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APPLE

Chen, D., Sun, Z., Wu, K., Zhang, Q., Song, Y., Wang, T., Fu, D., Cao, J., Luo, Y., & Qu, G. (2021). Dynamic changes in wax and cutin compounds and the relationship with water loss in "Red Fuji" and "Golden Delicious" apples during shelf life. *International Journal of Food Science & Technology*, *56*(12), 6335–6344. https://doi.org/10.1111/ijfs.15369

Abstract

Knowledge of the dynamic composition changes of combined cuticular wax and cutin in apples during their shelf life is scarce. Therefore, this issue was addressed using GC-MS analyses of the respective epidermal components in 'Red Fuji' and 'Golden Delicious' apples at 5 days intervals during the shelf life of 25 days. Water loss from the apples was also assessed. The proportion of total n-alkanes decreased in cuticular wax, whereas total acids increased gradually, and cutin monomer content significantly changed during the first 5 days. The predominant wax compound, nonacosane (C29), decreased by 40.13% and 26.22% in 'Red Fuji' and 'Golden Delicious' apples, respectively. The cutin monomers 10,16-dihydroxy hexadecanoic acid (10,16-diOH C16:0) and 9,10,18-trihydroxyoctadecanoic acid (9,10,18-triOH C18:0) were detected only at the beginning of shelf life in apples of both cultivars. Regression analysis indicated that the rate of water loss significantly correlated with eight components. Our results expand the understanding of the dynamics of both wax and cutin compounds in postharvest apples and help to target specific compounds to maintain the quality of apples throughout their shelf life.

Keywords: /Cuticle/ /Cutin/ /GC-MS/ /Malus domestica/ /Shelf life/ /Water loss/ / Waxes/

Martins Melo, A. A., Olabode, P. N., Atamian, H. S., Nyakundi, B., Pacioles, C. T., & Prakash, A. (2021). Irradiation reduces superficial scald by downregulating ethylene and α-farnesene biosynthetic enzymes in "Granny Smith" apples. *Radiation Physics & Chemistry*, *189*, 109650. https://doi.org/10.1016/j.radphyschem.2021.109650

Abstract

Superficial scald is a postharvest disorder of apples related to increased ethylene production in stored fruit which leads to α-farnesene accumulation and oxidation. Ionizing irradiation inhibits ethylene production and has been shown to reduce superficial scald, but this phenomenon has not been explored at the molecular level. The goal of this study was to determine the effect of irradiation on gene expression of enzymes related to ethylene and α-farnesene in 'Granny Smith' apples. Irradiation at 310 Gy controlled scald severity and incidence and inhibited the rise in AFS1 expression up to 90 d of cold storage followed by 7 d at room temperature, while 1000 Gy suppressed scald symptoms for either 90 and 180 d of cold storage, but showed internal browning. Irradiation at both doses reduced the formation of α-farnesene by more than 50% with concomitant decline of ACO enzyme activity and ethylene production as compared to the control, and suppressed the increase in ACS1 gene expression, but without the same effect on ACO1 gene. Irradiation treatment at 310 Gy and 1000 Gy may reduce superficial scald in 'Granny Smith' apples through inhibition of gene expression of enzymes related to ethylene and α-farnesene biosynthesis. Irradiation at 310 Gy reduces ethylene production and superficial scald. Reduced ethylene production correlates with lower ACS1 and AFS1 expression. Irradiation at 1000 Gy can cause internal browning in 'Granny Smith' apples.

Keywords: /α-farnesene/ /ACC synthase/ /ACC oxidase/ /*MdAFS1/ /MdACS1/*

Shoffe, Y., Nock, J., Zhang, Y. & Watkins, C. (2021). Physiological disorder development of 'Honeycrisp' apples after pre- and post-harvest 1-methycyclopropene (1-MCP) treatments. *Postharvest Biology and Technology, 182*, 111703. https://doi.org/10.1016/j.postharvbio.2021.111703

Abstract

Susceptibility of apple fruit to physiological storage disorders is affected by both pre- and postharvest factors that influence their ethylene production. In this study, the inhibitor of ethylene perception, 1-methylcyclopropene (1-MCP), applied before and after harvest, has been used to investigate the interactions between ethylene and development of physiological disorders in 'Honeycrisp' apples during storage. Preharvest 1-MCP (Harvista™) was applied to trees, either 2 weeks (early), 1 week (late), at 1 and 2 weeks (repeated), or at double rate 1 week, before first commercial harvest. Fruit was then untreated or treated with postharvest 1-MCP (SmartFresh®) and stored at 0.5 °C, or conditioned at 10 °C for 7 d and then stored at 3 °C (C + 3 °C), for 20 weeks. Fruit quality and physiological disorders were assessed after 4 d at 20 °C. Fruit from all preharvest 1-MCP treatments had lower internal ethylene concentrations (IECs) and were greener as indicated by higher I*AD* values compared with untreated controls, while effects on starch pattern indices (SPI) were inconsistent. After storage, preharvest 1-MCP -treated fruit were firmer than untreated fruit, but effects of the different application timings were inconsistent. Effects of postharvest 1-MCP on IEC and I*AD* values were greater at 0.5 °C than at C + 3 °C. High incidences of core browning and vascular browning developed during storage, especially in the preharvest 1-MCP-treated fruit. Soft scald was reduced by preharvest 1-MCP treatments compared with control. In the C + 3 °C storage treatment, preharvest 1-MCP-treated fruit had a higher bitter pit incidence than in control fruit, but less skin wrinkling and senescent breakdown. Postharvest 1-MCP treatment of preharvest 1-MCP fruit slightly decreased bitter pit incidence while greatly increasing that of core browning and leather blotch, and sometimes flesh browning and carbon dioxide injury. This study shows that pre- and postharvest inhibition of ethylene perception by 1-MCP can have marked effects on storage disorders that are affected by fruit maturity and storage temperatures.

Keywords: /*Malus domestica* Borkh/ /Fruit quality/ /Physiological disorder/ /1-Methylcyclopropene/ /Storage/

Smiri, M., Kheireddine, A., Hammami, R., Rouissi, M., Espeso, E. A., & Sadfi-Zouaoui, N. (2021). An assessment of the air quality in apple warehouses: new records of Aspergillus europaeus, Aspergillus pulverulentus, Penicillium allii and Penicillium sumatraense as decay agents. *Archives of Microbiology*, *203*(10), 5975–5992. https://doi.org/10.1007/s00203-021-02551-9

Abstract

Airborne fungi are one of the major components of aeromycobiota known to produce several fungal diseases in fruits. Their presence in indoor environment of warehouses may limit the storage period of apples. Qualitative and quantitative analyses of airborne fungal spores were conducted using gravity settling techniques to detect fungal airspora present in the atmosphere of two apple warehouses in Tunisia. In this study, 375 fungal isolates were obtained and purified. Phylogenetic analysis of calmodulin, beta-tubulin and ITS regions coupled with phenotypic characterization helped to identify 15 fungal species. Penicillium exhibited the highest diversity with ten species detected (Penicillium allii, P. chrysogenum, P. citrinum, P. expansum, P. italicum, P. polonicum, P. solitum, P. steckii, P. sumatraense and P. viridicatum), followed by four species of Aspergillus genus (Aspergillus europaeus, A. flavus, A. niger and A. pulverulentus) and Alternaria alternata. In vivo experiments confirmed the pathogenicity of 13 species at room temperature and under cold-storage conditions. Among them, A. europaeus, A. pulverulentus, P. allii and P. sumatraense were described for the first time as pathogens on apples. The present study identified the major airborne fungi associated with postharvest rot in apple storage facilities in Tunisia and may help in efficient control of postharvest and storage fruit diseases.

Keywords: /Airspora/ /Cold rooms/ /Fungi/ /Pathogenicity/ /Postharvest disease/

Thewes, F., Brackmann, A., Both, V., Anese, R., Ludwig, V., Wendt, L., Berghetti, M., Thewes, F., Klein, B., & Wagner, R. (2021). Respiratory quotient level variation during storage: Critical period for low oxygen tolerance, metabolism, and quality of 'Galaxy' apples. *Postharvest Biology and Technology, 182,* 111699. https://doi.org/10.1016/j.postharvbio.2021.111699

Abstract

New technologies for apple preservation include storage under dynamic controlled atmosphere (DCA) with respiratory quotient (RQ) monitoring or chlorophyll fluorescence (CF). Therefore, this study aimed to evaluate the effects of RQ variation on the metabolism, overall quality, and volatile organic compound concentration of 'Galaxy' apples after long-term storage and compare them to fixed RQ levels, controlled atmosphere (CA), and DCA-CF. We also aimed to identify the period during storage in which apples are more susceptible to low oxygen damage. Fruits were evaluated after nine months of storage plus 7 d of shelf life at 20 °C. Higher RQ (1.5 and 2.0) levels throughout the storage period or the first three months resulted in higher anaerobic metabolism, increasing the internal disorders and reducing overall fruit quality, healthy fruit and flesh firmness. The results evidenced that the critical period for low oxygen damage is the first three months of storage. Overall fruit quality is better maintained when fruit were stored under DCA-CF, DCA-RQ 1.1, DCA-RQ 1.3, and changing RQ from 1.1; 1.3; 1.5, being three months at each RQ level. Moreover, more healthy fruit, higher flesh firmness, and lower physiological disorders were observed under these storage conditions, although the main ester accumulation was reduced. In general, higher 2-methylbutyl acetate and butyl acetate were observed in fruit stored under CA and high RQ levels (1.5 and 2.0). This demonstrates that even with RQ level variations during storage, it was not possible to obtain apples with high overall quality and ester concentrations under the same storage condition.

