

**SELECTIVE DISSEMINATION OF INFORMATION
AS OF AUGUST 2018**

APPLE

Chang, M.S., Kim, G.H., Jeong, M.C. and Kim, D.M. (2018). Screening of various anti-browning agents for apple slices. *Acta Horticulturae*, 1209, 195-200. doi: 10.17660/ActaHortic.2018.1209.28

Abstract

Surface browning, caused by cutting and other wounds during minimal processing, is an very important quality criterion to consumers. This study was carried out to develop natural anti-browning agents for fruits and vegetables. Taraxacum platycarpum, Chrysanthemum morifolium, onion, cysteine, ascorbic acid, citric acid, NaCl and sucrose were used as anti-browning agents. Taraxacum platycarpum, Chrysanthemum morifolium, and onion were extracted three times with distilled water and 80% EtOH at 60°C for 6 h. Apples were purchased from a local market in Seoul, Korea. The apples were cut into 3-mm thick slices with a sharp stainless knife. The prepared, peeled apple slices were dipped in the various anti-browning treatment solutions (1, 5, 10, 20% extractions of Taraxacum platycarpum, Chrysanthemum morifolium, onion; 0.5, 1, 3, 5% ascorbic acid, citric acid, cysteine; and 0.9% sucrose and NaCl) for 1 min. The 10 and 20% extractions of Taraxacum platycarpum, Chrysanthemum morifolium, and onion were effective in reducing browning of apple slices. The appearance of sliced apples dipped in 3 or 5% cysteine were better than dipped in other agents, however the was a strong off-odor. The compounds 1% ascorbic acid, 5% citric acid or 0.9% NaCl delayed browning of apple slices. These agents could be expected to inhibit browning and extend the shelf-life of fruits and vegetables.

Keywords: Browning/ /Natural/ /Apple/ /Appearance/ /Screening/

Giacalone, G. and Chiabrando, V. (2018). Fresh-cut apple: effect of CaCl₂ dips on firmness and quality. *Acta Horticulturae*. 1209, 95-102. doi: 10.17660/ActaHortic.2018.1209.14

Abstract

The marketing of fresh-cut produce has increased rapidly due to the increased consumer demand for fresh and convenient foods. However, they have increased perishability and shorter shelf-life as compared with intact fruit. Firmness loss in fresh-cut apple is the main problem associated with quality loss, even under cold storage. Fresh-cut 'Golden Delicious', 'Granny Smith' and 'Scarlet Spur' apples were sliced, dipped in calcium chloride and in anti-browning

solutions, packed and stored for five days at 4°C. Changes in headspace atmosphere, firmness and sensory quality were measured during storage. A significant reduction in the rates of O₂ depletion and CO₂ production was observed in all the samples. Treatments had beneficial effects on maintaining flesh firmness and reducing cut surface browning. The soluble solids content generally increased during fresh-cut storage, but without significant differences between treated slices and controls. The firmness and quality attributes of the treated samples up to five days of storage, showed no significant differences compared with the fresh apple, so they would be commercially acceptable at least until day five of storage.

Keywords: /Ready to eat/ /Shelf-life/ /Surface browning/ /Storage/

Krasnova, I., Seglina, D., Aboltins, A., Juhnevica, K. and Karklina, D. (2018). Quality maintenance of fresh-cut apple salad by using different anti-browning agents. *Acta Horticulturae*, 1209, 217-224, doi: 10.17660/ActaHortic.2018.1209.31

Abstract

When using apples as a basic component for making fresh-cut fruit salad, prevention of fruit browning and maintenance of nutritional value is essential and commercially significant in selling fruit salad. Therefore, the impact of the treatment by sea buckthorn, quince and white currant juice, and solution of 4 and 5% antioxidant Natureseal® AS1 on browning of fruit slices was evaluated. Apple 'Auksis' was chosen for testing anti-browning efficiency by slicing and treating them with solutions of sea buckthorn, quince and currant juice and antioxidant Natureseal® AS1. Strained apple slices were packed into polypropylene boxes and stored in a refrigerator for 13 days at 4°C temperature. During storage samples were analysed every third day by estimating changes in colour, content of vitamin C, content of polyphenols, and antioxidant activity (FRAP, DFPH). The best results of efficiency of the used anti-browning agents on the quality of fresh-cut apple slices were reached by treating them with 5% Natureseal® AS1 solution. The selected anti-browning agent provided a higher content of vitamin C, phenolic compounds, and antioxidant activity (FRAP, DFPH) in the product, as well as maintained the initial light colour of apple slices in comparison with other browning agents.

Keywords: /Natural inhibitors/ /Phenolic/ /Vitamin C/ /Colour/ /Antioxidant activity/

BEAN

Palma, A. and D'Aquino, S. (2018). Changes in physical-chemical parameters in minimally processed faba bean (*Vicia faba* L.). *Acta Horticulturae*, 1209, 225-230, doi: 10.17660/ActaHortic.2018.1209.32

Abstract

The effects of passive modified atmosphere packages (MAP) on physical-chemical losses in minimally processed faba bean seeds has been evaluated. Bean seeds were sealed in MAP using BHE film (OTR 19000 cc m⁻² 24 h⁻¹) or MY film (OTR 2500 cc m⁻² 24 h⁻¹) and stored for 4, 8 or 12 days at 5°C. The texture, color, pH, titratable acidity, total soluble solids (TSS) and ascorbic acid as well as taste characteristics, browning development and in-package CO₂, O₂ and C₂H₄ were determined at each storage time. The final gas compositions of 16 kPa O₂/5 kPa CO₂ and 11 kPa O₂/9 kPa CO₂ were obtained with BHE and MY films, respectively. TSS (initial value 15.2%) and ascorbic acid concentrations (initial value 3.3 mg 100 g⁻¹) were retained more in BHE films than MY films during storage. The hue angle and chroma values decreased in seeds in BHE films, while resistance to puncture and specific deformation increased at a higher rate in beans in BHE films, although little effect occurred in the cut test. Panelists did not perceive appreciable changes in flavor and odor in both treatments after storage, but detected higher decreases in crispness associated with diffuse and intense browning of seeds packaged with BHE film. Thus, despite the slower degradation of TSS and vitamin C in bean seeds wrapped with BHE film, panelists scored seeds within MAP with BHE films higher than those packaged in MY films.

Keywords: /Vicia faba/ /Minimally processed/ /Modified atmosphere packaging/

BERRY

Kampuse, S., Kruma, Z., Dorofejeva, K., Ungure, E. and Kampuss, K. (2018). The comparison of gooseberry biochemical composition in different ripening stages. *Acta Horticulturae*, 1209, 157-164, doi: 10.17660/ActaHortic.2018.1209.23

Abstract

Though gooseberries are still considered as a minor berry crop, there is an increasing interest of growers, processors, and consumers in gooseberries and their products. However, there is still not enough information about the nutritional value of gooseberry cultivars in different ripening stages and products. The aim of this study was to evaluate the biochemical composition and nutritional value of 10 gooseberry cultivars and hybrids in two different ripening stages. The experiments were done at the Faculty of Food Technology, Latvia University of Agriculture (LLU), and the samples were collected from farm Mucenieki at technical maturity and fully ripen stages. The contents of ascorbic acid, total phenols, carotenoids, soluble solids, titratable acids, and pH of fresh gooseberry hybrid 323/09, 'Hinnomaki strain', 'Kolobok', 'Lada', 'Lielas Dzeltas', 'Masheka', 'Nezhnii', 'Russkii', 'Sadko', and 'Tukuma Konfeksu' were analysed. There were significant differences between the total carotenoids composition of the gooseberry samples in the technical and fully ripen stages: the carotenoids significantly increased during ripening. The highest carotenoid content, in both ripening stages, was detected in the gooseberry 'Masheka' (1.23 and 2.30 mg 100 g⁻¹, respectively). The soluble solid content

during ripening increased significantly, while the titratable acid content decreased. The highest soluble solid content was detected in 'Russkii', meanwhile the lowest titratable acid content was observed in the ripen 'Lielas Dzeltas'. There were no significant differences between the ascorbic acid and total phenolic content between the two ripening stages, although a tendency was observed that berries in fully ripen stage contained more phenols than in the technical maturity stage. The highest ascorbic acid content was found in the 'Masheka' and 'Tukuma Konfeksu' gooseberries, but the highest phenolic content was detected in the 'Tukuma Konfeksu' gooseberry.

Keywords: /*Ribes uva-crispa*/ /Maturity stages/ /Ascorbic acid/ /Phenols/ /Carotenoids/ /Soluble solids/ /Titratable acids/

CARROTS

Edelenbos, M. & Petersen, H.T. (2018). The impact of raw material selection for fresh-cut quality - with carrots as an example. *Acta Horticulturae*, 1209, 19-26. doi:10.17660/ActaHortic.2018.1209.3

Abstract

The quality of raw material for fresh-cut production is very important. In the industry, carrots for processing are mainly selected on the basis of appearance and texture, and washed roots free of defects are used for minimal processing. Whole carrots change quality after harvest even though they are harvested mature and stored at low temperatures. To provide fresh-cut carrots with a consistent high quality, a supply of stored carrots with specific quality attributes are needed. The aim of the present study was to study the impact of the raw material quality on fresh-cut processing quality. Mature carrots stored for up to 6 month at 1°C and >95% relative humidity were used. The carrots had different physiological ages at processing. Two experiments were carried out: one experiment with long-term storage of whole carrots and a second experiment with long-term storage of whole carrots followed by processing. During cold storage of the unprocessed carrots, the respiration rate decreased, and the respiratory quotient (RQ) increased. Similar results were observed for fresh-cut carrots, but the magnitude of physiological ageing and senescence on respiration and RQ was greater. During cold storage, whole carrots also began to sprout. Sprouting began around 3 months after harvest increasing up to 25 and 82% after 3½ and 5½ months of storage, respectively. All fresh-cut products developed a sour-fermented flavour during 8 days storage at 5°C, however, this off-flavour was less pronounced in fresh-cut carrots made from freshly harvested roots. The results show that it is important to take physiological age of the raw material into account when selecting materials for fresh-cut production. It is suggested to use quality parameters such as sprouting and RQ among others in the selection of carrots for fresh-cut quality.

