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As of April 2021

ALMONDS

Vega-Castellote, M., Pérez-Marín, D., Torres, I., & Sánchez, M. T. (2021). Non-destructive determination of fatty acid composition of in-shell and shelled almonds using handheld NIRS sensors. *Postharvest Biology and Technology*, *174*, 111459. https://doi.org/10.1016/j.postharvbio.2020.111459

Abstract

One of the major compounds in almond kernels, which determines their nutritional quality, are lipids. The aim of this research was to determine the fatty acid profile in intact in-shell and shelled almonds (145 samples) using two new generation handheld near infrared spectroscopy (NIRS) sensors, of different optical design and technical specifications, adapted for *in situ* analysis in different stages in the food supply chain: in the industry after harvest, at the reception points and during postharvest storage. For both instruments, two procedures for taking near infrared (NIR) spectra were tested: (1) static, where point spectral readings were taken of almonds placed on trays; (2) dynamic, where spectra were taken by scanning the entire trays. Modified partial least squares (MPLS) regression models were developed using NIR spectra with different combinations of signal pre-treatments — derivative and scatter correction methods. The residual predictive deviation for cross validation (RPD_{cv}) of the best models developed for the prediction of palmitic, stearic, oleic, and linoleic acids using shelled almonds were 2.40, 2.16, 3.98, and 3.77, respectively, and 1.73, 1.73, 2.02, and 2.11 for the in-shell almonds. These results confirm the feasibility of NIRS technology to measure the fatty acid profile in in-shell and shelled almonds. A comparison between the presentation mode (in-shell or shelled) and analysis mode (static or dynamic) showed that the best results were obtained for shelled almonds analysed in dynamic mode.

Keywords: /Almonds/ /*In situ* analysis/ /NIRS sensors/ /Fatty acid profile/ /Quality/ /Shelf life determination/

APPLE

Chigwaya, K., Karuppanapandian, T., Schoeman, L., Viljoen, D. W., Crouch, I. J., Nugraha, B., Verboven, P., Nikolai, B. M., & Crouch, E. M. (2021). X-ray CT and porosity mapping to determine the effect of 'Fuji' apple morphological and microstructural properties on the incidence of CO2 induced internal browning. *Postharvest Biology and Technology*, *174,* 111464. https://doi.org/10.1016/j.postharvbio.2021.111464

Abstract

There is considerable variability in the distribution of porosity within a fruit, hence non-destructive methods to map porosity of the entire fruit are essential. The objective of this study was to use X-ray computed tomography (CT) to map the porosity of 'Fuji' apple and help determine the extent to which different fruit morphological and microstructural properties influence the susceptibility of the fruit to CO_2 stress-induced internal browning (IB). X-ray CT based porosity mapping and high-resolution X-ray CT were used to determine porosity changes in fruit tissue following exposure to an atmosphere enriched with 50 % CO_2 at room temperature (21 °C) for 3 d after harvest. Low-resolution X-ray CT scans enabled the construction of porosity maps for intact fruit based on a linear regression model and a juice scan which acted as a 0 % porosity reference. Short-term exposure of fruit to a high level of CO_2 markedly induced IB in the core region of the fruit. Axial porosity profiles measured before the CO_2 stress treatment showed that porosity along the axial plane was usually lower in fruit that developed IB. Larger sized fruit were more susceptible to the CO_2 stress-induced IB disorder. The porosity in the IB affected fruit tissue declined from 8.6 to 5.4 % following the CO_2 stress treatment. It is recommended to ensure that levels of

CO_2 and O_2 in the controlled atmosphere (CA) storage environment are carefully controlled to minimize the risk of IB incidence.

Keywords: /Axial porosity profile/ /Computed tomography/ /CO_2 stress/ /'Fuji' apple/ /Fruit size/ /Internal browning/

Zuo, W., Lu, L., Su, M., Zhang, J., Li, Y., Huang, S., Li, C., Wang, N., Zhang, Z., & Chen, X. (2021). Analysis of differentially expressed genes and differentially abundant metabolites associated with the browning of Meihong red-fleshed apple fruit. *Postharvest Biology and Technology*, *174,* 111437. https://doi.org/10.1016/j.postharvbio.2020.111437

Abstract

Enzymatic browning affects the quality of fresh-cut produce. To elucidate the mechanism regulating the browning of red-fleshed apples, we analyzed the transcriptome and metabolome of freshly cut Meihong apple samples collected at 0, 0.5, and 4 h after cutting. The main differentially abundant metabolites during the browning process were phenols, amino acids and fatty acids. Phenols are substrates for enzymatic browning and most of them are negatively correlated with browning. Amino acids and their derivatives are associated with non-enzymatic browning and most of them are positively correlated with browning. A transmission electron microscopy analysis revealed the degradation of the cell membrane of cut fruit samples, which significantly affected the fatty acid content. The differentially expressed genes were mainly related to plant–pathogen interactions. Polyphenol oxidase (PPO) plays a major role during the early browning stage, but PPO gene expression was not higher than WRKY, AP2 and MYB transcription factors.

Keywords: /Transcriptome/ /Metabolome/ /Browning/ /Red-fleshed apple/

AVOCADO

Hernández, I., Uarrota, V., Paredes, D., Fuentealba, C., Defilippi, B. G., Campos-Vargas, R., Meneses, C., Hertog, M. & Pedreschi, R. (2021). Can metabolites at harvest be used as physiological markers for modelling the softening behaviour of Chilean "Hass" avocados destined to local and distant markets? *Postharvest Biology and Technology*, *174,* 111457. https://doi.org/10.1016/j.postharvbio.2020.111457

Abstract

The aim of this study was to model Chilean "Hass" avocado softening behaviour, destined to local and distant markets, taking into account the biological variation given by growing location and harvest stages. A total of 24 batches were obtained during the season 2018–2019 from different agro-climatic zones (coast, intermediate and interior) and two harvest stages (based on dry matter content). Fruit softening during either regular air (RA) or controlled atmosphere (CA) storage at 5 °C followed by shelf-life at 20 °C was modelled using a simplified mechanistic model. Most of the model parameters were treated as being generic for all fruit except for two fruit specific parameters, F_0 (firmness at harvest) and E_0 (amount of enzyme complex at harvest) that characterized the fruit at harvest and thus postharvest ripening behaviour. The model was able to describe 87.6 % of the observed variation of all 24 fruit batches studied from different agro-climatic zones at the batch averaged level, but 93.5 % of the observed variation at the fruit individual level. Since measured at harvest when most fruit are highly firm, initial fruit firmness by itself was not able to discriminate among the various batches as they all showed similar normal distributions among the different agro-climatic zones, in addition, the estimated E_0 values for each individual fruit were correlated to key metabolites to identify potential metabolite biomarkers discriminating among the different regions and batches. The developed model can be utilized to predict the batch specific ripening behaviour of "Hass" avocado under different postharvest logistic chains given the distribution of E_0 is known.

Keywords: /*Persea Americana/ /*Heterogeneity/ /Firmness/ /Modelling/ /Ripening/ /Metabolites/

Saidi, L., Duanis-Assaf, D., Galsarker, O., Maurer, D., Alkan, N., & Poverenov, E. (2021). Elicitation of fruit defense response by active edible coatings embedded with phenylalanine to improve quality and storability of avocado fruit. *Postharvest Biology and Technology*, *174*, 111442. https://doi.org/ 10.1016/j.postharvbio.2020.111442

Abstract

Edible coatings attract high research attention as an effective natural approach for maintaining fresh agricultural produce quality and storability. In this study, a series of polysaccharide-based coatings that contain, for the first time, an elicitor of fruit defense response, phenylalanine, were developed and applied on avocado fruit. After an initial screening of a series of polysaccharides coatings, the chitosan and carboxymethyl cellulose with stearic acid (CMC + StA) were chosen, and phenylalanine elicitor was added then to the polysaccharide matrices. These active edible coatings of either chitosan or CMC + StA that contained phenylalanine significantly reduced the fruit's natural decay caused by the fungal pathogens *Colletotrichum* and *Alternaria*. The coated avocado fruit has also demonstrated higher resistance to storage at sub-optimal temperature and showed less pitting, decay, and internal browning. The observed cold resistance correlated with a minor transcript upregulation of several genes as lipoxygenase, heat-shock protein, and several transcripts in the phenylpropanoid pathway. Interestingly, the coated fruit had a better flavor than the control fruit. Taken together, the reported results point to the ability of these new edible coatings to significantly increase fruit resistance to fungal pathogens and cold stress while maintaining the fruit quality and storability and improving their taste.

Keywords: /Chitosan coatings/ /Phenylalanine/ /Carboxymethyl cellulose coatings/ /*Persea Americana/ /* Fruit/

CABBAGE

Hu, H., Zhao, H., Zhang, L., Zhou, H., & Li, P. (2021). The application of 1-methylcyclopropene preserves the postharvest quality of cabbage by inhibiting ethylene production, delaying chlorophyll breakdown and increasing antioxidant capacity. *Scientia Horticulturae, 281*, 109986. https://doi.org/10.1016/j.scienta.2021.109986

Abstract

Freshly harvested cabbages were treated with air (control group) or 1 μL L−1 1-methylcyclopropene (1-MCP) for 12 h, followed by storage for 8 d at 25 ± 1 °C. The effects of 1-MCP on postharvest deterioration characteristics, antioxidant capacity, health-promoting compounds and nitrite accumulation in cabbage leaves were investigated. Treatment with 1-MCP significantly extended the shelf life, reduced postharvest deterioration, retarded chlorophyll degradation and inhibited the accumulation of malondialdehyde and nitrite in cabbage. Ethylene production and respiration rate were also inhibited by 1-MCP. Furthermore, 1-MCP treatment delayed the decrease in total glucosinolates, sulforaphane and folic acid during storage. High levels of ascorbic acid, total phenolic content and antioxidant capacity were also maintained in 1-MCP-treated cabbage. This study demonstrates that 1-MCP is a potential postharvest treatment to delay the senescence process, maintain desirable quality properties and reduce the loss of certain health-promoting compounds in cabbage.

Keywords: /Cabbage/ /1-MCP/ /Ethylene/ /Storage/ /Yellowing/

Li, F., Huang, H., Ding, X., Liu, J., He, M., Shan, Y., Qu, H., & Jiang, Y. (2021). Effect of CPPU on postharvest attributes of Chinese flowering cabbage during storage. *Postharvest Biology and Technology*, *174*, 111438. https://doi.org/10.1016/j.postharvbio.2020.111438

Abstract

Chinese flowering cabbage is an important cultivated leafy vegetable. Experiments were conducted to test the effect of exogenous application of N-phenyl-N-(2-chloro-4-pyridyl) urea (CPPU) as a cytokinin analogue on postharvest attributes of Chinese flowering cabbage during storage at low temperature. The results revealed that CPPU treatment significantly delayed the de-greening of Chinese flowering cabbage. The treatment reduced the H_2O_2 accumulation, $O_2^{\cdot-}$ production rate and malondialdehyde content, maintained membrane permeability and delayed the decrease in the contents of total unsaturated fatty acids. Meanwhile, the deficiency of energy status referred to the ATP level and energy charge in relation to the expressions of energy-related genes of Chinese flowering cabbage was slowed down after CPPU treatment. Furthermore, the decreases in the contents of chlorophylls, the transcript levels of chlorophyll catabolic genes *BrPAO1*, *BrPPH1*, *BrSGR1* and *BrNYC1* and senescence associated genes *BrSAG12* and *BrSAG19* were markedly suppressed. These results exhibited that exogenous application of CPPU efficiently retarded the oxidative damage of membrane integrity, helped to maintain the energy status, slowed down the rapid degradation of chlorophylls and, thus, delayed the leaf senescence of Chinese flowering cabbage during storage, which suggested that the application of CPPU might be as a postharvest handling for quality maintenance and shelf life extension of leafy vegetables.

