

**SELECTIVE DISSEMINATION OF INFORMATION (SDI)
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GENERAL

CONTROLLED ATMOSPHERE STORAGE

Watkins, C. B., et. al. 2015. Interactions between 1-MCP and **controlled atmospheres** on quality and **storage** disorders of fruits and vegetables. Acta Hort. 1071: 45 - 58.

Abstract

The use of 1-methylcyclopropene (1-MCP) to maintain quality attributes of horticultural products has been investigated extensively. Commercial applications of 1-MCP (SmartFresh™), are made to a range of horticultural crops, including avocados, bananas, melons, persimmons and tomatoes, but the majority of 1-MCP use is for apples. Apples are commonly kept in controlled atmosphere (CA) storage, and while 1-MCP can maintain the quality of fruit in air, the most consistent responses to 1-MCP are obtained when 1-MCP treated fruit are maintained in CA. An interesting feature of 1-MCP is the extent to which its use has revealed the interactions between ethylene production and the development of physiological storage disorders in a variety of fruits and vegetables. This has been especially true for apples because of their susceptibility to a wide range of disorders arising at least in part because of the extended storage periods routinely used. Here we review the effects of 1-MCP on quality and physiological disorders of fruits and vegetables, including studies on the interactions of 1-MCP with CA and modified atmosphere (MA) storage. We also present an overview of an international project on genomics and metabolomics concerning interactions between external carbon dioxide injury and flesh browning in CA stored apple fruit.

Keywords: /Ethylene/ /1-Methylcyclopropene/ /1-MCP/ /Controlled Atmosphere Storage/ /Modified Atmosphere Storage/ /Quality/ /Physiological Disorders/

DYNAMIC CONTROLLED ATMOSPHERE

Zanella, A., S. Stürz. 2015. Optimizing postharvest life of horticultural products by means of **dynamic CA**: fruit physiology **control atmosphere** composition during storage. Acta Hort. 1071: 59 - 68.

Abstract

The postharvest life of some horticultural products stored with the most appropriate cooling procedures can be prolonged further by modifying the storage atmosphere to the optimal composition based on values determined empirically and set statically for the entire storage period. This is known as controlled atmosphere (CA) storage. In the last decade developments took place on the field of CA storage of horticulture products, which announce a paradigm shift away from CA controlling postharvest life, and towards physiology controlling atmosphere composition. This means that CA can be dynamically adjusted to the horticultural product requirements specific for genotype, phenotype and time (dynamic CA, DCA), to provide postharvest quality benefits. Earlier applications of the DCA concept were based on empirical or invasive data while the recent developments rely on non-invasive, real-time bio-sensing, such as DCA by the means of ethanol sensing in the atmosphere or of fruit chlorophyll fluorescence response (DCA-CF). Taking this technological evolution into account, we will focus on the

development, validation, and influence of DCA-CF technique on the improvement of apple fruit quality preservation, not only from the point of view of research, but also on the commercial scaling up in South Tyrol, Italy, a significant apple-growing region that produces more than 1/10 of EU apple fruits. As of 2013 in this region, this technology penetrates approximately 15% of the market, which is similar to the market penetration of SmartFresh (1-MCP) and is the highest DCA-CF concentration worldwide.

Keywords: /Dynamic Controlled Atmosphere/ /1-MCP/ /Storage/

EDIBLE FILMS

Kowalczyk, Dariusz, et.al. 2015. Physicochemical and antimicrobial properties of biopolymer-candelilla wax emulsion films containing potassium sorbate – a comparative study. *Food Bioprocess Technol.* 8: 567 – 579.

Abstract

The comparative studies were performed in order to assess the most suitable matrix polymer for potassium sorbate (KS). The preservative (1.0, 2.0, 3.0, 4.0%w/w) was included into edible films made from different biopolymers: carboxymethyl cellulose (CMC), oxidized potato starch (OPS), soy protein isolate (SPI), gelatin (GEL), sorbitol, candelilla wax, and emulsifier. The incorporation of KS dramatically reduced the toughness of all tested films. The plasticizing action of KS was the weakest in CMC-based films, which exhibited the highest initial stiffness and the lowest stretchability. With the exception of GEL films, KS addition caused an increase in water vapor permeability of the films. Moreover, except for CMC films, increased KS content in the films led to increase in the stickiness, moisture content, and solubility. CMC-based films, regardless of the concentration of KS, had unchanged hygroscopicity and were completely water-soluble. In most cases, KS reduced transmission of light through the films. OPS, SPI, and GEL films, in contrast to CMC-based ones, exhibited sorbitol crystallization; however, the addition of KS successfully overcame this disadvantage. The antimicrobial effectiveness of all tested films increased by increasing the KS concentration. The kind of carrier used affected antimicrobial effectiveness of KS, and SPI films tended to have the weakest antibacterial and antifungal activity, especially at low KS content. The data given here may provide a useful guide in establishing the best compromise between conflicting film property demands. Taken together, our findings suggest that the CMC films could be the best carrier for KS.

Keywords: /Edible Films/

FRESH PRODUCE

Edelenbos, M., H. F. Seefeldt, M. M. Løkke. 2015. MA-Packaged Fruit and Vegetables – Discrepancy between visual and overall **freshness** of green **produce** and relations to product quality. *Acta Hort.* 1071:421 - 428.

Abstract

Freshness of MA-packaged fresh fruit and vegetables is the most important quality attribute for purchase and consumption. If green produce are packaged in films with too low an O₂ transmission rate (OTR) or distributed at higher temperatures or at a slower rates than expected, quality deteriorations occur that could influence product freshness and consumer trust. Discrepancy between visual and

overall freshness occurs when packaged fresh produce looks fresh but are perceived spoiled upon opening of the package. To study discrepancy of packaged fresh produce and the underlying quality attributes, wild rocket was packaged in L-OTR ($0.65 \text{ pmols}^{-1} \text{ m}^{-2} \text{ kPa}^{-1}$) and H-OTR film ($17.4 \text{ pmols}^{-1} \text{ m}^{-2} \text{ kPa}^{-1}$) and stored for 6 days at different combinations of time and temperatures which influenced the inside O_2 and CO_2 concentrations. The H-OTR combinations were: 1) 6 days at 2°C ; 2) 2 days at 2°C and 4 days at 10°C ; and 3) 3 days at 2°C and 3 days at 20°C . The L-OTR combinations were: 4) 2 days at 2°C and 4 days at 10°C ; and 5) 4 days at 2°C and 2 days at 20°C . Visual freshness scores ranged from 2.7 to 11.8 and overall freshness scores from 1.3 to 12.2 on a scale from low (0) to high (15) intensity. Visual and overall freshness scores were of similar magnitude when compared for wild rocket packaged in H-OTR film but differed for wild rocket packaged in L-OTR film. The inside O_2 gas concentrations of the H-OTR packages ranged from 13.4 to 19.9 kPa while it went down to around 0.5 kPa in the L-OTR packages. Inhomogeneous color and texture, loss of green color, yellowing and browning of the cut leaf surface influenced visual freshness of leaves from the H-OTR packages. No discrepancy was observed between H-OTR packages because overall freshness was highly correlated to visual freshness ($r=0.98$). In contrast, discrepancy was observed in the L-OTR packages. In these packages overall freshness was related to off-odor formation and changes in color. Multispectral analysis could detect color and texture differences between wild rocket samples but not differences that were related to off-odor formation.

Keywords: /Fresh Produce/ /Modified Atmosphere Packaging/ /Color/ /Texture/

Kireziova, Klementina, et.al. 2015. Towards strategies to adapt to pressures on safety of **fresh produce** due to climate change. Food Res. Int'l. 68: 94 – 107.

Abstract

This article outlines the findings from a Delphi study aimed to generate insights from a systems perspective about responding to climate change in terms of food safety of fresh produce. The study identified pressures to food safety of fresh produce at primary production, related to contamination of water sources and production environment with microorganisms, pesticide residues, mycotoxins and heavy metals due to heavy rainfalls and floods, droughts, increased temperature and change in seasonality, as results of climate change. First response to these pressures is realised by the core control activities implemented at farm, and depends on their current implementation and actual operation. The experts highlighted the need to strengthen activities, such as water control (including water treatment and quality monitoring), irrigation method, pesticide management (and pre-harvest intervals), personal hygiene requirements and (cold) storage control. Validating the effectiveness of control activities for the changed circumstances, guidance and training to the farmers was emphasized. Moreover, response strategies were proposed for farms to cope with the pressures immediately after occurring and to adapt long-term with support at the community level. The participating experts represented countries from the global north with industrialised food systems, and from the global south — with structured and traditional food systems. They assessed the likelihood of most pressures as higher for the countries from the global south, which was explained by existing response strategies in the global north. It was proposed that the adaptive and coping capacities of companies, regions and sectors are determined by the currently available adaptation and coping strategies. The pressures to food safety can differ per company, supply chain, region and sector due to variability of current climate vulnerabilities, control activities, and adaptive capacity. This paper argues that future adaptation actions should take into account the context of countries, sectors and companies, thus, focus on improving adaptive capacity from a systems perspective.

Keywords: /Fresh Produce/ /Climate Change/ /Fresh Produce/ /Food Safety/

FRESH-CUT

Cavaiuolo, M., et.al. 2015. Evaluation of an ELISA method to detect *Listeria monocytogenes* in **fresh-cut** rocket. Acta Hort. 1071:369 - 372.

Abstract

Leafy vegetables are consumed fresh after harvest with bland washes, not always efficient in removing pathogenic bacteria that may be attached to the external skin or surfaces. In this work, an optimized ELISA based method developed in our laboratory was used to detect the presence of *Listeria monocytogenes* in fresh-cut rocket leaves. From a certain quantity (5 g) of fresh rocket leaves contaminated with *Listeria monocytogenes*, bacteria were isolated and the pathogen was detected using an ELISA protocol. The preliminary results are promising in the use of antibody-antigen interaction to verify the presence of *L. monocytogenes* in the minimally processed vegetable distribution chain.

Keywords: /Fresh-Cut/ /Vegetables/ /Food Safety/

O'Beirne, D. 2015. Effects of atmosphere on survival and growth of pathogens in **fresh-cut** produce. Acta Hort. 1071:69 - 80.

Abstract

Increasing consumption of fresh produce has been paralleled by an increase in food poisoning outbreaks, some linked to fresh-cut products. Safety assurance occurs during growing and harvesting, processing, packaging and storage. Safe atmospheres are relevant to packaging and storage decisions and controls. There are potential safety issues associated with both intended and unintended modified atmospheres (MAs). O₂-depleted atmospheres used commercially to control enzymatic browning in fresh-cut lettuce, enhanced *Listeria monocytogenes* growth under mild abuse temperatures, but not at 3°C. Unintended anoxic atmospheres with high levels of CO₂ also selectively favoured growth of *Listeria monocytogenes* and *Salmonellae* at abuse temperatures. Growth of *E. coli* O157:H7 was unaffected by MAs found in fresh-cut products. The data have implications for product temperatures during distribution and retail, modest shelf life, greater attention to optimised packaging, application of alternative technology for control of enzymatic browning, and for effective sanitation of manufacturing facilities.

Keywords: /Fresh-Cut/ /Food Safety/ /Minimally Processed/ /Modified Atmosphere Packaging/

Russo, P., et.al. 2015. Detection and enumeration of *Listeria monocytogenes* in **fresh cut** vegetables using MPN-real-time PCR. Acta Hort. 1071: 567 - 574.

Abstract

Listeria monocytogenes is a gram positive, rod shaped, pathogenic bacterium, causative agent of a severe infection generally known as listeriosis. Packaging and storage conditions of fresh cut vegetables may favour the growth of this psychrotrophic pathogen leading to potential health threat. Detection and enumeration of *L. monocytogenes* in concentrations up to 10³ CFU/g, usually implies use

of the most-probable-number technique (MPN) which may take up to seven days for verified identification of the pathogen. We developed a fast and reliable protocol combining MPN with a Real-Time quantitative PCR (qPCR) approach. Samples of fresh cut salads (25 g) purchased at local shops were spiked with 1 to 10^5 CFU/g of *L. monocytogenes*. Samples were homogenized, and triplicate series of tubes containing 10^{-5} to 10 g of food were incubated in Fraser broth at 30°C for 48 h for standard MPN analysis. After incubation, broth samples were taken from each tube and DNA was extracted. DNA from enrichment tubes was used as template in a qPCR assay targeting a 64 bp *hlyA* gene sequence of *L. monocytogenes*. Results of this assay were then compared with those of standard MPN analysis and a complete accordance was observed. Furthermore, we tested an enrichment free approach using the same qPCR assay. Samples were prepared as described for MPN-qPCR while DNA extraction was performed prior to enrichment of inoculated salads. This approach allowed us to identify *L. monocytogenes* in samples spiked with 10^{-5} to 10^5 CFU/g. The whole process, including DNA extraction, required less than four hours, thus providing a fast and reliable tool for detection of *L. monocytogenes* in fresh cut vegetables.

Keywords: /Fresh Cut/ /Vegetables/

FRUITS

Pu, Yuan-Yuan, Yao-Ze Feng, Da-Wen Sun. 2015. Recent progress of hyperspectral imaging on quality and safety inspection of **fruits** and vegetables: a review. *Comprehensive Rev. Food Sci. & Food Safety*. 14: 176 - 188.

Abstract

Objective quality assessment and efficacious safety surveillance for agricultural and food products are inseparable from innovative techniques. Hyperspectral imaging (HSI), a rapid, nondestructive, and chemical-free method, is now emerging as a powerful analytical tool for product inspection by simultaneously offering spatial information and spectral signals from one object. This paper focuses on recent advances and applications of HSI in detecting, classifying, and visualizing quality and safety attributes of fruits and vegetables. First, the basic principles and major instrumental components of HSI are presented. Commonly used methods for image processing, spectral pretreatment, and modelling are summarized. More importantly, morphological calibrations that are essential for nonflat objects as well as feature wavebands extraction for model simplification are provided. Second, in spite of the physical and visual attributes (size, shape, weight, color, and surface defects), applications from the last decade are reviewed specifically categorized into textural characteristics inspection, biochemical components detection, and safety features assessment. Finally, technical challenges and future trends of HSI are discussed.

Keywords: /Fruits/ /Vegetables/ /Quality / /Food Safety/

HORTICULTURAL PRODUCTS

Magwaza, Lembe Samukelo, Umezuruike Linus Opara. 2015. Analytical methods for determination of sugars and sweetness of **horticultural products**—A review. *Scientia Hort.* 184:179 – 192.

Abstract

The determination and quantification of sugars is important for quality control and assurance of horticultural produce. This review discusses analytical methods for determination of sugars and sweetness of fresh and processed fruit and vegetables, including the use of destructive and non-destructive instrumental techniques to evaluate sugar composition and characterize taste profile or sweetness. From the standard hand-held refractometer to the hydrometer, electronic tongue and high pressure liquid chromatography (HPLC) equipped with different detectors, a wide range of devices have been used to determine sugar composition and sweetness of many fruit and vegetable products. Although chromatographic techniques are very accurate and useful, they require extensive sample preparation based on solvent extraction and hence are generally time-consuming and expensive. Visible to near infrared spectroscopy (vis/NIRS) has been proposed as an interesting alternative to traditional methods due to its rapidity, simplicity, cost effectiveness and potential for routine analysis if proper calibration and validation steps were developed. Current trends favour analytical methods that are simple to use, quick and non-destructive. The prospects for using emerging technologies such as hyperspectral imaging and nuclear magnetic resonance for non-destructive assessment of sugar content and sweetness of fresh and processed horticultural food products are also discussed.

Keywords: /Horticultural Products/ /Fruit/ /Vegetables/

MODIFIED ATMOSPHERE

Cukrov, D., S. Brizzolara, P. Tonutti. 2015. Molecular and metabolic responses of fruits to low oxygen postharvest stress. *Acta Hort.* 1071:37 - 44.

Abstract

The modulation of gas composition is widely used in storage rooms and/or packaging to delay ripening/senescence, to limit the incidence of postharvest physiological disorders, and, in some cases, to confine insect infestations. Hypoxic/high CO₂ conditions characterize the storage under MA and CA and fruit react to this stress by activating molecular and physiological mechanisms resulting in beneficial or detrimental effects depending on a number of endogenous (e.g., genotype, ripening stage) or exogenous (e.g., concentrations of the specific gas, duration of exposure) factors. Since the establishment of the first commercial CA rooms, the oxygen concentration showed a constant decrease throughout decades, reaching the low (<1 kPa) levels currently used in ULO (Ultra Low Oxygen), ILOS (Initial Low Oxygen Stress), and DCA (Dynamic Controlled Atmosphere) applications. The metabolic responses of fruit tissues to such extreme conditions are mainly related to dramatic changes in mitochondrial respiration and the activation of the fermentative metabolism. Several hypoxia-induced genes (e.g., alcohol dehydrogenase, ADH) have been identified in fruit tissues and anaerobic metabolites (e.g., alanine, succinate, malate, shikimate) are reported to differentially accumulate under low oxygen availability with marked consequences on the physiology of the fruit. The use and the integration of “omics” technologies represent key steps to better characterize the responses of fruit to low oxygen through the identification of specific metabolites, and to elucidate the mechanisms by which oxygen is perceived, the role of specific transcriptional regulatory elements, such as those belonging to the Ethylene Response Factors (ERF), and the involvement of ROS-related genes involved in both signaling and attenuation of oxidative-stress.

Keywords: / Modified Atmosphere/ /Controlled Atmosphere/

NON-CHEMICAL

Verschoor, J. A., et al.. 2015. Controlled atmosphere temperature treatment: **non-chemical** (quarantine) pest control in fresh plant products. Acta Hort. 1071:253 - 258.

Abstract

Insects, nematodes and mites that damage postharvest plant products can cause severe quality losses or trade restrictions in case of quarantine organisms. With the ban of the ozone depleting methyl bromide (MeBr), the most widely used chemical for phytosanitary treatments, effective and sustainable alternatives are required. A physical method, Controlled Atmosphere Temperature Treatment (CATT) can be a sustainable alternative for the control of pests on living plant products. Optimising CA-conditions besides temperature and exposure time can help in developing successful applications. In The Netherlands, a successful application to disinfest strawberry (*Fragaria × ananassa*) planting material from strawberry tarsonemid mite (*Phytonemus pallidus*) or plant parasitic nematodes *Meloidogyne hapla* was developed and implemented in practice. Initial tests with a number of other potential quarantine plant-pest combinations showed promising results of CATT.

Keywords: /Non-Chemical/ /Controlled/ /Atmosphere/

PACKAGING

Larsen, H. 2015. Low cost methodology for **package** optimising for fruit and vegetables. Acta Hort. 1071: 327 - 334.

Abstract

Numerous models are published integrating produce respiration data and gas transmission properties for packaging material in order to predict the optimal equilibrium headspace gas atmosphere. Gaining the data needed for input in the models can be cumbersome, and data found in literature are often given in different units and not stated at the desired storage conditions, e.g., gas transmission rates are usually measured at 23°C. Respiration data might also show great variation due to variety, quality and season, and literature data cannot automatically be transferred to own products. In this work a procedure for measuring produce respiration rates and gas transmission rate of the whole package is outlined. The respiration measurements are performed using low cost equipment and commercial packages as respiration chambers. The obtained results from the measurements for tested products were found to be in accordance with respiration data found in literature. The O₂ and CO₂ transmission rates of the whole packages were measured by a static method using a low cost gas analyser. The method can be used for packages with and without perforations, and it was also possible, within an acceptable accuracy, to calculate the transmission rate for a single hole. The respiration rates were measured at low and abused temperature (2 and 6°C for plums and 5 and 10°C for broccoli). Gas transmission rates of the packages were measured at 5, 10 and 23°C. Finally, a simple predictive model integrating produce respiration rates and gas transmission rate data for the whole package was developed. The modelled data were shown to be in accordance with empirical measurements for plums (*Prunus domestica* L.) packaged in laser-perforated pouches and for broccoli florets (*Brassica oleracea*) in sealed trays. The described procedure using low cost equipment and commercial packages is an alternative method for laboratories, packaging material producers, farmers and packaging houses to optimize their packages based on own measurements under realistic storage temperatures.

Keywords: /Packaging/ /Respiration Rate/ /Fruits/ /Vegetables/

POSTHARVEST

Yahia, E. M. 2015. The status of modified atmospheres (MA) and controlled atmospheres (CA) in developing countries. *Acta Hort.* 1071: 29 - 36.

Abstract

Development in the world in general is not very consistent nor uniform and much less well defined, and therefore it is very difficult to establish a very clear geographical classification for “developing” and “developed” countries. Some countries in continents generally considered as “developing” (Africa, Asia, Latin America) or some parts in these countries are as developed or more developed than certain countries or parts of countries in continents considered as “developed” (North America, Europe, Oceania). For simplification in this article, “developing countries” will denote those in Africa, Latin America and Asia except Japan and Singapore. MA and CA in their different applications (storage, marine transport, and packaging) have been used in some of the Developing Countries (DCs) for many years. For example, the use of MA for storage and packaging of different types of foods, although not in the form we know and apply today, has been used in ancient nations such as China, Egypt, Turkey and Mexico for hundreds of years. MA and CA, in their forms developed in the last 3-7 decades, have been used in several DCs for marine transport of several perishable foods and for storage of few commodities (mostly apples) for at least the last 4 decades. However, packaging in MA in an adequate form is still not practiced properly. Although there is a strong need for them and a strong potential for their development, all the 3 main applications of MA and CA in DCs, especially the packaging application, have not been developed nor used very well in the last several years due to several obstacles, among the most important are the very weak establishment and application of the cold chain, and very weak research and development, education, extension and awareness activities in these countries. This article will give an overview of the application of the different forms of MA and CA in DCs, the problems they are facing, and some recommendations for their improvement.

Keywords: /Postharvest/ /Technology/ /Storage/ /Transport/ /Packaging/ /Cold Chain/

FRUITS

APRICOT

Gabioud Rebeaud, S., et.al. 2015. Influence of temperature, 1-MCP, MA and CA on quality and aroma profiles of ‘goldrich’ **apricots**. *Acta Hort.* 1071: 297 - 302.

