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Book of Abstract

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Dear Colleagues and Friends,

It is with great pleasure that we welcome you to attend 9th SOI congress which, this year is joined to the *Spanish Society of Horticultural Science*.

We are honored by your presence and delighted to share these days of exchange, learning, and inspiration.

This event brings together experts, innovators, and passionate professionals from Italy and Spain and other Countries.

We hope the program will spark new ideas and foster meaningful collaborations. May each session be an opportunity to grow, connect, and contribute to our shared goals.

Beyond the conference halls, we invite you to explore the beauty, history, and culture of our wonderful city, especially the Botanic Garden, the venue of the Congress which celebrated its 230th birthday.

Enjoy the discussions, the discoveries, and the spirit of our community.

We thank the *Scientific Committee* and the *Secretariat* for their work and our *Sponsors* for giving us the chance to share with you some of our most traditional products during our coffee breaks and lunches.

We wish you an enriching experience and unforgettable memories.

The Conveners and the Organizing Committee

Sponsor We would like to thank the Institutions, Organizations, and Companies that contributed to the realization of the **9th National Conference of the SOI Working Group on Postharvest Management of Mediterranean Crops** as patrons and sponsors for the financial support provided.

Oral session I

Postharvest physiology, technology & precision management

Spectral techniques for non-destructive prediction of internal constituents of tomatoes

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This study investigated the efficacy of non-destructive optical techniques, specifically hyperspectral imaging (HSI) and Fourier Transform (FT)-NIR spectroscopy, for the non-destructive prediction of internal quality constituents of hydroponically grown tomatoes. To scale up the experiment, three distinct hydroponic growing techniques, varying in water and fertilizer use, were implemented across two cultivation cycles for two tomato varieties (cv 'Carminio' and cv 'Mose'). Hyperspectral images (HSI) in the Vis-NIR and NIR range, along with reflectance spectra obtained through Fourier Transform (FT)-NIR spectroscopy, were acquired throughout the harvesting period, on approximately 250 tomatoes at different maturity stages. Internal composition of individual fruit in terms of total soluble solid content (TSS), pH, total titratable acidity (TA), L-ascorbic acid (AA), and vitamin C (VC) was assessed. Predictive models for each quality attribute were developed using Partial Least Squares Regression Analysis (PLSR) (Geladi and Kowalski, 1986; Sijmen Jong, 1993) applied to HSI (Vis-NIR and NIR) and FT-NIR spectrometer spectra. Models constructed on FT-NIR data with selected ranges demonstrated superior accuracy and robustness in prediction (R2 of 0.96, 0.93, 0.89, 0.81, 0.83 for pH, TSS, TA, AA, VC, respectively) compared to models obtained using hyperspectral imaging. These findings demonstrate the potential FT-NIR spectroscopy in predicting chemical components in intact tomatoes. Notably, our results for Vitamin C content exceeded reported literature values, while other components, such as TSS, showed similar or better trends, considering experimental conditions and inherent variability. Furthermore, concentration maps generated through hyperspectral imaging provided spatial maps of quality attributes, such as TSS, across individual fruits, enabling a more detailed understanding of intra-fruit maturity variations. These advanced technologies offer potential benefits in quality assessment and grading processes, leading to enhanced product selection and reduced waste.

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Fatty acids metabolism and chilling injury in *Citrus* fruits: natural tolerance and preharvest factors

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Fatty acid (FA) desaturation has been long recognized as a critical adaptive response of plants to cold stress, since the increase in unsaturated fatty acids (UFAs) may enhance membrane fluidity and thereby improving cold tolerance. Fruits of many *Citrus* cultivars are sensitive to develop chilling injury (CI) under postharvest storage to low temperature which depreciates their external quality and marketability. However, the involvement of FA desaturation in the responses of citrus fruit to postharvest cold storage that may induce CI are not well understood. In order to elucidate these processes, we have analysed the changes in FA content and composition, and the expression of a number of genes involved in different steps of FA metabolism in the peel of fruits of CI-sensitive and CI-tolerant Citrus cultivars and stored for up to 8 weeks at 2ºC. FA desaturase genes involved in the synthesis of main FAs displayed variable pattern of expression and, interestingly, differences between CI-sensitive and CI-tolerant fruits at harvest were detected. Moreover, the content of unsaturated FA increased during storage, suggesting a common adaptive response to low temperature, but genotypic differences were also detected in fruits at harvest. Collectively, our results reveal significant alterations in FA desaturation between CI-sensitive and CI-tolerant Citrus fruits during storage at low temperatures. Moreover, pre-harvest conditions appear to have a major influence on both FA desaturation and in the response of the fruit to low temperature storage, that will be presented and discussed

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Investigation on postharvest attitudes of cauliflower

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Cauliflower is a high demand vegetable, due to its high nutritional value. Indeed, especially during wintertime in the northern hemisphere, it is an important source of vitamins, antioxidants and anti-carcinogenic compounds. After harvest and before consumer 'consumption, the curds are usually stored for several weeks at 1-4 °C but more critical is the storage in slices or fresh-cut for its perishability. The overall visual appearance and absence of off flavours are crucial criteria for buying decisions of consumers of this type of vegetable. Moreover, its firmness, colour and aroma both of raw and cooked cauliflower influence further consumers' acceptance. The variability among different types of cauliflower is consistent: mainly common cauliflower and Romanesco cauliflower both belong to Brassica oleracea var. botrytis, but their external surface, colour, and aroma are different. In this study, a standard protocol was developed to assess the firmness and external color of the curd for both cauliflower types at harvest and after 1 week of storage at 4°C. After a literature review, a protocol was established to identify the proper spots for firmness measurements (using a cylindrical probe, model 53205, TR snc.) and colour measurements (using a portable colorimeter, model PCE – XXM 30) on the curd. Furthermore, aroma profile of green and orange colour Romanesco type cauliflower in three biological replicates at harvest and after 10 days of storage at 4°C and 15°C were characterized by analysis of volatile organic compounds of raw and cooked samples by proton-transfer-reaction time-of-flight mass spectrometry (PTR-ToF-MS). The overall differences were observed between different colour types and storage conditions of cauliflower for both raw and cooked samples.

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Effect of ozone application for low-input postharvest dehydration of wine grapes

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The postharvest dehydration of grapes is a traditional practice to produce wines with unique traits (e.g., sweet, dry, or reinforced). Modern dehydration facilities are equipped with systems for artificial environmental control to achieve desired dehydration kinetics and prevent *Botrytis cinerea* infection. However, the conditioning systems are extremely energy-demanding and the identification of practical solutions effectively controlling/reducing the postharvest decay would lower the operational costs. With this objective, we evaluated the potential of ozone-based treatments on harvested grapes and preliminarily tested if the treatments could impact the normal behaviour and metabolism/composition of grapes during traditional dehydration. Harvested grapes from cv. Corvina and Sangiovese were treated with ozonated water (2 ppm) or ozone gas (6 and 60 ppm for Corvina; 6 ppm for Sangiovese), then partially dehydrated under controlled temperature and relative humidity up to 30% weight loss. Technological, metabolomic, and transcriptomic analyses were performed on berry samples collected at different times during dehydration. Minor differences in dehydration kinetics and technological parameters were detected between treated and untreated grapes. In cv. Sangiovese, ozone gas treatment resulted in higher levels of phenolic acids, flavanols, flavonols, and flavanones after 7 days of dehydration. Phenolic acids and stilbenes were higher in ozonated berries at final stages (25% and 31% weight loss). In contrast, cv. Corvina showed limited changes in phenolic profiles. In both cultivars, ozone treatment altered the berry amino acid pool. Transcriptomic analysis showed upregulation of stress-related genes, including peroxidases, phytosulfokines, and pathogenesis-related proteins, shortly after exposure to high ozone concentrations. However, modulation of transcripts related to secondary metabolism was minimal. Overall, this study highlights the physiological response of grapes to ozone during postharvest dehydration. Sanitizing grapes using ozone will significantly increase their capacity to withstand higher temperature and humidity conditions, reducing spoilage and production losses.

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Survey and monitoring of fresh fruit and vegetable storage facilities and technologies in Italy

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The National Biodiversity Future Center (NBFC) is one of five centers launched through Italy's National Recovery and Resilience Plan (PNRR), aimed at promoting frontier research across institutions and enterprises nationwide. As the first national center focused on biodiversity, the NBFC seeks to position biodiversity as a cornerstone of sustainable development. Within this framework, the Scuola Superiore Sant'Anna of Pisa, particularly the Institute of Crop Science, in collaboration with the SOI Postharvest Working Group, initiated a dedicated project to investigate the status, organization, and technological level of postharvest storage and handling facilities for fresh fruit and vegetable products in Italy. Special attention was given to the diversity of products and the storage protocols adapted/optimized for each crop. The year-long survey began in late 2023 and was based initially on the official list of Producer Organizations (POs), updated in January 2023, and classified by region. Notable companies outside PO networks were also included. A total of 249 companies from across the country (excluding Valle d'Aosta, Liguria, Umbria, and Molise) were selected and contacted via questionnaires and/or on-site interviews. A total of 65 completed questionnaires were received from 60 companies. The collected data provide an overview of company size, product types, storage facility features (age, construction materials), applied protocols, system types (refrigeration and controlled atmosphere), pre-cooling techniques, postharvest treatments, and processing lines. Though preliminary, the findings offer valuable insight into Italy's fresh produce storage sector and build upon previous regional studies, such as the one by Ri. Nova Soc. Coop. under the Emilia-Romagna Rural Development Plan (Measure 16.1.01). Continued expansion of this research could offer crucial data for both industry and research, supporting innovation and addressing ongoing challenges in the postharvest storage/handling of horticultural products.

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Preharvest chlorogenic acid treatments enhance the physico-chemical parameters of 'Navel' oranges during cold storage

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The quality of orange fruit at harvest determines its postharvest storability. This study therefore analysed the effect of preharvest treatments with chlorogenic acid (CGA) at 5 and 50 mg L^{-1} on quality traits at harvest and during 60 days of cold storage. The results showed that oranges treated with 5 mg L^{-1} CGA experienced lower weight loss and exhibited higher firmness values. This treatment also reduced the respiration rate at harvest and during cold storage. Oranges treated with 5 mg L^{-1} CGA were found to have a lower maturity index due to higher titratable acidity compared to control fruit and those treated with 50 mg L^{-1} CGA. The results for the citrus colour index showed lower values in fruits treated with 5 mg L^{-1} CGA, coinciding with carotenoid accumulation in the flavedo. The total phenolic content in the flavedo and juice was lowest in fruits treated with 5 mg L^{-1} CGA. Therefore, 5 mg L^{-1} CGA could effectively delay maturation on the tree and improve the postharvest storability of 'Navel' oranges.

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Improving postharvest performance in melon through the introgression of ripening-related QTLs

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Food production is responsible for 22% of global greenhouse gas emissions, with approximately one-third of all food produced lost annually. The United Nations Sustainable Development Goal (SDG) 12 aims to reduce food waste by 50% by 2030. In this context, extending the postharvest shelf life of fruits like melon represents a promising strategy to minimize losses and improve supply chain sustainability. This study evaluated the effect of introgressing non-climacteric quantitative trait loci (QTLs) from 'Piel de Sapo' melon cultivar into the climacteric genetic background of 'Védrantais' cultivar. Three melon lines were developed: two with single introgressions on chromosomes 6 (ETHQV6.3) or 8 (ETHQV8.1), and one with both QTLs combined (ETHQV6.3 + ETHQV8.1). Ethylene production was quantified, and the activity of key biosynthetic enzymes involved in ethylene production, ACC synthase (ACS) and ACC oxidase (ACO), was determined. Oxidative stress was evaluated through malondialdehyde (MDA) quantification, and antioxidant systems were assessed by measuring total antioxidant capacity and phenolic content.
Postharvest storage was studied under cold conditions (4 °C) and simulated shelf life (20 °C) at different time points. Fruit quality parameters were analyzed, including soluble solids content (SSC), titratable acidity (TA), firmness, texture profile analysis (TPA), fruit weight, and shape. Volatile compounds related to melon aroma were also evaluated by GC-MS. The lines with the ETHQV8.1 introgression and the double introgression (ETHQV6.3 + ETHQV8.1) did not produce ethylene and showed no ACS or ACO activity, confirming the inhibition of ethylene biosynthesis, with potential to delay ripening. These lines also maintained higher SSC and firmness during storage without negative effects on fruit weight, shape, or texture.
These results indicate that ETHQV8.1, along with its interaction with ETHQV6.3, may contribute to delaying ripening and improving melon quality and shelf life, offering a valuable tool for breeding programs aimed at reducing postharvest losses.

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Effect of combined field and postharvest treatments with pine resin biostimulant on the quality and shelf life of cold stored pigmented oranges *(Citrus sinensis* L. Osbeck cv Tarocco orange).

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Field and postharvest alterations significantly impact the plant growth, production, quality and shelf-life of citrus fruit, thus compromising their market value and consumer acceptability. Plant biostimulants can be considered a sustainable approach to enhance nutrient uptake, crop quality traits and tolerance to biotic and abiotic stress. In this context, the aim of this study was to investigate the effects of a pine-resin-based formulation on the growth and yield of Tarocco orange under open-field conditions, as well as on the quality and shelf-life of harvested fruits during cold storage. Pine resin was applied monthly in the field from September until harvest, either alone (RDP) or in combination with a seaweed extract (RDP+A), using combined foliar and root applications. Copper (CU) was used as the conventional treatment, while water (W) served as the control. In the postharvest phase, RDP, imazalil (IMZ) as the conventional treatment, and water (W) as a control were applied by fruit dipping, to assess their synergistic effect on improving the quality of Tarocco orange fruit during storage at 5±1°C and 90-95% RH for 60 days. In the field, trees volume, leaf SPAD index, fruit size increase, peel colour, yield and fruit drop were evaluated. On harvested fruit, weight loss, fruit volume and weight, peel and pulp colour, texture, microbial growth, bioactive compounds, and other chemical parameters were assessed throughout cold storage. Field application of RDP increased some quality traits, including SPAD index and yield, compared to the water (W) control. In postharvest trials, RDP was effective in reducing weight loss, retaining firmness, and increasing colour, total phenols and anthocyanins content, compared to W control, when combined with RDP and RDP+A field treatments. Other qualitative parameters did not show particular differences among treatments. Overall, the application of pine-resin-based formulations may be considered a sustainable strategy to obtain higher product quality with reduced environmental impact.

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Control atmosphere storage mitigates black spot development in Hass avocado exocarp

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Exocarp blackspot disorder in “Hass” avocado (*Persea americana* Mill.) manifests as dark lesions after cold storage, impacting postharvest fruit quality and marketability. This study aimed to elucidate the molecular mechanisms underlying blackspot development and its prevention under controlled atmosphere (CA) conditions through an integrative multiomics approach combining transcriptomic, metabolomic, and hormonal analyses. Export-quality “Hass” avocados were harvested at early maturity and stored for 30 days at 5°C under either regular air (RA) or CA (4 kPa O_2/6 kPa CO_2) conditions. Exocarp tissues from healthy and blackspot-affected fruits were collected and subjected to RNA sequencing, comprehensive metabolite profiling (polar, non-polar metabolites, fatty acids, phenolics), and targeted hormone quantification. Results revealed that blackspot-affected tissues accumulated higher levels of jasmonic acid, salicylic acid, gibberellins, and long-chain fatty acids, accompanied by upregulation of stress-related genes, including several peroxidases, lipoxygenases (PaLOX2), β-galactosidases (PaBGAL17, PaBGAL15), and transcription factors (PaWRKY55, PaZIFL1). Conversely, fruits stored under CA exhibited elevated levels of indole-3-acetic acid (IAA) and isopentenyladenine (iP), correlating with the absence of blackspot symptoms. Candidate metabolites (oleic acid, myoinositol) and transcription factors (PaMIF2, PaGRF9, PaMYB4R1) were associated with the maintenance of exocarp integrity under CA storage. The multiomics integration uncovered strong correlations between specific hormonal profiles, fatty acid composition, and gene expression patterns linked to both blackspot occurrence and its prevention. Notably, evidence suggests that the JA biosynthesis pathway, fueled by α-linolenic acid utilization, plays a pivotal role in blackspot symptomatology. These findings advance our understanding of blackspot disorder in avocado and provide molecular targets for developing strategies to prevent its occurrence during postharvest storage.

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Kiwifruit non-destructive quality evaluation using near-infrared spectroscopy: a comparison between standard and advanced chemometric algorithms

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Accurate assessment of internal fruit quality is crucial for postharvest management, supporting decisions on storage, marketing, and logistics. Near-infrared spectroscopy (NIRS) has emerged as a non-destructive tool to monitor key parameters such as soluble solids content (SSC) and firmness (F). This study investigates the potential of NIRS combined with machine learning models and integrated spectral preprocessing and feature selection techniques to predict the postharvest quality of kiwifruit from harvest to early storage. In addition to the traditional models, including Principal Component Regression (PCR), Partial Least Squares Regression (PLSR), and Support Vector Machines (SVM), the present paper describe the results obtained using innovative algorithm integrating optimized spectral preprocessing with variable selection techniques such as the Random Frog Algorithm (RF), Competitive Adaptive Reweighted Sampling (CARS), and Variable Importance in Projection (VIP), to improve the predictive performance on unknown samples of kiwifruit about F and SSC.
Among all the tested models, variable selection using CARS proved to be the most effective for predicting both SSC and kiwi F. The CARS-PLS model with second derivative and MSC normalization showed the best performance for SSC (R^2CV = 0.943; RMSECV = 0.976), while for F the best result was obtained with CARS applied to raw data (R^2CV = 0.892; RMSECV = 9.061). In both cases, the performance was also confirmed in external validation, with R^2P = 0.945; RMSEP = 1.053; RPDP = 4.32 for SSC, and R^2P = 0.812; RMSEP = 11.322; RPDP = 2.33 for F. These results highlight the value of integrating NIRS with variable selection and optimized preprocessing to improve model accuracy and generalization, supporting the development of reliable, data-driven tools for non-invasive quality monitoring along the fruit supply chain. Moreover, the results represent a preliminary step in designing an online control system for an electronic kiwifruit sorting line.

This study was carried out within the Agritech National Research Center and received funding from the European Union Next-Generation EU (PIANO NAZIONALE DI RIPRESA E RESILIENZA (PNRR) - MISSIONE 4 COMPONENTE 2, INVESTIMENTO 1.4—D.D. 1032 17/06/2022, CN00000022).

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Oral session II

Ripening, quality assessment, maintenance & sustainability of postharvest management

Second life of berry by-products: laboratory investigation for applicative solution

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In the postharvest phase fruit goes on towards the loss of quality. Perishability is actually a big problem for berries, due to their morphology and physiology, thus implementing the quality loss with respect to other major fruit. Postharvest technologies are improving every day to guarantee the longest quality maintenance of fruit, nevertheless, part of the production will always be discarded from the fresh market, mainly due to visual and colour defects and altered texture. Thus, waste is produced. The situation of blueberry and baby kiwi has been analysed. The objective of the research is the valorisation of the by-products from the packhouse proposing innovative and green solutions, also paying attention to the nutritional aspects. The upgrade of these wastes will consider also their geographical origin and the potential implementation and inclusion in the local production activities. Technologies such as drying, lyophilisation and spray-drying have been considered to obtain a snack or semi-finished product with multiple application possibilities, such as powders, additional ingredients or direct consumption. The characterisation of each product, starting from the raw material, will help in defining its role in recipes in terms of both technological and nutritional value. The main aspect emerged regards the colour of the product: drying, in fact, leads to the matrix browning and a deep change in the organoleptic characteristics. Textural changes also occurred according to the different water removal rates of each technology. Preliminary investigation of possible use as ingredient has been evaluated through water solubility index and water absorption capacity. As concerns about packaging may arise, water activity (aw) parameters have been considered. To conclude, the valorisation of damaged berries is interesting, but it is necessary to optimise the production, considering the utilization purpose and the economic aspect.

