

SELECTIVE DISSEMINATION OF INFORMATION
As of January 2019

APPLE

Eisenstecken, D., Stürz, B., Robatscher, P., Lozano, L., Zanella, A., & Oberhuber, M. (2019). The potential of near infrared spectroscopy (NIRS) to trace apple origin: Study on different cultivars and orchard elevations. *Postharvest Biology and Technology*, 147, 123–131. DOI: 10.1016/j.postharvbio.2018.08.019

Abstract

Analytical methods to assess quality and origin of food are well established, but frequently time consuming, costly, and destructive. Modern spectroscopic techniques such as near infrared spectroscopy (NIRS) have gained interest as fast, nondestructive methods for quality control and traceability in the fruit supply chain. In this work, NIRS combined with chemometrics was successfully used to classify 'Golden Delicious' apples from three different orchard elevation levels (225, 650, and 1000 m above sea level) as well as nine cultivars ('Braeburn', 'Coop39 - Crimson Crisp®', 'Fuji', 'Fujion', 'Gala', 'CIV323 - Isaaq®', 'Coop43 - Juliet®', 'sQ159 - Natyra®', 'UEB32642 - Opal®'). Principal component analysis (PCA) and quadratic discriminant analysis (QDA) based on PCA scores were used to classify the apples (n = 842) according to their orchard elevation and cultivar. Full cross validation (leave-one-out) was used as validation method in the development of the prediction models. PCA-DA models correctly classified 93.6% and 77.9% of the high- and low-elevation grown 'Golden Delicious', respectively. For the intermediate orchard level, a correct classification rate of 57.1% was achieved. Five ('Braeburn', 'Coop39 - Crimson Crisp®', 'Gala', 'CIV323 - Isaaq®', 'sQ159 - Natyra®') of nine apple cultivars were classified correctly at 100%, whereas 96.2% of 'Fuji', 92.3% of 'UEB32642 - Opal®', and 76.9% of 'Fujion' and 'Coop43 - Juliet®' were correctly recognized. When the models were validated using independent samples, a correct classification rate of 87.5% for orchard elevation and 86.3% for cultivar was found, respectively. Our results highlight the potential of NIRS combined with PCA-QDA as a non-destructive and fast analytical method to trace the origin of apples in terms of orchard elevation and to classify apple cultivars.

Keywords: /Malus × domestica/ /Apples/ /Near infrared spectroscopy/ /Authentication/ /Altitude/ /Orchard elevation/ /Discriminant analysis (DA)/ /Principal component analysis (PCA)/

AVOCADO

Obianom, C., Romanazzi, G., & Sivakumar, D. (2019). Effects of chitosan treatment on avocado postharvest diseases and expression of phenylalanine ammonia-lyase, chitinase and lipoxygenase genes. *Postharvest Biology and Technology*, 147, 214–221. DOI: 10.1016/j.postharvbio.2018.10.004

Abstract

Stem-end rot (*Lasiodiplodia theobromae*) and anthracnose (*Colletotrichum gloeosporioides*) are major postharvest diseases in avocado that cause severe postharvest losses throughout the supply chain. One of the strategies to reduce development of such decay agents resides in the application of resistance inducers (e.g. chitosan), capable of reducing fungal growth and inducing resistance in fruit tissues. The influence of chitosan treatment (1% or 1.5% w/v) was investigated on decay incidence, gene expression of phenylalanine ammonia-lyase (PAL), chitinase (CHI) and lipoxygenase (LOX) and antioxidant enzyme activity [superoxide dismutase (SOD) and catalase (CAT)] in i) drop-inoculated (without wounding) or ii) artificially infected (with wounding) avocado (cv. 'Hass') with *L. theobromae* or *C. gloeosporioides* pathogens and also in iii) naturally infected (natural inoculum) avocado. Fruit were dipped in 1% or 1.5% w/v chitosan dissolved in water for 3 min, followed by storage for 14 d and 28 d respectively at 7.5 °C, and thereafter for 5 d at 18 °C to simulate market shelf conditions. Chitosan at 1.5% significantly reduced the incidence of stem-end rot and anthracnose in both inoculated and naturally infected avocados. The up-regulation of PAL and down-regulation of LOX genes moderately allowed higher epicatechin contents (90 mg kg⁻¹FW) in the exocarp, which could have contributed to improved anthracnose control. The up-regulation of CHI genes and higher SOD activity could have contributed to control of stem-end rot. Chitosan solution (1.5%) retained moderate levels of C7 sugars and firmness up to 5 d shelf life. The control of stem-end rot and anthracnose of avocados obtained with 1.5% chitosan can be ascribed to a combination of its antifungal and eliciting properties.

Keywords: /Biofungicide/ /*Colletotrichum gloeosporioides*/ /Epicatechin/ /Fruit quality/ /Induced defence/ /*Lasiodiplodia theobromae*/

BELL PEPPER

Wang, Y., Gao, L., Wang, Q., & Zuo, J. (2019). Low temperature conditioning combined with methyl jasmonate can reduce chilling injury in bell pepper. *Scientia Horticulturae*, 243, 434–439. DOI: 10.1016/j.scienta.2018.08.031

Abstract

Bell pepper is a highly perishable vegetable and chilling injury is a principal physiological factor that negatively impacts the postharvest quality of peppers during transportation and storage. This study parsed the effects of low temperature conditioning (LTC) combined with methyl jasmonate (MeJA) on chilling injury during the storage of bell pepper fruit. The results showed that treatments of LTC combined with MeJA effectively maintained quality of bell pepper, suppressed the development of chilling injury index, delayed increase of malondialdehyde (MDA) content, inhibited the decline of chlorophyll and Vitamin C content, enhanced the activities and relative gene expressions of Peroxidase (POD), Catalase (CAT) and Ascorbate Peroxidase (APX). The results obtained point to treatments LTC combined with MeJA can be used as a useful technology for enhancing tolerance of postharvest chilling injury in bell pepper fruit.

Keywords: Bell pepper fruit/ /Low temperature conditioning/ /Methyl jasmonate/ /Chilling injury

BROCCOLI

Reyes Jara, A. M., Gómez-Lobato, M. E., Civello, P. M., & Martínez, G. A. (2019). Effects of hormonal and physical treatments on the expression of a putative chlorophyll b reductase gene (BoNYC1) during postharvest senescence of broccoli. *Postharvest Biology and Technology*, 147, 107–112. DOI: 10.1016/j.postharvbio.2018.09.010

Abstract

Senescence and degreening are the most important features that determine loss of quality during postharvest of broccoli. During senescence, chlorophylls are degraded with the purpose of avoiding presence of photoactive molecules. Chlorophyll b must be previously converted to chlorophyll a in order to be catabolized. This reduction process is catalyzed by two enzymes, chlorophyll b reductase (CBR) and hydroxymethyl chlorophyll a reductase (HCAR). In this work, we characterized the expression of a gene encoding a putative CBR (BoNYC1) during postharvest senescence of broccoli and analysed the effect of several postharvest treatments. BoNYC1 expression increased during first days of postharvest, but decreased in advanced senescence stages, simultaneously with chlorophyll degradation. The effect of different growth regulators and an inhibitor of ethylene action (1-MCP) were analyzed. Treatments with cytokinins and 1-MCP delayed the increment of BoNYC1 expression whereas ethylene accelerated the process. In addition, storage in modified atmosphere, exposure to hot air (45 °C, 3 h), UV-C and white light were also employed. These treatments delayed chlorophyll degradation but only hot air and UV-C delayed the increment of BoNYC1 expression whereas modified atmosphere and visible light caused a higher BoNYC1 expression. In conclusion, most of the hormonal and physical treatments that modify the rate of postharvest senescence of broccoli also affect the expression of BoNYC1.

