Journal of Food Biosciences and Technology,
Islamic Azad University, Science and Research Branch, Vol. 13, No. 3, 19-26, 2023
DOI: 10.30495/JFBT.2022.66795.10293 https://dorl.net/dor/20.1001.1.22287086.2023.13.3.2.2

The Effect of *Aloe vera* Gel and Chitosan as an Oral Coating on the Quality Properties and Shelf Life of Tomato (*Solanum lycopersicum*) During Storage

A. Imani [a], ***E. Danaee*** [b*]

[a] MSc Student of the Department of Horticultural Sciences, Garmsar Branch, Islamic Azad University, Garmsar, Iran.
[b] Assistant Professor of the Department of Horticultural Sciences, Garmsar Branch, Islamic Azad University, Garmsar, Iran.

Received: 23 May 2022 Accepted: 9 December 2022

ABSTRACT: The growing consumer demand for produces without chemical residues has focused efforts on the assessment of innovative natural antimicrobials. Tomato is one of most important vegetable in the world in terms of its economic value. The present study determined the effects of *Aloe Vera* gel (50 and 100%) and Chitosan (0.5 and 1%) to improve the quality properties and shelf life of tomato during storage at 4±1 degrees Celsius temperature and 85 to 90 percent humidity. Sampling and evaluation of traits were performed on 1, 7, 14 and 21 days. The results showed that the highest weight loss and total soluble solids were obtained in control on day 14. The highest titratable acidity, pH, vitamin C and total chlorophyll were observed in control on day 1 and the highest carotenoid content was obtained in *Aloe Vera* gel 50+ Chitosan 0.5 on day 14. The lowest weight loss and carotenoid content were observed in control on day 1. The lowest vitamin C and total chlorophyll were obtained in control on day 21. The lowest titratable acidity, total soluble solids and pH were reported on *Aloe Vera* 50, Chitosan 1and *Aloe Vera* 100 on day 14, respectively. Therefore, according to the results of the present study, the use of edible coatings of *Aloe Vera* gel and Chitosan can be recommended to improve the quality and shelf life of tomatoes.

Keywords: *Aloe Vera* gel, Antioxidant activity, Chitosan, Shelf life, Vitamin C.

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most important plants in Solanaceae family that is grown and fresh consumed vegetables worldwide (Yusuf *et al*., 2021). This vegetable have been estimated to cultivate with 28.7% of the total vegetable crop area in Iran. Low yield along with the inappropriateness of harvesting, packing and storage conditions are important factors in reducing nutritional production (Yeshiwas *et al*., 2018). Tomato have a high nutritional value of minerals, vitamins, amino acids and natural antioxidant compounds. In addition, several other beneficial health-related substances such as carotenoids, lycopene and β-carotene were found in tomatoes (Sati *et al*., 2021). Various chemical treatments have been used to improve the quality and shelf life of Tomato, but consumers' interest in food coatings using natural biomaterials as a

* Corresponding Author: dr.edanaee@yahoo.com; e.danaee@iau-garmsar.ac.ir

safer alternative is growing (Betchem *et al*., 2019). Natural and edible coating such as *Aloe Vera* gel and Chitosan are being considered as safer alternatives to increase the shelf life of perishable food products. *Aloe vera* gel is a hydrocolloid taken in a vacuole or in the cell wall and contains tissue water, which contains various polysaccharide compounds. *Aloe vera* gel has been identified as a novel coating agent with good antimicrobial properties (Garcia *et al*., 2015). Chitosan is a biodegradable compound derived from crustacean shells such as crabs and shrimp, the main feature of which is its polycotin content. It has been shown to promote improvement and growth before and post-harvesting horticultural products (Thi Nguyena *et al*., 2020). Previous studies have shown that Chitosan coating can be extending postharvest quality of tomatoes maintained at different storage temperatures (Kibar *et al*., 2018). Also, the use of Chitosan after harvesting tomato fruits improved the amount of nutrients and vitamin C (Bagheri *et al*., 2021). *Aloe Vera* gel in fig fruit delayed caries, increased firmness, improved sensory quality and increased its shelf life (Marpudi *et al*., 2013). Research by Sajid *et al*. (2019) showed that *Aloe vera* gel coating delays postharvest browning and maintains quality of harvested lychee fruit. Also, *Aloe Vera* gel as an environmentally friendly approach delayed aging and maintained post-harvest quality of green pepper for up to 28 days (Hasan *et al*., 2019). Therefore, considering the importance of using edible coatings to improve shelf life, while maintaining quality in fruits and vegetables, the present paper investigates the effect of post-harvest use of *Aloe Vera* gel and Chitosan on improving the quality and shelf life of tomato fruit.