Keywords: /*Daucus carota* L./ /long-term storage/ /physiological ageing/ /processing/ /fresh-cut quality/

CAULIFLOWER

Miceli, A., Vetrano, F. and Romano, C. (2018). Quality and shelf-life of minimally processed cauliflower. *Acta Horticulturae*, 1209, 277-280. doi: 10.17660/ActaHortic.2018.1209.40

Abstract

Cauliflower has been described as a vegetable with a high nutritional value due to its high content of vitamins, antioxidants and anti-carcinogenic compounds. Cauliflower inflorescences are harvested while they are totally immature, which implies severe changes in nutrient, water and hormonal status. Harvesting and the following processing can cause severe stress determining the appearance of accelerated senescence symptoms. The effects of processing and cold storage of minimally processed cauliflower were investigated. Florets were treated with antioxidants before storage in PE bags at 4°C for 21 days. During the storage period the weight loss, colour, firmness, SSC and pH were evaluated. Cauliflower showed a good shelf-life and overall quality maintenance but also a susceptibility to browning of cut zones.

Keywords: /Fresh-cut produce/ /Vegetables/ /*Brassica oleracea* L. var. *botrytis* L./ /Cold storage/ /Browning

COLD STORAGE

Mercier, S., & Uysal, I. (2018). Neural network models for predicting perishable food temperatures along the supply chain. *Biosystems Engineering*, 171, 91-100. doi: 10.1016/j.biosystemseng.2018.04.016

Abstract

Monitoring the temperature of perishable food along the supply chain using a limited number of temperature sensors per shipment is required for wide-scale implementation of quality-driven distribution. In this work, we propose to leverage the theoretical foundation and generalisation ability of a physical heat transfer model to develop a flexible neural net framework which can predict temperatures in real-time. More specifically, the temperature distribution inside a pallet subjected to different ambient temperatures are generated from a validated heat transfer model, and used to train a neural network. Simulations show that the neural network can predict the temperature distribution inside a pallet with an average error below 0.5 K in a one-sensor-per-pallet scenario when the sensor is properly located inside the pallet. Placing the

temperature sensor at the corner of the pallet provides a high information content with strong correlations to the other locations inside the pallet to maximise the accuracy of the temperature estimates. The application of an ensemble operator to combine the predictions from multiple randomly seeded neural networks improved by up to 35% the accuracy of the temperature estimates. Finally, the introduction of small Gaussian noise in the training data is an efficient approach to improve the generalisation ability of the neural network and improved by nearly 45% the accuracy of the temperature prediction in the presence of noisy temperature sensors.

Keywords: /Perishable food/ /Cold chain/ /Quality-driven distribution/ /Temperature prediction/ /Neural network/ /Heat transfer/

Sharma, P. K., & Kumar, H. A. (2018). Solar powered movable cold storage structure for perishables. *Current Science*, 114(10), 2020-2022.

Abstract

The article discusses the scientific research findings into the use of solar energy-powered cold storage equipment for storing perishable foods in India. Topics discussed include the properties of the materials used in the cold storage structures, along with the use of the solar photovoltaic system to power the cold storage system.

Keywords: /Perishable foods/ /Cold storage/ /Equipment and supplies/ /Perishable goods/ /Management/ /Solar technology/ /Cold storage industry/

DRAGONFRUIT

Chaemsanit, S., Matan, N., & Matan, N. (2018). Effect of peppermint oil on the shelf-life of dragon fruit during storage. *Food Control*, 90, 172–179. <https://doi.org/10.1016/j.foodcont.2018.03.001>

Abstract

Dragon fruit (*Hylocereus undatus*) is a short shelf-life, non-climacteric fruit which can be easily destroyed by mold growth during storage time. This study investigated the use of peppermint oil as an alternative method to inhibit surface mould and prolong the shelf-life of dragon fruit during storage. Peppermint oil adsorbed activated carbon at different concentrations (100–1000 $\mu\text{L L}^{-1}$) was placed with the dragon fruit in the storage box (1 L) at 25 ± 2 °C and $75 \pm 5\%$ RH for 21 days. The effect of peppermint oil adsorbed activated carbon on antifungal activity and quality of dragon fruit were evaluated. It was found that peppermint oil adsorbed activated carbon at 700 $\mu\text{L L}^{-1}$ could provide 100% inhibition of surface mould and decay fungi for more than 14 days of storage (control start decayed at day 7). In addition, essential oil

vapour maintained a more firm fruit, greenness of the bract, titratable acid value and total phenolic content after 21 days in comparison to the control. The possible mode of action was demonstrated by gas chromatography-mass spectrometry (GC-MS) analysis to involve the release of menthol from peppermint oil activated carbon, which then interacts with other compounds to exhibit antifungal activity. Peppermint oil vapour can preserve quality of dragon fruit up to 14 days. • Vapour is slowly released from activated carbon adsorbed with liquid peppermint oil. • Menthol is the main active component of peppermint oil vapour. • Peppermint oil components are found on dragon fruit.

Keywords: /Dragon fruit/ /Shelf life/ /Peppermint oil/ /Storage/

Fan, P., Huber, D. J., Su, Z., Hu, M., Gao, Z., Li, M., ... Zhang, Z. (2018). Effect of postharvest spray of apple polyphenols on the quality of fresh-cut red pitaya fruit during shelf life. Food Chemistry, 243, 19–25. <https://doi.org/10.1016/j.foodchem.2017.09.103>

Abstract

Apple polyphenols treatment delays discoloration in fresh-cut red pitaya fruit. • Colour retention by apple polyphenols is linked to delayed betacyanins degradation. • Apple polyphenols slows softening, and loss of soluble solids and titratable acidity. • Apple polyphenols delay loss of phenolics and maintain antioxidant activities. • Apple polyphenols suppress microbial growth and improve fresh-cut pitaya safety.

Fresh-cut (FC) red pitaya fruit were treated with 5g.a.i.l⁻¹ apple polyphenols (APP) and then stored at 20°C for up to 4days to evaluate the effects on attributes. Results showed that FC pitaya fruit with APP treatment showed greater colour retention, delayed softening, reduced loss of soluble solids content, titratable acidity, betacyanin and total phenolics compared with untreated FC fruit. APP treatment also maintained antioxidant activity, as indicated by higher DPPH radical-scavenging activity and reducing power compared with untreated FC pitaya fruit. APP treatment strongly suppressed microbial growth, contributing to improvement of product safety. Because APP is a natural product, we propose that application of APP could be a convenient, safe and low-cost approach to maintain the quality and extend the shelf life of FC red pitaya fruit.

Keywords: /Dragon fruit/ /Red pitaya/ / Fresh-cut/ /Apple polyphenol treatment/

EGGPLANT

Ghidelli, C., Sanchís, E., Rojas-Argudo, C., Pérez-Gago, M.B. and Mateos, M. (2018). Controlling enzymatic browning of fresh-cut eggplant by application of an edible coating and modified atmosphere packaging. Acta Horticulturae, 1209, 239-246. doi:

Abstract

Once cut, some vegetables, such as eggplant, become very perishable due to enzymatic browning of the tissue and loss of firmness. The use of edible coatings combined with antioxidants preserves quality of minimally processed commodities by decreasing respiration rate, weight loss and enzymatic browning. Moreover, packing under modified atmospheres (MAP) could enhance the shelf life of fresh-cut products. Therefore, the effectiveness of an edible coating with antioxidant activity and MA packaging has been investigated on fresh-cut eggplant. Eggplant pieces were dipped in a coating composed of soy protein isolate (SPI) and 0.5% cysteine, or in water as control. The samples were then packed in trays with air (NA) or two gas mixtures (MA-A: 15 kPa CO₂ + 5 kPa O₂; MA-B: 80 kPa O₂), sealed with polypropylene films and stored at 5°C for 8 days. In samples packed with air, a control treatment was also performed by macro perforating the polypropylene film (NA-P) to ensure no gas modification in the package. Changes in atmosphere composition in the package, color (CIE L*a*b*), visual quality, texture and weight loss were evaluated during storage. As expected, samples packed in MA and NA showed an increase and a decrease of CO₂ and O₂, respectively. Lower CO₂ production was detected in the headspace of the trays for coated samples than in the uncoated ones packed under MA-A and MA-B conditions. Coated samples packed under MA-B and NA-P showed the highest L* and the lowest a* values during the first 6 days of storage. Storage under MA-A did not improve the shelf life of minimally processed eggplant, showing low L* and high a* values. Moreover, this atmosphere increased the weight loss of uncoated samples during storage. Application of the coating without atmosphere modification (NA-P) improved the quality of fresh-cut eggplant and the samples were considered above the limit of commercialization until day 6 of storage. These results suggest that the application of the SPI-based coating can extend the shelf life of minimally processed eggplant. When comparing MA-packaging conditions, a high O₂ concentration (MA-B) was more effective than low O₂ concentration (MA-A) to preserve the quality of minimally processed eggplant.