Keywords: /Brassica crops/ /Postharvest senescence/ /Pigments catabolism/ /Gene expression/

CHERRY

Yang, Q., Zhang, X., Wang, F., & Zhao, Q. (2019). Effect of pressurized argon combined with controlled atmosphere on the postharvest quality and browning of sweet cherries. *Postharvest Biology and Technology*, 147, 59–67. DOI: 10.1016/j.postharvbio.2018.09.007

Abstract

Sweet cherries are in demand in domestic and international markets due to their medical and health benefits. However, storage and transportation of these cherries are difficult due to their thin skin. In this study, we investigated the effects of pressurized argon (0.5 MPa for 1 h at 0 °C), storage in a controlled atmosphere (5% O₂+ 10% CO₂+ 85% argon), and their combination on the postharvest quality and browning of sweet cherries during 63 d of storage at 0 °C.

Results showed that treatment with pressurized argon, controlled atmosphere, and their combination effectively reduced the fruit decay rate (13.33 (58.54%), 15.56 (68.29%), and 18.89 (82.93%), respectively) compared with the control fruit after 63 d of storage. The treatments also effectively maintained a high good fruit rate (28.89 (72.22%), 36.67 (91.67%), and 45.56 (113.89%), respectively) compared with the control fruit after 63 d of storage and delayed the decline of lightness, saturation, and hue angle. They also inhibited reduction in firmness, levels of total soluble solid, titratable acidity, and ascorbic acid content, thus maintaining better fruit quality. The accumulation of membrane lipid peroxide malondialdehyde and increase in relative permeability was significantly decreased. The decrease in fruit phenolic compound content and increase in polyphenoloxidase and phenylalanine ammonia lyase enzymatic activity were inhibited. Ultimately, the development of fruit browning was reduced, and the browning index was maintained (11.94, 6.94, and 3.10, respectively) at a low level after 63 d of storage. Combined treatment with pressurized argon and a controlled atmosphere yielded the best results and may be considered one of the ideal methods for preserving sweet cherries.

Keywords: /Sweet cherry/ /Pressurized argon/ /Controlled atmosphere/ /Browning/ /Quality/

Zhao, H., Liu, B., Zhang, W., Cao, J., & Jiang, W. (2019). Enhancement of quality and antioxidant metabolism of sweet cherry fruit by near-freezing temperature storage. *Postharvest Biology and Technology*, 147, 113–122. DOI: 10.1016/j.postharvbio.2018.09.013

Abstract

Near-freezing temperature storage (NFTS) is a novel method to inhibit quality loss of fresh fruit. However, little information is available on NFTS delaying the onset of senescence in sweet cherry (*Prunus avium* L.) fruit and regulating the changes on antioxidative enzymes participated in the balancing of reactive oxygen system (ROS). Fruits were stored at NFT (between super-cooling point and freezing point), 0 °C and 5 °C, respectively, until fruits exhibited visually rot (sampled every twenty days). NFTS effectively slowed senescence process in sweet cherry fruit, as indicated by extending storage duration and improving the changes of firmness, anthocyanins, ion leakage, peel color and sugars content. Moreover, fruit stored at NFT had higher levels of ascorbic acid, phenolics and organic acids and lower accumulation of carotenoids, malondiadehyde, hydrogen peroxide (H₂O₂) and superoxide radical (O₂•⁻). Additionally, NFTS maintained membrane integrity and prevented fresh browning of fruit by enhancing the activities of superoxide dismutase (SOD), catalase (CAT), ascorbate peroxidase (APX) and gluta thione reductase (GR) and inhibiting the activities of guaiacol peroxidase (POD), polyphenol oxidase (PPO) and lipoxygenase (LOX). Furthermore, NFTS fruit exhibited higher level of antioxidant capacity as measured by radical scavenging activity and reducing power at the end of storage. These results indicate that the activities of antioxidant enzymes to scavenge superoxide anions and H₂O₂during NFTS was implicated in the maintenance of membrane integrity, which might be a part of the mechanism associated with the delay of senescence in sweet cherry fruit.

Keywords: /Sweet cherry/ /Near-freezing temperature storage/ /Postharvest quality/ /Antioxidant enzyme/ /Reactive oxygen species/ /Antioxidant capacity/

Rabiei, V., Kakavand, F., Zaare-Nahandi, F., Razavi, F., & Aghdam, M. S. (2019). Nitric oxide and γ -aminobutyric acid treatments delay senescence of cornelian cherry fruits during postharvest cold storage by enhancing antioxidant system activity. *Scientia Horticulturae*, 243, 268–273. DOI: 10.1016/j.scienta.2018.08.034

Abstract

Cornelian cherry fruits suffer from senescence accompanying browning during postharvest life. Cold storage is not along sufficiently effectual for postponing fruit senescence accompanying browning during postharvest life. In this experiment, the mechanism employed by NO donor sodium nitroprusside (SNP) at 0, 250, 500 and 1000 μ M and γ -aminobutyric acid (GABA) at 0, 2.5, 5 and 10 mM on postponing senescence accompanying browning of cornelian cherry fruits during storage at 4 °C for 21 days was investigated. Our result showed that the cornelian cherry fruits treated with 500 μ M SNP and 5 mM GABA displayed remarkably lower fruits browning during storage at 4 °C for 21 days, which may ascribe to lower H₂O₂ accumulation arising from higher reactive oxygen species (ROS) scavenging enzymes superoxide dismutase (SOD), catalase (CAT), ascorbate peroxidase (APX) and glutathione reductase (GR) activity coincided with lower ROS making enzyme lipoxygenase (LOX) activity giving rise to higher membrane integrity displaying by lower electrolyte leakage and malondialdehyde (MDA) accumulation. Accordingly, our results suggest that the postharvest SNP and GABA treatments may be promising strategies for supplying cornelian cherry fruits with lower browning owing to alleviating oxidative stress which arises from employing ROS detoxifying system for diminishing ROS accumulation leading to maintaining membrane integrity.

Keywords: Antioxidant enzymes/ /Cornelian cherry fruits/ /Lipoxygenase/ /Membrane integrity/ /Oxidative stress/ /Postharvest browning

CITRUS

Wen, T., Zheng, L., Dong, S., Gong, Z., Sang, M., Long, X., Luo, M., & Peng, H. (2019). Rapid detection and classification of citrus fruits infestation by *Bactrocera dorsalis* (Hendel) based on electronic nose. *Postharvest Biology and Technology*, 147, 156-165. DOI: 10.1016/j.postharvbio.2018.09.017

Abstract

A sweeping electronic nose system (SENS) was self-developed to detect the presence of early infestation by *Bactrocera dorsalis* (Hendel) in citrus fruits. Principal component analysis (PCA) and linear discriminate analysis (LDA) were applied to analyze citrus fruits that were subjected to different types of treatments (invasion and incubation stage) caused infestation. The results indicated that the SENS could successfully detect the presence of early infestation by *B. dorsalis* in citrus fruits. The different types of treatments in citrus fruits could be effectively classified by PCA and LDA, respectively. Meanwhile, the specific infestation time of citrus fruits within treatment stage could be satisfactorily identified by LDA model with correct recognition rate of 98.21%. Importantly, an optimized sensor array achieved better performance in classification and discrimination than that of the non-optimized. This study showed the potential

feasibility of the electronic nose technology for in-field detection of postharvest pest infestation citrus fruits under market conditions.

