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The effect of some natural products on storability and fruit properties of Fuerte avocado

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Abstract: Four natural products namely gelatin, sage seed oil, moringa leaves extract and prickly pear stem extract were used as coating materials for Fuerte avocado and their effects were studied on storability and fruit properties. The harvested fruits were treated with the previous treatments comparing with the untreated one (control), then stored at 5^{o}c and 8590% RH for five weeks. The obtained results showed that all parameters under investigation were positively affected by different used treatments. However, it’s clear that sage treatment was the most effective in saving fruit firmness and reducing both fruit weight loss and respiration rate. While the fruits treated with moringa showed the highest content of ascorbic acid and SSC followed without significant by sage. The lowest value of acidity was obtained due to gelatin treatment followed in ascending order by moringa. On the other hand, while cellulase activity was reduced by all treatments along the storage period, pectinase activity was increased and the lowest activity values for both enzymes were recorded by moringa treatment.

Key word: Fuerte avocado, Gelatin, Seage, Moringa, Prickly pear, fruit properties.

Introduction

Because of increasing concerns about chemical usage in food and the environment, there is also renewed interest in nonchemical approaches to postharvest disease control[1]. In this concern, the postharvest use of chemicals as fungicides is restricted in most countries[2]. Since pathogenic fungi alone reduce about 20% of the major food yield and cash crops[3], several pre- and post-harvest technologies have been used to control their decay[2] and new preservation technologies are needed, which have to be considered as human-safe and environmentally friendly[4].

Among the various alternatives, natural plant products that are biodegradable and eco-friendly are catching the attention of scientists worldwide. Such products from higher plants are bio-efficacious, economical, and environmentally safe and can be ideal candidates for use as agrochemicals [5]. In this concern, numerous studies have been published on the antimicrobial activities of plant compounds against many different types of microbes, including food-borne pathogens[6 - 10].

In nature, essential oils play an important role in the protection of the plants as antibacterial, antiviral, antifungal, insecticides and also against herbivores by reducing their appetite for such plants [11]. The main constituents of essential oils – mono- and sesquiterpenes including carbohydrates, phenols, alcohols, ethers, aldehydes and ketones – are responsible for the biological activity[12].

Sage is the general name for the herbs of the *Salvia* species. The oil of *Salvia officinalis* is known for its medicinal-biological activities, such as antimicrobial, antivirial and fungicidal effects.[13 - 16]

On the other hand, edible films and coatings are an environmentally -friend and have long been known to protect perishable food products from deterioration by retarding dehydration, suppressing respiration, improving textural quality, helping retain volatile flavor compounds and reducing microbial growth. Also, several reviews reported on the efficacy of films and coatings containing antimicrobials to control microbial growth on fruits and vegetables, so edible coatings/ films are of great interest and considered as alternative method for their potential ability to extend the postharvest life and maintain the quality of fresh fruits and vegetables [17 - 25]. Specially formulated edible coatings may provide additional protection against contamination of microorganism while serving the similar effect as modified atmosphere storage in modifying internal gas composition[26].

Moringa (*Moringa oleifera*) is a special food for the tropics. Almost all parts are used as food and forage for livestock [27]. Moringa have long been known to protect perishable food products from deterioration by retarding dehydration, suppressing respiration, improving textural quality, helping retain volatile flavor compounds and reducing microbial growth[18].

Gelatin as a film-forming protein is commercially available at relatively low cost[28]. Gelatin reduced the weight loss % of pomegranate fruits, and save the fruits with an excellent appearance until 7 days of storage and recorded the lowest microbial count and mould and yeast colonies[29].

Studies on the composition of mucilage cells from prickly pear (*Opuntia ficus indica)* revealed that the mucilage aqueous solutions showed high elastic properties, similar to high elastic synthetic polymers like polyisobutylene. At constant shear stress, the normal stresses decreased, as the mucilage concentration was increased[30].

The aim of this study was to evaluate the effect of some natural products namely gelatin, sage seed oil, moringa leaves extract and prickly pear stem extract on storability and fruit quality of Fuerte avocado fruits.

Materials and Methods

Fruits:

Avocado fruits cv. Fuerte (*Persea americana* Mill) were obtained from a private orchard (Nemous), Giza governorate, Egypt. Fruits were harvested at maturity stage (the first November of 2013 and 2014) from 20 years old trees that were similar in growth vigor and subjected to the common horticultural treatments. Fruits weight were about 280 -300 gm, moisture content was 80% and the oil grade was about 12.9-13.5 %. Fruits were packed and transport to the laboratory of ADS project in Cairo University.

Treatments:

Sound and undamaged fruits were selected then washed, air dried, coated with some natural products namely gelatin, sage (*Salvia officinalis* L) seed oil, moringa (*Moringa oleifera*) leaves extract and prickly pear (*Opuntia ficus indica*) stem extract.

Gelatin:

Prepared by dissolved 2gm gelatin in 100 ml of distilled water to 2% concentration, and used in the further experiment.