Keywords: /Chinese flowering cabbage/ /N-Phenyl-N-(2-chloro-4-pyridyl) urea/ /CPPU/ /Leaf senescence/ /Fatty acid/ /Energy deficiency/

DRAGON FRUIT

Nguyen, H.T., Boonyaritthongchaia, P., Buanonga, M., Supapvanich, S., & Wongs-Areea, C. (2021). Chitosan and K-carrageenan-based composite coating on dragon fruit (*Hylocereus undatus*) pretreated with plant growth regulators maintains bract chlorophyll and fruit edibility. *Scientia Horticulturae, 281*, 109916. https://doi.org/10.1016/j.scienta.2021.109916

Abstract

Dragon fruit undergoes rapid senescence resulting in yellowing and wilting of bracts during storage. This study identified the synergistic effect of gibberellic acid (GA3) or methyl jasmonate (MeJA) dipping combined with chitosan- and κ-carrageenan-based composite coating on the postharvest quality of dragon fruit during storage at 10 °C, 90–95 % RH. Coating with 1.0 % chitosan and 0.2 % κ-carrageenan-based composite decreased the fruit weight loss to lower than 5 % after 30 days of storage and had a positive effect on reducing disease infection. Fruit dipped in 50 mg L−1 GA3 or 0.1 mM MeJA for 5 min maintained a better bract quality compared to the control. The treatment of 1.0 % chitosan and 0.2 % κ-carrageenan- based composite combined with 50 mg L−1 GA3 or 0.1 mM MeJA pretreatment retained a higher chlorophyll content in bracts (47.98 and 48.43 mg 100 g−1 DW, respectively) compared to the coating alone with 1.0 % chitosan and 0.2 % κ-carrageenan- based composite (45.46 mg 100 g−1 DW) via inhibiting the activities of chlorophyll-degrading enzymes. However, bract colour was maintained in all coating treatments compared to the control. The composite coating alone or pretreatment with MeJA significantly maintained titratable acidity, while the combination of GA3 or MeJA pretreatment and coating retained total soluble solids and increased vitamin C content. No treatment was found to have a significant effect on fruit firmness, ethanol and acetaldehyde, total phenolic content, antioxidant activity, and disease symptoms. We concluded that the chitosan- and κ-carrageenan-based composite coating was crucial for maintaining the freshness and bract colour, and in combination with GA3 or MeJA pretreatment was better in retaining chlorophyll content and dragon fruit eating quality.

Keywords: /Bract quality/ /Chlorophyll/ /Edible composite coating/ /Gibberellic acid/ /Methyl jasmonate/ /Postharvest handling process/

FOOD PACKAGING

Carina, D., Sharma, S., Jaiswal, A. K., & Jaiswal, S. (2021). Seaweeds polysaccharides in active food packaging: A review of recent progress. *Trends in Food Science and Technology*, 110, 559-572. https://doi.org/10.1016/j.tifs.2021.02.022

Abstract

Due to its short lifetime, food packaging leads to a rapid accumulation of plastic in our surroundings and thereby also has a huge impact on environmental pollution. To reduce these effects and create a more sustainable approach towards food packaging, biodegradable and biobased polymers have been developed and are emerging on the market. This review provides the current state of research regarding active packaging and the incorporation of seaweed into food packaging. Further, it summarises the resulting consequences of the seaweed incorporation on mechanical, physical, thermal, antioxidant, antimicrobial and chemical properties, as well as the release of active compounds to show the advantages of the polysaccharides as well as possible shortcomings in current research. To improve these polymers regarding their mechanical, thermal and antimicrobial properties etc. a variety of polysaccharides such as seaweeds can be used. They not only lead to an increase in hydrophilicity and improved mechanical properties such as tensile strength and elongation at break, but also create the possibility of using it as active packaging. This can be achieved due to the naturally occurring antioxidant properties in seaweed, which can minimise lipid oxidation and thereby increase the shelf life and nutritional value of food as well as reduce free radicals which might have a carcinogenic, mutagenic or cytotoxic effect. Some seaweeds such as H. elongate have also proven to inhibit the growth of gram-positive and gram-negative bacteria, meaning that they could possibly be used as antimicrobial packaging.

Keywords: /Seaweeds/ /Polysaccharides/ /Active packaging/ /Film microstructure/ /Antioxidant/ /Antimicrobial film/ /Biodegradable polymers/

Yu, Y., Zheng, J., Li, J., Lu, L., Yan, J., Zhang, L., & Wang, L. (2021). Applications of two-dimensional materials in food packaging. *Trends in Food Science & Technology,* 110, 443-457. https://doi.org/10.1016/j.tifs.2021.02.021

Abstract

The expectations for high food safety and quality keep rising in modern societies, driving food packaging technologies to evolve continuously. Recently, two-dimensional materials (2DMs) with some fascinating properties such as large specific surface area, high mechanical performance and unique electrocatalytic activity, have been widely explored for various applications including food packaging. This review summarizes recent advances regarding the applications of 2DMs (including graphene, transition metal dichalcogenides (TMDs), hexagonal boron nitride (h-BN), layered double hydroxides (LDHs), graphitic carbon nitride (g-C3N4), transition metal carbides and nitrides (MXenes)) in active packaging (such as improving the barrier property, mechanical property, thermal stability and antimicrobial activity, etc.) and intelligent packaging (such as preparing leak indicators, pH indicators, time-temperature indicators, gas sensors, intelligent labels, etc.). Current research gaps and future prospects of this field are discussed as well. Increasing numbers of studies have proven the versatility of 2DMs in food packaging. Yet, the potentials of 2DMs are still not fully explored, even the most reported graphene and its derivatives. In order to make 2DMs-based food packaging technologies commercially viable, some aspects such as cost, legislation, consumers' acceptance, as well as the migration behaviors and toxicology of 2DMs in packaging materials need more considerations and explorations.

Keywords: /Active packaging/ /Intelligent packaging/ /Two-dimensional material/

FOOD SAFETY

Hu, B., Pu, H., & Sun, D. W. (2021). Multifunctional cellulose based substrates for SERS smart sensing: Principles, applications and emerging trends for food safety detection. *Trends in Food Science and Technology, 110,* 304-320. https://doi.org/10.1016/j.tifs.2021.02.005

Abstract

Food safety issues leading to severe healthy, economic and even social problems and detection of food contaminants has been attracting remarkable attention in recent decades. Surface-enhanced Raman scattering (SERS) is one of the most promising techniques to enable detecting contaminants at trace levels. Besides, with the emergence of global resource shortages and environmental problems, there is a growing demand for environmentally friendly and renewable resources. As a sustainable and biodegradable raw material, cellulose has aroused great interest and stimulated researchers to develop cellulose-based SERS substrates with novel functions. The review focuses on the utilizing of cellulosic materials for the design and preparation of various SERS substrates, including cellulose-papers, cellulose fabrics (CFs) and membranes, cellulose nanofibrils (CNFs), bacterial cellulose (BC), nanocrystalline cellulose (NCC), and surface-modified cellulose. The applications, challenges and potential solutions of these cellulose-based substrates in food safety detection are also presented, proposed and evaluated. For the complexity and diversity of multitudinous food systems, multiple approaches have been successfully employed to manufacture cellulose-based SERS substrates. Various types of cellulose with diverse morphology and mechanical properties make them customizable and integratable with multiple technologies in certain realistic applications. The explorations of SERS detections display excellent performances especially for the complex system/surface analysis with the capability of extraction, swabbing, transferring and concentrating target molecules from complexing food systems. The widespread application and prominent performance demonstrates the huge potential for cellulose-based materials to realize commercially viable, sustainable, flexible and green substrates in the near future.

Keywords: /Cellulose/ /Nanocellulose/ /Surface-enhanced/ /Raman scattering/ /Substrates/ /Food safety/

Wu, Z., Pu, H., & Sun, D. W. (2021). Fingerprinting and tagging detection of mycotoxins in agri-food products by surface-enhanced Raman spectroscopy: Principles and recent applications. *Trends in Food Science & Technology*, 110, 393-404. https://doi.org/10.1016/j.tifs.2021.02.013

Abstract

Mycotoxin contamination in agri-food products compromises human and animal health throughout the supply chains, thus the establishment of rapid and accurate methods for the detection of mycotoxins is essential for food safety assurance. Among the preferred spectral methods, surface-enhanced Raman scattering (SERS) has emerged as an attractive solution for detecting trace mycotoxins in complex food matrices due to its advantages of high sensitivity, rapidness and non-destructiveness. However, relevant developments in research in this field are scarcely reviewed. In the current review, the fundamentals of SERS and substrates for detecting mycotoxin in agri-foods are introduced, technical developments in the detection procedure including combined techniques, fingerprinting and SERS tagging and spectral optimizations such as using chemometrics are elaborated. Recent applications of SERS methods for trace level detection of mycotoxins in agri-food samples including cereal grains, fruits, dairy products, and wine are also highlighted, and limitations and future prospects for developing the SERS technology for detecting mycotoxin contamination are finally presented. SERS is a rapid and sensitive technique for detecting trace mycotoxins. However, the preparation of high-performance SERS substrates for on-site quantitative analysis of real food samples is still a challenging scientific problem. Future research should focus on designing reliable SERS substrates, establishing SERS fingerprint libraries of mycotoxins, and developing accurate chemometric methods, and choosing suitable combined techniques in order to achieve an early adoption of the SERS method as a practical tool for detecting mycotoxin contamination in the agri-food industry.

Keywords: /Mycotoxins detection/ /Food contamination/ /Food safety/ /SERS fingerprint/ /SERS tags/

FRUIT AND VEGETABLE QUALITY

Kou, X., Yang, S., Chai, L., Wu, C., Zhou, J., Liu, Y., & Xue, Z. (2021). Abscisic acid and fruit ripening: Multifaceted analysis of the effect of abscisic acid on fleshy fruit ripening. *Scientia Horticulturae*, 281, 109999. https://doi.org/10.1016/j.scienta.2021.109999

Abstract

Fruit is the main dietary source of sugar, fiber, vitamins and minerals. It is an indispensable food for people and animals. Its ripening process is not only related to its shelf life, but also to the quality of the fruit. Abscisic acid is an important plant hormone that regulates the ripening process of fruit, and is involved in the processes of softening, coloring and synthesis of aromatic substances. These functions are achieved through direct or indirect action on substances that regulate key ripening genes, other plant hormones and transcription factors, as well as sugars and polyamines. Fruit ripening is a complex and delicate process, although ethylene has been established as the core position of phytohormone in climacteric fruit, the role of abscisic acid has become more and more prominent as research progresses. This article mainly introduces the contribution of abscisic acid to fruit ripening from various aspects, and discusses the fruit ripening mechanism, focusing on the regulation system with abscisic acid as the core. This review also provides an outlook for future research on abscisic acid.

