

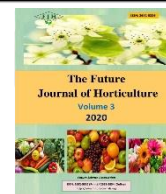


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USE OF SOME MEDICINAL PLANTS AS EDIBLE COATING TO MAINTAIN THE QUALITY OF ORANGE FRUITS DURING MARKETING

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ABSTRACT: Studies have shown that climatic changes may lead to a severe decrease in food production, so every fruit produced must be preserved in good condition until it reaches the consumer's hand. Natural edible coatings have encountered considerable attention in recent years because of their advantages, including their natural and they are considered safer for consumption, as they are non-toxic and economical. Our study was conducted to maintain the quality of Valencia orange fruits during marketing, in two successive seasons 2020 and 2021, to evaluate the efficiency of some natural products of medicinal plants, such as Lemon grass oil, Lemon grass plant extract, Aloe Vera plant extract, Aloe Vera gel and, Arabic gum on the postharvest life and fruit quality parameters of Valencia orange fruit at room temperature for four weeks as a market condition. The results revealed that all postharvest treatments helped to decrease fruit weight loss %, decay %, and respiration rate and maintained shelf life and fruits quality during marketing compared to control. Lemongrass and Aloe Vera extracts postharvest treatments were recorded with the lowest fruit weight loss %, decay %, followed by Arabic gum. While Lemongrass oil has red spots that make its appearance unacceptable.

Key words: Valencia orange, Lemon grass oil, plant extract, Aloe Vera gel, Arabic gum.

INTRODUCTION

Valencia orange (*Citrus. sinensis L. Osb.*) is considered one of the most important export crops. The total volume of Egypt's exports of oranges by the end of 2020 amounted to about 1.6 million tons according to The Central Administration for Plant Quarantine (CAHQ) of the Ministry of Agriculture and Land Reclamation (MALR).

Valencia Orange ranks second after Navel oranges. It's a late-ripening cultivar. Climate change-induced lack of irrigation water (drought), increased temperatures, and decreased crop production are expected to cause a reduction in product quality, (De-Pinto *et al.*, 2012). The deficit is of great concern in agriculture whereby it not only reduces the yield potential of a crop but also decreases the postharvest life of fruits by accelerating the ripening process of fruits (Henson, 2008). For minimizing undesirable changes in quality parameters during the postharvest period, different methods of strategies are of paramount importance to help growers all over the world to withstand the challenges that climate change

will impose throughout the next decades. Late harvest is one of the significant impediments to deviances during handling and marketing due to heat stress leading to a drop in the fruit quality and unacceptable physiological changes. Therefore, the usage of natural substances is one of the safe solutions for maintaining fruit quality and prolonging shelf life. Using natural plant products such as essential oils and plant extracts has emerged as the most promising ecological alternative over the last 20 years for fruits handled after harvest, reducing the perishable, delaying fruit, and enhancing the shelf-life period after harvest. (El Khetabi *et al.*, 2022). Essential oils and plant extracts are effective in reducing decay, quality maintenance, and essential improvement of the post-harvest life of many fruits (Serrano *et al.*, 2005).

Lemongrass oil is consisting of geranial up to 60%, neral up to 30%, geraniol up to 4%, limonene, and linalool. Lemongrass also has flavonoids and phenolic compounds, which consist of limiting,

catechol, chlorogenic acid, caffeic acid, hydroquinone, luteolin, isoorientin 2-O-rhamnoside, quercetin, kaempferol, and apigenin (Faruq, 1994; Mian and Mohamed, 2001). Lemongrass extract and essential oil have been reported to have strong antioxidant properties (Francisco *et al.*, 2011; Henning *et al.*, 2011; Shah *et al.*, 2011). Lemongrass coating of fruits helps to reduce quality changes and quantity losses by lessening respiration and transpiration rates, protecting texture and color, and reducing microbial growth, during postharvest handling. (Alkaabi *et al.*, 2022). Lemongrass extracts and essential oils were effective on the physicochemical parameters, disease occurrence, disease riskiness, and postharvest life of bananas (Mehedi *et al.*, 2020). Lemongrass oil was recorded to be antifungal activity against various plant pathogens, reduced the degree of diseases, weight loss, decrease in fruit firmness and suitable texture, and higher acceptance of guava fruits (Oliveira *et al.*, 2020).

Aloe Vera (*Aloe barbadensis* Miller) is a member of the family Liliaceae. Aloe Vera is a tropical or subtropical planted, contains glycoside (anthraquinone and aloin to 25%), polysaccharides, saponins, essential oil, enzymes, antibiotics, minerals, and salicylic acid that react as antioxidants that break free radicals (Keville, 1999).