Abstract

The influence of two storage temperatures (1 and 8°C), 1-MCP, modified atmosphere (MA) and controlled atmosphere (CA) was evaluated on quality (firmness, acidity, TSS and skin colour), incidence of decay and aroma profiles of ‘Goldrich’ apricots. Although storing fruit under MA and CA at 1°C better prevented fruit softening, 1-MCP treatment was more effective to limit the incidence of decay. Firmness losses were better reduced by 1-MCP treatment when fruit were stored under regular atmosphere (RA), but this effect was not observed as storage time increased. Regarding storage under MA, accumulation

of carbon dioxide (CO₂) inside the Xtend® packaging induced internal browning disorders. Aroma profiles of stored fruit clearly differed from those at harvest. For fruit stored under RA, similar volatiles patterns were observed. MA at 1 and 8°C influenced the aroma production, which was discriminated from the other storage conditions.

Keywords: /Apricot/ /Modified Atmosphere/ /Controlled Atmosphere/ /1-MCP/ /Fruit Quality/

Onursal, C. E., et.al. 2015. Combined effects of MAP and postharvest putrescine treatment on storage life and quality of 'alyanak' apricot. Acta Hort. 1071:165 - 172.

Abstract

The effects of combinations of modified atmosphere packaging (MAP) with putrescine treatment on the storage life and fruit quality of apricot (*Prunus armeniaca* L. 'Alyanak') were investigated. 'Alyanak' apricots were harvested at commercial harvest maturity stage from an orchard in Turkey (Isparta) and transported immediately to the laboratory. Air precooling was applied by using cold air. After precooling, fruits were dipped in an aqueous solution containing different concentrations of putrescine (0.5, 1, 2 and 4 mM) and Tween 20 (0.01%) as a surfactant for 10 min. A control group was immersed in distilled water for 10 min. After treatments fruits were dried with blotting paper and placed in modified atmosphere package and stored at 0°C and 90±5% relative humidity conditions for 40 days. The weight loss, soluble solid contents (SSC), titratable acidity (TA), fruit firmness, fruit skin color, respiration rate, ethylene production and gas composition in package and sensory evaluation (external appearance, taste-aroma and internal browning) were determined initially and at 10 day intervals. Weight losses of apricots in all treatments were at low levels at the end of the storage. The control group displayed the highest firmness loss, while 1 mM putrescine treatment preserved firmness best. The putrescine treatments delayed internal browning of apricots compared to the control group. According to the results of sensorial evaluation and firmness, apricot fruits treated with 0.5 and 1 mM doses of putrescine could be stored for 30-35 days with good quality.

Keywords: /Apricot/ /Modified Atmosphere Packaging/ /Cold Storage/

AVOCADO

Bustos, M. C., M. F. Mazzobre, M. P. Buera. 2015. Stabilization of refrigerated avocado pulp: effect of Allium and Brassica extracts on enzymatic browning. LWT - Food Sci. & Technol. 61:89 - 97.

Abstract

The aim of this paper was to study the effectiveness of Allium and Brassica extracts to inhibit the evolution of enzymatic browning of avocado pulp tissue stored at refrigeration temperature (4 °C). Color parameters and mathematical modeling were employed to determine browning kinetics. In general, the addition of Allium extracts to avocado pulp was more effective in delaying luminosity decrease during the first days of storage, compared to Brassica. Scallion, onion, white cabbage and cauliflower inhibited polyphenol oxidase (PPO), and avocado paste, could be preserved for more than 30 days. Brussels sprouts treatment generated the highest browning kinetic constant (0.86) and conserved acceptable color for less than 10 days. Scallion and garlic showed the great antibrowning indexes (0.96 and 0.77 respectively) considering L* decrease. Multivariate analysis indicated that vegetable extracts tested could be grouped by variety according to polyphenol content, and by their influence on PPO activity. The

results allow the conclusion that polyphenol content of vegetables extracts influence the change of color variables during the first days of storage, while PPO activity influence these parameters in the last period of refrigeration.

Keywords: /Avocado/ /Enzymatic Browning/

Defilippi, B. G., et.al. 2015. Preharvest factors influencing 'hass' **avocado** (*Persea americana* mill.) quality during long term storage. Acta Hort. 1071:137 - 142.

Abstract

Avocado quality variability is due to the broad range of conditions in which trees are grown, especially in terms of climate and soil, and also associated with different cultural practices used among avocado growers. In the last four years, we have been performing a project in order to understand this variability by determining the effect of preharvest factors (climate, nutrition, cultural management, etc.) on the postharvest life of 'Hass' avocados, shipped under regular air (RA) and controlled atmosphere (CA) conditions. Fruit was collected from 11 commercial orchards during the 2009/10, 2010/11 and 2011/12 seasons, stored under RA and CA (4%O₂ and 6% CO₂) for 40 and 55 days at 5°C and 90% RH, and ripened at 20°C after cold storage until reaching the ready to eat stage. The postharvest parameters evaluated included flesh firmness, color, physiological disorders and days to reach ripening. A multivariate analysis was performed to determine a possible relationship between preharvest factors and postharvest avocado quality. Under both storage conditions, a high fruit variability among experimental sites was observed in the different quality attributes evaluated after storage. Among the variables studied, the days between flowering and harvest had an inverse effect on fruit firmness level after storage. A similar behavior was found for N/Ca ratio and oil content at harvest. Other factors that directly affected fruit firmness were calcium content at harvest and orchard elevation.

Keywords: /Avocado/ /Controlled Atmosphere/ /Postharvest/ /Physiological Disorders/

BANANA

Luo, Zisheng, et.al. 2015. Hydrogen sulfide alleviates chilling injury of **banana** fruit by enhanced antioxidant system and proline content. Scientia Hort. 183:144 – 151.

Abstract

Hydrogen sulfide (H₂S) has been proven to act as an antioxidant in prolonging storage of postharvest fruits and vegetables, indicating that H₂S might have the potential to ameliorate chilling injury (CI). Effect of H₂S fumigation released from 0.5 mM H₂S donor (NaHS) on banana fruit during chilling storage followed by a ripening period was evaluated. Results demonstrated that H₂S fumigation maintained higher values of lightness, peel firmness and reduced accumulation of malondialdehyde. It was also found that H₂S promoted the phenylalanine ammonia lyase activity, total phenolics content and antioxidant capacity. Moreover, H₂O₂ and superoxide anion accumulation were reduced by H₂S with up-regulated activities of guaiacol peroxidase, superoxide dismutase, catalase, ascorbate peroxidase and glutathione reductase. Further investigation on proline metabolism showed that elevated proline content which resulted from increased Δ^1 -pyrroline-5-carboxylate synthetase activity and decreased proline dehydrogenase activity, might be related to CI tolerance improvement. These data indicate that

H₂S alleviates CI of banana fruit may through the enhancement of antioxidant system and proline content.

Keywords: /Banana/ /Chilling Injury/ /Antioxidants/

BITTER MELON

Han, Cong, et.al. 2015. Effects of 1-MCP on postharvest physiology and quality of **bitter melon** (*Momordica charantia* L.). *Scientia Hort.* 182: 86 – 91.

Abstract

Young immature bitter melons were fumigated with 1-MCP at different concentrations (0.5, 5.0 or 50.0 $\mu\text{l l}^{-1}$) for 12 h, then stored at 20°C and 85–90% relative humidity (RH) to investigate postharvest quality and physiology. According to the visual appearance of bitter melon, we determined the effective concentration of 1-MCP was 5. $\mu\text{l l}^{-1}$. Furthermore, we demonstrated that the application of 1-MCP inhibited ethylene production and thereby improved fruit quality of bitter melon as reflected from ascorbic acid (AsA) and soluble protein content. In addition, 1-MCP maintained antioxidant enzymes activities such as superoxide dismutase (SOD), catalase (CAT) and peroxidase (POD) of bitter melon at initial stage but suppressed at the subsequent shelf life. Our results suggested that the use of 1-MCP was an effective method to retain postharvest physiology and quality of bitter melon.

Keywords: /Bitter Melon/ /1-MCP/ /Postharvest Quality/ /Physiology/ /Ethylene/

BLACKBERRIES

Ramos-Solano, Beatriz, et.al. 2015. Bacterial bioeffectors delay postharvest fungal growth and modify total phenolics, flavonoids and anthocyanins in **blackberries**. *LWT - Food Sci. & Technol.* 61:437 - 443.

Abstract

Blackberries are naturally rich in functional components beneficial for human health. The postharvest period of these fruits is very short due to fungal development, therefore, it is of great economic interest. Flavonoids and anthocyanins are secondary metabolites, and thus, strongly inducible. The aim of this study was to evaluate the ability of 6 bacteria with biocontrol traits and demonstrated Induced Systemic Resistance capacity, to prevent fungal growth during the postharvest period; the secondary aim was to identify whether the bacterial determinant was structural or metabolic, and if the treatment would affect flavonoid and anthocyanin levels. To achieve this goal, bacterial strains were sprayed dead or alive; fungal growth and phytochemicals were recorded. Only one strain delayed fungal growth by 50%, being structural and metabolic elicitors independently as efficient as the strain itself (dead or alive). This protection was associated to a decrease in the evaluated metabolites (28% total phenolics, 33% total flavonoids, 24% anthocyanins), suggesting transformation of flavonoids and anthocyanins (phytoanticipins) onto other molecules (phytoalexins) involved in defense and confirming induction of natural immunity. This study shows the potential of beneficial bacteria to develop a biological product to extend fruit shelf life of blackberries, increasing benefits for health and economic profit.

Keywords: /Blackberries/ /Polyphenol/ /Anthocyanins/

BLUEBERRY

Peano, C., et.al. 2015. Evolution of qualitative characteristics during **blueberry** fruit storage in a modified atmosphere. *Acta Hort.* 1071: 343 - 348.

Abstract

The objective of this work was to evaluate the performance of different films to maintain MAP conditions for storing 'Duke' blueberries by verifying then evolution of qualitative traits of berries. The fruits were picked manually, individually deposited in polyethylene baskets and immediately transferred (1 h) to the laboratory under chilled conditions (10°C). The experimental storage units consisted of a pallet bag of two different types of film, polyethylene (100 µm) and a biobased film derived from starch (50 µm). The O₂ and CO₂ transmission rates, measured according to the ASTM F 2622-08 and ASTM F 2476-05 methods at 38°C and 90% RH, were, 2642 and 10654 [cm³/(m²·24 h)], respectively, for the polyethylene film and 655 and 1384 [cm³/(m²·24 h)], respectively, for the biobased film. The initial gas composition of the active MAP (11.2 kPa of O₂, 10.3 kPaCO₂ + 77.8 kPa N₂) was chosen based on a previous report with some modifications. The flow-through system used to modify the atmosphere operates with high and low pressure sides using CO₂, O₂ and N₂. The air present in the pallet bags was partially substituted with the desired gas mixture. A manual timer regulated both the time of evacuation and filling with CO₂. There was one pallet bag (with a volume of 1,728,000 cm³) for each treatment containing about 150 kg of blueberry fruits. The pallet bags were stored for up to 45 days at 1±1°C and at 85-90% RH. The results of both treatments were compared to a control (fruits stored in normal atmosphere). The overall results indicate that blueberry storage can be effectively extended by exposing the fruit to a cold environment and an adequate atmosphere composition. The 11.2 kPa of O₂, the 10.3 kPa CO₂ atmosphere composition reduced the changes in soluble solids content and acidity, and maintained acceptable levels of anthocyanins and phenolics.

Keywords: /Blueberry/ /Storage/ /Modified Atmosphere/

CITRUS

Lorente, D., et.al. 2015. Laser-light backscattering imaging for early decay detection in **citrus** fruit using both a statistical and a physical model. *J. Food Eng.* 154:76 – 85.

Abstract

The early detection of decay caused by fungi in citrus fruit is a primary concern in the post-harvest phase, the automation of this task still being a challenge. This work reports new progress in the automatic detection of early symptoms of decay in citrus fruit after infection with the pathogen *Penicillium digitatum* using laser-light backscattering imaging. Backscattering images of sound and decaying parts of the surface of oranges cv. 'Valencia late' were obtained using laser diode modules emitting at five wavelengths in the visible and near-infrared regions. The images of backscattered light captured by a camera had radial symmetry with respect to the incident point of the laser beam, these being reduced to a one-dimensional profile through radial averaging. Two models were used to characterise backscattering profiles: a statistical model using the Gaussian–Lorentzian cross product (GL) distribution function with five parameters and a physical approach calculating the absorption, μ_a , and

reduced scattering, μ'_s , coefficients from Farrell's diffusion theory. Models described radial profiles accurately, with slightly better curve-fitting results ($R^2 \geq 0.996$) for the GL model compared to Farrell's model ($R^2 \geq 0.982$), both indicating significant differences in the parameters between sound and decaying orange skin at the five wavelengths. For dimensionality reduction purposes, feature selection methods were employed to select the most relevant backscattering profile parameters for the detection of early decay lesions. The feature vectors obtained were used to discriminate between sound and decaying skin using a supervised classifier based on linear discriminant analysis. The best classification results were achieved using a reduced set of GL parameters, yielding a maximum overall classification accuracy of 93.4%, with a percentage of well-classified sound and decaying samples of 92.5% and 94.3%, respectively. Results also pointed out application limits of Farrell's diffusion theory at 532 nm laser wavelength, for which high absorption of pigments occurred.

Keywords: /Citrus/ /Decay Detection/

DURIAN

Wisutiamonkul, Apinya, et.al. 2015. Carotenoids in durian fruit pulp during growth and postharvest ripening. Food Chem. 180: 301 – 305.

Abstract

Durian (*Durio zibethinus*) cvs. Chanee and Monthong fruit were severed from the tree during 14 day intervals, from 10 weeks after anthesis until commercial maturity. We determined the pulp (i.e. aril; fruit flesh) carotenoid composition, together with pulp firmness, color and total soluble solids (TSS) and postharvest quality. In ripe cv. Chanee fruit the main carotenoids were β -carotene (about 80%), and α -carotene (20%), with minor levels of lutein and zeaxanthin. In ripe fruit total carotenoid concentration (expressed per gram FW) was about 9-fold higher in cv. Chanee than in cv. Monthong. Large differences between the cultivars were also found in β -carotene levels (about 11 times more in cv. Chanee), and even larger ones in those of α -carotene. Differences in lutein and zeaxanthin concentrations were small. Pulp color was deeper yellow in cv. Chanee than in cv. Monthong, which was correlated with α -carotene and β -carotene concentrations. Durian contains a high fat percentage, which is conducive to carotenoid uptake. It is concluded that it is advisable to consume cv. Chanee rather than cv. Monthong if intake of carotenoids is considered important.

Keywords: /Durian/ /Maturity/ /Ripening/

FIGS

Guilleń, F., et.al. 2015. Use of modified atmosphere packaging improves antioxidant activity and bioactive compounds during postharvest storage of 'collar' figs. Acta Hort. 1071: 263 - 268.

Abstract

Fig fruit has a short life and therefore exhibits very limited marketing. There is also a significant lack of awareness about contents of bioactive compounds in these fruits and how they evolve during postharvest storage. In this work we determined the antioxidant activity and bioactive compounds of figs (*Ficus carica* 'Collar') during modified atmosphere packaging (MAP) or unpacked (control) in order to improve the shelf life. Figs were stored at 2°C during 28 days. The results of this study showed that

bioactive compounds exhibited a different behavior in which total antioxidant activity and total polyphenols increased and the anthocyanins evolution was delayed under MAP condition in comparison with unpacked figs just under cold storage conditions. Bioactive compounds were different in the skin and in the flesh, and a combination of MAP technique with the cold storage resulted in higher values of the compounds in figs when compared with control samples. Therefore, MAP technique during cold storage could be a good tool to improve antioxidant activity and bioactive compounds of figs.

Keywords: /Figs/ /Modified Atmosphere Packaging/ /Modified Atmosphere/ /Fruit Quality/ /Storage/

GOOSEBERRIES

Kampuse, S., et.al. The influence of pre-treatment technology and packaging material on the quality of fresh gooseberries during storage. Acta Hort. 1071: 405 - 412.

Abstract

Although gooseberries are still considered a minor berry crop, there is increasing interest of growers, processors and consumers for the fresh fruit and in processed products. One of the most important tasks is to offer consumers fresh gooseberries during long time maintaining sensory and other quality properties. The aim of this study was to evaluate the quality changes of fresh gooseberries during storage when pretreated with ozone and disinfection solution, and packed in two different materials. The experiments were done in the Faculty of Food Technology, Latvia University of Agriculture (LLU). Samples were collected from the farm "Mucenieki" in a fully ripe stage. One third of the samples were pretreated with a 1.5% disinfection solution "Natureseal-AS5", the other third was pretreated with ozonated vapour, and the last part was untreated as a control sample. All samples were packed in two package materials: biaxially oriented polypropylene (BOPP), and AgriFresh (oriented polypropylene (OPP) with antifog coating and specific perforation). The content of ascorbic acid, total phenols, anthocyanins, soluble solids, titratable acids, and the gas composition in the headspace of package of fresh gooseberries of cultivar 'Tukuma Konfeksu' were analysed. The largest change of gas composition in the headspace of the packages was observed during the first 5 days of storage when a rapid decrease of O₂ and increase of CO₂ occurred. A decrease in titratable acids and ascorbic acid during the storage was observed in all samples. The lowest soluble solids content was detected after 22 days of storage in samples pretreated with ozone. The total phenolic content decreased during the storage but there were no significant differences between pretreatment technologies. The content of anthocyanins in berries pretreated with ozone and disinfection solution was higher than in control samples.

Keywords: /Gooseberry/ /Packaging Materials/

Muizniece-Brasava, S., et.al. 2015. The evaluation of physical parameters of gooseberries using different pretreatment technologies and packaging materials. Acta Hort. 1071: 381 - 388.

Abstract

Gooseberries (*Ribes uva-crispa*) of cultivar 'Tukuma Konfeksu' were collected at the fully ripe stage. Experiments were carried out at the Faculty of Food Technology of the Latvia University of Agriculture. The aim of this experiment was to evaluate the changes in physical parameters of gooseberries pre-treated with ozone and disinfection solution "Natureseal-AS5", packed in two different

materials and stored 22 days. One part of the samples was pre-treated with 1.5% disinfection solution "Natureseal-AS5", the second part was pre-treated with gaseous ozone, and the third part was packed untreated as a control group. Samples of 200±5 g were packaged in polymer pouches, hermetically sealed with a MULTIVAC C300 vacuum chamber machine, and stored at 3.0±1.0°C. Fruits were packaged in two materials: biaxially oriented polypropylene (BOPP), and Amcor AgriFresh (oriented polypropylene (OPP) with antifog coating). The physical properties – mass changes, firmness, colour, changes of atmosphere content (CO₂ and O₂) in package headspace, and microbial loads were analysed before packaging and after 5, 8, 12, 15, 19 and 22 days of storage. The gas composition most of all changed in the headspace of the packages during the first 5 days of storage when as a result of gooseberries' breathing a rapid decrease of O₂ and increase of CO₂ occurred. The mainly changes of physical parameters after 22 days of storage was detected in samples pre-treated with ozone.

Keywords: /Gooseberries/ /Packaging Materials/

GRAPE BERRIES

Wang, Kaituo, et.al. 2015. Effects of benzothiadiazole on disease resistance and soluble sugar accumulation in grape berries and its possible cellular mechanisms involved. *Postharvest Biol. & Technol.* 102: 51 - 60.

Abstract

This study was conducted to investigate the effects of benzo-thiadiazole-7-carbothioic acid S-methyl ester (BTH) treatments on disease resistance against *Botrytis cinerea* infection and soluble sugar accumulation in grape berries and to analyze the possible cellular mechanisms involved. In grape berries, the results indicated that BTH treatments at 0.1 or 1mmol L⁻¹ could effectively inhibit *B. cinerea* infection possibly by directly inhibiting pathogen growth and indirectly inducing disease resistance. However, an obvious change in the composition of the soluble sugars was simultaneously observed in the BTH-treated berries. In parallel, addition of BTH at 0.1 or 1mmol L⁻¹ to the medium could effectively trigger a SAR defense response in grape suspension cells, and the defense included a cellular H₂O₂ burst, VvNPR1.1 and PR1 genes expression, and the accumulation of stilbene phytoalexins. The 0.1 or 1 mmol L⁻¹ BTH treatment induced higher activity of sucrose-hydrolyzing enzyme SS-cleavage and lower activities of sucrose-synthesizing enzymes such as SS-synthesis, SPS and SPP than the controls, contributing to the gradual increase in sucrose hydrolysis, a decrease in the glucose content and the accumulation of fructose in grape cells. Therefore, our results suggest that BTH exerts its effect on reducing fruit decay perhaps through the cellular SAR response. Moreover, the presence of costs in terms of altered soluble sugar components in grape berries may be attributed in changing activities of cellular sucrose-metabolizing enzymes after effective BTH elicitations.

Keywords: /Grapeberries/ /Botrytis Cinerea/

GUAVA

Sahoo, Nihar R., et.al. 2015. Comparative study of MAP and shrink wrap packaging techniques for shelf life extension of fresh guava. *Scientia Hort.* 182: 1 – 7.

Abstract

Effect of packaging techniques and storage environment was assessed for maintaining quality and shelflife of guava. Changes in headspace gases, physiological loss in weight (PLW), ascorbic acid, texture, colour and subjective quality were evaluated. The in-pack guava created a suitable headspace with low O₂ and high CO₂ concentrations, which resulted in a better retention of freshness of the guava. Shrink packaging with bi-axially oriented polypropylene (BOPP) could not yield better result under ambient storage because of high water vapour transmission rate (WVTR) of the film and consequently loss of turgidity of fruits. Modified atmospheric packaging (MAP) in polypropylene (PP) with pin holes was found to be the best followed by vacuum pack with PP in cold condition and could be used to store for 28 and 24 days with maintenance of texture, colour, ascorbic acid and marketability. It is also inferred that under ambient conditions guava could be stored for 4 days using low density polyethylene (LDPE) with pin holes and PP with pin holes as MAP storage. The research findings of the study would give an innovative facet for fresh guava preservation and enhancing the commercial potential along with open new avenues for fresh fruit and vegetable industry.