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A holistic approach to fruit quality assessment in postharvest conditions: the importance of combining molecular, chemical, qualitative and sensory traits

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Chilled postharvest storage is the most widely used treatment to extend fruit shelf life, including that of each (*Prunus persica*) fruit. However, it can lead to fruit deterioration affecting quality characteristics, including texture, taste and aroma. In this study, a comprehensive approach, using chemical, sensorial, qualitative and gene expression analyses, was taken to explore the response of peach fruit (cv 'Sagittaria') exposed to 1°C and 4 °C for up to fourteen days. Qualitative traits fluctuated during storage; however, titratable acidity decreased at a faster rate at 4°C. The overall aroma profiles overlapped between temperatures, however differed between time-points. Among sensorial parameters harmony, showed positive correlation with parameters commonly associated with positive consumer perception such as fruitiness, juiciness and sweetness and increased from day 5 of storage with a higher rise for the fruit stored at 4°C. An augmented statistical approach revealed that the key sensory descriptor, harmony, was associated with fifteen favourable aroma compounds including acetyl acetate, 1-Hexen-3-one and 2-ethylfuran. The 15 aroma molecules were further tested by means of Weighted Gene Co-expression Network Analysis in association with differentially expressed genes deriving from a transcriptome analysis. A total of 633 Differentially Expressed Genes were associated with the favourable compounds. The gene 1-Aminocyclopropane-1-carboxylate synthase showed a significant correlation with 13 of the favourable compounds, while genes involved in the polyunsaturated fatty acid pathway associated with 11 compounds. The expression profile of several of these genes increased significantly from the day of harvest until the last day of storage. The combination of four approaches allowed an in-depth survey of postharvest parameters influenced by time and temperature revealing associations between sensory, qualitative, chemical and gene-expression traits. These findings provide a wide range of valuable insights for producers and breeders to optimize storage conditions, improve fruit quality, and increase consumer satisfaction and market competitiveness.

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Genotype effect on green almond (*Amygdalus communis* L.) behaviour

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Green almonds (*Amygdalus communis* L.) are appreciated for their unique taste and health promoting properties, yet their high perishability limits large-scale commercialization. This study assessed the postharvest behaviour and phytochemical profile of four genotypes ('Tuono', 'Ferragnes', 'Genco', 'Vairo') harvested at green stage. Parameters evaluated included respiration rate, weight loss, color variation, polyphenol and flavonoid content, antioxidant activity (DPPH, FRAP, CAA), and fiber fractions over four weeks of cold storage. 'Ferragnes' showed the highest initial levels of polyphenols and flavonoids but declined during storage. In contrast, 'Genco' emerged as the most suitable for fresh consumption, displaying high postharvest stability, with preserved or even enhanced antioxidant capacity, minimal weight loss, stable color, and a balanced fiber profile. These traits suggest 'Genco' is a promising candidate for fresh green almond commercialization, combining sensory appeal with nutritional quality over time. Findings highlight the relevance of genotype selection to improve shelf life and functional quality in green almonds.

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Influence of preharvest selenium applications and ripening stage on cherry tomato fruit quality during cold storage

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Tomato (*Solanum lycopersicum* L.) is one of the most important vegetables throughout the world, despite its climateric nature and potentially limited shelf life. Given their composition and high per capita consumption, tomatoes represent a valuable dietary source of micronutrients and bioactive compounds, playing a significant role in human diet. Recently, consumers' efforts in supplemental dietary intake of selenium (Se) have increased due to its beneficial role in preventing aging-related diseases and its essential function as a constituent of selenoproteins. Different Se biofortification protocols have been developed for tomato; however, research exploring its possible influence on tomato shelf life remains limited. This study investigates the effects of preharvest foliar applications of Se (as Na 2 SeO 4 , 0.5 mmol Se L -1) on key carpometric and compositional quality traits of cherry tomatoes (cultivar Durillo) harvested at two ripening stages, namely red stage (S1) and full-red stage (S2), and stored at 11.0 ± 0.5 °C for 0 (S 0), 10 (S 10), and 20 days (S 20). Compared to untreated fruits, the Se application promoted fruit firmness, dry matter content (DM), total soluble solids (TSS), titratable acidity (TA) and Se fruit content, but reduced the total carotenoid content (TCC). The S2 fruits showed the highest DM content, TSS and TSS/TA ratio (+4.1%, +10.2%, and +24.4%, respectively). Differently, the S1 fruits retained higher TA and total phenolics over time. At T 10, the S2 fruits proved the strongest variations in fruit firmness (-32.4%), fresh weight loss (FWL, -9.6%), a* (-6.2%) and b* (-7.8%) color components. Overall, the Se application delayed the decline of several quality traits associated with fruit over-ripening, highlighting its potential role in preserving key quality traits over time and thereby extending the shelf life of cherry tomatoes.

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Metabolic and molecular responses of 'Red Delicious' apple to static and dynamic extreme low oxygen concentrations during storage

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Red Delicious (RD) apples benefit from storage under low oxygen, which delays ripening and maintains fruit quality. However, sensitivity to such conditions often causes excessive accumulation of ethanol/off-flavors, and the onset of storage disorders, leading to unmarketability and losses. To mitigate these effects, Initial Low Oxygen Stress (ILOS) storage has been applied. ILOS involves exposing fruit to very low oxygen levels (<1kPa) at the beginning of cold storage, switching it to higher levels after few weeks and triggering stress responses that impact both fundamental and specialized metabolisms. To investigate these responses, RD apples were stored at 1 °C under different conditions: normoxia, extremely low oxygen (ELO; 0.3 kPa O_2,1.1 kPa CO 2) for 180 DIA, and ILOS (0.3 kPa O_2 for 30 DIA followed by 0.8 kPa for 150 DIA, 1.1 kPa CO 2). Peel and flesh tissues were collected separately at 30, 90, and 180 DIA and evaluated through transcriptomic and metabolomic analyses. Results confirmed strong induction of ethanol and high accumulation of ethyl esters and alanine under ELO. Common and tissue-specific responses between peel and flesh were identified. Both tissues accumulated non-ethyl esters under normoxia, anaerobic-related VOCs under ELO, and amino acids like valine and lysine under ILOS. Tissue-specific responses included higher polyphenol accumulation in the flesh under hypoxic storage and in the peel under normoxia. Transcriptomics analysis confirmed and complemented these findings, highlighting the possible role of ERF transcription factors in low oxygen responses. Notably, ERF-VII members MdRAP2.2, MdRAP2.3, MdRAP2.12, and the hypoxia-responsive MdHRE1, MdHRE2, and MdHRE-like, showed differential regulation under ELO and ILOS, with more moderate responses after ILOS. Genes commonly affected by hypoxia were mainly involved in polyphenol and amino acid metabolism, consistent with observed metabolomic patterns in the flesh. The study provides insights into metabolic and molecular adaptations underlying common and tissue-specific responses to low oxygen storage in RD apples.

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Postharvest application of short-term high CO_2 treatments enhances blackberry quality during low-temperature storage

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Red drupelet reversion (RDR) is one of the main postharvest disorders affecting blackberry quality during cold storage. Although high CO 2 treatments, such as controlled atmosphere and modified atmosphere packaging, have been explored to mitigate this issue, the effect of short-term applications has not been studied until now. This study aimed to evaluate the effectiveness of short-term treatments (3 days) at 1 °C with high levels of CO 2 (15% and 20 %) on the quality of two blackberry cultivars (Rubus fructicosus cv. DR-BK-0047 and DR-BK-1021), which differ in their susceptibility to RDR during cold storage. To assess fruit quality, several parameters were analyzed in treated and non-treated samples: RDR index, decay incidence, titratable acidity, total soluble solids, pH, total phenolic and anthocyanin content, antioxidant activity (ABTS and FRAP assays), and firmness. In addition, the relative expression of genes encoding key enzymes in the phenylpropanoid biosynthesis pathway—PAL, CHI, UFGT, FLS, LAR, and ANR—was evaluated. CO2 treatments effectively reduced RDR in both cultivars, with a more pronounced effect in DR-BK-0047, the more susceptible cultivar. They also decreased decay incidence and helped maintain fruit firmness, especially with the 20% CO 2 treatment. Furthermore, high CO2 concentrations modulated the transcriptional expression of genes involved in polyphenol biosynthesis, suggesting a molecular mechanism underlying the preservation of fruit quality. These results demonstrate that short-term exposure to high CO2 levels at low temperatures is a promising postharvest strategy to control RDR, reduce decay, and maintain the physicochemical and antioxidant properties of blackberries.
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Effect of pre-harvest heat stress on post-harvest physiology, metabolism, and gene expression at harvest and after chilled storage

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Rocket salad (Diplotaxis tenuifolia) is widely appreciated for its peppery flavour and nutritional content. However, it has a short shelf-life, and to prolong the life of leaves post-harvest, they are typically refrigerated. However, storage imposes multiple combined stresses on the young leaves including darkness, cold, and dehydration. The crop is also increasingly subject to stress during growth due to climate changes: in particular, more frequent heat waves can be problematic. We hypothesised that pre-harvest heat stress might still affect the rocket salad leaves after post-harvest chilled storage. We exposed 30-day old salad plants to 3 days of elevated heat (35 °C) immediately before harvest (controls were kept at 22 °C), and storage of harvested leaves for 7 days at 6 °C. We recorded effects on volatile organic compound (VOC) profiles, the overall metabolome, and transcriptomes. Physiologically, the leaves showed signs of increased damage such as reduction in chlorophyll content and increased ion leakage post-harvest as a result of the pre-harvest heat stress compared to controls. VOC and metabolome profiles were significantly affected by the pre-harvest heat stress even after 1 week of chilled storage. Transcriptomic analysis revealed changes in expression of over 900 genes after pre-harvest heat treatment and after 7 days of chilled storage. GO term and KEGG analysis of over-represented pathways indicates that after 1 week of chilled storage the most affected processes were stress responses, secondary metabolite biosynthesis and responses to hormones. Changes were consistent with models developed in the better studied model plant Arabidopsis in response to dark storage. These include preparation for senescence through chlorophyll and macromolecular degradation. Comparisons between changes in VOCs and gene expression suggest layers of post-translational regulation. Understanding the effects of pre-harvest heat stress provides us with tools for improved management strategies to maintain nutritional value during storage

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Preharvest potassium silicate treatments affect morphological appearance and enhance the quality of almond kernels

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The almond industry requires new strategies to improve the quality of almond kernels. The use of biostimulants such as potassium silicate (KSi) is an eco-friendly and non-polluting alternative. The aim of this work was the preharvest application of KSi solutions at 0.1 and 1 % to 'Peraleja' almond trees during two consecutive seasons to elucidate the effect on almond kernel quality at harvest. The results showed that the fresh weight, length and width of almond kernels treated with 1% KSi increased compared to the controls. Furthermore, 1% KSi almonds had a more elongated morphological appearance, while 0.1% KSi almonds were more spherical. Regarding nutrients, phosphorus and potassium levels increased in 0.1% KSi almonds, while magnesium content decreased in both KSi treatments. Total antioxidant activity and total phenolic content increased in almonds treated with 1% KSi almonds. In addition, significant differences in fatty acid levels were observed, particularly in oleic (O) and linoleic (L) acids. On average, the O/L ratio of almonds treated with 0.1% KSi was higher than those treated with 1% KSi and the controls. Therefore, based on these results, the effect of preharvest KSi treatments on almond kernel quality depends on the concentration, with both having potential applications in industry.

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Short-term CO_2 treatments improve firmness and phenolic content in organic blueberries during postharvest storage

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Blueberries (Vaccinium spp.) are soft fruit whose consumption has been increasing in recent years. This is partly due to their high content of phenolic compounds, which provide antioxidant properties beneficial to consumer health. However, the shelf life of these fruits is compromised by their high respiration rate, firmness loss and fungal attacks during postharvest storage. To extend the postharvest life of these fruits, short-term treatments with high concentrations of CO 2 (15-20%) at low temperature (1 ºC), were tested on two organic cultivars, Duke (highbush) and Ochlockonee (rabbiteye), harvested in June and September, respectively. Various quality and firmness parameters were evaluated, along with total anthocyanin and phenolic content and antioxidant capacity. Additionally, the expression of genes involved in the phenylpropanoid pathway and those related to cell wall maintenance and fruit firmness was studied. The results showed that the 3-day treatment with 20% CO 2 was more effective than the 15% CO 2 treatment in maintaining fruit quality. Both treatments modulated the expression of genes related to firmness, although the effect was more evident in the Duke cultivar. Regarding phenylpropanoid content, the CO_2-treated fruits of both cultivars showed higher levels of anthocyanins and total phenolics than non-treated fruits, which corresponded with a greater antioxidant capacity. Likewise, genes in the phenylpropanoid pathway were differentially modulated by the CO 2 treatments. In conclusion, short-term high-CO 2 treatments are effective for the postharvest preservation of blueberries, enhancing their health-promoting properties while preventing firmness loss and fungal attacks.

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Valorisation of polysaccharides extracted from avocado peel and seed for the production of edible coatings for fruit preservation

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There is a growing need to find new uses for biopolymers and active molecules derived from the agro-food industry. These biopolymers can be valorised as substrates for the design of active edible coatings and packaging materials for perishable foods contributing to circular economy principles. In the current work, hemicellulose, starch and lignin were extracted from avocado peel and seed residues with the aim to develop a formulation capable of carrying lauroyl arginate ethyl (LAE) as an antifungal agent. These compounds were mixed to create a sustainable and ecofriendly film forming solution that can be used as an edible coating to maintain avocado. Different percentages of LAE (2.5, 5 and 10% g /100 g biopolymer blend) was incorporated to the film-forming formulation. The antifungal effectiveness of this formulation was studied in vitro against *Colletotrichum gloeosporioide*. In addition, an *in vivo* analysis was carried out as a curative treatment by applying the final formulation on avocados previously inoculated with *C. gloeosporioide* and stored at 12 ºC. The degree of infection, fungal severity and the difference in color (AE) of the avocado pulp was evaluated at days 0, 6, 12, 18 and 20. The film formulated with 10% LAE presented *in vitro* fungicide effect. Therefore, *in vivo* antifungal studies were carried out with this formulation. The results showed that the fungal inhibition was greater in avocados coated with the film forming solution incorporating LAE. Moreover, some fungal inhibition was detected in avocados coated with the edible formulation without the active compared with uncoated avocados. The last day of the study, the infection of coated avocados without LAE was 100% compared to 66.66% for avocados coated incorporating the active, achieving uncoated avocados the greatest values of infection severity. The difference in pulp color was higher in the control avocados. In conclusion, this work demonstrated that the use of avocado residues to develop active coating for avocado can be a circular economy option to protect and improve avocado shelf life.

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Oral session III

Minimal processing and packaging of horticultural products

Modified Atmosphere Packaging (MAP) to preserve the organoleptic and nutraceutical properties of edible flowers

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Edible flowers are becoming increasingly popular as food products because of their aroma, colour, visual appeal and health-promoting compounds. A few days after harvesting, depending on the species, edible flowers begin to wilt, dehydrate and discolour. Along with the decline in appearance comes a loss of nutraceutical content, resulting in an overall loss of quality. The key to slowing down the onset of senescence is to store and transport edible flowers at low temperatures. In addition to storage temperatures, proper packaging can further extend the shelf life of edible flowers, ensuring food protection and safety from harvest to consumption. Modified Atmosphere Packaging (MAP) technology, which works by altering O2 and CO2 levels within the food package to reduce respiration rates, microbial growth and slow down enzymatic activity, has been successfully used to extend the shelf life of fruit and vegetables, but has been studied little in edible flowers. In this study, the effect of passive and active (N2: 100%) MAP technology coupled with cold storage on the post-harvest performance of three edible flowers, namely Begonia grandiflora 'Viking', Tropaeolum majus L. and Viola cornuta L. was evaluated. Active MAP was more effective than passive MAP in maintaining petal colour and slowing down the decay of edible flowers, reducing flower respiration in all three species and sugar consumption in begonia: it reduced weight loss in nasturtium and better preserved TPC in begonia and viola. Thus, this technology could help to preserve the organoleptic and nutraceutical properties of edible flowers, making them more available on the market.

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Biochemical, technical and applicative characteristics of pullulan produced by *Aureobasidium* pullulans: a sustainable apple coating

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Pullulan is a polysaccharide with multiple beneficial properties that makes it perfect for several applications and for the food industry. The polysaccharide is produced by Aureobasidium pullulans, a black yeast also known for its antagonistic properties against plant fungal pathogens. Ten strains, isolated from different environments, were evaluated for their pullulan producing ability. Three strains were selected as main producers (AP1, UOR18, M13). The pgm1 and ugp genes expression was evaluated, showing a significant difference between the strains. Pullulan produced by the strains was biochemically characterized by FT-IR (Fourier Transform Infrared Spectroscopy), DSC (Differential Scanning Calorimetry) and NMR (Nuclear Magnetic Resonance) analyses. By FT-IR and DSC analysis, the AP1 pullulan displayed to be more capable to entrap moisture in its structure, and by NMR, it showed to be more similar to the commercial pullulan. The biopolymer was formulated as apple coating, used to control fungal pathogens by in vitro and in vivo assays. The coating was activated by yeast cells that enhanced the antifungal activity of the treatment.

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Balancing postharvest quality preservation and aroma development: effects of DCA-CF and 1-MCP on 'Red Delicious' and 'Granny Smith' Apples

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Advanced storage technologies play a critical role in preserving postharvest apple quality by extending shelf life and maintaining key sensory traits. Among these, dynamic controlled atmosphere based on chlorophyll fluorescence (DCA-CF) and 1-methylcyclopropene (1-MCP) have demonstrated significant effectiveness in retaining texture, acidity and background color, while reducing the incidence of physiological disorders, especially superficial scald. Dynamic Controlled Atmosphere (DCA-CF) is a storage technology that monitors fruit hypoxia through chlorophyll fluorescence, enabling early detection of oxygen deficiency and preventing the onset of anaerobic metabolism in apple fruit during the storage period. 1-Methylcyclopropene (1-MCP) is a synthetic compound used to delay fruit ripening and senescence by binding ethylene receptors. However, their influence on the synthesis of volatile organic compounds (VOCs), key contributors to fruit aroma, raises questions about possible trade-offs in flavor quality. The present study investigated the effects of different storage conditions, regular air (RA), ultra-low oxygen (ULO) and DCA-CF alone or combined with 1-MCP, on the overall quality of two apple cultivars, 'Red Delicious' and 'Granny Smith'. Results revealed cultivar specific responses: 'Red Delicious' showed a greater sensitivity to storage conditions, with overall quality being more affected by the chosen technologies. However, it also exhibited a higher and more diverse VOC profile compared to 'Granny Smith', which displayed a more stable and less responsive behaviour. Both DCA-CF and 1-MCP effectively mitigated superficial scald development. While DCA-CF storage, particularly when combined with 1-MCP, significantly enhanced overall fruit quality, it also markedly suppressed VOC production, especially alcohols and esters, whereas aldehydes were less impacted. These findings underscore the importance of balancing post storage quality with aroma preservation, especially in light of increasing consumer awareness of flavor and the growing emphasis on the "flavor-life" paradigm in postharvest management.

