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APPLE

Celik, H. K., Ustun, H., Erkan, M., Rennie, A. E. W., & Akinci, I. (2021). Effects of bruising of "Pink Lady" apple under impact loading in drop test on firmness, colour and gas exchange of fruit during long term storage. *Postharvest Biology & Technology*, *179*, 111561. https://doi.org/10.1016/j.postharvbio.2021.111561

Abstract

The bruising phenomenon of apple fruit under impact loading is still a very important problem to be solved in order to design optimal harvest and processing systems and for ensuring the quality of the fruit during long-term periods of storage. This study focused on deformation simulation of apples (cv.' Pink Lady') under dynamic impact loading during drop tests in order to describe time-dependent bruising occurrence and the bruising effect on the postharvest fruit quality during long-term storage. In the study, analytical, experimental methods and finite element analysis based explicit dynamics simulation techniques were employed. Three drop heights (250 mm, 500 mm and 750 mm) and three impact materials (structural steel, high-density polyethylene and wood) and single fruit orientation (transverse) for the drop tests were considered. Experimental drop test, physical and chromatographic analyses at the time of harvest (first testing day) and during storage periods of 30, 120 and 210 days were realised. Physical and chromatographic analyses revealed that damaged apples lost a greater amount of weight when considering the increase in drop height. Furthermore, bruised surfaces of apples lost their luminosity just after the drop test. Ethylene production and respiration rates rapidly increased just after the fruit bruising and this increase was correlated with the drop height. Additionally, material tests revealed the yield stress point of the apple as 0.385 MPa and the simulation results provided useful visuals and numerical data related to the time-dependent bruising phenomenon. The validation study on the experimental and simulation setup revealed that bruising surface area is a more accurate measurement than bruise volume when evaluating bruising on the fruit flesh through a numerical method-based simulation study (average relative difference: 5.5 %).

Keywords: /Pink Lady/ /Apple/ /Bruising/ /Quality/ /Drop test/ /Finite element analysis/

Rux, G., Bohne, K., Huyskens-Keil, S., Ulrichs, Ch., Hassenberg, K. & Herppich, W.B. (2021). Effects of modified atmosphere and sugar immersion on physiology and quality of fresh-cut 'Braeburn' apples. *Food Packaging and Shelf Life*, *29*, 100726. https://doi.org/10.1016/j.fpsl.2021.100726

Abstract

Fresh-cut fruits are highly perishable and show a short shelf life. Therefore, storage in sugar syrup is commercially used to delay undesirable metabolic changes and to prevent browning. Investigations on the effects of syrup application on volatile organic compounds (VOCs), important for the consumers' acceptance, are rare. It is, however, known that low O2 availability, as found in fruit slices after immersion, may result in the formation of unwanted off-odour. This negatively affects the sensory quality of fresh-cuts. In the present study, fresh-cut 'Braeburn' apples were comparatively stored in air, in three modified atmospheres (O2: 10, 5 and approx. 0 %; CO2: 10, 15 and 20 %) or in sugar syrup (20 % sugar content). Relevant quality, physiological and microbiological parameters were evaluated on days 3, 6 and 10 of storage. Particular focus was laid on the evaluation of VOC emission to indicate biosynthetic responses that affect aroma-relevant VOCs. Atmospheric storage of apple slices, among others, increased the emission of ethyl acetate, which may create off-odour and negatively affects the customers' acceptance. In contrast, syrup-immersion of apple slices resulted in a pronounced loss of aroma but prevented the occurrence of off-odour. The results indicated metabolic changes, which were independent

of O2 availability. High CO2 or VOCs concentrations in the fruit tissue may inhibit esterification or may induce a feedback inhibition of VOC synthesis.

Keywords: /Minimal processing/ /Sugar syrup storage/ /Microbial analyses/ /Volatile organic compounds/ /Chemical prevention/ /Ready-to-eat fruit salads/

Waghmode, B., Masoodi, L., Kushwaha, K., Mir, J. I., & Sircar, D. (2021). Volatile components are non-invasive biomarkers to track shelf-life and nutritional changes in apple cv. "Golden Delicious" during low-temperature postharvest storage. *Journal of Food Composition & Analysis*, *102*, 104075. https://doi.org/10.1016/j.jfca.2021.104075

Abstract

Quality of Golden Delicious (GD) apples were evaluated during cold storage at 4 °C. Cold storage influenced the quality, nutritional value and metabolic profile of apples. VOC and phenolic profiles at six storage time points were also compared. Multivariate analysis using VOCs, separated fruit from different storage time points. α -Farnesene might be a marker for shelf-life prediction in stored GD apples. In this study, we investigated the time-course variations in the nutritionally important quality attributes of 'Golden Delicious' apples kept under postharvest storage at 4 °C. At harvest (0 day) and at day 15, 30, 45, 60, and 90 of postharvest storage, physicochemical properties, primary and secondary metabolites profile, and volatile organic compound (VOC) profiles were measured. Low-temperature storage significantly altered physicochemical characteristics, concentrations of 22 primary metabolites, 12 secondary metabolites, and 41 VOCs in the stored apples. Apples stored for different storage durations could be separated using partial least squares-discriminant analysis with VOCs as variables. In total, 13 VOCs showed variable importance in projection score more than one, and those VOCs are considered as potential shelf-life biomarkers for apples under storage with especial emphasis on α-farnesene. This study added new insights on the systematic metabolic changes occurring in 'Golden Delicious' apples under prolonged low-temperature storage. The biomarker VOCs detected in this study showed excellent correlation with storage duration and estimation of those VOCs will help us in the non-destructive prediction of fruit shelf-life. Additionally, metabolite profile data can be used to correlate storage duration with the fruit nutritional level, which is of especial interest to the consumers and the apple industry.

Keywords: /Fruit volatiles/ /GC–MS/ /HPLC/ /Phenolic compounds/ /Primary metabolites/ /Solid phase micro-extraction (SPME)/ /Volatile organic compound/

AVOCADO

Le, K. H., Nguyen, M. D.-B., Tran, L. D., Nguyen Thi, H. P., Tran, C. V., Tran, K. V., Nguyen Thi, H. P., Dinh Thi, N., Yoon, Y. S., Nguyen, D. D., & La, D. D. (2021). A novel antimicrobial ZnO nanoparticles-added polysaccharide edible coating for the preservation of postharvest avocado under ambient conditions. *Progress in Organic Coatings*, *158*, 106339. https://doi.org/10.1016/j.porgcoat.2021.106339

Abstract

Chitosan/gum arabic edible coating was supplemented with antibacterial ZnO nanoparticles. Antibacterial ZnO nanoparticles were added to chitosan/gum arabic edible coating. Avocado surface with ZnO/chitosan/gum arabic edible coating was characterized. Physicochemical properties of ZnO- coated avocados were determined. ZnO/chitosan/gum arabic coating significantly enhanced the freshness of avocado. Edible coatings or films are considered effective and sustainable in preventing the waste of millions of tons of fruits and vegetables resulting from decay and deterioration. In this study, we propose a new edible coating formulation to preserve avocado. The edible coating consisted of film-forming mixed polysaccharides (chitosan and gum arabic) supplemented with non-toxic zinc oxide (ZnO) nanoparticles using the mixing method. ZnO nanoparticles with diameters ranging from 10 to 40 nm were synthesized

using hydrothermal methods. The prepared ZnO and ZnO/chitosan/gum arabic edible coatings were characterized by scanning electron microscopy, X-ray diffraction, and Fourier transform infrared spectroscopy. The results showed that the edible film coated on the avocado's surface was smooth and uniform with an even distribution of ZnO nanoparticles in the film matrix. The physicochemical properties of avocados, such as appearance and brightness; weight; firmness; and reducing sugar content significantly improved after coating with the ZnO/chitosan/gum arabic edible film as compared to the uncoated samples. The best protective performance was achieved when the coating's optimum ZnO concentration was 0.3 % w/w. While the uncoated avocados rotted after seven days of storage at room temperature, the coated avocados remained fresh under similar storage conditions.

Keywords: /Antimicrobial activity/ /Edible coatings/ /Postharvest avocado/ /Shelf life/ /ZnO nanoparticles/

BANANA

Chen, L.-L., Shan, W., Cai, D.-L., Chen, J.-Y., Lu, W.-J., Su, X.-G., & Kuang, J.-F. (2021). Postharvest application of glycine betaine ameliorates chilling injury in cold-stored banana fruit by enhancing antioxidant system. *Scientia Horticulturae*, *287*, 110264. https://doi.org/10.1016/j.scienta.2021.110264

Abstract

Chilling injury (CI) represents a physiological disorder caused by improper low temperature management, which affects the postharvest quality and marketing potential of banana fruit. In this study, postharvest application of glycine betaine (GB) can significantly reduce the CI incidence of banana fruit during cold storage, as observed by lower CI index, electrolyte leakage, malondialdehyde (MDA) contents, and higher values of lightness, chlorophyll, soluble sugar contents. Moreover, GB not only increased the antioxidant substances such as total phenolics, glutathione and ascorbic acids (AsA), but also elevated the enzyme activities and gene expression of the antioxidant enzymes including ascorbate peroxidase (APX), catalase (CAT), superoxide dismutase (SOD) and peroxidase (POD). In addition, GB could obviously enhance the total antioxidant capacity of banana fruit under refrigerated storage. Collectively, these findings suggest that GB-attenuated CI incidence in banana fruit during cold storage might be, at least partially, ascribed to the enhancement of the antioxidant system involving antioxidant substances, as well as enzyme activities and gene expression of antioxidant enzymes.
Keywords: /Glycine betaine/ /Banana fruit/ /Chilling injury/ /Antioxidant system/ /Refrigerated storage/

Liu, J., Liu, M., Jia, C., Zhang, J., Miao, H., Wang, J., Zhang, J., Wang, Z., Xu, B., Li, X., & Jin, Z. (2021). Elucidating the mechanism of MaGWD1-mediated starch degradation cooperatively regulated by MaMADS36 and MaMADS55 in banana. *Postharvest Biology & Technology*, *179*, 111587. https://doi.org/10.1016/j.postharvbio.2021.111587

Abstract

Banana (*Musa acuminata*) is a common starch-conversion fruit. Starch is rapidly degraded and converted to soluble sugars during postharvest banana fruit ripening. The conversion efficiency directly influences fruit firmness, sweetness, and shelf life. Glucan, water dikinase (GWD) is the first rate-limiting enzyme of starch metabolism. *Musa acuminata glucan water dikinase 1* (*MaGWD1*) plays an important role in banana starch metabolism and its expression is regulated by transcription factors (TFs). However, the regulation of *MaGWD1* by MADS-box TFs remains unclear. In this study, the molecular mechanism underlying the cooperative regulation of *MaGWD*1-mediated starch degradation by MaMADS36 and MaMADS55 was investigated. The results indicated that MaMADS36 interacts with MaMADS55. Both MaMADS36 and MaMADS55 could directly bind to the same position on the CA/T(r)G box within the *MaGWD1* promoter. MaMADS36 and MaMADS55 cooperatively regulate banana fruit starch degradation via transcriptional control of *MaGWD1.*These findings improve our understanding of how TFs regulate starch degradation; this information may be used for banana fruit quality improvement and to support the

development of the banana industry.