Keywords: /Guava/ /Modified Atmosphere Packaging/ /Marketability/ /Weight Loss/

KIWIFRUIT

Benítez, S., et.al. 2015. Aloe vera as an alternative to traditional edible coatings used in freshcut fruits: A case of study with **kiwifruit** slices. LWT - Food Sci. & Technol. 61:184 - 193.

Abstract

In this work, a comparative study between Aloe vera, chitosan (formulated with acetic (-AC) or citric acid (-C)) and sodium alginate edible coatings was conducted to evaluate the effects on the quality and shelf life of minimally processed kiwifruit. The pH, soluble solids content, titratable acidity, ascorbic acid, color, texture properties, gas concentrations, pectin content, microbial load and sensory quality of the fruit were analyzed during 12 days at 4 ± 1 °C. Chitosan-AC and alginate based coatings act as a gas barrier, although after eight days of storage, a sharp rise in CO₂ production was detected for the alginate and chitosan-C coatings. Aloe vera coating maintained the firmness of the fruit, prevented the ascorbic acid losses and yellowing due to ripening. Aloe vera and chitosan-AC reduced microbial proliferation; however chitosan-AC coated slices were not accepted by the sensory panelists. In contrast, fruit treated with an alginate based coating had higher microorganism counts than the control samples. The sensory panel preferred the kiwifruit slices treated with Aloe vera or chitosan-C coatings compared to the other coatings. Our study indicates that Aloe vera was the best coating to both extend the postharvest shelf life and maintain the sensory properties of the product through the storage period.

Keywords: /Kiwifruit/ /Aloe Vera/ /Chitosan/ /Minimally Processed/ /Sensory Analysis/

LEMON

Castillo, S., et.al. 2015. Effect of different packaging materials on the quality of **lemon** slices. Acta Hort. 1071:237 - 240.

Abstract

In Spain and in southern east of Spain in particular, citrus production has predominantly focused on lemon, which is a fruit with great possibilities as a freshcut product for use in fruit salads and

as garnishes for drinks or cocktails. Lemon slices have good stability during cold storage because of their antioxidant activity. Nevertheless, fresh-cut lemon slices, already present to a limited extent in the European market, still present some qualitative problems concerning chemical, physical and sensorial stability. One of the main problems of fresh-cut slices is their susceptibility to juiciness loss resulting from degradation of cell wall materials. The aim of this work was to obtain fresh-cut lemon slices and packing them in different films for modified atmosphere packaging (MAP). Lemon slices were stored during 42 days with 3 different films composed by polyester-polyethylene differed in thickness: P (12-50 μm), M (12-60 μm) and I (12-72 μm). Quality attributes of slices were determined along storage together with gas composition and microbial counts. The greatest gas modification was obtained for film I (29 ± 0.6 kPa CO_2 and 2 ± 0.2 kPa O_2) and the lowest microbial counts, both mesophilic aerobics and yeast and moulds. However, exudate juice and fermentative odour were observed. Overall quality was best maintained with film M, which is recommended for commercial purposes.

Keywords: /Lemon/ /Packaging//Quality/

LYCHEE

Yang, Yi-Chao, et.al. 2015. Rapid detection of anthocyanin content in lychee pericarp during storage using hyperspectral imaging coupled with model fusion. *Postharvest Biol. & Technol.* 103: 55 – 65.

Abstract

A quantitative approach was proposed to evaluate anthocyanin content of lychee pericarp using hyperspectral imaging (HSI) technique. A HSI system working in the range of 350–1050 nm was used to acquire a 3-D lychee image. Successive projection algorithm (SPA) and stepwise regression (SWR) algorithm were utilized to reduce data dimensionality and search for optimal wavelengths related with anthocyanin content in pericarp. Radial basis function support vector regression (RBF-SVR) was adopted to establish quantitative relationship between hyperspectral image information in two sets of optimal wavelengths and anthocyanin content of pericarp. Finally, in order to improve prediction accuracy, SPA- RBF-SVR and SWR-RBF-SVR models were fused into a single model by radial basis function neural network (RBF-NN) algorithm. The results revealed that the fused model possessed a better performance than either SPA-RBF-SVR or SWR-RBF-SVR models alone, as the fused model showed higher coefficients of determination (R^2) of 0.891 and 0.872, and lower root mean square errors (RMSEs) of 0.567% and 0.610% for the training and the testing sets, respectively. Visualization maps based on the fused model were generated to display the anthocyanin distribution within lychee pericarp. This study demonstrates that HSI is capable of predicting and visualizing anthocyanin evolution in the pericarp of lychee during storage.

Keywords: /Lychee/ /Litchi/ /Anthocyanin/

MANGO

Mattiuz, Ben-Hur, et.al. 2015. Effect of propolis on postharvest control of anthracnose and quality parameters of 'Kent' mango. *Scientia Hort.* 184: 160 – 168.

Abstract

The objective of this study was to evaluate the efficacy of propolis treatment for reducing anthracnose development on mango fruit of variety Kent; and compare its efficacy to chitosan treatment, which is already a well-studied natural produce. For in vitro experiments, Petri plates were amended with (0, 0.5, 1.0, 1.5, 2.0 and 2.5% v/v) propolis or (0, 0.25, 0.5, 1.0, 1.5 and 2.0% w/v) chitosan solutions. For the in vivo experiments, mangoes were infected with a spore suspension of *Colletotrichum gloeosporioides* and solution of either propolis (1.5%) or chitosan (1.5%) were used for controlling the pathogen development. The fruits were stored for 14 days at $12 \pm 1^\circ\text{C}$ and $83 \pm 2\%$ RH, and then, for another 7 days at 23°C , 82%. Lesion area, firmness, chemical composition, as well as color of the skin were used for evaluating and compare the performance of the two products. Even if the in vitro results demonstrated the net superiority of propolis for controlling the development of the pathogen, the in vitro results showed the opposite order when classifying the performance of the products with alive fresh produce. The results obtained suggested that propolis, as well as chitosan, may be used as treatment for controlling anthracnose, maintaining quality, and increasing the shelf life in 'Kent' mango. However, propolis was far from producing competitive results to chitosan treatment performance.

Keywords: /Mango/ /Chitosan/ /Postharvest/ /Anthracnose/

MELON

Spadafora, N. D., et al. 2015. Physiological, metabolite and volatile analysis of cut size in melon during postharvest storage. *Acta Hort.* 1071:787 - 794.

Abstract

Melons are an important component of fresh fruit salads, however, they suffer from limited shelf life. Processing of melon fruit for use in fruit salads induces a number of changes including alterations in colour and texture. In addition, respiration rate and ethylene production are affected. Processing also elicits changes in flavour (sweetness) and aroma (production of volatile organic compounds – VOCs), of critical importance to the consumer. Several parameters govern shelf life; temperature is a critical factor. In this study we tested whether cut size is another parameter that can affect quality indicators. Melon (*Cucumis melo* 'Arapaho') cubes of three sizes were stored at 4°C and assessed for quality at five time-points over a 15-day period. We assessed a number of parameters including firmness, loss of fresh weight, respiration rate, antioxidant capacity, phenolic compounds and carotenoid content. In addition we measured VOC profiles to assess whether there were any qualitative changes associated with storage period and/or cut size. Fresh weight (FW) loss and respiration rate increased significantly with storage time and FW loss was affected by cut size. Total carotenoid levels remained stable during the storage time as did antioxidant capacity in all cut sizes. However, cinnamic acid levels tended to decrease in the last stage of the storage period and changes in β -carotene content correlated with cut size (though not significantly). We were also able to separate the VOC profiles from the different cut sizes indicating that VOCs may be useful markers as indicators of the effects of cut size and storage time on quality.

Keywords: /Melon/ /Fresh Cut/ /Senescence/ /Fruit Quality/

ORANGES

Deng, Lili, Yahan Zhou, Kaifang Zeng. 2015. Pre-harvest spray of oligochitosan induced the resistance of harvested navel **oranges** to anthracnose during ambient temperature storage. *Crop Prot.* 70: 70 - 76.

Abstract

In this study, the ability of pre-harvest oligochitosan spray to control *Colletotrichum gloeosporioides* of navel orange during ambient temperature storage was examined. Navel orange trees were sprayed thrice with oligochitosan (15 g L⁻¹ water) after physiological fruit drop. Results indicated that disease incidence and lesion diameter were lower in oligochitosan-treated fruit compared with the respective control. The inhibitory effects of volatiles in navel orange rind on the spore germination of *C. gloeosporioides* were significantly enhanced in the treated fruit compared with the control. Biochemical evaluations revealed that the contents of hydroxyproline-rich glycoprotein were increased. Protopectin degradation was delayed during storage. In addition, the activities of defense-related enzymes, including pectin methylesterase, peroxidase, chitinase, and phenylalanine ammonia-lyase, were increased in oligochitosan-treated navel orange fruit rinds. Our results suggested that pre-harvest oligochitosan spray can be a potential alternative to conventional control methods to prevent post-harvest anthracnose in navel orange.

Keywords: /Oranges/ /Anthracnose/ /Storage/

PEACH

Chiabrande, V., G. Giacalone. 2015. Maintaining quality of fresh-cut **nectarines** using heat treatments associated with modified atmosphere packaging. *Acta Hort.* 1071:97 - 104.

Abstract

The effect of modified atmosphere packaging (MAP) and short-term heat treatment on shelf life of fresh-cut nectarines cultivar 'Sweet Red', stored at 4°C for 11 days were evaluated. Modified atmosphere packaging systems are used extensively for fresh-cut fruit to extend shelf-life by reducing water loss, respiration rates, cut surface browning, microbial growth and ethylene biosynthesis. Among different fruit types, nectarines can be used and are highly appreciated as fresh-cut product although their commercial success is limited due to their short shelf-life and the quick onset of wounding-related physiological reactions. In this work, a pre-cutting heat treatment at 40°C for 50 min and two types of modified atmosphere packaging conditions was evaluated: passive (air) and active (5% O₂ and 5% CO₂) modified atmosphere. The quality-affecting parameters were evaluated by physical and chemical methods (weight loss, firmness, color, soluble solids content and titratable acidity) and by the evaluation of physiological aspects (PPO activity) as well as the changes in headspace gas composition. Significantly lower concentrations of CO₂ in the package atmosphere were recorded for active modified atmosphere. In contrast, no significant changes occurred for O₂ values. Heat treatments and modified atmosphere packaging did not reduce significantly firmness loss. Moreover, an insignificant effect of modified atmosphere, heat treatment or an association of the two, on chemical composition (total soluble solids, acidity, pH) and color parameters was observed.

Keywords: /Nectarines/ /Heat-Treatment/ /Postharvest/

Colantuono F., M. L. Amodio, G. Colelli. 2015. Comparison of different gas compositions on fresh-cut peach quality: a preliminary study. Acta Hort. 1071:763 - 770.

Abstract

The aim of this study was to evaluate the effect of different atmosphere compositions on fresh-cut peaches, and to identify a suitable gas mixture to extend their shelf-life. The research was performed on a yellow fleshed peach (*Prunus Persica* L. 'Tardi Belle'), cut into wedges and stored at 5°C for 7 days. During storage, peach samples were subjected to continuous and humidified flows of different atmosphere compositions (respectively air; 2 kPa O₂; 2 kPa O₂ + 10 kPa CO₂; 2 kPa O₂ + 20 kPa CO₂). Visual quality, physical attributes (color, weight loss, firmness) and chemical composition (total soluble solids, titratable acidity, vitamin C, total phenols, acetaldehyde and ethanol) of fresh-cut peaches were evaluated upon cutting and during storage. Among the different gas compositions tested, 2 kPa O₂ alone and/or combined with 10 kPa CO₂ was not beneficial to the quality of peach slices. In particular peach stored in these conditions as well as samples stored in air showed a poor visual quality due to the low value of b* and to browning development. On the other hand, the gas mixture with 2 kPa O₂ + 20 kPa CO₂ seemed more appropriate to extend the shelf-life of fresh-cut peaches, even though in these conditions a higher fermentative metabolism may occur, leading to significant higher contents in ethanol and acetaldehyde, with a possible negative influence on sensorial quality.

Keywords: /Peach/ /Ethanol/ /Firmness/

Falagán, N., et. al. 2015. Combining MAP, deficit irrigation and antibrowning treatment for keeping quality of fresh-cut peaches. Acta Hort. 1071:533 - 540.

Abstract

Agriculture in semi-arid areas faces the scarcity of water resources. The effect of deficit irrigation (DI) on quality of 'Flordastar' peach slices stored in modified atmosphere packaging was studied. The DI was programmed according to signal intensity (SI) of the maximum daily trunk shrinkage (MDS); DI plants were irrigated to maintain MDS SI values close to 1.4 or 1.3 in the case of DI1 or DI2 plants, respectively (see details in material and methods). Results were compared to a non-DI (NDI) watered at 150% crop evapotranspiration. Once harvested, peaches were cut in 6-8 pieces and two groups were made: 'Control', packaged in polypropylene trays, and 'Antibrowning' in which pieces were treated with 9% ascorbic acid (AA) before packaging. In both cases, a passive modified atmosphere (16.5 kPa O₂ and 3.5 kPa CO₂) was generated throughout storage at 5°C. On days 0, 4 and 8, firmness, vitamin C, microbial counts and sensory quality were evaluated. As results, DI1 and DI2 peaches showed higher firmness on the initial day than NDI fruits but no differences between irrigation treatments during storage were found. Initially, samples treated with AB solution showed higher AA content than control. During shelf life, no differences in AA content were registered between both kinds of treatments, following a decreasing trend with time. In general, the dehydroascorbic acid content tended to increase during storage, without differences among treatments. AA treated peaches reached the best rating by the sensory panel. In all treatments, microbial counts (mesophilic, yeast, moulds, *Salmonella* spp., *Listeria* mssp. and *E. coli*) were below the legal European limits. The main conclusions obtained were that the use of DI strategies saved an important water amount, providing similar quality fresh-cut fruits. The use of AA kept the appearance of the slices allowing a shelf life of 8 days.

Keywords: /Peach/ /Minimally Processed/ /Sensory Quality/ /Firmness/

Sergio, L., et. al. 2015. Postharvest performance of intermediate moisture peaches and prunes as affected by packaging and storage conditions. Acta Hort. 1071:739 - 746.

Abstract

The postharvest performance of two intermediate moisture fruits, peach (*Prunus persica* (L.) Batsch 'Giallone') and prune (*Prunus domestica* L. 'Stanley'), was evaluated. Fruit were washed, cut (peach into slices, prune into halves), stoned, dipped in 2% (w/v in water) acid solutions (ascorbic acid for peach, citric acid for prune), and sonicated in ultrasonic bath with a 45% (w/v in water) fructose solution. After this pretreatment, fruit pieces were dried with heat pump technology equipment. Semi-dried fruit pieces were packed in polypropylene trays sealed with a composite covering plastic film with a partial vacuum (P=450 mm Hg) air atmosphere. In order to test postharvest performance in both refrigerated and unrefrigerated conditions, products were stored at 4±1 or 18±1°C for 60 days. After 0, 20, 40, and 60 days in storage, visual and sensorial scores, colour, texture, aw, sugars, phenolic content, antioxidant activity, polygalacturonase activity, and microbial growth were evaluated. Peach and prune pieces stored in unrefrigerated conditions showed serious decay symptoms already after 20 days in storage; whereas, semi-dried fruit pieces stored at 4°C preserved their physical, sensorial, biochemical, and microbiological properties until 40 days in storage. After 60 days in storage, only peaches still maintained minimally acceptable quality; on the contrary, prunes were unmarketable.

Keywords: /Peach/ /Sensory Quality/ /Storage/ /Packaging/Microbiological Safety/

PEAR

Charoenchongsuk, Nongluk, et.al. 2015. Comparison of the expression of chlorophyll-degradation-related genes during ripening between stay-green and yellow-pear cultivars. Scientia Hort. 181: 89 – 94.

Abstract

Chlorophyll degradation is a key component of the changes in pigment composition that typically occur in fruit peel at the onset of ripening. In this study, two pear cultivars, which are different in color development patterns, were used to clarify the molecular mechanism of chlorophyll degradation during ripening. Fruit was harvested and stored at 1°C for cold treatment and then transferred to 20°C for ripening. 'Le Lectier' pears turned yellow during ripening with concomitant loss of chlorophylls a and b, and carotenoids. In contrast, 'La France' pears stayed green even when fully ripe. In this cultivar, chlorophyll and carotenoid contents did not change significantly. Ethylene was normally produced in 'La France' pears, indicating that the stay-green characteristics do not result from an inability of the fruit to produce ethylene. The expression levels of the chlorophyll degradation related genes, including chlorophyllase 1, pheophorbide a oxygenase, non-yellow coloring 1, and NYC1-like were lower in 'La France' than those in 'Le Lectier' pears. Suppression of these genes in 'La France' pears might be related to the stay-green characteristics when fully ripened.

Keywords: /Pear/ /Ripening/

Colás-Medà, Pilar, et. al. 2015. Effect of ripeness stage during processing on *Listeria monocytogenes* growth on fresh-cut 'Conference' pears. Food Microbiol. 49:116 - 122.

Abstract

There are several factors that affect the shelf life of fresh-cut fruit, including the cultivar, the ripeness stage of the fruit during processing and the fruit's storage atmosphere and temperature. The effect of fruit ripeness during processing on the survival and growth of *Listeria monocytogenes* on fresh-cut 'Conference' pear slices at different temperatures (5, 10 and 20 °C) was studied. The four ripeness stages studied in this work (assessed by a fruit's firmness) were mature-green (54-60 N), partially ripe (43-53 N), ripe (31-42 N) and overripe (<31 N). In our studies, pH, acidity and soluble solids content did not significantly change during conditioning at 20 °C. *L. monocytogenes* grew under all experimental conditions, showing an increase of approximately 2 log CFU g⁻¹ after 8 days of storage at 5 °C. There were significant differences in the *L. monocytogenes* population between different ripeness stages at the end of the experiments at 10 and 20 °C. Regardless of the ripeness stage of a fresh-cut pear, the growth potential of *L. monocytogenes* increased with increasing temperature. A pear's ripeness stage during processing is an important consideration to ensure the quality of a fresh-cut pear, but it is not as important for preventing *L. monocytogenes* growth at common storage temperatures.

Keywords: /Pear/ /Fresh-Cut/ /Ripening/

De Bonis, M. V., et. al. 2015. Computational modelling of modified atmosphere packaging: application to cactus pear and truffle as case studies. Acta Hort. 1071: 113 - 120.

Abstract

Shelf life improvement for two different products (cactus pears and truffles), stored at 8 and 5°C respectively under modified atmosphere packaging (MAP), was assessed by modelling heat and mass transport as well as package geometry and storage conditions. An innovative approach was implemented by coupling an engineering tool, such as the computational fluid dynamics (CFD) with experimental data, such as visual quality, respiration rate, head space composition, and weight loss upon MAP storage. The overall model, incorporating all phenomenological variations, has been finally tuned-up by means of a specific multi-objective optimization. It is seen that the models are able to simulate complex, multidimensional food-package ensembles under MAP conditions. As for cactus pears, a multidimensional, transient model is proposed by combining generalized transport notations with respiration and microbial growth kinetics. As for truffles, a model able to predict the effect of storage on quality loss was obtained. The adoption of predictive and comprehensive mathematical models is an economic method to evaluate packaging and operating performance, compared to more expensive experimental methods. Computational models, such as these, can be used to verify existing MAP configurations, or to design new ones. Exploitation of this mathematical tool would allow for informed technical and management decisions.

Keywords: /Pear/ /Modified Atmosphere Packaging/ /Shelf Life/ /Fresh Produce/

Deuchande, T., et.al. 2015. Internal browning disorders in 'Rocha' pear stored under high CO₂ atmospheres are triggered by oxidative stress. Acta Hort. 1071 :771 - 778.

Abstract

The aim of this work was to study the physiological basis, with special emphasis on antioxidant metabolism, of CO₂-related internal browning disorders in 'Rocha' pear (*Pyrus communis* L. 'Rocha') during storage under different controlled atmosphere (CA) conditions. Pears were stored for 5 months at 0°C and 3% O₂ + 0.5% CO₂ (normal CA storage) or up to 4 months at 0°C and 1% O₂ + 10% CO₂ (browning inducing CA storage) and the internal browning disorders were evaluated after 30, 60 and 120 days of storage. Changes in antioxidant enzyme activities (SOD, CAT, APX and POX), ascorbic (AsA) and dehydroascorbic acid (DHA) were also evaluated after 7, 15, 30 and 60 days of storage aiming at assessing the relationship between oxidative stress and internal disorders. During the entire storage period under normal CA up to 5 months, fruits did not develop browning disorders. In contrast, fruit stored under high CO₂ atmospheres exhibited high levels of internal browning (70% of damaged fruit) after 4 months of storage. High disorder incidence at high CO₂ levels was related to a decrease of total ascorbate levels during storage. Internal disorder incidence was also related to greater SOD, and to some extent APX activities as well as higher DHA/AsA ratios. Collectively these results suggest that internal disorders in 'Rocha' pear under high CO₂ atmosphere are the consequence of an oxidative stress within the fruit.

Keywords: /Pear/ /Antioxidants/ /Physiological Disorders/

Folchi, A., P. Bertolini, D. Mazzoni. 2015. Influence of controlled atmosphere and dynamic controlled atmosphere on physiology, scald prevention and ca related disorders of 'Abbé Fétel' pears during long-term storage. Acta Hort. 1071: 195 - 202.