Keywords: /Electronic nose/ /Citrus fruits/ /Infestation/ /*Bactrocera dorsalis*(Hendel)/ /Rapid detection/ /Classification/

GRAPE

Azuma, A., Yakushiji, H., & Sato, A. (2019). Postharvest light irradiation and appropriate temperature treatment increase anthocyanin accumulation in grape berry skin. *Postharvest Biology and Technology*, 147, 89–99. DOI: 10.1016/j.postharvbio.2018.09.008

Abstract

Grape skin color is important because consumers generally prefer well pigmented grapes, and the high marketability of these fruit is important for farmers. Poor coloration, caused mainly by high temperatures during maturation, is a common problem. We investigated the effect of 7- to 9-day light irradiation and temperature treatment at 10, 15, 20, and 25 °C on anthocyanin accumulation in harvested berries of grape accessions. Anthocyanin accumulation of berries, mainly in red- to purple-skinned accessions, could be increased by combining postharvest light irradiation (white light + UV light, or blue LED light) with 15–25 °C treatments. Our data suggest that the optimal temperature (15–20 °C) improves anthocyanin accumulation without a decline in titratable acidity and berry weight. The coordinated induction of anthocyanin biosynthesis-related genes under these conditions might explain the accumulation of anthocyanins. These findings will help us to develop techniques for stable production of well colored grapes.

Keywords: /Anthocyanin/ /Coloration/ /Grape/ /Light/ /Postharvest/ /Temperature/

JUJUBE

Li, H., He, C., Li, G., Zhang, Z., Li, B., & Tian, S. (2019). The modes of action of epsilon-polylysine (ϵ -PL) against *Botrytis cinerea* in jujube fruit. *Postharvest Biology and Technology*, 147, 1–9. DOI: 10.1016/j.postharvbio.2018.08.009

Abstract

Epsilon-polylysine (ϵ -PL) is a natural antimicrobial and has been widely used as a food preservative. Previous studies showed ϵ -PL being effective for control of foodborne bacteria; however, little is known about its control effects on postharvest pathogenic fungi and the possible modes of action. Here, we found that ϵ -PL could significantly inhibit mycelial growth, spore germination and germ tube elongation of *Botrytis cinerea* in vitro, as well as effectively control gray mold in harvested jujube fruit. Further investigation indicates that the modes of action of ϵ -PL against *B. cinerea* include (i) stimulating the accumulation of intracellular reactive oxygen species (ROS) and reducing the expression of pathogenesis-related genes of the pathogen, (ii) resulting in the leakage of soluble carbohydrates and nucleic acids, as well as the

damage of plasma membrane integrity of the fungal cells, (iii) inducing the expression of respiratory burst oxidase homolog (RBOH) genes in ϵ -PL-treated jujube fruit.

Keywords: /Antibacterial compounds/ /Fungal pathogen/ /Fruit decay/ /ROS/ /Plasma membrane integrity/ /Cellular leakage/

Chen, H., Sun, Z., & Yang, H. (2019). Effect of carnauba wax-based coating containing glycerol monolaurate on the quality maintenance and shelf-life of Indian jujube (*Zizyphus mauritiana* Lamk.) fruit during storage. *Scientia Horticulturae*, 244, 157-164. DOI: 10.1016/j.scienta.2018.09.039

Abstract

Indian jujube is perishable and has a relatively short shelf-life at room temperature. The effects of carnauba wax (CW) and CW containing glycerol monolaurate (CW-GML) coating on physico-chemical and qualitative attributes of jujube fruit are investigated during storage at 20 °C for 12 days. Compared to the control, both CW and CW-GML coatings reduce jujube weight loss, respiration rate, and ethylene production, maintain lower activities of polygalacturonase, pectin methylesterase and cellulase and delay the flesh softening. The two coatings also delay the change of skin color and ensure higher content of chlorophyll and ascorbic acid. However, the CW-GML coating most significantly inhibits the decay of jujube fruit and retains better sensory quality. After 12 d of storage at 20 °C, the decay index is only 44.3% of the control fruit, and 65.6% of the CW-coated jujube. These results confirm that CW-GML coating could be an effective means to contribute to the shelf-life extension and quality maintenance of jujube fruit stored at 20 °C.

Keywords: /Indian jujube/ /Edible coating/ /Glycerol monolaurate/ /Shelf-life/ /Sensory quality/

KIWIFRUIT

Mitalo, O. W., Asiche, W. O., Kasahara, Y., Tosa, Y., Tokiwa, S., Ushijima, K., Nakano, R., and Kubo, Y. (2019). Comparative analysis of fruit ripening and associated genes in two kiwifruit cultivars ('Sanuki Gold' and 'Hayward') at various storage temperatures. *Postharvest Biology and Technology*, 147, 20–28. DOI: 10.1016/j.postharvbio.2018.08.017

Abstract

Kiwifruit exhibit a peculiar ripening pattern, as extensive softening is known to occur in the absence of any detectable ethylene. We previously demonstrated that this softening is regulated by low temperature independent of ethylene. However, there are no reports that provide comparisons of the ripening patterns among different kiwifruit cultivars at various storage temperatures. The purpose of this study was to compare the ripening responses and associated gene expression in 'Sanuki Gold' (*Actinidia chinensis* var. *chinensis*) and 'Hayward' (*Actinidia chinensis* var. *deliciosa*) fruit, two kiwifruit cultivars differing in on-vine maturity dates and postharvest storability, during storage at 5 °C, 10 °C, 15 °C and 22 °C. Fruit softening, soluble

solids concentration (SSC) increase and reduction of titratable acidity (TA) occurred in the absence of any detectable ethylene, and treatment with an ethylene inhibitor 1-methylcyclopropene (1-MCP) failed to suppress the changes, suggesting that they were independent of ethylene. 'Sanuki Gold' fruit showed a higher sensitivity to low temperature supported by accelerated fruit softening and TA reduction, and induction of several genes such as AcACO3, AcXET2, AcPG, AcEXP1, AcPMEi, AcGA2ox1, AcMADS2, AcNAC5 and AcbZIP2 at 5 °C, 10 °C and 15 °C within 28 d. By contrast, 'Hayward' fruit exhibited a lower sensitivity to low temperature as accelerated softening, TA reduction and induction of most ripening-associated genes were recorded only at 5 °C and 10 °C. These differences in sensitivity to low temperature, between 'Sanuki Gold' and 'Hayward' fruit, would account for the dissimilarities observed in on-vine maturity dates and postharvest storability.

Keywords: /*Actinidia chinensis* var. *chinensis*/ /*Actinidia chinensis* var. *deliciosa*/ /Low temperature/ /On-vine maturity/ /Softening/ /Storability/

Salazar, J., Jorquera, C., Campos-Vargas, R., Jorgensen, C., Zapata, P., & Infante, R. (2019). Effect of the application timing of 1-MCP on postharvest traits and sensory quality of a yellow-fleshed kiwifruit. *Scientia Horticulturae*, 244, 82–87. DOI: 10.1016/j.scienta.2018.09.028

Abstract

Chile is the third largest exporter of kiwifruit in the world. Its varietal production has traditionally been focused on green-fleshed kiwifruit varieties, with 'Hayward' being the most exported variety. 'soreli' is a new Italian kiwifruit variety, which is characterized by its early ripening, big size, sweet taste, as well as its yellow flesh. This gives 'soreli' a good opportunity to promote the consumption of yellow-fleshed varieties, and a wider assortment of kiwifruit in the market. The aim of this work is to evaluate postharvest traits and consumer acceptance in kiwifruit var. 'soreli', with a combination of storage temperatures of 0 °C and 20 °C and 1-methylcyclopropene (1-MCP) applications. Cold storage and 1-MCP treatments caused a positive response in kiwifruit var. 'soreli'. In the case of fruits stored at 20 °C, 1-MCP treatment extended the postharvest life of the fruits at least 3 weeks while the fruits stored in cold at 0 °C treated with 1-MCP reached 8 weeks. In general, the respiration rate was higher in the control treatments with respect to the 1-MCP treatments, as well as the ethylene emission occurred earlier in the control. In addition, the kiwifruit sensory quality attributes were adequate in all cases, reaching a medium or high acceptability in the evaluation panel.