Sage seed oil extraction:

Fresh aerial parts of sage were collected from the greenhouse of medicinal and aromatic plants Department, Horticulture Research Institute, Egypt. The essential oil was extracted by hydro-distillation using a Clevenger apparatus for 3 hours, then dried with anhydrous sodium sulphate and stored at 4°C. The concentration tested were (0.3 %) as an emulsion in water using Tween 20 (0.05%).

Moringa leaves extraction:

Prepared by grinding 3 gm fresh leaves with 100 ml of distilled water and filtering it through double layered muslin cloth. It was diluted with distilled water to 3% concentration, and used in the further experiment.

Prickly pear stems extraction:

Prickly pear mucilage (stems were cooked with water in the ratio of 1: 5 in autoclave at 160^0C for h). The fruits then packed in carton boxes and storage at 5°C in controlled temperature room with 85-90 % relative humidity for five weeks and compared with the untreated fruits (control). Three replicates for each sampling date (7 days) were used and each replicate consisted of 5 fruits. Fruit quality measurements were assessed after storage at 5°C in each sampling date.

Determinations

Fruit weight loss:

Fruits were weighed at the beginning and after an interval of 7 days for a period of 35 days storage. The fruit weight loss percent was calculated by standard procedure as mentioned in [31] as the following equation.

Fruit weight loss % = wt. of 1*st* interval – wt. of 2*ed* interval x100 / wt. of first interval

Fruit firmness:

Fruit firmness was determined using Ametek pressure tester. Firmness of 5 fruits from each replicate was measured at two opposite points on the equator of each fruit. Results were calculated as Newton units [32].

Respiration rate:

Fruits of each sampling date were weighed and placed in 2-liter sealed jars at 5°C. Then O_2 and CO_2 production samples of the jars headspace were injected into Servomex Inst (Model 1450C-Gas Analyzer). Respiration rate was calculated as ml CO_2 / kg / hr [33, 34].

Fruit quality assessment:

Freshly pulp of avocado fruit sample was used to determine soluble solids concentration (SSC) using hand refrectometer, total acidity (TA) value that expressed as oleic acid and ascorbic acid (VC) using 2, 6 dichlorophenol indophenol titration as described by[32].

Pectinase and Cellulase Activities:

Sample of 0.5 ml of supernatant enzyme extraction were used and mixed in acetate and citrate buffer then incubated at 45 and 50°C for l0 min for pectinase and cellulase respectively. The reaction was stopped with 3 ml of 3, 5-dinitrosalicylic acid reagent, the color was obtained after heating for 10 min., and measured at wavelength of 570 nm and expressed as one unit of pectinase activity liberates 1 Mmol D-galactouronic acid in milliliter per min. While, cellulase color was measured at wavelength of 5 % nm with Shimadzu UV-VIS spectrometer model UV-240 and expressed as one unit of cellulose activity liberates1M mol glucose. Cellulose activity liberates 1M mol glucose in milliliter per minute[35, 36].

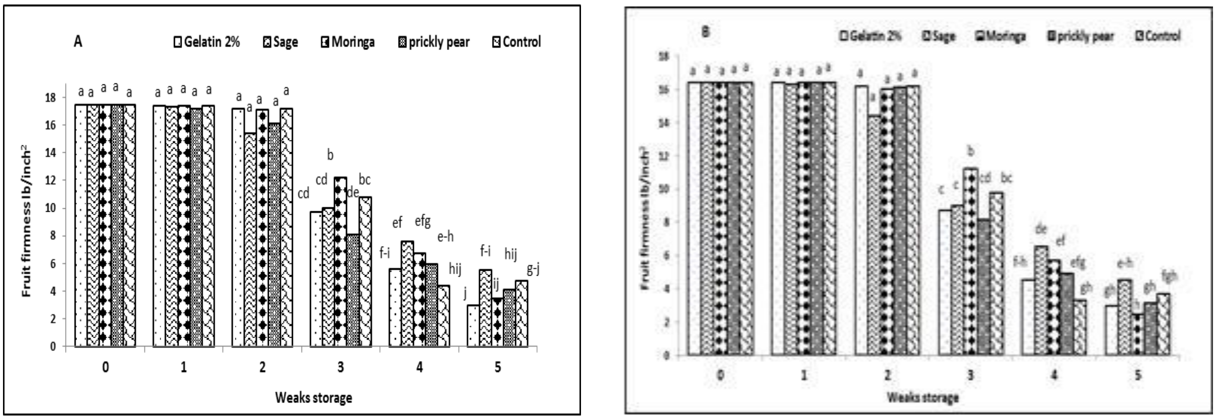
Statistical analysis:

The design for this experiment was a completely randomized design (CRD) with three replications. Data were analyzed with the analysis of variance (ANOVA) procedure of MSTATC program. Means were compared at 0.05 level of probability according to[37].

