

RESEARCH ARTICLE



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Study response of Barwary apple fruit to Aloe Vera gel and storage period.

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ABSTRACT

The study was carried out on the fruit of the local apple cultivar Barwary (Malus x domestica) cultivated within a private orchard located in Dohuk Governorate, Ekmalla village, Barwary bala, Iraq. The primary objective was to assess the impact of immersing fruits for 3 minutes in varying concentrations (0, 15, 30, 45, and 60%) of *Aloe Vera* gel solution on the quality of apples during storage periods of 1.5 and 3 months at cold storage conditions maintained at 1+1°C with relative humidity (RH) ranging between 85-90%. In general, it was observed that the fruit maintained its quality across all levels of *Aloe Vera* gel solution. Consequently, enhancements in firmness, acidity, and vitamin C content were noted in the apple fruit. Furthermore, the weight loss was reduced significantly compared to untreated fruits, as well as TSS and juice (%), but it did not reach significance. with respect to the storage duration, it was found that prolonged storage period from 1.5 to 3 months resulted in a significant increase in both total soluble solid % and fruit weight loss %. Despite these variations, no discernible impact was observed on total soluble solid %, juice %, and weight loss% across the experimental processes. Moreover, all levels of *Aloe Vera* gel maintained firmness, vitamin C concentration (mg.100 ml-1 juice), and acidity percentage significantly compared to the control group following cold storage for 3 months plus an additional 25 days under ambient temperature conditions (shelf life). *Keywords:* Fruit, Aloe Vera, cold storage, shelf life, postharvest .

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INTRODUCTION

Apples (*Malus* x *domestica* Borkh, which belongs to the Rosaceae family), are among the most widely consumed fresh fruits in the world. It is particularly important as one of the major temperate fruit crops grown worldwide. In 2019, the worldwide production of apples surpassed 87 million tones [1]. Within the agricultural landscape of the Kurdistan Region of Iraq, apple cultivation is prominently ranked, closely following grape cultivation. The ubiquity of apples in markets year-round, across numerous nations, underscores their significance as a substantial source of nutrients and bioactive compounds for human consumption [2]. Widely consumed apples are a veritable repository of rich sources of dietary fibers and a myriad of phytochemicals, including antioxidants, such as catechin, procyanidins, phloridzin, quercetin, and chlorogenic acid. The linkage between apple consumption and a decrement in the risk of cardiovascular ailments, certain forms of cancer, asthma, and diabetes has been corroborated through epidemiological studies [3,4,5]. *Aloe Vera* is a plant native to tropical and subtropical regions that has been esteemed for centuries owing to its medicinal and therapeutic virtues [6]. The gel extracted from aloe vera has prevailing medicinal uses as the gel juice taken orally is used against kidney problems. It also contributes to the diminution

and therapeutic virtues [6]. The get extracted from aloe vera has prevaining medicinal uses as the get futce taken orally is used against kidney problems, ulcers, digestive system and cardiovascular problems. It also contributes to the diminution of blood cholesterol and triglyceride levels. Beyond these, Aloe Vera exhibits anti-inflammatory and antibiotic properties against various diseases [7]. Aloe vera gel has been identified as a pioneering coating agent due to its ability to control loss of moisture, firmness, and brown oxidation, and reduce respiration and proliferation of microorganisms in fruits by containing various antibacterial and antifungal compounds [8,9,10]. Numerous studies have delved into the impact of Aloe Vera gel-based edible coatings on the quality parameters of coated fresh-cut apple fruits [11]. Presently, the gel derived from Aloe Vera leaves is prevalently utilized in medical research and cosmetic products, predominantly for the former. [12,13]. During 6-month storage of apple 'Granny Smith' fruit, aloe vera gel coating at 5 or 10% concentrations effectively prevented weight loss, delayed the decline of soluble solids and titratable acidity, and prevented their appearance from changing during cold storage and eventually increasing storage/shelf life [14]

Furthermore, the application of *Aloe Vera* gel on nectarine fruits stored at ambient or cold temperatures have been shown to retard ripening, reduce ethylene production, respiration rate, electrolyte leakage, loss of weight, fruit softening, and the ratio of total soluble solids to titratable acidity, alongside maintaining levels of ascorbic acid and total antioxidants [8]. It has also been reported that hydro colloidal coatings maintained the quality, firmness, crispness and juiciness of Golden Delicious apples after (8 weeks) of cold storage. [15]. Aloe vera gel coating is essential in delaying fruit ripening by reducing ethylene biosynthesis, respiration rate, and internal metabolic activities associated with fruit softening, color development, enzymatic browning, and decomposition. In addition, these coatings reduce microbial spoilage due to their antifungal properties and maintain visual appearance, hardness, total antioxidants, sugar: acidity and phenolic content,