Keywords: /*Actinidia chinensis*/ /Postharvest/ /Cold storage/ /1-MCP/ /Sensorial attributes/

Hu, H., Zhou, H., & Li, P. (2019). Lacquer wax coating improves the sensory and quality attributes of kiwifruit during ambient storage. *Scientia Horticulturae*, 244, 31–41. DOI: 10.1016/j.scienta.2018.09.026

Abstract

Here, kiwifruit were treated with 2% lacquer wax and then stored at ambient temperature for 12 d. The effects of coating on the physicochemical properties of kiwifruit were investigated. The results indicated that, apart from the effectiveness against the decrease of weight loss, coated kiwifruit exhibited slower ripening than uncoated samples, as indicated by inhibited loss of firmness, organic acids, and antioxidant activity, as well as decreased respiratory rate, and a delayed increase in the level of ethylene, malondialdehyde, and sugar. In addition, 2% lacquer wax exerted the same effect as 3% chitosan did in delaying kiwifruit senescence. These results suggest that lacquer wax coating is an effective strategy for prolonging the postharvest life of kiwifruit.

Keywords: /Kiwifruit/ /Lacquer wax/ /Ethylene/ /Chitosan/ /Senescence/

Goldberg, T., Agra, H., & Ben-Arie, R. (2019). Non-destructive measurement of fruit firmness to predict the shelf-life of 'Hayward' kiwifruit. *Scientia Horticulturae*, 244, 339–342. DOI: 10.1016/j.scienta.2018.09.057

Abstract

Kiwifruit are commercially harvested when mature but firm. The length of the softening process in shelf life (SL) till the fruit becomes edible depends upon several pre-harvest and postharvest factors, such as harvest maturity, environmental conditions (temperature, relative humidity, composition of the atmosphere) and duration of cold storage. The ability to predict the time till softening would be of considerable commercial value, but to date there is no reliable method to do so. We assessed the suitability of the non-destructive measurement of fruit firmness with the Sinclair IQ Firmness Tester (SIQ) to predict the time required for adequate fruit softening for consumption. 'Hayward' kiwifruit were harvested at commercial maturity and stored in either regular air (RA) or controlled atmosphere (CA), with or without pre-storage 1-MCP treatment. Fruit softening was monitored during shelf-life at 20 °C by finger pressure, SIQ and with a FTA penetrometer. Highly significant correlations were obtained between SIQ and both firmness assessments. The linear decline in firmness measured by the non-destructive SIQ enables us to construct models that can predict the time till softening, based on the SIQ value at removal from storage under different conditions.

Keywords: /Controlled atmosphere/ /Fruit softening/ /Fruit texture analyzer/ /Penetrometer/ /Sinclair firmness tester/

LETTUCE

McManamon, O., Kaupper, T., Scollard, J., & Schmalenberger, A. (2019). Nisin application delays growth of *Listeria monocytogenes* on fresh-cut iceberg lettuce in modified atmosphere packaging, while the bacterial community structure changes within one week of storage. *Postharvest Biology and Technology*, 147, 185–195. DOI: 10.1016/j.postharvbio.2018.10.002

Abstract

Listeria monocytogenes poses a risk to minimally processed ready-to-eat foods such as lettuce due to its ability to grow under refrigeration conditions. Since many natural anti-listerial products render Iceberg lettuce unsuitable for consumption within 2 d of storage, this study investigated the efficacy of Nisin A as anti-listerial agent and its sensory impact on lettuce. In addition, the evolution of the bacterial community on fresh-cut lettuce was monitored for the duration of storage. In-vitro assays confirmed the efficacy of Nisin A to inhibit growth of a three strain mix of *L. monocytogenes* in model atmospheres and air. The *L. monocytogenes* strain mix was added to lettuce that was subsequently treated either with Nisin, *L. lactis* DSM20729 (a Nisin A producer) or was kept without inoculation. Incubation took place at 4 and 8 °C under various atmospheres. On days 0, 2, 5 and 7, *L. monocytogenes* was enumerated on selective agar and a sensory panel graded the lettuce on visual appearance. At 4 and 8 °C a 10 to 100-fold reduction of *L. monocytogenes* growth was achieved with 5 mg kg⁻¹Nisin over a seven-day period, while lettuce kept an acceptable sensory appearance over the first 5 d. Direct application of *L. lactis* had no detectable effect on *L. monocytogenes* growth in situ. The bacterial community structure changed substantially from each sampling day to the next over the seven days of incubation. However, Pseudomonadaceae with the genus *Pseudomonas* were most abundant at all times and increased in relative abundance to over 90% by day 7. In conclusion, the application of Nisin A to minimally processed vegetables like lettuce seems to be a viable alternative to reduce and delay growth of pathogen *L. monocytogenes*, while not impacting the sensory appearance for 2–5 d.

Keywords: /Nisin A/ /Anti-listerial agent/ /Modified atmosphere/ /Next generation sequencing/ /*Lactuca sativa*/

Guo, Z., Liu, H., Chen, X., Huang, L., Fan, J., Zhou, J., Chang, X., Du, B., & Chang, X. (2019). Modified-atmosphere packaging maintains the quality of postharvest whole lettuce (*Lactuca sativa* L. Grand Rapid) by mediating the dynamic equilibrium of the electron transport chain and protecting mitochondrial structure and function. *Postharvest Biology and Technology*, 147, 206-213. DOI: 10.1016/j.postharvbio.2018.09.001

Abstract

The mechanism by which modified-atmosphere packaging (MAP) protects the quality of whole lettuce (*Lactuca sativa* L. Grand Rapid) was investigated in this study. MAP-treated lettuce exhibited a low respiration rate, weight loss, chlorophyll loss, and relative conductivity, together with improved overall quality. Transmission electronic microscopy (TEM) was used to reveal the integrated mitochondrial morphology in MAP-treated lettuce, and a further analysis found that MAP treatment could increase the calcium (Ca²⁺) content and Ca²⁺pump activity. MAP-treated lettuce also displayed low levels of the superoxide anion and hydroxyl radical, which was explained by a stable electron transport chain (ETC), as evidenced by high succinate dehydrogenase and cytochrome c oxidase activity. It was further found that MAP could increase superoxide dismutase and ascorbate peroxidase activity, as well as the ascorbic acid and glutathione content. These findings suggest that MAP maintains the quality of postharvest whole lettuce by protecting the mitochondrial structure and maintaining the ETC balance.

Keywords: /Lettuce/ /MAP/ /ETC/ /ROS/ /Mitochondria/

LISIANTHUS

Su, J., Nie, Y., Zhao, G., Cheng, D., Wang, R., Chen, J., Zhang, S., & Shen, W. (2019). Endogenous hydrogen gas delays petal senescence and extends the vase life of lisianthus cut flowers. *Postharvest Biology and Technology*, 147, 148-155. DOI: 10.1016/j.postharvbio.2018.09.018

Abstract

Exogenous hydrogen-rich water (HRW) improves vase life and quality of cut flowers, but the effects of endogenous hydrogen gas (H₂) are not known. During the vase of cut lisianthus flowers, endogenous H₂ concentrations decreased and redox homeostasis was impaired. The supplementation with HRW containing 0.078 mmol L⁻¹ H₂ blocked, but 2,6-dichlorophenolindophenol (DCPIP; a putative inhibitor of H₂ synthesis) increased, endogenous H₂ production. Senescence of cut flowers was delayed by H₂, but accelerated by DCPIP. Also, decreased vase life by DCPIP was blocked by H₂ administration. These beneficial roles of H₂ were associated with less lipid peroxidation, and the increased activities of superoxide dismutase, ascorbate peroxidase, guaiacol peroxidase, and catalase. Compared with DCPIP alone, the soluble protein, total chlorophyll, and proline contents were elevated when H₂ and DCPIP were added together. Overall, endogenous H₂ prolongs vase life of lisianthus cut flowers in part by maintaining redox homeostasis.