Materials and Methods

- *Experimental design and treatments*

Tomatoes Dafnis Cultivar with uniform colored, disease free and healthy fruits having similar size were bought from a greenhouse in Varamin. All fruits were transported and carefully handled to the Specialized laboratory. The fruits were immersed in 1% sodium hypochlorite solution for 2 minutes, then rinsed with distilled water and dried to air. Subsequently, different concentrations of *Aloe Vera* gel (50 and 100% volume ratio), Chitosan (0.5 and 1%) and control treatment (distilled water) were applied. There were 5 fruits per replication to evaluate the shelf life of fruits over the storage period. Then sample fruits were randomly taken from each replication to collected data. The samples were taken at 1,7,14 and 21 days of storage period.

- *Assessed traits*

In order to measure fruits weight loss, fruits were weighed at harvest, 1, 7, 14 and 21days storage duration using sensitive balance. The total weight loss of fruits equals [(Initial weight-Final weight)/ Initial weight] ×100 (Danaee and Abdossi, 2019). The Titratable acidity (TA), determined by titration of homogenized powder sample with 0.01 N NaOH using fenolftaleine-indicator (expressed as % citric acid) and Total soluble solids concentration (TSS) of the juices extracts were determined by refractor meter (Eyalati and Danaee, 2021). pH of juice squeezed from fruit was determined in 50 ml samples of pulp with a digital pH-meter; CP - 505 Clmeriron (Al-Dairi *et al*., 2021). The content of Vitamin C was measured by titrimetric method and calculated in mg (ascorbic acid) $100g^{-1}$ FW (Babashpour-Asl and Piryaei, 2022). The total chlorophyll content was

determined according to the method of Hosseinzadeh Rostam Kalaei *et al*., (2021). Carotenoid content was measured according to Zadehbagheri *et al*., (2012). Total antioxidants (DPPH) was measured according to Soroori *et al*., (2021). Tomato fruits treated in the refrigerator were placed at a temperature of 4±1° C and a humidity of 85 to 90% and the life after harvesting the fruits was finally expressed in terms of day due to symptoms such as loosening, crushing, plasticity and mold contamination (Noorbakhesh and Danaee, 2021).

- Statistical analysis

The factorial experiment was performed in a completely randomized design with 3 replications. The data were analyzed using SAS 23 and the comparison of the means was carried out by Duncan's multiple range at 1 and 5% levels.

Results and Discussion

The results of analysis of variance of the experiment showed that, the effect of treatments was significant on weight loss, titratable acidity, Vitamin C, carotenoids, total chlorophyll, total antioxidant activity and shelf life at 1% level and soluble solids and pH at 5% level. The effect of days was significant on weight loss, soluble solids, Vitamin C, carotenoids, total chlorophyll, total antioxidant activity and shelf life at 1% level and titratable acidity and pH at 5% level and the effect of treatments and days was significant on weight loss, soluble solids, pH, Vitamin C, carotenoids, total chlorophyll, total antioxidant activity and shelf life at 1% level and titratable acidity at 5% level (Table 1).

