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Impact of Edible Coating on Papaya Fruit Fresh-Cut Quality during Cold Storage

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Abstract

THE STUDY investigated the effect of *Aloe vera* gel alone and combined with lemon essential oil and chitosan as a possible alternative edible coating for maintaining quality of fresh-cut papaya cubes. The cubes were dipped in treatment solutions which were: chitosan (1%), chitosan (2%), *Aloe vera* gel (40 %), *Aloe vera* gel (40%) combined with lemon essential oil (1%), lemon essential oil (1%) and distilled water (control). Samples treated with *Aloe vera* gel (40%) combined with lemon essential oil (1%) had the best results in terms of weight loss, titratable acidity, vitamin C content, color values and total antioxidants while chitosan (2%) was the most effective treatment in reducing browning index, introducing the best sensory attributes, and increased total phenolics by 250% approximately than control.

Keywords: papaya, *Aloe vera*, chitosan, lemon essential oil, total antioxidants, total phenolics.

Introduction

Papaya (Carica papaya) is a tropical tree, and its fruit has global importance. It is a climacteric fruit and has high nutritional value, it contains high concentrations of ascorbic acid (vitamin C), vitamin A, minerals such as riboflavin, thiamine, pantothenic acid, iron, and fibres, with low calories. Owing to the rich nutritional value and health attributes of papaya fruit, its global demand has greatly increased, but fruits like papaya require more time to prepare before being ready to eat e.g. peeling and cutting. Therefore, sometimes consumers may neglect this important fruit. Due to the change in the consumer's life style, the demand for ready-to-eat fruits has increased, this can be achieved through peeling, cutting, washing, drying, packaging in plastic or foam trays, and finally, marketing it refrigerated. The peel removal leads to accelerated weight and nutrients loss, enzymatic reactions, color and texture change, rapid microbial growth, and product quality deterioration of the product (Yeoh et al., 2014). Thus, many studies including coating of fresh cut papaya fruit, have been conducted to prolong shelf life and maintain higher nutritional and sensory quality.

Edible coatings have attained commercial importance worldwide due to their role in reducing moisture loss and gas (O_2, CO_2) exchange, microbial growth and color degradation (Brasil et al., 2012). They are colorless, odourless and tasteless substances.

With the growing awareness of the need for environmental preservation, the use of additives and technologies based on natural compounds has emerged as an alternative maintaining the quality of fresh-cut fruits. In this context, edible coatings (EC) have gained significant popularity due to their natural components, which are considered safe, nontoxic for consumption, and economical. However, while edible coatings have beneficial effects on various fruits, their application still not widespread.

Edible coatings were initially created as thin solid sheet or layer, then applied on the food products as a wrapping. Recently, in order to coat all surfaces of product, edible coatings are formed in liquid substances and forms are invisible coat that separates the fruit surface from the surrounding atmosphere (Yousuf et al., 2018).

Edible coatings may be classified into five categories: lipids, hydrocolloids, proteins,

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polysaccharides and wax (Krochta, 2002). Among these, Aloe vera gel is one of the most studied natural substances used for edible coatings. It is eco-friendly, transparency, colorless, odorless, tasteless and oil-transparent as well as water-soluble, nontoxic and chemically stable (Wang et al., 2016). Aloe vera gel is rich in essential amino acids (providing 20 of 22 required for human diet), and it is a good source of vitamins A, B1, B2, B6, B12, C and E along with minerals such as magnesium, manganese, zinc, calcium, selenium and iron(Farina et al., 2020).

Aloe vera gel has been successfully used as an edible coating for various fruits, including fresh-cut papaya (Marpudi et al., 2011; Kuwar et al., 2015 and Farina et al., 2020), mangoes (Dang et al., 2008), apples (Ergun & Satici, 2012) and nectarines (Ahmed et al., 2009).

Chitosan is a polysaccharide coating obtained from the deacetylation of chitin in an alkaline medium, it is nontoxic, biodegradable and possesses antimicrobial activity.

Edible coatings contain important additives that act as antimicrobial and antioxidant agents, including essential oils. Essential oils are natural extract from fruits and vegetables. For example, lemon essential oil is derived from the Citrus genus (L. 1753) and contains volatile compounds known for their antioxidant and antifungal properties. These compounds, which can be add to edible coatings as alternative additives include limonene, esters, alcohols (linalool), aldehydes (citral), acids and others (Burt, 2004; Bakkali et al., 2008).

Additionally, various organic acids such as citric acid, ascorbic acid and oxalic acid have been incorporated into edible coatings to extend the shelf life of fruits (Rojas-Graü et al., 2009). In line with previous research, this study aims to evaluate the potential effects of chitosan, Aloe vera gel alone and (or) combination with lemon essential oil to maintain the quality of fresh-cut papaya fruit.

Materials and Methods

Forty fruits of papaya (Carica papaya L. cv. Solo) were harvested at early ripe stage when the peel color became 25% yellow, ensuring they had a uniform size, shape and color as possible and free from any external defects, from a private orchard in Sarabioum region, Ismailia, Egypt in 2024.