Keywords: /Banana (*Musa acuminata*)/ /MADS-box/ /*MaGWD1/* /Starch degradation/ /Transcriptional regulation/

Nguyen, T., Nguyen, T., Pham, B., Tran, T., Bach, L., Thi, P., & Thuc, C.N. (2021). Development of poly (vinyl alcohol)/agar/maltodextrin coating containing silver nanoparticles for banana (Musa acuminate) preservation. *Food Packaging and Shelf Life, 29*, 100740. https://doi.org/10.1016/j.fpsl.2021.100740

Abstract

Banana (Musa acuminate), a popular and abundant agricultural product in Viet Nam supplying for domestic consumption and the export to other countries, is rich in health-beneficial nutrients and minerals. However, banana is potentially susceptible to physical and biological deterioration resulting in remarkable postharvest losses during transportation and storage. Herein, the active nanocomposite coating based on polymeric blend of poly (vinyl alcohol) (PVOH), agar, and maltodextrin incorporated with silver nanoparticles (AgNPs) was applied to prolong the shelf life of banana through the pressurized spraying method. The bananas with and without coating were kept stable at 25 ℃ for 5 days. Changes in appearance and physicochemical properties including colour, respiration rate, weight loss, firmness, titratable acidity, total soluble sugar, total soluble sugar, and solution pH in fruits were also evaluated during storage. The results showed that such nanocomposite coatings may delay the banana ripening and extend the shelf life of banana for 5 days at 25 ℃. The PVOH/agar/maltodextrin/AgNPs nanocomposite coating around the fruits may act as physical barrier resulting in slow decrease in respiration rate, weight loss, softening, titratable acidity, total soluble sugar, and maintaining good appearance of banana (Musa acuminate) as compared to uncoated fruits and those coated with PVOH/agar/maltodextrin during storage period. Furthermore, the results also revealed nanocomposite films prepared from coating solution offered excellent bacterial inhibitory against Escherichia coli and Staphylococcus aureus, an important merit for food packaging application. Moreover, the addition of AgNPs also remarkably increased the flexibility and plasticity of nanocomposite film as compared to PVOH/agar/maltodextrin film. Briefly, the utilization of active nanocomposite coating from PVOH, agar, maltodextrin, and AgNPs could be considered as an additional approach for protecting banana (Musa acuminate) from physical and biological deterioration during storage and transportation.

Keywords: /Active nanocomposite coating/ /Banana preservation/ /Crosslinked poly (vinyl alcohol)/ /Post-harvest agri-products/ /Silver nanoparticles/

Wang, Z., Pu, H., Shan, S., Zhang, P., Li, J., Song, H., & Xu, X. (2021). Melatonin enhanced chilling tolerance and alleviated peel browning of banana fruit under low temperature storage. *Postharvest Biology & Technology*, *179*, 111571. https://doi.org/10.1016/j.postharvbio.2021.111571

Abstract

The effect of melatonin on chilling injury of banana fruit was investigated. Results showed that melatonin treatment delayed chilling injury and alleviated peel browning. Melatonin treatment increased the contents of phospholipids and unsaturated fatty acid, induced the reactive oxygen species (ROS) scavenging enzyme activities, and reduced the contents of H_2O_2, O_2– ·of banana fruit. It also induced the miR528 expression, resulting in the down expression of the potential target genes of *MaPPO1*, *MaPPO2* and *MaPPO3*, and inhibited the PPO activities. Moreover, the phenolic compounds in melatonin treated banana fruit peel were quantitatively analyzed by liquid chromatography-tandem mass spectrometry (UPLC-MS/MS). The results indicated that melatonin treatment changed the contents of 63 polyphenolics in banana fruit, and was involved in delaying chilling injury and alleviating peel browning. In conclusion, melatonin treatment is a potential technique in alleviating chilling injury of banana fruit under low temperature storage.

Keywords: /Banana/ /Chilling injury/ /Peel browning/ /Melatonin/

Wantat, A., Rojsitthisak, P., & Seraypheap, K. (2021). Inhibitory effects of high molecular weight chitosan coating on 'Hom Thong' banana fruit softening. *Food Packaging and Shelf Life, 29*, 100731. https://doi.org/10.1016/j.fpsl.2021.100731

Abstract

This study was undertaken to examine the effects of different molecular weights of 1% (w/v) chitosan coating on physicochemical characteristics and softening of 'Hom Thong' banana. The results indicated that high and medium molecular weights of chitosan coating (HMW-CTS; 540 kDa and MMW-CTS; 265 kDa) maintained banana fruit qualities during 25 °C storage compared to a low molecular weight of chitosan coating (LMW-CTS; 65 kDa) and control treatments. HMW-CTS expressed the highest ability to reduce respiration rate and ethylene production of the fruit and preserved fruit firmness by inhibiting cell wall degrading enzymes including polygalacturonase and pectate lyase activities which play an important role in pectin degradation. Additionally, HMW-CTS influenced a decrease in disease severity and cell membrane injury in relation to low malondialdehyde content and high antioxidant activities of coated fruit. The overall results suggest that HMW-CTS is a promising postharvest chitosan coating in maintaining fruit firmness and extending the shelf life of 'Hom Thong' banana fruit after harvest.

Keywords: /Fruit firmness/ /Shelf-life/ /Cell wall degrading enzyme/ /Pectin/ /Antioxidant activity/

BLACKBERRY

Heras-Mozos, R., Gavara, R., & Hernández-Muñoz, P. (2021). Development of antifungal biopolymers based on dynamic imines as responsive release systems for the postharvest preservation of blackberry fruit. *Food Chemistry*, *357*, 129838. https://doi.org/10.1016/j.foodchem.2021.129838

Abstract

Antifungal release systems based on reversible covalent chemistry were created. Active aldehydes were grafted to chitosan films via Schiff base formation. Aldehydes remained stable until hydrolysis of imine bonds favoured by acid medium. Responsive device extended the microbiological shelf-life of packaged blackberry fruit. This study describes the synthesis and reversibility of Schiff bases from chitosan and bioactive compounds, and their application in the antifungal packaging of fruit. Imine bonds between primary amine groups of chitosan and carbonyl groups of antifungal aldehydes were synthesised and their reversibility was assayed in an aqueous medium under different acidic conditions. The mechanism of action of the dynamers is based on the hydrolysis of an imine bond and the release of the active agent. The new films were effective at inhibiting the growth of Penicillium expansum and Botrytis cinerea , and their effectiveness depended on the degree of hydrolysis achieved which was greater when the bonds were hydrolysed in a mild acidic medium. A double bottom cylindrical tray was used for the responsive antimicrobial packaging of blackberries. The package extended the shelf-life of berries from 3 to 12 days without causing phytotoxic effects on the fruit being safe for human consumption.

Keywords: /Antifungal packaging/ Blackberries/ /Chitosan/ /Imine hydrolysis/ /Perillaldehyde/ /Reversible covalent bond/ /Schiff base/ /Trans-2-hexenal/

BLUEBERRY

Abeli, P. J., Fanning, P. D., Isaacs, R., & Beaudry, R. M. (2021). Blueberry fruit quality and control of blueberry maggot (Rhagoletis mendax Curran) larvae after fumigation with sulfur dioxide. *Postharvest Biology & Technology*, *179*, 111568. https://doi.org/10.1016/j.postharvbio.2021.111568

Abstract

Postharvest fumigation of fruits and vegetables is an important tool for managing pests and diseases that can cause devastating loss if not properly controlled. Sulfur dioxide (SO_2) may have promise as a replacement for methyl bromide, which is expected to be phased out. However, SO_2 is known to cause injury to small fruit such as table grapes (*Vitis vinifera* L.). We extend previous research on SO_2 fumigation by focusing on an economically important fruit pest genus and through quantitative and qualitative measurements of highbush blueberry (*Vaccinium corymbosum* L.) fruit bleaching. This study assesses fruit damage due to SO_2 fumigation at concentrations ranging 0–2.2 % (v/v) as well as the effectiveness of SO_2 as a fumigant prior to cold storage for control of blueberry maggot, *Rhagoletis mendax* Curran. We show that fruit quality traits such as firmness, total soluble solid content, and titratable acidity are largely unaffected except at the highest SO_2 concentration (2.2 %). SO_2 caused bleaching and discoloration of blueberry fruit in a dose-dependent manner. Damage was also cultivar-dependent, with cv 'Bluecrop', and 'Jersey' more susceptible than 'Draper', 'Elliott', and 'Liberty'. We show that *R. mendax* can be effectively controlled using a short-term (2 h), high concentration (22,000 μL L^{-1}) SO_2 fumigation followed by >14 d of cold storage at 0.5 °C. However, this treatment for control of *R. mendax* would likely result in damage, affecting fruit marketability.

Keywords: /Vacuum/ /Hypobaric/ /Fruit fly/ /Tephritid/ /Bleaching/

Bell, S. R., Hernández Montiel, L. G., González Estrada, R. R., & Gutiérrez Martínez, P. (2021). Main diseases in postharvest blueberries, conventional and eco-friendly control methods: A review. *LWT - Food Science & Technology*, *149*, 112046. https://doi.org/10.1016/j.lwt.2021.112046

Blueberry (Vaccinium corymbosum) is a very attractive crop mainly for its antioxidant and anti-inflammatory properties. Nevertheless, it is susceptible to different postharvest diseases such as gray mold and anthracnose caused mainly by fungi and bacteria. In this regard, different control methods of chemical nature, physical and biological origin are applied to these fruits to prevent and decrease these diseases. Synthetic fungicides are the main control method, however, they can cause harm to human health and the environment. Therefore, other methods have been studied such as modified atmospheres, UV radiation, and natural origin compounds such as chitosan and essential oils extracted from plants with antimicrobial properties, as well as microbial antagonists (bacteria, fungus, and yeast). Hence, the objective of this review is to analyze the main pathogens that attack blueberry fruits during the postharvest period, and to address the different control methods applied, their possible mechanisms of action and their impact on fruit quality. Fungicides are the main method for controlling diseases causing damage to health and the environment. Eco-friendly methods are promising alternatives for postharvest disease management. Management of postharvest diseases of blueberries can prevent large economical losses.

Keywords: /Blueberry/ /Eco-friendly alternatives/ /Pathogens/ /Postharvest/ /Traditional control/

Hu, X., Sun, H., Yang, X., Cui, D., Wang, Y., Zhuang, J., Wang, X., Ma, R., & Jiao, Z. (2021). Potential use of atmospheric cold plasma for postharvest preservation of blueberries. *Postharvest Biology & Technology*, *179*, 111564. https://doi.org/10.1016/j.postharvbio.2021.111564

Abstract

Blueberry is one of the major health foods, which is susceptible to microbial contamination during the postharvest storage period. More seriously, the gray mold caused by *Botrytis cinerea* (*B. cinerea*) is a major postharvest disease of blueberries. Atmospheric cold plasma (ACP) holds a great potential as an efficient, economical and eco friendly method for food sterilization. Herein, this study investigated the effects of ACP treatment with different time (0, 5, 10, 15 and 20 min) on the natural decay, gray mold decay caused by *B. cinerea*, and postharvest quality of blueberries (*Vaccinium corymbosum* L.) during 10-d storage at 25 ± 2 °C. The results showed that ACP treatment inhibited the native microbial growth and natural decay of blueberries during the storage period. Meanwhile, ACP treatment also exhibited marked inhibitory effects on the spore germination and mycelial growth of *B. cinerea in vitro*, and gray mold decay in blueberries inoculated with *B. cinerea* during the postharvest storage. For the postharvest quality, the short-time ACP treatment (≤ 15 min) had minor effects on the firmness, pH, ORP and anthocyanin concentration, but darkened the color and decreased lipid peroxidation, which overall improved the postharvest quality. However, 20-min ACP treatment caused severe oxidative damage to the blueberry peels, resulting in the fruit softening and anthocyanin decrease. Taken together, these results indicate that the short-time ACP treatment may be a promising candidate for the postharvest preservation of blueberries by trading-off between the microbial decay and postharvest quality.