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Postharvest application of avocado by-product extracts to control *Citrus* green mold

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The industrial processing of fresh avocados generates a large amount of by-products, such as stones (AVS) and peels (APE), that represent a high percentage of the weight of the product and can cause environmental problems. These by-products are rich in bioactive compounds, which may have antifungal properties and represent a potential alternative to synthetic chemical fungicides for the control of postharvest fungal diseases of fresh horticultural produce. The extraction of high value-added compounds and consequent valorization of agri-food by-products is in line with the principles of the circular bioeconomy, the EU Green Deal, and the UN Sustainable Development Goals. In this work, AVS and APE extracts were obtained using green technologies such as ultrasound (UAE) and microwave-assisted (MAE) extractions. The total phenolic content (TPC) and total antioxidant capacity (TAC) of the extracts were determined. Antifungal activity against Penicillium digitatum, the causative agent of citrus green mold, one of the most economically important postharvest diseases of citrus fruits worldwide, was first assessed in vitro using microtiter plate assays. The curative activity of promising extracts was then tested in vivo on citrus fruits artificially wound inoculated, treated 24 h later with a 30 µL extract drop in the inoculation site, and incubated for 7 days at 20 °C. Regardless of source and extraction method, all extracts showed comparable TPC and TAC. In vitro, all AVS and APE extracts inhibited fungal growth by more than 95%. In vivo, the AVS-UAE extract, at a concentration of 8 mg/mL, reduced disease incidence (percentage of infected wounds) on 'Tango' mandarins and 'Lanelate' oranges by 30 and 53%, and disease severity (lesion diameter) by 10 and 69%, respectively. These findings suggest that AVS-UAE extract holds promise as an eco-friendly and sustainable postharvest treatment to be included within non-polluting integrated disease management (NPIDM) strategies for the control of citrus green mold.

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Changes in quality and biochemical features during storage in blood oranges in relation to the rootstocks used

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Consumption of blood oranges (Citrus sinensis L. Osbeck) is increasing worldwide due to their antioxidant capacity bound to the presence of several compounds (e.g. ascorbic acid, vitamins and polyphenols) having beneficial effects on human health. The red color of blood orange peel and flesh, the main parameter in consumers' choice, is due to the presence of anthocyanins (specialized metabolites of blood oranges), which vary greatly depending on the genotype, harvesting time, environmental conditions and agronomic techniques, including rootstock. Specifically, being anthocyanin biosynthesis and accumulation cold-dependent, low temperature post-harvest storage can enhance anthocyanin concentration in blood oranges improving at the same time the internal fruit quality. In the last 20 years sour orange (Citrus aurantium L.) has been replaced with already known or recently released Citrus tristeza virus (CTV) tolerant rootstocks in the Italian citrus industry, particularly citranges [Citrus sinensis (L.) Osb. × Poncirus trifoliata (L.) Raf.] and other Poncirus-derived intergeneric hybrids (i.e., 'Swingle' citrumelo). In this context, the influence of new and recently released rootstocks on the fruit quality during post-harvest was evaluated. The scion genotype was Tarocco Scirè blood orange grafted onto Carrizo citrange (C. sinensis cv. Washington navel × Poncirus trifoliata), C35 [C. sinensis (L.) Osb. cv. 'Ruby' × P. trifoliata (L.) Raf.], Swingle citrumelo (C. paradisi Macf. × P. trifoliata [L.] Raf.) and Bitters (C22) (C. sunki × P. trifoliata). Fruits of T. Scirè were harvested in March at physiological maturity, then stored for 60 days at 7 °C. The results of two years of observation showed that fruit of T. Scirè grafted onto C35 and Bitters had the highest peel and juice pigmentation, while Swingle determined the lowest values. Regarding simple sugars content, no differences were observed between citranges and Bitters. Overall, all rootstock affected fruit texture, juice biochemical composition and antioxidant activity.

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Effect of preharvest methyl jasmonate applications on the shelf life of fresh figs following a supply chain simulation

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The globalization of the fruit market means more time is needed to distribute products, which increases food waste. To mitigate these economic losses for companies and ensure consumer health, food must reach its destination in optimal condition, preserving both its nutritional properties and food safety. Within this context, fresh figs are particularly perishable and have a very short shelf life. Innovative preharvest strategies can enhance fruit resistance to both biotic and abiotic stresses during prolonged storage. Based on the literature evidence of the effect of methyl jasmonate (MeJa) as an elicitor in other crops, a trial was conducted in an experimental orchard of fresh figs, cv. 'Calabacita', in which two different concentrations (0.5 and 1 mM) were used with three applications per concentration once the fruit had reached physiological maturity. Fresh figs were harvested at commercial maturity and subjected to the supply chain conditions for these fruits. The results obtained at the beginning and the end of storage were statistically analysed. Differences among treatments were observed following the simulation of the supply chain. The 1 mM MeJa treatment was the most effective, as it delayed the colour change and maintained the ripening index and moisture percentage throughout the supply chain. Additionally, this treatment yielded larger fruits with enhanced enzymatic and non-enzymatic antioxidant activity against reactive oxygen species, as well as a higher total phenol concentration. Therefore, the 1 mM MeJa shows attractive results for inclusion as a preharvest treatment to extend the postharvest life of fresh figs.

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Development of a modified atmosphere package for peeled garlic using a predictive finite element model

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Peeled garlic has gained attention in the food service industry due to its high convenience. However, the processing steps involved may significantly enhance transpiration, respiration rate, and microbial growth thereby substantially reducing the product's shelf life. Modified atmosphere packaging (MAP) using microperforated films presents a promising strategy to mitigate these effects and extend the shelf life of such highly respiring produce. Given the complexity of MAP system design, which involves multiple interdependent factors, the implementation of computational fluid dynamics (CFD) models offers a powerful tool to effectively optimise packaging configurations. Thus, the main objective of this work was to develop a spatially resolved 3D model using COMSOL Multiphysics® to simulate the gas composition dynamics in the headspace of microperforated packages during the storage of peeled garlic. The respiration of peeled garlic was measured at 4°C using a closed-loop respirometer, equipped with oxygen and carbon dioxide sensors, and respiration kinetics were characterized and integrated into the model. The model builds upon a previously validated framework that fully couples mass transport based on the Maxwell-Stefan equations with laminar flow described by the Navier-Stokes equations for compressible Newtonian flow. Experimental validation was performed by measuring the oxygen and carbon dioxide concentrations within microperforated packages. The model facilitated the evaluation of various packaging parameters, including the number and size of microperforations, product load, and package dimensions, enabling rapid optimization of MAP configurations to achieve targeted gas compositions that effectively preserves product quality.

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A transcriptomic and structural approach to decipher coating-induced chilling tolerance in cold storage *Lanelate* oranges

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The application of postharvest coatings is a common practice in the management of *Citrus* fruits to control weight loss, enhance gloss and protect fruits from chilling injury (CI) during cold storage. However, the mode of action of coatings controlling CI and whether it may be related to water loss is currently unknown. To unveil these processes, we performed a morphological and transcriptional study in Lanelate orange, highly susceptible to CI, uncoated or coated with two commercial CI-control coatings (PlantSeal and Sunseal, Citrosol), stored for up to 8 weeks at 2 ºC. Uncoated fruits developed CI after 3 weeks storage that was largely reduced in both coated-fruits, despite having different rate of water loss. The scanning electron microscope analysis revealed depressions and cracking of epidermal cells in the surface of uncoated fruits associated with areas devoid of natural waxes and CI, that were also absent in coated fruits. To investigate the molecular responses to the coating-induced tolerance to CI, a global transcriptomic analysis (RNAseq) was performed. Around 1000 genes were differentially expressed (DEGs) in the three treatments after 3 weeks of storage compared to freshly-harvested fruits. Interestingly, most DEGs were common for the different treatments, indicating common responses to cold. In uncoated fruits, the proportion of DEGs overexpressed was higher than those repressed whereas the opposite proportion occurred in coated-fruits, underlining the molecular responses associated with chilling-damage or chilling-tolerance. DEGs with higher differences between uncoated and coated fruits involved defense against stress, cell wall remodeling and lignification. In addition, transcriptional changes in genes of ethylene biosynthesis or antioxidant enzymes, known to be implicated in the responses of citrus fruits to chilling, were also evaluated. In summary, a detailed analysis of the cellular and transcriptomic changes involved in the mechanisms of susceptibility to CI in Lanelate orange and in the coating-induced tolerance to CI will be discussed.

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Effect of PBAT-based biocomposites from cactus pear glochids on the shelf-life of loquat (*Eriobotrya japonica*) fruits: A zero-waste solution for sustainable packaging.

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The transition toward sustainable packaging materials calls for innovative solutions that valorize agri-food waste streams. In this study, the biocomposite was produced via melt-compounding with a twin-screw extruder by incorporating 10 wt% of cactus pear (Opuntia ficus-indica) glochids coming from the mechanical fruit brushing process (waste) into a poly (butylene adipate-co-terephthalate) (PBAT) matrix. The glochids, naturally micrometric and oblong, were used without physicochemical modification. Thin films (thickness of about 200 µm) of the biocomposite were obtained through compression molding using a laboratory press. Morphological, rheological, mechanical, and thermal characterizations were subsequently performed to evaluate the functional effect of the filler on the polymeric matrix. Biocomposite films were thermo-sealed to create bags, which were used to store loquat (Eriobotrya japonica) fruits. Qualitative, nutraceutical, microbiological, and sensory analyses were conducted throughout the cold storage period (0, 7, 14, and 21 days at 5 ± 1°C) and during three distinct shelf-life phases (I shelf-life: 7 days at 5 ± 1°C plus 5 days at 15 ± 1°C; II shelf-life: 14 days at 5 ± 1°C plus 5 days at 15 ± 1°C; III shelf-life: 21 days at 5 ± 1°C plus 5 days at 15 ± 1°C). The findings highlighted that the incorporation of cactus pear glochids not only enhanced the biodegradability and performance of PBAT films but also provided an effective, eco-friendly solution for fresh produce packaging. This approach successfully combines waste valorization with the creation of fully biodegradable packaging materials, contributing to sustainable packaging alternatives in the agri-food sector.

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Development patterns of 'Blanca de Tudela' artichokes and their postharvest implications

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Globe artichoke (*Cynara cardunculus* L. var. scolymus) is a traditional Mediterranean crop widely appreciated for its nutritional value, health-promoting compounds, and culinary versatility. In Spain, the cultivar 'Blanca de Tudela' holds significant economic and cultural relevance, particularly in regions such as the Valencian Community and Murcia. Its perennial growth habit and staggered flowering pattern result in the sequential emergence of multiple flower head orders (main, secondary, and tertiary) each with distinct morphological and physiological characteristics. Despite its agronomic importance, there remains limited knowledge regarding the in-plant developmental dynamics of artichoke heads and how these relate to postharvest performance. This study aimed to characterize the developmental progression of 'Blanca de Tudela' artichokes by evaluating growth patterns across the three flower head orders throughout the harvest season. In parallel, a specific focus was placed on secondary heads, which constitute a substantial proportion of commercial yield. These were classified into five internal developmental stages (S1 to S5) to assess how their development level influences postharvest quality during cold storage. Secondary heads were stored at 2 °C for 21 days, and quality parameters were periodically evaluated.

The findings provide a comprehensive understanding of flower head emergence dynamics and highlight the importance of harvest timing and physiological development for ensuring optimal postharvest behaviour. This work offers practical implications for growers and suppliers aiming to enhance the quality and shelf-life of artichokes, supporting better selection criteria and handling protocols during the commercial postharvest phase.

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Oral session IV

Innovative Strategies for Enhancing Quality and Stress Tolerance in Horticultural Crops

Detection of pesticide residues in table grapes by mean of hyperspectral imaging

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Detecting pesticide residue levels is critical for food safety assessment. Traditional detection methods are time-consuming and laborious, while non-destructive detection is rapid and ensures quality. This research uses time-series hyperspectral imaging of red grapes to classify pesticide residue levels over several days. A combined solution of two pesticides was diluted to five concentrations: 100% (T1), 80% (T2), 60% (T3), 40% (T4), and 20% (T5). The pesticide solution was applied by spray, simulating field conditions. After the spray, the grapes were stored at 0 ℃. Hyperspectral images were taken with a line-scan scanner in the visible near-infrared (Vis-NIR, 400-1000 nm) and near-infrared (NIR, 900-1700 nm) ranges 24 hours, 8 days, 15 days, and 19 days after treatment. For classification, the data set was divided into five classes according to treatments. Partial least square discriminant analysis (PLSDA) was used. Vis-NIR spectra did not discriminate well, showing accuracy lower than 70%, while NIR spectra showed better discrimination. Cross-validation (CV) accuracy after 24 hours was below 70%, while for the remaining days, the average CV accuracies for T1-T5 were 98%, 88%, 75%, 70%, and 94%, respectively. Preliminary results suggest good potential for this method, encouraging the use of fast non-destructive methods for detecting pesticides on grapes.

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Reducing chilling injuries in nectarines: the role of controlled atmosphere and its molecular mechanisms

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The fast-ripening process of *Prunus persica* fruits presents a significant challenge global distribution. Cold storage (CS) is an effective practice for extending fruit shelf-life, but it can lead to physiological disorders known as chilling injuries (CIs), which manifest as symptoms like flesh mealiness, bleeding and browning. Combining CS with controlled atmosphere (CA), characterized by elevated CO_2 and low O_2 levels, has been shown to mitigate CIs. This study explores the molecular mechanisms underlying CI development using transcriptomic and epigenetic approaches. For this purpose, we stored "Fantasia" nectarines, which are known to be susceptible to CIs, for 3 weeks under CS, both with and without CA. Fruits were evaluated at harvest (E1), after 3 days of shelf-life (E2), after 3 weeks of CS with (E3CA) and without (E3) CA, and 3 days of shelf-life after storage (E4 and E4CA). Physiological parameters were assessed, and transcriptomic changes were analyzed. Additionally, we performed a de novo genome assembly of the "Fantasia" cultivar using PacBio HiFi reads, complemented with Illumina short reads. During shelf-life, CA treatment improved the quality of "*Fantasia*" nectarines after CS by maintaining juice content and ethylene production, which significantly reduced mealiness and reddening incidence. Concordantly, CA-treated fruits (E4CA) exhibited a transcriptomic profile similar to that of non-stored fruits (E2) during ripening. The main transcriptomic changes were observed during storage, despite no phenotypic variation between storage conditions. Gene Ontology (GO) analysis indicated that CA alleviates CIs by modulating processes related to membrane stability, amino acid biosynthesis, ROS responses, heat responses, proteome configuration, epigenetic responses, and energy metabolism. We will further investigate epigenetic responses, including DNA methylation and post-transcriptional histone modifications, to better understand CA-related effects on CIs.

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Fatty acids metabolism and chilling injury in *Citrus* fruits: natural tolerance and preharvest factors

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Fatty acid (FA) desaturation has been long recognized as a critical adaptive response of plants to cold stress, since the increase in unsaturated fatty acids (UFAs) may enhance membrane fluidity, and thereby improve cold tolerance. Fruits of many *Citrus* cultivars are sensitive to developing chilling injury (CI) under postharvest storage to low temperature which depreciates their external quality and marketability. However, the involvement of FA desaturation in the responses of citrus fruit to postharvest cold storage that may induce CI are not well understood. In order to elucidate these processes, we have analysed the changes in FA content and composition, and the expression of a number of genes involved in different steps of FA metabolism in the peel of fruits of CI-sensitive and CI-tolerant Citrus cultivars, and stored for up to 8 weeks at 2°C. FA desaturase genes involved in the synthesis of main FAs displayed variable pattern of expression and, interestingly, differences between CI-sensitive and CItolerant fruits at harvest were detected. Moreover, the content of unsaturated FA increased during storage, suggesting a common adaptive response to low temperature, but genotypic differences were also detected in fruits at harvest. Collectively, our results reveal significant alterations in FA desaturation between CI-sensitive and CI-tolerant Citrus fruits during storage at low temperatures. Moreover, pre-harvest conditions appear to have a major influence on both FA desaturation and in the response of the fruit to low temperature storage, that will be presented and discussed

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A decision support system to reduce food waste along the distribution: a case study applied on wild strawberry

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Due to the high-quality standards required by the consumers of high-income countries, fruit and vegetables (F&V) at retail and home level are often wasted if sensory criteria are not met, even when nutritional or physical standards are still upheld or minimally modified. The present study proposes a methodology to improve the information available on the package label, based on a decision support system queried on demand by the consumer using a QR code linking to a remote hosted database. The case study focused on the cold storage of wild strawberries, a highly perishable product used mainly for pastry decoration and, to a lesser extent, processed by freezing, drying and chopping. An accelerated shelf life test was conducted using a randomized block design experiment that included three replications, five sampling periods, three temperatures (1, 10, and 20 °C), and different packaging system. The main market standards—sensory, chemical, and physical-mechanical—over a storage period of 15 days were followed up. The degradation kinetics for each parameter and condition were obtained, and the shelf life was fitted using an Arrhenius's model for the most sensitive attributes (off-flavour, visual appearance). Multivariate analysis carried out by PCA highlights the possibility to classify the samples after the storage period in three different quality groups, corresponding to end-use possibilities, such as "suitable for fresh consumption", "suitable for processing", "not suitable for food purposes". The groups are characterized by different quality parameter related to distinct degradation kinetics. All data of each group were uploaded on a MySQL database, on a remote hosting (www.smartpackaging.cloud), managed by decision models. The final result is the possibility for the consumer to exploit the QR code to know the information on the product quality level and its possible end-use at the day of the QR code scanning, on the basis of packaging system and temperature used for the distribution.

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Preharvest glycine betaine induces cold tolerance in mandarins

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Low-temperature storage, while crucial for preserving fruit quality and extending postharvest life, frequently induces chilling injury (CI) in susceptible cultivars such as 'Nadorcott' mandarin. Current consumer preferences for eco-friendly alternatives to synthetic chemicals are driving research into plant-derived compounds. Glycine betaine (GB), a naturally occurring quaternary ammonium compound, is recognized for its vital role in cellular osmotic adjustment, protein stabilization, and enzymatic function, all contributing to enhanced cold tolerance in plants. Despite its established benefits, the efficacy of preharvest GB application on citrus quality, particularly in cold-stored mandarins, has been largely unexplored. This study aimed to investigate the impact of preharvest foliar application of a GB-rich organic nitrogenous fertilizer (STRESSLESS®, derived from beet molasses) on the postharvest quality of 'Nadorcott' mandarins subjected to prolonged cold storage. Treatments included a control (distilled water) and two GB concentrations (15 mM and 30 mM), applied at three critical stages of fruit development and ripening. After 60 days at 1 °C followed by 10 days at 20 °C (shelf-life), a comprehensive set of quality parameters were evaluated, including weight loss, firmness, respiration rate, ethylene production, color, total soluble solids, total acidity, ripening index, ion leakage, CI incidence, malondialdehyde (MDA) content, and ascorbate peroxidase (APX) enzyme activity. Results demonstrated that the 15 mM GB treatment significantly mitigated weight and firmness losses, and reduced ethylene production compared to control fruits. Furthermore, this treatment significantly decreased CI incidence, correlating with reduced MDA content and ion leakage, indicating improved membrane stability. The 15 mM GB application also stimulated APX enzyme activity, suggesting enhanced antioxidant defense. In conclusion, preharvest application of glycine betaine, specifically at 15 mM, presents a promising strategy to extend the postharvest shelf-life of 'Nadorcott' mandarins and significantly reduce the incidence of physiological disorders such as CI, offering a valuable tool for sustainable fruit quality management.