Preparation of edible coatings

Aloe vera gel

One kilogram of mature Aloe vera leaves were collected from the experimental field of Suez Canal University, transferred to the postharvest laboratory of the Horticulture Department, Faculty of Agriculture, and washed with tap water. Using a stainless-steel knife, the gelatinous parenchyma was separated from the outer epidermis. The gelatinous parts were crushed for 6 min at 24500 rpm (using blender 7009G, model HGBTAC30 USA) to obtain a homogenous substance, then it was filtered to remove the fibrous parts. A total volume of 500ml extract was obtained. Based on previous searches (Benitez et al., 2015 & Farina et al., 2020), 120ml of Aloe vera gel was diluted to 300ml (40%) for acceptable sensory due to the bitter taste occurred at higher concentrations.

Chitosan edible coating

Chitosan powder (0.5 g) (Iso-Chem Egypt) was dissolved in (100 ml) acetic acid (0.5% v/v) at 80°C for 60 min according to Escamilla-Garcia et al. (2017).

Different coatings at various concentrations were prepared based on previous researches, the treatments conducted in this investigation were:

1- Chitosan (1 %)

2- Chitosan (2 %)

3- Aloe vera (40%)

4- Aloe vera (40%) in combination with lemon essential oil (1%)

5- Lemon essential oil (1%) diluted in distilled water

6- Control (distilled water).

Moreover, citric acid (1% v/v) and ascorbic acid (0.5% v/v) as anti-browning and maintain the pH value below 4, in addition to 3% (v/v) glycerol to improve the film plasticity were added to all treatment's solutions except control.

Sample preparation and coating application:

All working area and surfaces which in direct contact with the fruits were washed and sanitized with sodium hypochlorite (2% v/v) to obtain the maximum sanitization effect.

All papaya fruits were washed in cold tap water (5°C) and then were immersed in sodium hypochlorite (2%v/v) at 5°C for 2 min. Afterwards, using sharp stainless- steel knife, the papaya fruits were peeled and cut into uniform cubes (2cm), and immersed in distilled cold water (5°C). Then, papaya cubes were immersed in the treatment solutions as mentioned above.

The excess solutions were drained off for 5min on tissue paper, after that papaya cubes of each treatment were packed in polypropylene trays and wrapped with transparent polyethylene films. All trays were stored at 4°C and 90%RH (Tabassum & Khan 2020) for further analysis which were carried out every 4 days up to 12 days. All parameters were estimated after the coating process to exclude the effect of the material composition itself on different estimates.

1- Weight loss (%): the weight of each tray was measured on day zero and every 4 days, weight loss was calculated using the following equation

Weight loss (%) = {(wi – wd) / wi} * 100

Where (wi) was the initial weight at zero time and wd was the weight measured during storage period.

2- Soluble solids content (SSC %): soluble solids content (%) in the juice was measured by using LC II-Digital refractometer (Medline scientific, United Kingdom, SR-95).

3- Titratable acidity (TA%): the same juice was used to determine SSC was also used for TA and vitamin C. TA was titrated with NaOH (0.1N) using 2 or 3 drops of phenolphthalein as an indicator, and results were expressed as percentage of citric acid (AOAC, 1990).

4- Ascorbic acid (vitamin C) content: ascorbic acid was determined through titration using 0.1% 2,6-dichlorophenolendophenol till a permanent pink color. Vitamin C content was expressed as ml/100ml juice (AOAC,1990).

5- Color: Minolta CR10 chromometer (Minolta crop, Japan) was used to evaluate the color of fresh-cut papaya cubes and L*, a*and b* coordinators were determined according to El-Shiekh (2002) and McGuire, 1992.

6- Browning index: Browning index was measured according to Saxena et al. (2012), samples of 0.5g were extracted in 5ml of ethanol (67%) for 1 hour, then the extract was filtered, and browning index absorbance was measured at 420 nm with 67% ethanol as blank

7- Total antioxidants: the total antioxidant activity was determined using DPPH method according to Ali et al. (2017); and Lee et al. (2003) and calculated using the following equation:

DPPH radical – scavenging activity (%) = $\{(A_{blank} - A_{sample})/ A_{blank}\} * 100$

Where, A_{blank} and A_{sample} were the absorbance values of the control and test samples, respectively. The absorbance was measured at 515 nm.

8- Total phenolics content: total phenolics were determined as described by Mazumdar and Majumder (2003). The optical density of the blue color was measured at 650 nm and expressed as mg Gallic acid/100 mg fresh weight.

9- Sensory evaluation: sensory analysis of fresh-cut papaya was performed after 4,8 and 12 days of cold storage by 15 semi-trained members including faculty members and students (7 males and 8 females, aged 20 to 40 years), and the parameters evaluated were color, texture, fruity aroma, presence of filaments, bitter, mealy and overall acceptance. The panelists' team used water to rinse their mouths before testing every new sample. The following scale was used to evaluate the intensity of each parameter: 1= absence of the parameter, 5= moderate presence of the parameter, and 9= maximum intensity of the parameter (Yousuf & Srivastava 2015).

Statistical analysis

The experiment was arranged in a completely randomized design with triplicate and factorial arrangement of data. Data were analyzed utilizing Costat version 6.303 1998-2004 by analysis of variance (Steel and Torrie 1980), the means were compared using least significant differences (L.S.D) at a significant level of 0.05.