Keywords: /Abscisic acid/ /Plant hormone/ /Transcription factor/ /Fruit ripening/ /Regulatory network/

Panahirad, S., Dadpour, M., Peighambardoust, S.H., Soltanzadeh, M., Gullon, B., Alirezalu, K., & Lorenzo, J.M. (2021). Applications of carboxymethyl cellulose- and pectin-based active edible coatings in preservation of fruits and vegetables: A review. *Trends in Food Science & Technology*, *110*, 663-673. https://doi.org/10.1016/j.tifs.2021.02.025

Abstract

The perishable nature of fruits and vegetables makes their shelf-life limited. Environmental factors, transportation and preservation conditions through postharvest could decrease the storage time and quality. Therefore, prolonging supply time of fruits and vegetables by safer postharvest treatments direct the preservation methods to edible coatings. Active edible coatings incorporating different types of functional substances can be used as a preservation method to boost strategies in improving quality, safety and shelf-life of fruits and vegetables upon storage. This review attempts to present a complete overview of carboxymethyl cellulose (CMC) and pectin as a basis for edible coatings and recent developments related to their application as active coatings for preservation of fruits and vegetables quality. CMC and pectin are two main polysaccharides with great potential in making edible coatings. The CMC- and pectin-based edible coatings are commonly odorless, tasteless, non-toxic, non-allergic, water-soluble, transparent and resistant to oil and fats. CMC and pectin, additionally, could be good carriers for active additives. In this sense, CMC and pectin-based active coatings could provide a great potential both for their protective effect and carrying functional compounds such as antimicrobials, antioxidants, anti-browning agents, texture enhancers and nutraceuticals into their coating matrix to prevent unwanted reactions (e.g., microbial growth, oxidation, enzymatic browning and softening) in horticultural products. Such strategy could inhibit microbial decays and enzymatic or biochemical damages and prevent physical or textural deteriorations in fruits and vegetables during storage.

Keywords: /Active coating/ /Carboxymethyl cellulose/ /Pectin Preservation Quality/

Rosberg, A., Darlison, J., Mogren, L., & Alsanius, B. W. (2021). Commercial wash of leafy vegetables do not significantly decrease bacterial load but leads to shifts in bacterial species composition. *Food Microbiology, 94*, 103667. https://doi.org/10.1016/j.fm.2020.103667

Abstract

Production of leafy vegetables for the “Ready-to-eat”-market has vastly increased in the last 20 years, and consumption of these minimally processed vegetables has led to outbreaks of food-borne diseases. Contamination of leafy vegetables can occur throughout the production chain, and therefore washing of the produce has become a standard in commercial processing. This study explores the bacterial communities of spinach (*Spinacia oleracea*) and rocket (*Diplotaxis tenuifolia*) in a commercial setting in order to identify potential contamination events, and to investigate effects on bacterial load by commercial processing. Samples were taken in the field, after washing of the produce and at the end of shelf-life. This study found that the bacterial community composition and diversity changed significantly from the first harvest to the end of shelf-life, where the core microbiome from the first to the last sampling constituted <2% of all OTUs. While washing of the produce had no reducing effect on bacterial load compared to unwashed, washing led to a change in species composition. As the leaves entered the cold chain after harvest, a rise was seen in the relative abundance of spoilage bacteria. E. coli was detected after the washing indicating issues of cross-contamination in the wash water.

Keywords: /Microbiome/ /Minimally processed leafy vegetables/ /Phyllosphere/ /Spinach (*Spinacia oleracea*)/ /Rocket (*Diplotaxis tenuifolia*)/

Wang, X., Feng, H., Chen, T., Zhao, S., Zhang, J., & Zhang, X. (2021). Gas sensor technologies and mathematical modelling for quality sensing in fruit and vegetable cold chains: A review. *Trends in Food Science & Technology, 110*, 483-492. https://doi.org/10.1016/j.tifs.2021.01.073

Abstract

Fruit and vegetable (F&V) harvested from plants trigger a series of stress-related physiological processes, potentially resulting in quality deterioration and considerable losses. Cold chain acting as abiotic stressors and activation of specific pathways to maintain metabolic activities is an effective way to reduce postharvest F&V loss. To this end, real-time monitoring of the micro-environment of the cold chain is an important approach. While temperature and humidity are routinely monitored nowadays, gas is much less explored despite it deeply interacts with the product quality of the cold chain. This article analyzes the requirement for quality sensing via gas signal, reviews existing and emerging gas sensor technology and gas signal processing method for F&V cold chain. Furthermore, mathematical models, which interpret sensed gas data and predict product quality, are systematically analyzed and discussed. Gas sensor technology and associated modelling method is an effective approach to improve transparency and product quality for F&V cold chain. The results illustrate that the gas sensor for quality sensing of F&V cold chain should have characteristic with high precise resolution and full scale, low power consumption, low cost and smaller size, existed gas sensors have been gradually developed from a single unit to a plurality of components, specially rigid and flexible structural materials and manufacturing process. Existing mathematical models still have limited prediction accuracy that gas signals interfere with product quality. Then, the model needs to improve the performances to explain the complex interaction relationship between gas and quality.

Keywords: /Quality sensing/ /Gas sensor/ /Mathematical modelling/ /Signal processing/ /Cold chain/ /Fruit and vegetable/

GOOSEBERRY

Balaguera-López, H. E., Espinal-Ruiz, M., Rodríguez-Nieto, J. M., Herrera-Arévalo, A., & Zacarías, L. (2021). 1-Methylcyclopropene inhibits ethylene perception and biosynthesis: A theoretical and experimental study on cape gooseberry (*Physalis peruviana* L.) fruits. *Postharvest Biology and Technology*, *174*, 111467. https://doi.org/10.1016/j.postharvbio.2021.111467

Abstract

Theoretical and experimental studies were conducted to determine the role of 1-MCP in the biosynthesis of ethylene in cape gooseberry fruits (*Physalis peruviana* L.), ecotype Colombia. A completely randomized experimental design was used with 3 treatments: ethylene (1000 μL ethephon L^{-1}), 1-MCP (1 μL L^{-1}), and a control with no applications. At 1, 6 and 11 days after treatment, volatile compounds, firmness and color were measured. The enzymatic activities of ACC oxidase (E.C. 1.14.17.4) and histidine kinase (HK, E.C. 2.7.13.3) were also determined *in vitro*. Subsequently, molecular docking studies with the enzymes, their respective substrates and 1-MCP were carried out. It was found that 1-MCP decreased the emission of volatile esters, color index, loss of firmness, and ACC oxidase and histidine kinase activities. Results indicated 1-MCP acted as a competitive inhibitor of ACC oxidase and as a noncompetitive inhibitor of HK. The coupling free energy was higher for 1-MCP in both the ACC oxidase (8.31) and the HK (4.22), compared to their respective substrates. The results also suggested that 1-MCP was able to decrease both the biosynthesis and activity of ethylene in cape gooseberry fruits.

Keywords: /*Physalis peruviana* L./ /Ethylene signaling/ /1-MCP/ /Histidine kinase/ /ACC oxidase/

KIWIFRUIT

Ma, T., Xia, Y., Inagaki, T., & Tsuchikawa, S. (2021). Non-destructive and fast method of mapping the distribution of the soluble solids content and pH in kiwifruit using object rotation near-infrared hyperspectral imaging approach. *Postharvest Biology and Technology*, *174*, 111440. https://doi.org/10.1016/j.postharvbio.2020.111440

Abstract

This work aimed to offer a non-destructive and fast approach to visualizing the soluble solids content (SSC) and acidity (pH) of the whole kiwifruit. Most of the visible-near-infrared spectral imaging techniques used in postharvest fruit and vegetables assessment exhibit issues related to the identification of the quality spatial distribution within intact samples, mainly due to sampling surface curvature effects. Here, a push-broom-type NIR hyperspectral imaging camera and a sample rotation stage were combined to scan entire kiwifruit surfaces. Then, key wavelengths in the range of 1002–2300 nm were extracted for constructing SSC and pH calibration models by partial least squares regression analysis. The resulting SSC prediction accuracy was sufficiently high: the coefficient of determination (R^2_{cv}) and the root mean square error ($RMSE_{cv}$) of the cross-validation set were 0.74 and 0.7 %, respectively. For pH, the R^2_{cv} and $RMSE_{cv}$ were 0.64 and 0.14, respectively. Finally, the SSC and pH 360° mapping results surpassed earlier works in this area that showed a distinct spatial distribution within each intact sample. It was concluded that the proposed object rotation hyperspectral imaging approach is promising for the non-destructive prediction mapping of SSC and pH in kiwifruit or other cylindrical-shaped samples.

Keywords: /Kiwifruit/ /Cylindrical-shaped sample/ /Hyperspectral imaging camera/ /Sample rotation stage/ /PLS regression analysis/ /Distribution map of SSC and pH/

LOQUAT

Ye, W. Q., Sun, Y. F., Tang, Y. J., & Zhou, W. W. (2021). Biocontrol potential of a broad-spectrum antifungal strain *Bacillus amyloliquefaciens* B4 for postharvest loquat fruit storage. *Postharvest Biology and Technology*, *174*, 111439. https://doi.org/10.1016/j.postharvbio.2020.111439

Abstract

Loquat fruit is a subtropical fruit with high commercial values in the international market, but it actually has a short postharvest life due to mechanical damage and microbial decay. Until now, there exist few appropriate storage methods or biocontrol agents to control postharvest diseases and prolong storage period of postharvest loquat fruit. Recently, by comparing twelve *Bacillus* strains with biocontrol activity, a potential *Bacillus amyloliquefaciens* B4 was found to be effective in controlling various pathogens of loquat fruit. The *in vivo* results displayed that the active constituent in B4 exerting antifungal activity was bacterium itself, rather than metabolites. Scanning electron microscope was applied to observe the interaction between B4 and pathogens, and bacterial colonization and site occupancy on postharvest loquat fruit appeared to be one of the reasons why B4 could inhibit growth of fungal pathogens. In brief, *Bacillus amyloliquefaciens* B4 tends to be the most broad-spectrum antifungal biological agent available so far against postharvest pathogens of loquat fruit. Furthermore, oral toxicity test results suggested *Bacillus* B4 is actually non-toxic, making it a really suitable biocontrol agent for postharvest loquat fruit. The treatment for loquat fruit with B4 resulted in a lower disease incidence, with only 62.5 % compared to all decayed in the untreated group 20 d after inoculation at 25 ℃. This study provides a promising biological agent to control diseases of postharvest loquat fruit and improves our understanding of the possible biocontrol mechanisms of the *Bacillus* strain.