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A biochemical and volatilomic approach to tomato shelf-life prediction: linking headspace volatile and physio-metabolic state

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The postharvest quality and shelf life of tomatoes, a climacteric fruit, are greatly affected by the physiological, biochemical, microbiological, and volatilomic interactions as influenced by biotic and abiotic factors. The complexity of these changes is frequently overlooked by the conventional quality assessment leading to inaccurate freshness evaluations and shelf-life predictions; thus, overall marketability is affected which could result in food waste. This study seeks to create a model for the prediction of the shelf-life of tomatoes using a holistic approach by combining the heads space volatile organic compounds (VOCs) profiling with important physio-metabolic indicators. Cherry tomatoes were used as sample model and were stored in a refrigerator at 6°C with 75% relative humidity to simulate a normal cold chain storage condition. The physicochemical, physiological, and microbiological parameters – including color, firmness, total soluble solids, titratable acidity, pH, respiration rate, and relative humidity – were monitored and gathered after 0, 3, 6, and 9 days of storage. Simultaneously, the VOCs released by the tomatoes were collected using Tenax TA sorption tubes and static headspace technique. Two-dimensional gas chromatography with flame ionization detector (FID) and mass spectrometer (MS) coupled with thermal desorption was used for VOC analysis. The obtained chromatograms were processed in a non-targeted approach using PARADISe software. Principal component analysis (PCA) was applied to find concealed patterns among VOCs and physio-metabolic changes. Hexanal, 2isobutylthiazole, 6-methyl-5-hepten-2-one, ethanol, acetic acid, acetoin, dimethyl trisulfide, and 3-methylbutanol were considered as biomarker for freshness and spoilage indicators among prominent volatiles. These volatiles were strongly correlated with oxidative stress markers and respiration parameters. The results indicate that using a holistic approach provides a better and faster evaluation of tomato´s quality and shelflife prediction than the conventional methods. This study provides a foundation for non-invasive techniques using sensor technology to optimize supply chains, reduce food waste, and promote sustainability.

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Comparison of volatile organic compounds, quality, and nutritional parameters from local italian and international apple cultivars

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Apple cultivars 'Annurca' and 'Limoncella' are grown locally in the Campania region of Italy and are valued for their distinctive flavour and characteristics, including a high content of nutritionally important bioactive compounds. However, apples are typically stored chilled for several months before consumption, so it is important to assess if the valuable characteristics are still present after postharvest storage. This study aims to evaluate the post-storage integrity of these key attributes. Here, we compare the quality, nutritional parameters, and aroma of these two cultivars with two widely grown international cultivars, 'Golden Delicious' and 'Fuji', after 60 days of storage. The aroma profiles of all four apples were analysed using thermal desorption and gas chromatography–time-of-flight mass spectrometry. We show that the local cultivars are distinct from the international cultivars in their bioactive compound content and their antioxidant activity. 'Annurca' and 'Limoncella' retained high levels of nutritionally beneficial compounds even after extended storage, highlighting their postharvest resilience. 'Limoncella' shows high sugar content, which may be acting as a cryoprotectant during storage, and high total phenolics in the flesh, which is of nutritional interest. We identified 104 volatile organic compounds (VOCs) and showed that the overall aroma profile is distinct for each cultivar, containing 11 published odorant compounds. The 'Annurca' profile is uniquely low in esters. These cultivar-specific aroma fingerprints suggest a strong genetic influence on VOC composition. Seven VOCs retain good discrimination across the four cultivars and, together with the quality and nutritional data, separate the two local cultivars from the international cultivars by hierarchical clustering. In conclusion, the data emphasizes the unique characteristics of the two local cultivars and their value as regionally adapted, nutritionally rich fruits with distinct sensory profiles that persist after storage.

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Chemical composition and anti-radical properties of coffee cherry cultivated in a Mediterranean climate

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The progressive shift in climatic conditions across the Mediterranean basin is enabling the cultivation of tropical and subtropical crops in this traditionally temperate region. This study explores the postharvest potential of coffee cherries (*Coffea arabica* cv. Caturra) grown experimentally in Sicily, Italy focusing on their chemical composition and antioxidant properties under Mediterranean climate conditions. Through detailed biochemical analyses, both coffee seeds and husks were evaluated, commonly regarded as by-products, highlighting their nutritional and functional profiles. Parameters assessed include total phenolic content, antioxidant activity, polyphenolic and alkaloid profiles, fatty acid and amino acid composition, as well as the presence of caffeine, vitamins, and minerals. Climatic data over more than a decade were also considered to contextualize the growth conditions. Results show that coffee cultivated in the Mediterranean has a composition of bioactive compounds comparable to that of traditional coffee-producing regions. The seeds exhibit significant antioxidant potential and a complex profile rich in chlorogenic acids, flavonoids, and alkaloids. Notably, coffee husks, often discarded, also revealed a valuable profile, with significant levels of phenolics, proteins, and essential nutrients, making them suitable candidates for use in nutraceutical or cosmetic applications. This research supports the feasibility of growing high-quality coffee in non-equatorial climates and highlights the importance of re-evaluating post-harvest coffee waste. By promoting the valorization of coffee husks, the study aligns with circular economic principles, offering new opportunities for sustainable fruit product management and diversification of agricultural systems in the Mediterranean area. In contrast to later harvested samples which seem to be more prepared for harvesting. Finally, the integration of omics data revealed that the phenylpropanoid pathway, exhibiting overexpression in early harvest samples, is primarily channeled towards the biosynthesis of lignin, quercetins, and epicatechins. Conversely, the anthocyanin biosynthesis pathway demonstrates repression when compared to late harvest samples. These findings, coupled with the observed color variations at harvest, indicate that the color transition in late-harvested fruits has already initiated by the time of harvesting, thereby promoting color synchronization.

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Nutritionally enriched edible coatings to improve the shelf-life of minimally processed pomegranate arils

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Minimally processed pomegranate arils are rich in fiber, vitamins, and potent antioxidants, making them a popular choice among health-conscious consumers. However, their widespread consumption is limited by two key challenges: the labor-intensive peeling process and their short shelf life due to rapid spoilage. This study investigates the use of edible coatings supplemented with citrus fruit by-products as a preservation strategy. Specifically, nano-emulsified extracts from lemon and grapefruit peels, along with their essential oils, were incorporated into coatings designed to prolong the freshness of pomegranate arils. Uncoated arils served as the control. Results showed that arils coated with the lemon by-product exhibited a significant reduction in mold and yeast growth, decreasing by 1.5 log CFU per g after 13 to 16 days at 5ºC, whereas other coatings did not demonstrate this effect. Additionally, the lemon by-product-based coating helped to maintain pH levels, while the control and other samples experienced a decline, likely due to lactic acid bacteria. Moreover, all coatings provided general protection against the degradation of anthocyanins and total phenolic compounds throughout shelf life, reducing their degradation by ~15-21%. Notably, the lemon by-product coating was the most effective in suppressing microbial growth while preserving the physicochemical and nutritional quality of the arils. While further optimization is needed, incorporating citrus by-products and essential oils into edible coatings offers a promising approach to extending the shelf life of fresh-cut pomegranate arils while enhancing their nutritional properties.

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Poster session

Combined immersion and microwave treatment to extend the shelf life of different varieties of *Artichokes*

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Artichoke (*Cynara scolymus* L.) is considered a healthy food because of its phytochemical and nutritional composition. However, the high polyphenol content makes artichoke difficult to commercialize as a fresh-cut product due to intense enzymatic browning. The objective of this work was to apply a combined treatment with an antibrowning agent (1.5% lactic acid for 1 hour) and a minimum microwave power (675 J/g) to inactivate the polyphenol oxidase (PPO) and extend the shelf life of different green and purple varieties of artichoke stored under modified atmosphere packaging (CO2 10% and N2 90%). Of the eight varieties studied, the two green varieties (Madrigal and Green Triump) showed good results in terms of color, firmness and sensory appreciation. Within the purple varieties, Brindisino and Spinoso Sardo showed the best results of firmness, however, Brindisino and Violetto di Manfredonia showed better results of color, also with good sensory scores. The weight losses were less than 1% for all varieties after 28 days at 5ºC. The gas composition in the bags remained at the initial settings but there was a slight increase in O2 (up to 0.6%) after 13 days at 5ºC. Total phenolic content decreased by 20-50% and antioxidants by 10-58% after MW treatment. In conclusion, treatment with 1.5% lactic acid + microwave was effective to inactivate the PPO enzyme in all varieties studied and maintain the quality of artichoke in a ready-to-eat format.

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Preharvest hesperidin: a strategy for accelerated tomato maturation and increased yield

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Preharvest application of hesperidin, a flavanone glycoside abundant in citrus, was observed to show promise in accelerating tomato fruit ripening and increasing total yield per plant. This study details the observed effects and potential mechanisms of hesperidin treatments on tomato ripening. Studies indicated that exogenous hesperidin influenced key physiological processes, including ethylene biosynthesis and respiration rates, which led to an earlier onset of ripening characteristics like color development, softening, and sugar accumulation. By promoting a more rapid and uniform ripening across the plant, hesperidin treatments were believed to potentially allow for earlier and more concentrated harvests, thereby reducing losses and increasing the overall number of ripe fruits produced per plant. This approach was considered a sustainable strategy for optimizing harvest timing and improving the economic viability of tomato production. Further research was deemed necessary to determine optimal application methods, concentrations, and the long-term impact on fruit quality and shelf life.

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Natural antifungal edible coatings as a sustainable strategy for preserving postharvest quality of citrus fruit

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Green and blue mold, caused by the fungal pathogens *Penicillium digitatum* Sacc. and *P. italicum* Weh., respectively, represent the most important postharvest diseases of citrus, leading to significant quality and economic losses. Current control strategies rely primarily on synthetic fungicides, the use of which is increasingly limited due to stricter regulations, environmental risk concerns, and growing consumer demand for products free of harmful residues. This study aims to develop antifungal edible coatings, derived mainly from processing waste, using natural extracts and essential oils along with pectin-based formulations, as a sustainable alternative to conventional fungicides. In a preliminary step, *in vitro* and *in vivo* screenings of natural extracts and essential oils were carried out to select the most effective in reducing *Penicilli* growth both on artificial microbial substrates and on artificially inoculated fruits. The coated citrus fruits were cold-stored, and decay incidence and severity, physical, chemical and microbiological quality were evaluated at different time intervals. Among the compounds evaluated, cinnamon and oregano essential oils showed the strongest antifungal activity, both *in vitro* and *in vivo*, effectively inhibiting the mycelium growth of *P. digitatum* and *P. italicum*, at diverse concentrations tested. Regarding the stored fruits, the combination of cinnamon and oregano oils with pectin resulted in low weight loss and helped maintain fruit firmness, as well as initial levels of peel and pulp color and titratable acidity. The results suggest that the tested formulations may represent a viable eco-friendly alternative for controlling postharvest fungal rots in citrus fruit, helping to reduce chemical inputs, preserving fruit quality, and improving the sustainability of production processes.

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Effect of controlled atmosphere with high carbon dioxide on quality of goji berry fruits (*Lycium barbarum* l.)

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Goji berry (*Lycium barbarum* L.), a superfruit with high antioxidant values, has a short shelf life, limiting its fresh market availability and leading to its primary marketing as dried or processed products. This study investigated the response of fresh goji fruits to controlled atmosphere storage with varying carbon dioxide (CO_2) concentrations. Replicates of 80 fruits were stored at 5 °C in humidified airflow enriched with 0% (control), 5%, 10%, or 20% CO_2 for up to 20 days. Firmness, overall appearance, soluble solids content (SSC), pH, titratable acidity (TA), vitamin C, total phenols, total antioxidant activity, visual damage, and mold incidence were evaluated. Results indicated that 20% CO_2 best maintained fruit quality, extending shelf life to 20 days with no mold and minimal visual damage. These fruits retained good firmness (e.g., 0.38 N), high SSC (e.g., 20.3%), and an overall appearance of 3.5 (on a 1-5 anchored scale). In contrast, fruits in air or in air + 5% CO_2 significantly deteriorated by day 15, exhibiting severe decay, firmness loss, and overall appearance below 1.5. Notably, 20% and 10% CO_2 treatments preserved total antioxidant activity (1.84 g Trolox/kg), comparable to initial levels (1.83 g Trolox/kg). These findings are crucial for designing effective packaging solutions to enhance the fresh market distribution of goji berries.

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Application of cell-free supernatants from *Lactic acid* bacteria as natural biopreservatives in fresh-cut oranges

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The expanding global demand for fresh ready-to-eat products has increased the attention related to microbiological safety, as these foods provide a nutrient-rich matrix conducive to the proliferation of foodborne pathogens. As a sustainable and low-cost strategy, postbiotics derived from beneficial microorganisms are gaining attention as natural bio-preservatives, capable of enhancing microbial safety in fresh food products. In this context, postbiotic compounds derived from lactic acid bacteria (LAB) represent a promising and sustainable alternative to conventional chemical preservatives. This study investigated the antimicrobial efficacy of cell-free supernatants (CFSs) obtained from LAB strains isolated from fresh fruits, targeting pathogenic microorganisms commonly associated with minimally processed produce. Following the *in-vitro* screening, a combination of selected CFSs was applied to fresh-cut orange slices packaged under passive modified atmosphere conditions. The antimicrobial activity of the treatment was assessed through intentional inoculation of *Escherichia coli* and *Staphylococcus aureus*, with microbiological and physicochemical analyses conducted up to 10 days of refrigerated storage. The results demonstrated that CFSs from *Lactiplantibacillus plantarum* and *Leuconostoc mesenteroides* significantly inhibited the growth of the tested pathogens, achieving a reduction of 1 Log CFU/mL for *E. coli* and complete reduction of *S. aureus*. These findings support the potential application of LAB-derived CFSs as natural, clean-label biopreservatives for fresh-cut fruits. Nevertheless, further studies are required to assess the CFSs stability, scalability, and compliance with relevant food safety regulations.

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Effect of nitrogen fertilization levels on quality attributes of rocket salad over storage: modelling degradation kinetics

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Rocket is a popular fresh-cut salad ingredient, produced mainly in Italy and distributed throughout Europe. This study focused on the interactive effect of pre-harvest factors, specifically nitrogen fertilization, on the post-harvest quality and shelf-life degradation rate of rocket leaves (*Diplotaxis tenuifolia* L. cv Dallas). Six levels of nitrogen (T70, T94, T126, T154, T182, and T210 ppm in the nutrient solution) were applied under soilless cultivation in an unheated greenhouse, following a randomized block design with 3 replications. After harvest, individual replicates were stored in clamshells under controlled conditions (5°C, 99% RH) to monitor quality changes over time. Vitamin C, texture, chlorophyll, microbial populations (total mesophilic count, yeast & mold), and sensory evaluation were measured during storage. For each quality attribute and N level, degradation curves were fitted with kinetic models. Quality parameters such as microbial load and Vitamin C degradation showed a direct relation with increased N fertilization, whereas chlorophyll content and firmness showed an inverse relation. Degradation kinetics were mostly described by a first-order reaction. Treatments T70 and T94 showed the least degradation rate for overall acceptability, maintaining good visual traits throughout an 18-day storage life. Higher N levels significantly accelerated the degradation of Vitamin C (T182), DHAA (T210), and AA (T182), with respective kinetic constants (k) of 0.076±0.005, 0.099±0.002, and 0.074±0.005. The end of shelf life correlated with the overall acceptability score from sensory evaluation, and predictive models were validated with satisfactory statistical accuracy. Adequate nitrogen supply is a critical factor not only for high-quality rocket leaves but also for guaranteeing environmental and production sustainability.

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Effect of ozone treatment on the Storage of onions variety 'Bianca di Margherita di Savoia'

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Ozone has gathered much attention as a potentially effective method for preserving fresh horticultural produce, owing to its strong oxidative characteristics and notable antibacterial efficacy. This study investigated the effect of gaseous ozone pre-treatment on the quality preservation of fresh onion bulbs of the variety *'Bianca di Margherita di Savoia`*, which is recognized with a Protected Geographical Indication (PGI) label. Gaseous ozone was adjusted to a concentration of 0.5 ppm in the chambers kept at 20°C for a duration of 17, 24, 36, or 48 hours. After treatments, onions were stored at 20°C for 23 days. The results showed that after 16 and 23 days of storage, the onions treated at 20 °C for 48h, demonstrated the least incidence of decay (5%) and the lowest loads for mesophilic and mold populations were seen after the 9 and 16 days, resulting in a good quality, while untreated bulbs showed an incidence of decay higher than 20% after 23 days of storage. Moreover, the ozone exposure did not have any negative effect on the physicochemical parameters of the onions. Our results suggest that gaseous ozone can be an effective postharvest solution for maintaining the quality of fresh onion bulbs *'Bianca di Margherita di Savoia`* -PGI, controlling the decay and deterioration of onion bulbs safely.

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Characterization and postharvest behavior of mulberry (*Morus nigra* L.) during ripening

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Mulberry (*Morus nigra* L.) is a highly appreciated but very perishable fruit, especially when harvested mature. Limited understanding of its postharvest physiology hinders shelf-life extension. This study aimed to characterize the metabolic behavior and physicochemical evolution of mulberries across 9 distinct maturity stages, both at harvest and during a subsequent 3-day storage period at room temperature. At harvest, fruits across these stages varied significantly in weight (0.52-5.7 g), firmness (23.3 down to 2.4 N), and color (Hue° 137°-328°). Key parameters including pH, total soluble solids (TSS), titratable acidity (TA), and ethylene production were monitored. Mulberries exhibited climacteric-like behavior, particularly pronounced in intermediate maturity stages (4, 5, and 6), which displayed distinct ethylene peaks (maxima: 83, 132, and 138 µL/kg·h, respectively) and continued ripening during storage. After 3 days, these stages (4-6) showed significant increases in TSS (e.g., 10.5% in stage 5) and pH (e.g., 32.7% in stage 5), and marked decreases in TA (e.g., 52% in stage 5), accompanied by color changes. In contrast, earlier stages failed to ripen properly, and later stages exhibited senescence. This study confirms possible mulberry's climacteric nature and, by characterizing a wide range of maturities, provides valuable data for optimizing harvest and postharvest handling.

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Metabolic composition of *Coffea arabica* L. under Mediterranean Conditions

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Coffee cultivation is primarily concentrated in tropical regions such as Brazil and Ethiopia, where the warm and humid climate provides optimal conditions for plant growth. Although Italy is not traditionally considered a coffee-producing country, studies conducted in recent years in Sicily have shown promising results. For this reason, the objective of this research was to investigate metabolic differences in coffee drupes at various ripening stages. Ten-year-old *Coffea arabica* plants propagated from seeds of 'Caturra' were taken, grown in the Palermo area (Sicily, Italy). Drupes were collected at five distinct ripening stages, identified by the color of the epicarp: green (A), orange red (B), bright red (C), red purple (D), and dark purple black (E). For chemical characterization, 20 mg of each drupe sample was freeze-dried and pulverized. Subsequently, untargeted metabolomic profiling coupled to multivariate statistical analysis, specifically Principal Component Analysis (PCA) and Random Forest classification, were performed. The untargeted metabolomic analysis identified a total of 178 primary and secondary metabolites. PCA and Random Forest analysis revealed a clear separation among samples based on the five ripening stages. Immature drupes (A and B) were characterized by higher concentrations of primary metabolic compounds, including fatty acids, amino acids, and nucleosides in stage A, as well as sugar alcohols and sugar acids in stage B. These early-stage fruits also exhibited higher levels of flavanols such as epicatechin, which are associated with bitter flavor notes. In contrast, more mature samples (C, D, E) showed elevated levels of oligosaccharides, ketoses, and hydroxycinnamic acids. Caffeic acid was predominant in stages C and D, while chlorogenic acid, the precursor of caffeic acid, was most abundant in stage E. The latter is generally associated with improved coffee quality. Given ongoing climate change, coffee cultivation may become viable in southern Italy; however, further studies are required to assess the bio-agronomic performance of coffee plants in environments markedly different from their conventional cultivation areas.