Abstract

'Abbé Fétel' pears harvested at two maturity stages, were stored in regular controlled atmosphere (CA) (3 kPa O₂ and 2 kPa CO₂), ultra low-O₂ (0.7 kPa O₂ and 0.8 kPa CO₂), dynamic controlled atmosphere (DCA) (0.4-0.7 kPa O₂ and 0.8 kPa CO₂) and conventional air storage. The fruit were kept in metal cabinets at -1°C and inspected after 90, 120 and 180 days. During storage, within each picking period, ethylene production by the fruit was in the following descending order, air storage > regular CA > Low-O₂ > DCA. The reverse for flesh firmness and green colour of fruit skin. Overall fruit metabolism was markedly lower in the first picking during 6 months storage. Low-O₂ and DCA prevented superficial scald development at the end of each storage period followed by shelf life. Air storage was characterized by a significant incidence of superficial scald that was reduced by regular CA. In these storage conditions a close relationship between superficial scald and increase of conjugated trienols during storage was detected, while a significantly lower content was found in Low-O₂ and DCA. The lowest incidence of superficial scald was detected in the second picking. All fruit batches, except those stored in air storage, developed soft scald, a CA storage related disorder. Low-O₂ and DCA promoted the highest incidence. At the end of shelf life all the fruit stored at the various conditions softened at different rates and fruit yellowing was sensibly delayed by low-O₂ and DCA. No brown core disorder was detected.

Keywords: /Pear/ /Ethylene/ /Postharvest/ /Superficial Scald/ /Soft Scald/

Han, Jian-long, et.al. 2015. Study of the pesticides distribution in peel, pulp and paper bag and the safety of pear bagging. Food Control 54:338 - 346.

Abstract

How to decrease the pesticides residue is a new challenge during growing, storage and processing of agricultural products. Pesticides distribution or migration study would be the key point to find a pesticide removal method. 173 pesticide components in peel, pulp or paper bag were extracted by acetonitrile after fortified with chlorpyrifos- d_{10} as isotope internal standard. The extract was simply purified by dispersive sorbent of primary secondary amine (PSA) and then measured by online gel permeation chromatography-gas chromatography/mass spectrometry (GPC-GC/MS). The positive results were used to study the pesticides distribution properties in peel, pulp and paper bag. The pesticides distribution properties between peel and pulp were well applied for pesticides removal, risk assessment and suitable eating way for pear. Except of pesticides with strong polarity and high water solubility, most of the pesticides stayed in the skin of a pear and can be eliminated by peeling. A pear is safe for pesticides residue if eaten with peeling and might exist risk to some degree if eaten without peeling. The practical application of pear bagging is safe as far as pesticides residue is concerned.

Keywords: /Pear/ /Pesticides Residue/ /Bagging/

Rizzolo, A., et.al. 2015. α -farnesene, conjugated trienols, fermentative metabolites and superficial scald in 'conference' **pears** as affected by 1-methylcyclopropene, initial low oxygen stress and controlled atmosphere storage. Acta Hort. 1071:429 - 436.

Abstract

The effect of initial low oxygen stress (ILOS) on α -farnesene, conjugated trienols (CTols), fermentative metabolites and superficial scald development in 'Conference' pears was investigated. At harvest, fruit were untreated or treated with 300 ppb 1-MCP. After 4 weeks at -0.5°C , fruit were stored up to 13 weeks in controlled atmosphere (CA, $2\text{ kPaO}_2 + 0.7\text{ kPaCO}_2$) with or without ILOS ($0.3\text{-}0.5\text{ kPaO}_2$) or in air (NA) at -0.5°C . ILOS was applied for 2 weeks either one time (ILOS1) or twice at 3 weeks interval (ILOS2), while monitored with fluorescence sensors (HarvestWatchTM). α -farnesene, CTols and fermentative metabolites were measured at the beginning and at the end of ILOS1 and ILOS2 in comparison with NA and CA storage and after 13 weeks of storage. Scald incidence was evaluated at the end of storage after 7 days at 20°C . Fluorescence monitoring indicated that in order to achieve the low oxygen stress in 'Conference' pears, O_2 has to be kept lower than 0.4 kPa in control fruit, and that 1-MCP treatment lowered the low O_2 limit. As in ILOS1 containers O_2 did not drop below 0.4 kPa , ILOS1 pears have not undergone any stress, as confirmed by the trends of fermentative metabolites, α -farnesene and CTols, which did not differ from the CA stored fruit. In ILOS2 there was lower α -farnesene and CT268 than in CA and NA, coupled to an increase in ethanol production. On average, fruit treated with 1-MCP had lower α -farnesene and CTols than untreated pears. α -Farnesene, CTols and ethyl acetate increased and acetaldehyde and ethanol decreased with storage. Storage atmosphere did not influence α -farnesene and CTols, but affected acetaldehyde and ethanol contents in the pulp, with CA, ILOS1 and ILOS2 stored fruit being characterized by lower amounts of acetaldehyde, and higher quantities of ethanol than NA stored pears. In all storage conditions, untreated fruit developed brown scald, with NA fruits having the highest incidence and severity. 1-MCP treated fruit developed some scald in all storage regimes, but less than untreated ones. ILOS2 pears showed the highest percentage of healthy fruits, irrespective of 1-MCP treatment. Our results indicated that, even if stress was obtained in ILOS2 storage, a clear correlation between α -farnesene, CTols and brown scald development was not found. However, ILOS2 fruit, having less α -farnesene and fermentative metabolites, showed the lowest percentage of scald.

Keywords: /Pears/ /Ethanol/ /1-MCP/

Vanoli, M., A. Rizzolo, M. Grassi. 2015. Fruit quality and sensory characteristics of 1-mcp treated 'abbé fétel' pears after storage under dynamic controlled atmosphere at different temperatures. *Acta Hort.* 1071:437 - 446.

Abstract

'Abbé Fétel' is the most important pear cultivar in Italy but is susceptible to superficial scald and soft scald during storage. Superficial scald is controlled by ethoxyquin but recently it has been excluded from the list of the active ingredients of chemicals used in food production. The combination of 1-MCP and dynamic controlled atmosphere (DCA) storage can be considered as an alternative to ethoxyquin because 1-MCP and DCA are effective in preventing superficial scald. However, 1-MCP at -0.5°C prevents pear ripening and DCA can favor the appearance of soft scald, especially after long storage. The aim of this work was to study the quality of 'Abbé Fétel' pears after 4 months of storage at -0.5 and 1°C in normal air (NA) and in DCA (0.8 kPa O₂ + 0.4 kPa CO₂). 1-MCP treated (300 µl/L) and control fruit were stored at -0.5 and 1°C in NA and DCA. After 4 months, fruit were put at 20°C up to 7 days and evaluated for skin color, flesh firmness, ethylene production (EP), sensory characteristics and storage disorders. Fruit softening and EP were strongly reduced by 1-MCP at -0.5°C; some EP was found after 7 days at 20°C in 1°C stored pears, which showed also firmness values lower than 40 N in 40% of NA fruits and in 15% of DCA fruit. Skin yellowing was slowed down by 1-MCP, especially in DCA fruit which kept the greenest color throughout the shelf life period whatever the storage temperatures; NA treated fruit turned yellow during shelf life, showing the highest *H*^o at -0.5°C. Control fruit stored in DCA showed a similar skin color to treated DCA pears at the beginning of shelf life which quickly yellowed up to the end of shelf life. Control fruit stored in NA at 1°C showed the lowest *H*^o. 1-MCP treated pears were perceived firmer, and less juicy, sweet and aromatic than control ones regardless of the storage condition. Control pears in NA at 1°C showed the lowest scores for juiciness and aroma and the highest for graininess while control pears stored in NA at -0.5°C and in DCA at both temperatures were judged soft, juicy, sweet and aromatic and slightly grainy, especially after 4 and 7 days at 20°C. 1-MCP prevented soft scald, superficial scald and internal breakdown, but was ineffective on internal browning. Control pears stored in NA showed a very high incidence of superficial scald at both temperatures; control pears stored in DCA at -0.5°C developed only some internal breakdown while those stored at 1°C showed also soft scald and internal browning.

Keywords: /Pear/ /Firmness/ /Ethylene/ /Superficial Scald/ /Soft Scald/

Wang, Yan, David Sugar. 2015. 1-MCP efficacy in extending storage life of 'Bartlett' pears is affected by harvest maturity, production elevation, and holding temperature during treatment delay. *Postharvest Biol. & Technol.* 103:1 – 8.

Abstract

The efficacy of 1-methylcyclopropene (1-MCP) in extending storage life of the Pacific Northwest 'Bartlett' pear is inconsistent. The effects of harvest maturity [H1: flesh firmness (FF)≈83.6 N; H2: FF≈74.8 N], production elevation (E1≈150 m; E2≈610 m), and holding temperature (0 and 5 °C) prior to application of 1-MCP have been measured with respect to ethylene production, fruit quality, and storage disorders of 'Bartlett' fruit during 6 months of storage at -1.1 °C. 1-MCP at 0.3 µL L⁻¹ for 24 h at 0 °C inhibited ethylene production, FF and green color losses, senescence disorders, and friction

discoloration for H1 fruit from both elevations. However, 1-MCP efficacy was reduced moderately in E1H2 fruit and reduced to a greater extent in E2H2 fruit. Internal ethylene concentration (IEC) at harvest was not detected in H1 fruit from either elevation, but it accumulated in E1H2 and E2H2 fruit (E2H2 > E1H2). The holding temperature at 5 °C but not 0 °C for 12 d between harvest and 1-MCP treatment increased fruit IEC and ethylene production rate and reduced the fruit response to subsequent 1-MCP treatment. The fruit physiological stage at the moment of 1-MCP treatment determined the efficacy of 1-MCP in extending the storage life of 'Bartlett' pears. 1-MCP retarded development of ripening capacity and 10–14 d at 20 °C were needed to ripen 1-MCP treated 'Bartlett' pears to optimum eating quality following 5–6 months of cold storage.

Keywords: /Pear/ /1-MCP/ /Harvest Maturity/ /Storage Disorders/ /Ripening/

Weksler, A., S. Lurie, H. Friedman. 2015. Controlled atmosphere storage of 'spadona' pears. Acta Hort. 1071:81-86.

Abstract

Pear fruit are often stored in controlled atmosphere (CA) for up to 12 months in Israel. A number of new agro-technical procedures have become routine in pear orchards, including the use of the synthetic cytokinin CPPU two weeks after full bloom to increase fruit size. This change in management conditions led us to validate the efficacy of the accepted CA formula of 1.5% O₂ and 2% CO₂. 'Spadona' pears were harvested three times in July from three orchards in the north of Israel. The fruit were first treated against decay (Marpan) and superficial scald (Ethoxyquin), sorted, samples were taken for ripeness parameters, and the rest placed in storage. The fruit were placed in storage at -1°C and CA of 1.5% O₂, with CO₂ concentrations of 0.5, 2, 5 and 7%, with an air storage comparison. Two removals were conducted, after 5 and 10 months, and evaluation was performed at removal and after 5 days at 20°C. After 5 months of storage the fruit were of good appearance, except for some decay in the air and 0.5% CO₂ stored fruit. There was also CO₂ internal damage in one orchard at 7% CO₂. Scratches appeared during shelf life, with the least in 5 and 7% CO₂. After 10 months, fruits from air storage had high levels of decay. There was decreasing firmness in the fruit as the harvest was later, and as CO₂ conditions were lower. CO₂ damage was apparent at 5% although only in the third harvest, and in 7% in all harvests. Internal browning was greatest in air and 7% CO₂ stored fruit, and almost absent in 2% CO₂ stored fruit. Taste tests were conducted in shelf life after both removals and overall taste was found to be best in fruit from 2% CO₂ and two orchards registered good taste in 5% CO₂. In conclusion, an atmosphere of 2% CO₂ and 1.5% O₂ is still the best for storage of 'Spadona' pears, although early harvested fruit benefit from 5% CO₂. Storage in 5% CO₂ led to firmer fruit and less scratch development during shelf life than 2% CO₂, but there was a danger of internal damage in later harvests.

Keywords: /Pear/ /Firmness/ /Peel Disorders/ /Internal Browning/

Zhou, Xin, et. al. 2015. Effects of intermittent warming on aroma-related esters of 1-methylcyclopropene-treated 'Nanguo' pears during ripening at room temperature. Scientia Hort. 185: 82 – 89.

Abstract

Refrigeration combined with 1-methylcyclopropene (1-MCP) treatment is an effective method for the long-term storage of climacteric fruit, but this benefit is offset by a loss of aroma when the fruit

is then ripened at room temperature. The pear cv. 'Nanguo' (*Pyrus ussuriensis* Maxim.) was treated with 1-MCP and continuously stored at $0 \pm 0.5^\circ\text{C}$ or exposed to the same storage temperature alternated with $20 \pm 1^\circ\text{C}$ for 1 d every 20 d during storage (namely, intermittent warming [IW]). Changes in aroma-related esters, levels of fatty acids, and the activity and gene expression of alcohol acyltransferase (AAT) and lipoxygenase (LOX) were investigated. Changes in the gene expression of the enzymes (1-aminocyclopropane-carboxylase (ACC) synthase (ACS) and ACC oxidase (ACO)) involved in ethylene biosynthesis and the expression of genes involved in ethylene signal transduction were also studied. Significantly higher ester content was found in IW-treated fruit. Increased activity and gene expression of AAT, LOX, and accumulated polyunsaturated fatty acids were associated with enhanced aroma quality in IW-treated fruit. The increased translation levels of PuACS1 and PuACO1 contributed to the elevated ethylene levels in IW-treated fruit. IW treatment seemed to have no significant effect on the induction of the expression of PuETR1 and merely stimulated the expression of PuCTR1 during the prior period of the shelf life at 20°C . Treatment with IW effectively prevented the loss of aroma-related esters from 1-MCP-treated 'Nanguo' pears, and possible mechanisms for this were discussed.

Keywords: /Pear/ /1-MCP/ /Ethylene/

PERSIMMONS

Izumi, H., Y., et.al. 2015. Microbiological and visual quality of enzymatically peeled baby **persimmons** stored in High CO_2 controlled atmospheres. *Acta Hort.* 1071: 203 - 210.

Abstract

Freshly peeled "baby persimmons", 3-4 cm in diameter and 20-25 g in weight, were prepared by enzymatic peeling of 'Totsutanenashi' cherry persimmon fruit (*Diospyros kaki* Thunb.), which is a bud mutation and miniature of the full size 'Hiratanenashi' persimmon. The microbiological and visual quality of enzymatically peeled baby persimmons as a fresh-cut fruit was evaluated during storage in air or high CO_2 atmospheres (10, 15 and 20%) at 10°C . The flesh of intact baby persimmon fruit showed counts of 2.6 log CFU/g for mesophilic aerobic bacteria and a non-detectable level for coliform groups and fungi. A hot water dipping treatment in the enzymatic peeling process reduced both the counts of mesophiles to levels below the lower limit of detection (2.4 log CFU/g) and the diversity of bacterial flora. Coliforms and fungi remained undetectable throughout the enzymatic peeling process. During storage in air, counts of mesophiles, coliforms, lactic acid bacteria, and fungi of baby persimmons increased to 4-5.5 log CFU/g by day 6, while high CO_2 atmospheres reduced the microbial growth, with the greatest reduction observed in 15 or 20% CO_2 . Diversity of the microflora also decreased in 20% CO_2 atmosphere as compared to air on day 6. High CO_2 atmospheres inhibited the development of brown discoloration in baby persimmons by day 4, but all samples developed browning to an unmarketable level by day 6. These results indicate that high CO_2 atmospheres of 15 to 20% are desirable for enzymatically peeled baby persimmons to extend the shelf life when stored at 10°C .

Keywords: /Persimmon/ /Browning/ /Quality/

Sanchís, E., et.al. 2015. Effect of postharvest 1-MCP treatment on shelf-life of fresh-cut 'rojo brillante' **persimmons** dipped in antioxidants. *Acta Hort.* 1071: 349 - 354.

Abstract

'Rojo Brillante' persimmon fruit has expanded greatly due to the application of technologies to remove astringency that improves commercialization and transport, maintaining a firm consistency. This allows its commercialization as a fresh-cut commodity; however, the shelf life of minimally processed persimmon is limited due to enzymatic browning and softening. The use of 1-MCP in postharvest is becoming a common technology to prolong the storage time and extend the campaign of persimmons. Thus, the aim of this work was to study the effect of processing on 1-MCP treated persimmon fruit stored at 1°C. Persimmon fruit were treated with 600 ppm of 1-MCP and stored at 1°C up to 60 days. Untreated fruit was also stored as control. Every 15 days, the astringency of the fruit was removed and cut in slices. Samples treated and untreated with 1-MCP were dipped in an antioxidant solution of 1% citric acid + 1% CaCl₂ or water, as control. Persimmon slices were packed under normal atmosphere and stored at 5°C for 9 days. Color, firmness and visual quality were measured during storage. Initial L* values decreased with storage at 1°C. L* and a* values of fresh-cut persimmons decreased and increased, respectively, during storage at 5°C, indicating surface browning. Antioxidant application significantly reduced browning; whereas, 1-MCP had no effect on color of fresh-cut tissue. Fruit firmness decreased during storage at 1°C, but 1-MCP reduced firmness loss significantly. The application of 1-MCP at harvest allowed to process 'Rojo Brillante' persimmon after 45 days of storage at 1°C. The persimmon slices dipped in the antioxidant solution were evaluated above the limit of marketability after 9 days of storage at 5°C.

Keywords: /Persimmon/ /Antioxidants/ /Controlled Atmosphere/ /1-Methylcyclopropene/ /Enzymatic Browning/ /Firmness/ /Minimally Processed/

PLUM

Kim, Ho-Youn, et.al. 2015. Non-climacteric ripening and sorbitol homeostasis in **plum** fruits. Plant Sci. 231: 30 – 39.

Abstract

During ripening fruits undergo several physiological and biochemical modifications that influence quality-related properties, such as texture, color, aroma and taste. We studied the differences in ethylene and sugar metabolism between two genetically related Japanese plum cultivars with contrasting ripening behaviors. 'Santa Rosa' (SR) behaved as a typical climacteric fruit, while the bud sport mutant 'Sweet Miriam' (SM) displayed a non-climacteric ripening pattern. SM fruit displayed a delayed ripening that lasted 120 days longer than that of the climacteric fruit. At the full-ripe stage, both cultivars reached similar final size and weight but the non-climacteric fruits were firmer than the climacteric fruits. Fully ripe non-climacteric plum fruits, showed an accumulation of sorbitol that was 2.5 times higher than that of climacteric fruits, and the increase in sorbitol were also paralleled to an increase in sucrose catabolism. These changes were highly correlated with decreased activity and expression of NAD⁺-dependent sorbitol dehydrogenase and sorbitol oxidase and increased sorbitol-6-phosphate dehydrogenase activity, suggesting an enhanced sorbitol synthesis in non-climacteric fruits.

Keywords: /Plum/ /Delayed Ripening/ /Ethylene/

POMEGRANATE

Martínez-Rubio, D., et.al. 2015. Application of an edible coating based on *Aloe vera* to improve general quality of minimal processed **pomegranate** Arils. Acta Hort. 1071:489 - 494.

Abstract

The pomegranate (*Punica granatum* L.) grown in many countries of the Mediterranean Sea, is usually consumed as fresh seeds (arils). The arils contain around 80% of juice and 20% of seed. The cultivar 'Wonderful' is quite appreciated by consumers, containing high concentrations of sugars, organic acids, vitamins, polysaccharides, and essential minerals. However, desiccation and browning result in important quality losses during postharvest storage of pomegranate arils. To prevent moisture loss and suppress desiccation-related browning, we applied an edible coating based on *Aloe vera* to improve commercial life and general quality of minimally processed arils. Pomegranate arils treated by immersion in a solution containing organic acids (control) and in *Aloe vera* gel solution after that, all the aril were placed inside plastic packages under cold storage up to 17 days. Results show, that the edible coating did not affect the natural flavour of pomegranate arils or the internal gas composition (CO₂ and O₂) of the package in comparison with control arils. On the other hand, the application of the edible coating resulted in lower ethylene concentration in the packaging head space and a higher firmness of the arils. A more advanced maturity was seen for control fruit arils in comparison with those which *Aloe vera* coating was applied. In addition, the edible coating reduced the microbial counts drastically. For these reasons, *Aloe vera* gel coating could be an effective additional technology to improve the general quality of this product.

Keywords: /Packaging/ /Storage/ /Edible Coating/ /Quality/

RASPBERRY

Flores, Gema, Maria Luisa Ruiz del Castillo. 2015. Variations in ellagic acid, quercetin and myricetin in berry cultivars after preharvest methyl jasmonate treatments. *J. Food Comp. & Analysis* 39:55 – 61.

Abstract

Effect of preharvest methyl jasmonate treatments on the levels of ellagic acid, quercetin and myricetin in raspberries and blackcurrants was investigated. Varietal influence on treatment effect was particularly considered. For this purpose, different cultivars of raspberry (Glen Lyon, Glen Ample and Tumaleen) and blackcurrant (Ben Hope, Ben Alder and Gairn) were studied. The treatments were carried out by spraying two distinct concentrations of methyl jasmonate (0.01 and 0.1 mM) on berry plants. Cultivar to cultivar variations in the contents of ellagic acid and myricetin were observed in untreated berries. No varietal differences were however found in quercetin content. The effect of preharvest methyl jasmonate treatments was also cultivar independent. Preharvest methyl jasmonate always resulted in a general increase of the flavonoids studied, particularly, ellagic acid and quercetin. For instance, the content of ellagic acid increased approximately from 10 to 22 mg 100 g⁻¹ and quercetin increased from 6 to 16 mg 100 g⁻¹ in Glen Lyon raspberries. Similarly, ellagic acid increased from 6 to 11 mg 100 g⁻¹ and quercetin from 4 to 9 mg 100 g⁻¹ in Ben Hope blackcurrants. Preharvest methyl jasmonate treatment can be useful to food industry to obtain berries with enhanced health promoting properties.