Keywords: /Antifungal/ /*Bacillus*/ /Biocontrol/ /Loquat fruit/ /Postharvest storage/

MELON

Zhang, Q., Shan, C., Song, W., Cai, W., Zhou, F., Ning, M., & Tang, F. (2021). Transcriptome analysis of starch and sucrose metabolism change in Gold Queen Hami melons under different storage temperatures. *Postharvest Biology and Technology*, *174*, 111445. https://doi.org/10.1016/j.postharvbio.2020.111445

Abstract

Temperature control is an effective method to maintain the postharvest quality of fruit and extend their shelf life. However, quality deterioration, or more specifically, faded sweetness, occurs in long-term cold-stored melons. This study aimed to characterize the transcriptomic profiles of Gold Queen Hami melon using RNA sequencing at different storage temperatures (21 °C, 3 °C, and 0.5 °C). The results indicated that storage temperature significantly affected the expression of numerous genes in the melon fruit, especially several key genes involved in the starch and sucrose metabolism pathway. The findings revealed that 23 genes presented opposite expression pattern between 3 °C and 21 °C, and 62 chilling-related candidate genes were obtained. Sweetness loss in Hami melons was enhanced at storage temperatures of 3 °C and 0.5 °C. Furthermore, storage at 3 °C was found to decelerate Hami melon softening, as the degradation of pectin and expression of polygalacturonase (PG) were reduced. Moreover, storage at 0.5 °C promoted starch degradation by regulating the expression of α-amylase (AMY) and β-amylase (BMY) genes, subsequently, the levels of soluble sugars increased, potentially preventing physiological or cellular damage from cold stress in the melon fruit. These results indicated that softening was delayed at 3 °C, but the sweetness of the Hami melon was negatively affected at the level of gene transcription, explaining the faded sweetness of cold-stored melon fruit.

Keywords: /Hami melon/ /Low temperature/ /Starch metabolism/ /Sucrose metabolism/ /Fruit softening/

Shekari, A., Naghshiband Hassani, R., & Soleimani Aghdam, M. (2021). Exogenous application of GABA retards cap browning in *Agaricus bisporus* and its possible mechanism. *Postharvest Biology and Technology*, *174*, 111434. https://doi.org/10.1016/j.postharvbio.2020.111434

Abstract

In this study, the effect of exogenous γ-aminobutyric acid (GABA) at 0 (control), 0.01, 0.1, 1, and 10 mM on cap browning and quality of button mushrooms during 15 d of storage at 4 °C was investigated. GABA at 0.1 mM yielded the lowest cap browning. Weight loss, electrolyte leakage, and malondialdehyde (MDA) content were significantly lower in mushrooms treated with 0.1 mM GABA, while their firmness was higher. The increased accumulation of total phenolic compounds in the 0.1 mM GABA treated mushrooms was associated with a higher expression and activity of phenylalanine ammonia-lyase (PAL) accompanied by a lower expression and activity of polyphenol oxidase (PPO). GABA treatment was capable of reducing H_2O_2 content and increasing ascorbic acid (AsA) content. Exogenous GABA increased the endogenous GABA content by increasing the expression of the glutamate decarboxylase (GAD) gene and decreasing the expression of the GABA transaminase (GABA-T) gene. Overall, GABA treatment could be employed for retarding cap browning and maintaining the sensory and nutritional quality of button mushrooms during cold storage.

Keywords: /Y-aminobutyric acid/ /Membrane integrity/ /Mushrooms cap browning/ /Endogenous GABA content/

MUSHROOM

Marcal, S., Sousa, A.S., Taofiq, O., Antunes, F., Morais, A.M.M.B., Freitas, A.C., Barros. L., Ferreira, I.C.F.R., & Pintado, M. (2021). Impact of postharvest preservation methods on nutritional value and bioactive properties of mushrooms. *Trends in Food Science & Technology, 110,* 418-431. https://doi.org/10.1016/j.tifs.2021.02.007

Abstract

Mushrooms are a good source of protein, dietary fibre, vitamins, minerals and phenolic compounds. However, mushrooms are a very perishable food and the implementation of preservation methods is essential to extend their shelf-life. The preservation methods for mushrooms can be classified into three categories: thermal (drying/freezing), chemical (edible coatings, films and washing solutions) and physical (packing, irradiation, pulsed electric field and ultrasound) processes. These processes can change the nutritional value and bioactive properties of this commodity. The goal of this review is to critically update and discuss the existing information about the effect of postharvest preservation methods on the nutritional value and bioactive properties of edible mushrooms. Drying, especially when high temperatures are applied, can cause the degradation of polysaccharides, proteins and flavour compounds. Freezing is one of the best methods to extend mushrooms' shelf life but cause the loss of vitamins. Edible coatings and films improve the total sugar, ascorbic acid and bioactive compounds preservation during the storage period. Washing solutions decrease amino acids content. Gamma and electron-beam irradiation decrease the unsaturated fatty acid content, whereas UV-B irradiation significantly increases the vitamin D content. However, there is still limited information about the impact of chemical processes, packaging, pulsed electric field and ultrasound on the nutritional composition and bioactive properties of mushrooms, opening research opportunities for the future. This review presents technological and economic alternatives that may support the mushroom processing industries to obtain value-added edible mushrooms and related products.

Keywords: /Edible mushrooms/ /Postharvest preservation methods/ /Nutritional composition/ /Bioactive properties/

OLIVE

Zipori, I., Fishman, A., Zelas, Z. B. B., Subbotin, Y., & Dag, A. (2021). Effect of postharvest treatments of mechanically harvested "Manzanilla" table olives on product quality. *Postharvest Biology and Technology*, *174*, 111462. https://doi.org/10.1016/j.postharvbio.2021.111462

Abstract

'Manzanilla', today's main table olive cultivar, is traditionally harvested manually. However, manual harvesting is becoming less economically feasible due to increasing labor costs and a shortage of workers. Consequently, we examined options for mechanical harvesting of these table olives. The 'Manzanilla' fruit skin is sensitive to bruising and damage caused by mechanical harvesting. Therefore, postharvest field (PHF) treatments were studied, to reduce the percentage of damaged fruit in the final product. The effect of PHF treatments on final product quality of mechanically harvested 'Manzanilla' table olives was studied over 6 consecutive years (2011–2016). In the first part of the study (2011–2013), a wide range of treatments was tested in 2 L containers; the most promising one seemed to be immersing the fruit in a 1 % NaOH solution immediately after harvest. Later in the study, this treatment was also tested in commercial-scale containers, with acceptable results, although there was a certain variability between years and even between different olive batches in the same year. Although the grower wishing to apply such a treatment is faced with a certain logistical challenge, it allows for the possibility of applying mechanical harvesting to 'Manzanilla', a procedure which, until now, has been considered unsuitable for this table olive cultivar.

Keywords: /Table olives/ /Mechanical harvest/ /Fruit quality/ /Post harvest treatment/ /NaOH/

ORCHIDS

Tsai, J.Y., Wang, T.T., Huang, P.L., & Do, Y.Y. (2021). Effects of developmental stages on postharvest performance of White Crane Orchid (*Calanthe triplicata*) inflorescences. *Scientia Horticulturae*, 281, 109988. https://doi.org/10.1016/j.scienta.2021.109988

Abstract

White crane orchid (*Calanthe triplicata*) is one of the native orchids in Taiwan. It features pure white flowers, a unique flowering pattern, an elegant inflorescence, and it is of high ornamental value. In order to evaluate the feasibility of white crane orchid for cut flower production, we characterized the growing and blooming of the white crane orchid inflorescence during its vase life in deionized water. Up to 30 florets on each rachis bloomed from the bottom to the top on the raceme of the white crane orchid. The floret at the lowest position began to wilt after more than 20 florets bloomed. The early senescence symptoms of a floret were the yellowing labellum and blackening anther cap. To investigate the flower longevity and the overall ornamental value of inflorescences, they were harvested when bearing 0, 11, and 20 opened florets. The inflorescences in the three developmental stages had a vase life of 22 days, 9 days and 6 days, respectively, in deionized water at 25 °C. Although they have the longest vase life, inflorescences that were harvested in the budding period (0 opened florets) had a relatively low ornamental value; conversely, the ornamental value of the inflorescences harvested in the blooming period (20 opened florets) was the highest, followed by that at the stage with 11 florets. The application of ethylene action inhibitors, such as 1-methylcyclopropene (1-MCP) or silver thiosulfate (STS), to the inflorescences harvested in the blooming period (20 opened florets) has extended their vase life from 6 days to 8 days and to 10 days, respectively.

Keywords: /Floret longevity/ /Inflorescence quality/ /Vase life/ /Ethylene action inhibitor/

ORGANIC FOOD

Mihailova, A., Kelly, S.D., Chevallier, O.P., Elliott, C.T., Maestroni, B.M., & Cannavan, A. (2021). High-resolution mass spectrometry-based metabolomics for the discrimination between organic and conventional crops: A review. *Trends in Food Science and Technology*, 110, 142-154. https://doi.org/10.1016/j.tifs.2021.01.071

Abstract

Global food regulations and consumer demands require that the provenance of food can be traced from farm to fork. Currently organic products are not routinely tested for authenticity even though they have substantial added value and are therefore clear targets for fraud. In recent years there has been a rising number of cases of misrepresentation of conventional produce as organic. Various analytical techniques have been applied for the authentication of organic crops over the past decade, but the lack of reliable markers and the diversity of organic and conventional cultivation strategies present challenges for the development of robust analytical methods that can be used routinely in food control systems. Novel approaches such as high-resolution mass spectrometry (HRMS) metabolomics are increasingly being applied for the authentication of foods. This paper reviews the latest applications, advantages, challenges and future perspectives of targeted and untargeted metabolomics for discrimination between organic and conventional crops. A growing number of studies report the potential of HRMS-based metabolomics approaches for discrimination between organic and conventional crops. Various primary and secondary metabolites are reported as markers for organic production. Approaches using data from combined techniques, such as untargeted and targeted metabolomics or metabolomics and stable isotope analysis, can improve the robustness of discriminative models and require further validation. Standardization of untargeted analyses and generation of HRMS metabolomics databases are required to facilitate the wider use of untargeted metabolomics for the authentication of organic crops.

Keywords: /Organic crops/ /Conventional crops/ /Food authentication/ /High-resolution mass spectrometry/ /Targeted metabolomics/ /Untargeted metabolomics/

Sanchez-Bravo, P. Chambers V, E., Noguera-Artiaga, L., Sendra, E., Chambers IV, E., & Carbonell-Barrachina, A.A. (2021). Consumer understanding of sustainability concept in agricultural products*. Food Quality and Preference,* 89, 104136. https://doi.org/10.1016/j.foodqual.2020.104136

Abstract

The term “sustainability” is based on three main pillars: environment, society and economy. To achieve sustainable development, agriculture is one of the main fields to be considered and it is key to address economic, environmental and ethical problems. Besides, consumers are increasingly demanding foods produced under sustainable practices and aiming to get involved in the process of enhancing food sustainability. Under such premises, a study was carried out with more than 3600 consumers in 6 countries (Brazil, China, India, Mexico, Spain and USA). Participants were asked questions organized in two main topics: general sustainability and willingness to pay on different food categories. In general, results showed that consumers thought that a sustainable product is “environmentally friendly”, “healthier”, has been grown using “few chemicals” and “have better quality”. More than 30% of consumers in the US and Spain were not willing to pay more for sustainable products. This percentage decreased to 20% in China, Mexico and Brazil and reached the lowest value in India (~14%). The main conclusion is that consumers are not fully aware of the importance of sustainability; in general, consumers tend to associate sustainable production with just organic farming and higher quality.