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Opuntia ficus-indica cladode mucilage for F&V post-harvest application

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Opuntia ficus-indica is a succulent plant belonging to the Cactaceae family, native from Mexico. Cladodes of *O. ficus-indica* have a high content of polyphenols, vitamins, minerals, and polysaccharides; for this reason, this species has scientifically spotlighted worldwide, due to their antioxidant and anti-inflammatory effects. Cladode is a source of mucilage, which is a complex polysaccharide that has a great capacity to absorb water and function as a promising hydrocolloid. The valorization of a biological matrix so far discarded (when pruning in the orchard) as an agri-food industry by-product is a sustainable approach of circular economy, alongside the application of extraction technologies which avoid organic solvents. In this work, mucilage from *O. ficus-indica* cladode (purple color Italian variety) was extracted with water and made as a powder by freeze-dryer (FD) and spray-dryer (SD), with yield of 2.5% and 3%, respectively. The polyphenolic content of FD and SD, by Folin-Ciocalteu assay, was 54.8 and 47.7 mg GAE/g dw, respectively. Mucilage was used to fabricate a mixture with saponin, a non-ionic surfactant belonging to sub-class of terpenoids, possessing an antifungal activity. The mixture (mucilage 2% in water plus saponin 0.1 and 0.2%) was evaluated *in vitro* for its activity against several fungi specific for citrus (*Penicillium italicum, P. digitatum,* and *P. expansum*) and general for F&V (*Aspergillus niger, Rhizopus, Alternaria, Fusarium,* and *Botrytis cinerea*). The mixture was also applied to fruits (orange or apple) by dipping methodology. Fruits stored at 4°C for 60 and 30 days, respectively for orange and apple, were evaluated for physicochemical parameters and spoilage by fungal contamination. Preliminary results indicated that mucilage coating protected fruits from decay, reducing weight loss, maintained their antioxidative polyphenols, and keeping them with a good texture and shiny look.

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Suitability of red-fleshed apples to be processed as fresh-cut products

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Fresh-cut apples are appreciated by consumers for their freshness, convenience and health benefits. Red-fleshed apple cultivars have recently gained interest for their attractive appearance combined with elevated levels of bioactive compounds. This study aimed to evaluate the suitability of the red-fleshed apple cultivar 'Red Moon'® (RM) for fresh-cut processing, in comparison with the white-fleshed cultivar 'MD03UNIBO' (MD). Cored apples were cut into 6 (RM) or 8 slices (MD), dipped in an antioxidant solution, drained, packed in air and analyzed after 0, 1, 4, 7 and 10 days at 4°C. After 10 days, O_2 decreased to 13%, while CO_2 increased to 7%, without signs of anoxia or toxicity in either cultivar. This observation is supported by the stability of electrolyte leakage and the maintenance of microbial loads (mesophilic and psycrophilic bacteria, yeasts, molds) within acceptable thresholds, with RM slices showing significantly lower counts than MD. The browning index increased in MD slices, whereas RM slices exhibited a color shift from pink-red to red-orange. Total phenols and antioxidant capacity did not change during shelf-life, displaying values twice as high in RM compared to MD slices. No difference was observed in anthocyanin content in RM slices during shelf-life. MD slices showed higher firmness and lower acidity than RM ones, while total soluble solids content was similar in the two cultivars. At sensory analysis, MD slices received the highest overall acceptability scores, as they were judged firmer, crispier, sweeter, more aromatic and less sour than RM ones and were also more appreciated for their appearance. Our results indicate that the red-fleshed 'Red Moon'® apples are suitable for fresh-cut processing, due to its limited quality deterioration during shelf life, low microbial loads, and high content of nutraceutical compounds. Nevertheless, its acceptability may be limited by its low firmness and pronounced acidity.

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Kaolin application to reduce sunburn damage and preserve quality on mango fruit in a mediterranean environment

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Sunburn is a physiological disorder that affects the fruit of many tropical and subtropical species cultivated in the Mediterranean basin, including mango (*Mangifera indica* L.). This physiological disorder, caused by a combination of high temperatures and solar radiation levels during the fruit's growing season, affects fruit quality, resulting in significant economic losses. This study aimed to evaluate not only the effectiveness of two different kaolin treatments, one in powder and the other diluted in water, as a strategy to mitigate sunburn, but also their impact on the physico-chemical characteristics of the fruit of two mango varieties widely cultivated in the Mediterranean environment: Glenn and Maya. The binary logistic regression model demonstrated that kaolin diluted in water was the most effective treatment, reducing the odds of sunburn occurrence by 68% compared to untreated fruit. The applications of kaolin did not significantly alter the main physicochemical characteristics of the fruit, including their size, external coloration (hue angle and chroma), titratable acidity and total soluble solids (TSS). In particular, fruit of the Glenn variety showed no significant differences among the treatments in terms of TSS, recording values of 16.80 °Brix in the control treatment, 17.24 °Brix in kaolin diluted in water and 18.05 °Brix in kaolin powder. Slight differences in hue and chroma were observed only in two of the four measurement points on the surface of the Glenn fruit, while in the Maya fruit the colour measurements showed no significant differences between the different treatments. Overall, kaolin treatments had no negative effects on fruit appearance or quality. These results support the use of kaolin, especially diluted in water, as an effective and economical strategy to reduce sunburn damage in mango fruit without compromising its quality.

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Survey of *Neofabraea vagabunda* in Friuli-Venezia Giulia region: causal agent of apple bull's eye rot

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Neofabraea vagabunda is the causal agent of bull's eye rot symptoms in pome fruits. *Neofabraea* can infect fruits from petal fall to harvest time, with susceptibility gradually increasing during fruit ripening. However, bull's eye rot (BER) symptoms only manifest at the postharvest stage. The infection becomes active only during cold storage, where the low temperatures and moist conditions promote its development. It is for this reason that this fungal behaviour poses a particularly challenging threat to postharvest management. However, there is considerable variation between and within fungal strains in the hosts colonization as well as the mycelial growth and sporulation, often connected to the optimal temperature, water activity (aw) and substrate biochemical composition. For all these reasons, in the present study, we aimed to isolate, identify and characterize the population of *N. vagabunda* strains currently found in the Friuli Venezia Giulia Region. The phylogenetic relationships among the 31 isolates confirmed *N. vagabunda* specie dominance. However, the molecularly characterised strains exhibited distinct morphological characteristics, indicating the presence of genetic variation within the species, which is likely influenced by environmental factors or host specificity. The most representative strains of the *N. vagabunda* population were characterised using in vitro and in vivo assays, together with genomic analysis. The biological response of three strains (M1, F1 and P2) to different water activity (aw) conditions on different apple cultivars and at two different incubation temperatures was investigated. Different aw values (0.99, 0.95, 0.90 and 0.85) and temperatures (0 °C and 15 °C) influenced the mycelial growth and conidial production of the three strains. Furthermore, the virulence of the strains on three different apple cultivars (Pink Lady, Morgenduft and Fuji) at two storage temperatures was verified. The results obtained provided a general overview of the pathogenicity of the strains under varying storage conditions and apple varieties.

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Testing *Bulbine frutescens* post-production performances for its potential ornamental use

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Mediterranean floricultural sector requires crop innovation for facing the challenges imposed by climate change. The PRIN-NATIVASA project was intended to search for multifunctional species having not only aesthetic potential, but also adaptive traits and nutraceutivaluesalue. The research was focused in two biodiversity hotspots (South Africa and Australia), rich in native and stress tolerant species having the potential to add value to the mediterranean floricultural market. Among the selected species is Bulbine frutescens (L.) Willd (*Asphodelaceae*), a rustic South African succulent plant, with edible leaves that own a gel rich in antiseptic properties. To investigate its post-production performance, a transport simulation in the dark lasting 7 days was conducted, followed by 7 days of retail phase at low light conditions (30 µmol m-2s-1). Before transport, potted plants were sprayed with 100 µM melatonin or treated with 1 ppm of 1-MCP on two plant pools, to evaluate their ability to delay *B. frutescens* shelf-life, comparing the results with control plants put in the dark; moreover, a pool of plants was subjected to MAP storage during all the phases of the experiment. In parallel, an ethylene sensitivity test with 10 ppm was carried out. Ethylene and CO_2 production, leaf pigments, malondialdehyde (MDA), polyphenols, and soluble sugars were analyzed at key points of the experiment. Results showed the low sensitivity of B. frutescens to exogenous ethylene and the capacity of both melatonin and 1-MCP to keep oxidative stress low and prevent pigments from degradation. Plants stored in MAP bags showed reduced ethylene production, retention of chlorophyll, and lower MDA levels after the simulation of dark transportation. *B. frutescens* showed to be able to retain quality even if exposed to long lasting transportations without evident aesthetic and qualitative damage, making it easy to expand its ornamental diffusion.

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Changes in phenolic composition of myrtle berries during post-harvest storage

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Myrtle (*Myrtus communis* L.) is an aromatic evergreen shrub typical of the Mediterranean maquis. Berries are extensively used in the liqueur, food, and cosmetic industries. Storage of this fruit has been shown to extend the processing window; however, there is limited knowledge of the optimal conditions for preserving their quality, especially phenolic compounds. The present study investigates the effects of three storage temperatures (2, 10, and 16 °C) over a 21-day period, followed by a 3-day shelf-life at 20 °C, on four myrtle cultivars (two with pigmented and two with unpigmented berries). In all cultivars, the greatest weight loss occurred in berries stored at 2 and 16 °C (about 50%), while berries stored at 10 °C maintained higher hydration levels (about 30% weight loss). The lowest value of weight loss was in the unpigmented cultivar 'Grazia', with berries stored at 10 °C (26.75%). During the storage period, total phenols increased in all cultivars, with the greatest increase for the 'Maria Antonietta' cultivar at 2 °C (from 10.94 to 27.79 mg GAE/g FW). The unpigmented berries exhibited low tannin content, with no increase observed at the three different storage temperatures, whereas, the pigmented cultivars showed a significant increase in all treatments, particularly in berries stored at 2 and 16 °C. Anthocyanins were detected only in pigmented cultivars, with the highest value in 'Ilaria' at 2 °C (12.72 mg cyanidin (C3G)/g FW). Correlation analysis revealed strong positive relationships among the different phenolic compounds, while no significant correlation was observed between weight loss and phenolic content, suggesting a possible de novo biosynthesis of these compounds during storage.

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Evaluation of postharvest behavior of albacor fig cultivar clones for fresh consumption

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There is a growing global demand for fresh figs due to their nutritional value and unique organoleptic qualities. However, from a postharvest perspective, figs are highly perishable, which limits their commercial distribution and shelf life after harvesting. Among dark-skinned fig cultivars, the Albacor cultivar (also known as “Cuello Dama Negro”) is traditionally prized in Mediterranean regions. The Centre for Scientific and Technological Research of Extremadura (CICYTEX) is conducting a trial with 26 clones of this variety that have different physicochemical characteristics and ripening dates. The study aimed to investigate the postharvest behaviour of six clones of the Albacor cultivar. The study consisted of stored figs at two temperatures, 0 °C (Trial 1), evaluated on days 0, 5, 8 and 12, and then at 20 °C (shelf life 0, 1, 2, 3, 4 and 5 days; Trial 2). Ethylene production, respiratory rate, firmness, soluble solids content and titratable acidity were determined. The results obtained show significant differences among clones for all parameters studied. In Trial 1, clone 19 showed the lowest respiratory rate and ethylene production, around 45 mL CO_2/kg·h and 2 µL C_2H_4/kg·h, respectively, after 12 days of storage. In Trial 2, clone 26 stood out for combining a moderate to low respiratory rate with decreasing ethylene production, reflecting more stable and predictable physiological behaviour under postharvest conditions. Concerning physicochemical parameters, differences among clones were observed in the two trials carried out. It was noteworthy that clone 3 showed greater firmness and relatively high acidity throughout the storage period at 20 °C. Therefore, clonal selection within the Albacor group offers a promising strategy for enhancing the postharvest quality of fresh figs.

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Extremophilic yeasts as biological control agents of *Penicillium expansum* of apple and their role in patulin reduction

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In light of the escalating challenges posed by climate change and food security, the adoption of sustainable agricultural practices is increasing. One innovative approach is the use of extremophilic yeasts as biocontrol agents (BCAs) to combat postharvest pathogens. This study evaluated the antagonistic potential of extremophilic yeasts against *Penicillium expansum*, the fungus responsible for apple green mould and patulin production. Sixteen yeast strains belonging to the *Naganishia* and *Papiliotrema* genera were isolated from extreme environments in the Algerian Desert and on the Swedish coast in winter 2023. Four strains were selected as promising BCAs against *P. expansum*: *Naganishia albida* RDSH (1), *Naganishia diffluens* S6P2 (4) and *Papiliotrema wisconsinensis* strains SP6(4) and S1BSC2(1). The selected yeasts were tested for their production of volatile (VOCs) and non-volatile organic compounds (No-VOCs) in both *in vitro* and *in vivo* assays. No-VOCs produced by the SP6(4) and S1BSC2(1) strains completely suppressed green mould on Pink Lady apples. In contrast, the VOCs produced by the RDSH (1) and S6P2(4) strains reduced disease severity by only 10% compared to the control. Furthermore, the presence of the pathogen was confirmed by quantifying pathogen DNA on treated apples using qPCR. The patulin content of treated and untreated apples was evaluated by HPLC. The metabolite profile of the yeasts was studied using Fourier Transform Infrared Spectroscopy (FT-IR) and Solid Phase Micro Extraction Gas Chromatography- Mass Spectrometry (SPME-GC-MS), revealing distinct metabolic profiles among the strains.

This study highlights the potential of extremophilic yeasts as new BCAs for managing postharvest diseases, offering a sustainable way to mitigate mycotoxin contamination and extend fruit shelf life. Funding: Prin 2022 "Fungal postharvest pathogens of apple in a climate change scenario: PRediction models, Epidemiological studies and sustainable control STrategies (PREST.APPLES)"PNRR M4C2 Inv.1.1 – Next generation EU – CUP G53D23004280001 Project Code 2022RBAHK8

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On-tree methyl jasmonate applications: analysis of physicochemical and physiological traits of fresh figs after two and three applications

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Fresh figs (*Ficus carica*, L.) are perishable fruits with a limited shelf life. The exogenous application of elicitors during on-tree fruit development and growth is a promising strategy for improving fruit quality and shelf life. Elicitors are molecules naturally involved in plant metabolism and, when applied in low concentrations at specific points during fruit ripening, can help to improve fruit resistance to abiotic and biotic stresses. One elicitor successfully used in other crops is methyl jasmonate (MeJa). MeJa triggered during stress processes, increasing enzymatic antioxidant activity and phenolics compounds production, thereby scavenging reactive oxygen and nitrogen species. However, there are no studies on its effects on fresh figs. For this reason, an experimental trial was carried out comparing two concentrations of MeJa (0.5 and 1 mM) and their impact on the physicochemical and physiological traits of the fruit after two or three applications. Regarding physicochemical traits, differences were observed between two and three applications. Fresh figs treated with two applications were generally greener and brighter, corresponding to a higher chlorophyll index. However, treatments with three applications achieved the same values. About weight and size, the application of the treatments improved fruit size compared to the controls at both concentrations, with three applications treatment of MeJa 1mM producing the largest fruits. Fruits treated with two applications had higher total soluble solids and titratable acidity values, resulting in a lower ripening index. On the other hand, regarding the physiological traits of the fruit, the treatments increased the respiration rate compared to the respective controls, especially in the case of the three applications. Nevertheless, the ethylene production rate showed the opposite trend, with lower production in the treated fruits, especially in the case of the three applications.

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Enzymatic extraction of phenolic compounds from lemon peels using xellulase or pectinase

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Lemon and lime production reached 23.6 million tons in 2023, of which up to 50% are by-products such as pulp, seeds, and peels. They are primarily used for extracting cellulose and pectin fibers, which are the main constituents of cell walls. However, they also contain secondary metabolites, especially flavonoids and phenolic acids, which exhibit interesting antioxidant properties. To facilitate their extraction for subsequent application, well-known green technologies that ease their separation from the mentioned fibers are being explored. In this study, an enzymatic-assisted extraction of lemon peel phenolic compounds was performed, comparing two types of enzymes: pectin methylesterase and cellulase. Aqueous solutions containing 1% of each enzyme were formulated, while control samples consisted of extraction with ultrapure water. The spectrophotometric analysis of total phenolic content (TPC) and total antioxidant capacity (TAC) revealed that, while cellulase did not provide better extraction yields than the control, pectin methylesterase resulted in ~25% and ~18% higher TPC and TAC. The analysis of the main individual compounds identified by HPLC-MS, including citric acid, 4'-O-methyllucenin, hesperidin, and eriocitrin, showed a similar trend, where pectinase provided ~36%, ~45%, ~7, and ~22%, respectively, higher extractions regarding control samples. In conclusion, the use of pectinase enzymes for the extraction of lemon peel improves the extraction of phenolic compounds unlike cellulase. This requires further investigation into the solid-liquid ratio, enzyme concentration, and incubation time to optimize yield and even to explore the synergistic effect combined with other green extraction methods.

Keywords: by-products, glycosylated flavonoids; cellulase; pectin methylesterase; total antioxidant capacity; *Citrus limon*.

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Prohexadione-Ca enhances fruit set and shelf life in high-density sweet cherry orchards

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Sweet cherry (*Prunus avium* L.) cultivation in Italy is a rapidly growing sector, driven by high commercial value and favorable market returns. To remain competitive, the industry must ensure that fruits reach the market with optimal quality and extended postharvest shelf life, particularly for direct consumption. In addition, production is often limited by environmental conditions and physiological constraints. Current orchard systems rely on high-density plantings with dwarfing rootstocks and protective netting against rain and hail. While these intensive systems offer economic advantages, they also present challenges such as poor fruit set rate and excessive vegetative growth, which can negatively impact both yield and fruit quality revealed as poor pigmentation, low firmness, and shortened shelf life. This study investigates the application of Calcium Prohexadione (Prohexadione-Ca) – Regalis® as a growth regulator to address these limitations. During the trial, which was conducted in a commercial orchard in Piedmont, Prohexadione-Ca was applied as foliar treatments (1.5 l/ha) at the floral bud and petal fall stages, approximately 15 days apart. The treatment effectiveness was assessed through measurements of marketable yield, and a range of quality parameters at harvest and after 21 days of cold storage (2°C, 75% RH). Results showed that Prohexadione-Ca significantly improved fruit set and yield, while also enhancing fruit quality at harvest. Treated fruits exhibited better firmness and pigmentation, with these improvements sustained during storage. These findings support the potential of Prohexadione-Ca as a valuable tool in the agronomic management of high-density sweet cherry orchards, contributing to improved productivity and postharvest performance.

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Impacts of the february 2023 Earthquakes Centered in Kahramanmaraş and Hatay on Cold storage facilities and packaging plants in Hatay Province

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This study evaluates the impacts of the February 2023 earthquakes, centered in Kahramanmaraş and Hatay, on cold storage facilities and agricultural product packaging plants located in Hatay province. The research analyzes the condition of these facilities based on field observations, public reports, and interviews with producers, and offers recommendations for the reconstruction process. The findings indicate that this infrastructure-critical for the continuity of agricultural production and the food supply chain-was severely affected in terms of both physical damage and challenges related to workforce and logistics. More than 60% of the cold storage facilities and agricultural packaging plants in the province suffered moderate to severe damage. In some facilities that were not structurally damaged, refrigeration systems malfunctioned, and packaging machinery became inoperative. Power outages led to spoilage of stored goods; workforce shortages arose due to migration and fatalities; the collapse of transportation infrastructure hindered access to ports, resulting in the cancellation of export contracts due to delayed shipments. In conclusion, the 2023 earthquakes caused extensive damage to cold storage and packaging facilities in Hatay and led to significant disruptions in the agricultural supply chain. The reconstruction and reinforcement of these facilities are of vital importance for the sustainability of agricultural production and the recovery of the regional economy. Moreover, establishing disaster-resilient infrastructure and developing emergency response plans will help minimize damage in the event of future disasters.