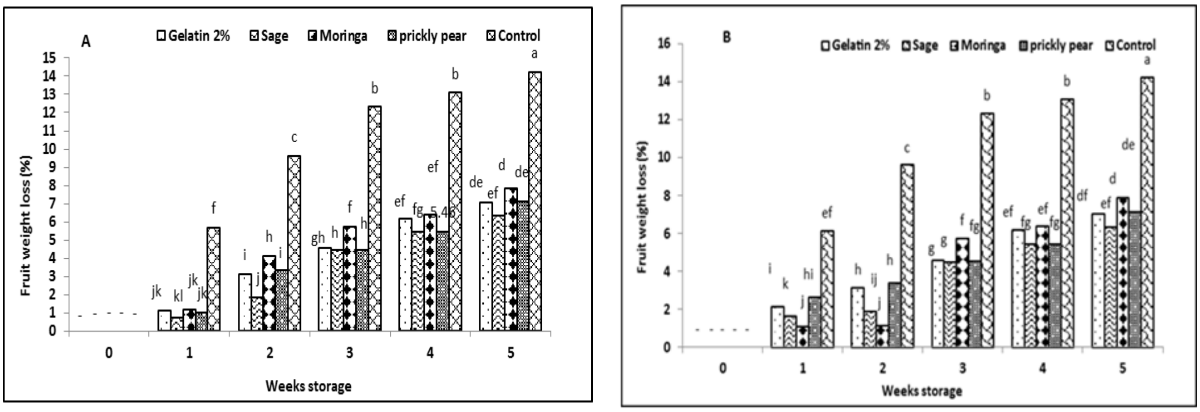
Results

Figs. 1 and 2 show the effect of different treatments on fruit firmness. Generally, it is clear that fruit firmness was gradually decreased during the storage period. However, the results indicated that sage treatment was the most effective comparing with the other treatments, since it recorded the highest firmness value at the end of the storage period, followed by the control and prickly pear treatments. This was true in both studied seasons.

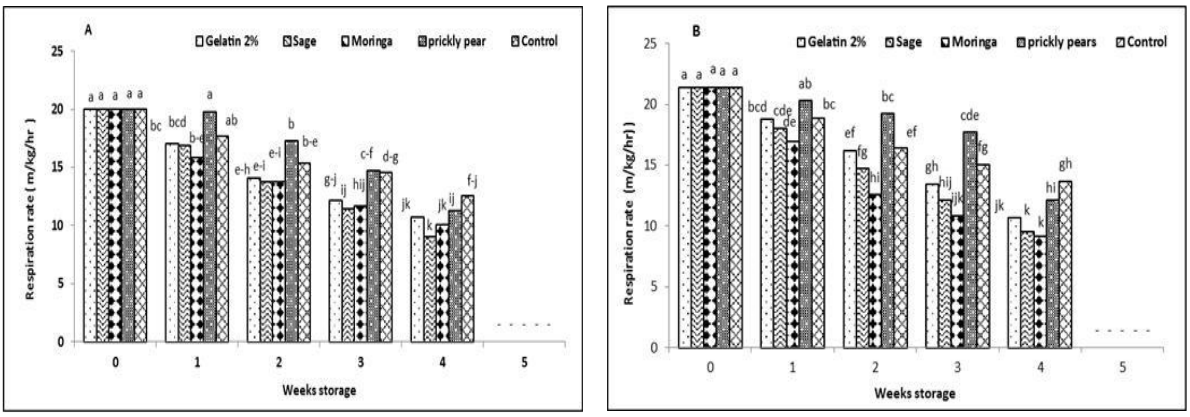
In respect to fruit weight loss, results in Figs. 3 and 4 reveal a gradual increase in weight loss %. This increment reached the maximum in the last week of the storage. However, it is observed that all treatments reduced the weight loss percentage comparing with the untreated fruits (control) that recorded the highest value among the storage weeks. Sage treatment was more effective in reducing fruit weight loss in the last week of the storage period.



Figs. 1 and 2: Fruit firmness of Fuerte avocado during the storage period as affected by different treatments in the first and second seasons.



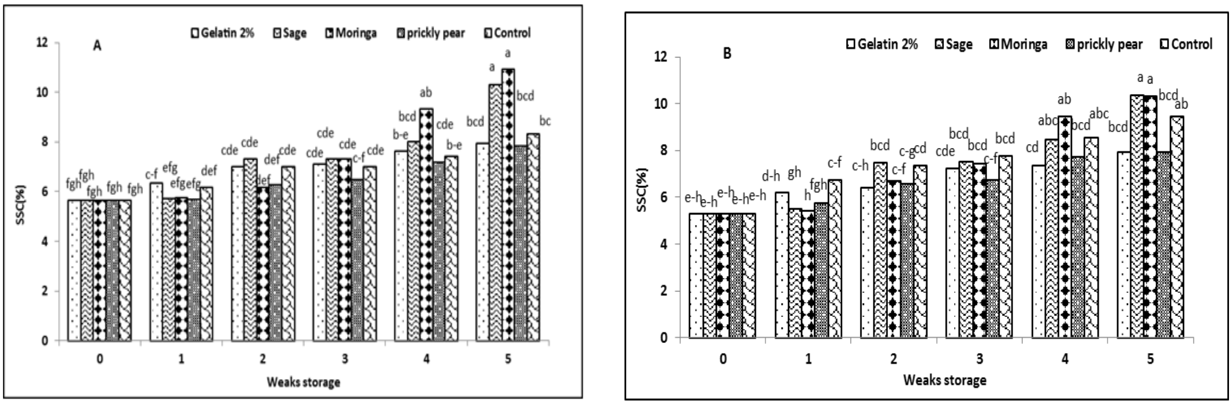
Figs. 3 and 4: Fruit weight loss of Fuerte avocado during the torage period as affected by different treatments in the first and second seasons.