Keywords: /Consumer behavior/ /Environmental friendly/ /Food categories/ /Organic food/ /Sensory quality/ /Willingness to pay/

PEACH

Ji, N., Wang, J., Li, Y., Li, M., Jin, P., & Zheng, Y. (2021). Involvement of PpWRKY70 in the methyl jasmonate primed disease resistance against *Rhizopus stolonifer* of peaches via activating phenylpropanoid pathway. *Postharvest Biology and Technology*, *174*, 111466. https://doi.org/10.1016/j.postharvbio.2021.111466

Abstract

The molecular mechanisms underlying methyl jasmonate (MeJA) primed defense against *Rhizopus stolonifer* through regulating phenylpropanoid pathway in peaches and the involvement of WRKY transcription factor were investigated. MeJA treatment enhanced the activity of phenylalanine ammonia-lyase (PAL) and 4-coumarate-CoA ligase (4CL), and promoted the accumulation of total phenolics, total flavonoids and lignin content as well as the main individual phenolic compounds, including chlorogenic acid, neochlorogenic acid and epicatechin. Moreover, transcripts of *PpPAL* and *Pp4CL* transcription were substantially and rapidly enhanced upon inoculation with the pathogen in MeJA-treated fruit, indicating that MeJA triggered a priming defense via enhancing phenylpropanoid pathway in peaches. Furthermore, MeJA primed the expression of *PpWRKY70*, which was identified as a transcription activator of *PpPAL* and *Pp4CL* via binding to their W-boxes. Taken together, our results demonstrate that *PpWRKY70* is involved in the MeJA-primed defense by activating the phenylpropanoid pathway.

Keywords: /Peach fruit/ /Methyl jasmonate/ /Induced disease resistance/ /Defense priming/ /WRKY transcription factor/ /Phenylpropanoid pathway/

Li, C., Wang, K., Xu, F., Lei, C., Jiang, Y., & Zheng, Y. (2021). Sucrose metabolism and sensory evaluation in peach as influenced by β-aminobutyric acid (BABA)-induced disease resistance and the transcriptional mechanism involved. *Postharvest Biology and Technology*, *174*, 111465. https://doi.org/10.1016/j.postharvbio.2021.111465

Abstract

This study attempted to provide evidence for the inhibitory efficiency of β-aminobutyric acid (BABA) treatments on postharvest decay development, soluble sugar accumulation, and sensory profiles in peach fruit and to analyze the possible transcriptional regulation involved. Specifically, 100 mmol L^{-1} BABA directly induced resistance as manifested by suppression of postharvest decay progression in peaches, and this suppression was accompanied by the consistently upregulated expression of the WRKY transcription factor *PpWRKY40* and a battery of pathogenesis-related (*PR*) genes, such as *PpNPR1s*, *PpPR1s*, *PpPR2s* and *PpPR5s,* throughout the storage period. However, treatment with 10 mmol L^{-1} BABA ignited priming resistance in peaches that underwent hostile conditions of high pressure during the late monitoring period. The peaches elicited by 10 mmol L^{-1} BABA had higher expression levels of *PpSSs*, *PpSPSs* and *PpSPPs* as well as lower expression levels of *PpNIs* and *PpAIs* than those treated with 100 mmol L^{-1} BABA, thus resulting in increases in soluble sugar content and the sweetness score during storage. On the other hand, the direct interaction between persistently highly expressed *PpWRKY40* and the regulatory protein *PpNPR1* was detected *in vivo* and *in vitro* by Y2H and pull-down assays; in addition, Y1H and DLR assays demonstrated that *PpWRKY40* bound to the W-box motif in the promoter of sucrose-metabolizing enzyme genes, including *PpSS1* and *PpSPS3*, and activated their transcription. Hence, we deduced that the dual regulation of key genes associated with systemic acquired resistance (SAR) and sucrose metabolism by *PpWRKY40* might be conducive to the balance of fitness and defense in BABA-primed resistance by maintaining soluble sugar accumulation at an intermediate level and activating resistance against stress in harvested peaches.

Keywords: /Peach fruit/ /WRKY/ /Sucrose metabolism/ /Quality/ /Priming defense/ /BABA/

Lurie, S. (2021). Genomic and transcriptomic studies on chilling injury in peach and nectarine. *Postharvest Biology and Technology*, *174*, 111444. https://doi.org/10.1016/j.postharvbio.2020.111444

Abstract

Peaches and nectarines are temperate climate stone fruits, which should be stored at 0 °C to prevent ripening of these climacteric fruits. However, if stored for too long they will develop chilling injury when removed from cold storage. The disorders which develop are internal and not detectable until the fruit is consumed. Chilling injury damage includes; 1) dry, mealy, woolly (lack of juice) fruit, 2) hard-textured fruit with no juice (leatheriness), 3) flesh browning, 4) flesh bleeding or internal reddening (Lurie and Crisosto, 2005). There are genetic components to these disorders in that early season fruit are generally more resistant than late season fruit, and white fleshed fruit more susceptible to internal browning than yellow fleshed fruit. This review examines genomic and transcriptomic studies which have endeavored to find quantitative trait loci (QTLs) and genes responsible for the different chilling injury symptoms.

Keywords: /*Prunus persica*/ /Mealiness/ /Wooliness/ /Internal reddening/ /Internal browning/ /Leatheriness/

PEAR

Brouwer, B., Mensink, M., Hogeveen-van Echtelt, E., & Woltering, E. J. (2021). Pre-storage application of 1-methylcyclopropene does not affect the flavour of 'Conference' pears ripened after 8 months of commercial-standard controlled atmosphere storage. *Postharvest Biology and Technology*, *174*, 111448. https://doi.org/10.1016/j.postharvbio.2020.111448

Abstract

Postharvest 1-methylcyclopropene (1-MCP) applications are commercially used on 'Conference' pears to obtain an improved fruit quality after storage for up to 11 months. Treatment with 1-MCP may result in firmer and greener fruit at the end of storage. During subsequent shelf life, 1-MCP treated pears may show slower ripening, including a reduced rate of softening and a reduced production of aroma volatiles. The lower levels of aroma volatiles and consumer complaints of reduced flavour suggest that flavour is negatively affected by 1-MCP treatments, which has raised concern within the Dutch fruit industry.
In the present study, the effect of pre-storage 1-MCP treatment on post-storage ripening and flavour perception was studied. Untreated and 1-MCP-treated pears (325 nL L^{-1}) were stored for 8 months at -0.8 °C under controlled atmosphere conditions of 3 kPa O_2 and 0.6 kPa CO_2 according to commercially used protocols. At day 7 and 9 of the subsequent shelf life at 10 °C, 1-MCP-treated fruit showed decreased yellowing and ethylene production, whereas firmness was similar to that of untreated fruit. The production of aroma volatiles was significantly reduced in 1-MCP-treated fruit; this was especially observed for different acetate esters, ethanol and butanol. Despite the reduction in aroma volatiles, a consumer panel could not distinguish (in a Tetrad test) between samples from untreated and 1-MCP-treated fruit with similar firmness. This indicates that the important aroma volatiles, although reduced in abundance, were still above threshold levels and did not affect overall flavour perception. We conclude that 1-MCP does not affect flavour when pears within equal firmness classes are compared.

Keywords**: /**Firmness/ /Flavour/ /Pear/ /PTR-ToF-MS/ /Volatiles/ /1-MCP/

Chi, Z., Dai, Y., Cao, S., Wei, Y., Shao, X., Huang, X., Feng, X., & Wang, H. (2021). Exogenous calcium chloride (CaCl2) promotes γ-aminobutyric acid (GABA) accumulation in fresh-cut pears. *Postharvest Biology and Technology*, *174*, 111446. https://doi.org/10.1016/j.postharvbio.2020.111446

Abstract

Effect of calcium chloride ($CaCl_2$) on γ-aminobutyric acid (GABA) accumulation pathways in fresh-cut pears was investigated. The metabolites, enzyme activity and gene expression associated with GABA shunt and polyamine degradation were measured. Results demonstrated that $CaCl_2$ treatment promoted GABA accumulation and reduced the glutamate (Glu) content in fresh-cut pears. Ca^{2+} fluorescence in pear cells, glutamate decarboxylase (GAD) activity and its gene expression increased significantly under $CaCl_2$ treatment correspondingly. Meanwhile, the Ca^{2+} channel blockers lanthanum chloride ($LaCl_3$) treatment not only significantly inhibited the activities of GAD, GABA transaminase (GABA-T), diamine oxidase (DAO), polyamine oxidase (PAO) and aminoaldehyde dehydrogenase (AMADH), but also down-regulated the transcripts of *PbGAD*, *PbGABA-T*, *PbPAO1* and *PbPAO2*. Taken together, it can be concluded that $CaCl_2$ seems to be more effective to GABA shunt, while $LaCl_3$ treatment mightily stimulate GABA shunt and polyamine degradation pathway.

Keywords: /Fresh-cut pears/ /$CaCl_2$/ /γ-aminobutyric acid (GABA)/ /GABA shunt/ /Polyamine degradation pathway/

Lindo-García, V., Giné-Bordonaba, J., Vall-Llaura, N., Duaigües, E., & Larrigaudière, C. (2021). Unravelling the cold-induced regulation of ethylene and α-farnesene and its involvement with the development of scald-like disorders in different pear cultivars. *Postharvest Biology and Technology*, *174*, 111441. https://doi.org/10.1016/j.postharvbio.2020.111441

Abstract

To better understand the cold-induced regulation of scald-like disorders in pears and the specific roles played by ethylene and α-farnesene, three pear cultivars with different patterns of ethylene production and chilling requirement were used in this study. Fruits were treated with 1-MCP (ethylene inhibitor) and Lovastatin (α-farnesene inhibitor) and stored at -0.5 °C and 90 % RH during 6 months. Changes in targeted metabolites, enzymes and genes were monitored periodically up to 120 d of storage and superficial scald incidence was assessed after this time and after 180 d of cold storage. 1-MCP treatment induced in the three cultivars a down-regulation of *PcACS1*, *PcACO1*, *PcERF1* and *PcAFS1* gene expression, but also a significant up-regulation of *PcETR*1 and *PcEIN2* that led in all cases to the inhibition of the disorder incidence. In contrast, Lovastatin treatment caused diverse molecular or biochemical responses depending on the cultivar. In 'Blanquilla' pears, this treatment completely inhibited superficial scald reinforcing the idea that ethylene-α-farnesene interaction plays a decisive role in this specific cultivar. In contrast to 1-MCP, Lovastatin treatment did not control the disorder incidence in 'Flor d'Hivern' pears. Inversely, 1-MCP inhibited the development of the disorder, showing then that the inhibition of ethylene biosynthetic and signalling pathways may control superficial scald even in cultivars producing very low or undetectable ethylene levels. Finally, the inefficacy of both treatments to prevent the disorder development in 'Conference' pears, suggests the existence of a disorder different from that observed for the other cultivars whose biochemical basis remains unknown. Collectively our results show that the regulatory processes triggered by cold stress in pears are complex and cultivar dependent.