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The effects of february 2023 earthquakes centered in Kahramanmaraş and Hatay, Turkiye on the region's agricultural sector

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On February 6, 2023, two powerful earthquakes (Mw7.7 and Mw7.6) struck Kahramanmaraş, followed by another (Mw6.4) in Hatay on February 20. These disasters devastated 11 provinces in Türkiye, home to 15.7 million people and 14% of the country's farmers. The region, vital to Türkiye's agricultural economy, contributes 15.3% of agricultural GDP and 20% of total agricultural output. The quakes caused around 54,000 deaths and massive damage to over half a million buildings, crippling infrastructure and disrupting essential services. Agriculture, fisheries, and livestock sectors were heavily impacted, with losses and damages estimated at USD 6.3 billion. The destruction affected more than 20% of Türkiye's agricultural production, leading to food insecurity, population displacement, and threats to rural livelihoods. Immediate aid, long-term planning, and strategic investment are crucial to recover the agricultural sector, support rural communities, and restore national food stability. Without these efforts, Türkiye risks increased food prices, greater import dependency, and rural depopulation.

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Impact of agrivoltaic system implementation on fig tree (*Ficus carica* l.) cultivation

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The fig tree, a woody species belonging to the *Moraceae* family, is well adapted to Mediterranean climatic conditions. However, optimizing its cultivation through the implementation of a "forced" system designed to increase planting densities through an innovative approach to off-season production of high-quality figs and brebas (early-season figs) constitutes a promising commercial strategy. An agrivoltaic system integrating solar energy production with greenhouse-based crop cultivation inevitably reduces incoming radiation potentially impacting crop yield and overall economic viability. Photovoltaic greenhouses are increasingly adopted in southern Europe, especially in Spain and Italy, due to their ability to enable the simultaneous production of food and electricity, aiming to achieve synergistic benefits. In this context, farmers' income is enhanced through energy sales, while crop production is conducted more sustainably, contributing to the mitigation of greenhouse gas emissions. Therefore, this study aims to assess the impact of implementing an agrivoltaic system on fig production including both, brebas and late-season figs— in order to evaluate its economic viability. A high density of solar panels above the fig trees resulted in pronounced shading which significantly stimulated vegetative growth while suppressing flowering and reducing yield. In contrast, a staggered (checkerboard) arrangement of solar panels provided moderate shading that did not significantly affect the vegetative or reproductive behaviour of the plants compared to the control. With respect to fruit quality, increased panel density did not impact fruit size; however, the associated shading hindered color development, resulting in figs remaining green. In contrast, fruit from control plants, exposed to full sunlight, developed the characteristic red pigmentation indicative with physiological maturity.

Keywords: Agrivoltaics, Fig tree, Sustainability, Production, Profitability

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Optimizing 'Annurca' apple storage: impact of controlled atmosphere and 1-methylcyclopropene on fruit quality and superficial scald development

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'Annurca' apple is valued for its distinctive taste and aroma. However, its traditional storage in air has become problematic due to the development of superficial scald, a physiological disorder that causes skin browning and reduces marketability. This study evaluated the effects of 1-MCP treatment, controlled atmosphere (CA), and dynamic controlled atmosphere (DCA) on quality and superficial scald development in 'Annurca' apples. Fruit picked in Vitulazio (Caserta-Italy) underwent the traditional 20-day reddening process (melaio), during which they were placed on straw beds under shade nets. Half of the fruits were treated with 1-methylcyclopropene (1-MCP) before and after melaio; then they were stored at 1 °C for seven months in AIR, CA (1%O_2, 1%CO_2), and DCA (≈0.6% O_2, ≈0.5% CO_2). At the beginning of storage, 1-MCP-treated fruits showed higher soluble solids content (14.5 vs. 13.7 °Brix) and titratable acidity (9.6 vs. 8.0 g/L malic acid) than untreated ones, and these differences were maintained throughout storage, regardless of the storage atmosphere. During storage, firmness was affected by 1-MCP-treatment (MCP>noMCP) and by the atmosphere, with fruit in CA (60.8N) and DCA (60.1N) having higher average values than AIR (52.8N). AIR-stored fruit also showed the highest ethylene production, followed by CA and DCA, while no effect of 1-MCP on ethylene was detected. Scald incidence did not change with 1-MCP, but it was significantly affected by the storage atmosphere, with fruit in AIR showing a much higher incidence (37.2 % after 7months) than DCA (6.1%) and CA (6.8%). Similarly, levels of α-farnesene and conjugated trienol 281 (CT281), compounds linked to scald development, were unaffected by MCP but were higher in AIR-stored fruit than in CA and DCA. Our results indicate that CA storage and 1-MCP treatment helped to maintain 'Annurca' fruit quality for seven months. Moreover, CA and DCA were highly effective in preventing superficial scald.

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Effect of differentiated irrigation availability on the postharvest quality parameters of *Actinidia chinensis* fruits

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Irrigation management in fruit orchards is currently receiving increasing attention due to issues related to climate change, reduced rainfall, and the need to rationalize water use to achieve greater irrigation efficiency. This issue is particularly relevant for species such as kiwifruit, which in southern Italy may require approximately 10,000 m^3/ha of water. The aim of this study was to determine whether a differentiated irrigation strategy, aimed at saving water while considering both yield and postharvest fruit quality, could be effectively implemented. The trial was conducted in an orchard of *A. chinensis* 'Gold 3', trained on a pergola system and located in the Gioia Tauro plain (RC), over two growing seasons. Three irrigation levels were compared starting from the second ten-day period of July, when the fruit had reached more than 80% of its final volume: the standard farm irrigation (180 $L \cdot h^{-1} \cdot plant^{-1}$), and two deficit irrigation treatments with 25% and 40% reductions. Yield parameters, ripening and nutraceutical indices were measured at harvest and after 120 days of cold storage at 4°C, during which each fruit was placed in polyethylene bag. From a yield perspective, no significant differences were observed among treatments. The comparison between standard irrigation and controlled deficit showed that a moderately reduced irrigation regime can influence certain parameters such as soluble solids, acidity, firmness, weight loss, and phenolic composition without compromising shelf life. In conclusion, the trial demonstrated that a moderately reduced irrigation regime can be adopted during the second stage of fruit development without affecting storage duration, with some quality parameters remaining within an 'optimal' range, while achieving a concrete rationalization of irrigation water use, allowing for kiwifruit management in a 'water-saving' perspective.

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Postharvest quality preservation in 'eva' grapes: physicochemical and microbiological outcomes of uvasys^{tm} treatment

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The 'Eva' grape (*Vitis vinifera* L.) is a landrace endemic to Los Santos de Maimona (Badajoz, Spain) and its surrounding region, characterized by spherical, yellowish-green and medium-sized berries. Traditionally grown as a table grape, its use shifted towards winemaking following the introduction of earlier ripening, seedless cultivars. Despite the current relevance of 'Eva' wines, local producers aim to reestablish their presence in the table grape market as a strategy for product differentiation. Therefore, developing and implementing postharvest technologies that preserve fruit quality and competitiveness throughout the supply chain is necessary for globalized trade. Uvasys™ (Agrofresh) is a postharvest technology consisting of double-layered plastic sheets impregnated with sodium metabisulphite, designed to protect grapes from fungal decay, mainly *Botrytis cinerea*. The first layer ensures a rapid sulphur dioxide (SO_2) release during the initial hours, eliminating spores and mycelium. The second layer allows a sustained release of SO_2 over time, prolonging antifungal protection during storage. To test its efficacy, a trial was carried out using 'Eva' grapes harvested and packed in bulk boxes, either with or without Uvasys™ sheets (control), and stored at 1 °C and 90% relative humidity. Physicochemical and microbiological assessments were conducted periodically over a 60-day storage period, after which control samples showed severe decay. After 30 days, physicochemical analyses revealed no significant differences in firmness or titratable acidity. Nevertheless, treated grapes showed higher total soluble solids and greener, brighter skin colour. Microbiological analysis revealed promising results. At 30-day sampling, total mesophilic aerobic bacteria and yeast counts were reduced by more than 50% in treated grapes; in contrast, moulds showed no significant differences. However, after 60 days, treated grapes exhibited a 59.52% reduction in mould counts, confirming the antifungal efficacy of the treatment and its potential to extend shelf life.

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Dyeing plants for innovative packaging to improve shelf life of strawberries and grapes

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Some fruits, such as strawberries and grapes, deteriorate rapidly after harvest. To extend the shelf life of fruits, several environmentally friendly preservation technologies have been developed, including modified and controlled atmosphere and packaging based on active biopolymers. One solution could be to use "smart packaging" obtained by treating the containers with extracts of *Rumex crispus* L. and *Punica granatum* L. Dock roots and pomegranate peel have both colorant and antimicrobial properties. In this work, the above citated extracts have been tested *in vitro* against fungi *Fusarium oxysporum*, *Botrytis cinerea* and bacteria *Pseudomonas syringae, Clavibacter michiganensis*. *In vivo* tests, the carton containers for fruit packaging were immersed in a solution of pomegranate peel extract at a concentration of 8% (Thesis A). In Thesis B the containers were immersed at the same concentration in a solution of dock root extract and pomegranate peel (50:50). In control Thesis C the containers were immersed in water. After treatment of the containers, the fruit was placed inside and stored at 20 ± 1 °C, with relative humidity of 95-98%, strawberries for 24, 48 and 96 hours, while grapes were stored for 12 days. An empirical scale was used to assess disease severity (SD) and disease incidence (DI), while the color of the fruit juice was assessed with a spectrophotometer. DS was estimated on a 0-5 scale where: 0 = no symptoms and 5 = more than 81% of the fruits' surface infected. The percentage disease severity of each treatment was calculated with a specific formula. The antimicrobial activity highlighted in this research clearly demonstrates that both dock root and pomegranate peel extracts have been able to improve the shelf life of strawberries and grapes. However, pomegranate peel extract appears to be more effective in reducing fruit decay. This work contributes to the development of natural and functional products for use in fruit and vegetable preservation packaging.

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Kefir-infused alginate edible coating: a natural strategy for quality preservation of fresh-cut apples

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The increasing demand for minimally processed and chemical-free fruits has led to exploring innovative and natural solutions to extend shelf-life. This study investigated the application of alginate-based edible coating enriched with a commercial kefir starter culture on fresh-cut apples to assess the impact of kefir on preserving the quality and safety of the product. Apple slices (Pink Lady®) were treated with 2% alginate coating (ALG), 2% alginate coating supplemented with kefir culture (Bionova Srl, Italy) (ALG+KEFIR), or water as a control (CTRL), and stored at 4 °C for up to 7 days. Microbiological analyses were performed (mesophilic load, yeasts and molds, and Lactic Acid Bacteria (LAB)). Respiration rate and visual quality were also evaluated. On day 0, all samples showed similar respiration rates, but by day 3 ALG apples showed a pronounced increase (10.7 mL CO_2/kg h), whereas the presence of kefir moderated this increase. After 7 days, CTRL apples reached the highest value, while both coated samples remained lower, indicating that the kefir-enriched alginate film stabilized and reduced respiration over storage time. As for microbiological aspects, by day 7 the ALG+KEFIR coating maintained a relatively low mesophilic (3.24 log CFU/g) and yeast and mold load (3.3 log CFU/g), while sustaining the highest LAB levels (3.1 log CFU/g) among all treatments, thus resulting in more effective modulation of the microbial ecosystem on fresh-cut apples, supporting both safety and potential probiotic quality over time. Moreover, kefir contributes to preserving the visual quality of apple slices, delaying browning occurrence. These findings suggest that the incorporation of kefir cultures into edible alginate-based coatings represents a promising strategy for the biopreservation of fresh-cut fruits. This approach offers a clean-label alternative to synthetic preservatives and aligns with consumer preferences for natural, functional food products.

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Valorization of tannins in the post-harvest of berries

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The control of losses and waste and the limit in the use of wrapping packaging to improve the shelf life is one of the critical points in the fruit supply chain and the post-harvest management of perishable fruits. In the fruit sector new strategies, new approaches, solutions and mitigating actions need to meet sustainability requirements. To extend berries' shelf life, different approaches were explored in the last years, such as postharvest treatment under different conditions with chemical substances or adding biofilms on berries' surface. Postharvest chemical treatments to improve the shelf life of fruits are not accepted by consumers due to the possible pollution or other undesired residues, so physical or natural antibacterial agents are used. Unfortunately, at the moment there are not many 'green' alternatives implemented in the fresh fruit storage supply chain and industries. In the perspective of circular economy tannins extracted by chestnuts woods (*Castanea Sativa* Miller) thanks to the high potential of antioxidant and antimicrobial activity could be a promising opportunity in the postharvest berries valorization supply chain. Different formulations were used in the coating fruits as spry or in the developing of active packaging cardboard. Preliminary results *in vitro* with the Agar Well Diffusion technique showed the good antimicrobic role of tannins and this effect was also maintained *in vivo* conditions. Coated fruits showed also the good maintenance of skin color and texture pulp if compared with control fruit. The use of tannins in the coating of cardboard packaging didn't show good performance in terms of quality maintenance of stored fruits.

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Postharvest evaluation of microgreens and baby leaves at low potassium content

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In recent years, the demand for fresh-cut vegetables with improved nutritional composition to meet specific dietary needs has been constantly increasing. A new frontier of biofortification is represented by the possibility, in soil-less cultivation systems, of modulating the concentration of dissolved nutrients in the nutrient solution (NS), aimed at producing plants with specific nutritional levels to obtain tailored foods. The research conducted concerned the post-harvest conservation of two classes of products: rocket and black cabbage microgreens and chicory and mizuna baby leaves. In both trials, microgreens grown using nutrient solutions (SN) with different potassium (K) levels (0, 60 and 120 mg/L) and baby leaves produced with reduced K content (50 mg/L), were washed in sodium hypochlorite (2%) and stored for 7 days at 5 °C. During storage, the main quality parameters (visual appearance, respiratory activity, electrolyte loss and ammonium content) were evaluated. In both microgreens and baby-leaves, the absence of K in NS caused an increase in respiratory activity and ammonium content compared to the control. On the contrary, in plants with reduced K supply, no significant effect on the analyzed parameters was observed. Regarding shelf life, microgreens grown with 60 and 120 mg/L of K were marketable for 1 week at 5 °C, while samples grown without K were more perishable. Very similar results were obtained on baby leaves; in particular, samples produced with reduced K supply-maintained marketability for up to 7 days. In conclusion, the results of these researches suggest that it is possible to produce baby-leaves and microgreens with reduced K content, thus obtaining functional horticultural products without negative effects on post-harvest qualities.

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Extending shelf-life with plasma: addressing the off-flavor challenge for packaged products

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In-package cold plasma technology shows promise for extending fresh produce shelf life by inhibiting microbial growth. Initial studies on table grapes demonstrated its effectiveness in slowing microbial growth without significantly altering most quality parameters. However, a critical issue of off-flavour production emerged, which requires further investigation to determine the feasibility of applying this treatment on packaged products. The aim of this study is to investigate the phenomenon of off-flavour formation in treated packages. To address the off-flavour issue, Central Composite Design (CCD) was employed to evaluate various combinations of treatment time, frequency, and voltage on ozone production and off-flavour generation, evaluated through sensory analysis, both with and without direct contact between the plasma source and the plastic material. Additionally, headspace gas chromatography analysis was performed on treated and untreated empty packages of common materials used to pack fruit and vegetable, to identify volatile organic compounds (VOCs) that might be associated with the observed off-flavours. Voltage was identified as the most influential parameter affecting both off-flavour and ozone production. Sensory analysis revealed no significant difference in off-flavour perception between packages treated with and without direct contact between the plasma source and the packaging, suggesting a probable correlation between off-flavour generation and ozone production. Gas chromatographic profiles of treated plastic films were distinctly different from untreated ones, indicating that the plasma treatment stimulates the production of numerous VOCs. The concentration of identified compounds varied depending on the type of packaging material analysed. The findings confirm that plasma treatment induces significant changes in packaged products, leading to the formation of numerous volatile organic compounds. These results highlight the critical need for further research to fully understand these plasma-induced alterations and ensure the quality and compatibility of packaging materials for future applications in minimally processed fruits and vegetables sector.

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Postproduction management of the promising plant 'Tulbaghia violacea Harv.': evaluation of ethylene control methods for maintaining quality.

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Ornamental edible plant species that integrate climate adaptability, aesthetic value, and nutritional functionality are gaining growing attention, driving the search for novel species with potential for ornamental applications. Within the *PRIN-NATIVASA* project, *Tulbaghia violacea* Harv. (wild garlic) has been selected as a promising yet underexplored ornamental plant. Native to South Africa, this drought-resistant herbaceous species with vivid violet flowers and a distinctive garlic-like flavor. The study focuses on the post-production handling of *T. violacea*, with particular emphasis on the transport and retail phases which are crucial for maintaining plant quality. An experiment was conducted over a two-week period to simulate transport and retail conditionsti plants were pre-treated with melatonin (100 µmol) and 1-MCP (1 ppm), then subjected to a simulated transport phase consisting of 7 days in darkness at room temperature, followed by a 7-day retail phase under low light intensity. In parallel, to assess ethylene sensitivity, plants were exposed to ethylene (10 ppm) for 24 hours under light conditions and compared to untreated controls. Throughout the experiment, ethylene and CO_2 production from leaf samples was measured using GC-FID. Leaf pigment content (chlorophylls and carotenoids), oxidative stress status on lipid peroxidation (*via* MDA levels), and metabolomic analysis using LC-MS-MS were performed. The results confirmed that *T. violacea* is sensitive to ethylene, demonstrated by increased endogenous ethylene production and higher MDA levels after ethylene exposure. Moreover, treatments with 1-MCP and melatonin demonstrated their potential as effective strategies to counteract ethylene sensitivity during transport. Specifically, 1-MCP-treated plants showed significantly lower MDA accumulation, indicating reduced oxidative damage, while melatonintreated plants maintained higher levels of various pigments, contributing to both aesthetic quality and antioxidant protection. Altogether, these findings reinforce the potential of *T. violacea* as an innovative, multi-purpose species with significant stress tolerant, ornamental and health-promoting qualities.

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Evaluation of pulsed led lighting effects on physiology and shelf-life of green and red lettuce in vertical farming

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Vertical farming can be used as a cultivation system to ensure optimal yield, quality and shelf-life of vegetables, by the optimization of all the parameters (fertigation, micro-climate, light, etc.). The main challenge for vertical farming is the cost, mainly regarding electrical consumption for climate management and lighting. The Pulsed LED lighting is an alternative to continuous lighting to deliver high intensity light with lower energy consumption, by modifying the frequence and duty-cycle. This study investigated the effects of pulsed LED light on two lettuce cultivars, green and red (*Lactuca sativa* L., var. "Multifoglia"), over a 48-day growing cycle. Two duty cycles were compared to 50% (D50), and 25% (D25), both at 1000 Hz frequency and a photoperiod of 16 hours, using a spectrum of 82% red, 11% green, and 6% blue lights. PPFD in the two chamber was measured in D50 was 122 µmol $m^{-2}s^{-1}$, while in the D25 was 71 µmol $m^{-2}s^{-1}$. A cultivation in a greenhouse with natural light during autumn season served as the control. After harvest the quality retain was evaluated for a 10-day period at 4°C in the dark. Physiological and biochemical parameters were analysed during storage. Results showed that at harvest the red-leaf cultivar under the D25 lighting had the highest fresh weight and energy use efficiency. Leaf pigments such as total chlorophyll and carotenoids were higher under D25 treatment in both cultivars and were maintained also after 10 days of storage. Ethylene production was also measured, and particularly after 10 days of cold storage, the levels of this hormone were significantly reduced under D25 treatment. This study highlights the effectiveness of pulsed LED lighting, especially the D25, in improving growth, physiological traits, efficiency and quality retain during postharvest. Further analysis of secondary metabolites will be performed to better understand the plant response to pulsed lighting and shelf-life of products.