Keywords: /Fresh-cut eggplants/ /Enzymatic browning/ /Antioxidant/ /Edible coating/ /Modified atmosphere packaging/

FOOD SAFETY

Alegbeleye, O. O., Singleton, I., & Sant'Ana, A.S. (2018). Sources and contamination routes of microbial pathogens to fresh produce during field cultivation: A review. *Food Microbiology*, 73, 177-208. doi: 10.1016/j.fm.2018.01.003

Abstract

Foodborne illness resulting from the consumption of contaminated fresh produce is a common

phenomenon and has severe effects on human health together with severe economic and social impacts. The implications of foodborne diseases associated with fresh produce have urged research into the numerous ways and mechanisms through which pathogens may gain access to produce, thereby compromising microbiological safety. This review provides a background on the various sources and pathways through which pathogenic bacteria contaminate fresh produce; the survival and proliferation of pathogens on fresh produce while growing and potential methods to reduce microbial contamination before harvest. Some of the established bacterial contamination sources include contaminated manure, irrigation water, soil, livestock/wildlife, and numerous factors influence the incidence, fate, transport, survival and proliferation of pathogens in the wide variety of sources where they are found. Once pathogenic bacteria have been introduced into the growing environment, they can colonize and persist on fresh produce using a variety of mechanisms. Overall, microbiological hazards are significant; therefore, ways to reduce sources of contamination and a deeper understanding of pathogen survival and growth on fresh produce in the field are required to reduce risk to human health and the associated economic consequences.

Keywords: /On-farm food safety/ /Soil/ /Irrigation water/ /Manure/ /Foodborne pathogens/ /Fruits and vegetables/

O'Beirne, D. (2018). Issues in ensuring safety of fresh-cut produce. *Acta Horticulturae*, 1209, 1-10. doi: 10.17660/ActaHortic.2018.1209.1

Abstract

There has been a low but increasing number of food poisoning outbreaks associated with fresh-cut produce. There are potential implications of field production, harvesting, minimal processing, packaging and distribution for contamination, survival and growth of human pathogens. Data on the implications of minimal processing, gas atmospheres and storage conditions are presented. Guidelines are presented for good agricultural practice (GAP) and hazard analysis and critical control points (HACCP) from pre-planting to post-production. Suggestions are outlined in relation to knowledge gaps and future needs.

Keywords: /Food safety/ /Human pathogens/ /HACCP/ /Minimal processing/ /Modified atmosphere packaging/

FRESH-CUT

Latifah, M.N., Abdullah, H., Ab Aziz, I. , Nur Aida, M.P., Fauziah, O. and Talib, Y. (2018). Fresh-cut fruit industry in Malaysia: status and challenges. *Acta Horticulturae*, 1209, 79-86. doi: 10.17660/ActaHortic.2018.1209.12

Abstract

Fresh-cut fruit is a growing sector of the food industry in many parts of the world. Its success depends greatly on several factors, especially the quality and consumers' confidence. Products are prepared in ready to-eat form whilst retaining the organoleptic characteristics of fresh fruits in terms of aroma, flavour, taste, colour and texture. Appropriate methods of preparation are obligatory in order to maintain their freshness. The preparation involves cleaning, washing, trimming, coring, slicing and other related steps of which many of these processes hasten the products to perish. Intensive research in the fresh-cut fruit processing has been conducted by using government funding as well as working in collaboration with the private sectors. Presently, the technology for commercial handling of fresh-cut fruits, namely, durian, jackfruit and pineapples has been successfully developed. Export trial for fresh cut jackfruit and pineapple by air shipment to the Netherlands had been successfully conducted in 2006. This was followed by a sea shipment trial of fresh-cut durian to Hong Kong in 2008. A cold truck trial for exportation of fresh-cut durian, pineapple and jackfruit to Singapore was also successfully conducted in 2009. In 2010, export trial for fresh-cut jackfruit was conducted to Dubai by using air shipment. Depending on the fruits, the fresh-cut products can be stored for 2-3 weeks at 2°C. An effective quality assurance program has been incorporated in the technology development to ensure the products are safe for consumers. Currently, fresh-cut jackfruit has been exported regularly by four companies to the Europe, Dubai and Singapore markets. Consumer demand for fresh-cut products is an increasing trend, leading to further development and growth of the industry. This paper discusses the current status and challenges of the fresh-cut fruits industry in Malaysia. Issues involved in maintaining both quality and safety of the fresh-cut produce will also be emphasized.

Keywords: //Fresh-cut/ /Status/ /Product behaviour/ /Challenges/

Csajbokne, E.Cs. and Gilingerne, M.P. (2018). Changes in quality of cut vegetable mixes during the storage. Acta Horticulturae, 1209, 143-150. doi: 10.17660/ActaHortic.2018.1209.21

Abstract

Fresh-cut packed vegetables are more and more popular in Hungary although less kinds are available than in other European countries. Vegetables belong to different botanic and morphologic groups and indicate a lot of diverse habits in the course of the storage. The rate of the psychological processes that occur during the storage are mostly affected by the temperature. We organized a storage trial with 10 kinds of single and multiplied component fresh-cut vegetables and 5 kinds of herbs. Samples were obtained from regular groceries. Storage trials were executed at 6, 12, and 20°C for a maximum of 11 days. The images of stored samples were digitally kept, and evaluated organoleptically. The organoleptic observations were diverse ranging from fresh appearance to emergence of disorders, including

withering, physiological browning, stale odors, rotting and acetic acid from fermentation. Vitamin C content was measured between 17-50 mg 100 g⁻¹, the lowest was in the iceberg lettuce, the highest in the white cabbage. The values usually decreased slowly during storage. The peroxidase enzyme activity was measured between 20-18,000 activity units g⁻¹, the lowest was in the iceberg lettuce and the highest in the white cabbage We can differentiate three groups according to the measured data and the organoleptic examination: 1) stable products with a long storage life, such as carrots, iceberg lettuce, endive, dill, mint, and spring onions, 2) poorly stored products with a tendency to rot, such as spinach, corn salad, rocket salad, celery, coriander, tarragon, and 3) products that cannot be stored for long with a tendency to ferment, such as white and red cabbage.

Keywords: /Vitamin C/ /Peroxidase enzyme activity/ /Spinach/ /Iceberg lettuce/ /White cabbage/ /Herbs/

GINSENG

Kim, H.S., Hong, S.I., Jeong, M.C., Lee, H.J., Kim, D.M. and Kim, G.H. (2018). Effects of surface coating treatments on the quality of washed fresh ginseng during marketing. *Acta Horticulturae*, 1209, 179-186. doi: 10.17660/ActaHortic.2018.1209.26

Abstract

To prevent the quality deterioration of washed fresh ginseng during distribution, the surface of fresh ginseng was coated with glycerol (Gly), soybean protein isolate (SPI), and sodium alginate (SA) at certain concentrations. The ginseng roots were put into a Polypropylene tray and sealed with a 0.035-mm thick oriented polypropylene film. After that, it was stored at 0°C for 10 weeks so as to determine changes in the quality. During storage, all the treated samples exhibited an increase in CO₂ concentration and a decrease in O₂ concentration in the package atmospheres. More specifically, the non-treated ones (CN), SPI-treated ones and Gly-treated ones had a 8-9% CO₂ concentration while SA-treated ones encountered a lower concentration in the packages. The moisture content changed slightly with storage time, with relatively less changes in Gly-treated and SA-treated ginseng. There was no significant change in the firmness of the ginseng roots during their storage. During storage, ΔE-value changed the most in SPI-treated ginseng while it was almost the same in the remaining treatments, with the non-treated ginseng changing the least. The number of viable bacterial cells on the surface of the ginseng was 3.7-4.0 log CFU g⁻¹ immediately after the coating and it increased as the storage period elapsed, with no distinct difference between the treatments. The number of mold counts was initially 3.2 log CFU g⁻¹ and increased as the storage period elapsed, with the count for SA-treated ginsengs being 3.3 log CFU g⁻¹ after 10 weeks, which was the lowest among the samples. In the sensory quality, the surface of SPI-treated fresh ginsengs rapidly discolored by 6 weeks and the quality of the rhizome and hairy root of CN- and SPI- treated samples largely

deteriorated in 8 weeks, while the quality generally remained good in the Gly- and SA-treated ginseng.

Keywords: /Fresh-cut products/ /Ginseng/ /Surface coating/

Kim, H.S., Hong, S.I., Jeong, M.C., Lee, H.J., Kim, D.M. and Kim, G.H. (2018). Effects of MAP conditions on the quality of washed fresh ginseng during storage. *Acta Horticulturae*, 1209, 187-194. doi: 10.17660/ActaHortic.2018.1209.27

Abstract

To investigate the effects of its packaging and packaging environments on the quality of washed fresh ginseng, the ginseng was put into a polypropylene tray and tightly sealed with a 0.035-mm thick OPP film (OPP-1, normal air in package; OPP-2, 50% air replaced with N₂; and OPP-3, 100% N₂), packaged with a 0.08-mm thick PE film (CN-PE) or vacuum packaged with a 0.1-mm thick Ny + PE film (Ny+PE-Vac). After that, it was stored at 0°C for 10 weeks so as to determine changes in the quality. It was found that, the CO₂ levels in OPP-2 and OPP-3 packages increased more than in OPP-1 and CN-PE during storage. During the storage, there was no significant difference in the moisture content and firmness of the treated fresh ginseng. The content of soluble solids content was initially 19.0 °Brix and increased as the storage period elapsed till it reached 19.5-25.3 °Brix in 10 weeks, and it least changed in Ny+PE-Vac and OPP-3 of all the treated ginsengs. A change in microbial population was relatively less in OPP-3 and Ny+PE-Vac and the sensory quality of ginseng in OPP-2 and OPP-3 was the best during storage.