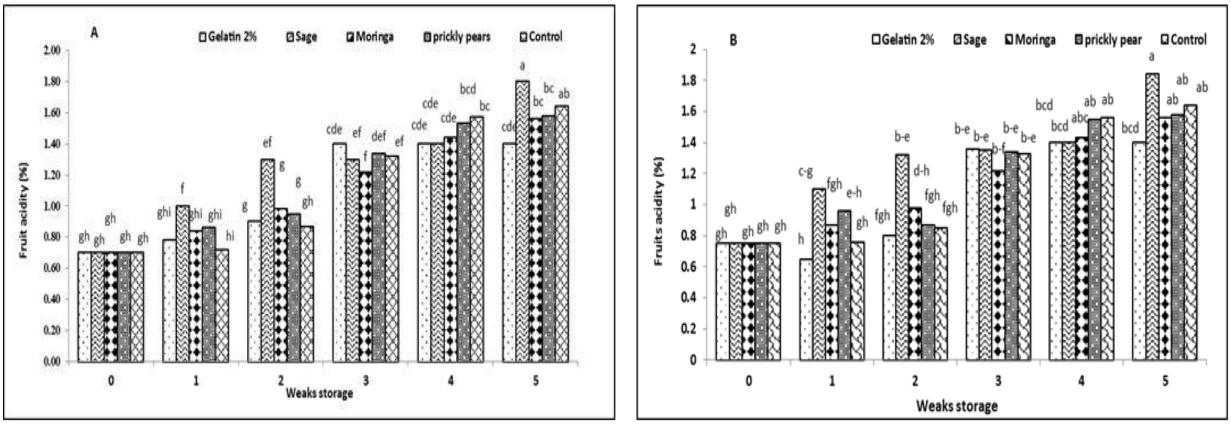
Figs. 5 and 6: Respiration rate of Fuerte avocado fruits during the storage period as affected by different treatments in the first and second seasons.

As for respiration rate, Figs. 5 and 6 show a decrease in respiration rate along the weeks of the storage. This was true with all studied treatments including the control. In this respect, the respiration rate was reduced due to all applied materials compared to the control. However, sage and moringa treatments recorded lower respiration rate comparing with all other treatments. Prickly pear treatment recorded the highest value of respiration among the second, the third and the forth weeks. The untreated fruits (control) recorded the highest value of respiration in the last week of the storage. This observation was detected in the two studied seasons.

Soluble solids concentration (SSC) as shown in Figs. 7 and 8 was gradually increased along the storage period. However, high value of SSC at the end of the fifth week was obtained with sage and moringa treatments comparing with the other treatments. This was true in the two seasons of the study.

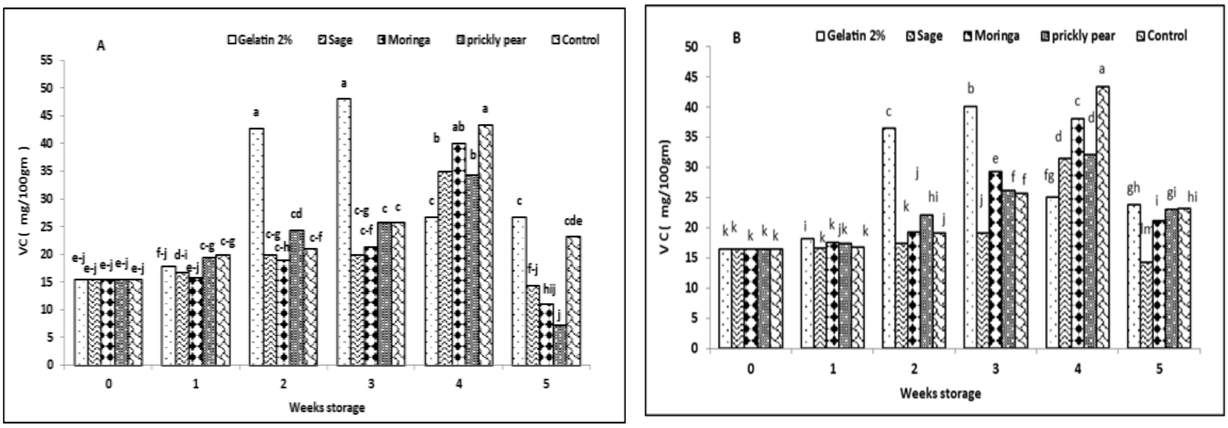


Figs. 7 and 8: Soluble solid content in Fuerte avocado fruits during the storage period as affected by different treatments in the first and second seasons.