- Morphological and physiological traits

The results of the present study showed that the highest Weight loss (12.54%) and TSS (6.58°Brix) were obtained in Control on day 14. The highest TA (0.54 mg $100g^{-1}$), pH (4.82), Vitamin C (8.32 mg $100g^{-1}$) and Total chlorophyll (0.8537 mg g^{-1}) were observed in Control on day 1 and the highest Carotenoid content (17.74 mg g^{-1}) was obtained in Aloe 50+ Chit 0.5 on day 14. The lowest Weight loss (00.00%) and Carotenoid content (7.65 mg g^{-1}) were observed in Control on day 1. The lowest Vitamin C (2.62 mg $100g^{-1}$) and Total chlorophyll (0.1148 mg g^{-1}) were obtained in Control on day 21. The lowest TA (0.24 mg $100g^{-1}$), TSS (4.52°Brix) and pH (2.68) were reported on Chit 1, Aloe 50 and Aloe 100 on day 14, respectively (Table 2). The increase in percentage of weight loss are mainly related to the removal of moisture from the skin surface of fruits, the amount of weight loss depends on the type of product, cultivar and its tissue characteristics. One of the reasons for fruit weight loss during storage

Table 1. Analysis of variance of *Aloe Vera* gel and Chitosan on Quality and Shelf-life Properties of Tomato (*Solanum lycopersicum*) during storage

Variations source	df	Mean squared								
		Weight loss (%)	TSS (°Brix)	TA (mg $100g^{-1}$)	pH	Vitamin C (mg $100g^{-1}$)	Carotenoid (mg g^{-1})	Total chlorophyll (mg g^{-1})	Total antioxidant (%)	Shelf life (Day)
Treatments	8	6.032**	3.101*	0.081**	3.573*	8.941**	24.017**	1.142**	7.348**	29.639**
days	3	9.425**	6.712**	0.153*	6.516*	11.933**	29.025**	1.968**	10.274**	32.485**
Treatments × Days	24	7.532**	5.106**	0.095*	4.463**	9.791**	26.142**	1.259**	8.063**	30.128**
Error	72	0.029	0.031	0.004	0.015	0.026	0.035	0.018	0.027	0.038
Coefficient of variation (%)	-	12.78	10.85	9.31	10.72	11.22	8.63	12.47	10.56	10.82

*, ** and ^{ns}: Significant at P<0.05, P<0.01 and insignificant, respectively.

is contamination with pathogens that can increase fruit weight loss by damaging fruit tissue. *Aloe vera* gel and chitosan act as a protector to prevent the transfer and evaporation of water from the skin of the fruit and delay water loss, also has antimicrobial properties by reducing post-harvest contamination to prevents fruit weight loss (Ali *et al*., 2019; Rostamzadeh *et al*., 2015). Reducing the weight of fruits and increasing its water concentration during storage after harvest due to the dissolution of cell wall constituents in the process of ripening and aging, as well as breaking of down polysaccharides and turning them into simpler compounds during respiration, can increase the amount of solids soluble. During storage, the acidity of fruits decreases, which is related to the respiration rate of fruits and the use of organic acid in respiratory enzymatic reactions. The amount of titratable acidity is also often negatively related to the pH of the juice. The use of *Aloe vera* gel and chitosan slows down the metabolic activities and the aging process of the fruit by creating a barrier against gas exchange and thus is effective in the process of changing soluble solids, titratable acidity, pH and taste index (Shah *et al*., 2020). Edible coatings of *Aloe vera* gel and chitosan reduce the rate of respiration, resulting in reduced ethylene synthesis and delayed aging, thereby reducing the degradation of plant pigments (Meighani *et al*., 2018). Coating fruits with *Aloe vera* gel and chitosan reduces the activity of ascorbic acid (vitamin C) oxidizing enzymes by reducing the penetration of oxygen into the fruit tissue and ultimately reduces its breakdown (Pirhayati *et al*., 2019). These are close to study of litchi and strawberry fruit by Ali *et al*. (2019) and Meighani *et al*. (2018).