Aloe Vera is one of the extremely biologically active plants since it is a wealthy origin of antimicrobial and antioxidant factors, such as phenolic compounds (Vega *et al.*, 2011). Aloe Vera extracts and gel have been applied to apples (Ergun and Satici, 2012), papaya (Vittorio *et al.*, 2020), table grapes (Castillo *et al.*, 2010 and Abdollah *et al.*, 2021), orange (Rasouli *et al.*, 2019), strawberry (Leila *et al.*, 2020) and Guava (Muhammad *et al.*, 2020) as an edible coating. Aloe Vera extracts shapes an invisible barrier on the surface of the fruit that separates it from the surrounding atmosphere (Krochta, 2002). It demonstrated more effectiveness in reducing control microbial growth and water loss while preserving fruit quality and giving the product better mechanical resistance.

Arabic gum is the oldest gum known for its diverse application of more than 5000 years. The gum is produced from some of the stems and branches of Acacia Senegal species of Acacia. Arabic gum is a mixture of potassium, magnesium, and calcium salts of polysaccharides and is easily soluble in water. As it possesses a unique biochemical structure and properties, it finds application as a stabilizer, emulsifier, bulking agent, thickener, carrier, glazing and firming agent, humectant, and antioxidant. Edible coating, with Arabic gum, has been studied by many authors and they reported that it is to be effective in increasing the shelf life of Pomegranate Fruit (Kawhena *et al.*, 2022). and Litchi Fruits (Minh *et al.*, 2019), Papaya (Ali *et al.*, 2014), postharvest

qualities of banana fruits (Ahmad *et al.*, 2018 and La *et al.*, 2021), reduces controls microbial growth and water loss of strawberry (Wani *et al.*, 2021), and guava fruits (Gurjar *et al.*, 2018) controlling respiration rate and vitamin C of chili (Muthmainnah *et al.*, 2019) and alternative for retarding the ripening and senescence in postharvest peach fruit (Zhang *et al.*, 2020).

MATERIALS AND METHODS

Fresh healthy and handpicked fruit orange (Valencia Orange) was purchased from a private farm at commercial maturity in the Aga region in El-Dakahlia Governorate, Egypt. In the last week of April 2020 and 2021 in the full-color stage and transferred to the Laboratory of the Horticulture Research Station at Mansoura. Then the fruits were washed with sterile distilled water to remove the dirt followed by air drying. Fruits chosen for this study were purchased and analyzed based on size, color, and absence of external injuries.

Experimental design and treatments

The experiment involves 6 treatments, each with three replications. The 540 fruits were divided into 6 lots of 90 fruits for each treatment. Fruits were treated by dipping into the tested treatment for 5 min and allowed to air dry with the assistance of a standing fan, and then the fruits were packaged in plastic boxes and kept at room temperature (22 ± 2 °C).

Treatments included

- 1- Control treatment (untreated treatment)
- 2- Fruits coated with lemongrass extract (LOE)
- 3- Fruits coated with lemongrass oil 2 % (LOO)
- 4- Fruits coated with aloe Vera extract (AVE)
- 5- Fruits coated with aloe Vera gel (AVG)
- 6- Fruits coated with Arabic Gum 10% (AG)

Preparation of Edible Coating from medicinal plant products

1- Lemon grass essential oil: The air-dried herb by distilling of herb samples for 2 -3.00 hrs to hydro-distillation using modified Clevenger traps in British Pharmacopoeia (2000). Essential oil constituents were analyzed using a Ds Chrom Gas Chromatograph equipped with a flame ionization detector for the separation of essential oil constituents. It was conducted Medicinal and Aromatic Plants Department at the Institute of Horticulture Research. The obtained chromatogram of GLC analysis was analyzed to calculate the percentage of the main components by matching their retention time (RT) with those of authentic samples under the same

conditions and the constituents of the essential oil were identified according to (Guenther and Joseph, 1978).

2- Lemon grass extract: Weigh 150 grams of dried lemongrass sample and 200 ml of ether solvent into the flask. Let the flask and contents stand for 18 hours. The extract was decanted into another beaker. 200 ml of ethanol was added to the extract. Separate the mixture in a separatory funnel. Collect the ethanol extract and ether layer into two separate beakers. To remove ethanol, keep the sample in a water bath at 75-80 degrees Celsius. and stored in dark-colored bottles at 4°C until use (Wagh *et al.*, 2021).

3- Aloe Vera gel: Matured leaves of the Aloe Vera plant were harvested. The leaves were then washed. The leaf skins were peeled to obtain the pulp. The resulting mixture was filtered to remove the fibers. The liquid obtained constituted the fresh Aloe Vera gel. It was then pasteurized at 70°C for 30-40 minutes. it was cooled immediately to an ambient temperature. The fresh Aloe Vera gel was stored in a dark bottle (Gulhane *et al.*, 2018).