Keywords: /Fresh-cut products/ /Washing/ /Ginseng/ /MAP/

HERBS

Gilingerne, M.P., Orban, Cs. and Csajbokne, E.Cs. (2018). Antioxidant activity of fresh cut green and dried spices. *Acta Horticulturae*, 1209, 151-156. doi: 10.17660/ActaHortic.2018.1209.22

Abstract

The antioxidant activity of fresh cut green and dried spices (basil, celery, coriander, dill, green onion, lovage, mint, oregano, ramsons, rosemary, tarragon and thyme) was evaluated. Dried oregano, rosemary and thyme that had been packed by different producers were also tested. The antioxidant activity was measured using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging method. Rosemary had the highest antioxidant activity, followed by thyme and oregano. Tarragon had the lowest antioxidant activity. The vitamin C content of fresh cut

spices changed widely, from 34 to 265 mg 100 g⁻¹ in rosemary. No correlation between the vitamin C content and the antioxidant activity was detected. The results are widely variable among different plant species. No significant differences between origins of dried spices was found.

Keywords: /Herbs/ /DPPH/ /Vitamin C/ /Rosemary/ /Tarragon/ /Oregano

JACKFRUIT

Latifah, M.N., Ab Aziz, I., Fauziah, O. and Talib, Y. (2018). Effect of inclusion of ethylene absorbent to the quality of the fresh-cut jackfruit stored at 10°C. *Acta Horticulturae*, 1209, 115-122. doi: 10.17660/ActaHortic.2018.1209.17

Abstract

The effect of inclusion of ethylene absorbant to the quality of the fresh-cut jackfruit during storage for 8 days at 10°C has been investigated. Rigid polypropylene containers (10×10 cm) with a clip-on lid, overwrapped with stretch film were used for packing fresh-cut jackfruit. The containers were either with or without a sachet of ethylene absorbent (FX 2gm). The O₂, CO₂ and C₂H₄ in each package, weight loss, surface colour (L*-lightness and b*-yellowness), total soluble solids (TSS), pH, and sensory evaluation of the fruits were determined every 2 days. The colour of the control fruits faded (L* 72.54) towards the end of the storage period (day 8). The taste of treated fruits was better due to the combined attributes of the higher TSS and pH values (27% and 4.97) on day 8. A better control of gas accumulation contributed to a better control of the respiration and ripening process of the fresh-cut jackfruit inserted with ethylene absorbent.

Keywords: /Fresh-cut/ /Ethylene absorbent/ /Quality/ /Shelf life/

LEAFY VEGETABLES

Gilardi, G., Gullino, M.L. and Garibaldi, A. (2018). Emerging soil-borne and foliar diseases on leafy vegetables for fresh-cut production in northern Italy. *Acta Horticulturae*, 1209, 65-70. doi: 10.17660/ActaHortic.2018.1209.10

Abstract

During the past years several diseases caused by soil-borne and foliar pathogens were observed for the first time in Northern Italy on fresh-cut vegetables. This sector is particularly exposed to the risk of the emergence of new diseases as a consequence of its dynamism, specialization and use of intensive cultivation techniques. Fusarium wilts have been recently

observed in Italy on lettuce (*Lactuca sativa*), wild (*Diplotaxis tenuifolia*) and cultivated (*Eruca sativa*) rocket, corn salad (*Valerianella olitoria*), chicory (*Cichorium intybus*) and endive (*Cichorium endivia*), while *Phytophthora tentaculata* was recently reported on *C. intybus*. Among the diseases caused by seed-borne pathogens, *Phoma valerianellae*, already reported in Italy on corn salad, caused severe losses on this crop. Attacks of *Rhizoctonia solani*, and *Pythium* spp. on lettuce, rocket, corn salad, endive and chicory were observed while *Phoma betae* on leaf beet (*Beta vulgaris* L. subsp. *vulgaris*) was recently observed for the first time in Piedmont (Northern Italy). Powdery mildew of corn salad, downy mildew of wild rocket and a leaf spot of wild and cultivated rocket caused by *Alternaria japonica* were recently observed as new foliar diseases on these crops. These diseases emerged as major production problems in protected crops, where every year repeated cropping is carried out in the same soil. The biology, epidemiology, physiological characteristics of the causal agents as well as disease management strategies are reported.

Keywords: /Varietal resistance/ /Biological control/ /Disease management/ /Seed dressing/

Martínez-Sánchez, A., Allende, A., Luna, C., Selma, M.V., Tudela, J.A. and Gil, M.I. (2018). Impact of climate change and global trends on the microbial quality of leafy greens. *Acta Horticulturae*, 1209, 51-56. doi: 10.17660/ActaHortic.2018.1209.8

Abstract

The safety of agricultural products might be influenced by different factors such as climate change and global trends. An unequivocal consequence associated to climate change is global warming, with a prediction of an average increase in global temperature by 2100 between 1.8 and 4°C. Among other climate effects, the global warming will also be associated with extended dry periods. In fact, climate change is exacerbating water scarcity problems, which is an increasingly frequent phenomenon in the European Union. The water scarcity is likely to reduce the water availability for irrigation in dry areas, which might have an impact in the microflora of vegetable products such as fresh-cut leafy greens. Global trends, leading to the reduction of chemical fertilizers, pesticides and herbicides, have increased the use of organic amendments and fertilizers, which are not produced by chemical synthesis. However, the use of organic waste and composting processes might represent a potential source of enteric contamination of fresh produce. In the present study, we have evaluated the impact of irrigation and stabilized organic wastes on the microbial quality of leafy greens to identify potential impacts of anticipated changes in climate and global change on food safety. It was observed that a reduction of about 25 and 50% of the irrigation doses regularly applied to Romaine lettuce during cultivation reduced the microbial load, including total coliforms when compared with excess water irrigation. On the other hand, the use of stabilized organic wastes at a rate of 2:225 t ha⁻¹ significantly increased the populations of faecal coliforms in rocket leaves. These preliminary studies show the intrinsic vulnerability of the fresh produce chain to potential

emerging microbial hazards associated with climate change and production trends. Thus, the risk evaluation of newly identified threats associated with the global trade system and anticipated climate change are very important to determine risk management strategies.

Keywords: /Irrigation management/ /Organic amendments/ /Faecal coliforms/ /Leafy vegetables/ /Electrolyte leakage/ /Sensory quality/

Nicola, S., Pignata, G. and Tibaldi, G. (2018). The floating growing system can assure a low microbial contamination of baby leaf vegetables at harvest. *Acta Horticulturae*, 1209, 57-64. doi: 10.17660/ActaHortic.2018.1209.9

Abstract

Growing systems are of paramount importance to obtain raw material that is free of microbiological risks for use in the fresh-cut process. Using floating growing systems (FGS) could increase the safety of baby leaf vegetables (BLV) which, since over-head irrigation is not adopted, have short growing cycles. However, there is a lack of information on the microbial load of BLV at harvest, thus FGS have been used to study the effects of species (green and red lettuce (*Lactuca sativa* L. var. *crispa*); rocket (*Eruca sativa* Mill.); spinach (*Spinacia oleracea* L.)) on the level of microbial contamination at harvest (total bacterial count TBC; yeast and mold count YMC). FGS have been adopted to study the effects of microbial infection at harvest on green lettuce (*Lactuca sativa* L. var. *crispa*) throughout the growing season as well as the effects of seasonality (summer; autumn; winter). Green lettuce was used as a reference in all the experiments and was compared with red lettuce, rocket and spinach, respectively. The lettuce and spinach were grown in a continuous floating system (FL), while the rocket was grown in an ebb-and-flow system (EF). A complete nutrient solution, with 6 mM N, was supplied in all the experiments. Seasonality was found to not affect the TBC or the YMC of the lettuce, which showed an average contamination of $1.7 \cdot 10^3$ cfu g⁻¹ and $4.7 \cdot 10^1$ cfu g⁻¹, respectively. As the same growing conditions were adopted in each comparison, it is possible to state that the species did not affect the TBC in the comparison between the green lettuce and red lettuce (average contamination: $7.4 \cdot 10^3$ cfu g⁻¹) or in the comparison between green lettuce and rocket (average contamination: $7.3 \cdot 10^3$ cfu g⁻¹), while it did affect the TBC in the comparison between the green lettuce and spinach. A greater contamination was found in spinach ($1.0 \cdot 10^6$ cfu g⁻¹) than in green lettuce ($4.4 \cdot 10^2$ cfu g⁻¹). The species did not affect the YMC in the comparison between the green lettuce and red lettuce (average contamination: $2.7 \cdot 10^1$ cfu g⁻¹) or in the comparison between the green lettuce and rocket (average contamination: $1.1 \cdot 10^2$ cfu g⁻¹), but it did affect the YMC in the comparison between the green lettuce and spinach. A greater contamination was found in spinach ($8.2 \cdot 10^2$ cfu g⁻¹) than in green lettuce ($4.6 \cdot 10^0$ cfu g⁻¹).