Table 2. Effect of *Aloe Vera* gel and Chitosan on Physiochemical traits and Shelf-life of Tomato (*Solanum lycopersicum*) during storage

Days	Treatments (%)	Weight loss (%)	TSS (° Brix)	TA (mg 100g^{-1})	pH	Vitamin C (mg 100g^{-1})	Carotenoid (mg g^{-1})	Total chlorophyll (mg g^{-1})
1	Control	0.00^{a}	4.97^{f}	0.54^{a}	4.82^{a}	8.32^{a}	7.65^{n}	0.8537^{a}
	Control	5.67^{f}	6.12^{b}	0.51^{ab}	4.05^{e}	5.25^{gh}	10.05^{l}	0.4501^{l}
	Aloe 50	5.26^{e}	5.21^{ef}	0.41^{cd}	3.96^{e}	6.21^{f}	11.36^{j}	0.5678^{i}
	Aloe 100	5.03^{de}	5.34^{e}	0.43^{c}	3.81^{ef}	6.72^{e}	12.81^{h}	0.6901^{ef}
	Chit 0.5	5.41^{ef}	5.87^{c}	0.31^{f}	4.63^{b}	5.68^{g}	10.43^{k}	0.5228^{j}
7	Chit 1	4.75^{de}	5.74^{cd}	0.33^{e}	4.71^{ab}	7.43^{c}	12.57^{hi}	0.6301^{g}
	Aloe 50+ Chit 0.5	4.37^{d}	5.47^{de}	0.37^{d}	4.19^{de}	7.19^{d}	14.65^{de}	0.8265^{b}
	Aloe 50+ Chit 1	3.76^{cd}	5.62^{cd}	0.35^{de}	4.28^{d}	8.15^{ab}	13.99^{ef}	0.8082^{bc}
	Aloe 100+ Chit 0.5	2.42^{b}	5.33^{e}	0.49^{b}	4.25^{d}	7.72^{b}	13.41^{fg}	0.7914^{c}
	Aloe 100+ Chit 1	3.21^{c}	5.56^{d}	0.46^{bc}	4.39^{cd}	7.31^{cd}	13.06^{gh}	0.7642^{d}
	Control	12.54^{n}	6.58^{a}	0.43^{c}	4.02^{e}	5.36^{gh}	11.81^{ij}	0.4312^{m}
	Aloe 50	10.25^{kl}	5.31^{e}	0.32^{e}	3.54^{f}	5.59^{fg}	13.42^{fg}	0.5508^{ij}
	Aloe 100	8.74^{j}	5.57^{d}	0.35^{de}	3.28^{g}	6.13^{fg}	14.46^{de}	0.6178^{gh}
	Chit 0.5	10.76^{l}	6.42^{ab}	0.27^{g}	3.92^{e}	4.62^{hi}	13.67^{f}	0.4908^{k}
14	Chit 1	9.79^{k}	6.08^{bc}	0.24^{h}	4.31^{cd}	6.51^{ef}	14.55^{de}	0.6512^{fg}
	Aloe 50+ Chit 0.5	8.23^{i}	5.82^{c}	0.30^{f}	4.13^{de}	6.95^{de}	17.74^{a}	0.6690^{f}
	Aloe 50+ Chit 1	7.84^{h}	6.36^{ab}	0.28^{fg}	4.47^{c}	7.06^{de}	16.92^{b}	0.7344^{de}
	Aloe 100+ Chit 0.5	6.62^{g}	5.99^{bc}	0.40^{cd}	4.23^{d}	7.42^{c}	16.18^{c}	0.7125^{e}
	Aloe 100+ Chit 1	7.23^{gh}	6.31^{ab}	0.38^{d}	4.36^{cd}	7.26^{cd}	15.64^{cd}	0.6937^{ef}
	Control	11.72^{m}	4.96^{f}	0.45^{bc}	3.26^{g}	2.62^{k}	9.41^{m}	0.1148^{p}
	Aloe 50	8.27^{i}	4.52^{h}	0.38^{d}	2.75^{h}	4.31^{i}	12.14^{i}	0.3478^{n}
	Aloe 100	7.29^{gh}	4.71^{g}	0.39^{d}	2.68^{h}	5.03^{h}	13.25^{g}	0.4006^{mn}
	Chit 0.5	8.93^{j}	4.59^{gh}	0.29^{fg}	3.41^{fg}	3.51^{j}	11.83^{ij}	0.2278^{o}
21	Chit 1	7.82^{h}	4.63^{gh}	0.27^{g}	4.01^{e}	5.74^{g}	12.54^{hi}	0.3743^{n}
	Aloe 50+ Chit 0.5	6.87^{g}	4.75^{g}	0.36^{de}	3.47^{fg}	6.04^{fg}	15.02^{d}	0.4995^{k}
	Aloe 50+ Chit 1	6.25^{fg}	4.94^{f}	0.32^{e}	3.91^{e}	6.25^{f}	14.76^{de}	0.5931^{h}
	Aloe 100+ Chit 0.5	5.12^{e}	4.79^{fg}	0.43^{c}	3.52^{f}	7.04^{de}	14.23^{e}	0.5125^{jk}
	Aloe 100+ Chit 1	5.65^{f}	4.85^{fg}	0.40^{cd}	3.79^{ef}	6.63^{e}	13.86^{ef}	0.5474^{ij}