Keywords: /Atmospheric cold plasma/ /Blueberry/ /Microbial decay/ /*Botrytis cinerea/ /*Gray mold/ /Postharvest quality/

Ktenioudaki, A., O'Donnell, C. P., Emond, J. P., & do Nascimento Nunes, M. C. (2021). Blueberry supply chain: Critical steps impacting fruit quality and application of a boosted regression tree model to predict weight loss. *Postharvest Biology & Technology*, *179*, 111590. https://doi.org/10.1016/j.postharvbio.2021.111590

Abstract

Blueberries have increased in popularity in recent years due to their nutritional benefits and sensory characteristics. However, to preserve quality and extend shelf-life, they need to be maintained at refrigerated temperatures and high relative humidity, conditions that are not routinely met along the supply chain. Poor temperature management leads to quality deterioration, increasing waste/losses along the supply chain. This study examined the impact of each step along the supply chain on the physicochemical quality and shelf-life of blueberries, identifying the most critical steps from field to consumption. The following steps were identified as critical in the blueberry supply chain: shipping to distribution centre (DC) (72 h at 5 °C), store display (48 h at 15 °C), and consumer (48 h at 20 °C). Given the economic importance of weight loss and its link to fruit quality and shelf-life, a boosted regression tree (BRT) model was built to predict weight loss using the post-harvest environmental conditions of a simulated supply chain applying different temperature-time scenarios. The model explained 84 % of the variance on the test set and highlighted the interactions of supply chain conditions on weight loss.

Keywords: /Cold chain/ /Shelf-life/ /Machine learning/ /Biochemical properties/ /Post-harvest storage/

Lu, J., Li, T., Ma, L., Li, S., Jiang, W., Qin, W., Li, S., Li, Q., Zhang, Z., & Wu, H. (2021). Optimization of heat-sealing properties for antimicrobial soybean protein isolate film incorporating diatomite/thymol complex and its application on blueberry packaging. *Food Packaging and Shelf Life, 29*, 100690. https://doi.org/10.1016/j.fpsl.2021.100690

Abstract

Heat-sealing parameters of the as-prepared antimicrobial soybean protein isolate (SPI) film incorporating diatomite/thymol complex (S/D/T film) were optimized using single factor experiment and response surface methodology, and further used to seal the films into packaging bags to preserve blueberries at

25 °C and 70 % relative humidity. The S/D/T film had a maximum sealing strength of 2.41 N/15 mm at the optimized sealing conditions of 139.5 °C, 2.5 s and 0.48 MPa due to the strong physical intermolecular interaction induced upon heat-sealing areas as confirmed by FT-IR and SEM. Moreover, the S/D/T film could effectively delay the deterioration in blueberry quality during 5 days of storage, exhibiting a better fresh-keeping effect than other groups. Additionally, all films were completely biodegraded in soil within 8 days. In summary, the developed antimicrobial protein films with improved heat-sealing ability and excellent biodegradability can provide a promising alternative to nondegradable synthetic materials in active packaging.

Keywords: /Active packaging/ /Protein/ /Sealing strength/ /Biodegradability/

CUCUMBER

Cid-López, M. L., Soriano-Melgar, L. de A. A., García-González, A., Cortéz-Mazatán, G., Mendoza-Mendoza, E., Rivera-Cabrera, F., & Peralta-Rodríguez, R. D. (2021). The benefits of adding calcium oxide nanoparticles to biocompatible polymeric coatings during cucumber fruits postharvest storage. *Scientia Horticulturae*, *287*, 110285. https://doi.org/10.1016/j.scienta.2021.110285

Abstract

CaO NP/coatings application has an alternative to postharvest treatment for cucumbers. CaO NP/coatings provided greater luminosity and reduced weight loss. CaO NP/coatings do not affect physicochemical properties. The purchase attractiveness of cucumbers is unaffected by the CaO-NP/coatings. CaO NP addition modified the P(VAc-co-VA) latex properties. Cucumber fruit commercialization is of great economic national, and global importance; however, this product suffers substantial postharvest losses, mainly due to poor and inadequate transport, handling, and postharvest storage. In this study, the application of poly(vinyl acetate–co–vinyl alcohol), P(VAc-co-VA), latex coatings added with calcium oxide (CaO) nanoparticles (NP) that have demonstrated antimicrobial activity, is reported. The experiment consisted of two controls [Control (no latex coating) and latex coating without NP], as well as the latex coatings added with CaO NP at 50, 100, and 150 mg· L −1. Cucumber fruits were grown ad hoc, monitoring the cultivation with corresponding cultural activities for this experiment and, once harvested, undamaged and malformation-free fruits were selected. Treatments were applied during the day of harvest and inside a cold chamber at 10 °C, where the fruits were stored. The visual quality of the fruits as well as their physical and chemical parameters were determined during the storage period every three days. The results indicated that CaO NP coatings provided positive effects on the appearance, visual quality, pigments, and antioxidants contents of the fruits in the applied concentrations (50, 100, and 150 mg· L −1). These changes allowed maintaining the quality properties of cucumbers during storage, extending the shelf-life up to 24 days postharvest. Thus, the P(VAc-co-VA) coating added with calcium oxide NP represents an alternative to postharvest treatment for cucumbers, providing higher luminosity and better visual quality, which is the main factor influencing the purchase and consumption of fruit products.

Keywords: /Antioxidants/ /C. sativus/ /Latex/ /Phenolic compounds/ /Shelf-life/ /Visual appearance/

BROCCOLI

Aghdam, M. S., & Flores, F. B. (2021). Employing phytosulfokine α (PSKα) for delaying broccoli florets yellowing during cold storage. *Food Chemistry*, *355*, 129626. https://doi.org/10.1016/j.foodchem.2021.129626

Abstract

The yellowing of florets limits the economic and nutritional value of broccoli during postharvest. We investigated mechanisms of action of 150 nM phytosulfokine α (PSKα) for delaying florets yellowing in broccoli during cold storage. Our results showed that SUMO E3 ligase (SIZ1) gene expression was higher in florets treated with PSKα, which may prevent endogenous H_2O_2 accumulation, resulting from the higher activity of superoxide dismutase, catalase, ascorbate peroxidase, and glutathione reductase. Besides, higher expression of methionine sulfoxide reductase and cysteine peroxiredoxin genes, concomitant with higher expression of heat shock proteins 70/90 genes, may arise from higher expression of SIZ1 gene. Lower expression and activity of phospholipase D and lipoxygenase may be liable for membrane integrity protection featured by lower malondialdehyde accumulation in florets treated with PSKα. Additionally,florets treated with PSKα exhibited higher endogenous cytokinin accumulation which may arise from higher expression of isopentenyl transferase gene, concomitant with lower expression of cytokinin oxidase gene.

Keywords: /Broccoli yellowing/ /Cytokinin oxidase/ /Heat shock proteins/ /Isopentenyl transferase/ /Methionine sulfoxide reductase/ /SUMO E3 ligase SIZ1/

Huang, H., Wang, D., Belwal, T., Dong, L., Lu, L., Zou, Y., Li, L., Xu, Y., & Luo, Z. (2021). A novel W/O/W double emulsion co-delivering brassinolide and cinnamon essential oil delayed the senescence of broccoli via regulating chlorophyll degradation and energy metabolism. *Food Chemistry*, *356*, 129704. https://doi.org/10.1016/j.foodchem.2021.129704

Abstract

The postharvest senescence accompanied by yellowing limited the shelf-life of broccoli. In this study, we developed a novel W/O/W double emulsion co-delivering brassinolide and cinnamon essential oil and applied it to broccoli for preservation. Results showed that double emulsion prepared by whey protein concentrate-high methoxyl pectin (1:3) exhibited best storage stability with largest particle size (581.30 nm), lowest PDI (0.23) and zeta potential (-40.31 mV). This double emulsion also exhibited the highest encapsulation efficiency of brassinolide (92%) and cinnamon essential oil (88%). The broccoli coated with double emulsion maintained higher chlorophyll contents and activities of chlorophyllase and magnesium-dechelatase were reduced by 9% and 24%, respectively. The energy metabolic enzymes (SDH, CCO, H^+-ATPase, Ca^{2+}-ATPase) were also activated, inducing higher levels of ATP and energy charge. These results demonstrated W/O/W double emulsion co-delivering brassinolide and cinnamon essentially delayed the senescence of broccoli via regulating chlorophyll degradation and energy metabolism.

Keywords: /Broccoli/ /Shelf-life/ /Brassinolide/ / Cinnamon essential oil/ Storage/

CARROT

Deng, L., Li, J., & Han, Z. (2021). Online defect detection and automatic grading of carrots using computer vision combined with deep learning methods. *LWT - Food Science & Technology*, *149*, 111832. https://doi.org/10.1016/j.lwt.2021.111832

Abstract

The demand for smart automatic systems in postharvest technology, particularly in the postharvest of carrot production is high. In this paper, an automatic carrot grading system was developed based on computer vision and deep learning, which can automatically inspect surface quality of carrots and grade washed carrots. Specifically, based on ShuffleNet and transfer learning, a lightweight deep learning model (CDDNet) was constructed to detect surface defects of carrots. Carrot grading methods were also proposed based on minimum bounding rectangle (MBR) fitting and convex polygon approximation.

Experimental results showed that the detection accuracy of the proposed CDDNet was 99.82% for binary classification (normal and defective) and 93.01% for multi-class classification (normal, bad spot, abnormity, fibrous root), and demonstrated good performance both in time efficiency and detection accuracy. The grading accuracy of MBR fitting and convex polygon approximation was 92.8% and 95.1% respectively. This research provides a practical method for online defect detection and carrot grading, and has great application potential in commercial packing lines. Mechanical machinery was constructed for carrot quality inspection and grading. A lightweight network (CDDNet) was developed for carrot defect detection. Propose new grading method based on MBR fitting and convex polygon approximation.

Keywords: /Carrot grading/ /CDDNet/ /Computer vision/ /Deep learning/ /Defect detection/

CITRUS

Hee, I., Ye, B., Kim, E., & Min S. (2021). Preservation of mandarins using a microbial decontamination system integrating calcium oxide solution washing, modified atmosphere packaging, and dielectric barrier discharge cold plasma treatment. Food Packaging and Shelf Life, 29, 100682. https://doi.org/10.1016/j.fpsl.2021.100682

Abstract

A new microbial decontamination system integrating with calcium oxide solution washing (CaOW), packaging in modified atmosphere (MAP), and treatment with dielectric barrier discharge cold plasma (CPT) was developed and its effects on mandarin storability were investigated. CPT was applied for 2 min at 27 kV to mandarins, formerly prepared with and without CaOW for 3 min and packaged with air or O2-CO2-N2 (9.9, 2.1, and 88.0%, respectively). CaOW-CPT effectively retarded the decrease in the ascorbic acid concentration and antioxidant capacity of mandarin flesh at 4 °C and 25 °C, and its total phenolic content (TPC) at 25 °C. Modified atmosphere more effectively delayed the increase in the concentration of CO2, generated by mandarins at 4 °C and 25 °C and the decrease in flesh TPC at 4 °C than air-packaging ($p < 0.05$). Both CaOW and MAP increased the efficiency of CPT in inhibiting *Penicillium digitatum* growth, immediately after treatment and during storage at 25 °C. The microbial decontamination system integrating CaOW, MAP, and CPT effectively retarded the decrease in ascorbic acid concentration and antioxidant activity of the flesh during storage at 4 °C and 25 °C, without influencing the pH and color of mandarins at both temperatures. This study demonstrated the technological potential of the microbial decontamination system combining CaOW, MAP, and CPT for extending the shelf life of mandarins.

Keywords: /Mandarin/ /Cold plasma/ /Calcium oxide/ /Modified atmospheric packaging/ /In-package treatment/ /*Penicillium digitatum*/

Jayasekara, A., Abeywickrama, K., Daranagama, A., & Kodituwakku, T. (2021). Physiological disorders of selected Citrus fruit species in Sri Lanka and their effect on fruit quality. *Journal of Horticulture and Postharvest Research, 4(3)*, 385-398. Doi: 10.22077/JHPR.2021.4250.1201

Abstract

Purpose: This study was conducted to identify the physiological disorders and their symptoms of selected *Citrus* fruit species (*C. sinensis*, *C. limon* and *C. crenatifolia*). Furthermore, it was aimed to determine whether physicochemical and sensory properties were affected by physiological disorders. Research method: *Citrus* fruits with physiological disorders were observed separately for visible changes and characters were recorded and photographed. Moreover, *Citrus* fruits with physiological disorders were analyzed for physicochemical and sensory properties. Findings: Many physiological disorders were recorded from three *Citrus* fruit species including chilling injury, sunburn, stem-end rind breakdown, oleocellosis, rind disorder, puff and crease, granulation, wind injury, peteca, fruit splitting and fruit cracking. Based on the overall result of sensory analysis, it can be concluded that most of the

physiological disorders in studied *Citrus* species appear on the peel but not adversely affect the edible internal portion of the fruits. Physicochemical properties of *C. limon* are not adversely affected by physiological disorders whereas *C. sinensis* and *C. crenatifolia* are affected by physiological disorders. Limitations: Availability of selected *Citrus* fruit species throughout the year is limited due to their seasonality. Originality/Value: This study provides novel information about the physiological disorders of some *Citrus* species in Sri Lanka and other parts of Asia and a future potential exists in controlling these disorders to provide healthy and quality fruits to the market.