Keywords: /Endogenous H₂/ /Petal Senescence/ /Vase life/ /Lisianthus cut flowers/ /Redox homeostasis/

MANGO

Fang, G., Zhang, X., Zhang, Z., Ye, H., Liu, Y., Yang, G., Chen, C., Chen, M., Yan, C., Wang, L., Zhang, J., and Zhang, J. (2019). Fungicidal activities of camptothecin semisynthetic derivatives against *Colletotrichum gloeosporioides* *in vitro* and in mango fruit. *Postharvest Biology and Technology*, 147, 139-147. DOI: 10.1016/j.postharvbio.2018.09.019

Abstract

Increasing attention to the resistance of plant pathogenic fungito fungicides and their residues impels the development of more efficient fungicides with novel mechanisms of action. Camptothecin (CPT-1) is a naturally occurring quinoline alkaloid with significant antineoplastic and pesticidal activities. To evaluate the anti-fungicidal activities of CPT-1 and its derivatives against postharvest mango anthracnose disease and their potential as a lead compounds for fungicide development, CPT-1 and its semisynthetic derivatives (CPT-2–15) *in vitro* and *in vivo* against Colletotrichum gloeosporioides were tested. Five of the agents, CPT-1, 16a-thiocamptothecin (CPT-2), 7-ethyl-camptothecin (CPT-6), 9-methoxycamptothecin

(CPT-11) and 7-benzyl-chloro-camptothecin (CPT-15) at doses of 20 mg L⁻¹ produced the effective mycelial growth inhibition of *C. gloeosporioides*. Among these, CPT-11 exhibited the strongest inhibition, with EC₅₀ and EC₉₀ values of 1.79 and 7.37 mg L⁻¹, respectively. At a dose of 100 mg L⁻¹, 10 of the tested derivatives inhibited the germination of *C. gloeosporioides* spores. In addition, CPT-1, -2, -6, -11 and -15 showed different abilities to inhibit appressorium formation. Dipping treatment with CPT-11 at 500 mg L⁻¹ exhibited an equivalent efficiency in suppressing postharvest anthracnose in three different cultivated varieties of mango fruit when compared with the commercial fungicide carbendazim at the same concentration, but it was less effective than prochloraz. Scanning and transmission electron microscopy observations revealed that CPT-11 caused alterations in the hyphal morphology and ultrastructures of *C. gloeosporioides*, including swelling, abnormal branching, and the rupturing and thickening of cell walls. These findings indicated that CPT-11 could be a potential antifungal lead compound for controlling postharvest mango anthracnose disease through a different mode of action than camptothecin.

Keywords: /Camptothecin derivatives/ /Antifungal activity/ /*Colletotrichum gloeosporioides*/ /Mango/

MELON

Ortiz-Duarte, G., Pérez-Cabrera, L. E., Artés-Hernández, F., & Martínez-Hernández, G. B. (2019). Ag-chitosan nanocomposites in edible coatings affect the quality of fresh-cut melon. *Postharvest Biology and Technology*, 147, 174–184. DOI: 10.1016/j.postharvbio.2018.09.021

Abstract

The effect of incorporating Ag-chitosan nanocomposites into chitosan coatings on the quality of fresh-cut melon over 13 d at 5 °C has been studied. The respiration rate of fresh-cut melon was reduced after coating treatments. Particularly, the coating with red claw crayfish-extracted chitosan (including red claw crayfish-extracted Ag-chitosan nanocomposites) showed lower RR increments during storage compared to that of the rest of coatings. Coated samples reached a steady-state atmosphere within packages of 12.6–16.2 kPa of CO₂/2.3–3.7 kPa of O₂ after 9–10 d. Softening was prevented in advanced storage periods by the coating with red claw crayfish-extracted chitosan (including red claw crayfish-extracted Ag-chitosan nanocomposites). The colour, soluble solids content, sucrose, glucose and fructose, pH, TA, and citric and malic acids were not greatly affected by the coating treatments. Furthermore, the coating with red claw crayfish-extracted chitosan (including red claw crayfish-extracted Ag-chitosan nanocomposites) showed the highest total vitamin C content after 13 d at 5 °C compared to the rest of the coating treatments. The coated samples were better sensory-scored than were the uncoated samples. Particularly, the coating with red claw crayfish-extracted chitosan (including red claw crayfish-extracted Ag-chitosan nanocomposites) showed lower translucency, which is the most important visual alteration in fresh-cut melon. Only the coating with red claw crayfish-extracted chitosan (including red claw crayfish-extracted Ag-chitosan nanocomposites) induced a microbicidal reduction (0.6 log units) from days 10 to 13. We conclude that the coating with red claw crayfish-extracted chitosan (including red claw crayfish-extracted

Ag-chitosan nanocomposites) has the potential to be applied in the fresh-cut industry to extend the shelf-life of these products.

Keywords: /Nanotechnology/ /Cucumis melo/ /Quality/ /Silver nanocomposites/ /Chitin/ /Antimicrobial/

MUSHROOM

Liu, J., Liu, S., Zhang, X., Kan, J., & Jin, C. (2019). Effect of gallic acid grafted chitosan film packaging on the postharvest quality of white button mushroom (*Agaricus bisporus*). *Postharvest Biology and Technology*, 147, 39–47. DOI: 10.1016/j.postharvbio.2018.09.004

Abstract

In this study, gallic acid grafted chitosan (GA-g-CS) film was used as a novel active packaging material for the preservation of *Agaricus bisporus*. Effect of GA-g-CS film packaging on the physico-chemical parameters and enzyme activities of *A. bisporus* during cold storage was investigated. As compared to mushrooms packaged with chitosan (CS) film and commercially used polyethylene (PE) film, mushrooms packaged with GA-g-CS film showed significantly lower respiration rate, browning degree, malondialdehyde content, electrolyte leakage rate, superoxide anion production rate and hydrogen peroxide content. Among all the treatment groups, mushrooms packaged with GA-g-CS film exhibited the highest superoxide dismutase and catalase activities as well as total phenolic content, however, the lowest polyphenol oxidase activity. Our results suggested GA-g-CS film packaging could increase the antioxidant status of *A. bisporus*, which in turn maintained the postharvest quality of mushrooms.

Keywords: /Active packaging/ /*Agaricus bisporus*/ /Antioxidant/ /Film/ /Gallic acid grafted chitosan/

ORANGES

Pérez-Marín, D., Calero, L., Fearn, T., Torres, I., Garrido-Varo, A., & Sánchez, M. (2019). A system using in situ NIRS sensors for the detection of product failing to meet quality standards and the prediction of optimal postharvest shelf-life in the case of oranges kept in cold storage. *Postharvest Biology and Technology*, 145, 48-53. DOI: 10.1016/j.postharvbio.2018.09.009

Abstract

The viability of using near infrared (NIR) spectroscopy was studied as a non-destructive analytical technique with the potential of being applied in situ to establish quality standards and the postharvest shelf-life of oranges kept in cold storage, as well as to detect substandard produce. In specific terms, it was applied to assessing the viability of increasing the period of postharvest storage depending on the quality exhibited by the produce. Initially, the spectral information from 80 oranges stored for up to four weeks in refrigeration chambers was used,

this being the maximum postharvest storage time in the citrus industry in the south of Spain, to establish the natural variability in spectra from refrigerated oranges meeting quality standards. The processing of the spectral data was carried out using principal component analysis and the spectral distances between the sets (fruit belonging to weeks 1 to 4 of cold storage) were calculated using n-dimensional statistics such as the Mahalanobis distance. Subsequently, oranges stored for between five and ten weeks were spectrally analysed and their distances from the standard or control population, described above, were calculated. The results were represented in the form of a Shewhart control chart, in which the mean scores and the corresponding control limits serving as warning systems were established. The findings suggest that NIR spectroscopy and the use of spectral distances will enable an innovative quality control system to be developed, based on spectral information that allows the establishment of quality standards in oranges, and the detection of non-standard produce.