Values marked by different letters are significantly different (P< 0.05).

- Total antioxidant activity

As presented in Figure 1, the highest antioxidant activity with 8.45% was related to Aloe 50%+Chit 1% on day 14, while the lowest with 6.24% was for Control on day 1. Oxidative stresses increase oxygen free radicals, but internal active antioxidant systems can kill free radicals, thus delaying aging. Decreased antioxidant activity during the final period of storage may be due to the aging process, increased oxidative stress and the production of free radicals and fruit rot. The use of *Aloe vera* gel and chitosan alone or in combination with each other strengthens antioxidant systems, reduces the production of free radicals and delays the aging process in tomato fruits during storage (Garcia *et al*., 2015; Rostamzadeh *et al*., 2015). This finding is consistent with the study of Bagheri *et al*. (2021).

- Shelf Life

As presented in Figure 2, the highest and lowest shelf life with 26 and 14.5 day was related to Aloe 50%+Chit 1% and Control. In order to improve the postharvest life of crops while maintaining their quality properties, several post-harvest treatments are performed. In this study, the use of *Aloe vera* gel and Chitosan as an edible coating was able to improve the storage life of treated tomatoes by improving physicochemical properties and antioxidant capacity was compared to the control (Asghari *et al*., 2014; Petriccione *et al*., 2015). Therefore, the findings of this study was in agreement with Shah *et al*. (2020).

Conclusion

The results of this study indicated that the application of edible coatings of *Aloe Vera* gel and Chitosan at different concentrations in postharvest could reduce the percentage of fruit weight loss and increase the physicochemical traits and shelf life of the fruit, while maintaining the quality. The highest storage life with 26 days was obtained in Aloe 50% + Chit 1% and the lowest with 14.5 days in control