Keywords: /Disorder symptoms/ / Physicochemical properties/ / Postharvest loss/ / Sensory properties/

Mayoussi, B., Zahir, H., Ellouali, M., Boubaker, H. & Latrache, H. (2021). Adhesion of Penicillium italicum and Penicillium digitatum spores to materials commonly used in the citrus packaging chain. Journal of Horticulture and Postharvest Research, *4(3),* 323-332 . Doi: 10.22077/JHPR.2021.3609.1159

Abstract

The purpose of this study was to investigate the adhesion of *Penicillium italicum* and *Penicillium digitatum* spores on four materials commonly used in the citrus packaging chain (plastic, PVC, stainless steel, 316L and wood). The physicochemical characterization of spores and material surfaces was carried out using the contact angle method. The number of adhered spores was estimated after being detached from supports in an ultrasonic bath. The results showed that all citrus materials processes were classified as hydrophobic except for the wood packaging. Surface spores of *P. digitatum* presented a relatively hydrophobic character, and surface spores of *P. italicum* presented a hydrophilic character. Both of the spores and all materials presented high electron donor/acceptor characters. The results showed that *P. digitatum* and *P. italicum* sporescould adhere to all the studied substrates. Furthermore, the highest adhesion was observed by *P. italicum* and *P. digitatum* spores on wood packaging (58 Î 106 CFU/cm2) and (45 Î 106 CFU/cm2), respectively. The wood packaging was the least hygienic material concerning the adhesion ability of *P. digitatum a*nd *P. italicum* spores, followed by plastic packaging, PVC, and 316 L stainless steel. A correlation between substratum physicochemical properties and spore adhesion was also examined, while a good correlation was observed between spore adhesion and donor electron character. There were no limitations to this study. This research studied the adhesion of spores on materials commonly used in the citrus packaging chain.

Keywords: /Adhesion/ / Citrus packaging materials/ /pores/

FRUITS AND VEGETABLES

He, X., Li, M., Gong, X., Niu, B., & Li, W. (2021) Biodegradable and antimicrobial CSC films containing cinnamon essential oil for preservation applications. *Food Packaging and Shelf Life*, *29*, 100697. https://doi.org/10.1016/j.fpsl.2021.100697

Abstract

The degradable antibacterial film (CSC) was prepared by overcoating method using chitosan as the outer layer and the mixture of sodium alginate and the amphiphilic starch encapsulated anti-bacterial cinnamon essential oil (CMS-LS-CO) as the intermediate layer, which was used in place of polyethylene film. The surface structural, biodegradability, mechanical, transmittance, antibacterial and preservation properties of the CSC films were investigated, considering the effects of CMS-LS-CO concentration. As the addition of CMS-LS-CO at 0.25, 0.5 and 1 % increased, TS and elongation at break of CSC films decreased and the water vapor permeability had little change. When CMS-LS-CO was added at 0.5 %, CSC films achieved better preservation and mechanical properties, at the same time, the inhibition rates of *E. coli* and *S. aureus* were 36 % and 30 %, respectively. The preservation experiment on cherry tomatoes showed that the CSC films exhibited a certain freshness effect, which maintained higher hardness and

lower weight loss rate within two weeks than polyethylene films. The nature degradation of the films showed that the soil biodegradability rate reached 70 % in 28 days. Compared to polyethylene films, the degradable CSC films had excellent antimicrobial activity and preservation properties, showing higher potential for fruit preservation applications.

Keywords: /Antibacterial film/ /Biodegradable film/ /Cinnamon essential oil/ /Preservation performance/

Sohail, M., Wills, B.H., Bowyer, M.C., & Pristijino, Pento. (2021). Impact of exogenous arginine, cysteine and methionine on the postharvest senescence of six green leafy vegetables. *Journal of Horticulture and Postharvest Research, 4(3),* 253-262. Doi: 10.22077/JHPR.2020.3844.1180

Abstract

Purpose: This study examined the efficacy of aqueous dips containing the amino acids, L-arginine, L-cysteine and L-methionine, to inhibit the senescence of six leafy green vegetables pak choy, coriander, choy sum, spinach, parsley and rocket. Research method: Pak choy was dipped in amino acid solutions from 2-100 mM to determine the optimum concentration that inhibited senescence. The other vegetables were dipped in solutions with the optimal concentration. Senescence of the vegetables was assessed during storage at 10 °C in air containing 0.1 µL L1 ethylene by determining loss of green colour (designated as green life), ethylene production and respiration rates. Findings: For each amino acid, a dipping concentration of 5 mM was found optimal to inhibit senescence as shown by an extended green life and reduced ethylene production and respiration rates of all vegetables to a similar extent, except methionine which did not show a significant effect with rocket, and for spinach only reduced ethylene production. Limitations: No limitations were encountered. Originality/Value: Arginine and cysteine showed considerable potential for commercial use to extend the market life of many green vegetables and with their Generally Recognized As Safe (GRAS) status the amino acids should be a safe, consumer-acceptable treatment.

Keywords: /Ethylene/ / Green colour/ /Market life/ /Respiration/

Sun, Q., He, Y., Ye, J., Zheng, X., Zhou, C., Fu, A., Wei, R., Yin, Y., Chai, L., Xu, Q., Cheng, Y., & Deng, X. (2021). Storage with apple fruit to improve peel color and maintain freshness of Newhall navel orange. *Scientia Horticulturae*, *287*, 110246. https://doi.org/10.1016/j.scienta.2021.110246

Abstract

A novel biological postharvest treatment by staying with apple (SWA) is proposed. SWA treatment promotes peel coloration and maintains fruit freshness. SWA treatment has similar effects to ethylene treatment on citrus peel coloration. SWA treatment significantly alleviates calyx senescence caused by ethylene treatment. A novel biological treatment of staying with commercially mature apple fruits was proposed to promote the peel coloration of 'Newhall' navel orange fruit (Citrus sinensis Osbeck), which could conduce to the formation of uniform orange red peel color. At 15 days after treatment (DAT), the staying with apple (SWA) treatment led to a nearly 4-fold increase in the total carotenoid content compared with the control. Specifically, the red color apocarotenoid β-citraurin showed the highest degree of enhancement (~6 fold) under SWA treatment. Simultaneously, the expression level of β-citraurin biosynthetic gene carotenoid cleavage dioxygenase 4b (CCD4b) was dramatically induced (about 35 folds). Furthermore, SWA had the same effect of promoting coloration and obviously alleviated calyx senescence of citrus fruit compared with ethylene treatment. In conclusion, SWA treatment is a potential environment-friendly and recyclable postharvest technology to improve peel color and maintain fruit freshness for citrus.

Keywords: /'Newhall' navel orange/ /Calyx senescence/ /Carotenoid/ /Peel coloration/ /Postharvest/ /Staying with apple/

Yang, H., Mei, W., Wan, H., Xu, R., & Cheng, Y. (2021). Comprehensive analysis of KCS gene family in Citrinae reveals the involvement of CsKCS2 and CsKCS11 in fruit cuticular wax synthesis at ripening. *Plant Science : An International Journal of Experimental Plant Biology*, *310*, 110972. https://doi.org/10.1016/j.plantsci.2021.110972

Abstract

Cuticular wax covers the surface of fleshy fruit and plays a protective role in fruit development and postharvest storage, including reducing fruit water loss, resisting biotic and abiotic stress and affecting fruit glossiness. The β-ketoacyl-CoA synthase (KCS) is the rate-limiting enzyme of very long chain fatty acids (VLCFAs) synthesis, which provides precursors for the synthesis of cuticular wax. In this study, a total of 96 KCS genes were identified in six Citrinae species, including 13, 16, 21, 14, 16 and 16 KCS genes in the primitive species (Atalantia buxifolia), the wild species (Citrus ichangensis), and four cultivated species (Citrus medica, Citrus grandis, Citrus sinensis and Citrus clementina), respectively. Compared with primitive species, wild and cultivated species showed expansion of the KCS gene family. Evolutionary analysis of the KCS gene family indicated that uneven gain and loss of genes resulted in variable numbers of KCS genes in Citrinae, and KCS genes have undergone purifying selection. Expression profiles in C. sinensis revealed that the KCS genes had diverse expression patterns among various tissues. Furthermore, CsKCS2 and CsKCS11 were predominantly expressed in the flavedo and their expression increased sharply with ripening. Subcellular localization analysis indicated that CsKCS2 and CsKCS11 were located in the endoplasmic reticulum. Further, heterologous expression of CsKCS2 and CsKCS11 in Arabidopsis significantly increased the content of cuticular wax in leaves. Thus, CsKCS2 and CsKCS11 are involved in the accumulation of fruit cuticular wax at ripe

Keywords: /Citrinae/ /Very long chain fatty acids (VLCFAs)/ /Wax; β-ketoacyl-CoA synthase/

KIWI FRUIT

Wang, H., Wang, J., Mujumdar, A. S., Jin, X., Liu, Z.-L., Zhang, Y., & Xiao, H.-W. (2021). Effects of postharvest ripening on physicochemical properties, microstructure, cell wall polysaccharides contents (pectin, hemicellulose, cellulose) and nanostructure of kiwifruit (Actinidia deliciosa). *Food Hydrocolloids*, *118*, 106808. https://doi.org/10.1016/j.foodhyd.2021.106808

Abstract

Kiwifruit undergoes rapid softening and quality changes after harvest, which has an important impact on consumer appeal, shelf life and market value. Effects of postharvest ripeness on physicochemical properties, microstructure, cell wall fraction (pectin, hemicellulose and cellulose) contents and nanostructure, and pectin molecular weight were investigated. As the postharvest time increased from 0 to 6 days, the contents of total soluble solid and water-soluble pectin increased by 77.4% and 113.0%, respectively; while the content of starch, water insoluble pectin, and hemicellulose decreased by 89.9%, 46.5%, and 33.5%, respectively. Disappearance of starch granules and the increase of intercellular space were observed using SEM. AFM analysis showed that both hemicellulose and pectin depolymerized gradually during storage. Measurements of the molecular weight confirmed the occurrence of depolymerization and degradation of pectin, while the cellulose content, nanostructure, and diameter of individual microfibrils did not change significantly. The findings in current work revealed the quality evolution and related mechanism of kiwifruit during storage. Post-ripening process affected physicochemical properties and texture. Cell wall structure destruction and starch hydrolysis led to the softening.Nanostructure of pectin, hemicellulose and cellulose were characterized by AFM. The micromorphology of hemicellulose changed and its molecules and node height decreased. Molecular weight of pectin and microstructure were used to explore quality changes.