thus maintaining edible quality [16]. As the storage period progresses, there is a noticeable increase in the total sugar content and an unnoticeable decrease in acidity, along with an increase in total soluble solids across all apple varieties. Ascorbic acid content, however, decreases in all apple varieties to varying degrees during storage at room temperature. Nevertheless, the pronounced decrease in acidity observed in 'Golden Delicious' apples indicates that they can It is stored for up to six weeks after ripening to achieve a suitable and good price in the market [17]. In a study on peach fruits cv. Indian Blood was coated with different treatments of AV gel for the evaluation of post-harvest shelf-life extension and changes in physiological and biochemical attributes when stored at ambient conditions ($25 \circ C \pm 2$) for nine days. The results revealed that peach fruits treated with AVgel (100 ml. L-1) maintained the good status of total soluble solids concentrations while keeping a high level of titratable acidity as compared with the control treatment on the final day of storage [18].

This study aimed to prolong the storability of local apple fruit, determine the influence of coating on fruit quality, and reduce fruit physiological disorders during cold storage.

Materials and methods

Fully mature and medium-sized fruits were hand-picked from trees homogeneous in age and growth during the early morning within a private orchard in Dohuk Governorate, Iraq. They were transferred to the Central Laboratory, College of Agricultural Engineering Sciences, University of Duhok. Sound fruits were kept in a cold room for pre-cooling. Healthy and homogeneous fruits in (size, colour and shape) were selected and divided into three groups for each period of storage (1.5, 3 months and 25 days for shelf life). Fruits of each group were immersed for 3 minutes in *Aloe Vera* gel solutions at concentrations (0, 15, 30, 45 and 60%), after that the fruits were air-dried and placed in perforated polyethylene bags depending to the treatments, the bags were tied, and stored in cold store at 1+1°C and 85- 90% relative humidity (RH). The bags were opened for analysis after each period (1.5 and 3 months) and shelf life.

The experiment was designed according to a Completely Randomized Design (CRD) for storage period and Randomize Complete Blook Design (RCBD) for shelf life. The experiment included two factors, namely *Aloe Vera* gel with five concentrations (0, 15, 30, 45and 60%) and two storage periods (1.5 and 3 months). The experiment was applied with three replicates and 6 fruits for each replicate in each storage period. The results were analyzed using analysis of variance and the means were compared using Duncan's test at 0.05 Duncan probability level. The parameters that were taken during the experiment; Total soluble solid (TSS%), vitamin C (mg. 100 ml-1 juice), juice percentage (%), fruit weight loss (%), Titratable acidity (TA %) [19] were analyzed after each storage period and shelf life.

Preparation of Aloe Vera gel:

Mature aloe vera (AV) leaves were harvested and washed with distilled water. They were then cut in half. The AV gel was separated from the outer skin of the leaves, and this colourless hydro parenchyma was ground in an electric blender. The resulting mixture was filtered to remove the fibers. We obtained fresh aloe Vera gel liquid. To prevent oxidation, the gel was later stored in a brown amber bottle [20].

Results

Total soluble solid (TSS %)

Table (1) proved that the percentage of total soluble solids (%) decreased significantly when the storage period was increased to 3 months. No significant differences were observed in total soluble solids between the results of all treatments used in the investigation.

The interactions between the storage period and treatment, showed that the packaged fruits of 1.5 months and untreated fruit (control) with AV gel had higher total soluble solid (%). These values were significantly different from the values of all interactions between the first storage period and treatment.

Table (2) results of Vitamin C were suggestive that V. C not affected significantly when the storage period was

Table 1. Effect of A	app	le fruits stored at 1+1°C	actions on total soluble solid (%) of
AV. Conc.	Storage period (SP)		Effect of AV gel
	1.5 month	3 months	Liter of Tit get
Control	11.333 bcd	13.367 a	12.350 a
15%	11.333 bcd	12.567 ab	11.950 a
30%	10.867 cd	12.533 ab	11.700 a
45%	11.367 bcd	12.700 ab	12.033 a
60%	10.400 d	12.233 abc	11.317 a
Effect of SP	11.060 b	12.680 a	
	Vitan	nin C (mg.100 ml-1 juice)	1

prolonged from 1.5 to 3 months. Aloe Vera gel has a positive effect in fruit juice vitamin C. The maximum vitamin C (4.784) represented in fruit dipped in 60% AV solution was significantly higher than untreated fruit. The interaction of SP1 or 1.5 months and 60% AV gel treatment significantly gave the highest value of Vitamin C (4.752) compared with most other interactions

AV. Conc. Storage period (SP) Effect of AV gel 1.5 month 3 months Control 3.384 bc 3.024 c 3.204 c 4.374 ab 15% 4.104 ab 4.239 ab 3.888 abc 30% 4.104 ab 3.996 b 45% 4.536 a 4.104 ab 4.320 ab 60% 4.752 a 4.815 a 4.784 a Effect of SP 3.987 a 4.230 a

Table 2. Effect of *Aloe Vera* gel (%), storage period and their interactions on Vitamin C of apple fruits stored at 1+1°C.