Results and Discussion

Weight loss (%)

The percentage of weight loss gradually increased with longer storage duration (Table 1). All treatments resulted in a significant reduction in weight loss comparing to control group. Treatments coated with a mixture of Aloe vera and 1% lemon essential oil, as well as those coated with Aloe vera alone, exhibited minimum significant weight loss. In contrast, the highest weight loss percentage was observed in the uncoated fruit samples (control). The rapid change in weight loss percentage in fresh fruits can be attributed to exposed and damaged subepidermal layers (Kuwar et al., 2015).

Similar results were reported by Ahmed et al. (2009), who suggested that applying 2.5% Aloe vera gel decreased weight loss and extended the postharvest shelf life of nectarine slices.

Additionally, these results align with those of Farina et al. (2020), who found that coating fresh-cut papaya cubes with Aloe vera gel reduced evaporation from the surfaces of the cubes, allowing them to retain more weight. The reduction in weight loss percentage associated with lemon essential oil may be due to its effective role as water barrier.

The interaction between different coating treatments and storage durations significantly affected weight loss of fresh-cut papaya fruits. However, fruit weight loss increased in all treatments with extending storage period, the highest percentage of weight loss (8.6) was obtained in uncoated samples after 12 days of storage while, it could be seen that coating papaya fresh-cut cubes with Aloe vera combined with 1% lemon essential oil had the lowest weight loss during storage period comparing with other treatments.

Soluble solids content (SSC%)

The estimation of SSC explains the natural ripening processes. the initial SSC % of all samples

on the zero time was ranged between 5.80 and 6.47 **%**, all the coated samples had slightly higher SSC value, this probably contributed to the coating material itself and its content of SSC. It increased over the storage period for all treated samples (Table 2). In contrast, the uncoated samples exhibited decline in SSC after a slight increase. This reduction may be due to degradation of sugars and conversion into acid, which might be due to higher respiration rate. The highest (6.89**%**) SSC was observed in samples coated with Aloe vera gel (40%) + lemon essential oil (1%), these results agree with Passafiume et al., (2020), they found that coating slices of kiwi fruit with Aloe vera gel combined with lemon essential oil had the highest value of SSC compared to other treatments and control. SSC was significantly increased with extending storage duration in all treatments. Significant interaction was detected between different edible coatings and storage durations on soluble solids content. The highest SSC (7.37**%**) was obtained from samples coated with Aloe vera gel (40%) + lemon essential oil (1%) after 12 days of cold storage. This maintenance of SSC value could be explained by the positive effect of Aloe vera gel (40%) + lemon essential oil (1%) as edible coating film thereby slow down respiration and degradation of sugars to acids.

Titratable acidity (TA)

The treatments of chitosan (1&2 %) and Aloe vera gel combined with (1%) lemon essential oil showed a slower decrease of TA comparing with the other treatments and control (Table 3). The higher values of TA which obtained in chitosan (1&2 %) might be contributed to the incorporation of acetic acid as a dissolvent of chitosan powder during preparation its dipping solution. So, in our vision, the titratable acid content in cubes coated with Aloe vera + essential lemon oil (1%) was more realistic and expressing the actual effect of the treatment. Organic acids such as citric acid (the main organic acid in papaya fruit) are utilized as substrates in cellular respiration during metabolic processes. The results are in harmony with Passafiume et al., (2020), they found that Aloe vera gel combined with lemon essential oil maintained TA of kiwi fruit slices compared to Aloe vera gel or control. TA was gradually and significantly decreased with prolonging of cold storage period. Titratable acidity was significantly affected by the interaction between the different edible coatings and storage durations. The least fruit acidity (0.07 %) was observed from control after 12 days of cold storage. While coating with chitosan (1%) was the best coating to maintain the fruit acidity throughout storage period.

Color

Consumers primarily choose fresh-cut fruits based on their color. The use of edible coatings has been shown to help maintain the color of fresh-cut papaya. In this study, the lightness values (L*) decreased across all treatments over the storage period while, uncoated samples showing a more significant decline (Fig. 1). The highest (L*) value was preserved in samples coated with Aloe vera gel combined with 1% lemon essential oil. Similar results have been reported for kiwifruit slices (Passafiume et al., 2020) and apple slices (Farina et al., 2020), they found that Aloe vera gel combined with lemon essential oil maintained brightness values of fruit slices compared to control samples. Specifically for papaya fruits, Farina et al., (2020) demonstrated that cubes coated with Aloe vera gel, either alone or in combination with other additives, had higher brightness (L*) values compared to the control.

The a* values of fresh cut papaya cubes was increased throughout storage period, indicating a shift toward a reddish color (Fig. 2). The highest a* values were observed in treatments with lemon oil and 2% chitosan, while the lowest values were found in the uncoated cubes. The b* value, which measures changes in yellow color during storage of fresh-cut fruits, did not follow a consistent trend over time (Fig. 3). The b* value increased in papaya cubes coated with Aloe vera gel either alone or in combination with 1% lemon essential oil, whilst it decreased in other treatments. The cubes coated with Aloe vera gel, and 1% lemon essential oil recorded the highest b* values, indicating a more yellowish color, whereas the uncoated cubes (control) had the lowest value.