Keywords: /Cell wall polysaccharide nanostructure/ /Kiwifruit/ /Microstructure/ /Pectin molecular weight/ /Post-ripening/

Zhang, Y., Wang, K., Xiao, X., Cao, S., Chen, W., Yang, Z., & Shi, L. (2021). Effect of 1-MCP on the regulation processes involved in ascorbate metabolism in kiwifruit. *Postharvest Biology & Technology*, *179*, 111563. https://doi.org/10.1016/j.postharvbio.2021.111563

Abstract

This research was conducted to investigate the mechanism of 1-methylcyclopropene (1-MCP) treatment on ascorbic acid (AsA) content in kiwifruit after harvest. Our findings indicated that 1-MCP treatment postponed the course of fruit senescence and maintained higher contents of AsA and total ascorbic acid (T-AsA) during storage in postharvest kiwifruit. Gene expression analysis revealed that the transcription level of genes involved in AsA metabolic pathways were regulated by 1-MCP treatment. The up-regulation of genes for AsA biosynthesis (*AdGME*, *AdGalDH*, *AdGalLDH* and *AdGalUR*) and regeneration (*AdDHAR* and *AdGR*) and down-regulation of degradation genes (*AdAO*) collectively contributed to the increase in AsA level in treated kiwifruit during storage. Moreover, the expression level of four candidate bHLH transcription factors, preliminarily screened from the transcriptome database of kiwifruit, was up-regulated by 1-MCP treatment by qPCR analysis. Taken together, our results suggested that due to its positive regulation on numerous ascorbate modifying genes and probably the candidate bHLH transcription factors, 1-MCP had a beneficial effect on AsA content.

Keywords: /1-MCPAscorbic acid/ /Gene expression/ /Kiwifruit/

LOTUS

Sun, H., Liu, Y., Ma, J., Wang, Y., Song, H., Li, J., Deng, X., Yang, D., Liu, J., Zhang, M., Xiong, Y., & Yang, M. (2021). Transcriptome analysis provides strategies for postharvest lotus seeds preservation. *Postharvest Biology & Technology*, *179*, 111583. https://doi.org/10.1016/j.postharvbio.2021.111583

Abstract

The rapid deteriorative quality is a major factor that currently limits storage and transport of fresh lotus seeds. However, the physiological changes and molecular mechanisms of lotus seeds during postharvest storage remains poorly understood. Here, physiological and RNA-sequencing analyses were conducted on the postharvest seeds of seed-lotus cultivar ‘Jianxuan 17’. A rapid increase in starch and protein content was observed, while soluble sugar content was continuously decreased during postharvest storage, which could explain increased hardness and reduced sweetness of lotus seeds. Transcriptome analysis identified a total of 3148 differentially expressed genes (DEGs), and functional enrichment analysis showed six pathways that included starch and sucrose metabolism were commonly enriched in all comparison groups. Most DEGs involved in energy metabolic pathways, such as glycolysis and tricarboxylic acid cycle were down-regulated. Altered starch and soluble sugar contents were associated with significant changes in activity of enzymes involved in starch and sucrose metabolism. In addition, the content of plant hormones including, auxin (IAA), jasmonoyl-isoleucine (JA-Ile) and salicylic acid (SA), increased in lotus seeds during postharvest storage, and the activation of signaling transduction pathways were demonstrated at transcriptional level. These results provide not only a valuable gene expression dataset for investigating molecular mechanism underlying changes during postharvest storage, but also is a useful reference for developing further preservation technology of fresh lotus seeds.

Keywords: /Lotus seeds/ /Postharvest storage/ /RNA-sequencing/ /Differentially expressed gene/ /Molecular mechanism/

MULBERRY

Afsharnia, F., Ghasemi, Raeini, M.G.N., Barzegar, H. & Ghasemi, P. (2021). Texture estimation model for mulberry fruit from linear measurements*. Journal of Horticulture and Postharvest Research, 4(3), 263-276*. Doi: 10.22077/JHPR.2020.3658.1162

Abstract

The texture is an essential feature of the nutritional value of fruit and vegetables and plays a critical role in the acceptance and success of these products by the consumer. However, mechanical injuries cause softening and abrasion in the mulberry fruit tissue during harvesting, difficult to assess. The experiment was conducted to estimate the mulberry fruit texture model by linear measurements for several harvesting conditions. The mulberry may fall from the highest or middle branches or harvest by hand since three heights, including 0, 1.5, and 3 meters, were considered for both maturity stage, including purple and black stage, for dynamic loading experiments to measure texture in an orchard simulated ambiance. Mulberry fruits were stored at 3 °C for seven days. The abrasion area of mulberry fruit was determined by image analysis. Also, TA-XT PLUS Texture Analyzer (micro stable system, England) was used to perform the compression tests of mulberry fruits. Regression analysis of abrasion area versus practical factors (harvesting method, maturity stage, and storage time) was used to develop several models for assessing the area of fruit abrasion.The combined effect of hot water for 3 minutes with 3% citric acid resulted in better quality fruits (less mass loss, less degradation of soluble solids, organic acids, and vitamin C), in addition to delaying the development of browning pericarp and pulp until the sixth day of storage. Limitations: No limitations were found. These models promisingly and accurately estimate the abrasion area of fruit without applying any inaccurate procedures, e.g., using a caliper in many experimental comparisons.

Keywords: /Abrasion area/ / Firmness/ / Linear measurements/ / Mulberry/ /Post-harvest quality/

MUSHROOM

Zhao, X., Wang, Y., Zhang, Z., Sun, L., Wei, Y., Bao, X., & Xin, G. (2021). Postharvest short-time partial dehydration affects shiitake mushroom (Lentinus edodes) storage quality and umami taste. *Scientia Horticulturae, 287*, 110274. https://doi.org/10.1016/j.scienta.2021.110274

Abstract

The application of STPD treatment on mushrooms was investigated. The storage quality and umami taste in mushrooms were examined. STPD treatment decreased respiration and maintained a high firmness of mushroom. STPD-2 effectively delayed the browning of fresh mushrooms. Mushrooms treated with STPD-2 had a higher level of umami taste. The effects of short-time partial dehydration (STPD) on the quality of shiitake mushrooms were evaluated. Quality properties included respiration, texture, color and umami taste. Results showed that STPD treatment (STPD-2 and STPD-3) can slow down respiration rate and delay respiration peak, thus providing more than 7 days of storage time stored at 20 ± 1 °C. Mushrooms subjected to STPD-2 and STPD-3 treatments also maintained better firmness. The STPD-2 treatment effectively delayed the browning of fresh mushrooms. Compared to other groups, the content of flavor 5′-nucleotides and total 5′-nucleotides in STPD-2 and STPD-3 samples were higher, and STPD-2 samples had higher total amino acid content during storage. Higher equivalent umami concentration (EUC) values were found in STPD-2 sample (17.58 – 38.69 g MSG 100 g −1) compared to STPD-3 sample (13.80 – 27.51 g MSG 100 g −1) and STPD-1 sample (5.11 – 14.19 g MSG 100 g −1). Thus, it indicated that STPD-2 treatment could effectively preserve monosodium glutamate-like (MSG-like) components and nucleotides in mushrooms. Results suggested that STPD treatment, especially STPD-2, could maintain mushroom overall quality.

Keywords: /Browning/ /Respiration/ /Shiitake mushrooms/ /Short-time partial dehydration/ /Umami taste/

MUSKMELON

Li, Z., Xue, S., Xu, X., Wang, B., Zheng, X., Li, B., Xie, P., Bi, Y., & Prusky, D. (2021). Preharvest multiple sprays with chitosan accelerate the deposition of suberin poly phenolic at wound sites of harvested muskmelons. *Postharvest Biology & Technology*, *179*, 111565. https://doi.org/10.1016/j.postharvbio.2021.111565

Abstract

Suberin poly phenolic is an important component of healing tissue. We aimed to develop a new method to accelerate wound healing of harvested muskmelons. In this study, the plants and fruits of muskmelons were sprayed with 0.1 % chitosan four times during fruit development to evaluate the effect of chitosan treatment on wound healing of harvested muskmelons. The results showed that preharvest chitosan sprays reduced the weight loss and disease index of harvested muskmelons during healing. Chitosan sprays also accelerated the deposition of suberin poly phenolic at wound sites of harvested muskmelons during healing. The treatment increased the activities of phenylalanine ammonia-lyase and cinnamate-4-hydroxylase, and promoted the accumulation of cinnamic acid, caffeic acid, ferulic acid, *p*-coumaric acid, total phenols and flavonoids at wound sites. We suggest that preharvest chitosan sprays activate phenylpropanoid metabolism, promoting the deposition of suberin poly phenolic at wound sites of harvested muskmelons.

Keywords: /Preharvest/ /Chitosan sprays/ /Suberin poly phenolic/ /Muskmelons/ /Wound healing/ /Phenylpropanoid metabolism/

MUSHROOM

Wang, L., Zhou, Y., Wang, Y., Bu, H. & Dong T. (2021). Changes in cell wall metabolism and flavor qualities of mushrooms (*Agaricus bernardii*) under EMAP treatments during storage. *Food Packaging and Shelf Life, 29*, 100732. https://doi.org/10.1016/j.fpsl.2021.100732

Abstract

To clarify the dynamic changes of cell wall metabolism and flavor components in *Agaricus bernardii* packed with the packaging materials during storage. The polyethylene (PE), poly (butylene adipate-co-terephthalate)/ poly (l-lactic acid) (ECFPLA) and PBAT/PLLA/ hydrophobic silica (ECFPLASiO2) with a different gas/water vapor permeability were used as equilibrium modified atmosphere packaging (EMAP) materials, and an appropriate gas concentration [O2 (0.01−0.03 %), CO2 (4.58–6.62 %)] was created inside the ECFPLASiO2 packaging, which led to *Agaricus bernardii* with higher level of cell wall components and lower level of cell wall degrading enzymes during the storage period. For the first time application of HS-SPME–GC–MS on an extract from fresh *Agaricus bernardii*. The results showed that volatile compounds of fresh *Agaricus bernardii* mainly consists of alcohols, ketones and aldehydes, with 3-octanol, 3-octanone, 1-octene-3-alcohol and phenylcarbinol being most abundant compounds. During the storage time, the varieties and content of volatile compounds were changed in all treatments. Alcohols, aldehydes, hydrocarbons and esters contents increased during the storage while ketones declined. Among all treatment groups, ECFPLASiO2 group showed higher most abundant compounds and organic acid content. The results suggest that ECFPLASiO2 film could be used to reduce the changes in cell walls and flavor components after harvest and extend the shelf life of *Agaricus bernardii.*

Keywords: /*Agaricus bernardii/ /*EMAP treatment/ /Cell wall metabolism/ /Flavor qualities/

PAK CHOI

Yuan, S., Zou, J., Li, X., Fan, X., Li. X., Wang, Q. & Zheng, S. (2021). Micro-perforated packaging delays leaf yellowing and maintains flavor of postharvest pak choi (*Brassica rapa* subsp. *chinensis*) following low-temperature storage. *Food Packaging and Shelf Life*, *29*, 100681. https://doi.org/10.1016/j.fpsl.2021.100681

Abstract

The objective of this study was to investigate the effects of micro-perforated packaging on the quality attributes of pak choi (*Brassica rapa* subsp. *chinensis*) during shelf life (20 °C) removed after 7 d at 4 °C. Gas composition in macro-perforated control packaging stayed close to air, non-perforated packaging resulted in anoxia, and micro-perforated packaging effectively held high enough O2 level, where 12.5 % O2 and 8.9 % CO2 was modified by 12 micro-perforations of 100 μm in diameter after 3 d of shelf life. Weight loss and yellowing were most serious in the control, and off-odor occurred in non-perforated packaging. Micro-perforated packaging delayed yellowing due to the lowered activities of chlorophyll-degrading enzymes, increased total polyphenol content, enhanced antioxidant capacity, and preserved flavor of pak choi. These results showed that micro-perforated packaging should be recommended for fresh leafy vegetables during shelf life following low-temperature storage, which is commonly utilized in the distribution chain.