Keywords: /Superficial scald/ /1-MCP/ /Lovastatin/ /Cold induction/ /Storage/

Mwaniki, M. W., Mitalo, O. W., Mworia, E. G., Owino, W. O., Hiwasa-Tanase, K., Rose, J. K. C., & Kubo, Y. (2021). Combined signal sequence trap and macroarray analysis identifies genes associated with differential fruit softening characteristics during ripening in European and Chinese pears. *Postharvest Biology and Technology*, 174, 111436. https://doi.org/10.1016/j.postharvbio.2020.111436

Abstract

During ripening, European pear (*Pyrus communis* L. cv. 'La France') fruit undergoes dramatic softening in response to increased ethylene production, whereas Chinese pear (*Pyrus bretschneideri* Rehd. cv. 'Yali') fruit remains firm, despite producing large amounts of ethylene. The molecular basis of this differential softening behavior is not well understood. In this study, we combined a yeast-based signal sequence trap (YSST) and macroarray gene expression analysis to identify putative genes encoding secreted proteins that control pear fruit softening. We identified 22 cDNAs annotated as encoding proteins with diverse cell wall-associated functions that were up- or down-regulated during fruit ripening in 'La France'. Gene expression analysis in fruit that were treated with the ethylene perception inhibitor 1-methylcyclopropene (1-MCP) at 4 d after the onset of ripening revealed that 16 of the targeted genes are ethylene-regulated, while the others appear to be ethylene independent. Comparative gene expression analyses of 'La France' and 'Yali' fruit during ripening suggested that four ethylene-regulated cDNAs encoding cell wall modifying proteins, contig 2 (polygalacturonase 3), contig 15 (expansin), contig 19 (expansin) and contig 55 (pectate lyase) contribute to the different softening behaviors of 'La France' and 'Yali' fruit. Additionally, one ethylene-independent cell wall related gene, contig 36 (expansin), and three genes encoding proteins of unknown function, contigs 1, 13 and contig 75 showed differential expression between 'La France' and 'Yali' fruit during ripening. The results presented herein represent promising candidates for future functional analysis and elucidation of softening mechanisms.

Keywords: /YSST/ /'La France'/ /'Yali'/ /Polygalacturonase/ /Expansin/ /Pectate lyase/

Wang, D., Li, W., Li, D., Li, L., & Luo, Z. (2021). Effect of high carbon dioxide treatment on reactive oxygen species accumulation and antioxidant capacity in fresh-cut pear fruit during storage. *Scientia Horticulturae*, 281, 109925. https://doi.org/10.1016/j.scienta.2021.109925

Abstract

Fresh-cut pear are popular for their nutritive, fresh and convenience. However, the oxidative stress caused by wounding aggravates quality loss. In the present study, the effects of 10 % CO2 on reactive oxygen species (ROS) metabolism and antioxidant capacity in fresh-cut pear were investigated. The results showed that 10 % CO2 effectively inhibited ROS accumulation during a 5-day storage, accompanied by reducing the content of hydrogen peroxide (H2O2) and superoxide anion radical (O2−). Furthermore, non-enzymatic antioxidant properties including free radical scavenging ability (DPPH), total antioxidant capacity (ABTS), and ferrous reducing ability (FRAP) in CO2-treated group were increased by 5.5 %, 23 % and 27 % respectively at the end of storage. Additionally, 10 % CO2 treatment enhanced the activities and genes expression levels of catalase (CAT), glutathione peroxidase (GPX), ascorbate peroxidase (APX), glutathione reductase (GR), superoxide dismutase (SOD) and peroxidase (POD), while NADPH oxidase (NOX) were inhibited. The accumulation of ascorbic acid (AsA) and reduced glutathione (GSH) were also accelerated by CO2. This study indicated that the generation of ROS was inhibited with inducing effects of genes and enzymes related to antioxidant capacity in response to 10 % CO2, which eventually alleviated oxidative damage and conserved storage quality of fresh-cut pear.

Keywords: /Carbon dioxide/ /Fresh-cut/ /Pear/ /ROS metabolism/ /Antioxidant activity/

Wang, D., Li, D., Xu, Y., Li, L., Belwal, T., Zhang, X., & Luo, Z. (2021). Elevated CO2 alleviates browning development by modulating metabolisms of membrane lipids, proline, and GABA in fresh-cut Asian pear fruit. *Scientia Horticulturae*, 281, 109932. https://doi.org/10.1016/j.scienta.2021.109932

Abstract

Enzymatic browning is a major problem of fresh-cut pear, which severely limits the shelf life. In the current study, elevated carbon dioxide (CO2) was applied to investigate its effects on quality maintenance and browning repression. The results showed that 5% and 10 % CO2 treatment maintained quality attributes, including firmness, color, and total soluble solids. Browning development was also inhibited by elevated CO2. Elevated CO2 delayed the decrease of unsaturated fatty acid in membranes by decreasing the activities of lipoxygenase (LOX) and phospholipase D (PLD), maintained the integrity of membranes, and therefore alleviated enzymatic browning. In addition, elevated CO2 triggered the accumulation of two stress adaptor molecules, proline and γ-aminobutyric acid (GABA), by improving their biosynthesis and repressing their degradation, which finally contributed to browning repression. However, excessive concentration (15 %) showed adverse effects because of CO2 injury. Our current study suggested a potential strategy for browning repression in fresh-cut pear fruit.

Keywords: /Elevated CO2/ /Fresh-cut pear fruit/ /GABA metabolism/ /Membrane lipids oxidation/ /Proline metabolism/

PETUNIA

Xu, J., Naing, A. H., Bunch, H., Jeong, J., Kim, H., & Kim, C. K. (2021). Enhancement of the flower longevity of petunia by CRISPR/Cas9-mediated targeted editing of ethylene biosynthesis genes. *Postharvest Biology and Technology*, *174*, 111460. https://doi.org/10.1016/j.postharvbio.2020.111460

Abstract

The transcriptional activation of genes that encode the ethylene biosynthesis enzyme 1-aminocyclopropane-1-carboxylate oxidase (*PhACO3* and *PhACO4*) during petunia flower senescence has been reported. However, no studies have elaborately investigated their specific roles in ethylene production and flower longevity using genetic manipulation. Hence, we used the CRISPR/Cas9 system to edit the genes (*PhACO3* and/or *PhACO4*) involved in ethylene production and flower longevity in petunia cv. Mirage Rose. The use of the CRISPR/Cas9 system with a sgRNA, which was designed from exon 2 of *PhACO3*, allows for the specific editing of the genes *PhACO3* and/or *PhACO4* with high mutation frequency, consequently producing different types of zygotes. The *PhACO3* and *PhACO4*-edited lines 8 and 9 showed remarkably reduced ethylene production (approximately 2.8- to 3.0-fold in corollas and 1.5-fold in pistils) during flowering and extended flower longevity (approximately 9.5 d), while the *PhACO3*-edited bi-allelic and *PhACO4*-edited homozygous T_0 mutant lines (14 and 23) showed enhanced flower longevity (approximately 8.0 d) compared with 6.0 d for the WT line. This was associated with reduction of PhACO4 protein levels in *PhACO4*-edited lines, which was confirmed using Western blot analysis and Image J software. Moreover, there was no undesirable editing effect on the *PhACO1* gene. The transmission of the edited alleles to the T_1 generation was also observed, and ethylene production and flower longevity were identical to those of the T_0 mutant lines. Taken together, this study demonstrated not only the single and combined role of *PhACO3* and *PhACO4* in ethylene production in petunia flowers but also reports improvements in flower longevity by editing of the aforementioned genes using the CRISPR/Cas9 system. Therefore, our study can pave the way for the editing of homologous genes in other ornamental plants using the CRISPR/Cas9 system with a common sgRNA, thus allowing for a time- and cost-effective approach to advancing plant biology and the floricultural industry.

Keywords: /Ethylene production/ /Floral organs/ /Genome editing/ /Mutant types/ /T_1 generation/

Li, Z., Wei, Y., Xu, Y., Han, P., Jiang, S., Xu, F., Wang, H., Tao, N., & Shao, X. (2021). Terpinen-4-ol treatment maintains quality of strawberry fruit during storage by regulating sucrose-induced anthocyanin accumulation. Postharvest Biology and Technology, 174, 111461. https://doi.org/10.1016/j.postharvbio.2020.111461

Abstract

Terpinen-4-ol, the main component of tea tree oil, controls postharvest decay of strawberry fruit. In this study, nuclear magnetic resonance (NMR)-based metabolomics was used to investigate global metabolic profiles in strawberries treated with terpinen-4-ol and stored at 20 °C for 3 d. Measurements showed higher levels of sucrose and fructose, and lower levels of α-D-glucose, β-D-glucose, and citric acid in terpinen-4-ol-treated fruit. Treatment also increased expression of FaSS and FaSPS mRNAs and decreased expression of FaAI. Terpinen-4-ol treatment maintained higher anthocyanin levels accompanied by increasing the expression of genes in the pentose phosphate, phenylpropanoid, and flavonoid pathways, and transcription factor MYB10. In addition, expression of FaSnRK1 was also increased in terpinen-4-ol-treated fruit. We conclude that terpinen-4-ol maintains strawberry fruit quality by regulating sucrose metabolism and anthocyanin biosynthesis, and that FaSnRK1 perceives the higher sucrose levels to induce anthocyanin accumulation in treated fruit.

Keywords: /Terpinen-4-ol/ /Metabolomics/ /Sucrose metabolism/ /Strawberry/ /Anthocyanin/

Ortiz-Sola, J., Abadias, I., Colas-Meda, P., Anguera, M., & Viñas, I. (2021). Inactivation of Salmonella enterica, Listeria monocytogenes and murine norovirus (MNV-1) on fresh strawberries by conventional and water-assisted ultraviolet light (UV-C). *Postharvest Biology and Technology*, 174, 111447. https://doi.org/10.1016/j.postharvbio.2020.111447

Abstract

The efficacy of the water-assisted ultraviolet-C light (WUVC) strategy was evaluated as an alternative to chlorine sanitization and compared to 'conventional' dry technology (DUVC) for the inactivation of *Salmonella enterica, Listeria monocytogenes* and murine norovirus (MNV-1) on strawberries. Strawberries were washed in a laboratory scale prototype (LAB-UVC-Gama) consisting of a tank filled with water, equipped with 4 UV-C lamps emitting a dose of 0.6, 1.3, 3.2 and 6.3 kJ m^{-2}. For DUVC, the same doses were used. Moreover, trials with the 4 lamps off with water, or with a chlorine solution (200 ppm, pH 6.5), were carried out as a control treatment. Reductions of artificially inoculated *L. monocytogenes* and *S. enterica,* and the infectivity of MNV-1 after WUVC treatments were comparable to those obtained with chlorine-wash, which were equivalent with all irradiation doses tested for all microorganisms studied ($P < 0.05$). The implementation of the WUVC strategy improved the DUVC system after 2-min exposure (1.3 kJ m^{-2}), by 1.2 and 1.6 log for *S. enterica* and *L. monocytogenes*, respectively. At 3.2 kJ m^{-2} dose (5 min), WUVC enhanced the inactivation of *S. enterica* compared with control washing treatment by 1.5 log. After 10 min, pathogenic bacteria were reduced by > 4 log by WUVC treatment and chlorine sanitization. For MNV-1 reductions, we reported > 1.4 log $TCID_{50}$ with 95 % certainty with the different treatments and exposure times after decontamination procedures. For MNV-1, the increase in the irradiation dose (kJ m^{-2}) applied did not affect their reduction on strawberries. Moreover, WUVC light was effective at significantly reducing the microorganisms in wash water, avoiding cross-contamination and thus, allowing water recirculation. The results obtained in the present study provide new tools to ensure the safety of strawberries intended to be processed, contributing to affording a more innovative and sustainable future for the food industry. However, industry operation studies are needed to conclude that the treatments tested in the present study are a good alternative to chlorine.