4- Aloe Vera extract: kg fresh leaves of Aloe Vera plant were washed and mixed with 1 L distilled water by an electric blender and the decoction thereafter was filtered through sterilized cheesecloth. The clear filtrate was stored in a refrigerator at 4°C.

5- Arabic gum: 10 g of Arabic gum powder in 1000 ml of distilled water for 60 minutes with low heat (40°C) on a magnetic stirrer then filtered to remove any non-dissolved impurities using a vacuum flask to prepare 1 L of 10% Arabic gum: 10 g of Arabic gum powder in 1000 ml of distilled water for 60 minutes with low heat (40 °C) on a magnetic stirrer then filtered to remove any non-dissolved impurities using a vacuum flask to prepare 1 L of 10%, % Arabic gum solutions. (Minh *et al.*, 2019).

Quality characteristics of coated and uncoated fruits during storage

Measurements of the parameters were made at harvest, 7, 14, 21, and 28 days after treatments.

1- Weight loss (%)

Weight loss was determined by the following equation:

$$\text{Weight loss (\%)} = [(A-B)/A] \times 100$$

Where A indicates the fruit weight at the time of harvest and B indicates the fruit weight after storage intervals. (A.O.A.C., 1994).

2- Firmness

Fruit firmness was determined according to (Mitcham *et al.*, 2003) using a fruit pressure tester (8 mm diameter probe) on the opposite surfaces of each fruit; data was presented as lb/inch

3- Decay (%)

$$\text{Decay (\%)} = (\text{Decayed fruit} / \text{Total fruit}) \times 100$$

4- Total soluble solid (TSS)

A hand refractometer was used to determine the soluble solids content in fruit juice according to (A.O.A.C., 1994).

5- Total acidity

Total acidity was measured by titrating 10 ml juice with 0.1 N NaOH solution and was then determined by the following equation:

$$\text{Acidity (\%)} = \frac{\text{Standard solu. (N)} \times \text{base solu. (ml)} \times 0.06404}{\text{Total juice volume (ml)}} \times 100$$

6- TSS/Acid ratio = TSS / Total Acid content.

7- Ascorbic acid content

Ascorbic acid was determined by using the phenol indophenols dye method (AOAC, 1990), 10g of the fresh sample was blended with 3% metaphosphoric acetic acid extracting solution to the homogenous slurry, and then 5ml of the filtrate extract was then titrated with standard indophenols until reached to the pink endpoint.

8- Respiration rate (RR)

Carbon dioxide produced by orange was determined after 10 hrs finished from treatment and then every 7 days. The airflow was passed through concentrated NaOH, to ensure that airflow is CO-free, before passing into a 1-liter jar fruit container (fruit ambient) one fruit/ jar was considered one replicate. The out-coming air flow was then passed into 100 ml. NaOH of 0.1 N for 1 hr. Such solution was then titrated against 0.1 N HCl and CO levels produced by the fruits were then calculated as mg CO /kg fruits/h (A.O.A.C., 1990).

Statistical analysis

The complete randomized design was used for performed all physiochemical parameters. Data were analyzed with the Analysis of variance (ANOVA) procedure of the MSTAT-C program. When significant differences were detected, means were compared by LSD range test at the 5% level (Snedecor and Cochran, 1980).

RUSLTUS AND DESCTION

Weight loss percentages

All treatments reduced loss in weight percentage more than the control at all marketing days (28 days) as shown in (Tables 1). Results revealed that using lemongrass as an extract phase is the best than using it in the oil phase which is true also with Aloe Vera used in an extract the best rather than using it in a gel. Whereas differences were noticed between the

different treatment percentages and the possible reason for this decrease in weight loss may be that extracts or Arabic gum served as a semi-permeable membrane around the fruit surface that resulted in the reduction of the respiration rate and the evapotranspiration. Our results were confirmed by (Wills *et al.*, 1980) who indicated that a decrease in the metabolic activities of the fruit results in a decrease in carbohydrate depletion rate and fruit

water loss and as a result, it efficiently delays the process of fruit senescence. Normally, weight loss occurs during fruit storage due to its respiratory process, the transference of humidity, and some processes of oxidation (Ayranci and Tunc, 2003).