Keywords: /Fresh-cut sector/ /Quality decay/ /Soilless culture system/ /Mesophilic aerobic bacteria/ /Yeast and mold contamination/

LETTUCE

Fernández-León, A.M., Nogales-Delgado, S., Delgado-Adámez, J., Hernández-Méndez, M.T., Bohoyo-Gil, D. and González, J.A. (2018). Effect of modified atmosphere packaging in minimally fresh industrially processed Batavia lettuce. *Acta Horticulturae*, 1209, 135-142. doi: 10.17660/ActaHortic.2018.1209.20

Abstract

A comparative study on the influence of passive and active modified atmosphere packaging on the quality decay of fresh industrially processed Batavia lettuce is presented. The lettuce was processed under usual and controlled conditions in a semi-industrial plant, using a clean room and the following procedure: reception, shredding, washing, draining, rinsing, centrifugation and packaging. Following industrial practices, the processed lettuce was packaged in sealed polypropylene bags using passive and active modified atmospheres. During a storage period of 10 days at 4°C, the quality attributes (texture, colour, browning), head space gas composition, functional content (antioxidant activity, chlorophylls) and microbial counts were monitored. All measured parameters showed negative effects, except the microbial counts, when a high concentration of CO₂ was used, possibly due to the fermentative processes. A chlorine concentration of 100 mg L⁻¹ and 10.0 g L⁻¹ ascorbic acid as antioxidant was suggested. A passive modified atmosphere could be used in the packaging of fresh-cut Batavia lettuce during shelf life of 7 days, maintaining all physical, chemical and microbiological qualities.

Keywords: /Industrial practices/ /Quality attributes/ /Package headspace/ /Functional content/ /Microbiological quality/

MINT LEAVES

Nicola, S., Tibaldi, G. and Pignata, G. (2018). Potentiality of mint leaves as a ready-to-use product: postharvest evaluation. *Acta Horticulturae*, 1209, 109-114. doi: 10.17660/ActaHortic.2018.1209.16

Abstract

The growing interest in wellbeing and in the healthy aspects of life has led to attention being focused on the importance of a daily intake of vegetables and fruit as well as the substitution of salt as a seasoning with herbs and spices. Lamiaceae species contain essential oils, which have a wide spectrum of biofunctional activities as well as antimicrobial and antioxidant characteristics. The presence of herbs in the fresh-cut sector could meet consumers' expectations for a ready-to-use product and prevent a reduction in quality due to the sensitivity

of the phytochemicals to a harsh postharvest process. For these reasons, the objective of the research was to study the effects of storage on the decay in quality of some minimally processed mint species and to establish the influence of different packaging bags on their shelf-life. Samples of *Mentha spicata* L. var. *rubra*; *M. spicata* L. var. *viridis* LSQUOCasablancaRSQUO; *M. × piperita* L. and *Calamintha nepeta* (L.) Savi were packaged in three different polypropylene film bags differing with respect to the permeability to O₂ (P1=560; P2=750; P3=1990 cm³ m⁻² d⁻¹ bar⁻¹) and were stored for an 8-day shelf-life at 4°C. Fresh weight loss (g) was measured daily during the shelf-life and the gas atmosphere (% O₂; % CO₂) inside the package was analyzed at the end of the shelf-life period. The packaging permeability to O₂ significantly affected the fresh weight loss at the end of the shelf-life (P=0.021). The P1 packaging had the highest fresh weight loss (-2.06%), along with P3, but it statistically differed from P2. Fresh weight was not influenced by the species. The species and the packaging permeability to O₂ did not affect the internal gas atmosphere at the end of the shelf-life. Considering the potential interest in mint by the fresh-cut sector, this study has confirmed how different packaging bags vs. different mint varieties are important to help maintain shelf-life and freshness.

Keywords: /Lamiaceae/ /Nutraceutical product/ /Packaging/ /Mint species/ /Freshness/ /Peppermint/ /Spearmint/

NECTARINE

Róth, E., Barriobero, J., Ozcoz, B., Mir-Bel, J. and López, R. (2018). Optimising packaging conditions of fresh-cut nectarine. *Acta Horticulturae*, 1209, 87-94. doi: 10.17660/ActaHortic.2018.1209.13

Abstract

Fresh-cut peach and nectarine slices have great market potential, but currently their success is limited due to their short shelf life thanks to cut surface browning, flesh softening and pit cavity breakdown. Research so far has been primarily focused on treatments capable to avoid these quality problems. The aim of this study was to optimise packaging conditions (films, packaging atmospheres, etc.) that can further improve the quality of fresh-cut nectarine by extending its shelf life and microbial safety. As preharvest conditions greatly influence the quality of the fresh-cut products, nectarines from different origins have been studied. A combination of a texture enhancing agent (calcium chloride), an antioxidant agent (ascorbic acid) and an antimicrobial compound (citric acid) has been included into the dip formulation that was used following the cutting operation in order to maintain the prime quality and microbial safety of the nectarine slices. The product has been packed in films with different permeability for gases and water (with or without anti-mist coating) and stored for 15 days at 4°C. The quality of the fresh-cut nectarine was judged at three day intervals during storage using instrumental (colour of cut surfaces, texture, soluble solid content, microbial counts, etc.) and sensorial tests. Results

show that films with lower permeability can better retain the original colour and reduce the microbial load of the slices by establishing a favourable headspace gas composition within three days of packaging.

Keywords: /Nectarine/ /Fresh-cut/ /Films/ /Shelf life/ /Packaging/

ONION

Forney, C.F., Fan, L., Doucette, C., Jordan, M.A. and Grant, R. (2018). Market life of diced red onion subjected to modified atmosphere packaging and antimicrobial dips. *Acta Horticulturae*, 1209, 201-208. doi: 10.17660/ActaHortic.2018.1209.29

Abstract

Fresh-cut red sweet onions (*Allium cepa* L.) have a short shelf life and are subject to loss of acceptable flavour, excessive microbial growth, and discoloration. Atmosphere modification and antimicrobial compounds have the potential to extend shelf-life. Therefore, this study evaluated the effects of modified atmosphere packaging (MAP) and treatments with potassium sorbate (KS) and chlorine dioxide (ClO₂) on the quality of diced red onions. Red onions were sanitized, diced, and dipped for 1 min in 1.0% KS, 15 ppm ClO₂, or water and spun for 10 s at 3,000 rpm to remove excess liquid. Diced red onions that received no dip treatment served as the control. Onions were then placed into sealed or vented, ridged polylactic acid (PLA) containers. Venting consisted of a single 0.07 mm hole. Packages were stored at 4.5°C and assessed after 0, 7, 12, 14, 18, and 21 days. The O₂ concentration in sealed PLA containers decreased to ±1% and the CO₂ concentration increased to ±35% after 18 days. The atmosphere composition in the vented containers changed slightly during storage reaching 18% O₂ and 4% CO₂ after 21 days. Respiration rates increased during storage, but remained the lowest in diced onions treated with 1.0% KS. The electrolyte leakage also increased during storage, but was lowest in onions treated with ClO₂ and water, reaching 30 and 37%, respectively after 21 days, while rates in the KS treated onions and controls reached 55 and 52%, respectively. Onion pH tended to decrease during storage, which was lowest in vented packages. Aerobic and anaerobic microbial plate counts exceeded 10⁶ CFU g⁻¹ after 12 days in all treatments. The aerobic and anaerobic counts were less in sealed packages, but were not significantly affected by antimicrobial dips. Potassium sorbate changed the onion colour from a purple-red to a pink hue. Onions treated with ClO₂ appeared dry after 7 days. After 14 days of storage, off-odours developed in association with anaerobic atmospheres and/or microbial growth. The marketable quality of diced red onions was maintained for 12 days in sealed PLA packages.

Keywords: /*Allium cepa*/ /Polylactic acid/ /Potassium sorbate/ /Chlorine dioxide/ /Sulfur volatiles/ /Microbial growth/

PEACH

Baninasab, B. (2018). Exogenous application of polyamines influences fruit quality of 'Zaferani' peach. *Acta Horticulturae*, 1209, 47-50. doi: 10.17660/ActaHortic.2018.1209.7

Abstract

Polyamines are positively charged small aliphatic amines, ubiquitous in nature, and are involved in various physiological processes including flowering, fruit growth and development, and senescence. An experiment was therefore conducted to test whether the application of polyamines (putrescine and spermidine) at various concentrations (0, 0.1, 0.5, and 1.0 mM) one week after full bloom would improve fruit quality of peach. The results showed that fruit weight and pulp firmness were affected by the types and various concentrations of polyamines applied at harvest time. Among the two polyamines tested, putrescine was the most effective in increasing fruit weight and pulp firmness. All concentrations of polyamines increased fruit weight and pulp firmness compared with control treatment. However, according to the taste panel results, fruit treated with 0.1 mM putrescine had a better quality in terms of firmness, appearance and taste. Soluble solid content and titrable acidity of the fruit were not significantly affected by the use of polyamines.