Vitamin C (ascorbic acid)

Ascorbic acid retention is a very significant parameter affecting the quality of papaya fresh-cut regarding the nutritional value. In the present study, all edible coatings under the study maintained higher concentration of ascorbic acid up to 12 days comparing with control (Table 4). Whereas coating papaya cubes with Aloe vera gel combined with 1% lemon essential oil caused the significant higher retention of ascorbic acid during the entire storage time, while the maximum reduction in ascorbic acid content was observed in uncoated samples. In fresh-cut fruits, the loss of ascorbic acid content depends on considerable factors i.e. cultivar, maturity stage, storage temperature and conservation approach (Kelin, 1987) where, ascorbic acid converts during oxidation reaction into dehydro ascorbic acid and then degraded to 2,3-diketo-gluconic acid (Deutsch, 2000). The results are in line with findings of Kuwar et al., (2015) who noted that coating papaya fresh-cut with Aloe vera alone or followed by honey 10% delayed the loss of ascorbic acid during the storage period. Likewise, Shahkoomahally and Ramezanian (2014) found that Aloe vera gel based coating retained higher concentration of ascorbic acid in table grape stored at 4°C for 35 days. Ascorbic acid content decreased over the storage period in all

treatments. The interaction between different edible coatings and storage periods was significantly effected on ascorbic acid content of fresh-cut papaya fruits, the highest (112.8) content after 12 days of cold storage was obtained in samples coated with Aloe vera gel combined with 1% lemon essential oil.

Browning index (BI)

Browning is considered one of the most important apparent changes occur in fresh-cut fruits and greatly affects the consumers judgment. It usually used as an indicator in sugar containing food products (Buera et al., 1986). Uncoated papaya cubes exhibited maximum browning index (0.106) however, all edible coatings used in this work delayed the increase in browning index. The lowest browning index (0.058) was determined in cubes coated with chitosan 2% (Table 5). Browning index was increased with time till the end of the storage period (0.131). As shown in Table 5, a peak of browning attributed with ripening was started from the fourth day in all treatments and reached maximum at the end of cold storage period. Browning index was significantly affected by the interaction between different edible coatings and storage periods where, the highest browning was detected in uncoated cubes after 12 days of cold storage. Action of peroxidase and polyphenol oxidase is believed to be the main cause of browning (Zhang and Quantick, 1998; Martinez and Whitaker, 1995; and Tomás-Barberán and Espin, 2001) and these changes were related to the changes of flesh color in different fruits. Coating apple cubes with 2.5g kg^{-1} chitosan (Zhelyazkov et al., 2014) or 1% chitosan combined with 5% ascorbic acid (Özdemor and Gökmen, 2019) retarded the browning of fruits.

Total phenolics content

Taking all treatments into account, total phenolics were increased as storage period extended (Fig. 4). This increment may be due to the activation of phenylalanine amonialase (the main enzyme in phenylpropanoid pathway) as a result fruit wounding (Saltveit, 2000). All edible coatings treatments increased total phenolics compared to control. The higher total phenolic content was observed in papaya cubes coated with chitosan 2%, it was higher by approximately 250% than control while, the treatments of chitosan 1%, Aloe vera gel combined with 1% lemon essential oil, Aloe vera individually and 1% lemon essential oil increased total phenolics by 145, 75, 60, and 51% compared to control, respectively. Phenolic compounds protect fruit cells from oxidative injury so that, the increased content of phenolics content indicates the stimulation of defence mechanism (Chawla et al., 2018). Coating papaya cubes especially with chitosan (2%) constantly increased total phenolics during cold storage. The results suggest that tested edible coatings had played an active role in enhancing total phenolics content to mitigate stress induced by the physical damage till the end of storage (12 days) as compared to uncoated samples. This could suggest that coating fresh-cut papaya cubes with 2% chitosan is more effective in preserving quality.

Total antioxidants

Antioxidants are the components which act against oxidative stress. Total antioxidant was increased in papaya cubes coated with Aloe vera combined with 1% lemon essential oil, Aloe vera individually, chitosan 2% and chitosan 1% from day 1 and reached the highest levels after 8 days of storage after that it slightly decreased (Fig 5). Total antioxidant activity was significantly increased in papaya cubes coated with Aloe vera combined with 1% lemon essential oil. This increment may be due to Aloe vera gel contains an important antioxidant components e.g. vitamins (A, C and E), B (thiamine), B2 (riboflavin), B12, niacin, choline, folic acid, flavonoids, carotenoids and polyphenolic compounds (Khanam and Sharma, 2013), as well as, lemon essential oil contains volatile ingredients which have an antioxidant properties (Burt, 2004). While the lowest antioxidant was observed in control during 12 days of cold storage at 4°C and 90%RH. The results are in line with those of Kumar et al. (2017) who found that coating Guava (Cv. Paluma) with Aloe vera gel maintained total antioxidants.

Sensory evaluation

Generally, consumers choose fresh-cut fruits and vegetables on the base of its appearance and freshness. During the storage period, Sensory attributes significantly decreased except for aroma and mealy characteristics, which increased throughout extended storage period (Table 6). Fresh-cut fruits have an injured tissues that cause stress, accelerating metabolic reactions and hence, undesirable changes in color, texture and flavour (Rivera-Lopez et al., 2005). There were significant differences between coated and uncoated papaya cubes in terms of visual color, texture, aroma, taste, presence of filaments, bitter, mealy and overall acceptance. The results indicated that uncoated papaya cubes fell below the level of acceptance after 12 days of cold storage. Judges determined that at 2% chitosan coating was the most effective treatment for maintaining high values of color and texture, as well as moderate values of aroma, however it exhibited the lowest bitterness. All studied coatings significantly altered the presence of filaments on the papaya cubes by the end of the storage period in contrast to uncoated cubes, which contained filaments after 12 days of cold storage.