Keywords: /*Malus domestica/ /*Chlorophyll fluorescence/ /Flesh breakdown/ /EstersAlcohols/

AVOCADO

Iñiguez-Moreno, M., Ragazzo-Sánchez, J. A., Barros-Castillo, J. C., Solís-Pacheco, J. R., & Calderón-Santoyo, M. (2021). Characterization of sodium alginate coatings with Meyerozyma caribbica and impact on quality properties of avocado fruit. *LWT - Food Science & Technology*, *152*, 112346. https://doi.org/10.1016/j.lwt.2021.112346

Abstract

This study was aimed to evaluate the physical, physicochemical, and thermal properties of sodium alginate (SA) films added with Meyerozyma caribbica (SAY) and their effect on quality properties of avocado after their storage (12 days/25 °C, or 10 days/6 °C and ripened at 25 °C/7 days). SAY films were highly soluble (>87%). During their storage, water vapor permeability decreased (1.93 g/(m.s.Pa) x 10−9) and a slight color change (2.11) was found. The thermal analysis allowed us to infer the protective effect of SA on M. caribbica. The yeast addition improved the puncture force of SA films. Besides, SAY coatings reduced the weight loss in avocados (22.8 and 29.8% at 25 °C and combined storage, respectively), delayed the increment of pH and total soluble solids, and the firmness of the whole fruit and flesh were higher than in uncoated fruits. Moreover, the application of SAY coatings allowed to inhibit the development of grey flesh in avocados under both storage conditions. This research demonstrated that SA coatings with M. caribbica are an alternative to maintain the quality properties of avocados for up to 12 and 17 days depending on storage conditions. The addition of M. caribbica to SA films improved its thermal properties. M. caribbica reduced the WVP and increased the puncture force of SA coatings. The SA + Yeast coatings contributed to extending the avocado fruit shelf-life. SA coatings with M. caribbica inhibited the flesh discoloration in avocado fruit.

Keywords: /Biocontrol/ /Biofilm coating/ /Postharvest/ /Thermal analysis/ /Yeast/

BAMBOO SHOOT

Zhang, J., Murtaza, A., Zhu, L., Iqbal, A., Ali, S., Xu, X., Pan, S., & Hu, W. (2021). High pressure CO2 treatment alleviates lignification and browning of fresh-cut water-bamboo shoots (Zizania latifolia). *Postharvest Biology and Technology, 182,* 111690. https://doi.org/10.1016/j.postharvbio.2021.111690

Abstract

The study evaluated the effect of high pressure CO2 (HPCD) treatment on the texture and color of fresh-cut water-bamboo shoots (WBS) during storage. In addition, the mechanism of HPCD treatment to maintain the quality of fresh-cut WBS was also investigated. The results exhibited that HPCD at 3 and 5 MPa could suppress the lignification-related and browning-related enzyme activities and delay the decline rate of phenolic content. PAL, CAD, POD, and PPO activities of 3 MPa HPCD-treated samples were 44 %, 31 %, 29 %, and 10 % lower than that of control ones at 10 d, respectively. Furthermore, low-field nuclear magnetic resonance results showed that HPCD treatment at 3 MPa could maintain the water content, which only decreased 7 % at the end of the storage, thereby retaining the original texture of WBS. The potential mechanism is that HPCD could alleviate lignification and browning of WBS by suppressing enzyme activities and retaining the moisture in samples. Hence, HPCD at appropriate pressure has a great potential to maintain the quality of fresh-cut fruit and vegetables during storage.

Keywords: /Water-bamboo shoots/ /High pressure CO2/ /Phenylalanine ammonia-lyase/ /Lignification/ /Browning/ /Quality/

BANANA

Pirsa, S. (2021). Nanocomposite base on carboxymethylcellulose hydrogel: Simultaneous absorbent of ethylene and humidity to increase the shelf life of banana fruit. *International Journal of Biological Macromolecules*, *193*, 300–310. https://doi.org/10.1016/j.ijbiomac.2021.10.075

Abstract

The main purpose of this study was to increase the shelf life of bananas using active hydrogel. For this purpose, carboxymethylcellulose/nanofiber cellulose/potassium permanganate (CMC/NFC/KMnO 4) hydrogel film was prepared. The morphology and physicochemical properties of CMC hydrogels was investigated. The prepared films were used as humidity/ethylene absorbent in banana packaging for 30 days at 0 and 25 °C. The physical, mechanical and sensory properties of bananas were studied during storage. SEM images confirmed the presence of nanofibers in the hydrogel structure. NFC and KMnO 4 increased the tensile strength of the film and decreased its elongation. On the 15th day of storage, bananas packaged with optimal active hydrogel (CMC/NFC/KMnO 4) at 25 °C had a flavor of 3 and a general acceptance of 3.5, while control bananas had a flavor of 0.5 and a general acceptance of less than 1. On the 30th day of storage, bananas packaged with optimal active hydrogel at 25 °C had a toughness of 4 (N·s) and a firmness of 20 (N), while control bananas had a toughness of about 1 (N·s) and a firmness of about 8 (N). On the 30th day of storage, the humidity inside the package of bananas packed with the optimum active hydrogel at 25 °C was 59.5%, while the humidity in the control packages was 85%, indicating that the hydrogel was able to absorb the moisture inside the package. Totally it can be said that CMC/NFC/KmnO 4 hydrogel can increase shelf life of a banana by simultaneously controlling ethylene and humidity in food packaging.

Keywords: /Banana/ /Ethylene absorbent/ /Hydrogel/ /Nanocomposite/ /Simultaneous absorbent/

Wei, W., Yang, Y., Su, X., Kuang, J., Chen, J., Lu, W., & Shan, W. (2021). MaRTH1 suppression of ethylene response during banana fruit ripening and is controlled by MaXB3-MaNAC2 regulatory module. Postharvest Biology and Technology, 182, 111707. https://doi.org/10.1016/j.postharvbio.2021.111707

Abstract

RTE1 (Reversion to Ethylene Sensitivity 1) and its homolog RTH play an important role in ethylene response through mediating the receptor signaling output, but their role in climacteric fruit ripening is not clear. In this study, we found two *RTE1/RTH* genes *MaRTH1* and *MaRTH2* in the banana genome. *MaRTH1* expression was inhibited by ethylene and down-regulated during ripening, whereas *MaRTH2* expression showed no significant changes during the whole ripening process. Transient over-expression of *MaRTH1* in bananas inhibited the effect of exogenous ethylene on endogenous ethylene production, thereby delayed fruit ripening. Using the MaRTH1 promoter as a target, we performed yeast one-hybrid screening and isolated the NAC transcription factor MaNAC2, a banana ripening-associated transcriptional repressor degraded by an E3 ligase MaXB3 through ubiquitination. DNA-protein binding assays further confirmed that MaNAC2 repressed the expression of *MaRTH1* by directly targeting its promoter. Moreover, the MaNAC2 transcriptional repression to *MaRTH1* was inhibited by MaXB3, and this inhibitory action was attenuated by the proteasome inhibitor MG132. Collectively, these findings reveal that *MaRTH1*, which is modulated by MaXB3-MaNAC2 regulatory module, functions as a negative regulator of ethylene response during banana ripening.

Keywords: /Banana/ /Fruit ripening/ /Ethylene response/ /RTHNACE3 ligase/

BELL PEPPER

Xu, D., Lam, S., Zou, J., Yuan, S., Lv, J., Shi, J., Gao, L., Chen, B., Sui, Y., Shui, G., Geng, S. & Wang, Q. (2021). Lipidomics reveals the difference of membrane lipid catabolism between chilling injury sensitive and non-sensitive green bell pepper in response to chilling. Postharvest Biology and Technology, 182, 111714. https://doi.org/10.1016/j.postharvbio.2021.111714

Abstract

Changes in membrane lipid composition play multiple roles in the response of pepper to chilling injury (CI). A membrane lipidomic approach was used to elucidate the response of a harvested pepper of a chilling-sensitive (CS) cultivar, ‘129′ and a chilling-tolerant (CT) cultivar, ‘130′ to chilling temperatures during storage. Changes in the lipid composition of CT fruit were proportionally smaller relative to the changes in CS fruit. Lipidomic analysis revealed that CI in CS fruit is associated with a decrease in lysophosphatidic acid, and an increase in phosphatidic acid, triacylglycerols, and steryl esters. Furthermore, a lower level of electrolyte leakage, malondialdehyde, lipoxygenase and phospholipases D activity was observed in CT fruit, indicating that CT fruit were able to maintain membrane function despite exposure to the low temperature. Overall, results indicate that CI in pepper is associated with extensive alterations in membrane lipid metabolism and that CT fruit can avoid CI by maintaining membrane lipid homeostasis.

Keywords: /Lipidomics/ /Phospholipases D activity/ /Chilling injury/ /Pepper/

BROCCOLI

Fang, H., Zhou, Q., Cheng, S., Zhou, X., Wei, B., Zhao, Y., & Ji, S. (2021). 24-epibrassinolide alleviates postharvest yellowing of broccoli via improving its antioxidant capacity. *Food Chemistry*, *365*, 130529. https://doi.org/10.1016/j.foodchem.2021.130529

Abstract

Postharvest crop yellowing is a major concern in the broccoli industry. The effect and underlying mechanisms of 24-epibrassinolide (EBR) treatment on yellowing in postharvest broccoli were investigated. Treatment with 2 μM EBR markedly inhibited the increase of the yellowing index and L* values, causing higher retention of the metric hue angle and chlorophyll content compared to the control. Treatment also alleviated oxidative damage by preventing the accumulation of malondialdehyde and superoxide anion ($O_2^{\bullet-}$). The ascorbic acid content of broccoli reached its lowest value at the end of its shelf life, whereas that of the treated sample was obviously higher than the control. Moreover, treated broccoli exhibited higher superoxide dismutase, ascorbate peroxidase, and phenylalanine ammonia-lyase activities. Multivariate statistical analysis further demonstrated the effective enhancement of EBR treatment on antioxidant enzymes. These results indicate that exogenous application of EBR ameliorates postharvest yellowing by improving the antioxidant capacity of broccoli.