Keywords: /Sanitization/ /Chlorine alternative disinfection/ /Fruit/ /Cross-contamination/

Wang, F., Xiao, J., Zhang, Y., Li, R., Liu, L., & Deng, J. (2021). Biocontrol ability and action mechanism of *Bacillus halotolerans* against *Botrytis cinerea* causing grey mould in postharvest strawberry fruit. *Postharvest Biology and Technology*, *174*, 111456. https://doi.org/10.1016/j.postharvbio.2020.111456

Abstract

Bacillus species are promising agents for the biological control of postharvest diseases. This study investigated the bio-control efficiency of *Bacillus halotolerans* KLBC XJ-5 against grey mould caused by *Botrytis cinerea* in postharvest strawberries, together with its underlying antagonistic mechanism. Treatment with *B. halotolerans* KLBC XJ-5 controlled mycelial growth as well as conidial germination of *B. cinerea* in vitro. The grey mould in strawberries inoculated with *B. halotolerans* KLBC XJ-5 was lower in comparison with that in the control fruit after 4 d of incubation. Genome sequencing and further bioinformatic analyses suggested that strain KLBC XJ-5 harboured six antimicrobial biosynthesis gene clusters, besides four glycoside hydrolase family 18 gene clusters involved in chitin degradation. In addition, it secreted the lytic enzyme chitinase (CHI). *B. halotolerans* KLBC XJ-5-treated strawberries exhibited significant induced enzyme activities (polyphenol oxidase, phenylalanine ammonia lyase, β-1, 3-glucanase, and chitinase) and compounds related to disease resistance (total phenols, flavonoids). Compared to the control fruit, *B. halotolerans* KLBC XJ-5-treated fruit did not present differences in nutritional quality (measured in ascorbic acid, titratable acidity, and total soluble solids). Thus, it can be concluded that *B. halotolerans* KLBC XJ-5 could be potentially useful as a suitable bio-control agent in harvested strawberries.

Keywords: /Antagonistic bacteria/ /Postharvest disease/ /Biological control/ /Strawberry/

PLUM FRUIT

Wang, L., Hong, K., Xu, R., Zhao, Z., & Cao, J. (2021). The alleviation of cold-stimulated flesh reddening in 'Friar' plum fruit by the elevated CO2 with polyvinyl chloride (PVC) packaging. *Scientia Horticulturae*, 281, 109997. https://doi.org/10.1016/j.scienta.2021.109997

Abstract

Flesh reddening (FR) is considered as one of the most important chilling injury (CI) symptoms of 'Friar' plums. The effect of different modified atmosphere packages on FR of 'Friar' plums was investigated and it was found that polyvinyl chloride (PVC) packaging could effectively alleviate FR. Especially, complete suppression of FR by PVC packaging was achieved during storage at 0 °C for 8 weeks and shelf life at 25 °C for 7 days following 4 weeks of storage. PVC packaging altered atmosphere components and completely inhibited cold-induced ethylene production in 'Friar' plums. The PVC-packaged plums lowered accumulation of metabolites and decreased activities of enzymes associated with the phenylpropanoids pathway and the anthocyanins biosynthesis. As a result, cyanidin 3-O-glucoside and cyanidin 3-O-rutinoside, two red pigments, failed to accumulate in the flesh of the PVC-packaged plums. Collectively, PVC packaging improved quality and alleviated CI of 'Friar' plums during refrigeration and shelf life.

Keywords: /Plum fruit/ /PVC packaging/ /Flesh reddening/ /Anthocyanins/ /Phenylpropanoids pathway/

STRAWBERRY

Cvelbar Weber, N., Jakopic,J., & Koron, D. (2021). The effect of storage conditions on the quality of everbearing strawberry cultivar 'Capri'. *Acta Horticulturae, 1309,* 1025-1032. DOI: 10.17660/ActaHortic.2021.1309.145

Abstract

Strawberry is one of the most economically important fresh consumed fruit due to its pleasant flavour, intense smell, and mouth-watering aroma. Storage with controlled atmosphere allows fruit without a significant decrease in quality, resulting in a longer shelf life of fresh fruit. A research on the effect of postharvest storage conditions (conventional cold room and controlled atmosphere storage with higher CO_2) on fruit firmness, chemical compositions and weight loss has been conducted. The fruits were stored for 7 days and samples for analyses were taken at harvesting, after two, four and seven days of storage. The observations revealed that the fruit quality had declined especially in fruit stored in conventional cold room. In comparison with fresh strawberries, stored fruits lost their firmness (up to 25%) and total weight (up to 0.7%) but an increase in total soluble solids (up to 20% Brix) was noted. Fruits that were stored in a cold room with controlled atmosphere were the least affected. Additionally, a change in the content of sugars and organic acids has been documented already after just two days of storage. To maintain a higher fruit quality, the fruit must be cooled soon after harvest and then stored under optimal conditions - a cold room with a controlled atmosphere.

Keywords: strawberry, storage, fruit quality parameters, primary metabolites

Dhorajiwala, R., Roberts, C., Dimitrova, S., Baldwin, A., Davoli, D., Ludlow, R., Tu, S., Jones, S., Spadafora, N., Müller, C., & Rogers, H. (2021). Storage of halved strawberry fruits affects aroma, phytochemical content and gene expression. *Acta Horticulturae, 1309*, 887-896. DOI: 10.17660/ActaHortic.2021.1309.127

Abstract
Strawberries are valued for their aroma and phytochemical content. However, they have a short shelf life and storage at low temperatures to prolong shelf life affects physiological and biochemical processes in the fruit. This impacts on their use in fresh cut ready-to-eat fruit salads. To assess changes in aroma and how these are related to phytochemical content and gene expression, *Fragaria* × *ananassa* 'Elsanta' strawberries were halved and stored at either 4 or 8°C for a period of 12 days. Phytochemical content was relatively unaffected whereas volatile organic compound profiles were distinct at different time points of storage. Gene expression changed significantly with storage over a 5-day period: a total of 1135 gene targets changed in expression (p<0.05; log2 fold change>1.5) with most changes between days 0 and 5 of storage. These included genes related to stress responses, and secondary metabolism. Real time PCR was used to verify expression profiles of two genes related to VOC classes represented in the aroma, showing changes in pattern of expression during storage.

Keywords: /*Fragaria* × *ananassa* Duch./ /Transcriptomics/ /Phytochemicals/ /Volatile organic compounds/

Mansouri, S., Sarikhani, H., Sayyari, M., & Aghdam, M.S. (2021). Melatonin accelerates strawberry fruit ripening by triggering GAMYB gene expression and promoting ABA accumulation. *Scientia Horticulturae*, 281, 109919. https://doi.org/10.1016/j.scienta.2021.109919

Abstract

In this experiment, we tested the exogenous melatonin (0, 1, 10, 100, and 1000 μM) injection at the light green stage for the regulation of strawberry (*Fragaria annanaca* cv. Sabrina) fruit ripening. Our results showed that a higher endogenous content of melatonin resulting from higher expressions of TDC, SNAT, T5H, and ASMT in response to 1000 μM melatonin injection may be attributed to an accumulation of H2O2 resulting from a higher expression of NADPH oxidase. Also, a higher endogenous accumulation of ABA (due to a higher expression of NCEDs genes) and a higher accumulation of anthocyanin (due to higher expressions of PAL and CHS genes) may be attributed to a higher expression of the GAMYB gene and a lower expression of SnRK2.6 gene, resulting from the endogenous accumulation of melatonin, involved in the ripening of strawberry fruits. Therefore, our results indicate that the exogenous application of melatonin can accelerate the ripening of strawberry fruits by 2–3 days.

Keywords: /Abscisic acid biosynthesis/ /Anthocyanin accumulation/ /Endogenous melatonin accumulation/ /Phenylalanine ammonia-lyase/ /Strawberry/

Neuwald, D.A., Dietsche, S, Büchele,. F. Wood, R., Pansera-Espíndola, B., Kittemann, D., & Wünsche J. (2021). Influence of forced air cooling regimes on postharvest quality of strawberries during the marketing period. *Acta Horticulturae, 1309*, 829-834 . DOI: 10.17660/ActaHortic.2021.1309.118

Abstract

The aim of this study was to develop an improved strawberry postharvest handling regime to minimize postharvest losses during marketing. The experiment was conducted with the strawberry cultivars 'Clery', 'Darselect', 'Elsanta' and 'Everest' grown in the Lake Constance region of southwestern Germany. Half of the batch for each cultivar was harvested between 7 and 8 am and the other half between 12 and 2 pm. Fruits were either rapidly cooled with forced air or slowly cooled in a conventional cool room to 2 or 8°C, respectively. Depending on harvest time and daily temperatures, the cooling treatments took 30 min for rapid cooling or 4-8 h for slow cooling. All treatments were then subjected to a simulated cool chain marketing process for 2 d at 8°C followed by 2 d at 18°C. The packaging material was also evaluated in this study. The standard cardboard (wood pulp) 500-g punnet was compared to plastic (PET), or flowpack (PET + perforated foil) punnets. At 2-d intervals, fruit were assessed for the percentage of marketable and non-marketable and for the quality parameters fruit firmness, colour, weight loss, total soluble solids, titratable acidity, fruit gloss and freshness of the sepals. Results showed that the method and speed of pre-cooling had no effect on all assessed quality criteria. The greatest fruit quality losses were observed during the simulated shelf-life period at 18°C. Fruit quality was similarly well maintained in the PET or cardboard punnet packaging material. The extreme cooling to 2°C (rapid or in a cold room) tended to have lower quality, especially with warmly harvested strawberries from 12 to 2 pm, as these subsequently had slightly less gloss and lower freshness of the sepals. For the early harvest time at 7-8 am, there were no differences between 2 or 8°C cooling. In conclusion, at the optimum harvest date extremely rapid cooling to 2°C showed no advantage over a rapid moderate cooling to 8°C or a room cooling.

Keywords: /*Fragaria* × *ananassa*/ /Fruit quality/ /Packaging/ /Postharvest/ /Pre-cooling/

Neuwald, D.A., Grötzinger, M., Wood, D., Kittemann, R., & Wünsche, J. Comparison of two strawberry postharvest handling strategies: rapidly cooled or non-cooled fruit to the distributor. *Acta Horticulturae, 1309,* 835-840. DOI: 10.17660/ActaHortic.2021.1309.119

Abstract

Strawberry freshness declines quickly and thus rapid marketing strategies are required. Strawberries are non-climacteric fruit and must be harvested when fully ripe and ready for immediate consumption. At this physiological stage, the fruit is particularly susceptible to spoilage during postharvest handling and shelf-life. A rapid marketing strategy cannot always be realized because of weather-related oversupply and long transport routes. Therefore, research is needed to investigate possible options to maintain fruit freshness during the marketing chain. This study evaluated two short-term postharvest marketing strategies for strawberries. In the standard strategy, fruit was transported to the packhouse and then rapidly cooled before being transported to the distributor, arriving at the market within two days of harvest. Alternatively, non-cooled fruit was transported directly from the producer to the distributor, reaching the market within one day (direct marketing). The alternative marketing strategy without rapid cooling had no negative influence on fruit firmness. In contrast, the standard marketing with rapid cooling resulted in a lower proportion of mechanical fruit injuries and fruit maintained better colour compared to direct marketing. Mechanical injuries on strawberries can be considerable during long transport routes and can be up to 40% at the end of the marketing chain. Different packaging materials (paper or plastic) had no influence on the external quality parameters of the strawberry. In summary, rapid cooling ensured the

marketing of high-quality strawberries.