It is important to note that adding lemon essential oil to edible coating slightly masks the original flavours of papaya fruit. These findings align with the studies by Zhelyazkov et al. (2014) who reported that chitosan coating retarded the drop in sensory

quality of fresh-cut apple cubes during storage period at 4°C for 17 days, while better crunchiness, juiciness and acidity in grapes treated with Aloe vera gel comparing with untreated ones (Valverde et al., 2005) however it gave an herbaceous taste of kiwifruit slices (Passafiume et al., 2020). On the other side, additive lemon essential oil in edible coatings didn't give rare flavours from apple slices (Farina et al., 2020) and preserved the quality of fresh-cut kiwifruit (Passafiume et al., 2020).

Conclusion

The application of edible coatings has been shown to maintain the quality of fresh-cut papaya. Based on the quality parameters studied, it is evident that coating papaya cubes with a 40% Aloe vera solution combined with 1% lemon essential oil effectively preserved fruit weight, titratable acidity, vitamin C levels, color values and total antioxidants. Additionally, the use of 2% chitosan reduced the browning index, introducing the best sensory attributes, and increased total phenolic content compared to the control group. Therefore, Aloe vera (40%) combined with 1% lemon essential oil and chitosan 2% can be recommended to use as alternative natural and safe edible coatings in order to preserve quality of fresh-cut papaya .***

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Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

TABLE 1. Effect of different edible coatings on weight loss (%) of papaya fresh-cut during cold storage

Treatments	Storage duration in days (B)				C.E.T (A)
	Zero*	4	8	12	
***Aloe vera* gel**	0.00	1.68	1.95	3.89	**1.88 D**
***Aloe vera* gel+ Lemon oil (1%)**	0.00	1.40	1.59	2.45	**1.36 F**
Chitosan 1%	0.00	1.79	2.01	2.67	**1.62 E**
Chitosan 2%	0.00	1.93	2.84	4.38	**2.29 C**
Lemon oil (1%)	0.00	1.43	2.03	7.34	**2.70 B**
Control	0.00	2.50	3.58	8.60	**3.67 A**
C.E.SD (B)	**0.00 d**	**1.78 c**	**2.33 b**	**4.88 a**	

Values followed by the same capital letter' (s) in column or by small letter' (s) in row are not significantly different at 5% level, *****=Initial values at harvest time, C.E.T= Composite effect of treatments, C.E.SD= Composite effect of storage duration, LSD for (A*B)= 0.194

TABLE 2. Effect of different edible coatings on SSC (%) of papaya fresh-cut during cold storage

Treatments	Storage duration in days (B)				C.E.T (A)
	Zero*	4	8	12	
***Aloe vera* gel**	6.23	6.80	6.97	6.97	**6.74 AB**
***Aloe vera* gel + Lemon oil (1%)**	6.40	6.70	7.10	7.37	**6.89 A**
Chitosan 1%	6.10	6.43	6.97	7.23	**6.68 B**
Chitosan 2%	6.47	6.57	6.77	7.27	**6.76 AB**
Lemon oil 1%	6.07	6.47	6.93	7.10	**6.64 B**
Control	5.80	5.93	6.17	5.73	**5.91 C**
C.E.SD (B)	**6.18 d**	**6.52 c**	**6.78 b**	**6.94 a**	

Values followed by the same capital letter' (s) in column or by small letter' (s) in row are not significantly different at 5% level, ***=** Initial values at harvest time, C.E.T= Composite effect of treatments, C.E.SD= Composite effect of storage duration, LSD for (A*B)= 0.296

TABLE 3. Effect of different edible coatings on titratable acidity (%) of papaya fresh-cut during cold storage

Treatments	Storage duration in days (B)				C.E.T (A)
	Zero*	4	8	12	
***Aloe vera* gel**	0.32	0.27	0.19	0.15	**0.23 C**
***Aloe vera* gel + Lemon oil (1%)**	0.38	0.27	0.19	0.19	**0.26 B**
Chitosan 1%	0.38	0.32	0.25	0.19	**0.29 A**
Chitosan 2%	0.34	0.28	0.24	0.18	**0.26 B**
Lemon oil (1%)	0.26	0.28	0.19	0.19	**0.23 C**
Control	0.18	0.15	0.11	0.07	**0.13 D**
C.E.SD (B)	**0.31 a**	**0.26 b**	**0.19 c**	**0.16 d**	

Values followed by the same capital letter' (s) in column or by small letter' (s) in row are not significantly different at 5% level, ***=** Initial values at harvest time ,C.E.T= Composite effect of treatments, C.E.SD= Composite effect of storage duration ,LSD for (A*B)= 0.038

TABLE 4. Effect of different edible coatings on vitamin C content (mg/100ml juice) of papaya fresh-cut during cold storage