Keywords: /Chlorophyll/ /*Brassica oleracea*/ /Postharvest storage/ /Oxidative stress/ /Multivariate analysis/

CASSAVA ROOT

Odoch, M., Buys, E. M., & Taylor, J. R. (2021). Effects of vacuum packaging storage of minimally processed cassava roots at various temperatures on microflora, tissue structure, starch extraction by wet milling and granule quality. *Journal of the Science of Food & Agriculture*, *101*(15), 6347–6354. https://doi.org/10.1002/jsfa.11305

Abstract

Vacuum package storage is commonly applied to reduce postharvest deterioration in minimally processed cassava roots. However, the influence of vacuum packaging conditions on root end-use quality is poorly understood. Hence, the effects of vacuum packaged storage at ambient, refrigerated and freezing temperatures on microflora, cassava tissue structure and starch extraction by wet milling were studied. Vacuum packaged storage temperature strongly affected cassava root quality. Minimal adverse effects were obtained with frozen storage. With refrigerated storage, there was negligible microbial growth but some disruption of the parenchyma cell wall structure suggestive of chilling injury. With ambient temperature storage, there was considerable Lactobacilli dominated fermentation. This caused substantial cell degradation, probably due to the production of extracellular cellulolytic and other cell wall degrading enzymes. A benefit of this cell wall breakdown was that it substantially improved starch extraction with wet milling from the stored cassava pieces; by 18% with pieces that had been ambient vacuum packaged and wet milled using a 2000 μm opening screen. However, ambient temperature storage resulted in some starch granule pitting due to the action of extracellular amylases from the fermenting microorganisms. The best vacuum packaging storage conditions for minimally processed cassava depends on application and cost. For short-term storage, refrigeration would be best for vegetable-type products. For several months of storage, freezing is best. For wet milling applications, this could be combined with subsequent short-term ambient temperature storage as it improves starch extraction efficiency and could reduce distribution energy costs.

Keywords: /Cassava/ /Cell walls/ /Starch extraction/ /Storage temperature/ /vacuum packaging/

CITRUS

Yang, Q., Qian, X., Routledge, M. N., Wu, X., Shi, Y., Zhu, Q., & Zhang, H. (2021). Metabonomics analysis of postharvest citrus response to Penicillium digitatum infection. *LWT - Food Science & Technology*, *152*, 112371. https://doi.org/10.1016/j.lwt.2021.112371

Abstract

Green mold caused by Penicillium digitatum is a common disease of postharvest citrus. Exploring its pathogenesis will contribute to the research and development of efficient and safe postharvest biological control methods for citrus. In this study, gas chromatography-mass spectrometry (GC-MS) and liquid chromatograph-mass spectrometer (LC-MS) were used to analyze the metabonomics of Citrus reticulata Blanco wound before and after P. digitatum infection. The results showed that the metabolites such as carbohydrates, esters, organic acids, and resistance-inducing substances changed dramatically in the citrus wound after infection with P. digitatum. In addition, in combination with previous results from physiological experiments and transcriptome analysis of P. digitatum before and after infection, we revealed the important changes of energy metabolism, protein hydrolysis process and defense response in the citrus wound after infection with P. digitatum and discussed the pathogenesis and mechanism of green mold disease after citrus harvest. From this study, we provided new insights into the mechanism of P. digitatum infection in postharvest citrus, which laid a certain foundation for the formulation of new control strategies. Metabonomics of citrus before and after P. digitatum infection were analyzed. The initial 48 h is the critical period for P. digitatum to complete infection. Extracellular enzymes, organic acids and other substances involved in infection. P. digitatum infection process is accompanied by ubiquitin-mediated proteolysis.

Keywords: /Citrus/ /Infection/ /Infection mechanism/ /Metabonomics/ /Penicillium digitatum/

FRUITS AND VEGETABLES

Ghate, V., Yew, I., Zhou, W., & Yuk, H.-G. (2021). Influence of temperature and relative humidity on the antifungal effect of 405 nm LEDs against Botrytis cinerea and Rhizopus stolonifer and their inactivation on strawberries and tomatoes. *International Journal of Food Microbiology*, *359*, 109427. https://doi.org/10.1016/j.ijfoodmicro.2021.109427

Abstract

In recent years, photodynamic inactivation (PDI) has emerged as a promising preservation method to complement refrigeration in the fresh produce supply chain. However, due to infrastructural limitations in the supply chain, fresh produce is often exposed to environmental conditions rather than recommended storage conditions. Hence, this study aimed to investigate the influence of two important environmental variables in the fresh produce supply chain - temperature and relative humidity (RH), on the PDI of fruit spoilage molds. It also aimed to demonstrate proof-of-concept of their inactivation on fruit surfaces. In the in vitro stage, Botrytis cinerea and Rhizopus stolonifer, the two molds selected for this study, were illuminated with 405 nm LEDs on Dichloran Rose-Bengal Chloramphenicol (DRBC) agar at three levels of temperature (7, 16 and 25 °C) and relative humidity (40, 60 and 80%). Illumination under these conditions caused reductions greater than 94% in the mold populations, at all temperatures and relative humidities. Even so, a temperature of 25 °C was observed to be marginally better for the inactivation as compared to 7 and 16 °C, as it necessitated the lowest dose (6-7 kJ) for the first log reduction of both the molds. Similarly, an RH of 40% worked slightly better for the inactivation of B. cinerea, as it induced inactivation without any lag phase and required the lowest dose (8.03 kJ) for the first log reduction. When the antifungal effect was investigated on fruit surfaces, it was discovered that the illumination reduced the populations of B. cinerea and R. stolonifer on strawberries by 67% and 19%, whereas on tomatoes, the respective inactivations were 79% and 70% respectively. These results demonstrate further promise of PDI as a postharvest technology for reducing the risk of fruit spoilage. This study is also the first to demonstrate the potential of PDI to add value to supply chains where compliance to ideal storage conditions is not feasible.

Keywords: /Antifungal method/ /Fruit spoilage/ /Fruit supply chain/ /Hurdle technology/ /Photodynamic inactivation/ /Temperature abuse/

López-Cuevas, O., Medrano-Félix, J. A., Castro-Del Campo, N., & Chaidez, C. (2021). Bacteriophage applications for fresh produce food safety. *International Journal of Environmental Health Research*, *31*(6), 687–702. https://doi.org/10.1080/09603123.2019.1680819

Abstract

Foodborne illnesses, mainly bacteria, are a major cause of morbidity and mortality worldwide. Pathogenic bacteria are involved in almost every step within the fresh produce chain compromising the companies' food safety programs and generating an ascending number of foodborne outbreaks in various regions of the world. Recently, bacteriophages return to the status of biocontrol agents. These bacteria-killing viruses are able to reduce or eliminate pathogenic bacterial load from raw and ready to eat foods. Phages are efficient, strain specific, easy to isolate and manipulate, and for that reasons, they have been used in pre and post harvest processes alone or mixed with antimicrobial agents for biocontrolling pathogenic bacteria. In this review, we focused on the feasibility of using lytic bacteriophage on fresh fruits and vegetables industry, considering challenges and perspectives mainly at industrial production level (packinghouses, supermarkets), where high volume of phage preparations and consequently high costs may be required.

Keywords: /Bacteriophage/ /Biocontrol/ /Food safety/ /Foodborne pathogenic bacteria/ /Fruits and vegetables/

GINGER

Huang, K., Sui, Y., Miao, C., Chang, C., Wang, L., Cao, S., Huang, X., Li, W., Zou, Y., Sun, Z., Wang, Q., Zeng, C., Liu, J., & Wang, Z. (2021). Melatonin enhances the resistance of ginger rhizomes to postharvest fungal decay. *Postharvest Biology and Technology, 182,* 111706. https://doi.org/10.1016/j.postharvbio.2021.111706

Abstract

Significant losses in harvested ginger can be directly attributed to decay fungi, including Fusarium oxysporum and Penicillium brevicompactum. Eco-friendly treatments, utilizing non-conventional chemical methods to manage postharvest decay on ginger rhizomes are being actively investigated. In the current study, the application of melatonin (N-acetyl-5-methoxytryptamine) was evaluated for controlling postharvest decay of ginger rhizomes, artificially-inoculated with F. oxysporum or P. brevicompactum. Results showed that the melatonin treatment (0.1 mM, 15-min immersion) reduced F. oxysporum and P. brevicompactum rots on rhizomes. Melatonin induced the expression of defense-related genes, including β-1,3-glucanase (GLU), phenylalanine ammonia-lyase (PAL), and coiled-coil nucleotide-binding site leucine-rich repeat (CC-NBS-LRR). GLU and PAL enzyme activity was also induced in ginger rhizomes, and the level of total phenols in rhizomes was elevated. Importantly, melatonin did not have a negative impact on rhizome quality. The ability of melatonin to enhance disease resistance may be partially attributed to the induction of defense response in ginger rhizomes. The findings of the present study have practical implications for the use of melatonin to reduce postharvest decays in ginger rhizomes.