Keywords: /Peach/ /Polyamines/ /Fruit weight/ /Fruit firmness/

PEAR

**Gomes, M.H., Beaudry, R.M. and Almeida, D.P.F. (2018). Volatile profile of fresh-cut 'Rocha' pear under various temperatures and oxygen levels. *Acta Hortic.* 1209, 247-250
DOI: 10.17660/ActaHortic.2018.1209.35**

Abstract

The objective of this work was to evaluate the effect of temperature and oxygen concentration on the volatile profile of packed fresh-cut 'Rocha' pear, to integrate flavor changes in the development of preservation technologies for fresh-cut fruit. Slices of 'Rocha' pear were packed in low-density polyethylene pouches, with varying fruit weight, film surface area and film thickness, and were stored at 0, 5, 10 and 15°C. After 5 days at 15°C, 8 days at 10°C and 10 days at 5 and 0°C, steady-state O₂ and CO₂ partial pressures were achieved and the volatile composition inside packages was measured. Samples were grouped in four classes depending on the levels of oxygen: high (>8 kPa), intermediary (8-1 kPa), low (1-0.5 kPa), and very low (<0.5 kPa, anaerobic metabolism). The acetate esters (methyl-, ethyl-, propyl-, butyl-, 2-methylbutyl-, pentyl- and hexyl-acetate) and alcohols (ethanol, butanol, 2-methyl butanol and hexanol) were analyzed for each atmosphere group. Volatile relative abundance was significantly affected by temperature and oxygen level. The levels of ethanol, the main alcohol

detected, increased with temperature and oxygen depletion. Acetate esters represented 20 to 25% of the total volatiles, with butyl acetate accounting for almost 50% of the total acetate esters. Absolute levels of total acetate esters were significantly lower at 0°C than at higher temperatures, but 2-methylbutyl-, pentyl- and hexyl-acetate were significantly higher at this temperature. Decreasing oxygen levels to anaerobiose increased the total acetate esters, due to an increase in ethyl acetate, while other esters decreased. 2-Methylbutyl acetate, a flavor-important volatile in pear described as fruity, banana, candy, citrus, peanut, and hexyl acetate were more abundant at 0°C and oxygen levels above 8 kPa. These results suggest that the oxygen levels affect volatiles of fresh-cut pear; the design of modified atmosphere packaging should take this effect into consideration for shelf life termination.

Keywords: /Acetate esters/ /Alcohols/ /Aroma/ /Minimal processing/ /Packaging/ /*Pyrus communis*/

Oyarzún, A., Obando-Ulloa, J.M., Mery, L., Machuca, A., Escalona, V.H. and Silveira, A.C. (2018). Cutting and temperature of preservation effect on the physiological activity and quality of fresh cut 'Packham's Triumph' and 'Shinco' pears. *Acta Horticulturae*, 1209, 281-290. doi: 10.17660/ActaHortic.2018.1209.41

Abstract

The aim of this work was to evaluate the effect of wedge and dice cut format and storage temperature on the physiological activity, firmness and organic acid and sugar content of fresh cut pears (*Pyrus communis* L.) 'Packham's Triumph' and 'Shinco'. The whole fruit was washed, peeled, cut, packed in modified atmosphere and subsequently stored at 5 and 8°C for 8 days. In 'Packham's Triumph' the storage temperature and the cutting format separately showed a significant effect on the physiological activity, which was lower in the wedges stored at 5°C. The cutting format and storage temperature, separately, also showed a significant effect on the firmness, the wedges showed a 12% higher firmness than dices (4.9 kg-f) while wedges and dices of 'Packham's Triumph' pears stored at 5°C were firmer (5.3 kg-f) than those stored at 8°C (5.1 kg-f). The interaction of the cutting format and storage temperature showed a significant effect on organic acid, the content of oxalic and malic acids was higher in wedges stored at 5°C compared with the other cutting format at both storage temperatures at the end of the storage. In 'Shinco', the cutting format and the storage temperature showed a significant effect on the ethylene rate, which was lower in the wedges stored at 5°C than those stored at 8°C. At the end of storage, the content of malic acid was affected by the cut format which was 18% higher in dices in comparison with wedges while the fructose content in dices stored at 5°C was the highest in comparison with the other cutting formats stored either at 5 or 8°C. In summary, the 'Packham's Triumph' and 'Shinco' pears can be minimally processed under wedge and dice cut format, respectively, and they both must be stored at 5°C packed in modified atmosphere in order to preserve their quality.

Keywords: /Respiration rate/ /Ethylene emission rate/ /Firmness/ /Organic acids/ /Sugars

**Seglina, D. , Krasnova, I. , Kviesis, J., Kviesis, K. and Gailite, I. (2018). The effect of sweeteners and inhibitors on the quality of fresh-cut pear slices after freezing. *Acta Horticulturae*, 1209, 209-216. doi: 10.17660/ActaHortic.2018.1209.30
<https://doi.org/10.17660/ActaHortic.2018.1209.30>**

Abstract

Fresh-pack and frozen pear slices are in demand for various applications, one of them a component in minimally processed products for catering. A number of different techniques are used to maintain the sensory properties and nutritive value of the product. The aim of the study was to investigate the most effective combinations of sweeteners and inhibitors to prevent fruit browning and to maintain quality of frozen pear slices. Pear cultivar 'Belorusskaya Pozdnaya' was used for testing the effectiveness of different inhibitors and their compositions to preserve the quality of the pear slices. Ascorbic acid (1.5%), citric acid (0.5%) and natural cranberry juice (20%) were added to fresh-cut slices for colour stabilization. Calcium chloride (0.5%) and calcium lactate (0.5%) were applied for structure stabilization of the product. 15% sugar and 15% fructose syrups were used as sweeteners to improve the taste of the pear pieces. Samples were frozen and stored at $-18\pm 2^{\circ}\text{C}$ for 3 months. The best combination of the inhibitors was: ascorbic acid 1.5%, citric acid 0.5% and calcium chloride 0.5%. The samples treated with these inhibitors, after defrosting, were found to have the best quality. The vitamin C content of the control pear slices decreased 50-55%, while in slices treated with calcium, citric and ascorbic acid it decreased 37-40%. Total phenol content after refrigeration decreased 56-59% in the control samples and 9.7-14.2% in samples treated with inhibitor compositions. However, the natural inhibitor, cranberry juice, delayed fresh cut fruit browning less than the calcium chloride inhibitor composition. The colour of pear slices treated with cranberry juice after freezing was brighter as well as the content of vitamin C and the total phenols was higher comparing to pieces without treatment.

Keywords: /Freezing/ /Browning/ /Total phenol/ /Vitamin C/ /Firmness

PERSIMMON

**Izumi, H., Murakami, Y. and Ozaki, Y. (2018). Microbiological quality of enzymatically peeled persimmon fruit for fresh-cut slices. *Acta Horticulturae*, 1209, 173-178.
doi: 10.17660/ActaHortic.2018.1209.25**

Abstract

The microflora was analyzed on persimmon fruit ('Tone-wase') that had been peeled

enzymatically and sliced for fresh-cut product and compared with those hand-peeled and sliced manually with a knife. The enzymatic peeling process involved porous treatment of the peel with a needlepoint holder allowing the penetration of a pectolytic enzyme solution under the peel, followed by heating at 100°C for 45 s to inactivate the substances in the peel that inhibit the pectolytic enzyme, cooling in tap water, infusion of 3% protopectinase (Pectinase-IGA) at 37°C for 3 h, and rinsing under running tap water to remove the peel and any residual enzyme. Peeled fruit was cut radially into four sections using a sanitized knife. The peel of persimmon fruit had microbial counts ranging from 3.0 to 3.3 log CFU g⁻¹ and a wide diversity of fungal flora. After the fruits were submerged in hot water at 100°C for 45 s, the microbial counts in the peel and flesh were reduced to levels below the limit of detection. After the enzyme infusion followed by gentle rinsing with tap water, microbial counts of enzyme-peeled fruit remained undetectable. When microbial contamination of enzyme-peeled and hand-peeled fresh-cut slices were compared, bacterial counts were >0.5 logs higher in hand-peeled slices than in enzyme-peeled slices which were below the detection level. The diversity of bacterial and fungal flora was less in enzyme-peeled slices than in hand-peeled slices. Surface lightness of enzyme-peeled slices was lower than that of hand-peeled slices, but other color indexes, pH, and texture were not affected by enzymatic peeling. These results indicate that enzymatic peeling could be an alternative to hand peeling of persimmon fruit for fresh-cut product to achieve effective peeling and microbial safety.

Keywords: /Microbial counts/ /Bacterial flora/ /Fungal flora/ /Protopectinase/ /Fruit quality/

Sanchís, E., Ghidelli, C., Rojas-Argudo, C., Pérez-Gago, M.B. and Mateos, M. (2018). Influence of controlled atmospheres and antioxidants on enzymatic browning and shelf life of fresh-cut persimmon 'Rojo Brillante'. *Acta Horticulturae*. 1209, 71-78. doi: 10.17660/ActaHortic.2018.1209.11

Abstract

Persimmon fruit 'Rojo Brillante' can be marketed as a fresh-cut commodity after removal of astringency by application of high levels of CO₂. However, the shelf life is reduced due to enzymatic browning. Therefore, the objective of this work was to study the effect of antioxidants combined with controlled atmosphere storage extending the shelf life of fresh-cut persimmons. Fruits were harvested with an external color index (CI) of 8.3 (where, CI = 1,000*a/L*b). Persimmon pieces were dipped in two different antioxidant solutions (1% ascorbic acid (AA) and 1% citric acid (CA)) or in water as control. Fruit slices were placed under continuous flow of air (Atm-A) or 3 different controlled atmospheres of 21 kPa O₂ + 10 kPa CO₂ (Atm-B), 21 kPa O₂ + 20 kPa CO₂ (Atm-C), 5 kPa O₂ + 10 kPa CO₂ (Atm-D) during 8 days at 5°C. Color (CIE L*a*b*), firmness and visual quality were determined during storage. Persimmon pieces stored in Atm-D had higher L* and lower a* values than pieces stored in the other atmospheres. 1% CA was more effective controlling enzymatic browning of fresh-cut persimmons than 1% AA, showing the lowest a* values in all the controlled atmospheres studied. However, samples

treated with CA had the lowest firmness. Samples stored in Atm-A showed the highest firmness values during storage; whereas, samples in Atm-D showed the lowest firmness. Storage of persimmon pieces in high CO₂ concentrations induced an internal browning of the tissue, different from enzymatic browning, that has been related in whole fruit to preharvest nutritional deficiencies, mechanical injury, and/or the effect of the treatment used to eliminate fruit astringency. This non-enzymatic browning limited the shelf life of the fresh-cut persimmon reducing the limit of commercialization significantly. The results show that atmospheres with low O₂ could reduce the enzymatic browning, whereas high CO₂ concentrations affect tissue internal browning of the samples.