Table (1). The effect of different natural edible coatings on weight loss percentage of Valencia orange during marketing

Weight loss (%)						
Season 2020						
Treatments	H	7	14	21	28	Means
Control	0.0 n	6.40 j	8.66 h	11.53 e	18.27 a	8.97 a
Lemongrass Extract	0.0 n	3.20 l	5.89 j	9.08 h	11.25 e	5.88 d
Lemongrass Oil	0.0 n	5.03 k	8.64 h	11.41 e	15.02 c	8.02 a
Aloe Vera Extract	0.0 n	3.01 m	5.93 j	11.63 e	13.97 d	6.90 c
Aloe Vera Gel	0.0 n	4.48 k	8.43 h	12.32 e	16.16 b	8.27 a
Arabic Gum	0.0 n	5.25 k	7.84 h	10.39 f	12.42 e	7.18 b
Means	0.0 e	4.56 d	7.56 c	11.06 b	14.51 a	
Season 2021						
Control	0.0 n	6.16 j	9.17 f	11.90 d	16.84 a	8.81 a
Lemongrass Extract	0.0 n	3.58 l	5.11 k	8.05 h	11.78 d	5.70 d
Lemongrass Oil	0.0 n	3.51 l	8.15 g	11.84 d	14.54 b	7.60 b
Aloe Vera Extract	0.0 n	2.35 m	5.40 k	8.14 g	13.47 c	5.87 d
Aloe Vera Gel	0.0 n	4.07 l	8.67 g	11.07 e	14.48 b	7.65 b
Arabic Gum	0.0 n	2.25 m	7.55 i	9.75 f	13.43 c	6.59 c
Means	0.0 e	3.65 d	7.34 c	10.12 b	14.09 a	

Means in each column which have the same letter (s) are not significantly different.

Decay percentage

Decay was started after 7 days on the control treatment whereas all coating treatments in this period had zero decay and the decay started after 14 days. All treatments had reduced decay percentage as shown in (Table 2). The extract phase for lemongrass or Aloe Vera was the best than in oil or gel phase. Essential oils had great antifungal activity and can be used as a benefit and safe tool for reservation of the grapefruit, decreasing decay percentages (Abdolahi *et al.*, 2010). The main components in essential oils (terpenes, terpenoids, and phenol) play a major role in the antimicrobial and biological effects of essential oils (Bakkali *et al.*, 2008, Abdolahi *et al.*, 2010).

Phenol compounds could affect the enzymes responsible for the spore germination of fungi and have also been recognized as bioactive components. (Tabassum *et al.*, 2013).

Firmness (lb inch⁻²)

Fruit freshness is usually provided by a firm value and plays a critical element in the decision of purchasing by the customers. From (Table 3) we found that fruit firmness decreased until the end of the storage period for all treatments. The best one which decreased firmness is Arabic gum flowed with lemongrass as an oil, and Aloe Vera as a gel. This was done in two seasons.

Table (2). The effect of different natural edible coatings on decay fruit percentage of Valencia orange during marketing.

Decay (%)						
2020 Season						
Treatments	H	7	14	21	28	Means
Control	0.0 k	1.19 i	2.04 d	3.40 c	6.57 a	2.64 a
Lemongrass Extract	0.0 k	0.0 k	1.16 j	1.25 h	1.86 f	0.85 d
Lemongrass Oil	0.0 k	0.0 k	1.28 h	2.66 e	5.22 b	1.83 b
Aloe Vera Extract	0.0 k	0.0 k	0.95 j	1.16 j	1.38 g	0.69 e
Aloe Vera Gel	0.0 k	0.0 k	0.0 k	1.73 f	2.71 e	0.88 d
Arabic Gum	0.0 k	0.0 k	0.0 k	1.75 f	3.06 d	0.96 c
Means	0.0 e	0.19 d	0.90 c	1.99 b	3.46 a	
2021 Season						
Control	0.0 m	1.13 j	1.24 i	2.19 e	5.65 a	2.04 a
Lemongrass Extract	0.0 m	0.0 m	1.11 j	1.49 h	2.25 e	0.97 c
Lemongrass Oil	0.0 m	0.0 m	1.54 h	3.59 c	4.78 b	1.98 a
Aloe Vera Extract	0.0 m	0.0 m	0.70 l	1.22 i	1.76 f	0.73 d
Aloe Vera Gel	0.0 m	0.0 m	0.94 k	2.00 f	2.89 d	1.16 b
Arabic Gum	0.0 m	0.0 m	0.0 m	1.71 g	2.83 d	0.91c
Means	0.0 e	0.18 d	0.92 c	2.03 b	3.36 a	

Means in each column which have the same letter (s) are not significantly different.