Treatments	Storage duration in days (B)				C.E.T (A)
	Zero*	4	8	12	
Aloe vera	120.00	116.00	113.30	108.90	**114.6 B**
Aloe vera + Lemon oil	124.67	122.00	117.30	112.80	**119.2 A**
Chitosan 1%	103.20	97.27	92.170	83.82	**94.11 C**
Chitosan 2%	103.50	84.10	69.53	66.66	**80.95 D**
Lemon oil 1%	113.10	97.50	85.53	81.18	**94.33 C**
Control	102.30	75.06	32.16	26.40	**37.60 E**
C.E.SD (B)	**111.17 a**	**98.70b**	**85.08 c**	**79.97 d**	

Values followed by the same capital letter' (s) in column or by small letter' (s)
in row are not significantly different at 5% level, *= Initial values at harvest time,C.E.T= Composite effect of treatments, C.E.SD= Composite effect of storage duration, LSD for (A*B) = 5.17

TABLE 5. Effect of different edible coatings on browning index of papaya fresh-cut during cold storage

Treatments	Storage duration in days B)				C.E.T (A)
	Zero*	4	8	12	
***Aloe vera* gel**	0.033	0.036	0.076	0.106	**0.063 E**
***Aloe vera* gel + Lemon oil (1%)**	0.036	0.066	0.106	0.136	**0.068 C**
Chitosan 1%	0.036	0.06	0.086	0.116	**0.071 D**
Chitosan 2%	0.033	0.036	0.066	0.096	**0.058 F**
Lemon oil (1%)	0.036	0.056	0.116	0.156	**0.091 B**
Control	0.036	0.076	0.136	0.176	**0.106 A**
C.E.SD (B)	**0.035 d**	**0.053 c**	**0.098 b**	**0.131 a**	

Values followed by the same capital letter' (s) in column or by small letter' (s)
in row are not significantly different at 5% level, ***=** Initial values at harvest time, C.E.T= Composite effect of treatments, C.E.SD= Composite effect of storage duration, LSD for (A*B) = 0.006

TABLE 6. Effect of different edible coatings on sensory quality of papaya fresh-cut during cold storage

Parameters	Storage duration (days)	Treatments						
		Aloe vera gel	*Aloe vera* gel + lemon oil (1%)	Chitosan 1%	Chitosan 2%	Lemon oil (1%)	Control	C.E.SD (B)
Color	Zero*	9.00	9.00	9.00	9.00	9.00	9.00	**9.00 A**
	4	9.00	9.00	9.00	8.67	6.67	4.67	**7.83 B**
	8	8.33	7.33	6.67	8.33	5.33	3.33	**6.55 C**
	12	6.00	7.33	6.33	8.00	4.33	2.67	**5.77 D**
	C.E.T (A)	**8.08 AB**	**8.17 AB**	**7.75 B**	**8.5 A**	**6.33 C**	**4.92 D**	
Taste	Zero*	8.33	7.67	7.33	5.00	6.33	8.00	**7.17 B**
	4	7.67	7.67	7.33	6.33	6.67	8.33	**7.27 B**
	8	8.33	8.67	7.67	7.33	6.67	7.33	**7.67 A**
	12	9.00	9.00	8.00	7.67	7.00	6.33	**7.83 A**
	C.E.T (A)	**8.33 A**	**8.25 A**	**7.58 B**	**6.58 C**	**6.67 C**	**7.50 B**	
Texture	Zero*	8.00	8.00	9.00	9.00	8.00	8.00	**8.33 A**
	4	6.00	6.33	6.67	7.33	6.33	3.00	**5.94 B**
	8	5.00	6.67	3.33	6.33	6.33	2.33	**5.00 C**
	12	4.00	6.00	3.00	5.00	6.00	2.00	**4.33 D**
	C.E.T (A)	**5.75 A**	**6.75 A**	**5.50 B**	**6.92 A**	**6.67 A**	**3.83 C**	
Aroma	Zero*	4	4.33	5.33	4.67	3.67	4.67	**4.44 D**
	4	4.33	4.67	6.00	5.67	4.67	6.67	**5.33 C**
	8	4.67	5.00	6.67	7.33	5.33	7.67	**6.11 B**
	12	5	5.33	7.33	7.67	5.67	8.67	**6.61 A**
	C.E.T (A)	**4.50 C**	**4.83 C**	**6.33 B**	**6.33 B**	**4.83 C**	**6.92 A**	
Overall acceptance	Zero*	8.00	8.00	7.00	7.00	8.00	9.00	**7.83 A**
	4	7.33	6.67	6.33	5.67	7.33	7.00	**6.72 B**
	8	6.67	6.00	5.67	5.00	6.67	3.67	**5.61 C**
	12	6.33	4.33	5.33	3.33	6.33	2.67	**4.72 D**
	C.E.T (A)	**7.08 A**	**6.25 B**	**6.08 B**	**5.25 C**	**7.08 A**	**5.58 C**	
Presence of filaments	Zero*	1.00	1.00	1.00	1.00	1.00	1.00	**1.00 B**
	4	1.00	1.00	1.00	1.00	1.00	1.00	**1.00 B**
	8	1.00	1.00	1.00	1.00	1.00	1.00	**1.00 B**
	12	1.00	1.00	1.00	1.00	1.00	3.33	**1.39 A**
	C.E.T (A)	**1.00 B**	**1.00 B**	**1.00 B**	**1.00 B**	**1.00 B**	**1.58 A**	
Mealy	Zero*	1.00	1.00	1.00	1.00	1.00	1.00	**1.00 D**
	4	2.33	2.67	2.00	5.33	2.00	7.33	**3.61 C**
	8	3.67	4.67	5.67	5.67	3.67	9.00	**5.38 B**
	12	6.33	5.33	6.00	6.33	6.67	9.00	**6.61 A**
	C.E.T (A)	**3.33 c**	**3.42 c**	**3.67 c**	**4.58 b**	**3.33 c**	**6.58 a**	
Bitter	Zero*	1.00	3.00	1.00	1.00	2.00	1.00	**1.50 D**
	4	1.67	4.67	1.00	1.00	7.67	7.33	**3.89 C**
	8	2.00	7.00	2.00	1.00	7.00	8.00	**4.50 B**
	12	2.33	6.67	2.33	1.67	7.33	8.67	**4.83 A**
	C.E.T (A)	**1.75 C**	**5.33 B**	**1.58 C**	**1.17 D**	**6.00 A**	**6.25 A**	