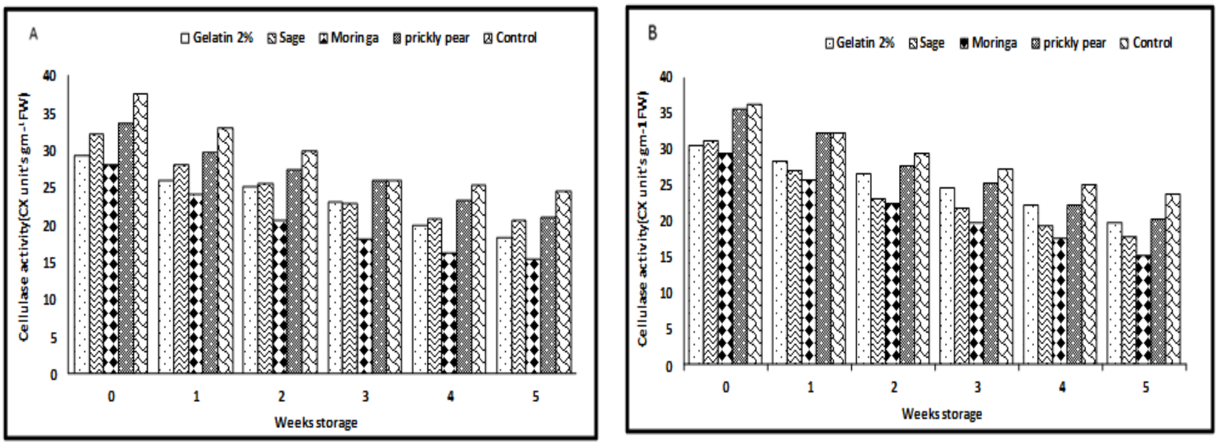
Figs. 9 and 10: Acidity percentage in Fuerte avocado fruits during the storage period as affected by different treatments in the first and second seasons.

Regarding acidity %, results in Figs. 9 and 10 indicate that acidity value was increased through the storage period and the highest value was recorded in the last week of the storage period. At the last week, all treatments reduced the acidity value than the control except sage treatment. The lowest value of acidity was obtained due to gelatin treatment followed in ascending order by moringa, while the highest value was obtained with sage treatment. This was true in both studied seasons.

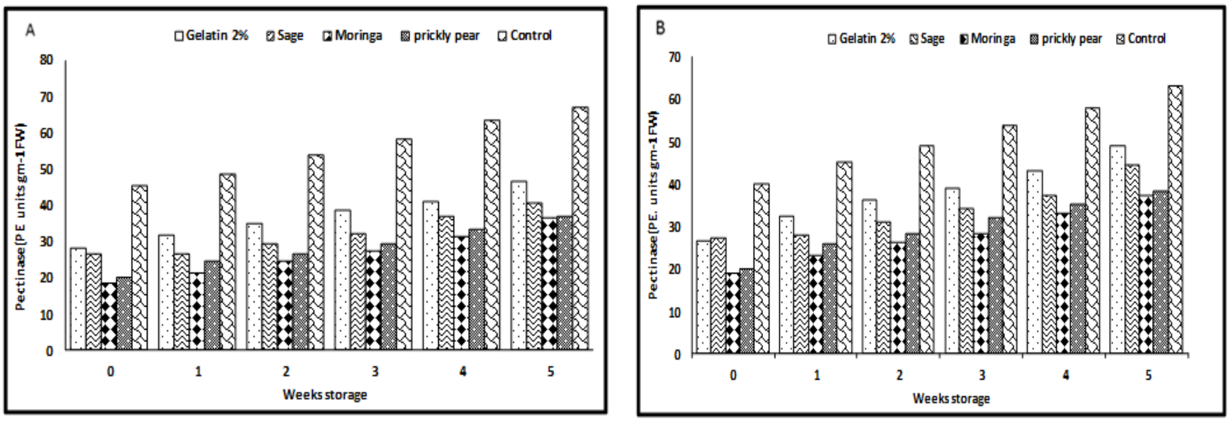


Figs. 11 and 12: Vitamin C content in Fuerte avocado fruits during the storage period as affected by different treatments in the first and second seasons.

Concerning ascorbic acid % (vitamin C) in the fruit pulp, Figs. 11 and 12 in general reveal that the studied treatments did not show a constant trend among the five weeks of the study in both seasons. However, V.C content in the fruits was increased gradually until the 4th week of the storage then deceased again at the end of the storage period. In this concern, at the fifth week, gelatin treatment recorded the highest value followed without significant by the untreated fruits. On the other hand, the other treatments gave different trends in the two seasons.