Keywords: /Raspberry/ /Methyl Jasmonate/ /Preharvest Treatment/ /Quercetin/

STRAWBERRIES

Magazin, N., et.al. 2015. modified atmosphere packaging of fully ripe **strawberries**. Acta Hort. 1071:241- 244.

Abstract

The objective of this research was to investigate how MAP influences quality attributes of fully ripe strawberries. Fully ripe fruits, 'Senga Sengana' from organic production and 'Arosa' from conventional, were stored under the following treatment conditions: A) fruits pre-cooled to 2°C and placed in MAP (transmission rates: O₂ 530 cc/m²/day and CO₂ 4200 cc/m²/day at 23°C, Xtend®, Stepac); B) MAP without pre-cooling; C) pre-cooled and cold stored fruit without MAP as a control. All fruits were stored at 1°C for 5 days. After removal from storage and MAP, fruits were kept at 20°C for 24 h. Fruit firmness, total soluble solids and titratable acidity, together with percentage of decayed, bruised and healthy fruits were assessed. 'Arosa' fruits were firmer if MAP-treated, regardless of pre-cooling, and they had less decay and bruising in MAP, especially if fruits were not pre-cooled. Treatments did not affect fruit firmness of 'Senga Sengana' while the effect of MAP was primarily a reduction in the percentage of bruised fruits. Total soluble solids and titratable acidity of either cultivar was not affected by treatment. These results show that MAP can be used for storage of fully ripe strawberries.

Keywords: /Strawberry/ /Modified Atmosphere Packaging/ /Quality/

SWEET CHERRIES

Çalhan, Ö., et.al. 2015. Effect of harvest date on postharvest quality of 'kordia' **sweet cherry** during MAP storage. Acta Hort. 1071:667 - 674.

Abstract

In this study, changes in the quality of 'Kordia' sweet cherry fruit harvested at different dates and stored in modified atmosphere packaging (MAP) were investigated. Fruits were picked at three different dates (P-1: early; P-2: optimum; P-3: late) at intervals of 5 d. Harvested fruit were stored at 0°C under MAP (Life Pack® bag for cherry) for 6 weeks. During storage, fruit quality analyses were made at intervals of 2 weeks. Weight loss of early- and late-picked fruit was greater than that of fruit from the optimum harvest date. The respiration rate was higher in the early- and late-picked fruit than those from the optimum harvest date. The respiration rate increased during storage for harvest dates. The total soluble solids decreased as harvest date progressed and with increasing storage time. The L* and a* values of the fruit decreased as harvest date progressed and with increasing storage time.

Keywords: /Sweet Cherry/

Giacalone, G., V. Chiabrandò. 2015. Modified atmosphere packaging of **sweet cherries** with different packaging systems: effect on organoleptic quality. Acta Hort. 1071:87 - 96.

Abstract

Using biodegradable polymers for packaging is an alternative to synthetic inert polymers and a possible, partial solution to the problem of accumulation of solid waste. In this study was assessed the

influence of two different packaging systems (biodegradable packaging and traditional packaging) on quality loss of 'Black Star*' sweet cherries. In particular, the fruits were packaged in two different baskets, sealed with two distinct films. The packaging systems were: 1. Polylactic acid (PLA) basket thermo-sealed with biodegradable film (Mater-Bi®); 2. Polypropylene basket thermo-sealed with polypropylene film (control). Cherry quality during storage (35 days; 4°C) was determined by monitoring headspace gas concentration, color (L* and hue angle), weight loss, firmness, total soluble solids, titratable acidity, anthocyanins content, phenolics content, total antioxidant capacity and incidence of postharvest diseases. Results suggest that biodegradable polymers could be used in packaging of sweet cherries without negative effects on final quality. During storage, an increase in CO₂ and decrease in O₂ concentration occurred inside the MAP packages, reaching a steady-state atmosphere after 14 days (Control: 0.2% O₂; 28% CO₂) or 21 days (PLA: 0.2% O₂; 31.5% CO₂). Firmness loss and color trends were the same for all samples. Total soluble solids content was substantially unchanged from the beginning to the end of storage almost no statistically significant differences between the two packaging systems while the incidence of postharvest diseases was almost always lower in sample packaged with biodegradable polymers probably as a consequence of high CO₂ level. In conclusion, cherries are particularly suitable to MAP and good results are usually obtained with traditional packaging associated with MA, while the biodegradable polymers are suitable as a packaging material for storage without reducing fruit quality.

Keywords: /Sweet Cherries/ /Postharvest Quality/ /MAP/

Koumanov, Kouman S. 2015. On the mechanisms of the sweet cherry (*Prunus avium* L.) fruit cracking: swelling or shrinking? *Scientia Hort.* 184: 169 – 170.

Abstract

This short communication brings to the attention of the scientific community a new hypothesis about the mechanism of the sweet cherry fruit cracking, which is a problem in most producing areas of the world and causes significant economic losses. It is commonly accepted that fruit crack after rainfalls because of the fruit-flesh swelling due to osmotic imbibition of water by cells. The proposed hypothesis attributes this phenomenon to fruit skin shrinking after its rapid cooling, caused by a rainfall or by sharp drop of the ambient temperature. If the proposed mechanism is correct, the cracking prevention measures should be thoroughly revised. Paradoxically, the expensive rain-preventing covers may be replaced by cheaper systems for cooling overhead (micro) sprinkling, which to be operated in the days with an unfavorable forecast. All related chemical treatments would not make sense anymore as well.

Keywords: /Sweet Cherry/ /Fruit Cracking/

Piazzolla, F., M. L. Amodio, F. Colantuono, G. Colelli. 2015. Effects of 1-methylcyclopropene (1-MCP) on quality of sweet cherry (*Prunus avium* L. 'Ferrovia') during storage. *Acta Hort.* 1071: 551 - 558.

Abstract

'Ferrovia' cherries were exposed to 1 ppm of 1-MCP for 24 hours at 4°C, and then stored at 4 and 20°C for 13 days. Initially, and after 6 and 13 days of storage, respiration rate, weight loss, cherry appearance score, peduncle appearance score, dehydration score for peduncle abscission zone, decay incidence, fruit color (L*, a*, b*, hue angle, and Chroma), and peduncle chlorophyll content, were monitored. Each treatment was replicated 3 times, and for each replicate 350 g of cherries were used.

Fruits stored at 20°C, were evaluated only at 6 days due to the high incidence of decay showed after that date. 1-MCP treated and untreated, control cherries were stored at 4°C showed a higher storability than those stored at room temperature, however, little effect of 1-MCP was observed on quality of cherry fruits at both temperatures. After 6 days at 20°C treated fruits showed lower weight loss and respiration rate comparing to the untreated cherries. In cherries stored at 4°C for 13 days, 1-MCP was only effective in slowing down respiration rate and delaying peduncle deterioration, whereas no other differences were detected between treated and untreated fruits. In conclusion, 1-MCP did not prevent quality loss of cherry fruits during storage at both temperatures, whereas at 4°C an effect on delaying peduncle discoloration was observed. Due to its minor impact on quality and storability, the commercial application of this technology is not advisable for cherries.

Keywords: /Sweet Cherry/ /1-MCP/ /Storage/ /Quality/

Wang, Yan, Lynn E. Long. 2015. Physiological and biochemical changes relating to postharvest splitting of sweet cherries affected by calcium application in hydrocooling water. Food Chem. 181:241 – 247.

Abstract

Hydrocooling sweet cherries shortly after harvest (4 h) and then transporting fruit in cold flume water during packing are used to maximize postharvest quality, but can cause fruit splitting. This study demonstrated that cherry fruit (two splitting-susceptible cultivars) absorbed Ca in a quadratic polynomial manner with increasing CaCl₂ concentration from 0.2% to 2.0% in cold water (0 °C) for 5 min, but did not take up Cl. The enhanced tissue Ca content reduced splitting potential by decreasing fruit soluble pectin release and increasing the splitting threshold. In contrast, depleting Ca from fruit tissue by EDTA or low pH, increased soluble pectin release and splitting potential. In a simulated commercial procedure, hydrocooling cherry fruit in appropriate CaCl₂ solutions (i.e., 0.2–0.5%) for 5 min and then passing the fruit in cold flume water for 15 min increased fruit firmness, retarded losses in ascorbic acid, titratable acidity, and skin color, and reduced splitting and decay following 4 weeks of cold storage.

Keywords: /Sweet Cherry/ /Postharvest/ /Shipping/ /Quality/

TABLE GRAPES

Carter, Michelle Qiu, et.al. 2015. Effect of sulfur dioxide fumigation on survival of foodborne pathogens on table grapes under standard storage temperature. Food Microbiol. 49:189 - 196.

Abstract

We examined the fate of *Listeria monocytogenes*, *Escherichia coli* O157:H7, and *Salmonella enterica* Thompson inoculated on freshly-harvested table grapes under standard cold storage with initial and weekly sulfur dioxide (SO₂) fumigation. *L. monocytogenes* and *S. enterica* Thompson were much more sensitive to cold temperature than *E. coli* O157:H7. Furthermore, *L. monocytogenes* was highly susceptible to SO₂. Initial fumigation with 100 or 200 ppm-hr was sufficient to eliminate this pathogen on grapes with low (10⁴ cells/grape) and high (10⁶ cells/grape) inocula, respectively. Initial fumigation with 300 ppm-hr reduced *S. enterica* Thompson population about 300- and 10-fold on grapes with low and high inocula, respectively. Initial fumigation with 300 ppm-hr reduced *E. coli* O157:H7 population to less than 10-fold, regardless of inoculum density. When grapes were inoculated with the high inoculum

and fumigated on days 0 and 7 with 200 or 300 ppm-hr SO₂, *S. enterica* Thompson and *E. coli* O157:H7 were completely inactivated between days 8 and 14 of cold storage. Standard cold storage combined with SO₂ fumigation was effective in reducing and eliminating all three pathogens on table grapes, however, depending on the dose, two or three fumigations were needed for elimination of *S. enterica* Thompson and *E. coli* O157:H7.

Keywords: /Table Grapes/ /Fumigation/ /Foodborne Pathogens/

Cefola, M., et.al. 2015. Active coatings for food packaging: a new strategy for **table grape** storage. *Acta Hort.* 1071:121 - 128.

Abstract

Table grape producers worldwide are constantly searching for new technologies that will allow grape clusters to maintain the fresh appearance they had immediately following harvest. Postharvest technologies used to extend table grape shelf-life include active packaging. In this paper, the effect of active PET packaging on the marketability and rachis browning development of 'Red Globe' and 'Crimson' seedless table grape was assessed, in comparison to the storage in polyethylene (PE) film alone or in combination with SO₂ pad. Active PET showed significant effect on the marketability and antioxidant activity preservation in comparison with the use of SO₂ pad. In particular, the active PET is able to ensure the marketability of the table grape, resulting a good competitor compared to the methods using the SO₂, slowing the process of rachis browning. In particular, the marketability of 'Crimson' is maximized by employing such system, whereas, it is reduced by 9 and 13% using PE alone or in combination with SO₂ pad. As for 'Red Globe', the marketability is positively influenced by the active PET which together with SO₂ pad guarantees maximum marketability, while the storage in PE alone causes a rapid loss of quality. In conclusion, active PET resulted a possible valid alternative to SO₂ in table grape storage.

Keywords: /Table Grapes/ /Active Coatings/ /Food Packaging/ /Shelf-Life/

Gatto, M. A., et.al. 2015. The role of CO₂ in reducing grey mould-caused diseases on stored **table grapes**. *Acta Hort.* 1071:747 - 754.

Abstract

Grey mould diseases caused by *Botrytis cinerea* are one of the main factors reducing table grapes postharvest quality. The effect of high CO₂ concentrations on some fruit biochemical parameters in the presence of a high disease pressure was evaluated. Bunches of 'Italia' table grapes were artificially infected by spraying with a conidial suspension of *B. cinerea*, packed in polyamide/polyethylene bags in three different initial modified atmosphere (MA) conditions and stored at 3°C for 18 days. Changes in phenolic compounds in skin and flesh, glucose and fructose content, polygalacturonase (PG) activity, and the incidence of grey mould rots were evaluated every 6 days during storage. The results showed that high CO₂ concentrations did not significantly affect PG activity which, on the contrary, was found higher in *Botrytis*-infected samples than in corresponding non-inoculated samples. Moreover, in artificially infected samples, a positive correlation between high CO₂ levels associated to the lowest disease incidence and the high concentration of caftaric acid (the most representative phenolic compound) in the skin was found. Therefore, it can be assumed that high CO₂ concentrations could

contribute to maintain high levels of phenolic compounds in the table grapes' skin, which, in turn, might be involved in counteracting the disease development.

Keywords: /Table Grapes/ /Postharvest Rots/ /Modified Atmosphere/

Wieczyńska, J., et. al. 2015. Effect of O₃ and High CO₂ application during cold storage on quality of organic **table grape** (*Vitis vinifera* L. 'Italia'). Acta Hort. 1071:575 - 582.

Abstract

The mediterranean climate creates perfect conditions for table grape (*Vitis vinifera* L.), which makes Italy one of the world's leaders in grape production and export. However, during postharvest handling and shipping, fruit quality decreases mainly because of development of grey mold (*Botrytis cinerea*). The growing demand for organic fresh products leads to a search for new alternatives to conventional handling methods in order to prolong shelf-life of organic fruits, which are more vulnerable to fungi infestation as use of fungicides is not permitted. Quality assessment of organic table grapes ('Italia') was carried out in order to compare effectiveness of different pre- and postharvest treatments, on shelf-life of table grapes. The evaluation was done through chemical, physical and sensory analysis of grape samples subjected in the field to the treatment with potassium bicarbonate (KHCO₃) and during cold storage with ozone (O₃) alone or in combination with high carbon dioxide (CO₂), in order to control the development and the diffusion of *B. cinerea*. Organic table grapes, packaged in perforated polypropylene bags, were stored at 0°C and 90-95% RH for 28 days and treated with continuous O₃ (0.8-1.2 µl/L) or combination of CO₂ (30 kPa for 48 h) and O₃ after field treatment of KHCO₃. Samples were analyzed on weekly basis. The experimental conditions including pre-treatment in the field with KHCO₃, packaging with perforated polypropylene bags, low temperature (0°C) and high relative humidity (90-95%) combined with CO₂ (30 kPa for 48 h) and O₃ (0.8-1.2 µl/L), have restricted the development of *B. cinerea* and preserved good commercial quality for 28 days of storage plus 1 day of shelf-life (12°C). The obtained results conclude that appropriate combination of different treatments can help to increase the time of commercialization of fresh organic grapes.

Keywords: /Table Grape/ /Shelf-Life/ /Organic Farming/

VEGETABLES

BROCCOLI

Cefola, M., et.al. 2015. Compositional and marketable quality of fresh-cut florets of four specialty **brassicas** in relation to controlled atmosphere storage. Acta Hort. 1071:455 - 462.

Abstract

Brassica vegetables are consumed year-round as raw salad or cooked ingredients. Four *Brassica* species were selected for this study, broccoli (*Brassica oleracea* var. *italica*), broccoli raab (*Brassica rapa* L.), choisum (*Brassica rapa* var. *parachinensis*), and gailan (*Brassica oleracea* var. *alboglabra*). While there is abundant information about broccoli, research on gailan, choisum and broccoli raab is very limited. The effect of CA (3% O₂ alone or in combination with 7 or 15% CO₂, 1% O₂ alone or combined with 15% CO₂) and air on marketable quality (overall visual, yellowing, discoloration, decay) and chemical parameters (antioxidant activity, chlorophyll, sugar, fermentative volatiles, and ammonia

content) during storage at 5°C was evaluated. Products were obtained from a wholesaler, washed in chlorinated water, trimmed into florets and placed in unsealed polyethylene bags that were held in polycarbonate chambers through which humidified air or the controlled atmospheres flowed. Visual quality was evaluated after 0, 8, 12, 16 and 20 days, while chemical parameters were measured after 0, 8, 16 days. Generally, CA treatments did not affect the antioxidant activity, chlorophyll or sugar concentrations in any of the specialty brassicas studied. On the other hand, both ammonia content and visual quality evaluations were affected by atmosphere composition. Florets stored in low oxygen (3% O₂) often had the best visual quality but generally all atmospheres maintained better marketable quality than air storage. The 3% oxygen CA improved marketability to about 16 days. Low oxygen delayed postharvest and post-cutting deterioration of florets from all *Brassica* species, and based on changes in ammonia concentrations, was considered beneficial to maintain quality of fresh-cut brassicas stored at 5°C.

Keywords: /Broccoli/ /Controlled Atmosphere Storage/

Fernández-León, M. F., et. al. 2015. Concentrations of intact glucosinolates in 'parthenon' **broccoli** florets stored in modified atmosphere packaging and air. *Acta Hort.* 1071: 583 - 588.

Abstract

Interest in healthier diets has increased dramatically, with consumers demanding easy-to-cook and easy-to-eat products not only with relevant nutritive value but also with other healthy properties. Broccoli demand has increased and a key factor is the abundance of health-promoting compounds in this cruciferous plant, such as glucosinolates. As the concentrations of these compounds decrease after harvest, the aim of this research was to identify, quantify and compare the evolution of the content of intact glucosinolates of 'Parthenon' broccoli florets during storage under two different conditions. The first one consisted of a modified atmosphere package (MAP) of 10% O₂ + 5% CO₂ at the steady state, reached by using microperforated polypropylene plastic bags of 25×25 cm with a thickness of 30 µm. The second one was broccoli florets stored in unsealed bags as control. Glucosinolate concentrations in storage for 12 days at 5°C were compared to those in freshly harvested (Fresh) samples. A high-performance liquid chromatography instrument coupled to an Ion Trap mass spectrometer was used for the intact glucosinolates separation and determination. Thirteen intact glucosinolates were identified, which were classified according to their chemical structure into aliphatic, indole and aromatic. Compared to Fresh samples the loss of intact glucosinolates content in MAP samples was about 23%, while in control the loss was about 57%. Therefore, the retention of these biocompounds was higher under MAP than air storage conditions.

Keywords: /Broccoli/ /Modified Atmosphere Packaging/

Navarro-Rico, J., et. Al. 2015. Effect of edible coatings and electrolyzed water sanitation on fresh-cut 'bimi' **broccoli** quality. *Acta Hort.* 1071:463 - 470.

Abstract

Traditionally, edible coatings have been used as a barrier to minimize water loss and retard the natural senescence of horticultural products through selective permeability to gases. In this work, the effect of two edible coatings on quality of fresh-cut 'Bimi' broccoli during shelf life was studied. The broccoli was sanitized under neutral electrolyzed water (NEW) (ORP=900 mV; 5°C; pH=7; contact time=2

min). Two edible coatings were applied: Naturcover® (5% of sucroesters) and sodium alginate (2 g/100 ml) using glycerol as plasticizer and sunflower oil as emulsifier (contact time: 1 min; drying time: 1min). The product was then stored under modified atmosphere packaging throughout 15 days at 5°C. As control, washing with cold tap water and no coating was used. The colour, sensory quality and microbial loads (mesophilic, enterobacteria and yeasts and moulds) evolution throughout shelf life was studied. The equilibrium gas partial pressure was 12-14 kPa CO₂ and 9-12 kPa O₂ reached after 5-6 days. No colour differences were observed among treatments. The microbial loads ranged between 4 and 7 CFU g⁻¹ during shelf-life for the three microorganism groups analysed. After 15 days at 5°C, broccoli samples coated with Naturcover® showed the best sensory scores. As main conclusion, fresh-cut 'Bimi' broccoli coated with Naturcover® showed better quality than that coated with sodium alginate and control samples during shelf life.

Keywords: /Broccoli/ /Modified Atmosphere Packaging/ /Minimally Processed/

Pérez-Balibrea, S., et. al. 2015. Modified atmosphere packaging for **broccoli** sprouts affected by film permeability. Acta Hort. 1071:269 - 274.

Abstract

Consumption of fresh germinated vegetables (i.e., sprouts) is one of the fastest-growing industries due to the increasing demand by consumers for healthy convenience food. In this work, broccoli (*Brassica oleracea* var. *italica*) sprouts were packaged by using commercial films composed of polyester-polypropylene differing in thickness (P (12-50 µm), M (12-60 µm) and I (12-72 µm)) and then stored at 1°C for 16 days. Gas composition, visual quality and microbial counts (molds and yeasts and mesophilic aerobes) were assessed to determine the effects of modified atmosphere packaging (MAP) on the shelf-life of the sprouts. The package atmosphere analysis showed an increase of CO₂ and a decrease in O₂ levels throughout the storage period in the films, although atmospheric composition inside the packages was significantly different depending on the film used. On the other hand, those broccoli sprouts packed with the film having the lowest permeability exhibited the highest concentration of ethylene. The initial mesophilic counts of the packed broccoli sprouts was 8.1 log cfu·g⁻¹ and no significant differences were observed in the mesophilic bacterial population in any of the thermo-sealed packages during the 16 days of cold storage. With respect to mold and yeast counts in broccoli sprouts, the initial load of 4.3 log cfu·g⁻¹ was significantly decreased in all the packaging conditions. Overall results suggest that the use of a film generating a gas composition of 18% O₂ + 0.36% CO₂ was the best option to avoid anaerobic metabolism during postharvest handling the retail sale period of this novel, healthy and convenient food.

Keywords: /Broccoli/ /Ethylene/ /Modified Atmosphere Packaging/

Pliakoni, E. D., et. al. 2015. Physical and biochemical changes in **broccoli** that may assist in decision-making related to international marine transport in air or CA/MA. Acta Hort. 1071: 651 - 658.

Abstract

In conducting a supply chain project for the US Army, we learned that broccoli is one of the most commonly rejected items during marine transport of mixed loads of fresh fruits and vegetables in the Pacific region. Preliminary MAP experiments with freshly harvested broccoli indicated that temperature control alone is sufficient to maintain broccoli quality during shipping for up to 3 weeks.