Values followed by the same capital letter' (s) in column or by small letter' (s) in row are not significantly different at 5% level, *= Initial values at harvest time, C.E.T= Composite effect of treatments, C.E.SD= Composite effect of storage duration, LSD (A*B) for color = 0.71, for taste = 0.90, for texture = 0.75, for aroma = 0.88, for overall acceptance = 0.77, for presence of filaments = 0.19, for mealy = 0.78, and for bitter = 0.59.

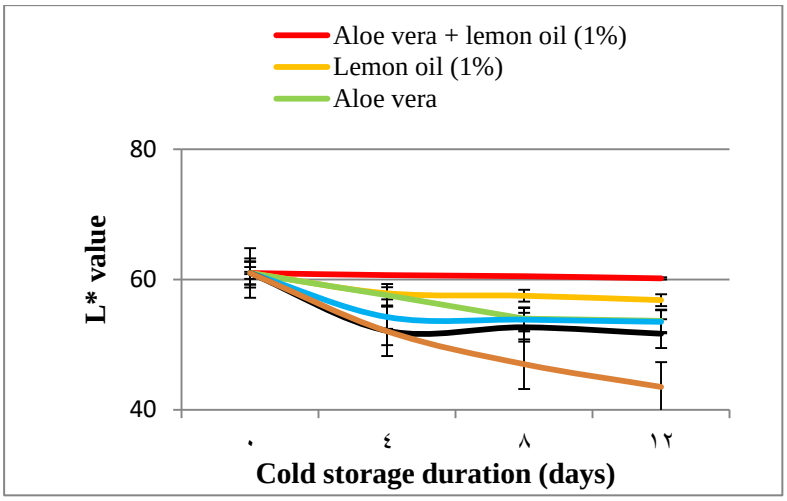

Fig. 1. Changes in lightness values (L*) of papaya fresh-cut during cold storage.

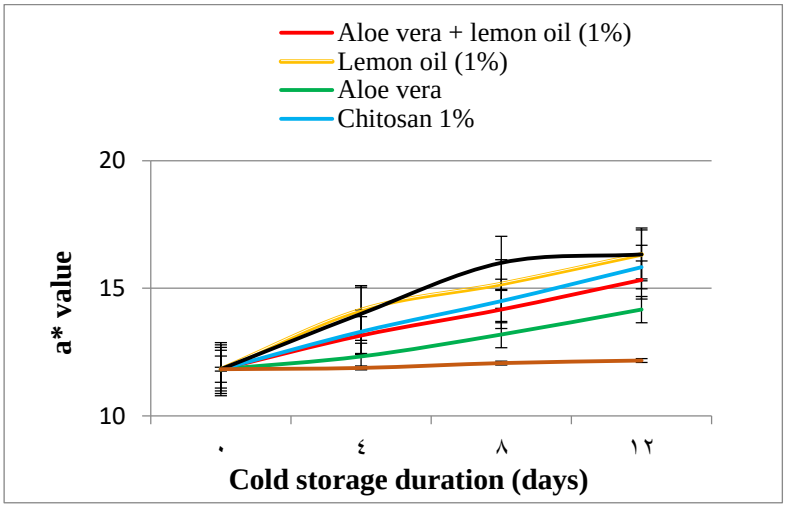

Fig. 2. Changes in (a*) values of papaya fresh-cut during cold storage.

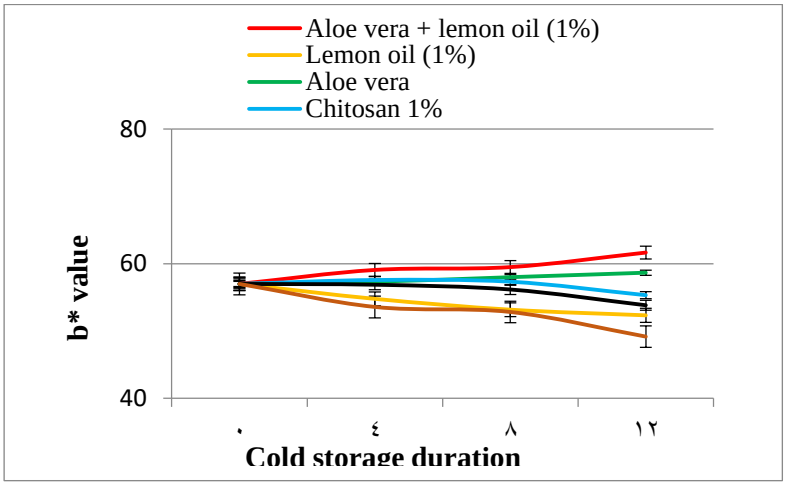

Fig. 3. Changes in (b*) values of papaya fresh-cut during cold storage.