Figs. 13 and 14: Cellulase activity of Fuerte avocado fruits during the storage period as affected by different treatments in the first and second seasons.



Figs. 15 and 16: Pectinase activity of Fuerte avocado fruits during the storage period as affected by different treatments in the first and second seasons.

The effects of different treatments on the activity of cellulase and pectinase enzymes among the storage weeks are shown in Figs. 13, 14, 15 and 16. However, it's clear that all treatments including the control decreased cellulase enzyme activity among the five weeks of the storage. In this respect, the untreated fruits recorded the highest cellulase activity during all storage period. In another words, all treatments reduced the activity of cellulase enzyme comparing with the untreated fruits. In the last week of the storage, the lowest cellulase activity was obtained by moringa followed in ascending order by gelatin treatment in the first season and by sage in the second season. As for pectinase, all treatments increased pectinase activity through all the storage period including the control. Although, all treatments under the study increased pectinase activity, these treatments recorded lower values than that of the control which gave the highest pectinase activity in the two studied seasons, while the lowest activity was recorded by moringa followed in ascending order by prickly pear treatment.

Discussion

It's clear from the above results that the usage products had a positive effect on improving storability and fruit properties either as physical or chemical properties of Furuet avocado. In this concern, sage treatment was the most effective in saving fruit firmness and reducing both fruit weight loss and respiration rate, while fruits treated with moringa recorded the highest content of SSC followed without significance by sage. The lowest value of acidity was obtained due to gelatin treatment followed in ascending order by moringa that had recorded the highest ascorbic acid content.

On the other hand, while cellulase activity was reduced by all treatments including the control along the storage period, pectinase activity was increased. However, the lowest activity values for both enzymes were recorded by moringa treatment. As observed in the abovementioned results, all studied products had reduced both cellulase and pectinase activities comparing with the untreated fruits (control) which recorded the highest enzymes activity, these results may explain the role of the usage materials for saving fruit firmness during the store period. In this concern, the obtained results may be due to the explanation of [38] who reported that softening of most fruits is accompanied by a decrease in total pectin and by an increase in water-soluble pectin. They add that, ripening fruit softens because pectin and other cell wall carbohydrates are broken down enzymatically. Pectin is degraded by a group of pectinases enzymes, which are produced during the natural ripening process of some fruit. On the other hand, [39] indicated that cellulase is considered to be one of the most important enzymes involved in the degradation of cell wall polysaccharides. They add that, the role of cellulase in fruit softening is uncertain. Cellulase is ubiquitously distributed in ripening fruit, and is associated with softening, but their precise role in fruit softening is not clear reported by [40].

Regarding the effect of products containing plant essential oils such as sage, the obtained results are in agreement with those obtained by [41] who reported that **t**he essential oils application significantly decreased weight loss percentage and increased life storage fruits. They added that essential oils positively affected postharvest quality factors including total soluble solids, titrable acidity, anthocyanin, carbohydrate content, pH value and it had the lowest decay and acidity. The results showed that essential oils have strong impact on postharvest decay and fruit quality of peach. The postharvest quality of strawberry and tomato fruits after treated with eucalyptus and cinnamon volatile oil compounds and storage at 13 °C during or following vapour exposure evaluated by [42]. He found that fruit decay was decreased in the fruits treated with oil vapours. He added that cinnamon- treated tomato maintained fruit firmness during exposure; also oil vapours stimulated levels of total soluble solids during exposure.

As for the treatment of edible coatings with moringa, the obtained results are confirmed with those obtained by [18] who indicated that moringa have long been known to protect perishable food products from deterioration by retarding dehydration, suppressing respiration, improving textural quality, helping retain volatile flavor compounds and reducing microbial growth**.** In this respect, edible films and coatings form a semipermeable barrier to gas and water vapor that reduce respiration and weight loss, also edible films and coatings may help in maintaining firmness and provide gloss to coated fruits [17, 21, 23, 24.]

The obtained results concerning gelatin treatment in comparing with the control are agreed with those of [43] who treated sweet cherry fruit with gelatin at different concentrations and heated at two different application temperatures before coating. They reported that there is great potential to counteract moisture loss, the main parameter associated with quality loss in cherries by application of simple films after harvest. On the other hand, the treatments of lavender oil loaded on Carboxy Methyl Cellulose (CMC) as well as gelatin and UV for 20 minutes as coating material on pomegranate are the best treatments for preserving pomegranate arils, since they reduced the weight loss %, have excellent appearance until 7 days of storage, recorded the lowest microbial count and mould and yeast colonies reported by [29]**.**

Finally, the results concerning prickly pear treatment in compare with the untreated fruits are confirmed with those obtained by [44] who found that coating date palm fruits with cactus (prickly pear) mucilage reduced fruit decay and weight loss and increased fruit storage life. They reported that along the storage period TSS were increased and titratable acidity and tannins contents were decreased. They found that storage date palm diseases were decreased due to prickly pear cactus mucilage treatment.