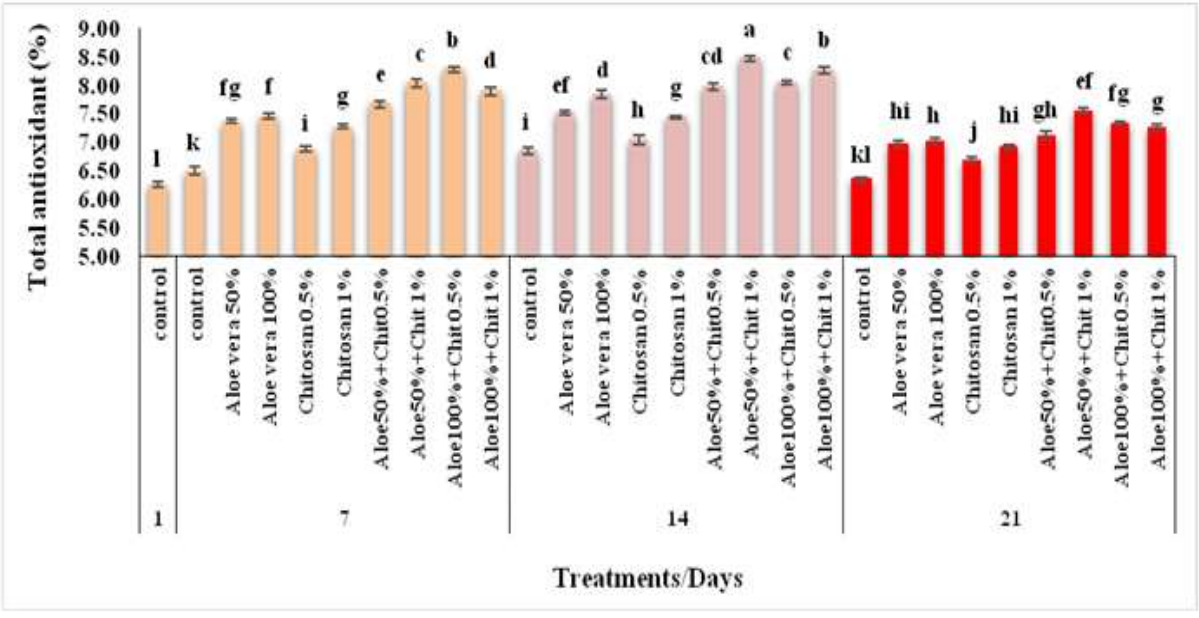

Fig. 1. Effect of *Aloe Vera* gel and Chitosan on total antioxidant activity. Values marked by different letters are significantly different (P< 0.05).

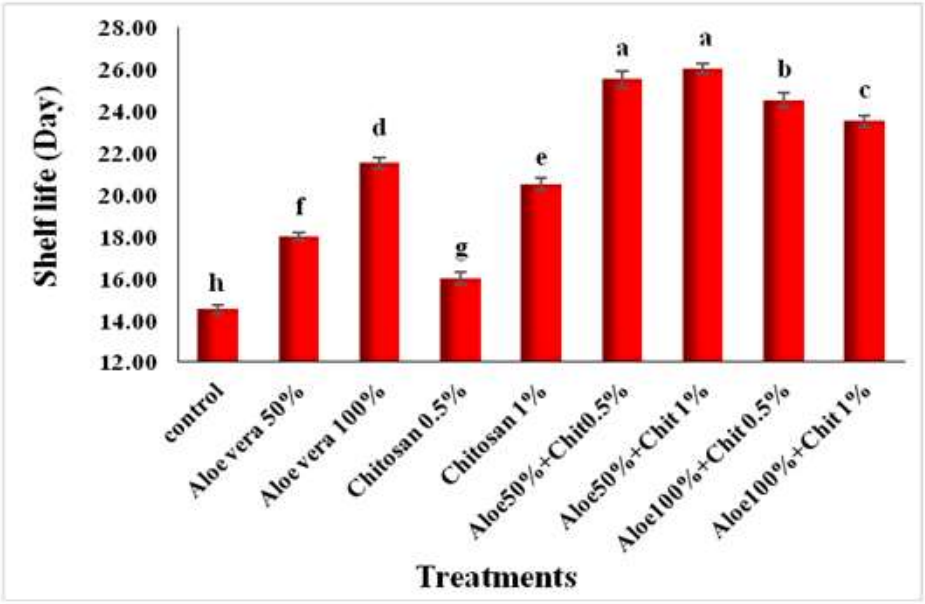

Fig. 2. Effect of *Aloe Vera* gel and Chitosan on Shelf life. Values marked by different letters are significantly different (P< 0.05).

treatment. This study provides comprehensive physiological evidence on how *Aloe Vera* gel and Chitosan method may enhance the postharvest life of industrially valuable fruit like tomato. Based on the findings, it appears that *Aloe Vera* gel and Chitosan improves postharvest life of fruits like tomato via stimulating antioxidant system, delaying senescence, decreasing weight loss. Future studies, especially molecular assessments, are required to illustrate the exact mechanisms involved.