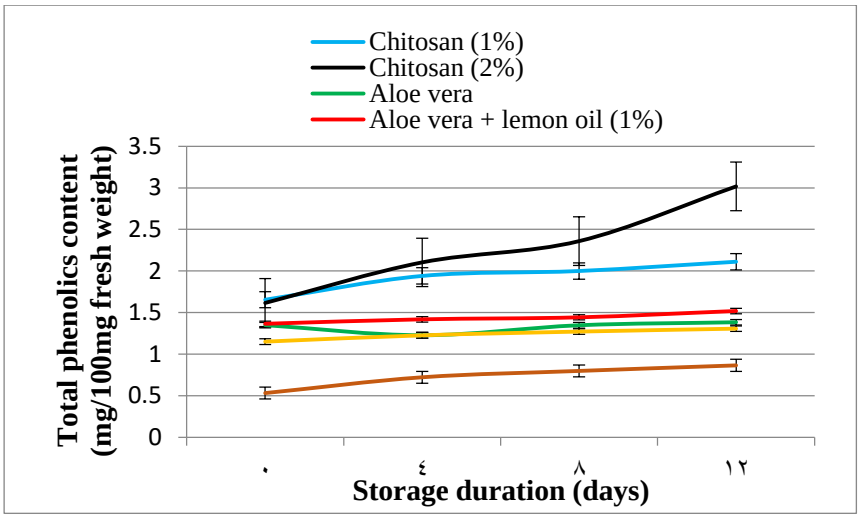

Fig. 4. Changes in total phenolics content in papaya fresh-cut during cold storage.

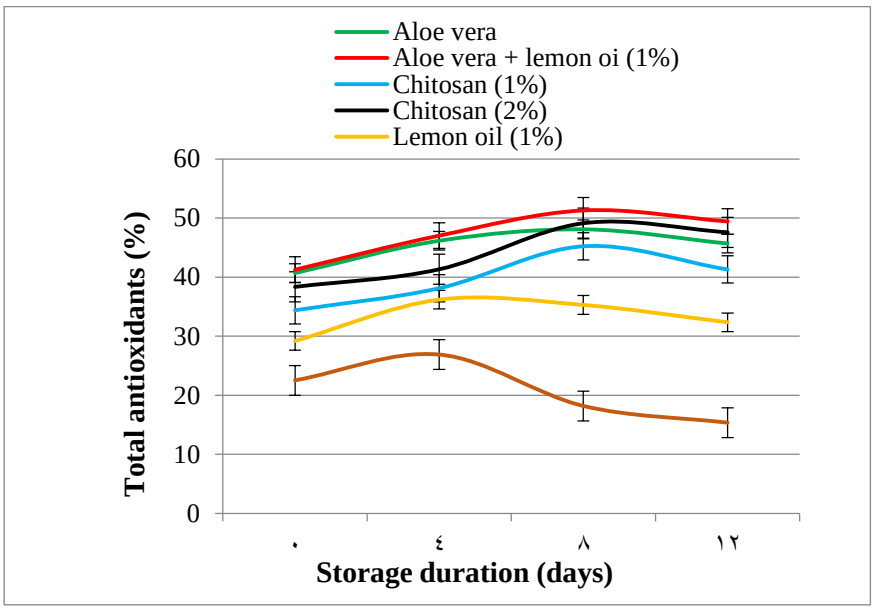

Fig. 5. Changes in total antioxidant in papaya fresh-cut during cold storage.

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تاثير مواد الطلاء القابلة للأكل على جودة ثمار الباباظ الطازجة المقطعة اثناء التخزين المبرد

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المخلص

لقد أجريت هذه الدراسة لبحث تأثير چل صبار الألوفيرا منفرداً أو ممزوجآ معه زيت الليمون وكذلك تأثير الشيتوزان كمواد طلاء صالحة للأكل على جودة مكعبات الباباظ المقطعة الطازجة ، حيث تم غمس المكعبات فى محاليل المعاملات والتى كانت : الشيتوزان بتركيزى(١ ، ٢ %) و چل صبار الألوفيرا (٤٠%) ، و چل صبارالألوفيرا (٤٠%) ممزوج به زيت الليمون (١%) وزيت الليمون (١%) والماء المقطر (كنترول)، ولقد أظهرت النتائج أن الطلاء بـچل صبار الألوفيرا (٤٠%) الممزوج معه زيت الليمون (١%) قلل الفقد فى كلا من الوزن والحموضة وفيتامين ج وقيم اللون وأدى لزيادة مضادات الأكسدة لمكعبات الباباظ ، بينما أدى الطلاء بالشيتوزان (٢%) لتقليل التلون باللون البنى وإعطاء أفضل صفات أكلية وزيادة نسبة الفينولات الكلية الى ٢٥٠% تقريبا عن الكنترول.

الكلمات الدالة: الباباظ ، چل الصبار الالوفيرا ، الشيوزان ، زيت الليمون ، مضادات الأكسدة الكلية، الفينولات الكلية.