Keywords: /Micro-perforation/ /Packaging/ /Leaf vegetable/ /Chlorophyll/ /Volatiles/

PEACH

Kibar, H., Taş, A., & Gündoğdu, M. (2021). Evaluation of biochemical changes and quality in peach fruit: Effect of putrescine treatments and storage. *Journal of Food Composition & Analysis*, *102*, 104048. https://doi.org/10.1016/j.jfca.2021.104048

Abstract

The paper studies quality properties on peach fruit of putrescine treatments at 0 °C during 40-day storage. 1.2 and 1.6 mM putrescine indicated best results regarding quality and biochemical peach fruit. Putrescine treatments maintained the quality of peach fruit at different storage times. These results could be useful for peach fruit to decrease postharvest losses. The effects of putrescine (0.4, 0.8, 1.2 and 1.6 mM) on quality and bioactive compounds of peach fruit (cv. Monley) are the focus of this study. Fruits were stored at 0 ± 0.5 °C and 90 ± 5% relative humidity for 40 days. In the controls, increases in weight loss, decay and soluble solids concentration, and decreases in fruit density, firmness, titratable acidity, pH, respiration rate and L* , a* , b* , C* and H° detected highly throughout the storage period. All these properties examined were delayed importantly after putrescine treatments. It was observed that the phenolics, vitamin C and organic acid contents of fruits in general decreased during storage. All doses of putrescine prevented the breakdown of phenolic compounds more than the control group. The least changes in chlorogenic acid (9.26 mg 100g-1) and rutin (5.74 mg 100g-1) contents on the 40th day were obtained in 1.6 mM. Malic acid, which is the dominant organic acid of fruits, was determined as 6.73 and 8.61 g kg-1 in the treatments of 1.2-1.6 mM putrescine on the 40th day, respectively. It was noted that 1.6 mM (12.90 mg 100g-1) application prevented the breakdown of vitamin C more than the control group (6.10 mg 100g-1).

Keywords: /Organic acids/ /Peach/ /Phenolic compounds/ /Putrescine/ /Storage/

Wang, L., Wang, Y., Hou, Y., Zhu, X., Zheng, Y., & Jin, P. (2021). Physiological and metabolomic analyses of hot water treatment on amino acids and phenolic metabolisms in peach cold tolerance. *Postharvest Biology & Technology*, *179*, N.PAG. https://doi.org/10.1016/j.postharvbio.2021.111593

Abstract

Hot water (HW) treatment is useful to reduce chilling injury (CI) in several kinds of fruit including peach. However, the systemic regulatory mechanisms remained unknown. Physiological, metabolomic and transcriptomic analyses were applied in this study to reveal amino acids and phenolic metabolisms in HW-treated peaches. Results showed that reduced CI and malondialdehyde (MDA) content were accompanied with higher levels of amino acids, phenolic compounds and their derivatives contents such as arginine, proline, γ-aminobutyric acid (GABA), polyamines (PAs), cholorogenic acid, kaempferol and quercetin in HW treatment compared to control. The activities of these metabolism-related enzymes were significantly enhanced by HW. In addition, transcriptomic and metabolomic evaluation indicated that HW treatment activated the biosynthesis of amino acids and phenolic, and suppressed the degradation of amino acids. Thus, the present results suggested that HW treatment could enhance chilling tolerance of peaches by regulating phenolic and amino acids metabolisms, maintaining high levels of phenolic and amino acids contents, which contributed to enhancing antioxidant capacity and alleviating membrane injury during cold storage.

Keywords: /Peach/ /Hot water/ /Amino acids/ /Phenolic/ /Cold tolerance/

PEAR

Cruz, S., Guerra, R., Brazil, A., Cavaco, A., Antunes, D., & Passos, D. (2021). Nondestructive simultaneous prediction of internal browning disorder and quality attributes in 'Rocha' pear (*Pyrus communis* L.) using VIS-NIR spectroscopy. *Postharvest Biology and Technology, 179,* 111562. https://doi.org/10.1016/j.postharvbio.2021.111562

Abstract

This study explores the possibility of predicting the soluble solids content (SSC), firmness and the presence of internal browning disorders in 'Rocha' pear (*Pyrus communis* L.) using a single VIS-NIR spectroscopic measurement in semi-transmittance mode. The spectroscopic measurement setup was developed to mimic real world conditions and takes into account geometry and technical requirements of a commercial fruit sorting optical module. The randomness of the fruit position during the spectra acquisition was simulated by sampling each fruit on four sides. Calibration models for internal quality properties were built using individual and/or average side spectra. The results show that models using the spectrum of each side as an individual sample only under-perform slightly relatively to the models based on spectra averages, which are common in the laboratory but very difficult to implement on an automated grading line. The performance of PLS, SVM and Ridge Regression models was compared for the prediction of SSC and firmness. Multiple types of spectra pre-processing were computed and the best combination of model and pre-processing method identified. The lowest RMSEP results for SSC and firmness were 0.7% ($R^2 = 0.71$) and 7.66 N ($R^2 = 0.68$) respectively, achieved using SVM on data pre-processed with Standard Normal Variate corrected 2nd derivative. For the internal disorder detection (browning), a classification benchmark composed by five different models (PLS-LDA, PCA-Logistic Regression, PCA-Extremely Randomized Trees, Extremely Randomized Trees and SVC) was implemented. PLS-LDA applied to the raw spectra presented the highest sensitivity, 76%. The results confirm that simultaneously achieving viable firmness and SSC predictions and internal disorder detection levels in pears is possible using a single VIS-NIR spectral measurement.

Keywords: /VIS-SWNIR spectroscopy/ /Regression/ /Classification/ /Soluble solids content/ /Firmness/ /Browning/ /Internal quality/ /Machine learning/

Liu, Y., Li, Y., Bi,Y., Jiang, Q., Mao, R., Liu, Z., Huang, Y., Zhang, M., & Prusky, D. (2021). Induction of defense response against Alternaria rot in Zaosu pear fruit by exogenous L-lysine through regulating ROS metabolism and activating defense-related proteins. *Postharvest Biology and Technology, 179,* 111567. https://doi.org/10.1016/j.postharvbio.2021.111567.

Abstract

L-lysine, an important basic amino acid, its catabolic pathway is activated upon microbial pathogen attack in plants and has a central role in plant immunity. The control effects of exogenous L-lysine treatment on *Alternaria* rot in postharvest 'Zaosu' pear fruit and possible mechanisms involved were studied. The results showed that L-lysine treatment inhibited *Alternaria* rot development and the effect was negatively correlated with the treatment concentration, lesion diameter of 0.1 mM L-lysine treated fruit was 43.7 % lower than that of the control 15 d after treatment. Further studies showed that L-lysine treatment significantly suppressed O_2^-, H_2O_2, Malondialdehyde (MDA) content, and enhanced catalase (CAT), peroxidase (POD), and superoxide dismutase (SOD) activities and gene expression in pear fruit. β-1,3-glucanase (GLU), and chitinase (CHI) activities and *PbrGLU*, *PbrCHI*, and *PbrPR-1* gene expression were also induced by exogenous L-lysine. The findings suggest that postharvest L-lysine treatment effectively enhanced disease resistance through inhibiting reactive oxygen species (ROS) production and activating defense-related protein in pear fruit.

Keywords: /Pear fruit/ /*Alternaria alternata*/ /L-lysine/ /Reactive oxygen species (ROS)/ /Induce disease resistance/

PERSIMMON

Qi, Y., Wu, H., Liu, J., Chen, L., Jiang, Z., Zhang, Y., Tian, X., Li, R., Yang, Y., & Ren, X. (2021). Lycopene β-cyclase plays a critical role in carotenoid biosynthesis during persimmon fruit development and postharvest ripening. *Scientia Horticulturae*, *287*, 110265. https://doi.org/10.1016/j.scienta.2021.110265

Abstract

The aim of the current study was to characterize the functional role of *DkLCYb* in carotenoid biosynthesis in persimmon fruit. The accumulation of carotenoids and the expression of carotenogenic genes were investigated during persimmon fruit development and postharvest ripening. *DkLCYb* was cloned and its functional role in carotenoid biosynthesis was characterized. The results showed that carotenoids constantly accumulated during persimmon fruit development and postharvest ripening. More carotenoids accumulated during postharvest storage than during fruit development. The carotenoid composition of unsaponified extracts of the persimmon fruit flesh showed that the major carotenoids were lycopene and β-carotene in 'Huoguan' and 'Heishi', respectively. Consistent with this result, the expression of six carotenogenic genes increased to their highest levels during postharvest storage. The selected carotenoid biosynthesis genes showed an increased expression pattern during fruit development and in the early period of postharvest storage. A significant decrease in carotenogenic genes was found after stage 6 (*DkPSY, DkLCYb, DkZDS* and *DkBCH*) or stage 5 (*DkLCYe*,). Both *DkLCYe* and *DkBCH* showed a steady increase from stage 1 to stage 5; however, dramatically decreased expression of *DkLCYe* and sharply increased expression of *DkBCH* were found at stage 6. Correlation analysis showed that the expression of *DkPSY, DkPDS, DkZDS, DkLCYb* and *DkBCH* was significantly correlated with the accumulation of one or more carotenoid compounds analysed in this study. However, a negative correlation was found between the expression of *DkLCYe* and the accumulation of lycopene, β-cryptoxanthin and zeaxanthin. Specifically, expression of *DkLCYb* showed the highest correlation ($p < 0.01$) with β-carotene ($r = 0.74$) accumulation. We cloned *DkLCYb* and analysed its functions *in vitro* and *in vivo. DkLCYb* contained typical domains that were highly conserved and essential for lcyb protein activity. The cyclization activity of the encoded protein was demonstrated by functional analysis in *E. coli* BL21. Transient overexpression of *DkLCYb* significantly enhanced the accumulation of β-carotene in persimmon fruit. These results indicate that *DkLCYb* is a genuine lycopene cyclase gene and it plays an essential role in β, β-carotenoid (β-carotene and β-cryptoxanthin) biosynthesis in persimmon fruit.

Keywords: /Persimmon/ /Gene expression/ /Lycopene β-cyclase/ /Carotenoid biosynthesis/ /Gene function/

PLUM

Du, H., Liu, G., Hua, C., Liu, D., He, Y., Liu, H., Kurtenbach, R., & Ren, D. (2021). Exogenous melatonin alleviated chilling injury in harvested plum fruit via affecting the levels of polyamines conjugated to plasma membrane. *Postharvest Biology & Technology*, *179*, 111585. https://doi.org/10.1016/j.postharvbio.2021.111585

Abstract

Polyamines (PAs) are related closely with many abiotic stresses. However, conjugated PA functions are not clear in alleviating chilling injury in fruit. The contents of free PAs in plum flesh cell and conjugated PAs in plasma membrane (PM), the activities of *S*-adenosylmethionine decarboxylase (SAMDC) and transglutaminase (TGase), and the degree of chilling injury were investigated in harvested plum (*Prunus salicina* L.) fruit pre-treated with exogenous melatonin. Chilling treatment resulted in the injury of plasma membrane (PM), as judged by the increased PM permeability, chilling injury index and malondialdehyde (MDA) content, and the decreased sulfhydryl group contents. Exogenous melatonin alleviated chilling injury, in parallel with the increased levels of free spermidine (Spd) and spermine (Spm) in cell, conjugated non-covalently (CNC) Spd and Spm, and conjugated covalently (CC) Put and Spd in PM, resulting from the increased activities of SAMDC and TGase. The results of the additional experiments with two inhibitors, methylglyoxyl-bis (guanylhydrazone) (MGBG) and phenanthrolin, which inhibit the activities of SAMDC and TGase, respectively, were complementary evidence for our research. MGBG and TGase treatment decreased the level of CNC PAs (Spd and Spm) and CC PAs (Put and Spd), respectively, coupled with aggravating the chilling injury. From these above-mentioned-results, it could be suggested that exogenous melatonin alleviated chilling injury by elevating the levels of CNC Spd, CNC Spm, CC Put and CC Spd in PM.