References

1. Wilson L.C., Franklin J.D. and Otto B. Fruits volatiles inhibitory to *Monilinia fructicola* and *Botrytis cinerea*. Journal Plant Disease, 1987, 71, 316-319.
2. Serrano M., Martinez – Romero D., Castillo S., Guillen F., and Valero D. The use of the natural antifungal compounds improves the beneficial effect of MAP in sweet cherry storage. Innovative Food Sci. and Emerging Technologies, 2005, 6, 115-123.
3. Agrios G.N., Significance of plant diseases. Plant pathology London, UK: Academic Press, 2000, 25-37.

4. Duru M.E., Cakir A., Kordali S., Zengin H., Harnandar M. and Izumi S., Antifungal activities of the leaves of three Pistacia species grown in Turkey. Fitoterapia, 2003, 74, 170-176.
5. Macias F.A., Castellano D., Oliva R.M., Cross P. and Torres A., Potential use of allelopathic agents as natural agrochemicals. Proceedings of Brighton Crop Protection Conference—Weeds, Brighton, UK. 1997, 33-38.
6. Tassou C.C., Drosinos H.E. and Nychas J.G., Effects of essential oil from mint (Mentha piperita) on Salmonella enteritidis and Listeria monocytogenes in model food system at 4 degrees and 10 degrees J. Appl. Bacteriol., 1995, 78, 593-600.
7. Friedman M., Henika R.P., and Mandrell E.R., Bactericidal activities of plant essential oils and some of their isolated constituents against Campylobacter jejuni, *Escherichia coli*, *Listeria monocytogenes*, and *Salmonella enterica*. J. Food Protect, 2002, 65, 1545-1560.
8. Grujić-Jovanović S., Skaltsa D.H., Marin P. and Soković M., Composition and antibacterial activity of the essential oil of six Stachys species from Serbia. Flav. Fragr. J., 2004, 19, 139-144.
9. Mimica-Dukić N., Bozin B., Soković M. and Simin N., Antimicrobial and antioxidant activities of *Melissa officinalis* L. (Lamiaceae) essential oil. J. Agric. Food Chem., 2004, 52, 2485-2489.
10. Rančić A., Soković M., Vukojević J., Simić A., Marin P., Duletić-Laušević S. and Đoković D., Chemical composition and antimicrobial activities of essential oils of *Myrrhis odorata* (L.) Scop, *Hypericum perforatum* L and *Helichrysum arenarium* (L.) Moench. J. Ess. Oil Res., 2005, 17, 341345.
11. Bakkali F., Averbeck S., Averbeck D. and Idaomar M., Biological effects of essential oils – A review– Food and Chemistry Toxicology, 2008, 46(2):446-475.
12. 12- Kalemba D. and Kunicka A., Antibacterial and antifungal properties of essential oils. Curr. Med. Chem., 2003, 10, 813-829.
13. Carta C., Moretti M. and Peana A., Activity of the oil of *Salvia officinalis* L. against Botrytis cinerea. J. Ess. Oil Res., 1996, 6, 173-179.
14. Lawless J. The illustrated Encyclopedia of essential oils Element Books, Imago, Singapore (1999) pp. 225.
15. Edris A.E., Buchbauer L.G., Denkova Z., Stoyanova A. and Slavchev A. , Chemical Composition, Antimicrobial Activities and Olfactive Evaluation of a *Salvia officinalis* L. (Sage) Essential Oil from Egypt. J. Ess. Oil Res., 2007, 19 (2), 186-189.
16. Barlcevic D. and Bartol T., SAGE - The Genus Salvia. (Ed. S.E. Kintzios). Harwood Academic Publishers, Amsterdam, 2000, 143-184.
17. Baldwin E.A., Edible coatings for fresh fruits and vegetables: past, present, and future. In J. M. Krochta, E. A. Baldwin, & M. O. Nisperos-Carriedo (Eds.), Edible coatings and films to improve food quality, Lancaster, PA, USA: Technomic Publishing Co. Inc.,1994, 25-64.
18. Debeaufort F., Quezada-Gallo J.A. and Voilley A., Edible films and coatings: Tomorrow’s packaging: A review. Critical Review in Food Science, 1998, 38, 299-313.
19. Wu Y., Weller C.L., Hamouz F., Cuppett S.L. and Schnepf M., Development and application of multicomponent edible coatings and films: a review. Advances in Food Nutrition Res., 2002, 44, 347394.
20. Cagri A., Ustunol Z. and Ryser E. T., Antimicrobial edible films and coatings. Journal of Food Protection, 2004, 67(4), 833-848.
21. Pérez-Gago M.B., Serra M., Alonso M., Mateos M. and del Río M.A., Effect of Whey protein- and hydroxypropyl methylcellulose-based edible composite coatings on color change of fresh-cut apples. Postharvest Biol. Technol., 2005, 36(1), 77-85.
22. Ayala-Zavala J.F., Del Toro-Sánchez L., Alvarez-Parrilla E., Soto-Valdez H., Martín-Belloso O. and Ruis-Cruz S. Natural antimicrobial agents incorporated in active packaging to preserve the quality of fresh fruits and vegetables. Steward Postharvest Review, 2008, 3(9), 1-9.
23. Olivas G.I., Dávila-Aviña J.E., Salas-Salazar N.A. and Molina F.J., Use of edible coatings to preserve the quality of fruits and vegetables during storage. Stewart Postharvest Review, 2008, 3(6), 1-10.
24. Vargas M., Pastor C., Chiralt A., McClements D. J. and González-Martínez C. Recent Advances in edible coatings for fresh and minimally processed fruits. Critica l Reviews in Food Science and Nutrition, 2008, 48, 496-511.
25. Burtoom T., Edible films and coatings: characteristics and properties. Int. Food Res. J., 2008, 15, 237-248.
26. Park H.J., Development of advanced edible coatings for fruits. Trends in Food Sci. Technol., 1999, 10, 254-260.
27. Ram, J., Moringa, a highly nutritious vegetable tree, Tropical Rural and Island/ a toll 152 Development Experimental Station (TRIADES), Technical Bulletin No. 2. 1994.