Keywords: /Disease resistance induction/ /Fungal pathogens/ /Ginger/ /Melatonin/ /Postharvest decay/

GRAPE

de Souza, W. F. C., de Lucena, F. A., da Silva, K. G., Martins, L. P., de Castro, R. J. S., & Sato, H. H. (2021). Influence of edible coatings composed of alginate, galactomannans, cashew gum, and gelatin on the shelf- life of grape cultivar "Italia": Physicochemical and bioactive properties. *LWT - Food Science & Technology*, *152*, 112315. https://doi.org/10.1016/j.lwt.2021.112315

Abstract

Table grapes are widely consumed around the world due to the health benefits provided to consumers. As they are highly perishable, postharvest practices are required to maintain the quality and increase their shelf-life. This work aimed to optimize the combinations of alginate, galactomannans, and cashew gum using an experimental design of mixtures to produce edible coatings; and to evaluate their effects on the shelf-life of ' Italia ' table grapes. The influence of edible coatings on the physicochemical composition (weight loss, firmness, pH, acidity, soluble solids, and color), total phenolic content, and antioxidant properties measured by ABTS, DPPH, and FRAP assays was evaluated. The edible coating composed of alginate (2.0%), galactomannans (0.5%), cashew gum (0.5%), and gelatin (2.0%) reduced weight loss in grapes and maintained their firmness and color at 9 days of storage as compared to the control. In addition, this formulation improved the content of phenolic compounds, contributing to the high antioxidant potential of coated grapes. The use of simplex-centroid mixture design proved to be an effective tool for determining different combinations of alginate, galactomannans, and cashew gum. The biopolymers demonstrated high potential to be used as edible coatings, and as an alternative to preserve the table grapes. Table grapes were coated with galactomannans, cashew gum, alginate, and gelatin. A simplex-centroid mixture design determined the best combination of edible coating. Antioxidant properties of coated grapes were improved.

Keywords: /Alginate/ /Cashew gum/ /Edible coatings/ /Galactomannans/ /Vitis vinifera L/

Habib, W., Khalil, J., Mincuzzi, A., Saab, C., Gerges, E., Tsouvalakis, H. C., Ippolito, A., & Sanzani, S. M. (2021). Fungal pathogens associated with harvested table grapes in Lebanon, and characterization of the mycotoxigenic genera. ***Phytopathologia Mediterranea*****, *60*(3), 427–439. https://doi.org/10.36253/phyto-12946**

Abstract

Table grapes are exposed to fungal infections before and after harvest. In particular, Aspergillus, Penicillium, and Alternaria can cause decay and contamination by mycotoxins. The main fungi affecting Lebanese table grapes after harvest were assessed as epiphytic populations, latent infections, and rots. Effects of storage with and without SO2 generating pads were also evaluated. Representative isolates of toxigenic genera were characterised, and their genetic potential to produce ochratoxin A, fumonisins, and patulin was established. The epiphytic populations mainly included wound pathogens (Aspergillus spp. and Penicillium spp.), while latent infections and rots were mostly caused by Botrytis spp. The use of SO2 generating pads reduced the epiphytic populations and rots, but was less effective against latent infections. Characterization of Aspergillus, Penicillium, and Alternaria isolates showed that A. tubingensis, P. glabrum, and A. alternata were the most common species. Strains of A. welwitschiae and P. expansum were also found to be genetically able to produce, respectively, ochratoxin A plus fumonisins and patulin. These data demonstrate the need for effective measures to prevent postharvest losses caused by toxigenic fungi.

Keywords: /Alternaria/ /Aspergillus/ /Mycotoxins/ /Penicillium/ /Postharvest/ /Sulphur dioxide/

KIWIFRUIT

Li, R., Yang, S., Wang, D., Liang, J., Huang, T., Zhang, L., & Luo, A. (2021). Electron-beam irradiation delayed the postharvest senescence of kiwifruit during cold storage through regulating the reactive oxygen species metabolism. ***Radiation Physics & Chemistry*****, *189*, 109717. https://doi.org/10.1016/j.radphyschem.2021.109717**

Abstract

The purpose of this study was to investigate the effects of electron-beam (e-beam) irradiation (0, 0.3, 0.4, and 0.5 kGy) on fruit firmness, total soluble solids (TSS), and active oxygen metabolism related indexes of kiwifruit during postharvest storage at 0–1 °C for up to 90 d. Results showed that e-beam irradiation retarded decrease in firmness as well as increase in TSS content in kiwifruit. The water-soluble pectin (WSP) content and ethylene production of the fruit decreased effectively after triggered by e-beam treatment. In addition, e-beam irradiation was able to improve the activities of peroxidase (POD), catalase (CAT) and ascorbate peroxidase (APX), thus reducing the superoxide anions (O 2 −·) production rate, hydrogen peroxide (H 2 O 2) content, malondialdehyde (MDA) content, and Lipoxygenase (LOX) activity. In general, 0.5 kGy e-beam irradiation presented the optimal preservation effects as the active oxygen metabolism and membrane lipid oxidation were inhibited to the greatest extent. The results of this work suggested that the appropriate dose of e-beam irradiation is an effective method for slowing down the increase in reactive oxygen species, maintaining normal metabolic processes and reducing the loss of fruit quality in kiwifruit during cold storage. E-beam prompted the increase of O 2 −· and H 2 O 2 immediately. E-beam delayed postharvest senescence by inducing antioxidant enzymes. E-beam retarded the decrease of firmness and the increase of TSS, WSP and ethylene. 0.5 kGy e-beam has the best effect in delaying active oxygen metabolism. The appropriate dose of e-beam is an effective method to preserve kiwifruit.

Keywords: /Electron beam irradiation/ /Kiwifruit/ /Preservation effect/ /Reactive oxygen metabolism/

Liu, H., Pei, H., Jiao, J., Jin, M., Li, H., Zhu, Q., Ma, Y., & Rao, J. (2021). 1-Methylcyclopropene treatment followed with ethylene treatment alleviates postharvest chilling injury of “Xuxiang” kiwifruit during low-temperature storage. *Food Control*, *130*, 108340. https://doi.org/10.1016/j.foodcont.2021.108340

Abstract

Kiwifruit, a cold-sensitive fruit, often suffers chilling injury (CI) during low-temperature storage. Ethylene plays an important role in regulating cold tolerance in many types of fruit postharvest. However, the effect of ethylene treatment alone or 1-methylcyclopropene (1-MCP) combined with ethylene treatment on CI in harvested kiwifruit under low temperatures remains unclear. In this study, four treatments (air; 1 μL L−1 ethylene; 0.25 μL L−1 1-MCP; and 0.25 μL L−1 1-MCP combined with 1 μL L−1 ethylene) were applied to 'Xuxiang' kiwifruit at 20 °C, which were then stored at 0 °C for up to 100 d. Indicators related to the CI of kiwifruit were then evaluated. The results showed that 1 μL L−1 ethylene treatment accelerated the development of CI, with this treatment resulting in the most serious water-soaked appearance and the highest lignin content in pulp tissue among the four treatments and increasing the endogenous production of ethylene, the relative leakage of electrolytes and malondialdehyde (MDA) content. The combination treatment (0.25 μL L−1 1-MCP + 1 μL L−1 ethylene) alleviated CI of 'Xuxiang' kiwifruit during low-temperature storage, enhanced the chilling tolerance of kiwifruit by decreasing electrolyte leakage and MDA content to maintain membrane integrity and increased the activities of catalase (CAT) and ascorbate peroxidase (APX). The results of this study reveal a possible superior storage method for 'Xuxiang' kiwifruit that allows longer storage than existing methods while maintaining fruit quality: 0.25 μL L−1 1-MCP treatment followed with 1 μL L−1 ethylene treatment and storage at a low temperature. • The 1 μL L−1 ethylene treatment accelerated the CI in 'Xuxiang' kiwifruit. • The combined treatment of 0.25 μL L−1 1-MCP and 1 μL L−1 ethylene alleviated CI. • Combined treatment alleviated CI by holding membrane integrity & antioxidant activity.

Keywords: /Chilling injury/ /Kiwifruit/ /Ethylene/ /1-Methylcyclopropene/

Xie, Y., Nian, L., Zeng, Y., Wang, M., Yuan, B., Cheng, S., & Cao, C. (2021). Dynamic variation of endogenous flora in kiwifruit and its association with ripening metabolism in response to ethylene micro-environment. Postharvest Biology and Technology, 182, 111695. https://doi.org/10.1016/j.postharvbio.2021.111695

Abstract

The interaction between endophytes and their host affects fruit health and adaptability to the environment. To explore the intimate association between endogenous flora of postharvest fruit and its host under specific metabolic conditions, the ethylene micro-environment was constructed to accelerate kiwifruit ripening. The results showed that the ethylene micro-environment accelerated the ripening metabolism of kiwifruit. The bacterial and fungal microbiome may play various roles as kiwifruit endophytes and display different variations under the effect of micro-environment. While the correlation patterns among core bacterial and fungal members in different groups also showed different variations. In addition, three bacterial genera and six fungal species were found to show correlations with soluble solids content, skin hardness, flesh firmness, water soluble pectin content and protopectin content of kiwifruit. Our results revealed the dynamic variations of endophytes and their associations with kiwifruit ripening under the effect of ethylene micro-environment.