References

Al-Dairi, M., Pathare, P.B. & Al-Yahyai. R. (2021). Chemical and nutritional quality changes of tomato during postharvest transportation and storage. Journal of the Saudi Society of Agricultural Sciences, 20(6), 401-408.

Ali, S., SattarKhan, A., Nawaz, A., AkbarAnjum, M., Naz, S., Ejaz, Sh. & Hussain, S. (2019). Aloe vera gel coating delays postharvest browning and maintains quality of harvested litchi fruit. Postharvest Biology and Technology**,** 157.

Asghari, M.R. & Khalily, H. (2014). Effect of Aloe vera gel on Polyphenol Oxidas Enzyme Activity, Quality Attributes and Storage Life of Sweet Cherry Fruit (Prunus avium cv. Siahe mashhad). Journal of Horticulture Science, 3, 399-406.

Babashpour-Asl, M. & Piryaei, M. (2022). Antioxidant Activities and Several Bioactive Substances of Different Extracts of Vitis vinifera L. Journal of Food Biosciences and Technology, 12(2), 49-60.

Bagheri, S., Moradi, P., Nematolahi, F., Zarinnia, V. & Abdossi, V. (2021). Investigation the empact of Ag nanoparticles of Orange fruits peel, chitosan and silamol treatment on tomato nutritional health content. Food & Health Journal, 4(1), 5-9.

Betchem, G., Adwoa, N., Johnson, N. & Wang, Y. (2019). The application of chitosan in the control of post-harvest diseases: a review. Journal of Plant Diseases and Protection, 126, 495–507.

Danaee, E. & Abdossi, V. (2019). Evaluation of the Effect of Foliar Application of Iron, Potassium and Zinc Nanochelate on the Enzymatic Activity and Nutritional Value of Some Leafy Vegetables. Food Technology & Nutrition, 16(2), 47-57.

Eyalati, K. & Danaee, E. (2021). Evaluation of the Effect of Application of Ascorbic Acid and Chitosan on Quality, Nutrition Value and Storage of Agaricus bisporus. J Food & Health, 4(3), 7-12.

Garcia, M.A., Ventosa, M., Diaz, R., Falco, S. & Casariego, A. (2015). Effects of Aloe vera coating on postharvest quality of tomato. Fruits, 69, 117-125.

Hasan, MU., Malik, AU., Anwar, R., Sattar Khan, A., Wasim Haider, M., Riaz, R., Ali, S., Naveed Ur Rehman, R. & Ziaf, K. (2021). Postharvest Aloe vera gel coating application maintains the quality of harvested green chilies during cold storage. Journal of Food Biochemistry, 54(4), 1–12.

Hosseinzadeh Rostam Kalaei, M., Abdossi, V. & Danaee, E. (2021). Investigation of different selenium sources on phytochemical characteristics of Echium amoenum fisch. & C.A. Mey. as a medicinal herb of Iran. Food & Health Journal, 4(2), 1-7.

Kibar, H.F. & Sabi, F.K. (2018). Chitosan coating for extending postharvest quality of tomatoes (Lycopersicon esculentum Mill.) maintained at different storage temperatures. AIMS Agriculture and Food, 3 (2), 97–108.

Marpudi, S.L., Ramachandran, P. & Srividya, N. (2013). Aloe vera gel coating for post harvest quality Maintenancme of fresh Fig fruits. Research Journal of Pharmaceutical, Biological and Chemical Sciences, 4(1), 878-887.