Table 3. Effect of Aloe Vera gel (%), storage period and their interactions on juice (%) of apple fruit at

1+1°C.				
AV. Conc.	Storage pe	eriod (SP)	Effect of AV col	
	1.5 month	3 months	Effect of AV ger	
Control	50.169 a	50.784 a	50.477 a	
15%	51.598 a	53.042 a	52.320 a	
30%	53.365 a	51.793 a	52.579 a	
45%	48.933 a	52.163 a	50.548 a	
60%	52.203 a	53.613 a	52.908 a	
Effect of SP	51.253 a	52.279 a		

Juice (%), the results of Table (3) showed that all *Aloe Vera* concentrations did not appear significant in the percentage of fruit juice when the storage period extended to three months.

(Table 3) No significant differences were noticed in juice percentage of apple fruit when dipped in all concentrations of AV gel (%). As a result, the interaction between *Aloe Vera* treatments and storage period did not show any significant effect in juice %.

Fruit weight loss (%)

The decrease in fruit weight (%) increased significantly when the storage period increased from 1.5 - 3 months. But decrease in fruit weight loss did not show a significant effect by dipping fruit in all concentrations of Aloe Vera gel when compared with untreated fruit. (Table 4)

The lowest fruit weight loss (0.419) was the result of 45% Aloe Vera gel, plus 1.5 months' storage which was significantly differ from the highest fruit weight loss (1.433) in the untreated fruits and 3months storage.

Table 4. Effect of *Aloe Vera* gel (%), storage period and their interactions on fruit wight loss (%) of apple fruits stored at $1+1^{\circ}C$

		at 1+1 C.		
AV. Conc.	Storage p	period (SP)	Effect of AV gel	
	1.5 month	1.5 months		
Control	12.650 d	12.662 d	12.656 d	
15%	14.750 abc	14.562 bc	14.656 b	
30%	14.725 abc	14.500 bc	14.613 b	
45%	14.237 c	13.917 c	14.077 c	
60%	15.462 a	15.125 ab	15.294 a	
Effect of SP	14.365 a	14.153 a		

Titratable acidity (%)

Table 5 shows that the titratable acidity percentage (%) decreased significantly when the storage period was extended to 3 months.

Fruits treated as dip in all concentration caused a significant increase in the titratable acidity as compared with the untreated fruits where it was the highest value (0.603) in concentration of 60% the highest fruit titratable acidity (0.632%)

AV. Conc.	TSS	Firmness	VC	Acidity%	Juice %	Wight loss
Cont.	13.667 a	11.958 b	2.736 b	0.493 b	44.947 a	2.965 a
15%	13.967 a	13.437 a	3.672 ab	0.526 ab	51.243 a	2.553 a
30%	13.200 a	14.075 a	3.240 b	0.549 a	50.631 a	3.166 a
45%	13.633 a	13.575 a	3.600 ab	0.551 a	46.286 a	2.956 a
60%	13.567 a	14.083 a	4.248 a	0.556 a	46.865 a	2.993 a

Table 7. Effect of Aloe Vera gel on some characters of fruits after 3months cold storage +25 days at ambient temperature.

was registered by *Aloe Vera* gel 60% and 1.5month storage period, which was significant as compared with the lowest titratable acidity (0.522) from the interactions between the control fruits and 3 months storage (table 5).

Firmness

About firmness, the table (6) shows that there was no significant difference when the storage period extended from 1.5 to 3 months. The results of the dipping treatment showed a significant increase in firmness compared to

the untreated fruit. The highest firmness value (15.294) was recorded at AV 60%.

The interaction of 1.5 months and 60% AV gel significantly gave the highest firmness (15.462) compared with some other interactions.

Shelf life

The *Aloe Vera* gel (0 as control, 15, 30, 45 and 60%) process did not cause a significant effect on some qualitative characteristics of the fruits (Total soluble solid %, juice % and weight loss%) after cold storage for 3 months +25 days at ambient temperature (shelf life).