28. Wang L., Liu L., Kerry J.F. and Kerry J.P., Assessment of film-forming potential and properties of protein and polysaccharide-based biopolymer films. International Journal of Food Science and Technology, 2007, 42, 1128-1138.
29. Salama M.I., Ayaad H.M., Aboul-Anean H.E. and Fahmy H. M., Effect of edible coating as carrier of essential oils and ultraviolet light (UV-C) on improving quality of minimally processed Manfalouty pomegranate. Res. J. Agric. Biol. Sci., 2012, 8(2), 315-324.
30. 30- Medina-Torres L., Brito-De La Fuente E., Torrestiana-Sanchez B. and Katthain R., Rheological properties of the mucilage gum (*Opuntia ficus indica*). Food Hydrocolloids, 2000, 14, 417-424.
31. AOAC., Official Methods of Analysis. Association of Official Analytical Chemists. 1111North 19th Street, Suite 20, 16th Edi. Arlington, Virginia, USA. 1994, 22209.
32. AOAC., Official Methods of Analysis. Association of Official Analytical Chemist. 9th pp. 832-Ef., Benjamin Firmin Station, Washington, D.C.Z.,P.O. Box,1990, 450.
33. Pesis E. and Ben-Arie R., Involvement of acetaldehyde and ethanol accumulation during induced deastringency of persimmon fruits. J. Food Sci., 1984, 49, 896-899.
34. Lurie S. and Pesis E., Effect of acetaldehyde and anaerobiosis as post-harvest treatment on the quality of peaches and nectarines. Post. Biol. Technol., 1992, 1, 317-326.
35. Miller G.L., Use of dinitrosalicylic and reagent for determination of reducing sugar. Analytical Chem., 1959, 31, 426-428.
36. 36- Vaheri M.P., Vaheri M.E. and Kappinen V.S., Formation and release of cellnloytic enzymes during growth of trichedermareesei on cellobiose and glycerol. Eur. J. Appl. Microbial. Biotechnol., 1979, 8, 73-80.
37. Duncan D.B.C., Multiple Range and Multiple F Tests. Biometrics, 1955, 11, 1-42.
38. Majumder K. and Mazumdar B.C., Changes of pectic substances in developing fruits of cape – gooseberry (*Physalis peruviana* L.) in relation to the enzyme activity and evolution of ethylene. Scientia Horti., 2002, 96, 91-101.
39. Abu-Goukh A.A., and Bashir H.A., Changes in pectic enzymes and cellulase activity during guava fruit ripening. Food Chemistry, 2003, 83, 213-218.
40. Huber D.J., The role of cell wall hydrolases in fruit softening. Horti. Rev., 1983, 5, 1 69-219.
41. Mohammadi S. and Aminifard M.H., Effect of Essential Oils on Postharvest Decay and Some Quality Factors of Peach (*Prunus persica* var. Redhaven). J. Biol. Environ. Sci., 2012, 6(17), 147-153.
42. Nikos G.T., Maintaining postharvest quality of fresh produce with volatile compounds. Innovative Food Sci. and Emerging Technologies, 2007, 8, 111-116.
43. Lim R., Stathopoulos C.E. and Golding J.B., Effect of edible coatings on some quality characteristics of sweet cherries. Int. Food Res. J., 2011, 18(4), 1237-1241.
44. Abd El-Moniem E.A., Abd El-Kareem F. and Nassar M.A., A new technique for extention the storage life of date palm fruits cvs Zaghloul and Samany during cold storage. Natural Products, 2012, 8 (6), 223-231.

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