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The use of hyperspectral imaging to assess pulp redness level of blood oranges (cv. Tarocco Sant'Alfio)

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The global fruit industry continually faces technological challenges to meet the increasing consumer demand for high-quality produce. For hiqh quality blood oranges it's very critical the insurance of intensity and uniformity of the pulp red color, not discernible from the external surface. Nowadays color can be assessed only cutting the fruit and on a limited number of randomly selected fruit, but non-destructive techniques have proved to be effective in predicting internal quality and composition of fruit and vegetables. This study aimed to investigate the potential of VIS-NIR (4001000 nm) and NIR (900-1800 nm) hyperspectral imaging combined with Partial Least Squares Discriminant Analysis (PLS-DA) and machine learning algorithms including artificial neural networks (ANN), and k-nearest neighbors (kNN) to classify Tarocco Sant'Alfio oranges into two classes of redness, namely Red and Non-Red. A total of 400 oranges were scanned using a hyperspectral imaging system. Following image acquisition, the fruits were longitudinally cut and RGB image of the internal section was taken to assess redness index. Among the algorithms used, the best performance was achieved by PLS-DA. Fruit classification was obtained using the preprocessing of the first derivative combined with the mean center, for VIS-NIR spectra, resulting in classification accuracies of 80% and 80% for calibration and prediction, respectively. Similar performance was achieved in the NIR region reaching 83 and 77% in calibration and prediction, respectively. These results demonstrate the potential of hyperspectral imaging as an effective, nondestructive method for assessing internal color variations in Tarocco Sant'Alfio oranges which can be implemented on selection line for fruit classification.

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Quality and phenolic profile of various artichoke cultivars processed as fresh-cut products

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In the present study twelve artichoke cultivars, including local varieties and commercial hybrids, were cultivated in an experimental field at Ordona (Apulia region, 41.347154, 15.753231, 0 m a.s.l.), to evaluate productive characteristics and the adaptability to be processed as a fresh cut product. Artichokes were harvested at maturity, cut into halves, packed in microperforated bags (polypropylene + polyammide) and stored at 5°C for 6 days. Moisture loss, antioxidant activity, total phenolic content, polyphenol oxidase, sensory, colour and image analysis were performed at initial and final storage time; the color variation (ΔE), used as index for browning potential, was calculated by CIEL*a*b primary colour indexes, and finally all data were evaluated through a multivariate approach (Hierarchical Clustering-Heatmap). Four cultivars with varying susceptibility to browning (Green Triumph, Madrigal – low susceptibility, Spinoso Sardo, Troianella - high susceptibility) were selected for further identification and semi-quantitative comparison of their phenolic derivatives using liquid chromatography coupled to mass spectrometry (LC-MS), both at initial and final storage time. All the cultivars, whether fresh or browned, exhibited a distinctive and complex phenolic profile, including several caffeoylquinic acid derivatives. The behaviour of these compounds during storage varied depending on the specific phenolic compound. These findings highlighted that the differing attitude of artichoke cultivars for fresh-cut processing is linked to the relative proportions of individual phenolic compounds and their derivatives. This suggests the need for further investigation into the role of specific caffeoylquinic acid derivatives in the browning process following cutting.

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Sustainable inputs in soilless tomato production: effects of biochar and wood distillate on shelf life of *Solanum lycopersicum* L., cv. Cikito

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Fertilizers derived from agricultural waste, such as biochar (BC) and wood distillate (WD), offer promising solutions in sustainable agriculture, with the potential to enhance fruit quality while promoting circular economy practices. However, their effects on the postharvest traits of tomato fruits remain poorly understood. This study examines the combined impact of BC and WD on the shelf-life of *Solanum lycopersicum* L., cv. Cikito, grown in a greenhouse under soilless conditions. BC was added to a commercial agriperlite substrate at 2% and 4% (v/v). At transplanting, plantlets were root dipped in a WD solution (300 mL/hL). WD was also applied weekly, as a foliar spray (200–250 mL/hL according to the plant developmental stage), and biweekly via fertigation (0.5 kg/1000 m). Fruits from upper trusses were stored in a cold room at 10 °C and evaluated at harvest (T0) and after two shelf-life intervals (T1 and T2) for weight (FW), color, Total Soluble Solids (TSS), juice yield, Antioxidant Activity (ORAC assay), and Total Polyphenol Content (TPC). Statistical analysis revealed significant treatment effects on several quality traits. Fruit weight remained stable in fruits from 2% BC-treated plants, without WD, throughout storage time (on average 13.84 ± 1.36 g). These fruits, also, retained a higher juice yield at T2 compared to the control (123.00 ± 7.91 vs. 102.35 ± 9.68 mL/10 fruits). Notably, TPC increased at both T1 and T2 in fruits from plants treated with 2% and 4% BC, without WD, unlike the trend observed in other treatments. These findings suggest that BC—particularly at 2%—may positively influence the postharvest quality and shelf-life of tomatoes, encouraging further investigation into the physiological mechanisms involved.

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Advanced modified atmosphere packaging strategies for extending shelf life and preserving quality of fresh L*itchi chinensis* Sonn.

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Pericarp browning and postharvest microbial deterioration are major factors that significantly hinder the marketability of fresh litchi fruit (*Litchi chinensis* Sonn. cv Kwai Mai). This study evaluated various modified atmosphere packaging (MAP) combinations, stored at 5 ± 1 °C, using natural and food-safe gas mixtures as an alternative to the conventional sulfur dioxide (SO_2) treatment, which is typically used to preserve fruit color after harvest. The results showed that control fruits began to exhibit early signs of deterioration after six days of storage, with the appearance of lesions and microbial infections, confirmed by the presence of mesophilic bacteria and molds. These issues were not observed in fruits treated with MAP, especially in those exposed to the MAP 3 combination (5% O_2 + 20% CO_2 + 75% N_2), which demonstrated the best performance. By the end of the storage period, control fruits displayed complete pericarp browning, while those treated with MAP 3 maintained their red color, preserved vitamin content, and retained stable levels of soluble solids (SSC), titratable acidity (TA), and desirable sensory attributes. Furthermore, microbiological analysis confirmed the absence of undesirable microorganisms in the MAP-treated samples. In conclusion, the MAP 3 treatment proved to be an effective and safe solution to delay pericarp browning and preserve the organoleptic quality of fresh litchi during cold storage.

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Effects of nano-sized zinc oxide particles on vase life of buttercup cut flowers

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Traditional antimicrobial compounds as well as innovative nanotechnology-based techniques can improve the vase life of cut flowers. The limited longevity occurring in fresh flowers is *inter alia* due to the bacteria spoilage in the vase solution used to preserve the cut flowers. This study aimed to evaluate the effectiveness of vase solutions based on nano-sized zinc oxide (ZnO) particles (Desert Roses) on the postharvest quality of cut flowers of *Ranunculus asiaticus* L. ('Cloud'). The vase solutions were prepared according to the following treatmentsti a) tap water (control); b) 8-hydroxyquinoline sulphate (200 mg L^{-1}) + sucrose (20 g L^{-1}); c) ZnO (25 mg L^{-1}) + sucrose (20 g L^{-1}); d) ZnO (50 mg L^{-1}) + sucrose (20 g L^{-1}); e) ZnO (100 mg L^{-1}) + sucrose (20 g L^{-1}). The evaluation of postharvest performance was based on visual check for symptoms of senescence alteration, loss of stem fresh weight, *in vivo* chlorophyll content, variation in flowers diameter and flower buds opening, inhibition of the development of bacterial colonies in vase solutions and on destructive analyses (chlorophyll, carotenoids, phenols concentration and antioxidant activity). Treatments with 50 mg L^{-1} of ZnO nanoparticles was the most effective in reducing stem bending (1 bent stem compared to 6 in the control). Furthermore, ZnO nanoparticles limited and postponed the loss of petals. The application of both 8-hydroxyquinoline sulphate and ZnO nanoparticles generally reduced the incidence of petal browning compared to the control, but the concentration of ZnO nanoparticles at 50 mg L^{-1} completely avoided the appearance of this senescence symptom. Treatments based on ZnO nanoparticles were also effective in reducing stem browning and leaf yellowing. Thus, ZnO nanoparticles can be considered as effective antimicrobial compounds to prepare alternative preservative solutions to preserve cut flowers during postharvest.

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Post-harvest application of essential oils obtained from agro-industrial by-products as an alternative to conventional strategies for quality improvement and fungal decay control in lemon.

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Post-harvest fungal diseases are a major threat to the quality and storage life of lemons. The most important pathogens that lead to significant economic losses are *Penicillium* digitatum, *Penicillium italicum* and *Geotrichum citri-aurantii*. In recent years, the use of chemical fungicides for the control of these diseases has been increasingly rejected due to their harmful effects on human health and the environment. Among the alternatives to chemical products for decay control, the use of essential oils and plant extracts as possible natural substitutes has aroused great interest in recent years. Thus, the aim of this study was to evaluate the effect of post-harvest application of essential oils obtained from citrus industry by-products on fruit quality and shelf-life, as well as the reduction of decay incidence in lemons. For this purpose, lemons were treated with essential oil obtained from lemon peel and lemon juice at three concentrations (100, 500 and 1000 µL/L) and compared to water-treated control fruit. Oil-treated and control lemons were distributed in lots of 30 fruits per treatment and sampling day and stored at 8 °C and 85% relative humidity for 28 days. Weight loss, respiration rate, firmness, colour, total soluble solids, titratable acidity, total phenolic content and fungal incidence percentage were evaluated weekly. The results showed that lemons treated with essential oil from peel at 500 and 1000 µL/L showed a greater reduction of the percentage of accumulated rot after 28 days of storage without affecting the rest of the lemon quality parameters evaluated.

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Mass modeling of six loquat (*Eriobotrya japonica*) varieties for post-harvest grading based on physical attributes

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Consumers generally prefer fruits with uniform size, weight, and shape. Mass modeling of fruit provides valuable insights for optimizing the design of grading and sizing machines, reducing packaging and transportation costs, and enhancing marketability. Loquat fruits are especially appreciated for their early ripening period, which occurs in spring in temperate climates, when few other fruits are available on the market. However, their commercialization is greatly limited by their short shelf life and poor storability. This study presents a comparative analysis of various models for mass estimation of six local and international loquat varieties cultivated in southern Italy. Approximately 300 loquat fruits were analyzed. For each fruit, both volume and mass were measured. Three dimensions longitudinal diameter (length), major transverse diameter (width), and minor transverse diameter (thickness) were manually recorded and used as parameters for model development. Simple and multiple linear regression analyses, including quadratic and cubic models, were applied to both the complete dataset and individual varieties. Predictive models were developed to estimate fruit mass based on measured or assumed volumes, considering the fruit shape (oblate spheroid or ellipsoid). The best-fitting models were selected based on higher R^2 values (closer to 1) and lower RMSE values. A global volume modeling equation based solely on the minor transverse diameter proved highly effective in predicting loquat fruit volume and achieved the highest R^2 across all six varieties studied. This equation could be useful in the design of fruit packaging equipment and processing lines. The developed models enable the establishment of high-performance systems for mass-size estimation, suitable for integration into machine-vision systems.

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Development of a green active packaging strategy for cherry tomatoes: effects on quality and microbial stability

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The cherry tomato (*Solanum lycopersicum* var. *cerasiforme*), prized for its sweet flavor, firm texture and high commercial value, is a highly perishable fruit and highly susceptible to dehydration, weight loss and microbial contamination, which can affect its sensory qualities and marketability. The present study evaluated the effectiveness of an innovative antimicrobial gel pad developed to extend the shelf life and maintain the overall quality of cherry tomatoes during storage and transport. The gel pad was developed using a biopolymer matrix of gelatin and potato starch, selected for their film-forming and moisture-regulating properties. Linalool was incorporated into the matrix as an antimicrobial agent. This natural compound, known for its antifungal and antibacterial properties, had to be released slowly within the package to inhibit microbial growth, especially in the moist microenvironment created by fruit respiration. Commercially ripe cherry tomatoes were packaged in PLA containers and stored under controlled conditions initially at 12 ± 1 °C for the first 10 days and then at 5 °C until the end of the experimental period. The samples were divided into three groups: a control group (CTR), a group with gel (CP), a gel pad with linalool (CPL). Analyses were performed at 0, 3, 7, 10, 14 and 21 days to evaluate physicochemical parameters, microbiological stability, antioxidant activity and sensory quality. The results showed that the gel pad, especially in the CPL treatment, the physical-chemical parameters were preserved over time and the organoleptic characteristics were not altered by the presence of linalool, which was released slowly over time, dramatically slowing microbial proliferation. So, the combined action of the biopolymer matrix and the active ingredient demonstrates a promising strategy to improve not only the post-harvest management of cherry tomatoes in a sustainable and functional manner but also of any susceptible fruit in storage and preservation.

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Development of a smart sunflower oil-based emulsion gel package to extend the shelf-life and absorb the aromatic compounds of fresh black truffles.

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Fresh truffles are highly valued for their distinctive aromatic profile. However, truffles have a reduced shelf-life, and different technologies have been applied to overcome this limitation. Recently, a novel packaging system based on a gelatine hydrogel has been applied on fresh truffles. This package can extend the shelf life of the truffles by regulating gas exchange and trapping aroma compounds in the gel matrix. The aim of this study was to maximize the truffle aroma absorption by adding sunflower oil into an aqueous gelatine solution to form an emulsion gel, as key black truffle aroma compounds are lipophilic. Black truffles were immersed in the developed emulsion using individual containers and stored at 4 °C for 35 days. Truffles encased in gelatine hydrogel were used as a control. Shelf-life extension of truffles was evaluated through microbiological and sensory analysis. A trained panel assessed the aroma and the physical properties of both the truffles and the gel matrix. During storage, no significant differences were found in microbial growth between truffles stored in the emulsion gel package and those in the hydrogel package. Similarly, no significant differences were observed between the two gelatine matrices in terms of microbial growth. Sensory analysis results indicated that truffles preserved their sensory attributes, with no significant differences between both packages. The presence of sunflower oil did not interfere with the truffle aroma and the intensity of truffle aroma and flavour was higher in the emulsion gel compared to the hydrogel. The shelf-life of fresh truffles stored in the edible gelatine-oil emulsion gel package was extended to 21 days, being limited by firmness loss and gleba degradation after 28 days. This new edible package generates two products high-quality fresh truffles and an emulsion gel with a truffle-enhanced aroma absorption, providing interesting culinary applications.

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Time-course changes in fruit cuticle and cuticular waxes in 'Fuji' apples during on-tree development: A role on post-harvest water loss?

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The plant cuticle evolved as an adaptation against desiccation during plant territorialization. As such, the cuticle is lipidic in nature, its main component being cutin, a polyester matrix composed of fatty acid derivatives covered and embedded with different types of wax compounds. Historically, the main role attributed to fruit cuticles has been linked to its waterproofing properties, but experimental evidence points to additional roles on other important quality traits, including the modulation of mechanical properties and susceptibility to pests, diseases and skin disorders. Profiles of cuticular constituents evolve throughout fruit development and hence need to be examined in detail. In this work, 'Fuji' apples (*Malus* × *domestica* Borkh.) were sampled periodically during on-tree development. Cuticles were isolated enzymatically, and waxes extracted in chloroform prior to chromatographic quantification and identification. A sustained increase in total cuticle loads was observed during fruit development. Weight loss of fruit after each sampling was found to be related to cuticle yields at very immature stages, but virtually independent thereof for fruit displaying loads around 1.7 mg/cm^2 or higher, suggesting that, beyond a given cuticle coverage, transpirational water loss after fruit picking be related to compositional and structural features rather than to total cuticle amounts. Cuticular waxes were therefore extracted from the isolated cuticular membranes. Total wax coverage increased steadily along the sampling period when expressed in quantitative terms. The content of specific wax compound families varied widely along the experimental time, the ratio of acyclic to cyclic wax compounds increasing noticeably during fruit maturation. Fruit were kept at 20 °C during 3 weeks after commercial harvest. Cuticle yields and wax-to cutin ratios were found to be higher than those at harvest, whereas average chain length of acyclic wax compounds was significantly lower. These changes are presented and discussed.

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Energy-saving strategies in postharvest storage without compromising fruit quality

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This abstract presents a compilation of studies conducted at our research institute since 2008, in collaboration with other institutions. Storing apples for up to one year is a well-established practice aimed at ensuring a continuous supply of locally produced fruit to consumers while adapting to market demands and maximizing profits. Temperature control remains the cornerstone of postharvest preservation, with apples typically stored at temperatures between 0 and 3 °C. However, the energy-intensive process of initial cooling and continuous temperature maintenance presents significant financial challenges and contributes to the carbon footprint of horticultural products. While much research has focused on how low temperatures can go without causing chilling injuries, the current global context calls for a shift in perspective. The new question is: How high can storage temperatures be raised without compromising fruit quality preservation? This study investigates the potential of advanced storage technologies, such as the application of 1-methylcyclopropene (1-MCP), ultra-low oxygen (ULO), dynamically controlled atmospheres (DCA), and DCA with dynamic temperature control (DCA-Plus), to enable elevated storage temperatures, thereby reducing energy consumption for cooling without impairing fruit quality. In addition, results from large-scale experiments are presented to demonstrate how optimized ventilation programming can achieve energy savings while preventing the risk of detrimental temperature and atmospheric stratification. The integration of advanced monitoring and control systems, along with data analysis and energy management strategies, is also discussed as a means of optimizing apple storage. These approaches can be implemented in conventional storage facilities without requiring costly structural modifications. The potential benefits of elevated storage temperatures in alleviating oxidative stress in stored fruit and thereby reducing the occurrence of physiological disorders are also discussed. Finally, the use of innovative wireless sensors to monitor storage conditions and gain insights into fruit behavior and stress responses during storage is highlighted as a valuable tool for improving postharvest management.

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Maturity-related differences in cuticular wax profiles: A comparative study of two grapevine (*Vitis vinifera* L.) cultivars

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Surface properties of plant organs impact their susceptibility to pests and diseases. Profiles of chemical constituents thereof evolve throughout organ development, which may be a factor underlying differential susceptibility across phenological stages as it may affect oviposition preferences of female insects. Grapevine (*Vitis vinifera* L.) is a major crop in many European countries, and its main insect pest is the moth *Lobesia botrana* (Denis & Schiffermüller). A better understanding of insect-plant interactions is a fundamental aspect of pest management. This work presents preliminary information regarding the identity of key compounds from the host plant potentially underlying differential susceptibility to *L. botrana* oviposition. Grapes (cv. 'Macabeu' and 'Cabernet sauvignon', differing in susceptibility to infestation by *L. botrana*) were obtained from commercial vineyards located in NE Spain at three stages (pea size -BBCH 75-, *veraison* -BBCH 83-85- and ripening -BBCH 89-). Cuticles were isolated enzymatically from skin disks, and waxes extracted in chloroform prior to chromatographic quantification and identification. Cuticle yields decreased significantly along fruit maturation in both 'Macabeu' (from 1.72 to 0.55 mg cm^{-2} in pea size and ripe fruit, respectively) and 'Cabernet sauvignon' (from 3.01 to 0.64 mg cm^{-2}, correspondingly) samples. Even so, and for both cultivars, the percentages of total waxes over total cuticle were roughly two-fold higher in ripe than in pea-sized fruit. Although cuticle yields were consistently lower in 'Macabeu' than in 'Cabernet sauvignon' fruit, the relative contents of cuticular waxes were around 1.4-fold higher in 'Macabeu' than in 'Cabernet sauvignon' samples (22.2 and 15.4 % in ripe fruit, respectively). Wax compound profiles were characterised along fruit maturation. Quantitative and qualitative differences were observed between both cultivars, which will be presented and discussed.