Keywords: /Fresh-cut persimmon/ /Enzymatic browning/ /Antioxidants/ /Controlled atmosphere/

POMEGRANATE

Peña Estevez, M.E., Artés-Hernández, F., Aguayo, E., Artés, F. and Gómez, P.A. (2018). Postharvest quality of whole and fresh-cut pomegranates cultivated under deficit irrigation. *Acta Horticulturae*, 1209, 265-270. doi: 10.17660/ActaHortic.2018.1209.38

Abstract

An arid climate and the persistent shortage and low quality of available water resources are typical of Spanish Mediterranean agricultural systems. Fruit production in these areas must be oriented towards the use of less water and stress-resistant plant materials that, under deficit irrigation (DI) strategies, may allow important water savings while keeping high commercial quality. Due to its hardiness, pomegranate is an interesting crop for areas with few and low quality water resources. In this work, the postharvest quality of Mollar de Elche was studied in whole and minimally processed pomegranates, from scheduled DI and was compared with fruits obtained under traditional cultivation. The initial and final quality of fruit stored 30 days at 5°C and 90% RH was evaluated. After that the arils were extracted by hand, washed with chlorinated water (100 ppm, 2°C, pH 6.5, 2 min), rinsed and packaged under passive modified atmosphere. The overall quality of fresh-cut arils was evaluated during 14 days at 5°C. At harvest, the whole fruit coming from DI presented a better colour than control (°Hue= 51.4 vs. °Hue= 61.9), higher content of total soluble solids (17.1 vs. 15.5° Brix) and better sensory quality. That trend was maintained after 30 days at 5°C, when DI fruit also did not show any chilling injury (CI) symptom, compared with 33% of control fruit that expressed CI. The shelled efficiency was higher for DI pomegranates, being 67.7% edible product vs. 60.4% for control fruit. After 14 days at 5°C, the gas composition within packages was the same for both treatments (12-15 kPa O₂ and 6-8 kPa CO₂). Arils from DI were slightly sweeter than the control ones (16.9 vs. 15.6° Brix) and had better sensory quality. In conclusion, cultivation under scheduled DI allowed the whole pomegranate and fresh-cut arils to obtain a higher overall quality than that obtained by a traditional irrigation system.

Keywords: /Punica granatum L./ /Water stress/ /Chilling injury/ /Modified atmosphere/ /Minimal processing/

POSTHARVEST FRESHNESS

**Barriobero, J., Ozcoz, B., Róth, E., Mir-Bel, J. and López, R. (2018). Edible coatings with antioxidant properties for fresh-cut 'Conference' pear. *Acta Horticulturae*, 1209, 165-172
DOI: 10.17660/ActaHortic.2018.1209.24**

Abstract

Edible coatings could serve as a new alternative to extend the shelf-life of fresh-cut pears. They can be applied to fresh pear wedges to delay changes in colour, flavour and texture. Antioxidant compounds can also be added to the edible coating to maintain the product quality. A gellifying agent from plant origin (based on carrageenan and carob gum) of Comercial Artesana Sosa, S.L. has been used as an edible coating in this study. Carrageenan is a complex mixture of galactose polymers which form a gel in the presence of monovalent or divalent cations. The edible coating, with or without added ascorbic acid, has been compared with dipping the slices in a water bath. The pears were grown in the orchard of Protected Designation of Origin in Rincón de Soto (La Rioja, Spain). Whole pears were washed, peeled, sliced, treated (as mentioned above) and packed with a micro-perforated polypropylene film. The pears were processed in the pilot plant of CITA-La Rioja. The changes in headspace gas composition, firmness, total soluble solid content, pH, microbial counts and water loss were monitored during the shelf-life of the fresh-cut product. The parameters were measured at three day intervals during the 15 days storage at 4°C. Additionally, the respiration rate and the production of ethylene were measured immediately after each treatment. It can be concluded that edible coatings combined with anti-browning agents can extend the shelf-life of minimally processed 'Conference' pear slices. The treatment delayed the respiration rate and the ethylene production of the product, minimized water loss, retarded ripening and reduced the microbial counts in the final product.

Keywords: Enzymatic browning/ /Polyphenol oxidase/ /Pyrus communis L./ /Ascorbic acid/ /Antioxidant/ /Calcium chloride/

Gong, T., Li, C., Bian, B., Wu, Y., Dawuda, M.M., & Liao, W. (2016). Advances in application of small molecule compounds for extending the shelf life of perishable horticultural products: A review. *Scientia Horticulturae*, 230, 25-34. doi: 10.1016/j.scienta.2017.11.013

Abstract

Most of the horticultural products are highly perishable and reducing their postharvest losses is extremely important. There is a worldwide trend to explore new alternatives to increase shelf life and postharvest quality of horticultural products. This review discusses the use of gaseous and some other low molecular mass compounds as a feasible way to maintain quality and prolong shelf life of rapidly deteriorating horticultural products during postharvest stage. These compounds including nitric oxide (NO), carbon monoxide (CO), hydrogen sulfide (H₂S), hydrogen peroxide (H₂O₂), hydrogen gas (H₂), carbon dioxide (CO₂) and chlorine dioxide (ClO₂) could delay horticultural products senescence through different mechanisms such as suppressing respiration rate, inhibiting ethylene biosynthesis, delaying browning and regulating activity of antioxidant enzymes. The review also summarizes the interaction between these molecules and ethylene during horticultural products senescence process. Additionally, NO may cross talk with H₂O₂ or H₂S to promote the quality and prolong the postharvest life of perishable fruits and vegetables. Those compounds regulate the expression of genes during senescence, including ethylene biosynthesis related genes, lipoxygenase gene, cysteine protease gene and chlorophyll degradation related genes. Because of the obvious benefits of these compounds to postharvest freshness of fresh-cut flowers, fruits and vegetables, this area has been and will continue to be one of the priorities of horticultural research in the future.

Keywords: /Horticultural products/ /Postharvest freshness/ /Small molecule compounds/ /Cross talk/ /Expression of genes/ /Senescence/

POSTHARVEST TREATMENTS

Aghdam, M.S., Jannatizadeh, A., Luo, Z., & Paliyath, G. (2018). Ensuring sufficient intracellular ATP supplying and friendly extracellular ATP signaling attenuates stresses, delays senescence and maintains quality in horticultural crops during postharvest life. *Trends in Food Science & Technology*, 76:67-81. doi: 10.1016/j.tifs.2018.04.003

Abstract

As universal energy currency, intracellular ATP (iATP) shortages in horticultural crops during postharvest stresses and senescence. In addition to function as intracellular energy currency, ATP serves as friendly extracellular signaling molecule (eATP). Postharvest treatments attenuate stresses, delay senescence and maintain quality in horticultural crops by ensuring sufficient iATP supplying, which was accompanied with lower phospholipase D (PLD) and lipoxygenase (LOX) enzymes activity concomitant with higher antioxidant system activity which along with higher heat shock proteins (HSPs) accumulation resulting in lower reactive oxygen species (ROS) accumulation leading to higher membrane unsaturated/saturated fatty acids (unSFA/SFA), higher shikimate and phenylpropanoid pathways activity revealing by higher phenylalanine ammonia lyase (PAL) enzyme activity leading to higher phenols accumulation, higher endogenous proline and glycine betaine accumulation, higher endogenous polyamines accumulation, and higher pathogenesis (PRs) proteins accumulation, which are crucial for

membrane fluidity and integrity maintaining and cell wall fortification. In addition to intracellular energy currency, friendly eATP signaling is crucial for promoting iATP biosynthesis machinery activity and reinforcing defense response by triggering jasmonic and salicylic acids signaling pathways. Also, friendly eATP signaling not only is crucial for regulating stomatal closure which is pivotal for attenuating stresses and delaying senescence in horticultural crops but also is crucial for postharvest biofactories representing high phenols accumulating fresh horticultural crops in response to abiotic stresses which are beneficial for human health. Ensuring sufficient iATP supplying and friendly eATP signaling would be crucial for attenuating stresses, delaying senescence and maintaining quality in horticultural crops during postharvest life.

Keywords: /Browning/ /Chilling injury/ /Energy status/ /Fungal decay/ /Postharvest biofactories/ /Senescence/

Toivonen, P.M.A. (2018). 1-MCP before and after processing of fresh-cut produce: from science evidence to technology transfer. *Acta Horticulturae*, 1209, 11-18. doi: 10.17660/ActaHortic.2018.1209.2

Abstract

Research on the use of 1-methylcyclopropene (1-MCP) for fruits and vegetables in fresh-cut processing streams has involved the application of 1-MCP using one of three approaches: 1) application to the whole fruit at or near harvest and before storage after which it is fresh-cut, 2) application of the whole fruit or vegetable immediately before it is fresh-cut, and 3) application immediately after fresh-cutting. Each of the three approaches has advantages and disadvantages. The current state of the research on the application of 1-MCP in fresh-cut processing streams of fruits and vegetables, as well as the advantages and disadvantages of each approach in the real world situation of the fresh-cut industry will be discussed. Research findings on the co-application of other treatments along with 1-MCP will also be explored, since the research in that area has probably shown the greatest overall benefit to fresh-cut fruit and vegetable quality and safety.