Keywords: /*Fragaria* × *ananassa*/ /Fruit quality/ /Postharvest/ /Commercialization/

Oz, A.T., & Kafkas, N.E. (2021). Postharvest hexanal vapor applications on strawberry fruit. *Acta Horticulturae 1309*, 815-820. DOI: 10.17660/ActaHortic.2021.1309.116

Abstract

Hexanal is successfully used in preharvest and postharvest applications in fruits and vegetables. It is commonly known as a volatile aroma substance that is mostly used in foods and considered as natural (GRAS) found in plants. Hexanal has an organic origin and environmentally friendly compounds and plays an important role against stress factors and regulates growth and development process in plants. In addition, it has an alternative potential instead of application of chemical fungicides due to having antifungal protection effects. It can be used to reduce the losses of pathogen-induced decay in fruits and vegetables. Strawberry is a soft fruit, characterized by rapid loss of texture during ripening. The significant postharvest loss in such fruits due to rapid and excessive softening have evoked considerable attention into the mechanism that governs the fruit softening process. For this purpose, in this study, efficiacy of various concentrations of hexanal vapor applications were studied to prolong the shelf life of 'Fortuna' strawberries with reducing the fruit quality losses. According to obtained results, the concentration of postharvest hexanal applications have a positive effect on the fruit quality and to extent the shelf life of the 'Fortuna' strawberry cultivar.

Keywords: /Strawberry/ /Hexanal/ /Sugar/ /Vapor/ /shelf life/

Pistón, F., Pérez, A.G., Sanz, C., & Refoyo, A. (2021). Strawberry postharvest shelf life is related to total acid content and fruit firmness. *Acta Horticulturae, 1309*, 869-872. DOI: 10.17660/ActaHortic.2021.1309.124

Abstract

Strawberry fruit has a short postharvest shelf life because it is very perishable and susceptible to several pathogens that quickly reduce the quality of the fruit. A large part of Huelva's strawberry production is exported, so the shelf life of the fruit is one of the main factors that determines the quality of the fruit when it reaches its destination. The aim of this work was to explore the relationship between postharvest shelf life and the agronomic and quality traits in different strawberry genotypes during several seasons. For this, the postharvest shelf life, early and total yield, soluble solids content, fruit firmness and the content of sugars and organic acids were quantified during four consecutive seasons (2016-2019). First, the relationships of the shelf life with the other variables were explored through a principal components analysis (PCA). Subsequently, the variables that showed a stronger association with the shelf life were analysed in more detail by correlation and linear regression analysis. The PCA showed a positive relationship of the shelf life with the acid content and with fruit firmness measured with penetrometer and subjectively. Specifically, the correlation between the shelf life and firmness (measured with a penetrometer and subjectively) and the total acid was 0.59, 0.48 and 0.53, respectively. In conclusion, the variables of firmness and acid content can be useful to select genotypes in a strawberry breeding program with an increased shelf life.

Keywords: /Shelf life/ /Fruit quality/ /Firmness/ /Organic acid/ /Vitamin C/ /Fructose/ /Glucose/ /Titratable acidity/ /Total soluble solids/ /Strawberry/

Taghavi, T., Bahamdan, G., Bell, M., Patel, H., Taylor, E., & Rafie, R. (2021). Comparison of five essential oils on postharvest strawberry fruit quality. *Acta Horticulturae, 1309,* 941-946. DOI: 10.17660/ActaHortic.2021.1309.134

Abstract

Strawberry fruits are very perishable and susceptible to diseases. The conventional method to control the disease is the fungicide application, which has raised health concerns. Therefore, there is a lot of interest to develop eco-friendly practices to maintain fruit quality and control fruit diseases after harvest. Plants are a natural source of metabolites that have antifungal properties. These metabolites have been used successfully in in vitro conditions to control the pathogen. These metabolites are part of the plant self-defense system. Some are volatile and can be used in storage conditions as fumigants without direct contact with fruits to control diseases. However, there are few reports on their application as a vapor phase in commercial storage conditions. The preliminary experiments have shown promising effects. Therefore, we compared five plant volatiles (thymol, cinnamon, eugenol, clove bud oil, and nonenal) to extend strawberry fruits' shelf life ('Jewel', 'Albion', 'Allstar', and 'Sweet Charlie') and reduce fungal decay. Five plant volatiles were placed on cotton balls at a concentration of 30 ppm. Ten to 20 strawberries were placed in strawberry clamshell containers and kept at 4°C and 95% humidity for 4 weeks. Weight, titratable acidity, total soluble solid content, and fungal contamination of strawberries were recorded at the beginning of the storage and every week for four weeks. Weight loss and titratable acidity were not affected by essential oils, but such attributes were cultivar-dependent. SSC content did not change dramatically among essential oil treatments, but was highest in cinnamon oil treatment. Fungal decay was less pronounced in strawberries treated with nonenal and highest in strawberries treated with clove bud oil treatments.

Keywords: essential oils, thymol, carvacrol, eugenol, clove bud, nonenal, fruit quality, pathogens, shelf life

TOMATO

Li, D., Li, Z., & Tchuenbou-Magaia, F. (2021). An extended finite element model for fracture mechanical response of tomato fruit. *Postharvest Biology and Technology*, *174*, 111468. https://doi.org/10.1016/j.postharvbio.2021.111468

Abstract

Fresh fruit micro-rupture generally occurs during mechanical handling, which severely affects the product's postharvest quality along the supply chain. An extended finite element (XFEM) model was developed for investigating the fracture mechanical response of tomato fruit under postharvest mechanical compression. A 1/4 tomato fruit was modeled using three parts: exocarp, mesocarp and septa frame, and pre-crack. An amplitude curve-based uniformly distributed pressure load was applied over the internal surface of the locule for replacing the pressure change of the liquid in the fruit locule during compression simulation. The XFEM-based cohesive segments method in conjunction with Phantom nodes was used to simulate the initiation and propagation of the pre-crack in the fruit model. It was assumed that the fruit tissues were linear elastic and ideally brittle solid materials before fracture, the tissue fracture energy was independent of the size and geometry of the cracked tissue specimen, the tissue fracture response met a linear elastic traction-separation behavior, the crack initiation followed the maximum principal stress criterion and the crack evolution followed a linear softening law and a mode-independent and energy-based fracture criterion. The peak force applied over the locule surface was predicted as 0.02 MPa when the crack of the fruit virtually started to propagate. The XFEM model was found to be capable of reproducing the compression force-percentage deformation behavior as well as crack propagation of a tomato fruit in compression up to 28 % deformation with an average relative error of about 8 %. Both XFEM simulation and experiment data showed a rapid pre-crack propagation, the percentage deformation was more than 20 %. Furthermore, the propagation length of the crack in the fruit model was sensitive to the peak pressure in the locule and the fracture mechanics (*e.g.*, elastic modulus, Poisson's ratio, failure stress, fracture energy) of the exocarp and mesocarp. This study

demonstrates the application of XFEM as a novel tool to understand how fruit rupture under mechanical loading when the fruit mechanics varies at different conditions (*e.g.*, ripeness), and the extent of crack propagation which are important for improving or developing new mechanical handling technologies.

Keywords: /Tomato fruit/ /Textural quality/ /Mechanical damage/ /Fracture mechanics/ /Crack propagation/ /Extended finite element method/

Min, D., Zhou, J., Li, J., Ai, W., Li, Z., Zhang, X., Fu, X., Zhao, X., Li, F., Li, X., & Guo, Y. (2021). SlMYC2 targeted regulation of polyamines biosynthesis contributes to methyl jasmonate-induced chilling tolerance in tomato fruit. *Postharvest Biology and Technology*, *174*, 111443. https://doi.org/10.1016/j.postharvbio.2020.111443

Abstract

Chilling injury (CI) is a major limiting factor in the retention of the postharvest quality of chilling-sensitive vegetables and fruit stored at low temperatures. The enhanced chilling tolerance induced by methyl jasmonate (MeJA) treatment might be related to the polyamines biosynthesis. However, the molecular mechanism of polyamines biosynthesis induced by MeJA is far from clear. Here, we found that the application of 0.05 mmol L^{-1} MeJA enhanced the activities of arginase, arginine decarboxylase and ornithine decarboxylase, as well as the transcripts of *SlARG1, SlARG2*, *SlADC* and *SlODC*, promoted the accumulations of polyamines and further inhibited CI development. In addition, polyamines induced by MeJA were strongly positively correlated with the *SlMYC2* expression level. Moreover, MeJA-induced polyamines biosynthesis was largely inhibited due to the silencing of *SlMYC2*. The (*SlMYC2*-silenced + MeJA)-treated fruit possessed a higher incidence and index of CI than the MeJA-treated fruit. Combining these findings with results of the principal component analysis, we concluded that SlMYC2 is involved in MeJA-induced chilling tolerance in postharvest tomato fruit by regulating polyamines biosynthesis. Furthermore, the electrophoretic mobility shift and dual-luciferase reporter assays indicated that SlMYC2 could activate the transcription of *SlARG1, SlARG2*, *SlADC* and *SlODC* by binding directly to G/E-box elements in their promoters. From the findings, it was revealed that the targeted up-regulation of *SlARG1, SlARG2*, *SlADC* and *SlODC* by SlMYC2 is involved in MeJA-induced polyamines biosynthesis, which enhances chilling tolerance in tomato fruit.

Keywords: /MYC2 transcription factor/ /Methyl jasmonate/ /Polyamines/ /Chilling injury/ /Tomato fruit/

Tao, X., Wu, Q., Li, J., Wang, D., Nassarawa, S.S., & Ying, T. (2021). Ethylene biosynthesis and signal transduction are enhanced during accelerated ripening of postharvest tomato treated with exogenous methyl jasmonate. *Scientia Horticulturae*, 281, 109965. https://doi.org/10.1016/j.scienta.2021.109965

Abstract

Phytohormone methyl jasmonate (MeJA) plays an important role in fruit ripening. This research aimed to investigate the regulation of MeJA in ethylene biosynthesis and signal transduction during postharvest tomatoes ripening. After mature green cherry tomatoes were infiltrated with MeJA (0.5 mM) or deionized water (control) respectively, fruit colour and firmness, ethylene production, the activities and expressions of ACS and ACO, as well as the expressions of major genes involved in ethylene signal transduction were periodically monitored. Results showed that a significant acceleration in ripening in MeJA-treated fruit was observed, along with the accelerated changes of ethylene production, the enhanced activities and expression levels of ACS and ACO. The expression levels of ETR3, ETR4, ETR6, ETR7, EIN2, EIL2, EIL3, EIL4 and ERF1 were up-regulated (from 1.26- to 6.50-fold) by MeJA during tomatoes ripening. The expression of CTR1, however, was down-regulated (from 0.23- to 0.54-fold). Moreover, the expression of EIL1 was positively regulated at the early ripening stage whereas negatively regulated at the late ripening stage (11.76-/0.39-fold), whereas the expressions of CTR3 and CTR4 showed the opposite expression patterns (0.15-/7.78-fold, 0.48-/2.00-fold). Results suggested the up-regulation of the genes associated

with ethylene biosynthesis, as well as the up-regulated transcriptional levels of the most genes involved in ethylene signal transduction, leading to the increase of ethylene production, response and action, would be one of the major mechanisms of MeJA in accelerating postharvest tomatoes ripening.

Keywords: /Ethylene biosynthesis/ /Methyl jasmonate/ /Ripening/ /Signal transduction/ /Tomato/