Table (3). The effect of different natural edible coatings on firmness (lb inch⁻²) of Valencia orange during marketing

Firmness (lb inch ⁻²)						
2020 Season						
Treatments	H	7	14	21	28	Means
Control	8.3 a	7.5 d	7.3 e	7.1 e	6.9 g	7.4 ab
Lemongrass Extract	8.3 a	7.2 e	7.1 e	7.0 f	6.0 i	7.1 c
Lemongrass Oil	8.3 a	8.1 b	7.3 e	6.6 h	6.3 h	7.3 b
Aloe Vera Extract	8.3 a	8.3 a	7.0 f	6.8 g	6.1 i	7.3 b
Aloe Vera Gel	8.3 a	8.3 a	7.8 c	6.4 h	6.2 i	7.4 ab
Arabic Gum	8.3 a	8.2 a	8.1 b	7.2 e	6.1 i	7.6 a
Means	8.3 a	7.9 b	7.4 b	6.8 c	6.2 c	
2021 Season						
Control	8.2 a	7.8 a	7.5 b	7.0 b	6.3 c	7.3 b
Lemongrass Extract	8.2 a	8.0 a	7.0 b	6.6 c	6.0 d	7.1 c
Lemongrass Oil	8.2 a	8.0 a	7.6 a	7.0 b	6.3 c	7.4 ab
Aloe Vera Extract	8.2 a	8.2 a	7.7 b	7.0 b	6.3 c	7.5 a
Aloe Vera Gel	8.2 a	8.0 a	7.3 b	6.6 c	6.0 d	7.2 b
Arabic Gum	8.2 a	8.2 a	7.8 a	7.0 b	6.0 d	7.4 ab
Means	8.2 a	8.0 a	7.5 b	6.8 c	6.1 d	

Means in each column which have the same letter (s) are not significantly different.

Retention of firmness can be explained by retarded degradation of components responsible for the structural rigidity of the fruit, primarily the insoluble pectin and proto-pectin. During fruit ripening, depolymerization or shortening of pectin and other pectic substances occurs with an increase in pectin esterase and poly-galacturonase activities. Low oxygen and high carbon-dioxide concentrations in the environment potentially reduce the activities of these enzymes and allow retention of the firmness of fruits and vegetables during storage (Maftoonazad and Ramaswamy, 2005).

The coating of fruits can be expected to modify the internal gas composition of fruits, especially by reducing the oxygen concentrations and elevating carbon dioxide concentrations which might explain the slower textural changes in the coated fruits (Maftoonazad *et al.*, 2008).

Peel Appearance

We note in our trial that fruits treated with lemongrass oil have red spots that make their appearance unacceptable while other treatments of lemongrass extract, aloe Vera extract, aloe Vera gel, and Arabic gum to reduce the change rate of peel color might be attributed to its making gelatinous layer around the fruits which lead to it reduces fruit respiration and losses of water and reduce loss of peel color.

While increasing the loss of peel color by using lemongrass oil due to the combination between essential oil components and peel carotins it then leads to a change in peel color. Similar results were obtained by (Mshraky *et al.*, 2016) on Valencia oranges and (Kahramanoğlu *et al.*, 2019) on strawberry fruits.



Lemongrass Extract



Lemongrass oil



Aloe Vera Extract



Aloe Vera Gel



Arabic Gum



Control

Respiration Rate

After crops are harvested, respiration is the major process to be controlled. In order to minimize undesirable changes in quality parameters during the postharvest period, high temperatures can affect respiration, aqueous relations and membrane stability as well as levels of plant hormones, primary and secondary metabolites.

From (Table 4) it is noticeable that, decrease in value of the rate of respiration at the end of market period (28 days) compared with the initial respiration rate values at harvest day in all postharvest treatments during the two seasons. Respiration rates were decreased for all treatments whereas Aloe Vera gel

and Gum Arabic reduced respiration rates more than other treatments. Lemongrass extract has the best result than lemongrass oil which was near control. Our result was harmony with those found by (Mshraky *et al.*, 2016) on Valencia Orange and (Kawhena *et al.*, 2022) on Pomegranate Fruit, found that natural edible coating such as aloe Vera gel reduced the Respiration rate. The reduction in respiration rate by essential oil on treated fruits during cold storage could be oils work as coatings are barriers to O₂ and CO₂, modifying internal atmospheres and slowing down the respiration rate of fruit. (Debeaufort *et al.*, 1998).

Table (4). The effect of different natural edible coatings on respiration (mg/kg) of Valencia orange during marketing