Keywords: /Endogenous flora/ /*Actinidia chinensis*/ /High-throughput sequencing/ /Ethylene micro-environment/ /Ripening metabolism/

Zhe-Xin Li, Min Chen, Yu-Xiang Miao, Qiang Li, Yun Ren, Wen-Lin Zhang, Jian-Bin Lan, & Yi-Qing Liu. (2021). The role of AcPGIP in the kiwifruit (Actinidia chinensis) response to Botrytis cinerea. *Functional Plant Biology*, *48*(12), 1254–1263. https://doi.org/10.1071/FP21054

Abstract

Kiwifruit (Actinidia chinensis) is rich in nutritional and medicinal value. However, the organism responsible for grey mould, Botrytis cinerea, causes great economic losses and food safety problems to the kiwifruit industry. Understanding the molecular mechanism underlying postharvest kiwifruit responses to B. cinerea is important for preventing grey mould decay and enhancing resistance breeding. Kiwifruit cv. 'Hongyang' was used as experimental material. The AcPGIP gene was cloned and virus-induced gene silencing (VIGS) was used to explore the function of the polygalacturonase inhibiting protein (PGIP) gene in kiwifruit resistance to B. cinerea. Virus-induced silencing of AcPGIP resulted in enhanced susceptibility of kiwifruit to B. cinerea. Antioxidant enzymes, secondary metabolites and endogenous hormones were analysed to investigate kiwifruit responses to B. cinerea infection. Kiwifruit effectively activated antioxidant enzymes and secondary metabolite production in response to B. cinerea, which significantly increased Indole-3-acetic acid (IAA), gibberellin 3 (GA3) and abscisic acid (ABA) content relative to those in uninfected fruit. Silencing of AcPGIP enabled kiwifruit to quickly activate hormone-signaling pathways through an alternative mechanism to trigger defence responses against B. cinerea infection. These results expand our understanding of the regulatory mechanism for disease resistance in kiwifruit; further, they provide gene-resource reserves for molecular breeding of kiwifruit for disease resistance.

Keywords: /AcPGIP/ /Antioxidant enzyme activities/ /Botrytis cinerea/ /Endogenous hormones/ /Hormone-signaling pathways/ /Kiwifruit/ /Plant defense response/ /Secondary metabolites/ /Virusinduced gene silencing/

LETTUCE

Song, H.-J., & Ku, K.-M. (2021). Optimization of allyl isothiocyanate sanitizing concentration for inactivation of Salmonella Typhimurium on lettuce based on its phenotypic and metabolome changes. *Food Chemistry*, *364*, 130438. https://doi.org/10.1016/j.foodchem.2021.130438

Abstract

Allyl isothiocyanate was optimized based on the quality of lettuce. Allyl isothiocyanate causes physiological disorders at 2.5 μL L−1 or higher. 1 μL L−1 of allyl isothiocyanate was determined as the optimal concentration. 1 μL L−1 of allyl isothiocyanate had significantly reduced Salmonella Typhimurium. Allyl isothiocyanate (AITC), a natural compound, is a promising food additive and preservative because of its safety and effectiveness. In order to determine optimal AITC concentrations for disinfection of food pathogen on lettuce without compromising postharvest quality, various concentrations of AITC (0, 1, 2.5, 5 and 7.5 μL L−1) were applied to Salmonella Typhimurium inoculated lettuce in air-tight box at 7 °C. As a result, the decline in visual quality, weight loss via cell membrane damage, and significantly reduced antioxidant activity were observed in lettuce treated with an AITC concentration of 2.5 μL L−1, 5 μL L−1 or higher. Moreover, metabolome analysis showed a pattern of increased respiratory and cell damage, such as lipid peroxidation. Based on physiological changes, 1 μL L−1 was determined as the optimal AITC concentration that significantly reduced S. Typhimurium population (4.01 log CFU g−1) on lettuce.

Keywords: /Allyl isothiocyanate/ /Postharvest quality/ /S. Typhimurium/ /Storage/

Xie, Y., Du, X., Li, D., Wang, X., Xu, C., Zhang, C., Sun, A., Schmidt, S., & Liu, X. (2021). Seasonal occurrence and abundance of norovirus in pre- and postharvest lettuce samples in Nanjing, China. *LWT - Food Science & Technology*, *152*, 112226. https://doi.org/10.1016/j.lwt.2021.112226

Abstract

To assess the contamination of lettuce with norovirus in Nanjing city (China), two hundred and eighty one lettuce samples were collected between 2017 and 2018 from production sites (preharvest) and retail outlets (postharvest) and analyzed. The presence of norovirus was confirmed in 26.9% (71/264) of lettuce samples, with norovirus genogroup I detected more frequently (20.1%) than norovirus genogroup II. Norovirus was detected less frequently in lettuce samples from supermarkets (4.9%) than in samples from greengrocers or farmer markets (36.5%) and was detected both in field-grown (28.9%) and in hydroponic lettuce samples (30%). The norovirus occurrence and levels varied markedly by seasons. The norovirus was more frequently detected in the cold season, with evident correlations between norovirus contamination and ambient temperatures. Interestingly, the norovirus occurrence in loose lettuce was significantly higher ($p < 0.05$) than in packaged lettuce, highlighting that norovirus contamination might have occurred during lettuce production. The data of this study add to the currently limited body of information on norovirus occurrence in fresh produce in China, highlighting the need for implementation of effective food safety monitoring and management. The presence of norovirus was confirmed in 26.9% of lettuce samples in Nanjing. Norovirus was detected less frequently in lettuce samples from supermarkets. Norovirus was detected both in field-grown and hydroponic culture lettuce samples. A markedly increased percentage of lettuce samples tested positive in cold season. Lettuce isolates were genotyped, with high similarity to human fecal isolates.

Keywords: /Lettuce/ /Norovirus/ /Occurrence/ /Production base/ /Retail/

LITCHI

Liu, B., Xue, W., Guo, Z., Liu, S., Zhu, Q., Pang, X., Zhang, Z., & Fang, F. (2021). Water loss and pericarp browning of litchi (Litchi chinensis) and longan (Dimocarpus longan) fruit maintain seed vigor. *Scientia Horticulturae*, *290*, 110519. https://doi.org/10.1016/j.scienta.2021.110519

Abstract

Pericarp of litchi and longan fruits rapidly loses water soon after harvest. Rapid water loss of pericarp prevents the aril and seeds from water loss. Seeds in the fruits maintain high vigor, while bare seeds dramatically lose water and vigor after harvest. Fruit decay index exhibits a significantly negative

correlation with seed vigor. Phenolics from the pericarp after browning inhibit the growth of Peronophythora litchii. Water loss is a key factor in pericarp browning during storage and transportation of litchi and longan fruit. However, whether this water loss is of biological significance is unclear. The loss of water in different tissues during browning of the two fruits, and the relationship between water loss and seed vigor were investigated. The pericarp of both fruits lost 60% of water after 4 days at 20 °C without packaging, in contrast, water loss in the aril and seed was insignificant. Water loss led to browning, a denser and thinner pericarp, correlating with a decrease in permeability to water of the pericarp. The seeds maintained 40% water content and 80% of them germinated when kept in the intact fruit after 12 days. In contrast, bare seeds stored without package retained 20% water content and germinated less than 10%. Germination was negatively correlated with fruit decay index. Phenols extracted from the pericarp after browning inhibited the growth of Peronophythora litchii more than those extracted before browning. Pericarp browning triggered by water loss of the tissue after harvest maintains seed vigor by preventing dehydration and infection of the seeds.

Keywords: /Litchi/ /Longan/ /Pericarp browning/ /Seed vigor/ /Water loss/

MANGO

Bhardwaj, R., Pareek, S., Gonzalez-Aguilar, G., & Dominguez-Avila, A. (2021). Changes in the activity of proline-metabolising enzymes is associated with increased cultivar-dependent chilling tolerance in mangos, in response to pre-storage melatonin application. Postharvest Biology and Technology, 182, 111702. https://doi.org/10.1016/j.postharvbio.2021.111702

Abstract

Exogenous melatonin (100 μM) was applied to four mango fruit cultivars, namely, ‘Langra’, ‘Dashehari’, ‘Chaunsa’, and ‘Gulab Jamun’, and subsequently stored at 5 ± 1 °C for 28 d. ‘Langra’ mangos responded best to melatonin treatment by increasing their chilling tolerance during storage, while ‘Gulab Jamun’ mangos did not experience any significant effect. MT reduced chilling injury index by 4.8, 1.8, 1.7 and 1.1 times in ‘Langra’, ‘Chaunsa’, ‘Dashehari’ and ‘Gulab Jamun’, respectively, as compared to non-treated mangos, after 28 d of storage at 5 ± 1 °C. This efficacy of MT on quality preservation at chilling temperatures was associated with delayed ethylene production and respiration rate, a lower concentration of malondialdehyde, as well as maintenance of physicochemical properties like firmness, pH, total soluble solids, and titratable acidity in most cultivars, except for ‘Gulab Jamun’. Additionally, MT treated ‘Langra’ mangos showed 1.39 times higher proline content, as compared to non-treated mangos. This was likely due to higher activities of Δ1-pyrroline-5-carboxylate synthetase and ornithine-δ-aminotransferase, in addition to lower proline dehydrogenase activity at 28 d of storage. This effect was not apparent on ‘Gulab Jamun’ mangos, whereas ‘Chaunsa’ and ‘Dashehari’ mangos showed a moderate response to the MT treatment on their physiochemical properties and proline metabolism. Thus, our data suggests that MT treatment exerted a cultivar-dependent control on signs of chilling injury.