Keywords: /1-methylcyclopropene/ /quality/ /safety/ /fresh-cut/ /fruits/ /vegetables

SPINACH

Glowacz, M., Reade, J., Monaghan, J. and Mogren, L. (2018). Hot water treatment after harvest preserves nutritional quality of spinach during storage. *Acta Horticulturae*, 1209, 123-128. doi: 10.17660/ActaHortic.2018.1209.18

Abstract

The concentration of antioxidants in fresh produce is important in terms of human nutrition. The

main antioxidants, found in relatively high concentrations in leafy vegetables, are ascorbic acid (AsA), carotenoids and flavonoids. There is an increasing interest in finding ways to improve the nutritional quality of vegetables by increasing or maintaining antioxidant content during storage. This study has investigated the effect of postharvest high temperature treatments on nutritional quality changes in spinach during subsequent storage. Ascorbic acid was determined by HPLC during storage. The hot water (40°C) pre-treatment reduced AsA loss during storage of spinach. However, the treatment was only effective in the case of spinach leaves subsequently stored at 0°C, while in spinach leaves stored at 6°C this effect was lost. In conclusion, hot water (40°C) treatment can potentially be used for nutritional quality preservation in spinach leaves. Physiological processes induced by hot water treatment require further investigation.

Keywords: /Ascorbic acid/ /Leafy vegetables/ /Shelf life/ /Temperature treatments/

STRAWBERRIES

Nicola, S., Pignata, G. and Tibaldi, G. (2018). Fresh-cut chain for soilless grown 'Mara des Bois' strawberries: the cutting process reduces the shelf-life of the produce. *Acta Horticulturae*, 1209, 129-134. doi: 10.17660/ActaHortic.2018.1209.19

Abstract

The strawberry (*Fragaria × ananassa* Dutch.) crop is highly profitable and it can be marketed throughout the year thanks to the everbearing cultivars and as a result of the growing systems that are adopted. Soilless growing systems, using a sterile medium, can guarantee raw material that is suitable for the fresh-cut sector. Strawberries are a highly perishable product, due to their fast metabolism rate, and an appropriate process should be adopted to preserve their quality. Thus, the present research has been aimed at studying how the postharvest management (fresh product vs. fresh-cut product) and the packaging permeability to O₂ (P₁=560; P₂=750, P₃=1990 cm³ m⁻² d⁻¹ bar⁻¹) can affect the physiology and fresh quality of 'Mara des Bois' strawberry grown in a soilless culture system and stored at 4°C. The effect of postharvest processes has been evaluated on the shelf-life of the product. The biometrical parameters were measured at harvest in order to characterize the cultivar. The total bacterial count (TBC), and the yeast and mold count (YMC) were also analyzed to test the effective safety of the growing system. The soilless growing system led to strawberries being produced with a low microbial contamination (TBC=3.89 Log₁₀ CFU g⁻¹; YMC=3.37 Log₁₀ CFU g⁻¹), which lasted 6 days as a packaged fresh product, and only 4 days when processed as fresh-cut fruit. The postharvest process did not affect the fruit fresh weight loss over time, while the packaging permeability to O₂ affected the fruit fresh weight loss after 4 days of the shelf-life and after 6 days of the shelf-life, with the greatest loss being observed when P₁ was used. The gas concentration (average O₂=9.8%; average CO₂=10.2%) was not affected by the treatments. The microbial contamination was still low on the 4th day (TBC=5.58 Log₁₀ CFU g⁻¹; YMC=5.14 Log₁₀ CFU g⁻¹).

Keywords: /Fragaria ananassa Dutch/ /Minimally processed food/ /Microbial contamination/ /Fresh weight loss/ /Packaging permeability/ /Gas analysis/

SUPPLY CHAIN

Gokarn, S., & Kuthambalayan, T. S. (2019). Creating sustainable fresh produce supply chains by managing uncertainties. *Journal of Cleaner Production*, 207, 908–919. <https://doi.org/10.1016/j.jclepro.2018.10.072>

Abstract

The aim of this empirical paper is to study the influence of supply, demand, and price uncertainties in fresh produce supply chains (FSC), in an effort to improve sustainability. Fresh produce are foods of plant origin with short shelf life, and the uncertainty in FSC stem from intrinsic characteristics (e.g., perishability, quality variation, seasonality) of the produce. As per resource-based view (RBV), a firms' performance depends on its resources and capabilities. In line with RBV theory, internal integration (through operational capability) and external integration (through relational and information technology capabilities) are viewed as a resource, which lead to improved delivery performance, of Firms' supplier (the dimension of FSC performance), and enables the firm to improve its sustainability measures. It is proposed that FSC performance is positively associated with the performance of the firm, and that FSC uncertainty negatively moderate the positive relationships between firms' capabilities and FSC performance. Survey data is used to independently calibrate and validate a structural equation model. Results provide support for the model, and the finding fits with the theoretical bases. In conclusion, to manage uncertainties, firms need to strike a balance between the benefits and investments in resources. In case of large firms, substantial resource commitment is often necessary when undertaking integrative activities and an improvement in Firm performance may take substantial time. The small firms in this study are able to integrate both internally and externally without committing significant resources, and see an improvement in Firms' performance, as indicated by sustainability measures. Indian fresh produce supply chain is studied from wholesalers' perspective. •Food loss and waste is included as measure of Firm performance. •Firm improves sustainability measures without committing significant resources. •Uncertainties reduce the benefit of Firms' capabilities to it and supply chains.

Keywords: /Fresh produce supply chains/ /Sustainability/ /Resource-based view theory/

Hess, T., & Sutcliffe, C. (2018). The exposure of a fresh fruit and vegetable supply chain to global water-related risks. *Water International*, 43(6), 746. Retrieved from <http://search.ebscohost.com/login.aspx?direct=true&db=edb&AN=132399283&site=eds-live>

Description

We have combined estimates of the UK's supply of fresh fruit and vegetables (1996 - 2015) with estimates of water requirements and water scarcity in producing countries, to identify where the supply is exposed to physical, regulatory and reputational water risks and how this has changed over time. Some 76% of the freshwater consumed in the supply of fresh fruit and vegetables to the UK is withdrawn overseas. The supply chain is particularly exposed to water risks in Spain, Egypt, South Africa, Chile, Morocco, Israel and Peru. Exposure has increased over time.

Keywords: /South Africa/ /Spain/ /UK/ /Water scarcity footprint/

Sohail Mazhar, M., Ehsan Bajwa, B., & Ahmad, T. (2017). Aflatoxin in Fresh Produce Supply Chains in Pakistan: Review and Way Forward. Journal of the Chemical Society of Pakistan, 39(5), 879–884. Retrieved from <http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=126280264&site=eds-live>

Abstract

Pakistan is an agriculture based economy and horticulture is an important industry of this sector. Fresh produce export contributes significant amount of resources to National Gross Domestic Product. However, with increasing food quality and safety awareness amongst the consumers in high end international and domestic markets, and the lack of capacity on behalf of growers and traders to cater the needs of the well-deserved fresh produce consumers is resulting in loss of export markets for the fresh produce industry of Pakistan. Prevalence of aflatoxins in fresh produce commodities at the time of consumption is one of the growing food safety concerns. While some of the published research has established that aflatoxins are found in fresh produce commodities grown in Pakistan and marketed in Arab countries, Europe, and in domestic markets, only limited and random scientific research supports the evidence of presence of the specific quantities and types of aflatoxins in specific fresh produce commodities. There remains a need to conduct a supply chain focused comprehensive research study on assessment of aflatoxins in the major fresh produce commodities of Pakistan.

Keywords: /Aflatoxin/ /Fresh produce/ /Supply Chains/

SWEET CHERRY

Chiabrando, V. and Giacalone, G. (2018). Factors affecting the quality of fresh-cut sweet cherry. *Acta Horticulturae*, 1209, 103-108. doi: 10.17660/ActaHortic.2018.1209.15

Abstract

Sweet cherries are a very perishable commodity with a short shelf life in conventional cold storage. Sweet cherries are an important fruit in terms of production volumes for Italy. Their shelf life is shortened by loss of firmness, rot susceptibility, discoloration and desiccation of the stem. Postharvest treatments providing even a short extension of shelf-life would benefit the marketing of fresh cherries. Modified atmosphere packaging (MAP) has been successfully applied in order to prolong the shelf-life of sweet cherries. High CO₂ concentrations maintain fruit brightness, preserve acidity and firmness and extend storage life. For these reasons, the aim of this work was to determine the potential of packaging as a practical technique for ready to eat sweet cherry. Hand harvested 'Giulietta' was used to verify the possibility to employ cherries as a ready to eat product. Samples were stored for a short period (10 days), to simulate the shelf-life of ready to eat products. The followed parameters were evaluated: soluble solids content (°Brix), titratable acidity (meq L⁻¹), colour (CIELAB), texture (Durofel Index), total anthocyanin content (mg of cyanidin-3-glucoside 100 g⁻¹ product) and antioxidant capacity (mmol Fe 2 kg⁻¹ product). The results show that 'Giulietta' can be suitable for use as a ready to eat product because good firmness and titratable acidity was retained after 10 days of storage.

Keywords: /'Giulietta'/ /MAP/ /Ready to eat/ /Shelf-life/ /Storage period/