Keywords: /NIR spectroscopy/ /Orange/ /Postharvest storage/ /Quality standards/ /Shewhart control chart/ /Substandard produce/

PAK CHOY

Al Ubeed, H. M. S., Wills, R. B. H., Bowyer, M. C., & Golding, J. B. (2019). Interaction of the hydrogen sulphide inhibitor, propargylglycine (PAG), with hydrogen sulphide on postharvest changes of the green leafy vegetable, pak choy. *Postharvest Biology and Technology*, 147, 54–58. DOI: 10.1016/j.postharvbio.2018.09.011

Abstract

Propargylglycine (PAG) is an inhibitor of hydrogen sulphide (H₂S) production and has been used to explore the mode of action of H₂S in prolonging storage of horticultural produce but little attention has been given to how PAG and H₂S interact when both are applied to produce. This study examined the effect of sequential application of PAG and H₂S on a range of postharvest senescence factors of the leafy vegetable pak choy (*Brassica rapa* subsp. *Chinensis*) stored at 10 °C. The results showed differential responses between factors when compared to application of PAG or H₂S alone. As expected, fumigation with H₂S reduced the rate of loss of leaf green colour, respiration rate, ethylene production, ion leakage and enhanced antioxidant activity and leaves sprayed with PAG showing converse effects. If PAG acted solely by inhibiting endogenous H₂S production then subsequent treatment with H₂S should fully negate any effect induced by PAG. However, for the combined PAG + H₂S treatment, respiration was similar leaves fumigated with H₂S, loss of green leaf colour was similar to the PAG single treatment and less than the untreated control, antioxidant activity was less than for PAG but greater than for control leaves, and ethylene production and ion leakage were similar to control leaves. Thus, the concept that PAG is exclusively an inhibitor of endogenous H₂S production was not validated, with PAG having effects on metabolism that are not linked to the action of endogenous H₂S. The additional actions of PAG could be through its inhibition of pyridoxal-5'-phosphate (PHP) which is a coenzyme for numerous enzyme systems.

Keywords: /PAG/ /Hydrogen sulphide/ /Senescence/ /Pak choy/ /Ethylene/

PEAR

Stropek, Z. & Gołacki, Z. (2019). Impact characteristics of pears. *Postharvest Biology and Technology*, 147, 100-106. DOI: 10.1016/j.postharvbio.2018.09.015

Abstract

The effect of impact on two pear cultivars have been studied in terms of maximum force, impact time, maximum deformation, permanent deformation, restitution coefficient and maximum stress. The above mentioned characteristics were related to bruise sizes and the bruise initiation was determined for a given weight and firmness. Bruise initiation was described by the restitution coefficient. The stabilization of mean values of maximum stress at different drop heights confirmed that the pear damage occurred after specified stress values were exceeded. The rate of bruise development was dependent on the fruit firmness. Firmer pears were more resistant to impact and the bruise initiation occurred at a higher impact velocity.

Keywords: /Impact/ /Bruise/ /Pear/ /Restitution coefficient/ /Maximum stress/ /High speed camera/

Hahn-Schlam, F., Valle-Guadarrama, S., & Jenkins, T. (2019). Robotic cactus pear cryocauterization increases storage life. *Postharvest Biology and Technology*, 147, 132-138. DOI: 10.1016/j.postharvbio.2018.09.014

Abstract

Cactus pear (*Opuntia* spp.) is a highly perishable fruit that starts to deteriorate after several days of storage at room temperature. After two weeks, 70% of the fruit show signs of deterioration. A cauterization process used a pneumatic robotic gripper to press a cactus pear against a dry-ice wall inserted inside a thermally isolated chamber. Batches of 1800 cactus pears were processed daily under different environmental conditions (sun, cloud, and rain). The best cryocauterizing treatment for fruit was 150 kPa for 15 s, which on sunny, cloudy, and rainy days resulted in marketable fruit index of 0.86, 0.84, and 0.82, respectively, after 90 d (where 1.0 = 100% marketable fruit). Cryocauterization is a good alternative to increase storage life of cactus pear, but it should be applied early in the working day and without rainy conditions.

Keywords: /Opuntia spp./ /Cryocauterization/ /Dry ice/ /Robotic pneumatic machine/ /Shelf life/

Zhang, L., Wang, J., Zhou, B., Li, G., Liu, Y., Xia, X., Xiao, Z., Lu, F., & Ji, S. (2019). Calcium inhibited peel browning by regulating enzymes in membrane metabolism of 'Nanguo' pears during post-ripeness after refrigerated storage. *Scientia Horticulturae*, 244, 15–21. DOI: 10.1016/j.scienta.2018.09.030

Abstract

The post-harvest ripening of 'Nanguo' pears (*Pyrus ussuriensis* Maxim.) can be effectively postponed by refrigerated storage. However, peel browning (PB) often appears in the pears after refrigerated storage during the shelf life at room temperature. In order to find an effective method to relieve PB of pears, 2% CaCl₂ was used to treat the fruit after low temperature. In the study, CaCl₂ treatment on the pears has efficiently restrained the appearance of PB. Higher firmness and polyphenol content were detected in CaCl₂-treated fruit during the shelf life. Electrolyte leakage and malondialdehyde (MDA) concentration were lowered in CaCl₂-treated fruit. Gene expression levels of phospholipase D (PLD) and polyphenol oxidase (PPO) were inhibited by CaCl₂ treatment, and the activities of PLD and PPO were lower in CaCl₂-treated fruit. The activity and gene expression of superoxide dismutase (SOD) were promoted under CaCl₂ treatment. Consequently, CaCl₂ treatment effectively alleviated the PB appearance of 'Nanguo' pears after refrigerated storage during the shelf life at room temperature and brown-related genes are regulated by CaCl₂ to varying degrees, which can help improve the quality of postharvest pears undergoing long term refrigeration and gene modification of brown pears.

Keywords: /'Nanguo' pears/ /Peel browning/ /Membrane metabolism/ /CaCl₂/

Cheng, Y., Liu, L., Feng, Y., Dong, Y., & Guan, J. (2019). Effects of 1-MCP on fruit quality and core browning in 'Yali' pear during cold storage. *Scientia Horticulturae*, 243, 350-356. DOI: 10.1016/j.scienta.2018.08.041

Abstract

'Yali' pear (*Pyrus bretschneideri* Rehd. cv. Yali) is susceptible to core browning after a long term of cold storage. In this study, the effects of 1-methylcyclopropene (1-MCP) with different concentrations (0, 0.25, 0.5, 1.0 $\mu\text{L L}^{-1}$) on the quality and core browning of 'Yali' pear fruit were investigated. The results showed that 1-MCP significantly reduced the ethylene production, kept higher firmness and titratable acidity (TA) content, and lowered core browning. Moreover, the most effective concentration of 1-MCP was found at 1.0 $\mu\text{L L}^{-1}$. Compared with control, 1.0 $\mu\text{L L}^{-1}$ 1-MCP treatment decreased the content of H₂O₂, while maintained higher levels of ascorbic acid (AsA) and glutathione (GSH) of core, and meanwhile, it reduced phenolics content and polyphenol oxidase (PPO) activity of core. In addition, among the four encoded the enzyme of PPO genes (PbPPO1, PbPPO4, PbPPO5 and PbPPO6), the expressions of PbPPO1 and PbPPO5 were markedly inhibited by 1-MCP. It suggested that 1-MCP could effectively keep fruit quality, and inhibit core browning which was resulted from the inhibition on accumulation of reactive oxygen species, reduction on phenolics content, PPO activity and its associated genes (PbPPO1 and PbPPO5) expression of core in 'Yali' pear during cold storage.