Treatments	Respiration (mg/kg)					
	2020 Season					
	H	7	14	21	28	Means
Control	7.68 a	4.85 b	3.86 d	3.52 d	2.30 j	4.44 a
Lemongrass Extract	7.68 a	4.78 b	2.90 f	2.63 h	1.44 k	3.88 c
Lemongrass Oil	7.68 a	3.08 f	2.82 g	2.66 h	1.67 k	3.58 d
Aloe Vera Extract	7.68 a	4.48 c	3.33 e	2.87 f	1.57 k	3.98 b
Aloe Vera Gel	7.68 a	4.06 c	2.87 f	2.30 j	1.40 k	3.66 e
Arabic Gum	7.68 a	4.78 b	2.83 g	2.41 i	1.30 k	3.80 c
Mean	7.68 a	4.33 a	3.10 b	2.73 c	1.55 d	
2021 Season						
Control	6.55 a	5.28 b	4.32 d	4.57 c	3.32 f	4.80 a
Lemongrass Extract	6.55 a	3.04 g	2.97 h	2.29 j	1.38 l	3.24 c
Lemongrass Oil	6.55 a	2.94 h	2.70 i	2.13 k	1.32 m	3.13 d
Aloe Vera Extract	6.55 a	3.97 e	2.82 h	2.16 k	1.66 l	3.43 b
Aloe Vera Gel	6.55 a	3.46 f	2.81 h	2.45 j	1.24 m	3.30 b
Arabic Gum	6.55 a	3.10 g	2.78 i	2.14 k	0.97 m	3.10 d
Mean	6.55 a	3.63 a	3.06 b	2.62 c	1.64 d	

Means in each column which have the same letter (s) are not significantly different.

Total soluble solids (TSS)

In our study, TSS was evaluated as an indicator of the metabolic status of oranges, and as a fruit quality factor. All treatments at the end of the marketing period increased the percentage of total soluble solids without significant differences, while Gum Arabic was the most relative treatment in increasing the TSS while there is no significant difference between lemongrass as an extract or as oil the two phases have increased in TSS, in two season of study, while, Aloe Vera as the gel is the best then it as an extract, that is viewed in (Table 5), which is probably related to delay in metabolic activity and reduced respiration rate and vital processes, thus due

to increasing TSS during storage. In control fruits, the increase in microbial spoilage, degradation of fruits, and over senescence lead to an increase in respiration rate and metabolic activity.

These results are in agreement with (Gurjar *et al.*, 2018) on guava fruits (Kawhena *et al.*, 2022) on Pomegranate and (Wani *et al.*, 2021) on strawberry fruit reported that Arabic gum was more effective in increasing the total soluble solid.

Sage essential oil and Aloe Vera gel positively affected on total soluble solids and postharvest quality of tomato fruit. (Tzortzakakis *et al.*, 2019).

(Rehman *et al.*, 2020) found that with treatment with Aloe Vera gel a gradual increase in T.S.S was observed until the end of the storage period on guava fruits.

(Minh *et al.*, 2019) reported that optimal total soluble solids could be maintained at appropriate

levels by coating litchi fruit with Arabic gum. Also, (El-Hadidy *et al.*, 2015) on palm fruits, (Oliveira *et al.*, 2020) on guava fruits, and (Mehedi *et al.*, 2022) on banana fruits demonstrated that lemongrass essential oil showed positive effects on fruit quality characteristics such as total soluble solids.

Table (5). The effect of different natural edible coatings on the TSS of Valencia Orange during marketing

TSS						
2020 Season						
Treatments	H	7	14	21	28	Mean
Control	9.6 i	10.4 f	10.2 g	11.6 c	12.2 b	10.6 b
Lemongrass Extract	9.6 i	10.1 h	10.5 e	11.1 d	12.1 b	10.6 b
Lemongrass Oil	9.6 i	10.0 h	10.6 e	11.5 c	12.2 b	10.7 b
Aloe Vera Extract	9.6 i	10.3 g	10.4 f	10.9 d	11.7 c	10.5 b
Aloe Vera Gel	9.6 i	10.3 g	10.6 e	11.4 c	12.5 b	10.8 b
Arabic Gum	9.6 i	10.6 e	10.9 d	11.8 c	13.0 a	11.1 a
Means	9.6 e	10.3 d	10.5 c	11.4 b	12.2 a	
2021 Season						
Control	9.8 h	10.7 f	11.0 e	12.4 b	13.6 a	11.5 a
Lemongrass Extract	9.8 h	10.5 g	10.7 f	11.6 d	12.6 b	11.0 c
Lemongrass Oil	9.8 h	9.7 i	11.1 e	12.0 d	12.3 b	10.9 c
Aloe Vera Extract	9.8 h	10.3 g	10.8 f	12.1 c	12.6 b	11.1 b
Aloe Vera Gel	9.8 h	10.5 h	11.6 d	11.9 d	12.5 b	11.2 b
Arabic Gum	9.8 h	11.5 d	11.2 e	12.3 b	13.3 a	11.6 a
Means	9.8 e	10.4 d	11.1 c	12.0 b	12.6 a	

Means in each column which have the same letter (s) are not significantly different.

