant coated with an aloe vera gel coating solution during storage for 21 days at 25°C

The soluble solids content of coated eggplants with sterile distilled water, 5, 10, and 20% ALV gel coating solution was 5.9, 5.7, 5.6, and 5.4%, respectively, while it was 6.6, 6.1, 5.8, and 5.5%, respectively, whilst it was 6.9, 6.4, 6.0, and 5.6%, respectively during storage for 10, 20, and 30 days at 4°C (Figure 3).

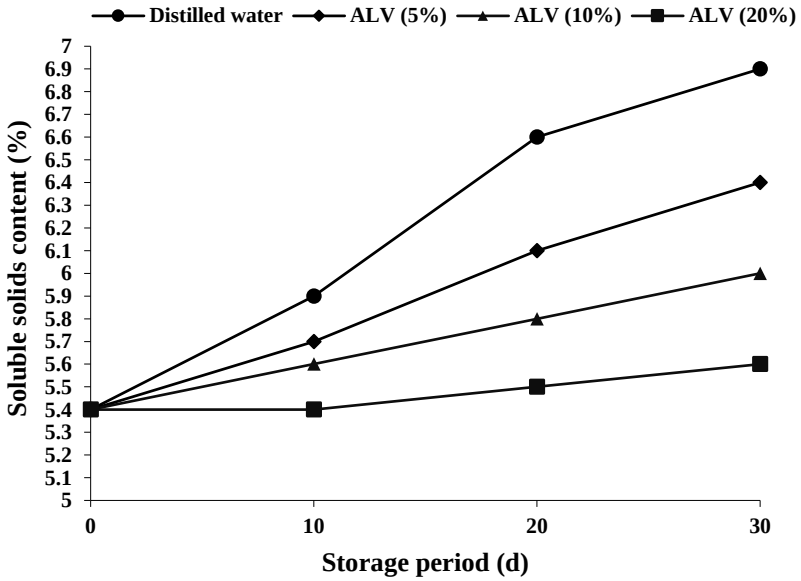

Figure 3: Soluble solids content of eggplant coated by an aloe vera gel coating solution during storage for 10, 20, and 30 days at 4 °C

The results indicate that the coating of eggplant with ALV gel coating solution (20%) led to a lower rate of loss in weight and soluble solids content during the storage period.

In this regard, Alsoufi and Aziz [14] noted that the weight loss of pears coated with rosemary and pullulan (1:1) was 0.21 and 6.7% in the 10 and 21 days of storage at 4 and 25 °C, respectively. The coating of pear led to a decrease in weight loss of nearly 50% after storage for 21 days at 25°C and extended the shelf life up to 3 days after storage for 10 days at 4°C without any changes in general appearance or weight. Hern'andez-Guerrero et al. [24] report that the average mass loss of mango fruit was 3.36% for coating by banana starch, while it was 4.04% for uncoated plants during storage for 10 d at 22 °C. The soluble solids content of fruit coated with mango starch increased from 26.43 to 28.76% at the end of storage for 15 days at 10 °C. As well, coating with ALV gel led to a stop in the weight loss of papaya fruit up to 3 days of storage and the ability to preserve firmness up to the end of storage, and a reduction in respiration rate due to coating led to a lower rate of increment in soluble solids content, delaying the ripening process in fruits [25]. Zhou et al. [26] found that the use of shellac for coating Huanghua pears (Pyrus pyrifolia) was more effective in the retention of soluble solids content levels during storage for 60 days at 4°C due to the decrease in gas permeability of the coating material, which has the effect of lowering respiratory rates and metabolic activities during storage. Similarly, Ozturk et al. [27] observe that the use of aloe vera and modified atmosphere packaging for coating cherry laurel (*Prunus laurecerasus*) leads to a lower soluble solids content level after 15 and 30 days of storage at 0°C compared to the control sample. Also, Wu [28] indicates that the lost weight of fresh cut potatoes was 21.06%, whereas cut potatoes lost 3.41% after coating by *Opuntia dillenii* polysaccharide at the end of the 5th day of storage at 5°C. Similarly, the highest weight loss of uncoated papaya fruits was 13.19% after 15 days of storage at 28°C.

Weight loss in fresh fruits and vegetables during storage was considered a big problem due to undesirable changes in appearance, quality, and taste that caused economic losses for producers, marketers, and sellers. Therefore, the use of coating for these types of foods is a beneficial application to ensure quality, safety, and extending shelf life due to its role in

preventing microorganism growth and weight loss during storage and marketing for consumers [29, 30, 31].

4. Conclusion

The coating of eggplant with an aloe vera gel coating solution led to a lower rate of loss in weight and soluble solids content during the storage period and an extended shelf life during storage without any changes in general appearance or weight.

5. Ethics Approval and Consent to Participate

Only plant samples were used to carry out this research. No humans and/or animals participated in it.

6. Funding and Financial Support

This work was financially supported and conducted at the Market Research and Consumer Protection Center, University of Baghdad, Iraq.

7. Conflict of Interest

The authors declare that there is no conflict of interest regarding this work.

8. Availability of Data and Material

All data and materials mentioned in the manuscript contain all relevant raw data and will be freely available to any researcher who uses them for non-commercial purposes.

9. Acknowledgment

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