Keywords: /Chilling injury/ /Mango/ /Malondialdehyde/ /Melatonin/ /Physiology/ /Proline/

MUSHROOM

Pourbagher, R., Abbaspour-Fard, M. H., Sohbatzadeh, F., & Rohani, A. (2021). In vivo antibacterial effect of non-thermal atmospheric plasma on pseudomonas tolaasii, a causative agent of Agaricus bisporus blotch disease. *Food Control*, *130*, 108319. https://doi.org/10.1016/j.foodcont.2021.108319

Abstract

This study aimed to investigate the inactivation of Pseudomonas tolaasii (P. tolaasii) strain Pt18 inoculated on button mushroom (Agaricus bisporus) by non-thermal plasma (NTP), using surface

dielectric barrier discharge (SDBD). Furthermore, the effects of NTP on the postharvest preservation of Agaricus bisporus during 21 days of storage at 4 °C were studied. The so-called response surface methodology (RSM) was employed to investigate the efficacy of the plasma process parameters on bacterial inactivation and qualitative characteristics of Agaricus bisporus. The NTP at the optimum conditions of treatment time of 180 s and excitation frequencies of 6200 Hz under hydrogen peroxide vapor and air gas (H 2 O 2 +air) reduced P. tolaasii on Agaricus bisporus by 4.23 log CFU g−1 after 21 days of storage. The corresponding biological properties of NTP treated and control samples were also assessed. The results of firmness and moisture content suggested that plasma treatment could delay mushroom softening. In addition, vitamin C content of the treated button mushrooms increased despite observing insignificance (P > 0.05) in pH. Hydrogen peroxide vapor and argon gas (H 2 O 2 +Ar) treatment showed less Agaricus bisporus color changes during the 21-day period. Therefore, it can be concluded that NTP as a novel technology has an excellent potential for improving the microbial contamination and enhancing qualitative properties of Agaricus bisporus. The effectiveness of plasma treatment against Pseudomonas tolaasii assessed. No notable change observed in the pH of Agaricus bisporus treated with SDBD plasma. The combination of H 2 O 2 vapor with plasma gases enhanced the quality of the mushroom. Plasma-treated mushrooms showed fewer color changes than control samples. Vitamin C content increased after H 2 O 2 +Ar Non-thermal plasma treatment.

Keywords: /Agaricus bisporus/ /Hydrogen peroxide vapor/ /Non-thermal plasma/ /Pseudomonas tolaasii, quality enhancement/

Wang, X., Sun, Y., Liu, Z., Huang, X., Yi, F., Hou, F., & Zhang, F. (2021). Preparation and characterization of chitosan/zein film loaded with lemon essential oil: Effects on postharvest quality of mushroom (Agaricus bisporus). ***International Journal of Biological Macromolecules*****,** ***192*****, 635–643. https://doi.org/10.1016/j.ijbiomac.2021.10.068**

Abstract

In this study, different concentrations of lemon essential oils (LEO) were incorporated into chitosan/zein complex film (C/Z/L films) to improve its antioxidant and antimicrobial capacity, and the effects of C/Z/L films on mushroom quality were evaluated at 4 °C for 12 d. The antioxidant and antimicrobial activity of C/Z films were effectively improved by addition of LEO in a concentration-dependent manner. What's more, EAB value and gas permeability increased while TS value and water vapor permeability decreased upon the gradual increase of LEO content. During the entire storage, C/Z/L films were effective in suppressing PPO and POD activity of mushrooms as well as inhibiting the growth of microorganisms. Mushrooms packaged with the film containing 6% LEO showed the lowest browning index and respiration rate. In addition, the C/Z/L film-treated mushrooms exhibited higher antioxidant capacity and more satisfactory texture properties. The results of our study presented that C/Z active film loaded with LEO could be used to maintain the postharvest quality of mushrooms.

Keywords: /Antibacterial properties/ /Antioxidant properties/ /C/Z/L film packaging/

Zuo, C., Hu, Q., Su, A., Pei, F., Ma, G., Xu, H., Xie, M., Liu, J., Mariga, A., & Yang, W. (2021). Transcriptome analysis reveals the underlying mechanism of nanocomposite packaging in delaying quality deterioration of Flammulina velutipes. Postharvest Biology and Technology, 182, 111723. https://doi.org/10.1016/j.postharvbio.2021.111723

Abstract

To expound the molecular mechanism of nanocomposite packaging material (Nano-PM) in delaying quality deterioration of *Flammulina velutipes* during storage, transcriptome analysis was conducted to observe the changes of gene expression in *F. velutipes* that was packaged in Nano-PM, polyethylene packaging material (Normal-PM) and no packaging material (No-PM). In comparison with Normal-PM, 379 differentially expressed genes (DEGs) were identified in Nano-PM packaged *F. velutipes*, comprising

161 up-regulated genes and 218 down-regulated genes. Gene Ontology (GO) and Kyoto Encyclopedia of Genes and Genomes (KEGG) enrichment analysis indicated that Nano-PM improved the stress resistance of *F. velutipes* by up-regulating *RBOHF* and *msp2*, which were related to reactive oxygen species (ROS) metabolism. Nano-PM also ensured sufficient energy supply by regulating oxidative phosphorylation and glycolysis/gluconeogenesis. Moreover, the regulation of gene expression also delayed programmed cell death (PCD) and lignification. Furthermore, the quantitative real-time PCR (qRT-PCR) results were also in accordance with transcriptome analysis. Therefore, Nano-PM could regulate the expression of specific genes, which in turn alleviated quality deterioration of *F. velutipes* during storage.

Keywords: /*Flammulina velutipes*/ /Nanocomposite packaging/ /Transcriptome analysis/ /Quality deterioration/

ORANGE

Guo, X., Qiao, M., Yang, Y., Luo, K., Liu, Z., Liu, J., Kuznetsova, N., Liu, Z., & Sun, Q. (2021). Bacillus amyloliquefaciens M73 reduces postharvest decay and promotes anthocyanin accumulation in Tarocco blood orange (Citrus sinensis (L.) Osbeck) during cold storage. *Postharvest Biology and Technology, 182*, 111698. https://doi.org/10.1016/j.postharvbio.2021.111698

Abstract

Due to its antifungal effects on a variety of phytopathogenic fungi and growth-stimulating activity, the effects of *Bacillus amyloliquefaciens* M73 on the preservation and especially the anthocyanin accumulation in Tarocco blood orange (*Citrus sinensis* (L.) Osbeck) during cold storage at 4 °C were investigated. Compared with the untreated fruit, *B. amyloliquefaciens* M73 culture supernatant (BMCS)-treated blood oranges exhibited the lower percentage of fruit decay and greater desirable darker purple coloration. BMCS-treated fruit also maintained the lower weight loss and richer contents of total soluble solids, vitamin C, titratable acidity and anthocyanins, with higher transcription levels of anthocyanin biosynthesis related genes of *CHS1*, *CHS2*, *F*3'5'*H*, *ANS*, and *Ruby* in the pulp. The treated fruit had higher activities of peroxidase and polyphenol oxidase that were related to fruit disease resistance, as well as the lower mold count on the pericarp. BMCS treatment did not aggravate the generation of off-flavors during the storage. Our study suggested that *B. amyloliquefaciens* M73 had the potential to be developed into a novel preservative of high efficiency and low cost on maintaining the storage quality and increasing coloration of Tarocco blood orange during cold storage.

Keywords: /Blood orange/ /*Bacillus amyloliquefaciens* M73/ /Cold temperature storage/ /Physical and chemical indicators/ /Anthocyanin biosynthesis/

PEACH

Li, C., Wang, K., Huang, Y., Lei, C., Cao, S., Qiu, L., Xu, F., Jiang, Y., Zou, Y., & Zheng, Y. (2021). Activation of the BABA-induced priming defence through redox homeostasis and the modules of TGA1 and MAPKK5 in postharvest peach fruit. *Molecular Plant Pathology*, *22*(12), 1624–1640. https://doi.org/10.1111/mpp.13134

Abstract

The priming of defence responses in pathogen-challenged model plants undergoes a preparation phase and an expression phase for defence function. However, the priming response in postharvest fruits has not been elucidated. Here, we found that 50 mM β-aminobutyric acid (BABA) treatment could induce two distinct pathways linked with TGA1-related systemic acquired resistance (SAR), resulting in the alleviation of Rhizopus rot in postharvest peach fruit. The first priming phase was elicited by BABA alone,

leading to the enhanced transcription of redox-regulated genes and posttranslational modification of PpTGA1. The second phase was activated by an H2O2 burst via up-regulation of PpRBOH genes and stimulation of the MAPK cascade on pathogen invasion, resulting in a robust defence. In the MAPK cascade, PpMAPKK5 was identified as a shortcut interacting protein of PpTGA1 and increased the DNA binding activity of PpTGA1 for the activation of salicylic acid (SA)-responsive PR genes. The overexpression of PpMAPKK5 in Arabidopsis caused the constitutive transcription of SA-dependent PR genes and as a result conferred resistance against the fungus Rhizopus stolonifer. Hence, we suggest that the BABA-induced priming defence in peaches is activated by redox homeostasis with an elicitor-induced reductive signalling and a pathogen-stimulated H2O2 burst, which is accompanied by the possible phosphorylation of PpTGA1 by PpMAPKK5 for signal amplification.