Acidity percentage

Data in (Table 6) showed that acidity percentage decreased gradually in all fruits with the progress in storage duration. Acids are important substrates for respiratory metabolism so, the coated treatments showed retarded water loss and controlled gas exchange, thereby reducing respiration and oxidation reactions, during the storage period. For inoculated sample a However, the decrease in acidity percentage was significantly higher, particularly after day 28 storage control treatment resulted in significantly the highest acidity followed by Arabic gum during the storage period. Statistically, the lowest juice acidity % was attained by lemongrass oil postharvest treatment. The results recorded that lemongrass as oil reduced acidity more than it was an extract in successive two seasons, while, Aloe Vera as an extract reduced acidity more than it was a gel in the second season.

Atress *et al.* (2010) found that the total acidity significantly decreased as a function of storage time for coated strawberries due to the use of organic acid in the enzymatic reactions of respiration. However, all treatments retained more acidity compared to

untreated fruits during storage. Also (Kahramanoğlu *et al.*, 2019) on strawberry fruits reported that lemongrass oil was more effective to reduced acidity while, (Tzortzakis *et al.*, 2019) on tomato they found that aloe Vera gel was more effective to reduced acidity.

TSS/ acid ratio

The data in (Table 7) demonstrated that the rate of TSS/ acid ratio has increased with increasing marketing days for all treatments as a previous in TSS, after 28 days at room temperature Arabic gum has no significant difference with untreated fruit while lemongrass as oil increased TSS/ acid ratio than it as an extract. So also, Aloe Vera as a gel increased TSS/ acid ratio than in the extract phase. The obtained values are due to the use of citric acid in the process of respiration of fruits. Then with the passage of time degradation of citric acid leads to more TSS as the structural formula of citric acid is similar to glucose. Therefore, decrease in citric acid is correlated with the increase in TSS/ acid ratio so sugar content has become higher than acidity (Manazano and Diaz, 2001).

Table (6). The effect of different natural edible coatings on acidity percentage of Valencia orange during marketing

Acidity (%)						
2020 Season						
Treatments	H	7	14	21	28	Mean
Control	1.24 a	1.22 b	1.15 d	1.12 d	1.03 e	1.15 ab
Lemongrass Extract	1.24 a	1.23 a	1.20 b	1.12 d	0.93 f	1.14 b
Lemongrass Oil	1.24 a	1.21 b	1.16 c	1.00 f	1.03 e	1.13 b
Aloe Vera Extract	1.24 a	1.20 b	1.18 c	1.13 e	1.01 f	1.15 ab
Aloe Vera Gel	1.24 a	1.24 a	1.15 d	1.08 e	0.97 f	1.13 b
Arabic Gum	1.24 a	1.23 a	1.20 b	1.13 e	1.05 e	1.17 a
Mean	1.24a	1.22 b	1.17 b	1.09 c	1.00 c	
2021 Season						
Control	1.30 a	1.31 a	1.17 f	1.08 e	1.12 d	1.17 b
Lemongrass Extract	1.30 a	1.30 a	1.19 e	1.18 e	1.08 f	1.18 b
Lemongrass Oil	1.30 a	1.26 b	1.10	1.05 h	0.94 g	1.13 d
Aloe Vera Extract	1.30 a	1.26 b	1.22 d	1.12 f	0.86 g	1.14 c
Aloe Vera Gel	1.30 a	1.24 c	1.17 f	1.13 f	1.09 f	1.15 c
Arabic Gum	1.30 a	1.27 b	1.24 c	1.20 d	1.11 f	1.20 a
Mean	1.30 a	1.27 a	1.18 b	1.12 c	0.87 d	

Means in each column which have the same letter (s) are not significantly different.

Table (7). The effect of different natural edible coatings on the TSS/ acid ratio of Valencia orange during marketing

TSS/ acid ratio						
2020 Season						
Treatments	H	7	14	21	28	Means
Control	7.74 m	8.52 k	8.86 j	10.35 f	11.84 c	9.46 b
Lemongrass Extract	7.74 m	8.21 l	8.75 j	9.91 g	13.01 a	9.52 b
Lemongrass Oil	7.74 m	8.26 l	9.13 h	11.50 d	11.84 c	9.69ab
Aloe Vera Extract	7.74 m	8.58 k	8.81 j	9.64 g	11.58 c	9.27 c
Aloe Vera Gel	7.74 m	8.30 l	9.21 h	10.55 e	12.88 a	9.73 a
Arabic Gum	7.74 m	8.61 k	9.08 i	10.44 e	12.38 b	9.65ab
Means	7.74 d	8.41 c	8.97 c	10.39 b	12.25 a	
2021 Season						
Control	7.53 n	8.16 m	9.40 j	11.48 e	12.14 c	10.29 b
Lemongrass Extract	7.53 n	8.07 m	8.99 k	9.83 i	11.66 e	9.63 a
Lemongrass Oil	7.53 n	7.96 n	10.09 h	11.42 e	13.08 b	10.42a
Aloe Vera Extract	7.53 n	8.17 m	8.85 k	10.80 f	14.65 a	10.0 b
Aloe Vera Gel	7.53 n	8.46 l	9.91 i	10.53 g	11.46 e	9.57 c
Arabic Gum	7.53 n	9.05 k	9.03 k	10.25 h	11.98 d	9.56 c
Means	7.53 e	8.03 d	9.26 c	10.42 b	12.49 a	

Means in each column which have the same letter (s) are not significantly different.