Keywords: /1-methylcyclopropene/ /Core browning/ /Phenolics/ /Polyphenol oxidase/

POMEGRANATE

Kashash, Y., Doron-Faigenboim, A., Holland, D., and Porat, R. (2019). Effects of harvest time on chilling tolerance and the transcriptome of 'Wonderful' pomegranate fruit. *Postharvest Biology and Technology*, 147, 10–19. DOI: 10.1016/j.postharvbio.2018.09.005

Abstract

We observed that harvest time markedly affected chilling tolerance of 'Wonderful' pomegranate fruit; early-harvested fruit were extremely chilling sensitive, whereas late-harvested ones were relatively chilling tolerant. Damage to inner membranes is the most obvious phenotypic damage observed in pomegranate fruit exposed to chilling. To elucidate the molecular mechanisms that govern chilling tolerance of pomegranate fruit, we conducted RNA-Seq analysis of inner membrane tissues from early- and late-harvested fruit on harvest day and after a 2-week exposure to a cold quarantine treatment at 1 °C. Pair-wise comparisons revealed that 6853 transcripts were significantly ($p \leq 0.01$) induced or repressed by a factor of at least 4 after exposure to chilling in early-harvested fruit, as compared with 8000 transcripts in late-harvested ones. In early-harvested, chilling-sensitive fruit most (63%) differentially expressed transcripts were down-regulated by cold storage, whereas in late-harvested fruit most (62%) differentially expressed transcripts were up-regulated, indicating activation of adaptation processes. The results demonstrate that transcripts related to several regulatory, metabolic, and stress-adaptation pathways were specifically induced in late-harvested fruit while suppressed in early-harvested, chilling-sensitive fruit. These regulatory mechanisms included activation of jasmonic acid and ethylene biosynthesis and signal transduction pathways, induction of various stress-related transcription factors, including AP2/ ERFs, MYBs, WRKYs, bHLH, homeobox, and HSFs. The observed changes in transcripts related to metabolic pathways involved primary and secondary carbohydrate metabolism, including activation of starch degradation and of galactinol and raffinose biosynthesis genes. Finally, we observed up-regulation of transcripts corresponding to stress-tolerance, most notably heat shock proteins.

Keywords: /Chilling/ /Quarantine/ /Pomegranate/ /Postharvest/ /Transcriptome/

Ashtari, M., Khademi, O., Soufbaf, M., Afsharmanesh, H., & Sarcheshmeh, M. A. A. (2019). Effect of gamma irradiation on antioxidants, microbiological properties and shelf life of pomegranate arils cv. 'Malas Saveh'. *Scientia Horticulturae*, 244, 365-371. DOI: 10.1016/j.scienta.2018.09.067

Abstract

In the present study, the effect of gamma irradiation on the reduction of microbial population and the maintenance of qualitative attributes of arils in pomegranate cv. Malas-e-Saveh in post-harvest stage was investigated. For this purpose, pomegranate arils, after being separated from the fruit, were irradiated with gamma doses of 0 (as control), 1, 3 and 5 kGy, packed in polyethylene container using cellophane film, and then maintained at 4 °C and relative humidity above 80%. After 7 and 14 days of storage, the arils were removed from the storage and were examined for count of bacteria, fungi and yeasts, anti-oxidant properties and other qualitative

characteristics. The results indicated that gamma irradiation in all doses significantly reduced the population of bacteria, fungi and yeasts when compared with control. However, in comparison with control, samples irradiated with gamma irradiation, especially in high doses, contained lower soluble solids, titratable acidity, phenol, anthocyanin and ascorbic acid contents, antioxidant capacity and activity of polyphenol oxidase enzyme, but higher hydrogen peroxide content. Therefore the effects of gamma irradiation in low dose (1 kGy) on the quality of arils were not considerable and would be effective in increasing the shelf life of pomegranate arils.

Keywords: /Antioxidant metabolites/ /Gamma irradiation/ /Microbial contamination/ /Quality/

POSTHARVEST SYSTEMS HANDLING

Basiak, E., Linke, M., Debeaufort, F., Lenart, A., & Geyer, M. (2019). Dynamic behaviour of starch-based coatings on fruit surfaces. *Postharvest Biology and Technology*, 147, 166–173. DOI: 10.1016/j.postharvbio.2018.09.020

Abstract

A method to characterising the surface water relations of coated fresh fruit has been developed. Based on a modification of the Fick's law of diffusion, application of this method allows for a quantitative assessment of the impact of produce type and of production method of coating, and environment on water losses both of the fruit body and the coating. Resistances in the water vapour pathway were analysed to determine the effects of coating on the surface water relations of plums. Experiments were conducted, evaluating the dynamic behaviour of two different starch-based coatings both at high and low potential water losses. Applying three layer-coatings, both starch and starch-whey protein coatings increased the total resistance in the water vapour pathway of individual plums by 60–75% at high transpiration potentials. Even at low transpiration potentials, an increase of 11–20% was observed. The starch coating tended to have a slightly lower effectiveness than the coating enriched with 20% whey protein.

Keywords: /Plum/ /Edible coatings/ /Starch/ /Whey protein/ /Water relations/ /Postharvest behaviour/

Pathak, N., Caleb, O. J., Rauh, C., & Mahajan, P. V. (2019). Efficacy of photocatalysis and photolysis systems for the removal of ethylene under different storage conditions. *Postharvest Biology and Technology*, 147, 68–77. DOI: 10.1016/j.postharvbio.2018.09.006

Abstract

Most fresh horticultural commodities are highly perishable and ethylene often plays an important role in their ripening and senescence process. Reduction of ethylene concentrations around these commodities may lead to the slowing down of metabolic processes, which could potentially extend their storage or shelf life. The objective of this work was to investigate photocatalytic oxidation (PCO) and vacuum ultraviolet light (VUV) photolysis for ethylene

removal in fruit storage. The efficacy of both techniques for ethylene removal was analyzed under different storage conditions (initial ethylene concentration, oxygen, relative humidity and temperature). Ethylene removal in VUV photolysis was much faster than PCO with the reaction mechanism followed by Langmuir-Hinshelwood and first-order equations, respectively. Higher O₂ concentration in the reactor favored both ethylene removal processes. However, high relative humidity impeded PCO and enhanced VUV photolysis efficacy of ethylene oxidation. Lowering the temperature from 21 °C to 1 °C showed no consistent trend of temperature effects on ethylene removal in the PCO process, whereas in VUV photolysis, reducing the temperature decreased ethylene removal significantly ($p \leq 0.05$). Ethylene removal in a gas stream with a single pass through VUV photolysis reactor was 84.8% whereas it was only 14.9% in PCO reactor. Apple storage revealed that the ethylene concentration increased to 70 $\mu\text{L L}^{-1}$ in 8 days at 1 °C. This concentration was brought down to 24 and 2.6 $\mu\text{L L}^{-1}$ in storage chambers connected to PCO and VUV reactors, respectively. Further research efforts are needed to improve the performance of the reactors for the complete removal of ethylene in postharvest storage of fresh produce.