Keywords: /Conjugated polyamines/ /Chilling stress/ /Plum (*Prunus salicina* L.)/ /Plasma membrane/

Fang, Z., Lin-Wang, K., Jiang, C., Zhou, D., Lin, Y., Pan, S., Espley, R. V., & Ye, X. (2021). Postharvest temperature and light treatments induce anthocyanin accumulation in peel of "Akihime" plum (Prunus salicina Lindl.) via transcription factor PsMYB10.1. *Postharvest Biology & Technology*, *179*, 111592. https://doi.org/10.1016/j.postharvbio.2021.111592

Abstract

Anthocyanin accumulation is responsible for red pigmentation in plum peels and affected by light and temperature. We investigated the effects of temperature and LED light (400−800 nm, with following red: green: blue ratio 20.9: 75.7: 3.4 respectively) with total radiant flux adjusted at 150 mol m^{-2} s^{-1} on anthocyanin accumulation in postharvest 'Akihime' plum peel and found that 20 °C/light could induce anthocyanin concentration and therefore improve red coloration. However, no significant anthocyanin accumulation was detected in the peel of plums treated with 30 °C or under dark conditions. RNA-Seq and qRT-PCR analysis showed that the transcript levels of anthocyanin accumulation-related genes, including *phenylalanine ammonialyase* (*PAL*), *cinnamate-4-hydroxylase* (*C4H*), *4-coumaroyl:CoA-ligase* (*4CL*), *chalcone synthase* (*CHS*), *chalcone isomerase* (*CHI*), *flavanone 3-hydroxylase* (*F3H*), *dihydroflavonol 4-reductase* (*DFR*), *anthocyanidin synthase* (*ANS*), *UDP-glucose: flavonoid 3-O-glucosyltransferase* (*UFGT*) and *glutathione S-transferase* (*GST*) in the peel were upregulated by 20 °C/light treatment. Transcription factors differentially regulated by temperature and light were identified. A homolog of peach anthocyanin MYB activator, namely *PsMYB10.1*, was lowly expressed in the peel of unpigmented fruit but significantly upregulated by 20 °C/light treatment. The function of *PsMYB10.1* was verified by transient overexpression in *Nicotiana tabacum* leaves, resulting in strong anthocyanin accumulation when co-infiltrated with *PsbHLH3*. Dual luciferase assays further showed that PsMYB10.1 activated the promoters of the anthocyanin biosynthetic genes *PsANS*, *PsUFGT* and *PsGST*. These results suggest that appropriate temperature and light regimes at postharvest can induce anthocyanin accumulation in the peel of 'Akihime' plum by activating the expression of the positive regulator *PsMYB10.1* and consequently the genes involved in biosynthesis and transportation of anthocyanin.

Keywords: /Plum fruit coloration/ /Low temperature/ /Anthocyanin biosynthesis/ /Transcription factor/ /*PsMYB10.1/*

POSTHARVEST DISEASE

Fernandez-San Millan, A., Larraya, L., Farran, I., Ancin, M., & Veramendi, J. (2021). Successful biocontrol of major postharvest and soil-borne plant pathogenic fungi by antagonistic yeasts. *Biological Control*, *160*, 104683. https://doi.org/10.1016/j.biocontrol.2021.104683

W. anomalus 32 is an effective BCA for Fusarium / Verticillium wilts in soil conditions. A two-step in vivo scheme for soil-borne antagonist yeast selection has been developed. Several strains totally control B. cinerea and P. expansum in tomato fruits. Antagonistic strains are also efficient in other fruits such as grapes and apples. Antifungal properties of protective yeast strains involve a combination of mechanisms. Fungal pathogens are the main biotic burden of productivity for economically important crops under field, greenhouse or postharvest conditions. The discovery and development of new environmental-friendly solutions, such as application of living organisms and their derivatives to control plant diseases and pests, are of enormous interest. This study presents the results of a mass screening designed to detect yeast strains with antagonistic activity against postharvest pathogens (Alternaria alternata, Penicillium expansum and Botrytis cinerea) and soil-borne diseases (Verticillium dahliae and Fusarium oxysporum). In fact, this is the first study that focuses on screening the antagonistic potential of a wide variety of yeast genera (13) and species (30) against vascular wilts. The results from in vivo trials demonstrated that fungal infected tomato plants, grown under hydroponic or soil conditions, showed a significant reduction in disease severity after yeast treatment. Wickerhamomyces anomalus Wa-32 was able to antagonise both pathogens and reduce the disease severity up to 40% (V. dahliae) and 50% (F. oxysporum) in soil conditions. In addition, this strain became endophytic in tomato plants. The features of Wa-32 are of enormous interest since no effective antagonistic biocontrol product is available for the simultaneous control of these two fungal pathogens. Postharvest assays with wounded tomato fruits showed that several strains displayed very high biocontrol levels against P. expansum and B. cinerea (up to 86 and 97% reduction in disease severity, respectively) but none of them showed protection against A. alternata. The best protection against B. cinerea was again achieved with W. anomalus Wa-32 and two Metschnikowia pulcherrima strains (Mp-22 and Mp-30). However, the best antagonistic strains of P. expansum were Candida lusitaniae Cl-28, Candida oleophila Co-13, Debaryomyces hansenii Dh-67 and Hypopichia pseudoburtonii Hp-54. These biocontrol effects were also demonstrated in grapes and apples.

Keywords: /Biocontrol/ /Botrytis/ /Postharvest/ /Soil-borne pathogen/ /Wickerhamomyces/ /Yeast/

Sare, A. R., Jijakli, M. H., & Massart, S. (2021). Microbial ecology to support integrative efficacy improvement of biocontrol agents for postharvest diseases management. *Postharvest Biology & Technology*, *179*, 111572. https://doi.org/10.1016/j.postharvbio.2021.111572

Abstract

Harvested fruits and vegetables are threatened by pathogens which can cause losses for up to 55 % depending on the fruit and country. A potentially sustainable control method is the biological control of these postharvest diseases using biocontrol agents (BCA). Nevertheless, the lack of reliability in practical conditions compared with synthetic chemical pesticides is a major hindrance. Strategies combining BCA application to nutrient additives, salts, edible coatings, or physical treatments have been evaluated to improve BCA antagonism activity, but with only relative success. The fruit surface is colonized by complex microbial communities that are often resilient. In such an environment, BCA establishment might be difficult. The integration of the role of microbial communities to assemble a BCA-friendly microbiota, is a promising solution to manage the reliability of BCA in real conditions. Biocontrol phenotype of a microbiota is a complex metabolic phenotype that can be broken down in a multiple process supported by a network of beneficial microorganisms and molecules. Combining BCA application in a suitable complex

biocontrol mix including for example beneficial helper strains, essential macro and micronutrients also acting as prebiotic of biocontrol could help the establishment of BCA in the epiphytic microbial network. At the same time, it could achieve a biocontrol efficacy and reliability comparable to synthetic chemical pesticides. In addition, the timing of beneficial microbial application has been reviewed based on the available literature. For example, we propose that shifting application at flowering stage (to induce a “path dependency”) could be considered for the future management of postharvest disease of fruits and vegetables. This application moment shift could be extended to other plant organs like seeds.

Keywords: /Microbial ecology/ /Fruits and vegetables postharvest diseases/ /Biocontrol/ /Helper strains/ /Prebiotics of biocontrol/ /Timely application/

POSTHARVEST TECHNOLOGY

Lu, W., Chen, M., Cheng, M., Yan, X., Zhang, R., Kong, R., Wang, J., & Wang, X. (2021). Development of antioxidant and antimicrobial bioactive films based on *Oregano* essential oil/mesoporous nano-silica/sodium alginate. *Food Packaging and Shelf Life, 29,* 100691. https://doi.org/10.1016/j.fpsl.2021.100691

Abstract

In this study, *Oregano* essential oil (OEO) was embedded into mesoporous silica nanoparticles (MSNPs). To protect post-harvest *Agaricus bisporus* from *Curvularia lunata* (*C. lunata*), OEO-MSNPs/sodium alginate (SA) films were prepared by solvent casting method. The effect of the different OEO-MSNPs concentration on the active film was investigated. Scanning electron microscopy (SEM) analysis showed that the 0.8 wt% concentration of OEO-MSNPs was conducive to obtain a more even distribution of OEO-MSNPs in the films. The results of Fourier transform infrared (FT-IR) spectroscopy revealed that hydrogen bonds were formed between OEO-MSNPs and SA molecules. X-ray diffraction (XRD) showed that original structures of the SA were disordered. Moreover, the mechanical properties and physical properties of the films were affected by the dosage of OEO-MSNPs, and the optimal OEO-MSNPs dosage was found to be 0.8 wt%. The addition of OEO-MSNPs markedly improved the properties of film against UV light. An examination of the inhibitory effect of DPPH showed that the SA film with 1.0 wt% OEO-MSNPs had the strongest antioxidant capacity in 95 % ethanol food simulant, with the inhibition of 75.31 %. The SA film with 1.0 wt% OEO-MSNPs exhibited prominent antimicrobial activity against *C. lunata*.

Keywords: /*Oregano* essential oil/ /Mesoporous silica nanoparticle/ /Sodium alginate/ /Film/

Roy, K., Chaudhuri, S. S., & Pramanik, S. (2021). Deep learning based real-time Industrial framework for rotten and fresh fruit detection using semantic segmentation. *Microsystem Technologies*, *27*(9), 3365–3375. https://doi.org/10.1007/s00542-020-05123-x

Abstract

Computer vision finds a wide range of applications in fruit processing industries, allowing the tasks to be done with automation. Classification of fruit's quality and thereby gradation of the same is very important for the industry manufacturing unit for production of best quality finished food products and the finest quality of the raw fruits to be sellable in the market. In the present paper, detection of rotten or fresh apples has been accomplished based on the defects present on the peel of the fruit. The work proposes a semantic segmentation of the rotten portion present in the apple's RGB image based on deep learning architecture. UNet and a modified version of it, the Enhanced UNet (En-UNet) are implemented for segmentation yielding promising results. The proposed En-UNet model generated enhanced outputs than UNet with training and validation accuracies of 97.46% and 97.54% respectively while UNet as the base architecture attaining an accuracy of 95.36%. The best mean IoU score under a threshold of 0.95 attained by En-UNet is 0.866 while that of UNet is 0.66. The experimental results show that the proposed model is

a better one to be used for segmentation, detection and categorization of the rotten or fresh apples in real time.

Keywords: /Deep learning/ /Computer vision/ /Fruit processing/ /Food quality/ /Fruit/ /Fruit skins/

POTATO

Zhu, Y., Zong, Y., Liang, W., Sabina, A., Chai, X., Li, Y., Bi, Y., & Dov, P. (2021). β-Aminobutyric acid treatment accelerates the deposition of suberin polyphenolic and lignin at wound sites of potato tubers during healing. *Postharvest Biology & Technology*, *179*, 111566. https://doi.org/10.1016/j.postharvbio.2021.111566

Abstract

β-Aminobutyric acid (BABA) is a nonprotein amino acid that induces plant defense responses to numerous biotic and abiotic stresses. However, whether BABA treatment affects the wound healing process of potato tubers has yet to be reported. In this study, we examined the effects of BABA treatment on the weight loss and disease index of *Solanum tuberosum* L. cv. Atlantic potato tubers inoculated with *Fusarium sulphureum* and assessed the deposition of suberin polyphenolic (SPP) and lignin at the wound sites of these tubers during healing. We also investigated the indexes involved in phenylpropane metabolism, H_2O_2, and peroxidase in the underlying effect mechanism. BABA treatment effectively reduced the weight loss of wounded tubers (by 41.0 %) and the disease index of inoculated tubers (by 43.2 %) during healing (at 21 d and relative to the control). BABA treatment also accelerated the deposition of SPP and lignin at wound sites. SPP and lignin cell layers in the treated tubers were 58.45 % and 54.72 % thicker, respectively, than the equivalent cell layers in the controls at 7 d of healing. Additionally, BABA treatment significantly enhanced the activities of phenylalanine ammonia-lyase (PAL), 4-coumaryl coenzyme A ligase (4CL), cinnamic acid-4-hydroxylase (C4H), and cinnamyl alcohol dehydrogenase (CAD) while also promoting the synthesis of cinnamic acid, *p*-coumaric acid, caffeic acid, ferulic acid, sinapic acid, cinnamyl alcohol, coniferyl alcohol, and sinapyl alcohol, as well as increasing total phenolic and lignin content, at wound sites during healing. Furthermore, BABA treatment increased H_2O_2 content and peroxidase activity at the wounds. These results suggest that BABA treatment activates phenylpropanoid metabolism, increases H_2O_2 content and peroxidase activity, and accelerates the deposition of SPP and lignin in potato tuber wounds, all of which lead to reductions in the weight loss and disease index of tubers during healing.