Keywords: /β-aminobutyric acid/ /MAPKK/ /Peach/ /Priming resistance/ /Redox/ /Rhizopus stolonifer/ /TGA1/

PEAR

Hiruta, T., Sasaki, K., Hosoya, N., Maeda, S., & Kajiwara, I. (2021). Firmness evaluation of postharvest pear fruit during storage based on a vibration experiment technique using a dielectric elastomer actuator. *Postharvest Biology and Technology, 182*, 111697. https://doi.org/10.1016/j.postharvbio.2021.111697

Abstract

This study proposes a vibration technique based on the dielectric elastomer actuator (DEA) excitation to determine the resonance frequency of La France pear fruit. Postharvest pear fruit ripen during storage to improve their quality. A non-destructive measurement technique is necessary to predict maturity without damaging the fruit. The maturity of pear fruit is correlated with firmness, which can be assessed by a firmness index derived from the resonance frequency and the mass. Because DEAs exhibit characteristics that are conducive to vibration applications such as flexibility, lightweight, responsiveness, and deformability, they can be applied and effectively transfer excitation forces to fruit or vegetables with curved surfaces. In this study, the proposed technique is used to evaluate the variations in firmness indices of pear fruit during storage. Additionally, the firmness is measured using a penetrometer to verify the correlation with the firmness index. Using a vibration test system, the distinct frequency responses of pear fruit are obtained and the resonance peaks of the first elastic mode are observed around 700 Hz. The firmness indices of the target fruit are Hz2 g2/3 on day 0 and tend to decrease during storage. The tendency of each fruit is approximated based on a nonlinear least square method. Moreover, the firmness indices are well correlated with the results of the penetrometer test, demonstrating the effectiveness of the proposed technique to evaluate pear fruit quality.

Keywords: /Pear fruit firmness/ /Firmness index/ /Non-destructive test/ /Dielectric elastomer actuator/ /Vibration experiment/ /Modal analysis/

Sinha, A., Gill, P. Jawandha, S.K. Kaur, P. & Grewal, S.K. (2021). Chitosan-enriched salicylic acid coatings preserves antioxidant properties and alleviates internal browning of pear fruit under cold storage and supermarket conditions. Postharvest Biology and Technology, 182, 111721. https://doi.org/10.1016/j.postharvbio.2021.111721

Abstract

Pear being climacteric in nature undergoes alterations in antioxidant properties during storage due to intense metabolic activities. In an attempt to maintain antioxidants level, pears were treated either with chitosan (CH) coatings alone (CH 1.0 and 2.0 %) or were incorporated with 2.0 mM salicylic acid (SA) and stored for a period of 67 d under cold temperature (0 – 1 °C and 90–95 % RH) and 20 d under supermarket conditions (20–22 °C and 80–85 % RH). Evaluation study for different physico-chemical

attributes of pears suggested that the SA loaded CH coatings restricted the climacteric peak and delayed the polyphenol oxidase (PPO) enzyme activity. As compared to control, these composite coatings promoted the preservation of total phenolics content (TPC), ascorbic acid (AsA) and retained higher total antioxidant activities (TAA) in fruit till 67 d of cold storage period and 20 d under supermarket conditions. Furthermore, CH 2.0 % + SA 2.0 mM coatings strictly impeded the development of internal browning (IB) symptoms of pears throughout the storage period. Combined coatings of CH plus SA contributed higher efficacy in terms of maintaining the functional properties of fruit as compared to individual coatings of CH or SA dip.

Keywords: /Antioxidant activities/ /Chitosan/ /Pear/ /Polyphenol oxidase/ /Respiration rate/ /Salicylic acid/

Wang, Z., Tang, Y., Liu, Y., Zhang, H., Zhang, Y., & Lan, H. (2021). Inhibitory effect of CaCl2 and carboxymethyl chitosan coating on the after‐ripening of Korla fragrant pears in cold storage. *International Journal of Food Science & Technology*, *56*(12), 6777–6790. https://doi.org/10.1111/ijfs.15339

Abstract

Korla fragrant pears were treated with CaCl2 and carboxymethyl chitosan coating (CC), while distilled water was used as control (CK) to clarify the effects of CaCl2 and CC treatments on the after‐ripening of Korla fragrant pears in cold storage. The results showed that the CaCl2 and CC treatments could maintain the balance of cell wall components and active oxygen metabolism, reduce membrane lipid peroxidation and damage, and delay and reduce the respiratory and physiological activity intensity, thus delaying the consumption of nutrients in the Korla pear during cold storage and preserving fruit storage quality. Compared with the CK group, both CaCl2 and CC treatments could effectively delay after‐ripening and reduce the intensity of physiological activity. Furthermore, the combination of CaCl2 and CC treatment groups yielded better results than the CaCl2 or CC treatments alone.

Keywords: /After‐ripening/ /Korla fragrant pear/ /Quality/ /Storage period/

POSTHARVEST DISEASE

Li, Y., Guo, L., & Zhou, Z. (2021). Exploring the antifungal mechanism of limonin-loaded eugenol emulsion against Penicillium italicum: From the perspective of microbial metabolism. Postharvest Biology and Technology, 182,111704. https://doi.org/10.1016/j.postharvbio.2021.111704

Abstract

Penicillium italicum (P. italicum), the cause of citrus blue mould, is a pathogenic fungus that seriously affects the postharvest quality of citrus fruit and causes severe economic loss. Our previous research showed that adding limonin to eugenol nanoemulsion could improve the antifungal activity, and inhibited the growth of P. italicum on the surface of citrus fruit. Accordingly, the present study aimed to investigate the underlying mechanism of limonin-loaded eugenol emulsion (EuLm) against P. italicum based on the influence on membrane structure and intracellular substance metabolism. Results indicated that EuLm showed disruptive activity on the fungal cell membrane, mitochondrial membrane potential and the ergosterol synthesis. Meanwhile, EuLm treatment causes the intracellular substances of total lipids, cell proteins and total sugars to decrease by 56.7 %, 37.4 % and 17.4 %, respectively. GC–MS-based metabolomics showed 34 metabolites declined after EuLm treatment, including amino acids, fatty acids, carbohydrates, alcohols, and glycosides. The results suggested that EuLm interferes with fungal metabolic pathways, such as the TCA cycle, lipid metabolism and protein synthesis. Our study provides new insight into exploring the underlying mechanisms of antifungal phytochemicals against P. italicum.

Keywords: P. italicum/ /Limonin/ /Metabolite/ /GC/EI/MS/ /Metabolic pathway/

Nguyen, H., Park, A., Hwang, I., & Kim, J. (2021). Identification and delineation of action mechanism of antifungal agents: Reveromycin E and its new derivative isolated from Streptomyces sp. JCK-6141. Postharvest Biology and Technology, 182, 111700. https://doi.org/10.1016/j.postharvbio.2021.111700

Abstract

Streptomyces species have been used as biocontrol agents for the management of fungal postharvest diseases. Reveromycin E (RE) and its new derivative, reveromycin E 1-methyl ester (REME), were isolated from Streptomyces sp. JCK-6141. Both compounds displayed broad-spectrum and extensive antifungal activities at acidic conditions, but their activities were dramatically reduced at neutral or base conditions. These compounds effectively suppressed the cherry tomato gray mold and mandarin blue mold caused by Botrytis cinerea and Penicillium italicum, respectively, at 10 and 50 mg L−1. In in vitro and in vivo assays, RE showed stronger antifungal activity than REME. Reveromycin was known as an isoleucine tRNA synthetase (IleRS) inhibitor. However, there is an unconsolidated result in confirming the binding site of reveromycin in previous studies. A computational study revealed that RE had a lower binding energy than REME and both compounds tend to bind catalytic domains rather than editing domains of IleRS. Our results indicated that Streptomyces sp. JCK-6141 producing reveromycins can be widely used as a new microbial fungicide for the control of postharvest diseases on fruit.

Keywords: /Acidic pH/ /Action mechanism/ /Antifungal activity/ /Isoleucine t/ /RNA synthetase/ /Reveromycins/

RADDISH

Zhao, X., Zhang, Y., Ma, Y., Zhang, L., Jiang, Y., Liang, H., & Wang, D. (2021). Inhibitory mechanism of low-oxygen-storage treatment in postharvest internal bluing of radish (Raphanus sativus) roots. *Food Chemistry*, *364*, 130423. https://doi.org/10.1016/j.foodchem.2021.130423

Abstract

Oxidative stress in radish roots causes internal blue discoloration and decreases vegetable quality. Accordingly, the effects of different oxygen concentration treatment on this coloration during storage was investigated; 4-hydroxyglucobrassicin content (a precursor of the blue component); the reactive oxygen species (ROS) superoxide (O_2^-) and hydrogen peroxide (H_2O_2); the antioxidants ascorbic acid (AsA) and glutathione (GSH); and the activities and gene expression levels of the enzymes catalase (CAT), peroxidase (POD), ascorbate peroxidase (APX), glutathione peroxidase (GPX), were monitored under normal and low-oxygen conditions. The results indicated that packaging radish roots under 10% O_2 prevents blue discoloration by decreasing the activity and expression of the oxidant enzyme POD, increasing the levels of antioxidant and reducing substances, and upregulating antioxidant enzymes, all of which act to decrease the generation of ROS (O^{2-} and H_2O_2).