Keywords: /Postharvest/ /Titanium dioxide/ /Fresh produce/ /Storage/ /Fruit and vegetables/

POSTHARVEST QUALITY

Ali, S., Nawaz, A., Ejaz, S., Haider, S. T. A., Alam, M. W., & Javed, H. U. (2019). Effects of hydrogen sulfide on postharvest physiology of fruits and vegetables: An overview. *Scientia Horticulturae*, 243, 290-299. DOI: 10.1016/j.scienta.2018.08.037

Abstract

Hydrogen sulfide (H₂S) is a flammable, colorless and hazardous gas. Initially it was considered as an environment toxic gas; but, after its endogenous production discovery in plants, a wide variety of functions have been found associated with H₂S. H₂S plays an imperative role in the modulation of ripening and quality changes in various fruits and vegetables by regulating certain physiological aspects such as respiration, ethylene biosynthesis, color metabolism, enzymatic browning, softening, chilling injury and postharvest decay during storage. H₂S also acts as a signaling molecule to combat against oxidative stress by scavenging reactive oxygen species (ROS) due to up-regulation of antioxidative enzymes activities. Reduced membrane permeability, inhibited lipid peroxidation, up-regulation of antioxidant activities and inhibition of ROS production eventually leads to reduced senescence having conserved quality with extended shelf or cold storage life of H₂S treated fruits and vegetables. Potential of H₂S in delaying ripening and reducing senescence of fruits and vegetables is generally accepted. However, it may be worth considering the commercial H₂S application as a strategy of conserving external color, retarding senescence and reducing various physiological storage disorders of fruits and vegetables with acceptable consumer quality in the future. This review summarizes the possible role and mechanism of H₂S in prolonging storage life and conserving the quality attributes of fruit and vegetable crops during shelf or low temperature storage.

Keywords: /Chilling injury/ /Ethylene biosynthesis/ /Oxidative damage/ /Postharvest quality/ /Storage potential/ /Signaling molecule/

STRAWBERRY

Yan, J., Luo, Z., Ban, Z., Lu, H., Li, D., Yang, D., Aghdam, S. S., and Li, L. (2019). The effect of the layer-by-layer (LBL) edible coating on strawberry quality and metabolites during storage. *Postharvest Biology and Technology*, 147, 29–38. DOI: 10.1016/j.postharvbio.2018.09.002

Abstract

Postharvest strawberries (*Fragaria × ananassa* Duch.) were coated either by the layer-by-layer (LBL) electrostatic deposition, based on chitosan and carboxymethyl cellulose (CMC), or coated by 1% chitosan. Results suggested that LBL edible coating was significantly effective at inhibiting the loss of fruit firmness and aroma volatiles of strawberry, with little effect on the total soluble solids and total acidity contents. Through an untargeted metabolomic analysis, we found that the LBL application significantly reduced the primary metabolite contents involved in carbohydrate, fatty acids and amino acids metabolism, as well as the secondary metabolite contents involved in terpenoid, carotenoid, phenylpropanoid and flavonoid metabolism after storage. Our results indicated that the LBL edible coating could be potential to maintain strawberry quality with lower metabolites contents after eight days of storage.

Keywords: /Strawberry/ /Edible coating/ /Postharvest/ /Layer by layer (LBL)/ /Metabolomics/

Kelly, K., Madden, R., Emond, J. P., & do Nascimento Nunes, M. C. (2019). A novel approach to determine the impact level of each step along the supply chain on strawberry quality. *Postharvest Biology and Technology*, 147, 78–88. DOI: 10.1016/j.postharvbio.2018.09.012

Abstract

Strawberries are among the most frequently wasted fruits because of their high perishability and handling requirements. Loss of quality begins at the farm and accumulates throughout the supply chain. There is a lack of information regarding the level of impact of each step along the supply chain on strawberry quality, and on how to prioritize actions along the supply chain to achieve an immediate and effective impact on waste reduction. The objectives of this study were to determine the impact level of each step along the supply chain, from the farm to the consumer, on the quality of strawberries, and to identify critical supply chain steps where the decline in strawberry quality was highest. To quantify the impact level of each step of the supply chain on strawberry quality, a control at constant optimum conditions (1 °C and 90% RH) plus 16 time-temperature supply chain scenarios were conducted simultaneously. Sensory quality was determined subjectively, and color, texture, weight loss, acidity, soluble solids, anthocyanins, sugars, and ascorbic acid contents were determined by quantitative analysis.

Results from this study showed that maintaining constant optimum temperature throughout the supply chain is paramount to reducing losses in strawberry quality, particularly in appearance, texture, weight loss, sugars, and bioactive compounds. Non-optimum conditions such as storage at the grower at 5 °C, shipping to the stores at 8 °C and storage at the consumer level at 20 °C had the greatest impact on strawberry overall quality, in comparison to maintaining optimum conditions, and were considered critical supply chains steps.

Keywords: /Fragaria x ananassa/ /Supply chain/ /Waste/ /Temperature/ /Bioactive compounds/ /Sugars/

Blanch, M., Álvarez, I., Sanchez-Ballesta, M. T., Escribano, M. I. and Merodio, C. (2019). Involvement of fatty acids in the response to high CO₂ and low temperature in harvested strawberries. Postharvest Biology and Technology, 147, 196-205. DOI: 10.1016/j.postharvbio.2018.10.001

Abstract

Fatty acids (FAs) play important roles in membrane fluidity, energy status and the production of specific FA-dependent esters. However, little is known about the modifications in FAs induced by high CO₂ that can improve fruit quality and prevent the disorders associated with storage at low temperature. For this purpose, total, free and esterified FAs in neutral and polar lipid fractions were characterized and quantified and their relationship with straight-chain esters was examined in strawberries treated with high doses of CO₂ and different times of exposure during early storage at 0 °C. In strawberries stored without added CO₂ (T1), storage at 0 °C led to an imbalance in the saturated/unsaturated ratio of polar lipids, mainly due to the decrease in the amount of saturated fatty acids (SFA). In addition, a decrease in the amount of free polyunsaturated fatty acids (PUFA) linked to a prevalence of butanoates and hexanoates esterified to long alcohols was observed. A strong negative correlation ($P \leq 0.01$; $r \geq 0.7$) between butanoate esters and free PUFA was quantified. In contrast, the application of 2 d 20 kPa CO₂ treatment (T2), increased the amount of PUFA from the neutral and polar fractions, with a preference for α -linolenic acid (18:3n3) which results in a rise in the 18:3/18:2 ratio, and which can confer membrane stability and fluidity. Furthermore, our results also showed a strong positive correlation ($P \leq 0.01$; $r \geq 0.75$) between α -linolenic acid (18:3n3) of polar lipids and some ethyl esters that contribute mostly to the aroma in strawberries. However, 3 d 40 kPa CO₂treatment (T4) depleted the content of FAs from all the lipid fractions in association with deficit ATP levels and an increased lipid peroxidation. These results suggest an active lipid breakdown which could play a causal role in the reported increased leakage of cellular water into intercellular air spaces in stressed-CO₂ fruit. Taken together, our results provide new insights into the beneficial effect of 2 d 20 kPa CO₂ treatment at 0 °C on the enhancement of PUFA in the polar lipid fraction and on the emission of esters other than ethyl acetate, which could improve membrane fluidity and could contribute to enriching aroma in strawberries.

Keywords: /Lipid fractions/ /Volatile esters/ /Firmness/ /MDA/ /Energy supply/