Ascorbic acid

Data in (Table 8) reported that ascorbic acid % decreased with a prolonged period of shelf life of the fruits. Lemongrass extract gives decrease ascorbic acid value nearly Arabic gum. Ascorbic acid had decreased (12.8% in the end of the first season and 13.3% in the end of the second season) for using Lemongrass extract. While the reduction value on using Arabic gum was (13.4% in the end of the first season, 12.4% in the end of the second season), while the reduction with using lemongrass as oil was (18.4% in the end of the first season 17.5% in the end of the second season). Aloe Vera as a gel reduced ascorbic acid percentage (14.1% in the end of the first season and 13.3% in the end of the second season) while Aloe Vera an extract is the worst treatment it was (15.9% in the end of the first season and 14.5% in the end of the second season). The reduction in the

control of ascorbic acid was (21.1% in the end of the first season and 22.3% in the end of the second season). These results have normally been done because of the Activity of phenoloxidase and ascorbic acid oxidase enzymes due to a decrease in ascorbic acid during storage. The retention of ascorbic acid % in the treated fruits could be due to a decreased respiration process and reduction of oxidation of ascorbic acid content while the decreasing level of ascorbic acid in control might be due to an increased respiration process. Ascorbic acid alleviates oxidative damage by scavenging radicals during postharvest storage of persimmons (Naser *et al.*, 2018). Ascorbic acid content decreases due to oxidation during postharvest storage of fruits (Ali *et al.*, 2018; Shah *et al.*, 2017). Postharvest treatments such as coating application are considered effective in reducing the oxidation-induced decrease in ascorbic acid in fruits (Gurjar *et al.*, 2018).

Table (8). The effect of different natural edible coatings on V.C (mg/100mL) of Valencia orange during marketing

Treatments	V.C (mg/100mL)					
	2020 Season					
	H	7	14	21	28	Means
Control	32.6 a	31.5 a	29.6 b	27.0 b	25.7 d	29.2 c
Lemongrass Extract	32.6 a	32.3 a	31.5 b	30.2 c	28.4 e	31.0 a
Lemongrass Oil	32.6 a	30.5 c	29.0 d	28.4 b	26.6 g	29.4 c
Aloe Vera Extract	32.6 a	32.0 a	30.9 c	29.2 d	28.0 e	30.5 b
Aloe Vera Gel	32.6 a	31.4 b	30.6 c	28.8 e	27.4 f	30.1 b
Arabic Gum	32.6 a	32.0 a	31.2 b	30.0 c	28.2 e	30.8 b
Means	32.6 a	31.6 b	30.4 c	28.9 d	27.4 e	
2021 Season						
Control	33.1 a	31.6 d	29.7 e	27.4 h	25.7 i	29.2 b
Lemongrass Extract	33.1 a	32.4 b	31.1 d	29.3 f	28.7 g	30.5 a
Lemongrass Oil	33.1 a	32.1 c	30.7 e	29.1 f	27.3 g	30.2 a
Aloe Vera Extract	33.1 a	32.3 b	31.8 d	30.6 e	28.7 g	28.7 c
Aloe Vera Gel	33.1 a	32.4 b	31.5 d	29.4 f	28.3 g	28.1 c
Arabic Gum	33.1 a	32.6 b	31.7 d	30.6 e	29.0 f	31.4 b
Means	33.1 a	33.2 a	31.0 b	29.4 c	27.9 h	

CONCLUSION

Edible coatings Lemongrass, Aloe Vera or Arabic Gum can be an effective method to improve the quality and extending the shelf life of Valencia orange. Lemongrass or Aloe Vera as an extract is more effective than using it as oil or as a gel with no differences between them and Arabic Gum. They are approved to be a good respiration barrier, thus forbidding the weight loss by evaporation. Edible coatings maintained the firmness, total acidity, ascorbic acid of Valencia orange. Samples of all

treatments had good sensorial scores especially the Valencia orange stored 28 days was recorded for control samples stored at room temperature

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RESEARCH ARTICLE

Use of Some Medicinal Plants as Edible Coating to Maintain the Quality of Orange Fruits During Marketing

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