Those results suggested that the broccoli in the shipments being simulated is not always freshly harvested at the time of container loading. Therefore, in this research we investigated potential indicators of broccoli freshness (i.e., physiological age) using delayed establishment of CA conditions. Fresh broccoli was obtained locally and held overnight in air at 0.5°C prior to the start of each experiment. Broccoli was placed into air or CA (1 kPa O₂ plus 10 kPa CO₂) at 0.5°C immediately or after 5 or 10 days in air at 0.5 or 5°C. Color changes on the florets and the cut surface of the stalks, weight loss, chlorophyll fluorescence, and overall subjective visual quality were evaluated after 10 and 20 days of storage at 0.5°C and after 20 days of storage plus 2 days shelf life at 20°C. Additional samples were stored for later analyses of vitamin C, chlorophyll a, chlorophyll b, total chlorophyll, total sugars, total amino acids, total phenolics and total protein. Although there were changes during storage and differences between treatments, none of the indices could be used as a 'freshness indicator' due to variability between different lots of broccoli that precluded determination of the physiological age. Optimum temperature conditions during transport can prevent rapid deterioration of freshly harvested broccoli for 3 weeks without further benefit from the use of CA/MA, but without specific knowledge of the product's prior temperature history, such shipments remain risky.

Keywords: /Broccoli/ /Quality/ /Weight Loss/

CABBAGE

Nyawali, Bechani, et. Al. 2015. Enzymatic browning reduction in white **cabbage** (*Brassica oleracea*) using honey: Does honey color matter? *LWT - Food Sci. & Technol.* 61:543 - 549.

Abstract

Thirteen honey groups consisting of 66 samples from different geographic locations in Zambia were screened for total phenolics, total flavonoids and antioxidant activity, and their color parameters (L*, a* and b*) were measured by transmittance. Total phenolic and flavonoid contents ranged from 479.2 ± 1.1 to 1383.9 ± 3.7 mg Gallic Acid Equivalents per kilogram of honey (mg GAE/kg) and from 85.5 ± 1.8 to 609.2 ± 3.7 mg Catechin Equivalents per kilogram of honey (mg CE/kg) respectively while total antioxidant activity ranged from 3.9 ± 0.5 to 7.8 ± 0.9 mmol (Fe²⁺)/kg. Enzymatic browning reductions increased with decreasing honey lightness (L* value) and honey redness (a* value) but were not found to be significantly affected by honey yellowness (b* value) (p > 0.05), implying that darker honeys possess stronger ability to reduce enzymatic browning in white cabbage than lighter honeys. Furthermore, the effect of honey color on aroma and taste characteristics was not significant (p > 0.05). However, geographic location had an effect on flowery (b = -0.21, t = -2.48, p < 0.05) and acidic (b = -0.52, t = -3.47, p < 0.01) characteristics of honey, suggesting that honey aroma or taste is likely to be influenced by the location where honey is harvested rather than by its color.

Keywords: /Cabbage/ /Enzymatic Browning/ /Antioxidant/

CARROT

Guimarães,, I. C., et. al. 2015. Fresh-cut **carrot** coated with starch/montmorillonite films and subjected to modified atmosphere packaging. *Acta Hort.* 1071: 559 - 566.

Abstract

Starch/montmorillonite films have potential as edible coatings on intact and fresh cut fruits and vegetables. The dispersal of montmorillonite (MMT) clay into edible coatings affects the barrier properties and can reduce the mass loss of fruits and vegetables. Its use should be accompanied with the proper choice of packaging, to ensure an ideal modified atmosphere to extend the shelf life of those products. The goal of this work was to evaluate fresh cut carrot (FCC) coated with MMT subjected to modified atmosphere packaging. Carrots were sanitized with sodium hypochlorite, cooled, peeled, sliced, sanitized again and centrifuged. Half of FCC was coated with starch/MMT film and another half was not. FCC, with or without coating, was packed in polypropylene rigid tray, covered with polypropylene rigid lid or sealed with polyethylene + propylene film (60 μm), setting up 4 treatments (RL = rigid lid; RLC = rigid lid + coating; ST = sealed tray; STC = sealed tray + coating). FCC was stored at 4°C and analyzed weekly for 4 weeks (mass loss, firmness, L*, hue angle, C*, organic acids, O₂, CO₂ and respiration rate). The sealed packages, in spite of coating of FCC, reduced mass loss compared with packages with rigid lid. FCC without coating had greater firmness than coated FCC. Higher L* occurred in RL, whereas higher C*, in RLC. RL promoted higher concentrations of citric and malic acids at the end of storage. The internal atmosphere of packages covered with rigid lid did not change over the storage period whereas the level of O₂ decreased to 14% and CO₂ increased to 17%, in sealed packages, after 7 days. The starch/MMT coating did not affect the respiration rate of FCC, but slowed the mass loss of FCC packed in PP with RL.

Keywords: /Carrot/ /Edible Film/ /Coating/ /Modified Atmosphere Packaging/

Nunes, E. E., et. al. 2015. Profile of volatile compounds of freshly cut peruvian carrot during storage. Acta Hort. 1071: 659 - 666.

Abstract

The objective of this work was to verify variation in the volatile compound profile of freshly cut Peruvian carrot during storage at 5°C for 15 days. The volatile compounds were isolated by the hydrodistillation technique in a modified Clevenger apparatus, quantified by gas chromatography, identified by mass spectrometry and Kovats indices and appraised by olfactometry by the sniffing technique. It was concluded that the character-impact compound of freshly cut Peruvian carrot is 2-acetyl-1-pyrroline, the major component is 2,9-heptadecadiene-4,6-diin-8-ol, and that the global aroma undergoes modifications during storage.

Keywords: /Carrot/ /Fresh-Cut/

LETTUCE

Baldassarre, V., et. al. 2015. Effect of argon-enriched atmospheres on shelf life of fresh-cut 'iceberg' lettuce. Acta Hort. 1071:755 - 762.

Abstract

The objective of this study was to evaluate the effect of Ar-enriched atmospheres, on the maintenance of quality characteristics of fresh-cut lettuce during refrigerated storage. 'Iceberg' lettuce was processed according to industry procedures and stored in a humidified flow of air (as a control) and of the following atmosphere: 97% Ar + 3% O₂, 50% Ar + 3% O₂, (balanced with 47% of N₂), and 97% N₂ + 3% O₂. Samples were stored at 5°C and evaluated before and after 2 and 9 days of storage. All

atmospheres were effective in slowing down respiration rate at 9 days, whereas no significant difference in color, texture, flavor, phenols, antioxidant activity, acetaldehyde and ethanol content were observed. After 9 days of storage, lettuce stored in 50% Ar and in N₂ atmosphere showed lower PPO activity than control, whereas samples stored under 97% Ar-enriched atmosphere exhibited an intermediate value. On the other hand, samples stored in 50% Ar-enriched atmospheres and control samples showed a higher cut edge discoloration, compared to samples stored in N₂ atmosphere, whereas sample stored in 97% Ar showed intermediate value. Moreover, lettuce stored in 97% Ar best retained ascorbic acid content up to 2 days of storage, but no differences among treatments were detected at the end of storage. At this time samples stored in N₂ atmosphere showed the lowest mesophilic load, whereas both 97% Ar and 97% N₂ were effective in slowing down yeast and mould. Our results suggest that the effects of argon-enriched atmosphere are quite similar to that of nitrogen, with a lower control of mesophilic bacteria and a better retention of vitamin C. Further investigations are needed to propose argon as an alternative gas in modified atmosphere packaging of fresh-cut lettuce.

Keywords: /Lettuce/ /Controlled Atmosphere/ /Quality/ /Fresh-cut/

Rodov, V., et. al. 2015. Active MAP of ready-to-eat **lettuce**: interplay between food quality and safety (the quafety approach). Acta Hort. 1071:287 - 296.

Abstract

Oxidative enzymatic browning of cut edges and microbial spoilage are the two major causes of deterioration of ready-to-eat lettuce. Furthermore, we have demonstrated that these two processes are interrelated and the presence of spoilage pseudomonad bacteria on cut lettuce surface hastens the accumulation of phenolics and enhances browning, presumably as part of the host defense response. Preventing browning by heat treatment promoted bacterial growth and tissue maceration of *Pectobacterium*-inoculated lettuce core discs. The red-colored phenolic oxidation products have been isolated from cut lettuce and are currently under investigation. Modified atmosphere packaging (MAP) is used to preserve the quality of fresh-cut lettuce by inhibiting both the oxidative browning and the growth of microbial populations. Flushing the packages with a gas mix of desired composition (active MAP) expedites the achievement of favorable atmosphere conditions improving the product quality preservation. At the same time, the active MAP favored the survival of *Salmonella* on lettuce leaves, possibly due to the elimination of its natural antagonists. Atmosphere modification does not ensure microbiological safety of ready-to-eat lettuce and must be supported by appropriate sanitation practices. Washing with active chlorine followed by potable water rinsing did not taint shredded lettuce with unacceptable level of disinfection byproducts but produced wastewater heavily contaminated with trihalomethanes. The comprehensive approach to quality and safety of ready to eat fresh products is the basis of the EU FP7 QUAFETY project.

Keywords: /Lettuce/ /Modified Atmosphere Packaging/ /Fresh-Cut/

Siroli, Lorenzo, et. al. 2015. Natural antimicrobials to prolong the shelf-life of minimally processed lamb's **lettuce**. Postharvest Biol. & Technol. 103: 35 – 44.

Abstract

Plant essential oils (EOs) and their components, generally recognized as safe and endowed with a wide antimicrobial activity, have been investigated in this paper as natural sanitizer alternatives to

chlorine to control spoilage bacteria and naturally occurring pathogens associated with minimally processed vegetables. From this perspective, the efficacy of oregano and thyme EOs and carvacrol was evaluated in comparison with chlorine for lamb's lettuce decontamination. Their effects were evaluated on mesophilic aerobic bacteria, yeasts, LAB, color parameters and volatile molecule profiles demonstrating the same efficacy of chlorine. A further optimization of the process highlighted that thyme and oregano EOs controlled minimally processed lamb's lettuce spoilage microflora without negatively affecting the quality and sensory properties of the products. These results demonstrate the potential of washing treatments based on natural antimicrobials, as alternatives to chlorine for the sanitization of minimally processed vegetables.

Keywords: /Lettuce/ /Minimally Processed/ /Shelf-Life/

Toivonen, P. M. A., et. al. 2015. Hypoxic atmospheres can induce subsequent increases in cutting-induced hydrogen peroxide production by fresh-cut romaine **lettuce**. Acta Hort. 1071:519 - 526.

Abstract

The potential of hypoxic treatments to induce increased hydrogen peroxide at cut edges in order to improve food safety of fresh-cut lettuce was studied. Hypoxic atmospheres (0.5 kPa O₂) were applied at 4°C for several days before fresh-cut processing in Romaine lettuce grown in both growth chambers and in the field. When the hypoxic atmosphere was applied to young growth chamber-grown lettuce, the production of hydrogen peroxide at the cut was increased by 30 to 50%. This resulted in lower survival of epiphytic bacteria and *E. coli* O157:H7 inoculated onto the lettuce prior to cutting. Older lettuce grown in the chambers did not show such a dramatic response. Response to hypoxic treatment increased up to seven days, after which it began to decline. Chamber grown lettuce infected with powdery mildew showed a reduced response to hypoxic treatment. Romaine lettuce grown in the field and harvested at the same stage as the young chamber grown lettuce showed varied response to hypoxic treatments, showing large increases in H₂O₂ production or no response to the treatment. Lettuce tested immediately after a severe heat stress event in the field showed no response to hypoxic treatments. Exposure to severe stress or infection by powdery mildew appears to reduce response to hypoxia. These results suggest that treatments to enhance wound-generated oxygen radical production are only effective in cases where the plant tissue has not been exposed to other stresses. This work helps to highlight the importance and limitation for stress treatment cross tolerance adaptation approaches to manage fresh-cut produce quality and safety.

Keywords: /Lettuce/ /Shelf Life/ /Food Safety/ /Fresh-Cut/

MUSHROOM

Wrona, Magdalena, Karim Bentayeb, Cristina Nerín. 2015. A novel active packaging for extending the shelf-life of fresh **mushrooms** (*Agaricus bisporus*). Food Control 54: 200 - 207.

Abstract

Active packaging plays a promising approach to extend the shelf-life of packed fresh mushrooms without compromising the fresh status. Four different active agents were incorporated into the packaging material to extend the shelf-life of packed mushrooms: sodium metabisulphite combined

with citric acid; green tea extract; cinnamon essential oil and purple carrot extract. The sulphur dioxide-based packaging maintained the mushrooms white and appealing to consumers for a longer time than conventional packaging. The release of sulphur dioxide was carefully adjusted to avoid undesirable yellowing while keeping the whitening effect. Sulphur dioxide was determined in the mushrooms after the storage period, being the resulting concentration below the current limit of 10 µg/g. Green tea extract at high concentration maintained white colour of mushrooms longer than blank samples. Cinnamon essential oil and purple carrot extracts did not show enough antioxidant properties to inhibit the spoilage of mushrooms and/or extending their shelf-life.

Keywords: /Mushrooms/ /Active Packaging/ /Shelf-Life/

ONION

Terry, L. A., K. Cools, S. Foukaraki. 2015. Understanding the underlying mechanisms by which ethylene supplementation extends storage life of onions and potatoes. Acta Hort. 1071:181 - 186.

Abstract

Ethylene is known to have profound effects on the postharvest quality of climacteric fresh produce. Understandably, far less emphasis has been given to understanding the role that ethylene might have in the regulation of dormancy or senescence in non-climacteric systems. It is now well established that continuous ethylene supplementation can extend the storage life of onions and potatoes even though these organs are low ethylene producers. In potato ethylene triggers dormancy break, but also inhibits sprout growth. In onion, both ethylene and the ethylene antagonist 1-methylcyclopropene (MCP) inhibit sprouting, suggesting a surprisingly similar pattern of control. Indeed, 1-MCP may act synergistically when combined with ethylene. Given this apparent dichotomy, the underlying mechanisms of hormones in regulating entry into dormancy, dormancy release and rate of postdormant sprout growth will be discussed since new evidence suggests that abscisic acid has a role in establishing dormancy.

Keywords: /Onion/ /Potato/ /Storage/

RADISH

Tsouvaltzis, P., J. K. Brecht, D. J. Huber. 2015. Reduced pO₂ better maintains visual quality, fresh weight, and antioxidant content of bunched radish (*Raphanus sativus* L.) than air storage. Acta Hort. 1071:187 - 194.

Abstract

The effect of reduced O₂ atmosphere on shelf life of radish (*Raphanus sativus* L.) was investigated. Bunched radishes were stored in 2 kPa O₂ or ambient air (21 kPa O₂) for 6 days at 10°C. Leaf discoloration developed in both treatments during storage, as indicated by higher L* and chroma values and lower hue, but the changes were reduced by low pO₂. In particular, low pO₂ reduced yellowing during storage as indicated by maintenance of lower a* value. Red coloration of hypocotyls increased during storage, but was not affected by storage atmosphere. Weight loss of bunched radishes was <1.5%, but was 2-fold higher in air compared with 2 kPa O₂. Ascorbate content and total antioxidant capacity decreased during storage, but remained higher in radishes stored in low pO₂. Phenolic content did not

change during storage. Peroxidase and ascorbate peroxidase activities declined during storage, but were unaffected by the storage atmosphere, while catalase activity increased in both atmospheres, resulting in significant decreases in hydrogen peroxide content. The results of this study indicate that storage of bunched radishes in reduced pO₂ is beneficial for maintaining fresh weight and leaf color, as well as reducing losses of ascorbate and antioxidant capacity in the hypocotyls, without induction of plant oxidative stress.

Keywords: /Radish/ /Controlled Atmosphere/ /Quality/

ROCKET LEAVES

Amaro, A. L., et. al. 2015. Respiration rate and functional quality of **rocket leaves** as affected by passive modified atmosphere packaging. Acta Hort. 1071:717 - 724.

Abstract

Fresh-cut wild rocket (*Diplotaxis tenuifolia* L.) represents a very interesting ready-to eat (RTE) product with a high market value. Scarce information is available on product freshness and on quality attribute deterioration during storage. The aim of this work was to evaluate the respiration rate and functional quality of rocket salad when packaged under passive atmosphere composition in two different permeability bags. Wild rocket was packaged on two different sealed polypropylene bags: macroperforated (P) and a non-permeable (NP) film bag. Bags were stored at 4°C during 15 days and the O₂ and CO₂ concentrations inside the bags, the respiration rate, the functional quality (ascorbic acid, phenolic compounds, anthocyanins, and chlorophyll) and microbial load of RTE rocket were evaluated at five different time points. Results showed that NP packages generated a passive modified atmosphere, with continuous decrease of O₂ concentration (close to anaerobiosis by 14 days) and with increasing CO₂ levels up to ca. 8 kPa after 5 days. Rocket preserved in this type of bag showed higher respiration rate in the first 2 days, when compared with rocket packaged in P bags. The evolution of carbon dioxide and oxygen concentration in both systems did not exhibit significant impact in the ascorbic acid and chlorophyll content. A positive effect of oxygen availability inside P packages was observed on total phenolic compounds and total anthocyanin concentration of rocket leaves, but simultaneously higher microbial contamination by day 5 in comparison with NP packages.

Keywords: /Rocket Leaves/ /Films/

TOMATO

Cantwell, M., M. Saltveit. 2015. Tolerance of grape **tomatoes** to controlled atmospheres at low temperature. Acta Hort. 1071:627 - 634.

Abstract

Grape and cherry tomatoes comprise about one quarter of retail tomato sales in the United States and are also important components in fresh-cut mixed vegetable trays. The latter require low temperatures and packaging which can produce a range of modified atmospheres (MA) to achieve 14 days of shelf-life. Postharvest handling recommendations for good tomato quality do not usually include low temperatures or MA. Storage studies were conducted to ascertain the effect of low temperatures and MA on grape tomato quality. Grape tomatoes (orange-red or more advanced color) can be stored in

clamshells for up to 18 days at 5°C and still be of marketable quality if kept cold. Continuous storage at 5°C in air resulted in minimal weight loss (a significant cause of quality loss in grape tomato stored at warmer temperatures), and retention of vitamin C levels, but no lycopene synthesis, and decreased sugar concentrations. However, if fruit were transferred from 5 or 10°C to warmer temperatures (i.e., 20°C), typical chilling injury symptoms (decay, poor color formation) occurred on fruit stored at 5°C but not at 10°C. Controlled atmospheres (CA) of 3 or 10% O₂ with 0, 7, 12 or 18% CO₂ provided little or no benefit, but were tolerated by grape tomatoes for up to 21 days at 5°C. These results are based on evaluation of visual appearance, discoloration, decay, aroma, off-odors, flavor, and changes in concentrations of lycopene, sugars, vitamin C, ethanol and acetaldehyde. Although not ideal, near-ripe high quality grape tomatoes perform well as components of fresh-cut vegetable trays at low temperatures and under atmospheres not usually recommended for tomatoes.

Keywords: /Tomato/ /Temperature/ /Controlled Atmospheres/

de Chiara, M. L. V., et. al. 2015. Photocatalytic degradation of ethylene on mesoporous TiO₂/SiO₂ nanocomposites: Effects on the ripening of mature green **tomatoes**. *Biosystems Eng.* 132: 61 - 70.

Abstract

Ethylene (C₂H₄) acts as plant hormone in horticultural and ornamental crops, and is responsible for a variety of effects that could be beneficial or detrimental. It accelerates senescence, stimulates chlorophyll loss, enhances excessive softening, promotes degreening and browning of vegetal tissues. These reported effects should be avoided during postharvest handling. In this study the photocatalytic degradation of C₂H₄ using mixed titania/silica (TiO₂/SiO₂) materials under UV light irradiation was investigated. Mixed phase TiO₂/SiO₂ nanocomposites with varying TiO₂/SiO₂ weight ratios were prepared by sol-gel method under mild hydrothermal conditions. Five types of nanocomposite powders, with weight percentage of TiO₂:SiO₂ of 100:0, 90:10, 80:20, 70:30, and 0:100 were prepared and are named as TiO₂, 90Ti-10Si, 80Ti-20Si, 70Ti-30Si, and SiO₂, respectively. The photocatalytic degradation test in the gas phase was conducted in a glass chamber using UV light as the irradiation source. The degradation efficiency of the different catalysts was investigated by measuring the percentage reduction of C₂H₄ in the reaction chamber at given time interval. It was observed that 80Ti-20Si sample showed the best degradation activity, resulting in complete ethylene removal from the atmosphere. The reduction rate increased when the contact time with the photocatalyst was prolonged. Mature green tomatoes were exposed to an ethylene-enriched atmosphere treated with 80Ti-20Si nanocomposite. The effect of photocatalytic ethylene removal was evident in the slower epicarp colour evolution compared to control samples. The developed material could be suitable for postharvest handling of the fresh produce (e.g. tomatoes) to prolong their shelf life and reduce losses.

Keywords: /Tomato/ /Ethylene/ /Postharvest/ /Ripening/

Deltsidis A. I., et. al. 2015. **Tomato** flavor changes at chilling and non-chilling temperatures as influenced by controlled atmospheres. *Acta Hort.* 1071:703 - 710.

Abstract

Postharvest temperatures recommended as safe to avoid chilling injury (CI) based on lack of visible symptoms suppress tomato aroma development. We investigated how temperatures at or above

the putative CI threshold of 12.5°C affected aroma of pink ‘Tasti Lee’ tomatoes and if controlled atmosphere (CA) could overcome loss of shelf life at the higher temperatures without compromising aroma. Fruit were held for 10 days in air or CA. Aroma volatiles and other quality features were measured on days 0, 5, and 10 as well as after shelf life (2 days in air at 20°C). Fruit at 15 and 18°C ripened more uniformly during shelf life. 6-Methyl-5-hepten-2-one (MHO), a CI marker, increased at 18°C and was lowest at 12.5°C, and was also lower in CA than in air, even though its percentage of the total volatiles was higher in CA. Beta ionone, a volatile with very high log odor units, was also higher in air than in CA at all temperatures after D10. Geranyl acetone, which has a fruity aroma, and citral were higher at 18°C followed by 15 and 12.5°C on D10. Hexanal, a basic tomato aroma, increased over time at all temperatures. However, in CA its contribution as a percent of the total volatiles was higher than in air, indicating suppression of the other volatiles in CA. While CA reduced CI and extended shelf life, aroma was reduced, especially in more extreme CA, likely due to inhibition of ripening.