Keywords: /BABA/ /Potato tubers/ /Wound healing/ /Phenylpropanoid metabolism/

STRAWBERRY

Paulsen, E., Barrios, S., & Lema, P. (2021). Production of packaged ready – to – eat whole strawberries (cv. San Andreas): Packaging conditions for shelf-life extension. *Food Packaging and Shelf Life*, *29*, 100696. https://doi.org/10.1016/j.fpsl.2021.100696

Abstract

The aim of the present work was to provide objective shelf-life data for directly applicable and low-cost packaging conditions in the production of whole ready–to–eat strawberries (cv. San Andreas). Strawberries were washed, cut to remove calix and NaClO disinfected. Six packaging conditions were evaluated at laboratory scale, comprising PE, PP and PET packages, passive and active atmospheres and storage temperature of 5 °C. PET and PE passive packages were also tested at pilot scale at 5 and 10 °C. Package internal atmosphere, general quality attributes and microbiological quality were followed throughout storage. Data from consumer studies was used to objectively determine product shelf-life. PE, PP and PET resulted in adequate packaging alternatives, achieving shelf lives of up to 9 d, limited by sensory attributes or fungal growth. Results are directly applicable to minimally processed industries

offering objective shelf-life information based on consumer perception.

Keywords: /*Fragaria ananassa*/ /Modified atmosphere packaging/ /Fresh-cut/ /Minimally processed/

TOMATO

Alvarez-Hernandez, M., Martinez- Hernandez, G., Castillejo, N., Matinez, J., & Artes-Hernandez, F. (2021). Development of an antifungal active packaging containing thymol and an ethylene scavenger. Validation during storage of cherry tomatoes. *Food Packaging and Shelf Life*, *29*, 100734. https://doi.org/10.1016/j.fpsl.2021.100734

Abstract

Active sachets with antifungal effects and a C2H4 scavenger were developed. Firstly, free thymol (T) or encapsulated thymol (ET) was added at different dosages into sachets containing a KMnO4-loaded sepiolite (SK) and evaluated against *Botrytis cinerea* at 11 °C *in vitro* and on inoculated cherry tomatoes. Secondly, the functionality of such sachets was validated on cherry tomato quality during 28 d at 11 °C + 3 d at 22 °C. From the *in vitro* assay, T-containing sachets led to the highest fungal inhibition (≥91 %), followed by the SK + ET combinations and SK. In contrast, SK- and T-including sachets comparably restrained fungal incidence on tomatoes, but their combination led to an increased incidence. This effect was lessened by the thymol encapsulation. From the validation experiment, the quality changes in cherry tomatoes followed zero-order kinetics and Weibull models. The C2H4-scavengers were found helpful in controlling postharvest fungal diseases while preserving fruit quality.

Keywords: /*Solanum lycopersicum*/ /*Botrytis cinerea*/ /Encapsulation/ /Chitosan/ /Antifungal/ /Quality/

Mata, C. I., Magpantay, J., Hertog, M. L. A. T. M., Van de Poel, B., & Nicolaï, B. M. (2021). Expression and protein levels of ethylene receptors, CTRs and EIN2 during tomato fruit ripening as affected by 1- MCP. *Postharvest Biology & Technology*, *179*, 111573. https://doi.org/10.1016/j.postharvbio.2021.111573

Abstract

Many studies have focused on the plant hormone ethylene because of its key role in controlling, among others, climacteric fruit ripening and fruit senescence. These processes can be controlled by applying 1-MCP, which tightly binds to the ethylene receptors thereby blocking the ethylene signaling pathway. 1-MCP is known to inhibit the action of ethylene and to delay the climacteric ripening of tomato fruit. Less is known about its long term effect when the inhibitory effect 1-MCP inhibition is eventually released. Our objective was to study this transient 1-MCP inhibition during tomato fruit ripening in terms of fruit quality, ethylene production, respiration rate and the expression and protein abundance of receptors, CTRs and EIN2. For the identification and quantification of proteins, we used an LC–MS based targeted method of Parallel Reaction Monitoring (PRM), while gene expression was done using real time qPCR. Different color stages of tomatoes were harvested and treated with 1-MCP and subsequently stored to follow up postharvest fruit ripening. The difference with previous 1-MCP studies is that we sampled 1-MCP treated tomatoes at different physiological stages during ripening (and not time), matching the color stages of the untreated control fruit. This allows to properly compare the underlying regulation of the ethylene signaling pathway during a 1-MCP-mediated suppression of ripening. We hypothesized that the levels of the ethylene signaling components would be different for 1-MCP treated fruit due to a reduced ethylene-mediated autocatalytic feed-back. Our results showed that fruit treated with 1-MCP at mature green stage showed a lower respiration rate during subsequent ripening as compared to the untreated fruit, suggesting that climacteric ripening was effectively inhibited by 1-MCP. However, these 1-MCP treated fruit showed a higher ethylene production as compared to untreated fruit. The 1-MCP treated fruit also showed lower to equal levels of gene expression and protein abundance of the ethylene receptors, CTRs and EIN2. As receptors and CTRs are negative regulators of ethylene signaling, decreasing the

production of new signaling proteins could subsequently activate downstream ethylene signaling and with that expression of downstream genes. This could lead to higher ethylene production levels, which in turn can compensate for 1-MCP mediated inhibition of fruit ripening.

Keywords: /Ethylene signaling/ /Ethylene receptors/ /CTRsEIN2/ /Tomato ripening/ /1-MCP/

Locali-Pereira, A., Guazi, J., Conti-Silva, A., & Nicoletti, V. (2021) Active packaging for postharvest storage of cherry tomatoes: Different strategies for application of microencapsulated essential oil. *Food Packaging and Shelf Life*, *29*, 100723. https://doi.org/10.1016/j.fpsl.2021.100723

Abstract

Pink pepper essential oil was microencapsulated in single-layer (protein stabilized) and double-layer (protein-polysaccharide stabilized) emulsions, which were applied in poly(ethylene terephthalate) boxes for storage of cherry tomatoes (*Solanum lycopersicum var. cerasiforme)* following two different strategies: a thin coating formed after emulsion drying directly on the box lid, or a sachet containing spray-dried emulsion powder attached to the box lid. Fruits were stored for 21 days at 25 °C. Packaging without essential oil was used as a control. Active packaging resulted in lower weight loss, total soluble solids, pH and lycopene concentration, while fruits stored in non-active packaging showed evidence of faster ripening based on these parameters. The greater release of volatiles from coatings (≈ 90 %) compared to spray-dried powder (76.9–86.9 %) suggests that this approach was a more advantageous strategy to maintain the fruit quality ($p < 0.05$). Both approaches showed potential for post-harvest storage of fresh fruit.

Keywords: /*chinus terebinthifolia/ /*α-PineneSoy protein isolate/ /High methoxyl pectin/ /Emulsion/ /Encapsulation/

Tsaniklidis, G., Charova, S. N., Fanourakis, D., Tsafouros, A., Nikoloudakis, N., Goumenaki, E., Tsantili, E., Roussos, P. A., Spiliopoulos, I. K., Paschalidis, K. A., & Delis, C. (2021). The role of temperature in mediating postharvest polyamine homeostasis in tomato fruit. *Postharvest Biology & Technology*, *179*, 111586. https://doi.org/10.1016/j.postharvbio.2021.111586

Abstract

Polyamines are actively involved in diverse processes, including fruit ripening and stress responses. The aim of this study was to investigate the role of storage temperature on polyamine metabolism of tomato fruit, which were either harvested at the turning stage or left to mature on-plant. The applied temperatures (5, 10 and 25 °C) and storage duration (7 d) are regularly employed in real-world scenarios. The metabolic profile of polyamines (putrescine, spermidine and spermine), gene transcription of the enzymes mediating polyamine biosynthesis and catabolism, protein accumulation of the putrescine synthesis enzyme and the putrescine-produced H_2O_2 were evaluated. Putrescine was the major polyamine in all cases, and its content generally increased during ripening, as well as in chilled fruit (stored at 5 °C). Increases in arginine decarboxylase protein content and in arginine decarboxylase transcription of both attached fruit and detached ones stored at either 10 or 25 °C showed that putrescine accumulation was mainly driven via the arginine decarboxylase biosynthetic pathway. Interestingly, putrescine catabolism by copper-containing amine oxidase was favored in parallel with increases in arginine decarboxylase and ornithine decarboxylase transcripts in fruit stored at 5 °C. However, the arginine decarboxylase protein accumulation suggests that ornithine decarboxylase is mainly responsible for putrescine accumulation at 5 °C. This study indicates that storage temperature modifies the homeostasis of polyamines in tomato fruit, which in turn orchestrates ripening-associated physiological processes.

Keywords: /Chilling/ /Fruit ripening/ /Polyamine biosynthesis/ /Polyamine catabolism/ /PutrescineTomato/

Xiang F., Xia, Y., Wang, Y., Wang, Y., Wu, K., & Ni, X. (2021). Preparation of konjac glucomannan based films reinforced with nanoparticles and its effect on cherry tomatoes preservation. *Food Packaging and Shelf Life*, *29*, 100701. https://doi.org/10.1016/j.fpsl.2021.100701

Abstract

Present study aims to investigate the effect of nanoparticles (zein nanoparticles, nanocellulose, nano-TiO2, nano-SiO2) incorporation on rheological properties of film-forming solutions and physicochemical properties of konjac glucomannan (KGM) based films, and to evaluate the effect of KGM/nanoparticles blend film on cherry tomatoes preservation. The results showed that the blend film-forming solutions exhibited shear-thinning behavior, and the KGM/zein nanoparticle film-forming solution showed the lowest crossover frequency value of storage (G′) and loss (G") moduli due to enhanced molecular interaction and entanglement. The nanoparticles were dispersed homogeneously in the KGM continuous matrix and had good compatibility with KGM, thereby improving physicochemical properties of KGM based films. KGM/zein nanoparticle blend film (KNZ) showed the best properties, such as smoother surface and denser cross-section, the highest glass transition temperature and elongation at break, as well as the best moisture and oxygen barrier. In comparison with the control and polyethylene film packaging, cherry tomatoes in KNZ film packaging showed lower weight loss and firmness reduction, and had relatively stable content of total soluble solids, vitamin C content and pH value during storage up to 10 days at 26 °C. The results suggested the high potential of KNZ film for application in cherry tomatoes preservation.

Keywords: /Rheology/ /Microstructure/ /Physical properties/ /Preservation/

WATER CHESTNUT

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Abstract

In this paper, the effect of high-pressure carbon dioxide (HPCD) inhibiting the browning of fresh-cut Chinese water chestnut (CWC) was explored by comparing the differences between damaged and non-damaged tissues. The results showed that the browning of fresh-cut CWC could be effectively inhibited by 2 and 4 MPa treatment, and with these conditions, the microbial load was kept at a low and stable level during the whole storage period. In damaged tissues, the phenylalanine ammonia-lyase (PAL) activity was decreased, thus cutting off the accumulation of naringenin and eriodictyol (only slightly detected at 1 MPa). In non-damaged tissues, the activities of polyphenol oxidase (PPO), peroxidase (POD), and PAL were significantly increased to overcome the treatment stress. The structural change of PAL proved its activity reduction. The mechanism of browning inhibition could be explained by direct inactivation of PAL in damaged tissue and indirect regulation of stress resistance response in non-damaged tissue.

Keywords: /Chinese water chestnut/ /High-pressure carbon dioxide/ /Browning/ /Phenylpropanoid pathway/ /Polyphenol oxidase/