Keywords: /Low-oxygen storage/ /Blue discoloration/ /Radish root/ /Enzyme/ /4-Hydroxyglucobrassicin/

STRAWBERRY

Li, H., Brouwer, B., Oud, N., Verdonk, J., Tikunov, Y., Woltering, E., Schouten, R., & Pereira da Silva, F. (2021). Sensory, GC-MS and PTR-ToF-MS profiling of strawberries varying in maturity at harvest with subsequent cold storage. Postharvest Biology and Technology, 182, 111719. https://doi.org/10.1016/j.postharvbio.2021.111719

Abstract

Harvesting strawberry fruit before they are fully ripe and allowing them to further ripen during postharvest cold storage is a common practice. The effect of these storage conditions on consumer liking is not well understood. The first aim of this study is to investigate the effects of maturity at harvest and subsequent cold storage on consumer liking, expressed as sweetness and aroma attributes, and volatile composition. The second aim of this study is to investigate whether volatile organic compounds (VOCs) can be used to predict consumer liking. Strawberries (*Fragaria* × *ananassa* cv. Lusa) were harvested either at the ¾ red stage or full red stage and stored at 4 °C for one, five or nine days. Strawberries were subjected to sensory profiling, colour-, firmness-, GC–MS- and PTR-ToF-MS- measurements. The sensory profile of strawberries harvested at ¾ red stage showed lower sweetness and aroma than full red harvested strawberries. VOC analysis of these strawberries showed lower presence of volatile fatty acids, furanones and most esters even after nine days of cold storage, compared to full red strawberries. Strawberries harvested at full red stage showed the highest value for aroma attributes after one day of cold storage. Surprisingly, peak intensities of most esters (except for methyl butanoate and methyl hexanoate) and furanones were low on the first day, compared to ripe harvested fruit after longer storage. Ripe harvested fruit stored for nine days showed the highest peak intensities for most VOCs, but this did not correspond to the highest sensory aroma attributes. These fruits were judged with the lowest values for aroma attributes, perhaps related to the production of volatiles with off-flavours (acetaldehyde, ethyl acetate). PLS modelling showed that VOCs exist that are characteristic for both sweet and aromatic sensory attributes of ‘Lusa’ strawberries, based either on GC–MS (mainly volatile fatty acids) or PTR-ToF-MS analysis (mainly alcohol/ester fragments). This could lead to fast, non-destructive, selection of strawberries with high consumer liking using PTR-ToF-MS.

Keywords: /Consumer liking/ /Expert panel/ /Multivariate analysis/ /PLS modelling/ /Volatile organic compounds/

Li, D., Li, L., Xu, Y., Wang, L., Lin, X., Wang, Y., & Luo, Z. (2021). Exogenous ATP attenuated fermentative metabolism in postharvest strawberry fruit under elevated CO2 atmosphere by maintaining energy status. *Postharvest Biology and Technology, 182*,111701. https://doi.org/10.1016/j.postharvbio.2021.111701

Abstract

Elevated CO2 shows adverse effects in horticultural crops including off-flavor formation and carbohydrate consumption. Here, 1 mM adenosine triphosphate (ATP) was applied to strawberry fruit under 20 % CO2 atmosphere to investigate its regulation on fermentative and carbohydrate metabolism. The results showed that ATP treatment increased endogenous ATP content by 27 %, and delayed the decrease of energy charge under elevated CO2 atmosphere. Exogenous ATP showed no adverse effects on fruit firmness and color but attenuated the accumulation of acetaldehyde and ethanol, which were 72 % and 75 % lower in ATP+CO2-treated fruit compared CO2-treared fruit, respectively. The inhibition of fermentative metabolism resulted from the repression of pyruvate decarboxylase (PDC), alcohol dehydrogenase (ADH) activities, as well as *FaADH* expression. Meanwhile, ATP treatment also maintained carbohydrate levels under elevated CO2 atmosphere, with 6 %, 7 %, and 11 % more glucose, fructose and sucrose observed at the end of the storage period as compared with the CO2-treated group, respectively. The down-regulation of enzyme activities and gene expressions involved in sucrose catabolism and glycolysis may account for the inhibition of carbohydrate consumption. These results indicated that exogenous ATP might be a strategy to optimize elevated CO2 treatment to avoid its adverse effects.

Keywords: /Exogenous ATP/ /Elevated CO2/ /Fermentative metabolism/ /Carbohydrate metabolism/ /Strawberry fruit/

Lin, Y., Huang, R., Sun, X., Yu, X., Xiao, Y., Wang, L., Hu, W., & Zhong, T. (2021). The p-Anisaldehyde/β-cyclodextrin inclusion complexes as fumigation agent for control of postharvest decay and quality of strawberry. *Food Control*, *130*, 108346. https://doi.org/10.1016/j.foodcont.2021.108346

Abstract

In order to evaluate the potential of developed β-cyclodextrin (β-CD)/ p -Anisaldehyde (PAA) inclusion complexes as a fumigation agent for the postharvest decay control in strawberry, both in vitro and in vivo tests were conducted. According to the colony morphology analysis on PDA media, inclusion complexes showed activity on inhibiting the mycelial growth of the fungi including Rhizopus stolonifer , Aspergillus niger and Penicillium. The effect of inclusion complexes on controlling postharvest decay in fresh strawberry was also confirmed by an in vivo test, in which the inclusion complexes-treated fruit displayed significantly lower incidence and severity than control, β-CD-treated and free PAA-treated fruit. Moreover, evaluations of fruit qualities including color, weight loss, firmness and TSS, as well as the sensory indexes including appearance, color, texture and flavor were carried out in turn, showing there was no significant difference between inclusion complexes-treated fruit and the other groups. The p -Anisaldehyde/β-CD inclusion complex was used as a fumigation agent. The inclusion complex displayed in vitro activity against three common fungi. The inclusion complex reduced the incidence and severity of the decay in strawberries. The inclusion complex maintained the fruit quality during storage

Keywords: /Antifungal activity/ /Colony morphology/ /Cyclodextrin/ /Encapsulation/ /Essential oil/ /Fruit quality/ /Fumigation agent/ /Incidence/ /Inclusion complexes/ /Postharvest decay/ /Sensory
Strawberry/

TOMATO

Shu, P., Li, Y., Wang, X., Yao, L., Sheng, J., & Shen, L. (2021).Exogenous ferulic acid treatment increases resistance against Botrytis cinerea in tomato fruit by regulating nitric oxide signaling pathway. Postharvest Biology and Technology, 182, 111678 .https://doi.org/10.1016/j.postharvbio.2021.111678

Abstract

This study was to explore the effect of ferulic acid (FA) treatment in response to *Botrytis cinerea* (*B. cinerea*) infection of tomato fruit and potential mechanisms of action. The results showed that fruit treated with 100 μM FA increased resistance against *B. cinerea* as revealed by decreased disease incidence and lesion area. In addition, the activities of phenylalanine ammonialyase (PAL), polyphenol oxidase (PPO), chitinase (CHI) and β-1,3-glucanase (GLU) were significantly higher in tomato fruit treated with 100 μM FA. The increase of disease resistance was accompanied by a higher expression of genes (*PR1*, *NPR*1, *MYC2*, *LoxD*) related to salicylicacid (SA) and jasmonic acid (JA) signaling pathways. Furthermore, the activity of nitric oxide synthase (NOS) was also enhanced by FA treatment and consequently increased the content of nitric oxide (NO). However, the simultaneous addition of 0.2 mM *N*ω-nitro-*l*-arginine (l-NNA), a specific inhibitor of NOS, abolished such effects of 100 μM FA produced as well as decreased the expression of genes (*C3H*, *C4H*, *COMT*, *PAL*) related to FA biosynthesis. Additionally, FA treatment improved the correlations of NOS with *MYC2* (r = 0.85*), GLU (r = 0.93**) and CHI (r = 0.94**). These findings indicated that FA treatment could be a promising approach to improve resistance against *B. cinerea* in tomato fruit, which was related to NO signaling pathway.

Keywords: /Ferulic acid/ /*B. cinerea*/ /Tomato fruit/ /Nitric oxide/

WATERMELON

Acharya, P., Singh, J., Jayaprakasha, G. K., Jifon, J. L., Crosby, K. M., & Patil, B. S. (2021). Impact of storage period and nanoparticle treatment on phytochemical composition of watermelons (Citrullus lanatus). *Journal of Food Composition & Analysis*, *104*, 104139. https://doi.org/10.1016/j.jfca.2021.104139

Abstract

Post-harvest storage at room temperature affects retention of the phytonutrients in watermelon. Lycopene content was enhanced at 10 d storage as compared to the fresh watermelons. l -Citrulline and total ascorbic acid were significantly reduced in 20 d of storage. Plant-mediated nanomaterials did not impact the phytochemical profile of watermelon. The nutritional quality of many fruits and vegetables is regulated by pre-harvest management factors that can be manipulated to attain desired quality standards. In this study, the impact of seed nanopriming on the phytochemical composition of watermelon was studied. Seeds of two watermelon varieties namely: River Side (diploid) and Maxima (triploid) treated with two nanomaterials (silver nanoparticle and turmeric nanoemulsion) along with untreated seeds were grown in five locations over two seasons. Physico-chemical properties and phytochemical profiles were assessed after mature fruits were harvested and stored at 23 °C for 0, 10, and 20 d. Key physico-chemical characteristics that were impacted by storage included fruit weight, rind thickness, pH, and soluble solid content. Similarly, levels of health-promoting compounds such as carotenoids, l -citrulline, and total ascorbic acid were maintained and/or enhanced in watermelons after 10 d of storage compared to untreated fruits at harvest. However, l -citrulline (10.40 g/kg) and total ascorbic acid (57.52 g/kg) was significantly reduced in watermelons after 20 d of storage (8.6 and 19.09 g/kg, respectively) regardless of treatment and location ($p < 0.05$) in River Side and the trend is similar in Maxima. Combined analysis across all locations demonstrated non-significant treatment effects on the levels of health-promoting compounds among the control and the nano-treated watermelons. These observations suggest that seed priming with nanomaterials does not have any detrimental effect on the fruit's nutritional quality and the consumer's health.

Keywords: /Carotenoids/ /l-citrulline/ /Nanotechnology/ /Phytochemicals/ /Postharvest/ /Total ascorbic acid/ /Watermelon/