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Effects of different thinning strategies on growth dynamics and fruit quality of 'Peluche' loquat (E*riobotrya japonica)*

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Under favorable conditions, loquat plants produce many fruits that often do not reach adequate commercial quality. Thinning is a cultivation practice that reduces the number of fruits on the tree, modifying the source–sink relationship and improving the quality of the remaining fruits. This study compared different types of thinning on the 'Peluche' cultivar, evaluating their effects on growth dynamics and fruit quality. The following treatments were analyzed: FL (flower thinning), FR (fruit thinning), F+F (flower and fruit thinning), and CTR (control). After the fruit set, fruit size was measured, and the relative growth rate (RGR) was calculated. Additionally, growing degree days (GDDs) were estimated and totaled 1965, which proved sufficient to obtain high-quality fruit. The fruits from the FL treatment reached larger final sizes than those from FR and CTR, with a maximum growth rate 38% higher than FR and 47% higher than CTR. The FL treatment also showed the highest average fruit weight and soluble solids content, while presenting the lowest organic acid content. Flower thinning proved the most effective in improving quality, as it reduces competition between fruits from the outset, unlike fruit thinning which intervenes later, when competition is already active.

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Sustainable polyphenol recovery from avocado peel waste and their application on walnut antioxidant packaging

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The peel and seed of the avocado fruit constitute more than 15% of the fruit weight, which leads to the generation of large amount of waste by guacamole or avocado oil processing industries. Avocado peel contains a considerable amount of polyphenols, carotenoids, and tocopherols that can be extracted and used for the development of active food packaging, supporting the principles of a circular economy. In the current study, polyphenol rich extract of avocado peel was obtained through maceration process fixing 50 °C for 2 h and different hydroethanolic solvents, and its active properties were thoroughly evaluated. Then, the avocado peel extract was incorporated into hydroxypropyl methylcellulose (HPMC) coatings, which were then applied to poly (lactic acid) (PLA) films. Antioxidant and optical properties of films were assessed, as well as its barrier properties. Finally, the developed films were applied to packaging chunks of walnuts that are highly perishable due to oxidation processes. The extracts with ethanol: water mixture showed the highest antioxidant properties, which were successfully incorporated into a polymeric matrix (HPMC) to create a PLA coating. PLA films containing HPMC enriched with polyphenols improved the UV light and oxygen barrier as well as its antioxidant activity. Walnut packaging assay revealed a decrease in peroxide levels when the active films were used. Additionally, sensory analysis showed a lower rancidity in nuts stored in active films, highlighting their potential for active food preservation. In conclusion, avocado peel extract is a valuable source of active molecules for the design of antioxidant films for walnut preservation.

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Synchronization between exocarp color development and mesocarp softening in Hass avocado is governed by harvest maturity

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Fruit mesocarp firmness and exocarp color are important parameters that determine Hass avocado ripening and consumer acceptability. After harvest, the fruit firmness changes from values as high as 140 N to 4-14 N, and the exocarp color changes from green to black. However, an emerging physiological problem is the desynchronization of these indicators, which creates confusion for consumers. This study investigated the relationship between harvest maturity and this desynchronization by metabolomic, transcriptomic and hormonal differences among avocado fruits harvested at different harvest stages according to dry matter (DM) content: early (18-23% DM), middle (>23-27% DM), and late (>27-30% DM). Phenotyping including hedonic and CIELAB scales indicate that early harvested fruit develop olive green color versus late harvested fruit that develop expected black color, also at harvest it is possible to observe differences in CIELAB parameters between fruit from different harvest dates. The metabolic and hormonal measurements revealed distinct profiles between early and late harvest samples highlighting the abundance of mannoheptulose, derivatives of quercetin 3-glucoside and epicatechin, xylitol, arabitol, GA, JA, ABA, iP and IAA as potential biomarkers for the avocado color-softening desynchronization at harvest stage. While transcriptomic analysis reveals a significant higher expression of genes related to photosynthesis and the phenylpropanoid and flavonoid biosynthesis pathways in early harvested samples suggesting that early harvested samples are still undergoing active growth and development, in contrast to later harvested samples which seem to be more prepared for harvesting. Finally, the integration of omics data revealed that the phenylpropanoid pathway, exhibiting overexpression in early harvest samples, is primarily channeled towards the biosynthesis of lignin, quercetins, and epicatechins. Conversely, the anthocyanin biosynthesis pathway demonstrates repression when compared to late harvest samples. These findings, coupled with the observed color variations at harvest, indicate that the color transition in late-harvested fruits has already initiated by the time of harvesting, thereby promoting color synchronization.

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Effects of extreme low-oxygen conditions on volatile compound production in 'Pink lady' apples

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Storage in dynamic controlled atmosphere is one of the most applied method to reduce postharvest loss, but a reliable method to monitor fruit metabolism over stressed gas condition is still a challenge. This study investigated the effects of extreme low-oxygen conditions on the volatile compound profile and physicochemical characteristics of 'Pink Lady' apples. A total of 400 apples were stored at 1 °C under four controlled atmosphere conditions: (ANOX) anoxia (100% N_2), (0.5%) 0.5% O_2 + 99.5% N2, (1%) 1% O_2 + 99% N2, and (AIR) air as control. After 10 days of storage, key quality parameters were evaluated, including respiration rate, firmness, total soluble solids (TSS), titratable acidity (TA), color and volatile compounds profile. Volatile profiles were assessed using solid-phase microextraction (SPME) followed by gas chromatography–mass spectrometry (GC-MS). A Hierarchical Cluster Analysis (HCA), combined with heatmap visualization, was used to explore similarities among treatments based on their volatile signatures. This approach enabled the visualization of relationships among samples based on their volatile profiles, aiding in the identification of treatment-specific effects. Additionally, Partial Least Squares Discriminant Analysis (PLS-DA) was performed to classify samples according to treatment and to identify the most influential volatile compounds differentiating the four treatments. Preliminary results indicated that specific volatiles particularly ethyl acetate, 1-butanol, 1-butanol-2-methyl, and several short-chain esters such as ethyl butanoate and ethyl propanoate were significantly affected by low-oxygen storage conditions, demonstrating to be strong potential biomarkers for differentiating aroma profiles across varying oxygen levels. The findings underscore the pivotal role of oxygen availability in regulating volatile biosynthesis and highlight the importance of precise oxygen control in dynamic controlled atmosphere (DCA) storage systems to extend shelf life while maintaining the sensory quality of the fruit.

Keywords: low oxygen, controlled atmosphere, postharvest storage, volatile compounds, 'Pink Lady' apple, dynamic storage

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Impact of irrigation with very high salinity water on mango fruit quality in a Mediterranean environment

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The cultivation of mango (*Mangifera indica* L.) is increasingly spreading across the Mediterranean basin, but it faces significant challenges, including the use of low-quality water during the irrigation season. This condition, often caused by seawater intrusion into the groundwater during dry periods, leads to the accumulation of salt in the soil and, over time, to toxic conditions for the plant, especially due to the high concentration of chlorides. The aim of the study was to evaluate the impact of irrigation with very high salinity water on the yield and some quality parameters of mango fruit. The study was carried out on mango plants of the cultivar Keitt grafted on Gomera-3 during an irrigation season. Two irrigation treatments were compared, one with very high salinity water (4 mS/cm) (SL) and the other with desalinated water (NSL). Fruit of the SL treatment showed an average weight of 750 g and a total soluble solids content of 15 °Brix, while those of the NSL treatment averaged 600 g and 11 °Brix. Overall, the SL treatment performed significantly better, aligning more closely with the quality standards required by the European market. Preliminary data showed promising results yet further data are needed it in order to assess the long-term effect on fruit and soil quality.

Keywords: Low-quality irrigation water; Fruit quality; Preharvest Management; Salinity

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Bioactive coatings with pomegranate leaf extract for strawberry preservation

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Strawberries are highly perishable fruits with a short postharvest shelf life due to their high-water content, soft texture, and susceptibility to microbial decay. Edible coatings have emerged as a promising strategy to extend the shelf life of fresh produce by providing a protective barrier that helps preserve quality and reduce spoilage, as they form, after drying, a semi-permeable film that regulates gas exchange and controls water loss from the fruit. In this context, agricultural byproducts such as pomegranate (Punica granatum L.) leaves offer a sustainable source of bioactive compounds with potential antioxidant and preservative properties. This study aimed to develop edible coatings enriched with aqueous extracts from pomegranate leaves and evaluate their effects on the quality of strawberries during storage. Extracts were obtained under different conditions of concentration, temperature, and extraction time. The optimal extract (1:50 w/v, 50 °C, 25 min) showed strong antioxidant activity (FRAP: 7085 ± 72.0 µM $FeSO_4$/g; ABTS: 4921 ± 149.0 µM Trolox/g), although it lacked antimicrobial effects against S. aureus, E. coli, and S. Typhimurium. The extract was incorporated into gelatin- and starch-based edible coating matrices and applied to fresh strawberries. Over nine days of refrigerated storage, coated strawberries exhibited reduced weight loss, stabilized pH, and delayed senescence compared to uncoated controls (3 days). The gelatin-based coating was particularly effective, reducing fruit mass loss by 21.69% and inhibiting visible fungal growth. These findings demonstrate the potential of pomegranate leaf extract as a functional and eco-friendly ingredient for bioactive edible coatings. By repurposing a commonly discarded part of the plant, this approach not only improves fruit shelf life and quality but also contributes to waste valorization and sustainable food packaging solutions.

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Determination of the quality of blood oranges using NIR spectroscopy

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In recent years, Spanish consumers have increasingly appreciated blood oranges due to their pleasant flavour and attractive red colour, both externally and internally. However, it has been observed that in some varieties such as Sanguinelli orange growth in south-eastern Spain, the external colour does not correspond to the internal colour. Fruits with a slightly reddish exterior can have an intense red internal colour, as well as a high sugar content, indicating an appropriate state of ripeness and high quality, and vice versa. In this study it has been shown that NIR spectroscopy in the 950–1700 nm range can be used to create various PLS-R models to predict TSS, with an R 2 of 0.577. This study demonstrates that NIR spectroscopy is a promising tool for quality assessment.

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Brassinosteroids preharvest treatments as a useful tool to increase crop yield and quality traits in blood orange fruit

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Blood oranges are very appreciated by consumers due to its attractive peel and juice red colour and their antioxidant and health benefit properties. However, increase in temperatures due to climatic change compromises anthocyanin biosynthesis depreciating their market value. Brassinosteroids (BRs) are plant hormones with important effects in plant adaptation to environmental stresses. The present experiment aimed to evaluate the effects of tree foliar treatments with different 24-epibrassinolide (24-BL) concentrations (0.01, 0.1, and 1 µM) on crop yield and fruit quality properties of 'Sanguinelli' blood orange at harvest and during storage, with special emphasis on anthocyanin content in peel and juice. Results of two-year experiments (2021-2022 and 2022-2023, carried out in Alicante, Spain) showed that 24-BL treatments improved total crop yield. Fruit quality properties, such as firmness, total soluble solids and titratable acidity were also enhanced as well as red colour in flavedo and juice, due to enhanced total and individual anthocyanin concentrations. The greatest improvements were recorded at 0.1 µM 24-BL treatment, in which the enhanced peel colour led to a 41% increase in yield of commercial fruit with respect to control trees which would have important beneficial impact on growers' profit. In addition, the consumer acceptance would increase by 24-BL, since red colour is the most important parameter valued by consumers in blood orange, as well as their health beneficial effects by enhancing total anthocyanins and phenolics.

Keywords: *Citrus sinensis*, 24-epibrasinolide, anthocyanin, commercial quality, elicitation, phenolics, soluble solids, acidity

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Preliminary evaluation of pomegranate peel extracts for the control of *Rhizopus* rot of stone fruits

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Rhizopus or soft rot caused by *Rhizopus stolonifer* is one of the most important postharvest diseases of stone fruits, potentially causing nests of decay and significant economic losses. Natural plant extracts such as those from pomegranate (*Punica granatum* L.) fruit peels can exert antifungal activity, mainly due to their high polyphenol content. Fruit peels and membranes can be obtained in large amounts as by-products of the pomegranate processing industry. The objective of this work was to preliminarily assess the ability of two 'Mollar de Elche' pomegranate peel extracts (PPE), a methanolic PPE and an aqueous PPE, to control soft rot on 'Big Bang' and 'Carmina' nectarines and 'Angeleno' plums. For this, each fruit was artificially inoculated once in a peel wound with a spore suspension of R. stolonifer and, 2 h later (assessment of curative activity), 30 µL of PPE were applied in the same wound with a micropipette. After 7 days of incubation at 20 ºC, the application of methanolic PPE (30 g/L) reduced the incidence of Rhizopus rot (number of infected wounds) by 58, 28, and 63% and the Rhizopus rot severity index (RRSI, scale 0-4 where 0 = 0%, 1 = 1-25%, 2 = 26-50%, 3 = 51-75%, and 4 = 76-100% of decayed fruit surface) by 82, 56, and 57%, compared to the control treatment (30 µL of water), on the cultivars 'Big Bang', 'Carmina', and 'Angeleno', respectively. Aqueous PPE (30 g/L) was less effective, with disease incidence reductions of 21, 31, and 24% and RRSI reductions of 61, 53, and 24%, respectively. In conclusion, 'Mollar de Elche' PPEs could be promising sustainable postharvest treatments to be included within non-polluting integrated disease management (NPIDM) strategies for the control of soft rot of stone fruits. Furthermore, the valorization of pomegranate by-products can greatly contribute to circular bioeconomy as well to the EU Green Deal and the UN Sustainable Development Goals.

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Ripening and postharvest physiology of "Dulcis" fruit, a new green-fleshed variety of *Actinidia chinensis*

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'Dulcis' is a newly developed Actinidia chinensis cultivar with green flesh, bred to offer a more aromatic alternative to traditional green kiwifruit. As a novel genotype, its postharvest performance remains largely unexplored, and understanding the physiological changes during ripening is essential to preserve key quality traits (e.g. texture, color and flavor) throughout storage and commercialization. The advancement of high-throughput omics technologies has enabled system-level approaches to complement traditional postharvest research by uncovering molecular and metabolic mechanisms underlying fruit quality. After harvest, 'Dulcis' kiwifruit were treated with 1-methylcyclopropene (1-MCP) or ethylene and maintained at room temperature to monitor ripening physiology. Untreated and 1-MCP-treated fruits were also stored at 0.5 °C (95% RH) for 4 months and collected monthly. Technological parameter analysis was flanked by metabolomic, volatilomic, proteomic, and transcriptomic analyses to characterize alterations associated with ripening and cold storage. The identification of key molecular and metabolic changes may provide insights into the regulation of quality traits development, and tolerance to chilling injuries (e.g. SBD, Storage Breakdown Disorder). Preliminary results showed that 'Dulcis' kiwifruit is characterized by a broad flavor profile, dominated by a blend of esters, aldehydes, ketones and terpenes. Treatment with 1-MCP effectively delays ripening but also reduces aroma volatiles synthesis, resulting in a milder flavor but extended shelf life. The inhibition of ethylene perception effectively delayed the degradation of aldehydes (hexanal, (E)-2-hexenal) and ketones (penten-3-one, octen-3-one) during both shelf-life and refrigerated storage. 1-MCP strongly slows down ester biosynthesis (e.g. ethyl butanoate and ethyl benzoate) but it does not affect terpenes, which give to the fruit aromatic and fruity notes. Polyphenols biosynthesis (e.g. catechin and chlorogenic acid) appears to be strongly dependent on ethylene action, making these compounds potential markers for 'Dulcis' ripening. Proteomic analysis confirms that 1-MCP downregulate ripening-related proteins, supporting the preservation of firmness and overall quality during storage.

Keywords: Ethylene, Ripening Physiology, Cold Storage, Omics

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Postharvest microbial control and quality retention in ready-to-eat mangoes through ionizing radiation

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Ready-to-eat fruits such as fresh-cut mangoes (*Mangifera indica* L.) are highly perishable products subjected to minimal processing, which makes them particularly susceptible to accelerated microbial growth, enzymatic degradation, and rapid sensory deterioration during storage. In this study, the efficacy of ionizing radiation, delivered through an ion generator (Ionny, Fruit Control, MI, Italy) was evaluated as a non-thermal strategy to reduce microbial contamination and preserve quality parameters during a 14-day storage period at 4±1°C. Results clearly demonstrated a significant reduction in microbial development in ionized samples compared to controls, as shown by the consistently lower decay index and the absence of visible lesions throughout storage. This effect is attributable to the ability of ionizing radiation to inactivate pathogens by damaging microbial DNA through the action of free radicals. Moreover, ionized fruits retained better firmness, lower browning index, and more stable levels of soluble solids and titratable acidity, suggesting a delay in senescence and ripening processes. Importantly, despite invasive processing operations, ionization effectively maintained the nutritional, visual, and structural integrity of mango cubes, preserving their freshness and consumer appeal. This work supports ionizing radiation as a safe, sustainable, and chemical-free alternative for surface decontamination and microbial control in minimally processed fruit, with the added benefit of reducing post-harvest losses and extending shelf-life without compromising quality.

Keywords: Ionizing radiation; Microbial inhibition; Fresh-cut mango; Ready-to-eat fruits; Postharvest quality; Non-thermal processing; Food safety

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Pectin-based packaging functionalized with pecan nutshell extracts as promising technology to improve the quality of fresh-cut apples during storage

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As a consequence of the negative impact in the environment due to the excessive use of fossil-based materials for food packaging, the exploitation of bio-based and biodegradable polymers is constantly increasing. Recently, biopolymers as polysaccharides, emerged as a potential source for the development of new ecofriendly food packaging materials. Among these materials, only a few studies have demonstrated the potential of pectin in food packaging formulations. Furthermore, natural extracts have been investigated in the packaging industry for their biological activities, including antioxidant, antimicrobial, antifungal, and antiproliferative effects. In particular, pecan nutshell extracts have attracted attention due to their promising antioxidant properties. In this research, neat pectin film (PF) and pectin film doped with pecan extract (PPF), were successfully obtained by casting solution. The characterization of the films showed that incorporation of pecan nutshell could enhance the bioactivity of the pectin-based films due to its high antioxidant capacity. Fresh-cut apples (cv Golden) were packaged in PF, PFF and polyethylene bags (as control), and stored for 7 days at 5 °C. Apples stored in PF and PFF films showed a significantly increase in the antioxidant activity, which was respectively 5 or 6 fold higher than the control (approximatively 62 mg Trolox/100 g fresh weight). Additionally, apples slices packaged in PF or PFF films appeared brighter compared to the control. In conclusion, packaging fresh-cut apples in pectin films enriched with pecan extract represents a promising, and valid approach to improve the quality of stored fresh-cut apples in a sustainable way.

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