Meighani, H., Boroomand, N. & Moghbeli, E. (2018). Effect of chitosan coating and $CaCl_2$ on maintaining postharvest quality and antioxidant compound of strawberry fruit. Journal of Food Science and Technology (Iran),75(15), 307-317.

Noorbakhesh, Sh. & Danaee, E. (2021). Effect of Chitosan and Aloe Vera Application on Oxidative Stability and Nutritional Value of Strawberry Fruit (Fragaria ananassa) cv. Camarosa . J Hum Environ Health Promot, 7(4), 189-196.

Petriccione, M., Mastrobuoni, F., Pasquariello, M.S., Zampella, L., Nobis, E., Capriolo, G. & Scortichini, M. (2015). Effect of Chitosan Coating on the Postharvest Quality and Antioxidant Enzyme System Response of Strawberry Fruit during Cold Storage. Jornal Foods, 4, 501-523.

Pirhayati, A., Daraei garmakhany, A., Gholami, M., Mirzakhani, A. & Khalilzadeh Ranjbar, G. (2019). Application of Aloe vera Gel Coating Enriched with Golpar Essential Oil on the Shelf Life of Peach Fruit (Prunus persica var, Zafarani). Iranian Journal Nutrition Sciences Food Technology, 13(4), 75-88.

Rostamzadeh, B., Ramin, A.A., Amini, F. & Pirmoradian, M. (2015). Effect of Chitosan Coating on Increasing Postharvest Life and Maintaining Apple Fruit Quality Cv “soltani”. Journal of Crop Production and Processing (JCPP), 5(17), 253-271.

Sati, F. & Qubbaj, T. (2021). Effect of calcium chloride postharvest treatment in combination with plant natural substance coating on fruit quality and storability of tomato (Solanum lycopersicum) fruits during cold storage. Journal of Applied Botany and Food Quality, 94, 100 – 107.

Sajid, A., SattarKhan, A., Nawaz, A., AkbarAnjum, A., Naz, S., Ejaz, Sh. & Hussain, S. (2019). Aloe vera gel coating delays postharvest browning and maintains quality of harvested litchi fruit.

Postharvest Biology and Technology, 157, 110960.

Shah, S. & Hashmi, S. M. (2020). Chitosan–Aloe vera gel coating delays postharvest decay of mango fruit, Horticulture. Environment and Biotechnology, 61, 279–289.

Soroori, S., Danaee, E., Hemmati, K. & Ladan Moghadam, A. (2021). Evaluation of Nutritional Value and Shelf Life of Marigold with the Application of Spermidine, Citric acid and Proline. Journal of Food Technology and Nutrition, 18(3), 89-102.

Thi Nguyena, H., Boonyaritthongchaia, P., Buanonga, M., Supapvanichc, S. & Wongs-Aree, Ch. (2020). Postharvest Hot Water Treatment Followed by Chitosan- and κ-Carrageenan-Based Composite Coating Induces the Disease Resistance and Preserves the Quality in Dragon Fruit (Hylocereus undatus). International Journal of Fruit Science, 20(23), 2030–2044.

Yeshiwas, Y. & Tolessa, K. (2018). Postharvest quality of tomato (Solanum lycopersicum) varieties grown under greenhouse and open field conditions. International Journal of Biotechnology and Molecular Biology Research, 9(1), 1-6.

Yusuf, C.S., Zakawa, N.N., Tizhe, T.D., Timon, D. & Philip, E.A. (2021). The Efficacy of plant Extracts on the Control of Post-harvest Loss of Tomato. International Network Organization for Scientific Research, 7(1), 86-95.

Zadehbagheri, M. & Seif, S.N. (2012). Assessment of vine ripened, postharvest ripened and storage period on phenolic compounds, carotenoids content and postharvest quality of tomato (Lycopersicon esculentum Mill. cv. Fado). Postharvest Physiology and Technology of Horticultural Crops, 1, 45-61.