On the other hand, the fruit treated with all AV gel level retained their firmness, vitamin C (mg.100 ml-1 juice) and Acidity % significantly as compared with fruits of control after storage cold for 3 months +25 days at ambient temperature. (Table 7)

Table 6. Effect of Aloe Vera	gel (%), storage period a	and their interactions on	firmness (%) of apple fruits
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stored	at	$1 + 1^{\circ}$	C.
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AV. Conc.	Storage period (SP)		Effect of AV col
	1.5 month	3 months	Effect of AV ger
Control	0.536 b	1.433 a	0.985 a
15%	0.638 b	1.205 ab	0.922 a
30%	0.537 b	1.046 ab	0.792 a
45%	0.419 b	0.998 ab	0.709 a
60%	0.652 b	1.209 ab	0.931 a
Effect of SP	0.556 b	1.178 a	

Discussion;

According to the results of this study the effect of dipping fruits in aloe vera gel solutions with different concentrations were clear on the quality of apple fruits that [total soluble solid, juice, and weight loss (%)] had positive influence but not significantly. While the fruits retained their vitamin C, juice%, and titratable acidity, significantly when treated with different concentrations of AV gel. Aloe vera gel contains polysaccharides, which act as a natural barrier to the loss of moisture and oxygen, both are the main causes of wilting of fruits and vegetables [21]. However, the mechanism of these beneficial effects of edible layers of aloe vera gel on physiological fruits depends on their hygroscopic properties, which allow the formation of a barrier to the spread of water between the fruit and the external environment, which prevents its transfer abroad [22]. It might also be AV gel have prevented moisture loss, controlled respiration rate, and delayed oxidation of fruits [23]. AV gel has been found effective to maintaining the cell structure, the stabilizing effect can be explained by the formation of cross-links between the carboxyl group of the polyuronide chains located in the middle lamina of the cell wall. Edible coatings also increase cell swelling pressure [24] and stabilizes the cell membrane [25]. Surface coatings such as aloe vera gel help develop the modified atmosphere inside the fruit, and also provide skin resistance against the partial diffusion of gases or completely clogs the pores which ultimately leads to reduced respiration rate and delayed ripening of the fruits during storage [26]. Edible coatings based on aloe vera gel are considered safe and compelling alternative to enhance shelf life and preserve quality [27].

Conclusion;

Based on these observations of the local apple cultivar Barwary under study, it was concluded that the fruit quality of dipping apple fruit in *Aloe Vera* gel solution were better compared to untreated fruit under 3months cold of storage. More ever, the quality and shelf life of apple fruits can be maintained for up to 25 days at ambient temperature after cold storage for 3 months without any physiological disorder. That is, it increases the shelf life of the fruits in the markets, and this is economically beneficial.

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دراسة استجابة ثمار التفاح البرواري لجل الالوفيرا وفترة التخزين.

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الخلاصة

اجريت الدراسة على ثمار التفاح المحلي صنف برواري المزروعة ضمن بستان خاص في محافظة دهوك قرية اكمالة برواري بالا العراق. الهدف الاساسي منه هو لتقييم تاثير غمر الثمار لمدة 3 دقائق في تراكيز مختلفة (0–15–30–60 %) من محلول جل الصبار (الالوفيرا) على جودة ثمار التفاح خلال فترات التخزين (1.5 و 3) أشهر خلال التخزين البارد عند درجة حرارة (1+1) م ورطوبة نسبية نتراوح بين 85 –90 %.

بصورة عامة لوحظ ان الثمار حافظت على جودتها عند غمرها بجميع مستويات محلول جل الصبار (الالوفيرا). ونتيجة لذلك احتفظت بصلابتها ونسبة فيتامين ج والحموضة للثمار وانخفضت نسبة الفقدان بوزن الثمار بصورة معنوية مقارنة مع الثمار غير المعاملة، وكذلك بالنسبة لنسبة المواد الصلبة الذائبة ونسبة العصير المئوية ولكن لم تصل الى المعنوية. اما بالنسبة لمدة التخزين فقد زادت النسبة المؤية المواد الصلبة الذائبة والفقدان بالوزن بصورة معنوية عند اطالة مدة التخزين من 1.5 الى 3 أشهر. على الرغم من هذه الاختلافات لم تؤثر جميع العوامل تحت الدراسة على نسبة المواد الصلبة الذائبة ونسبة العصير والفقدان بوزن الثمار. لكن جميع تراكيز جل الالوفيرا حافظت على صلابة الثمار وفيتامين ج والحموضة بصورة معنوية عائمار غير المعاملة بعد خزنها لمدة ثلاثة أشهر بالاضافة الى 25 يوما في درجة حرارة المحيط (مدة الصلاحية).

الكلمات المفتاحية : ثمرة- الصبار - الخزن المبرد- مدة الصلاحية - بعد الحصاد.