Keywords: /Tomato/ /Low Oxygen Storage/ /Chilling Injury/

Gonzalez, Carla, et. al. 2015. **Tomato** cv. ‘Micro-Tom’ as a model system to study postharvest chilling tolerance. *Scientia Hort.* 184: 63 – 69.

Abstract

Storage at low temperature is a common practice to extend the market life of many vegetables. Among other horticultural crops, tomato fruit suffers chilling injury when it is storage under refrigerated conditions. Much effort has been made to understand the mechanisms of generation of this physiologic disturbance, but many aspects need to be clarified yet. Tomato (*Solanum lycopersicum*) cv. “Micro-Tom” is a miniature tomato plant with various properties that make it useful as a model system in plant biology. In this work, the potential of tomato cv. “Micro-Tom” fruit as a model to study chilling injury was investigated. The effect of postharvest chilling was compared on cvs. “Micro-Tom” and “Minitomato”, another variety with fruit of similar size. Green mature fruits cvs. “Micro-Tom” and “Minitomato” were harvested and stored during 4 weeks at 4°C. It was observed that tomato cv. “Micro-Tom” fruit was clearly tolerant to chilling while tomato cv. “Minitomato” fruit developed severe chilling injury symptoms and avoided ripening. Harvest and chilling altered the length of time between the different ripening stages, the development of red full color and smell. Also, it was shown that harvesting fruits by visual appreciation is a rapid and useful method for distinguishing the different ripening stages during tomato cv. “Micro-Tom” fruit ripening. These results showed that tomato cv. “Micro-Tom” fruit was able to counteract the strain resulting from the imposed chilling stress. Altogether these data indicate that tomato cv. “Micro-Tom” fruit is a good model to study the mechanism of postharvest chilling response and tolerance in tomato.

Keywords: /Tomato/ /Chilling injury/ /Ripening stages/ /Postharvest/

Li, Zhiguo, et. al. 2015. Multi-scale engineering properties of **tomato** fruits related to harvesting, simulation and textural evaluation. *LWT - Food Sci. & Technol.* 61: 444 - 451.

Abstract

In this study, multi-scale engineering properties related to the harvesting, simulation and textural evaluation of two tomato cultivars at six ripening stages were simultaneously investigated. A potential ripening scale based on the ratio of R:G:B for a given ripening stage was suggested. The

geometric mean diameter was most closely correlated with the fruit mass. Tomato fruit feature an irregular shape and asymmetric internal structure at the macro-scale, non-unique tissue thickness at the meso-scale and an irregular change of size, shape and arrangement of single cells at the micro-scale. The hardness and shear strength of fruit at different scales and the single cell mechanics varied with the fruit ripening stage but not the chosen cultivars. The contribution of exocarp to the hardness of whole fruit gradually increased with fruit ripeness. The hardness and shear strength of fruit tissues and the fruit's single cells varied between 0.37 and 2.25 MPa and 0.04 and 11.58 MPa, respectively. This puncture experimental method is well-suited to measure the hardness and shear strength of tomato fruit at different scales and single tomato cell mechanics.

Keywords: /Tomato/ /Harvesting/

Tsilikochrisos, Georgios, et. al. 2015. Glutamate dehydrogenase is differentially regulated in seeded and parthenocarpic **tomato** fruits during crop development and postharvest storage. *Scientia Hort.* 181: 34 - 42.

Abstract

Cherry tomatoes are more susceptible than larger fruit varieties to producing auxin-induced parthenocarpic fruits indistinguishable from seeded fruits in most organoleptic characteristics. In this study, the effects of auxin-induced parthenocarpy and of the short-term cold storage on the expression of GDH genes, one of the main regulatory enzymes of nitrogen metabolism, were examined. Seeded and parthenocarpic fruits exhibited differences in the pattern of expression of the genes coding for α - and β -subunits of GDH during fruit development. Short-term cold storage at 5°C significantly increased transcript accumulation of GDH genes, while storage at 10°C for five days mostly caused a reduction in the expression of the genes in both fruit types. Finally, no significant differences between the two fruit types were detected in the localization of GDH protein and GDH enzyme activity.

Keywords: /Tomato/ /Postharvest/ /Storage/

Van de Perre, Evelien, et. al. 2015. Climate impact on *Alternaria* moulds and their mycotoxins in fresh produce: the case of the **tomato** chain. *Food Res. Int'l.* 68: 41 – 46.

Abstract

Climate change will affect the presence and concentration of mycotoxin in various foods. Recently, a concern arised on the presence of *Alternaria* mycotoxins in tomatoes and derived tomato products. The objective of this study was to evaluate the effect of climate change on their growth and mycotoxin production on tomatoes in function of changing temperatures. Therefore, a climate change model "HadGEM2-ES" was applied and downscaling of coarse gridded data was done towards a tomato field surface. After transforming the daily temperature data towards hourly data, the growth model of the *Alternaria* mould was applied. This leads to an assessment of growth rate and actual growth for three time frames being current (1981–2000), near (2031–2050) and far future (2081–2100). The influence of the harvesting period in a growing season, RCP scenarios and time frames was evaluated and two regions, Spain and Portugal were compared with each other. For Spain there were no significant differences for RCP 2.6 and 4.5. For the more extreme RCP scenarios (6.0 and 8.5) the diameter of the mould was significantly lower for the far future compared with the current time frame. This can be explained by the higher temperatures (18.2–38.2 °C) which become too high for fungal

growth. For Poland, there was a significant difference in the different time frames, the diameter of themouldwas for the far future N near future N current time frame. This is due to the predicted higher temperatures in the far future (14.2–28.4 °C) which becomes closer to the optimal temperature for the growth of *Alternaria* spp. Compared with the colder temperatures in the present. According to the results, the situation in Poland in the far future (2081–2100) will became similar as the situation in Spain in the present time frame (1981–2000).

Keywords: /Tomato/ /Mycotoxins/

Wrzodak, A., F. Adamicki, M. Gajewski. 2015. Effect of 1-methylcyclopropene on postharvest quality of **tomato** fruit (*Lycopersicon esculentum* mill.) during storage. Acta Hort. 1071:211 - 218.

Abstract

Tomato fruits 'Faustine' F₁ were harvested at mature green and full-red stages and treated with 1 and 2 μL·L⁻¹ of 1-methylcyclopropene (1-MCP) at 20°C for 21 h. Treated and control fruits were stored at 12.5 and 20°C and 85-90% RH. Lycopene and phenolic contents, fruit firmness, weight loss and percentage of rotten fruits were determined after 4-week storage. The results showed that the effect of 1-MCP on fruit ripening was related to the stage of maturity and storage temperature. The mature green stage of the fruits was optimal for 1-MCP treatment when fruits storage was at 12.5°C. 1-MCP treatment significantly delayed the decrease of firmness and compressive strength and inhibited lycopene accumulation in the fruits. Phenolics content in 1-MCP treated fruits was significantly higher than in the control fruits. 1-MCP also reduced fruits rotting and weight loss. These results suggest that 1-MCP treatment can be used as a commercial technology for tomatoes due to its ability to delay fruit ripening.

Keywords: /Tomato/ /*Lycopersicon esculentum*/ /1-MCP/ /Fruit Quality/ /Maturity/ /Storage/

Zhu, Qibing, et. al. 2015. Ripeness evaluation of 'Sun Bright' **tomato** using optical absorption and scattering properties. Postharvest Biol. & Technol. 103:27 – 34.

Abstract

Ripeness is one of the most important factors in determining the processing and eating quality of tomato. The objective of this research was to evaluate the changes of optical absorption and scattering properties in tomatoes during ripening, and develop classification models for grading the ripeness of tomatoes using optical absorption and scattering spectra. Optical absorption (μ_a) and reduced scattering (μ'_s) coefficients over the spectral region between 500 nm and 950 nm were measured, using a hyperspectral imaging-based spatially-resolved instrument, for 281 'Sun Bright' tomatoes harvested at six ripeness grades (i.e., 'Green', 'Breaker', 'Turning', 'Pink', 'Light-red', 'Red'). Absorption peak around 675 nm decreased consistently with the progression of ripeness, and its mean value for 'Red' tomatoes was almost zero. The reduced scattering spectra, on the other hand, decreased monotonically with the increasing wavelength; the value of μ'_s also decreased successively from 'Green' to 'Turning', and an opposite trend was observed from 'Pink' to 'Red'. Partial least squares discriminant analysis (PLS-DA) models yielded 92.1%, 84.4%, 92.3%, and 92.1% classification accuracies for the three ripeness grades (i.e., 'Green/Breaker', 'Turning/Pink', and 'Light-red/Red'), when using the full spectra (500–950 nm) of μ_a , μ'_s , μ_a & μ'_s and the effective attenuation coefficient ($\mu_{\text{eff}} = [3 \mu_a (\mu_a + \mu'_s)]^{1/2}$), respectively. The PLS-DA model using μ_{eff} achieved an overall classification accuracy of 88.4% for the six

ripeness grades, which was 2.5% and 10.2% better than using the optical parameters of μ_a and μ'_s alone. The research demonstrated that the optical absorption and scattering spectra, especially their combinations, are effective for classification of tomato ripeness.

Keywords: /Tomato/ /Ripening /

HERBS AND SPICES

CHILLI PEPPER

Bhutia, Nangsol Dolma, et. al. 2015. Estimation of Heterosis, dominance effect and genetic control of fresh fruit yield, quality and leaf curl disease severity traits of **chilli pepper** (*Capsicum annum* L.). *Scientia Hort.*182: 47 – 55.

Abstract

Development of chilli hybrids having high pungency, antioxidant vitamins and appreciable tolerance against leaf curl virus is the present need in major part of the tropics. Five genetically diverse parents were selected out of twenty two genotypes of diverse origin through multivariate analysis. They were crossed in diallel fashion without reciprocals to produce 10 F₁hybrids to determine mode of gene action, extent of heterosis and dominance effect, and to estimate combining ability for 14 quantitative characters. The predictability ratio revealed overwhelming response of non-additive gene action in controlling the expression of fresh fruit yield per plant and most of the yield components, antioxidant vitamins (vitamin C and beta-carotene, a precursor of vitamin A) content of fruit and severity of leaf curl virus disease. The breeding procedures applicable to improvement of studied characters are discussed. The maximum extent of significant heterobeltiosis in desired directions was recorded from hybrids in a five-parentdiallel of chilli for fruit yield per plant (71.06%*, significant at the 5% level), PDI of leaf curl virus (-47.61%**, significant at the 1% level), capsaicin content of fruit (46.67%**), beta carotene content of fruit (36.17%**)and vitamin C content of fruit (28.93%**). The study depicted that hybrid vigour is available for commercial production of chilli hybrid, and that isolation of pure lines from the segregating generation of heterotic F₁'s is an alternative approach to improve fruit yield, quality and viral disease tolerance. Partial- to over-dominance effects were found to be involved in the inheritance of fruit yield and other horticultural traits. Two inbred lines BCCH Sel-4 and Chaitali were the most promising general combiners for fruit yield per plant and other important traits that could be utilized in future chilli improvement programmes. We could also able to isolate a promising hybrid, BCCH Sel-4 × AC-575 on the basis of its per se performance; heterosis manifested in them and the sca effects, and this hybrid could make a dent by fulfilling the major horticultural attributes in commercial chilli growing zones of the tropics.

Keywords: /Chilli Pepper/ /Quality/

GARLIC

Sothornvit, R., P. Tangworakit. 2015. Effect of edible coating on the quality of fresh-cut **garlic** in modified atmosphere packaging (MAP). *Acta Hort.* 1071:413 - 420.

Abstract

Garlic is commonly used as a seasoning or condiment in most dishes worldwide and it is recognized for its medicinal health benefit. However, the removal of the peel results in a significant reduction of shelf life due to an increase in weight loss, color discoloration, rooting formation and microbial growth. The objective of this study was to determine the effect of an edible coating in combination with modified atmosphere packaging (MAP) on the quality of fresh-cut garlic cloves. Hydroxypropyl methylcellulose (HPMC) with and without glycerol was used as edible coating in combination with active MAP (1% O₂ and 10% CO₂). Uncoated and water dipped garlic cloves were used as control treatments. Garlic cloves were packed in low density polyethylene (LDPE) bags and stored at 25°C for 12 days. Application of the HPMC coating did not show any root formation and lower apparent microbial growth in fresh-cut garlic cloves compared to uncoated and water dipped. The coating did not reduce the weight loss of garlic cloves, probably due to the hydrophilic nature of the HPMC. There were no significant differences in firmness among treatments during storage. Coated fresh-cut garlic cloves presented significant higher gloss than uncoated garlic. Higher concentration of CO₂ in the headspace of MAP of coated garlic cloves was found. This might indicate an increase in respiration rate as fresh-cut garlic cloves were coated, however, further research is needed to validate this result. The O₂ concentration in all treatments increased from the initial O₂ value, which might be due to the high oxygen permeability of LDPE. Results show the potential of edible coatings to extend the shelf life of garlic cloves by reducing rooting and improving gloss. Further research is required to improve the composition of coating to reduce weight loss and to determine microbial growth.

Keywords: /Garlic/ /Fresh-Cut / /Modified Atmosphere Packaging/ /Edible Coating/

PEPPER

Ying, Sun Chun, et. al. 2015. Resistances to anthracnose (*Colletotrichum acutatum*) of **Capsicum** mature green and ripe fruit are controlled by a major dominant cluster of QTLs on chromosome P5. *Scientia Horticulturae* 181:81 – 88.

Abstract

Anthracnose (*Colletotrichum* spp.) is a serious disease worldwide in pepper (*Capsicum*) production. Inheritance of resistance to *Colletotrichum acutatum* from a *Capsicum chinense* accession (PBC932) was studied in a BC₁ population derived from a hybrid with *Capsicum annuum* line 77013 (susceptible) using a QTL analysis method. Resistance test was performed on detached mature green and mature red fruit under laboratory conditions by evaluated in disease incidence, true lesion diameter and overall lesion diameter. Based on a linkage map with 14 linkage groups, 385 markers (SSR, In Del and CAPS), 1310.2 cM in length, inclusive Composite Interval Mapping (ICIM) revealed main effect QTLs located in a close marker interval on P5 chromosome for all fruit stages and resistance criteria, and four minor-effect QTLs only at green mature stage. Identification of recombinant individuals suggested that resistance in green versus red fruit may be controlled by distinct genes within the QTL interval on P5.

Keywords: /Capsicum/ /Anthracnose/ /Pepper/

RED BELL PEPPER

Horvitz S., M. J. Cantalejo. 2015. Effects of modified atmosphere packaging on quality and shelf-life of partially dehydrated **red bell pepper**. *Acta Hort.* 1071:231 - 236.

Abstract

The efficacy of different modified atmospheres (MA) was investigated for extending the shelf-life of partially dehydrated strips of red pepper. The fruits were packaged in polypropylene trays using air (control) and two active MA (3/5 and 10/5 kPa O₂/kPa CO₂, respectively). The samples were stored at 8 °C. Changes in gas composition in the packages and mass loss, water activity (Aw), pH, color, firmness and microbial growth on peppers were periodically evaluated. Regardless of the atmosphere used, weight loss was negligible and Aw remained unchanged during the storage period. The best results were obtained with a MA of 10 kPa O₂/5 kPa CO₂. Under these conditions, neither gas composition nor physicochemical and microbial quality of the peppers changed significantly until day 35. The color, pH and firmness of the peppers held in a MA of 3-kPa O₂/5-kPa CO₂ remained unchanged throughout the storage period. However, O₂ decreased to very low concentrations and CO₂ levels significantly increased after day 14. By day 21, excessive juice leakage and microbial growth were observed in the samples in low-O₂ MAP. The reduction in the pH and the loss of lightness, red color and firmness were greater and detected earlier in control samples compared with those peppers held in active MA. The active MAP also delayed microbial growth and the counts were lower when compared with the control. In all samples, both the mesophilic and psychrotrophic populations were below the acceptable counts established by the Spanish legislation, whilst molds and yeasts exceeded those limits. Based on these results, the shelf-life of the peppers held in air and low-O₂ MAP was 17 days, whereas packing the peppers with 10 kPa O₂ extended the shelf-life of the samples up to 38 days.

Keywords: /Red Bell Pepper/ /Refrigeration/ /Storage/

TUBERS AND ROOTCROPS

POTATO

Rady, Ahmed M., Daniel E. Guyer. 2015. Evaluation of sugar content in **potatoes** using NIR reflectance and wavelength selection techniques. *Postharvest Biol. & Technol.* 103:17 – 26.

Abstract

Near-infrared (NIR) diffuse reflectance has been extensively and successfully applied on quality assurance for fruits, vegetables, and food products. This study is principally aimed to extract the primary wavelengths related to the prediction of glucose and sucrose for potato tubers (of Frito Lay 1879 (FL), a chipping cultivar, and Russet Norkotah (RN), a table use cultivar, and investigating the potential of classification of potatoes based on sugar levels important to the frying industry. Whole tubers, as well as 12.7 mm slices, were scanned using a NIR reflectance spectroscopic system (900–1685 nm). To extract the most influential wavelength in the studied range, interval partial least squares (IPLS), and genetic algorithm (GA) were utilized. Partial least squares regression (PLSR) was applied for building prediction models. Prediction models for RN showed stronger correlation than FL with $r(\text{RPD})$ (correlation coefficient (ratio of reference standard deviation to root mean square error of the model)) values for whole tubers for glucose being as high as 0.81(1.70), and 0.97(3.91) for FL and RN; in the case of sliced samples the values were 0.74(1.49) and 0.94(2.73) for FL and RN. Lower correlation was obtained for sucrose with $r(\text{RPD})$ for whole tubers as high as 0.75(1.52), 0.92(2.57) for FL and RN; and the values for sliced samples were 0.67(1.31) and 0.75(1.41) for FL and RN respectively. Classification of potatoes based on sugar levels was conducted and training models were built using different classifiers (linear discriminant analysis (LDA), K-nearest neighbor (Knn), partial least squares discriminant analysis

(PLSDA), and artificial neural network (ANN)), in addition to classifier fusion. To obtain more robust classification models for the training data, 4-fold cross validation was used and results were tested using separate sets of data. Classification rates of the testing set for whole tubers, based on glucose, were as high as 81% and 100% for FL and RN. For sliced samples, the rates were 83% and 81% for FL and RN. Generally, lower classification rates were obtained based on sucrose with values of whole tubers of 71%, and 79% for FL and RN, and for sliced samples the rates were 75%, and 82% which follows a similar trend as PLSR results. This study presents a potential of using selected wavelengths and NIR reflectance spectroscopy to effectively evaluate the sugar content of potatoes and classify potatoes based on thresholds that are crucial for the frying industry.

Keywords: /Potatoes/

Rocha, Artur B. O., et. al. 2015. Effect of UV-C radiation and fluorescent light to control postharvest soft rot in potato seed tubers. *Scientia Hort.* 181: 174 – 181.

Abstract

Wet rot due to *Pectobacterium carotovorum* subsp. *carotovorum* is one of the main bacteria diseases that affect all potato cultivars causing significant losses. Potato plants contain glycoalkaloids being α -chaconine and α -solanine the main. The accumulation of these glycoalkaloids can be stimulated by several factors, especially light, having them important antimicrobial properties. The aim of this research was to evaluate how postharvest exposition to ultraviolet C (UV-C) and fluorescent light affects the development of *P. carotovorum* soft rot as well as the accumulation of α -chaconine and α -solanine, sprouting, weight loss and soluble solids content in potato seed tubers 'Agata' and 'Monalisa'. Susceptibility of *P. carotovo-rum* to UV-C light was first in vitro tested. For that, bacterial aliquots (10^7 CFU mL⁻¹) were grown in Petri dishes (culture medium YDC) and subjected to 0.0, 2.3, 6.9, 11.5 or 34.5 kJ m⁻² of UV-C (254 nm) and stored at 25°C in darkness. Number of colonies was counted after 24 h. For in vivo analysis, potato seed tubers were subjected to UV-C (34.5 kJ m⁻²) with subsequent storage of half of the samples in darkness and the other half under fluorescent light (photon flux of 1.6 μ mol m⁻²s⁻¹) at 25°C and 88% RH during 21 days. Development (incidence) and severity of wet rot, concentration of α -chaconine and α -solanine, sprouting, and quality parameters were analyzed. Non UV-C treated tubers were used as control. UV-C light at 34.5 kJ m⁻² completely inhibited the development of *P. carotovorum* subsp. *carotovorum* in in vitro studies. For in vivo experiments, the control and the UV-C treated tubers stored under fluorescent light were less affected by soft rot than the UV-C treated stored under darkness since any disease incidence was detected on them. Control and UV-C treated tubers stored under fluorescent light as well as UV-C tubers kept in darkness showed an increased concentration of α -chaconine and α -solanine for both cultivars. The largest amount of these glycoalkaloids had an effective influence on controlling soft rot. These tubers also showed highest sprouts number, increased weight loss and soluble solids content. The use of UV-C, firstly reported here, and fluorescent light are advantageous to control soft rot without adversely affecting sprouting.

Keywords: /Potato/ /Postharvest/ /Soft Rot/

ORNAMENTALS

ANTHURIUM

Favero, B. T., et. al. 2015. Quality in anthurium andraeanum after postharvest BAP treatment. Acta Hort. 1060. 183 - 186.

Abstract

To ensure the ongoing quality of anthurium inflorescence it is necessary to use postharvest treatments aimed at extending the vase life and delaying senescence. Thus, the objective of this study was to assess the effect of postharvest spray application of 6-benzylaminopurine (BAP) in anthurium quality and sugar levels. Two experiments were done, one where inflorescences were sprayed 0, 100 and 200 mg L⁻¹ of BAP and kept under 23±1°C and relative humidity of 65±5% for evaluations, and in the second experiment BAP concentrations were reduced to 0, 50 and 100 mg L⁻¹ and inflorescences were cold stored for 2 days at 13±1°C and then transferred to the same evaluation conditions from the first experiment. Quality assessments were performed according to Paull (1982) for spathe loss of gloss and blueing and spadix necrosis along with stem weighting for fresh weight (FW) variation every two days. In the first experiment FW loss was significantly lower from the 14th until 26th day after harvest. Anthurium sprayed with 100 and 200 mg L⁻¹ showed significantly less fresh weight loss when compared to control stems and in the second experiment 50 and 100 mg L⁻¹ did not reduce fresh weight loss. Means of scores from quality analysis, blueing and loss of gloss of spathes and spadix necrosis, were significantly lower in BAP sprayed anthurium (100 and 200 mg L⁻¹) than in control flowers and by lowering BAP spray concentration and cold storing stems for two days this positive effect was only observed for spadix necrosis and not observed for spathe parameters.

Keywords: /Anthurium/ /Biochemistry/

CHRYSANTHEMUM

Barbosa, J. G., et. al. 2015. Production and postharvest quality of chrysanthemum flowers grown in hydroponic system under different N:K ratios. Acta Hort. 1060: 281 - 288.

Abstract

In a hydroponic system of production, the knowledge of the requirements of the plants improves the conditions for growth and development. For the success of this system, the knowledge of composition of the nutrient solution is crucial, which depends not only on the concentration and relationship between nutrients, but also on factors related to the crop, including the type of hydroponic system and cultivar in production. The assimilation of K is attached to N, with a specific relationship between them, which varies depending on the soil type, climate and cultivar. The objective of this work was to evaluate the effect of different N:K ratios, the production and postharvest life of inflorescences in six cultivars of chrysanthemums for cut flower production. A randomized block design was used in a 4×6 factorial arrangement with four ratios of N:K w/w (1.0:2.5; 1.0:3.0; 1.0:3.5; 1.0:4.0) and six cultivars ('Calabria', 'Dark Flamengo', 'White Reagan', 'Dark Orange Reagan', 'Dragon' and 'Yellow Sheena') comprising three replications. For vegetative growth, the plants were maintained in a regime of 35 long days (LD) with 16 h of light, followed by 35 short days (SD) for flowering induction, which was achieved by covering the tops with a black tarp. After the induction, plants were kept under normal day until harvest (2/3 open inflorescence). The fresh and dry weights of inflorescence and shoots, total number of inflorescences, diameter of the largest inflorescence, diameter and length of the stem, and longevity were determined. Data were subjected to analysis of variance (ANOVA) and regression, and the means were compared by Tukey test at 5% of probability for qualitative traits. For quantitative traits,

regression models were adjusted. The cultivar 'Calabria' was more productive in relation to the others. A linear increase in longevity of inflorescences was found as potassium concentration increased and the cultivar 'Calabria' showed longer postharvest life than the others.

Keywords: /Chrysanthemum/ /Postharvest/ /Longevity/

Burana, C., T. Kurokura, K. Yamane. 2015. Short-term controlled atmosphere and 1-MCP effects on the vase life of **cut flowers**. Acta Hort. 1071:635 - 640.

Abstract

Senescence of various cut flowers is characterized by autocatalytic ethylene production from parts of the flower and subsequent wilting of the petals. Previous studies reported that elevated CO₂ delayed the onset of autocatalytic ethylene production of cut carnation flowers. In this study, effects of short-term CA and 1-MCP on vase life of cut carnation (*Dianthus caryophyllus* L.), prairie gentian (*Eustoma grandiflorum* (Raf.) Shinn), and chrysanthemum (*Dendranthema grandiflora* Tzvelev) flowers were investigated. Cut flowers were treated for 2 h at 5°C with elevated CO₂ concentrations of 10, 15 or 20% with or without 1-MCP and then were placed in water at 23°C to follow senescence. Treatment with short-term CA at 15 or 20% CO₂ plus 1-MCP, reduced ethylene production in carnation. Both short-term CA and 1-MCP treatments delayed senescence and prolonged the vase life of cut carnations and prairie gentian for 3 and 2 days compared with 10 and 8 days in untreated controls, respectively. However, these treatments did not affect the vase life of chrysanthemum indicating that this flower was not sensitive to ethylene. It is concluded that short-term CA can decrease ethylene production and prolong the vase life of ethylene-sensitive flowers. More studies should be accomplished for optimizing CO₂ level, duration and temperature of CA treatment.

Keywords: /Cut Flowers/ /Vase Life/ /1-MCP/

FOLIAGE

Bosch, E., et. al. 2015. Schinus molle: perspectives for use as cut **foliage**. Acta Hort. 1060: 127 - 132.

Abstract

Consumers place value on products with low environmental impact, whose production requires less use of agricultural chemicals and water consumption. Many native species meet these requirements. Schinus molle L. (Anacardiaceae) is a native species with beautiful flexible green stems and small leaflets with serrated edges, which may be used as cut foliage. The purpose of this study was to evaluate if the species has the minimum features required by florists and evaluate the vase life of the stems. The ornamental potential of the species was assessed by florists, which evaluated 20 stems according to criteria previously defined in the literature. The results obtained showed that Schinus molle has high potential as cut foliage, mainly for table arrangements, party arrangements and floral wreaths. In addition, S. molle stems were kept in water containers and evaluated every two days for loss of turgidity and color changing (means of the three dimensional CIE L* a*b* color msystem). The stems presented an average vase life of eight days, showing suitability for the proposed use.

Keywords: /Foliage/ /Floral Arrangement/ /Floral Art/ /Cut Foliage/ /Ornamental/ /Vase Life/

GLADIOLUS

Pêgo, R. G., et. al. 2015. Postharvest of cut flower 'Amsterdam' gladiolus grown under colored shade net. Acta Hort. 1060: 165 - 170.

Abstract

Gladiolus is an important cut flower commercialized on the Brazilian market. These plants are traditionally grown under full sunlight; however, cultivation may also occur under shading mesh in areas where the solar radiation is excessive. Although different environmental conditions can affect the quality and production of gladiolus flowers, there is no information about the condition of shading on postharvest of cut stems. Thus, the aim of this study was to evaluate the postharvest shelf life of gladiolus grown under different shading. For this, plants of gladiolus 'Amsterdam' were grown under three shading nets, thermo-reflective net of metallic coloration, red and blue. The control plants were grown under full sunlight. The stems were harvested with three floret buds showing color, which were standardized to 80 cm in height and placed in individual bottles containing 200 ml of tap water. Daily cuts were made at 0.5 cm from the base of the stems and the water uptake, fresh weight, number of open and longevity of florets were measured. There was no significant difference in water uptake of cut stems grown under different environmental conditions; higher water uptake was observed until the third day of postharvest. The fresh weight of the stems increased until the third day of postharvest and from the fifth day the weight began to decrease. The changes of fresh weight were similar in all treatments. The opening of florets was lower in plants grown in full sunlight with a maximum of 9.6; in the thermo-reflective netting of metallic coloration, red and blue the maximum of 12.2, 12.4 and 11.6, respectively. There was no difference in longevity of the stem flowers. All the treatments had eight days of longevity.

Keywords: /Gladiolus/ /Longevity/ /Flower Opening/ /Vase Life/

Ramos, P. A. S., C.A. Megguer, F. L. Finger. 2015. Longevity of red gladiolus affected by pulsing with sucrose and stage development. Acta Hort. 1060: 153 – 158.

Abstract

This study aimed to establish pulsing conditioning solutions, specific to the species *G. grandifloras* 'Red', aiming to increase the vase life by the use of sucrose and in different stages of harvest. The inflorescences were collected at two development stages: 1, all florets closed and swollen; stage 2, 1 to 3 florets showing final petal color. Afterwards, the stems were placed in jars for 6, 12, 18, 24 and 48 h in 20% sucrose solution. Regardless which stage the inflorescences were harvested intense flower opening started in the first 24 h, with more than half opened at the end of the vase life. Treatment with 6 h of pulsing was effective in prolonging the vase life from inflorescences harvested at stage 2 with a total of six days and five days for the stage 1. Treatment with 12 h with 20% sucrose solution was more efficient in prolonging the vase life. Pulsing for 48 h inhibited the opening of the flowers, indicating a possible damage to the petals.

Keywords: /Gladiolus/ /Cut Flower/ /Ornamental/ /Pulsing/ /Vase Life/

HELICONIA

Costa, L. C., et. al. 2015. Postharvest longevity of heliconia wagneriana. Acta Hort. 1060: 193 - 200.

Abstract

Heliconia flowers are known for their lush beauty of shapes and colors. However, the final quality is mainly linked to the postharvest handling. Therefore, we evaluated the postharvest quality of *Heliconia wagneriana* after pretreatment with preservative solutions of 10 and 20% sucrose, 30 and 75 mg L⁻¹ silver nitrate (AgNO₃). Recutting the stems' base at every 48 h improved the quality and maintained the ornamental status for a longer period, maintaining the tissues' color and brightness for 18 days. Control stems showed a decreased ornamental value at the 9th day after packing, and by the 12th, the stalks had dark bracts, with yellowing and dehydrated tips. These symptoms may have been caused by high transpiration rates and low absorption of water by the uncut stems.

Keywords: /Heliconia/ /Floriculture/ /Cut Flowers/

Costa, A. S., et. al. 2015. Chilling injury symptoms in species of heliconia. Acta Hort. 1060: 55 - 62.

Abstract

The severity of chilling injury in plants depends on temperature, length of exposure to low temperatures and the sensitivity of each species. Temperatures between 10 and 13°C can cause damage in tropical and subtropical species. The aim of the present study was to induce, describe and compare the differences of chilling injury and senescence symptoms in eleven *Heliconia* genotypes. Flowering stems of each species were submitted to two conditions: a) refrigerated treatment (RT) at 6.5°C and 81% relative humidity; b) control treatment (CT) with flowering stems kept at room temperature at 24.7°C and 66% relative humidity. Flowering stems kept at RT were evaluated daily and removed when the inflorescences presented the first chilling injury symptoms. After being removed from the low temperature, the stems were kept in water at room temperature to evaluate the evolution on the chilling injury symptoms. The number of days it took for chilling injury symptoms to appear on stems after the low temperature treatment were: two days for *H. rostrata*; five days for *H. bihai* 'Peachy pink', *H. caribaea* × *H. bihai* 'Jaquini', *H. stricta* 'Iris red' and *H. stricta* 'Tagami'; six days for *H. caribaea*, *H. foreroi*, *H. stricta* 'Dwarf Jamaican', *H. stricta* 'Bucky' and *H. wagneriana*; seven days for *H. orthotrica* 'Candy cane'. Initially, chilling injury symptoms appeared on the bracts as darkened spots near to the junction with the rachis. These spots evolved to darker tones and then to necrotic spots. In the control stems, the initial senescence symptoms, in the majority of species, appeared as wilted areas at the bracts apex. The withering advanced towards the bract base. The evaluation of the chilling injury and senescence symptoms are different and allow to make the comparative description of both kinds of symptoms. Senescence symptoms of *H. stricta* cultivars are different from the senescence symptoms of other species.

Keywords: /Heliconia/ /Refrigerated Storage/ /Postharvest/

Souza, S. O., et. al. 2015. Longevity and quality of heliconia psittacorum × *H. Spathocircinata* 'Golden Torch' treated with 8-Hydroxyquinoline Citrate. Acta Hort. 1060: 187 - 192.

Abstract

This study aimed to evaluate the effect of 8-hydroxyquinoline citrate (8-HQC) on the quality and longevity of heliconia 'Golden Torch' inflorescences stored at $23.9\pm 1.8^{\circ}\text{C}$ and $51\pm 9\%$ RH. The treatments consisted of 0, 100, 200 and 300 mg L^{-1} 8-HQC, evaluated at 0, 2, 4, 6 and 8 days after harvest. The inflorescences were pulsed with 8-HQC for 18 h and subsequently transferred to flasks with distilled water. At every two days, floral appearance, fresh mass, flower opening, chroma and lightness were determined. The floral appearance was influenced by storage time and by the treatment with 8-HQC. However, the values of fresh weight, the flower opening, lightness and chroma were affected only by the number of days in storage. The fresh weight decreased by 1.6% from the first to eighth day after harvest. At the end of the storage time, the inflorescences exhibited two open flowers at the start of expansion. The lightness value increased by 3.4%, while the chroma decreased by almost 4.9% in bracts during storage, indicating the passage of dark orange color to light orange. The 8-HQC did not increase the vase life of inflorescences compared to control. Based on the scale of appearance, the inflorescences treated with 300 mg L^{-1} of 8-HQC had superior vase life compared with the other treatments, within eight days of evaluation.

Keywords: /Heliconia/ /Vase Life/ /Cut Flower/

LILAC

Skutnik, E., et. al. 2015. Effect of the flower preservative on water balance in cut shoots of common lilac. Acta Hort. 1060: 333 - 340.

Abstract

Cut shoots of common lilac are praised by florists due to their high decorative value but they are not widely produced in Poland because of the insufficient postharvest longevity. The aim of the work was to study effects of a flower preservative on vase life of common lilac (*Syringa vulgaris* 'Andenken an Ludwig Spaeth') harvested from shrubs forced between March and April and to determine water balance in cut shoots during their vase life. Chrysal Professional® increased the lilac vase life from 5.2 days (water control) to 10.7 days. During flower ageing the fresh weight, water uptake and transpiration decreased, being always higher in lilacs placed into the preservative which also delayed the appearance of the negative values of water balance. Lilac vase life did not seem to be directly related to the amounts of absorbed and transpired solutes.

Keywords: /Lilac/ /Vase Life/ /Transpiration/

LILIES

de S. Santos, M. N., A. M. Mapeli. 2015. Preservative solutions on conservation of cut lilies flower. Acta Hort. 1060: 89 - 96.

Abstract

Lilium pumilum is a species with high ornamental value due to the inflorescence colorfulness and fully blooming flowers. Plants are sold in pots or as cut flower, but little is known about its responses to preservative solutions. Freshly cut inflorescences, containing flowers and buds in different stages (point of commercialization), were treated as follows: T1) distilled water; T2) sucrose (20 g/L); T3)

citric acid (100 mg/L); T4) silver nitrate (AgNO_3 – 0.2 mM); T5) silver thiosulphate (STS – 0.2 mM); T6) sucrose + citric acid; T7) AgNO_3 + Sucrose; T8) sucrose + STS; T9) AgNO_3 + citric acid; T10) STS + citric acid; T11) STS + citric acid + sucrose; T12) AgNO_3 + sucrose + citric acid. Daily, the flower development and senescence was determined (E0 – green bud flower; E1 – bud showing the first petal color; E2 – orange bud; E3 – semi open bud; E4 – open flower; E5 – beginning of flower senescence and E6 – wilted flower), length and diameter of the buds, fresh mass and flower longevity. Diameter of *L. Pumilum* flowers ranged from 18.5 to 14.8-fold to treatments T3 and T5, respectively, in relation to control. However, reduction of 17.1-fold was verified to treatment T4, T8, T11 and T12 when compared to T1. Independently of change, this occurred about 24 hours after storage in preservative solution. The longevity was 1.6 days higher for treatments T8 and T11 than T2, T5 T6, T10 and T12, and 3.21 days in relation to treatments T1, T3, T4, T7 and T9. *L. Pumilum* buds showed major percentage of opening flower on advanced stages, independently of preservative solution. Change of weigh can improve by recovery of turgescence after cutting independently of the preservative solution. Treatments containing AgNO_3 induced stem and leaves yellowing after three days from harvest. Thus, for this flower, the use of vase solutions containing sucrose + STS or STS + citric acid + sucrose is recommended.

Keywords: /Lilies /Sucrose/ /Citric Acid/

LISIANTHUS

Cavasini, R., et. al. 2015. Soluble proteins and polyphenoloxidase activity in bud flowers, flowers and leaves of cold lisianthus. *Acta Hort.* 1060: 103 - 108.

Abstract

This study evaluated the activity of the enzyme polyphenol oxidase (PPO) and the content of soluble protein present in lisianthus bud flowers, flowers and leaves in room temperature ($24\pm 2^\circ\text{C}$) and pre-exposure cold chamber at $9\pm 2^\circ\text{C}$ for 24 h, in order to examine a possible correlation between these parameters and postharvest longevity of lisianthus flowers. After treatments, flowers were kept in pots with water, stored at room temperature and evaluated every three days until the end of their decorative life for biochemical analyzes. During the experimental period the enzymatic activity increased with the aging of the material, directly related to the high concentration of phenolics that were accumulated in injured tissue, providing browning, while soluble protein content slightly decreased. Thus, PPO enzyme activity can be applied for plant senescence evaluation, acting as a biochemical marker for product visual quality.

Keywords: /Lisianthus/ /Postharvest/ /Polyphenoloxidase/

POTTED PLANTS

Tromp, Seth-Oscar, et. al. 2015. Modelling the quality of potted plants after dark storage. *Postharvest Biol. & Technol.* 103(5): 9 – 16.

Abstract

Prolonged dark storage affects the quality of potted plants. A model was designed to quantify the effect of storage time and temperature on the display life of potted plants, such that logistics can be optimized, resulting in increased remaining quality and less rejected plants. Experiments were carried

out with two Phalaenopsis cultivars, two Anthurium cultivars and two Cyclamen cultivars, the latter with two colour variants per cultivar. Plants were stored for different storage times at different temperatures. The aim of the chosen times and temperatures was to determine the quality effect of transport at optimal and suboptimal temperatures. After storage, plants were stored at 20 °C for 14 days, for simulating a display period. Different quality aspects were scored immediately after storage and after 7 and 14 days of display. For each cultivar, a model was fitted consisting of a logistic function for representing the storage-time dependency of quality. In order to cope with both senescence symptoms at higher temperatures and chilling injury at lower temperatures, two non-interfering Arrhenius equations were incorporated. Because the effects of chilling exposure are commonly manifest only when the chilled plants are returned to ambient temperatures, the quality of Phalaenopsis and Anthurium plants measured immediately after storage at low temperatures was not taken into account. The behaviour of the Phalaenopsis and the Anthurium cultivars was well described by their models. The coefficients of determination based on the unexplained variation due to lack of fit were in the range of 0.89–0.99.

Keywords: /Potted Plants/ /Quality/ /Storage/ /Senescence/ /Chilling Injury/

ROSE

Almeida, E. F. A., et. al. 2015. Effect of water deficit stress on the quality and postharvest conservation of roses. Acta Hort. 1060: 321 - 326.

Abstract

The amount of water to be supplied to greenhouse plants by irrigation has significant economic and environmental importance. Thus, the aim of this study was to evaluate the effect of water deficit through different soil water tensions as monitoring of irrigation on the quality and postharvest 'Carolla' rose flower stems. The experiment was conducted with 'Carolla' rose graftings in a greenhouse located at Empresa de Pesquisa Agropecuária de Minas Gerais (EPAMIG), with 6 soil water tensions (15, 30, 45, 60, 90 and 120 kPa) and 5 replications. Each plot was irrigated by drip irrigation line driven by electric valves according to each treatment, irrigating up to soil moisture at field capacity. Tensiometers and granular matrix sensors were installed for monitoring water tension. The harvests for quality assessment were performed for one year (May 31, 2011 to May 30, 2012) in 'Carolla' rosebush. After this period, the flower stems were harvested and evaluated for postharvest longevity at room temperature. In the quality evaluation, only the bud diameter was affected by water deficit treatments, which showed decreasing linear with increasing tensions. The best and worst results were observed for tensions of 15 and 120 kPa with diameters of 36.44 and 34.96 mm, respectively. No significant differences were observed between treatments on postharvest longevity of 'Carolla' flower stems, which showed average vase life of 11 days. Average fresh weight loss and water absorption from the beginning to the end of the experimental period (11 days) were of 5 g and 74 ml, respectively. To obtain better quality of 'Carolla' flower stems, irrigations with soil water tensions of 15 and 30 kPa are recommended.

Keywords: /Rose/ /Cut Flower/

Clark, E.R., J.M. Dole. 2015. Storage temperature and duration affect cut *Rosa* 'Freedom', 'Charlotte' and 'Classy' vase life. Acta Hort. 1060: 63 - 70.

Abstract

Flowers are commonly shipped great distances to reach their market, often at variable temperatures. When *Rosa* L. 'Freedom' stems were stored at 1, 10, 20, or 30°C for 12, 24, 36, or 48 h, the longest vase life, 11.7 d, was obtained for stems stored for 12 h at 1°C. Vase life decreased linearly with both time and temperature to 6.4 d at 30°C for 36 h. 'Charlotte' stems also had the longest vase life, 8.6 d, at 1°C for 12 h, and shortest of 2.9 d at 30°C for 36 h. 'Classy' stems had the longest vase life, 9.3 d, at 1°C for 24 h, and shortest, 5.8 d, when held at 30°C for 48 h. Water uptake and petal bluing were positively correlated with vase life. Flower opening for 'Charlotte' stems was unaffected by time and temperature, while 'Classy' and 'Freedom' flowers opened less as temperature increased. In a second study, the longest vase life, 15.3 d, was obtained when 'Freedom' stems remained at 1°C for 48 h, while the shortest vase life, 11.5 d, occurred when stems remained at 20°C for 48 h. Interrupting cold storage (44 h, 1°C) with a 4-h period of 20°C temperature reduced vase life compared to constant 1°C storage for 48 h, but the timing of the warm temperature period had no effect. Water uptake and flower openness were positively correlated with vase life. In a third study on *Rosa* 'Freedom' interrupting cold storage (134 h, 1°C) with a 6-h period of 20°C temperature had no effect on vase life compared to constant 1°C storage for 140 h, regardless of when the warm period occurred. The longest vase life, 11.7 d, occurred when stems were not stored (20±2°C). The shortest vase life, 1.9 d, occurred when stems remained in 20°C for the duration of the storage time.

Keywords: /Roses/ /Postharvest/ /Vase Life/